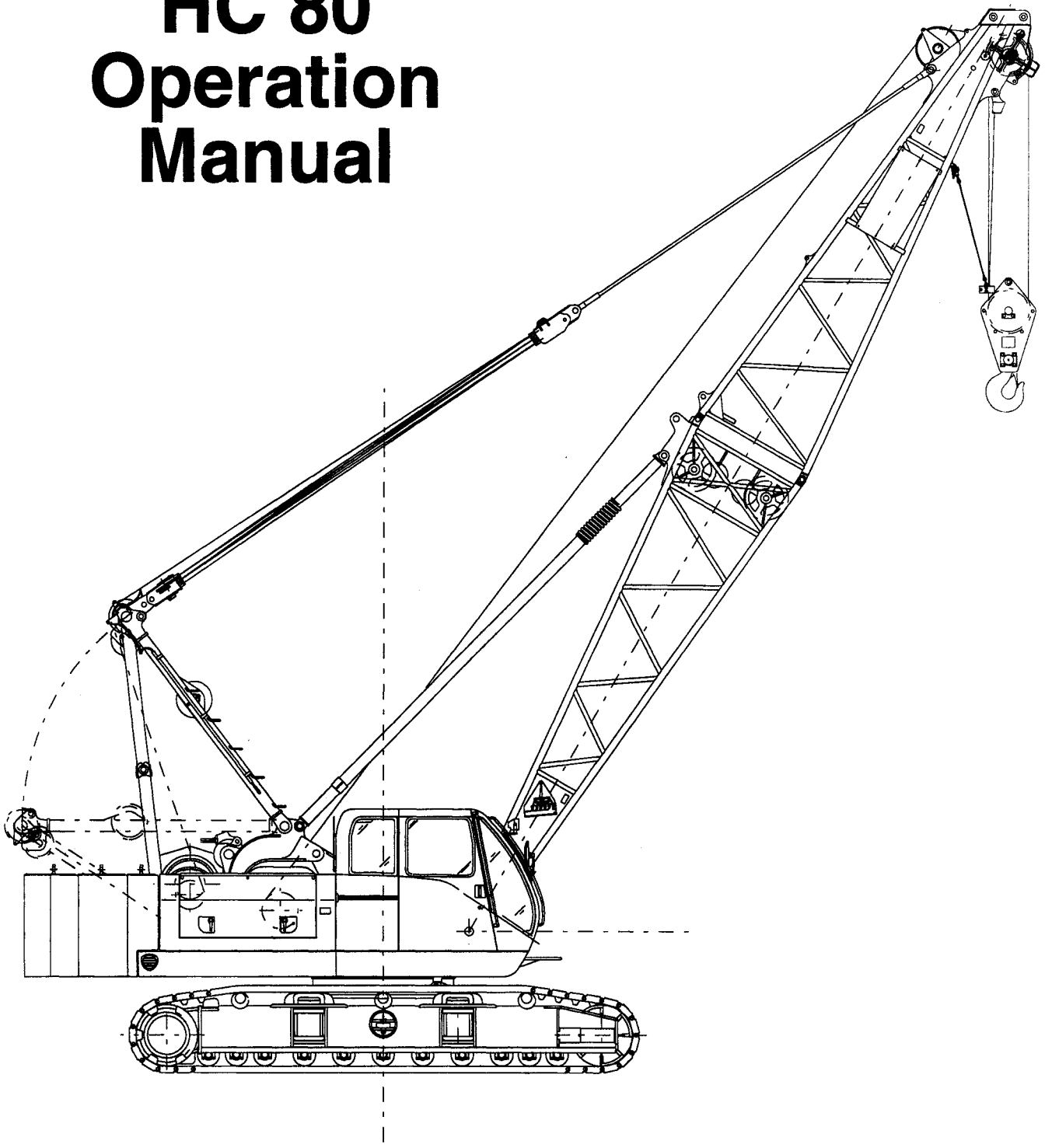
TEREX | AMERICAN

HC 80 Operation Manual



American Crane Corporation
Wilmington, North Carolina

AMERICAN CRANE WARNINGS

American Crane has developed Accident Prevention Signs and Labels that are used throughout the Crane and Operator Manual. It is very important that the user understands these warnings, as they alert the user to potential hazards which can result in personal injury or death.

SIGNAL WORDS

Signal words such as **DANGER, WARNING** and **CAUTION** are used to identify levels of hazard seriousness.

WARNING COLOR

The Warning or Hazard Alert colors (red, orange and yellow) function as a visual code to reinforce the meaning of the Signal Word. They also serve as a strong color accent which at a glance alerts the user to the severity of the hazard at hand.

RED

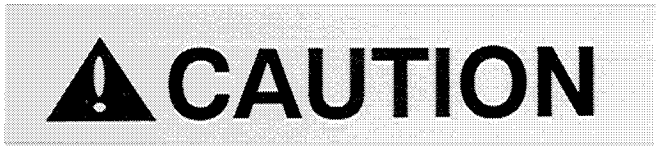
DANGER - Immediate hazards which WILL result in severe personal injury or death.

This will appear in some warnings which use the signal word "DANGER", indicating the highest degree of risk. When red is used in the signal word panel, white letters are used for the word "DANGER". If a safety alert symbol is used along with the signal word such as an exclamation mark inside of a triangle, the triangle will be solid white and the exclamation mark will be red.

ORANGE

WARNING - Hazards or unsafe practices which COULD result in severe personal injury or death.

This will appear in some warnings which use the signal word "WARNING". When orange is used in the signal word panel, black letters are used for the word "WARNING". If a safety alert symbol is used along with the signal word, such as an exclamation mark inside of a triangle, the triangle will be solid black and the exclamation mark will be orange.



YELLOW

CAUTION - Hazards or unsafe practices which COULD result in minor personal injury or product or property damage.

This will appear in some warnings which use the signal word "CAUTION". When yellow is used in the signal word panel, black letters are used for the word "CAUTION". If a safety alert symbol is used along with the signal word, such as an exclamation mark inside of a triangle, the triangle will be solid black and the exclamation mark will be yellow.

Our Products Safety Signs comply with ANSI Z535.4

AVOID SERIOUS BODILY INJURY OR PROPERTY DAMAGE. DO NOT ATTEMPT TO START OR OPERATE THIS MACHINE WITHOUT THOROUGHLY READING AND UNDERSTANDING THE INSTRUCTIONS PROVIDED IN THIS OPERATOR'S MANUAL.

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PREFACE

This Operating and Maintenance Manual is designed to familiarize owners and operators with the many advantages built into AMERICAN equipment in order to maximize performance. Maintenance and repair sections are provided with procedures which are periodically necessary to keep your equipment in top operating condition.

This manual is intended for use by persons skilled in operation and maintenance of crawler cranes. American Crane Corporation is not responsible for qualifying these personnel.

We have also provided lubrication and inspection checklists which recommend intervals and procedures necessary to help insure that your equipment receives the basic care required for continued operation. Our recommendations are based on the highest standards in the industry and reflect many years of experience. Use these checklists to establish your own program of adjustments, maintenance and lubrication.

Regular inspections will often detect potential problems before failures occur and save on untimely delays.

⚠ WARNING

ANY MODIFICATION TO THIS CRANE NOT APPROVED BY THE FACTORY IS PROHIBITED. THIS INCLUDES THE USE OF REPLACEMENT PARTS, ACCESSORIES OR COMPONENTS NOT AUTHORIZED BY THE FACTORY.

For proven dependability and performance,

USE ONLY GENUINE AMERICAN® PARTS

When ordering parts for your equipment, always refer to the serial number of the machine. This is located on a plate on the front of the machine under the operator's cab window.

For all engine information, please refer to the manufacturers' manuals found in the parts books provided with the original crane order. These manuals are not provided in the reordered parts books.

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INTRODUCTION

Owners, Users, and Operators:

Terex Cranes appreciates your choice of our machine for your application. Our number one priority is user safety, which is best achieved by our joint efforts. We feel that you make a major contribution to safety if you as the equipment users and operators:

1. **Comply** with OSHA, Federal, State, and Local Regulations.

2. **Read, Understand, and Follow** the instructions in this and other manuals supplied with this machine.

3. **Use Good, Safe Work Practices** in a common sense way.

4. **Only have trained operators** – directed by informed and knowledgeable supervision – running the machine.

NOTE: OSHA prohibits the alteration or modification of this crane without written manufacturers approval. Use only factory approved parts to service or repair this unit.

If there is anything in this manual that is not clear or which you believe should be added, please send your comments to Manager of Publication, Terex Cranes, P.O. Box 260002 / Highway 501 East, Conway, South Carolina 29526; or contact us by telephone at (843) 349-6900.

Thank you!

THIS SYMBOL MEANS YOUR SAFETY IS INVOLVED! READ, UNDERSTAND, AND FOLLOW ALL DANGER, WARNING, AND CAUTION DECALS ON YOUR MACHINE.

INTRODUCTION

Many aspects of crane operation, inspection and testing are discussed in standards published by the American National Standards Institute. These Standards are updated on an annual basis with addendas, which are sent by ASME to the original purchasers of the standard. Terex recommends that you purchase and refer to the following standards.

ANSI/ASME B30.5 - Mobile & Locomotive Crane (Latest Version)

These standards can be purchased from:

American Society of Mechanical Engineers
United Engineering Center
345 East 47th Street
New York, NY 10017

SYMBOLS

The symbols below are used to inform the operator of important information concerning the operation of this unit.

DANGER – Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING – Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION – Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

ATTENTION – Indicates a situation which, if not avoided, may result in property or equipment damage.

SAFETY

WARNING

These are general safety rules, which must be followed. You are also required to read and understand the Operators Manual as there are instructions, which are more detailed specific to this machine.

HANDLING PERSONNEL

1. Cranes can only be used to lift people when it is the least hazardous way to do the job. (See OSHA 1926.550g, and ASME / ANSI B30.23.)

TRAINING AND KNOWLEDGE

1. Safety must always be the operators most important concern.
2. Do not operate this crane until you have been trained in its operation. This crane must only be operated by trained personnel, who have demonstrated their ability to do so safely.
3. Comply with the requirements of current Occupational Safety and Health Administration (OSHA) standards, the current American National Standards Institute (ANSI) B30.5 latest edition.
4. Read and Understand all Decals and Warnings.
5. Read and Understand the Rating Chart.
6. Know that the crane can safely lift each load before attempting to lift.

7. Operator must understand crane signals and take signals only from designated signal people; except the operator must obey the stop signal from anyone.

OPERATOR'S RESPONSIBILITIES

1. Read and understand the Operator's Manual.

2. Make sure the machine is in proper order and that all operational aids and warning signals are functional before operating.

3. Keep the machine clean, including all instrumentation, windows, lights and other glazed surfaces.

4. Remove all oil, grease, mud, ice and snow from walking surfaces.

5. Store tools and other necessary items in the tool box.

6. Never lift a load without a Rating Chart Manual in the cab.

7. Know the load to be lifted.

8. Be alert, physically fit and free from the influences of alcohol, drugs or medications that might affect the operators eyesight, hearing, or reactions.

9. Keep people, equipment and material out of the work area.

10. Signal person must be used when the operators vision is blocked or working in hazardous areas such as power lines or people.

11. Keep a fully charged fire extinguisher and first aid kit in the cab at all times, and be familiar with how to use these items.

12. Know about movements of other machinery, trucks and personnel at the jobsite.

13. Never permit people on the machine platform while the machine is working.

14. Make sure everyone is in a safe place before moving the hook, boom, load or outriggers.

15. Start and stop movements smoothly and swing at speeds that will keep the load under control.

16. Keep at least two full wraps of wire rope on drum when operating.

17. Feet must be kept on the pedals while foot pedal brake locks are in use.

18. Use tag lines to keep loads under control.

19. Keep load close to ground.

20. Use shortest boom possible.

21. Never leave a running machine unattended or load suspended.

22. Always use outriggers in accordance with requirements of Load Rating Chart and operators manuals.

⚠ SIGNAL PERSON'S RESPONSIBILITY

1. Standard crane signals must be used, and understood.

2. Assist the operator in safe and efficient operation, without endangering people or property.

3. Have a clear understanding of the work to be done.

4. Signal people must place themselves where they can be clearly seen and where they can safely observe the entire operation.

⚠ RESPONSIBILITIES OF ALL CREW MEMBERS

1. Unsafe conditions or practices must be corrected.
2. Obey all warning signs.
3. Watch out for your safety and the safety of others.
4. Know and understand proper machine erection and rigging procedures.
5. Alert operator and signal person of dangers, such as power lines, unstable ground etc.

⚠ MANAGEMENT RESPONSIBILITY

1. Operator must be competent, physically fit and if required licensed.
2. Operator, signal people and riggers must be trained in correct crane operation and use.
3. Operator and Signal people must know standard crane signals.
4. Have a supervisor at job site to be responsible for job safety.
5. Crew members given specific safety responsibilities and instructed to report any unsafe conditions to supervisor.
6. Supply the weight on the load to be lifted to the operator.
7. Verify that all crew members are familiar with OSHA, ANSI B30.5 requirements as well as instructions in manuals.

⚠ PLANNING THE JOB

1. Have a clear understanding of work to be done.
2. Consider all dangers at jobsite.
3. Know what crew members are needed.
4. Assign responsibilities.
5. Know the weight of load to be lifted.
6. Determine lift radius, boom angle, and the rated lifting capacity of crane.
7. Establish how signal people will communicate with operator.
8. Utilize equipment which will do job safety.
9. Establish how equipment can be safety transported to job site.
10. Determine where gas lines, power lines, or structures are which must be moved.
11. Ensure that surface is strong enough to support machine and load.
12. Determine how load will be rigged.
13. Establish special safety precautions, if necessary.
14. Consider weather conditions.
15. Keep unnecessary people and equipment away from work place.
16. Position machine to use shortest boom and radius possible.

OPERATOR'S SAFETY CHECK

1. Safety related items must be in place.
2. Check machine log book, to see if periodic maintenance and inspections have been performed.
3. Ensure that necessary repairs have been completed.
4. Inspect wire rope for damage (kinks, broken wires etc.)
5. Be sure no unauthorized field modifications have been made.
6. Check for air and hydraulic oil leaks.
7. Check control positions before starting engine.
8. After starting engine, check all gauges and indicators for proper readings.
9. Test all controls.
10. Check brakes and clutches.
11. Check load brakes by lifting a load a few inches off the ground and holding it.

OPERATOR AIDS CHECK

Ensure that the listed items are in place and operational.

1. Boom hoist upper angle limit switch. (Lattice Boom).
2. Boom angle indicator.
3. Backup Alarms.
4. Anti-Two Block devices.
5. Overload Protection, Load Indicators, Rated Capacity Limiters.

OPERATION OVERLOAD PREVENTION

1. Know the weight of the load.

2. Load radius will increase when the load is lifted. Reduce radius at start of lift to allow for this.

3. Know the weight of hook, and rigging.

4. Know boom length, jib length, parts of line and operating area.

5. Use next lower rated capacity when working at boom lengths or radius between the figures on the rated lifting capacity chart.

6. Never lift a load without knowing whether it is within the rated capacity.

7. Never operate with anything other than recommended counterweight.

ATTENTION

Unauthorized reduction or additions of counterweight constitute a safety hazard.

8. Do not lift loads if winds create a hazard. Lower the boom if necessary. See the Rating Chart Manual for possible restrictions.

9. Avoid side loading.

10. Never let the load or any other object strike the boom.

11. Release load slowly, be sure boom never tightens against back stops. (Lattice Boom).

12. Place the boom point directly above the load when lifting.

13. Be sure loads are freely suspended.

OPERATION SETUP

1. Be sure the load bearing surface is strong enough to support the machine and load.

2. Be sure cranes are level, check frequently and relevel when necessary.

3. Stay away from rotating cranes, erect barricades to keep people away. Make sure these areas are clear before swinging.

POWER LINE SAFETY

1. Determine whether there are power lines in the area before starting any job. Only operate around power lines in accordance with Federal, State and Local Regulations as well as ANSI B30.5 latest edition.

2. Never remove materials from under powerlines with a crane if the boom or machine is capable of contacting them.

3. No part of crane or load must come in contact with, or violate the minimum allowable clearance required for operation of crane near electrical lines.

4. Should contact occur stay on crane until the boom is cleared or until the current is turned off.

5. If in contact keep all personnel off the crane. If you must leave the crane, JUMP, DO NOT STEP OFF, leave area by jumping with feet together.

6. Use a signal person when working around power lines.

SLIP AND FALL PREVENTION

1. Always wait until machine has stopped before getting on and off equipment. Do not jump on or off.
2. Do not use controls and steering wheel as hand holds.
3. Keep the machine clean and dry.
4. Replace all broken ladders.
5. Keep non-slip surfaces in good condition.

TRAVEL

1. Care must be taken when cranes are driven (traveled) whether on or off the job site.
2. Watch for people, power lines, low or narrow clearance, bridge or road load limits, steep hills or uneven terrain.
3. Position boom in line with the direction of travel.
4. Inflate tires to specified pressure.
5. Travel slowly and avoid sudden stops and starts.
6. It is recommended that the seat belt be used during transit and travel.
7. Make sure travel surface can support weight of machine and load.
8. Always set parking brakes when parking machine.

⚠ WARNING

TO PROPERLY AND SAFELY OPERATE A CRANE, THESE GUIDELINES MUST BE FOLLOWED

1. Do not make any lifts without first becoming totally familiar with all the load lifting restrictions and regulations in the Ratings Section of this book.
2. Never exceed the rated capacity of your machine. Rating charts are found in the operator's cab. Radius in feet is the horizontal distance at ground level from the crane's center of rotation to a vertical line through the center of gravity of the suspended load. If a Load Chart is not located in the Load Chart Holder of your crane, order the proper Load Chart from American Crane Dealer. **Do not** operate without the proper Load Chart.

THERE IS A COMMON MISCONCEPTION THAT RADIUS DISTANCE IS MEASURED FROM THE BOOM FOOT PIN, WHERE THE BOOM INNER IS PINNED TO THE DECK. THIS COULD CAUSE DANGEROUS OVERLOADS NEAR THE LIMIT OF RATED CAPACITY, SINCE DISTANCE WILL BE CALCULATED INCORRECTLY.

3. Never make lifts while the machine is on soft ground. Use mats to level and support the machine properly.
4. Do not lift loads without making recommended safety checks. Wire rope should be replaced immediately if it becomes worn out or damaged.
5. Do not allow a load to swing back and forth or in and out while traveling. This may side load the boom or cause the crane to tip. Use taglines to steady the load.
6. Never drag a load along the ground sideways by swinging.
7. Do not travel over rough ground with the boom high. Do not back up with the boom high without being certain that the ground is firm, level, and free of obstructions.
8. Never get closer that the minimum safe distance from high voltage lines. Refer to page 1-119 for safe distance guidelines for specific voltage levels. Keep well clear when voltage level is not known. Consult the local power company for additional information.
9. Keep the entire machine clean. Quick and easy inspections are possible on a clean machine. Dirt can hide potential failures.
10. Lubricate the machine according to the recommendations in the Lubrication section. This is a prime contributor to long equipment life. Remember that using the right lubricant for the job is equally as important as following the recommended application intervals.
11. For optimum service life of hydraulic systems, it is especially critical that only approved pre-filtered hydraulic oil be used. Select only accepted oils for each application and ambient temperature conditions, according to the Hydraulic section of this manual.
12. To minimize the possibility of inadvertent damage to the machine, do not make any adjustments without proper tools and instructions.

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IMPORTANT WARNINGS AND CAUTIONS

⚠ CAUTION

READ AND UNDERSTAND THE OPERATIONS AND MAINTENANCE MANUAL THOROUGHLY BEFORE BEGINNING TO OPERATE THE CRANE. THIS MANUAL IS NOT INTENDED TO TEACH "HOW TO OPERATE" A CRANE. THIS MANUAL POINTS OUT SPECIFIC FEATURES OF THIS CRANE, ALONG WITH MAINTENANCE AND TROUBLE SHOOTING INFORMATION.

GENERAL NOTE

Proper operation and maintenance are prime factors in the reduction of costly down time. This manual contains suggested procedures for operation, general inspection and safety precautions that should be employed to maintain the machine in proper working order. This manual, however, cannot take into account all the variables the serviceman or operator will encounter in the field. Therefore, a generally applicable rule is offered here:

Approach your machine, and every new working situation, with respect and a SAFETY FIRST attitude.

ATTENTION

ALL INFORMATION, ILLUSTRATIONS, AND SPECIFICATIONS CONTAINED IN THIS MANUAL ARE BASED ON THE LATEST PRODUCT INFORMATION AVAILABLE AT THE TIME OF PUBLICATIONS APPROVAL.

RIGHTS TO ALTER AND SUBSTITUTE SPECIFICATIONS AND METHODS AT ANY TIME ARE RESERVED.

LIABILITY FOR ANY PERSONAL INJURY OR PROPERTY DAMAGE OCCASIONED BY THE USE OF THIS MANUAL IN EFFECTING MAINTENANCE, OPERATION, OR REPAIR OF YOUR AMERICAN UNIT IS IN NO WAY ASSUMED BY AMERICAN CRANE CORPORATION.

ACCORDINGLY, ANYONE USING A PROCEDURE NOT RECOMMENDED BY AMERICAN CRANE SHOULD FIRST COMPLETELY SATISFY HIMSELF THAT HIS PERSONAL SAFETY AND THE MACHINE'S INTEGRITY WILL NOT BE JEOPARDIZED BY THE METHOD SELECTED.

⚠ WARNING

AMERICAN CRANES ARE HEAVY DUTY UNITS DESIGNED FOR MATERIAL HANDLING, AND GENERAL HOISTING SERVICE. THEY ARE NOT DESIGNED FOR HOISTING PERSONNEL AND DO NOT MEET THE SAFETY REQUIREMENTS FOR PERSONNEL HOISTS.

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ACCIDENT PREVENTION SIGNS

GENERAL INFORMATION

Accident prevention signs are found in several locations on American cranes. They are color and format coded to convey 5 different types of messages. The first two of these five designs will be found on every American product that has been issued with accident prevention signs. The latter 3 types may or may not be found on a given machine, depending upon the safety requirements for that product. If any sign is lost or damaged, a replacement may be ordered from the Parts Book supplied with your machine. The correct mounting location for each sign can be found on a separate drawing in the Parts Book which is included for reference, so that the crane owner may be assured that all required safety information is properly posted at all times.

Accident prevention signs on your machine should be read, understood, and complied with.

I. Signs marked **"DANGER"** are posted to warn anyone in the vicinity of the machine of an immediate hazard or peril capable of causing serious injuries or severe equipment damage. This sign may also be used to prohibit any activity or practice which is hazardous. The right half of each sign carries a graphic symbol inside a red circle identifying the type of hazard or prohibiting a specific activity. The sign shown in Figure 1, for example, warns of the danger present during assembly or disassembly of boom sections. A falling boom can cause serious injury to anyone standing on, in, or under a boom section. Booms can fall when pins are removed, if not properly supported by blocking, or if boom suspension ropes are not relocated as described in the operator's manual.

COLORS:

RED

WHITE

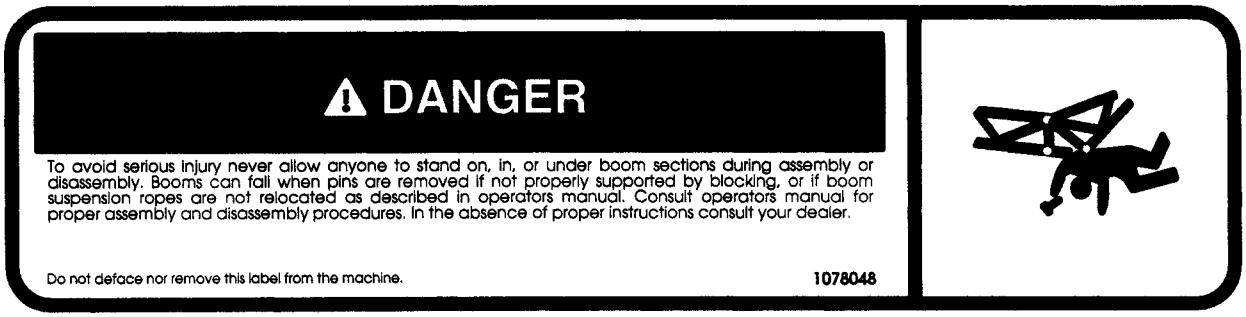

Figure 1

COLORS:

BLACK

ORANGE

II. Signs marked **"WARNING"** are used to call attention to hazards or unsafe practices which could result in severe personal injury or death.

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ACCIDENT PREVENTION SIGNS
(Continued)

COLORS:

BLACK

YELLOW

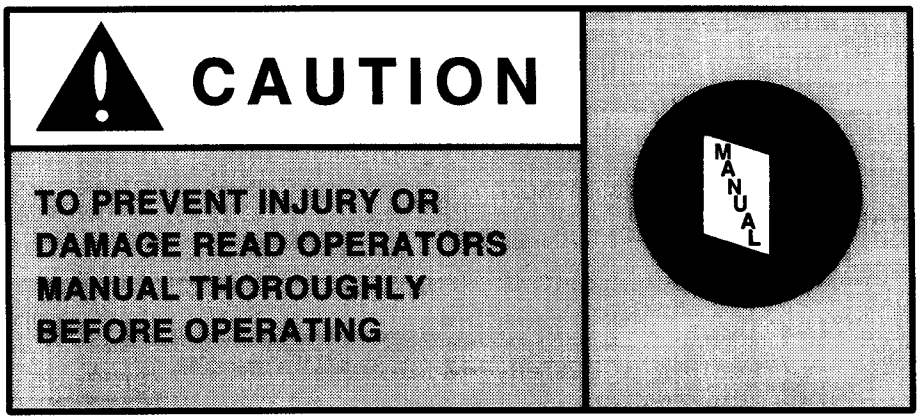

Figure 2

III. Signs marked **"CAUTION"** are used to call attention to specific potential dangers or hazards which could cause serious but not irreversible damage or injury. This sign may also be used to warn against practices or hazards in a more broadly general way, where no immediate danger is apparent, as in Figure 2 which recommends reading the manual before operating the crane.

IV.-VI. Three other types if signs may also be used: green and white **"GENERAL SAFETY"** signs (IV) (indicating rules relating to health, first aid, housekeeping, or general safety precautions), red and white **"FIRE"** or **"EMERGENCY"** signs (V) (indicating fire hose or fire extinguisher location, or access information), and blue and white **"NOTICE"** signs (VI) (relating to location of equipment or information helpful to operation).

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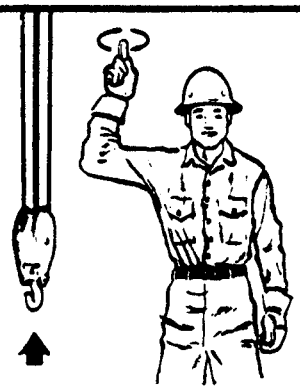
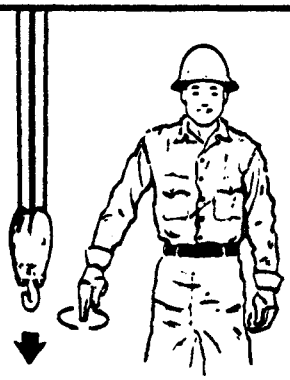
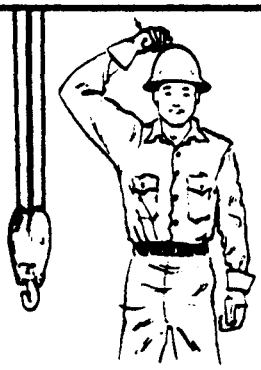
HAND SIGNALS



HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circle.

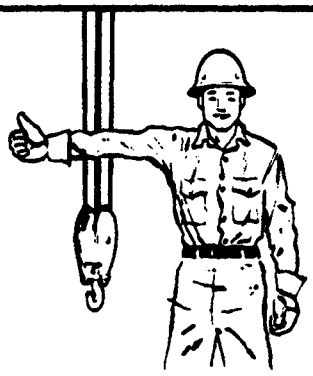


LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circles.

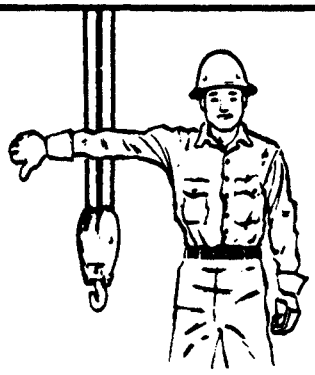


USE MAIN HOIST. Tap fist on head; then use regular signals.

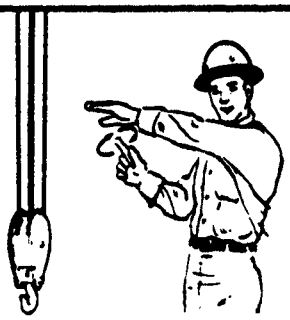
USE WHIPLINE (Auxiliary Hoist). Tap elbow with one hand; then use regular signals.



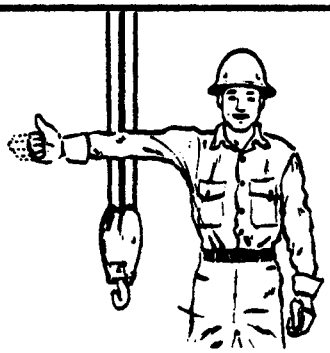
RAISE BOOM. Arm extended, fingers closed, thumb pointing upward.



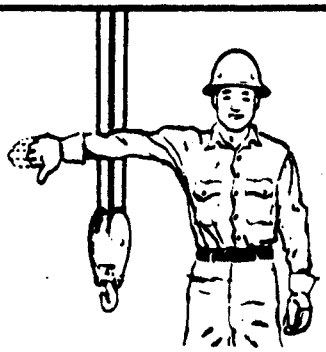
LOWER BOOM. Arm extended, fingers closed, thumb pointing downward



MOVE SLOWLY. Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist slowly shown as example.)



RAISE THE BOOM AND LOWER THE LOAD. With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.



LOWER THE BOOM AND RAISE THE LOAD. With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.

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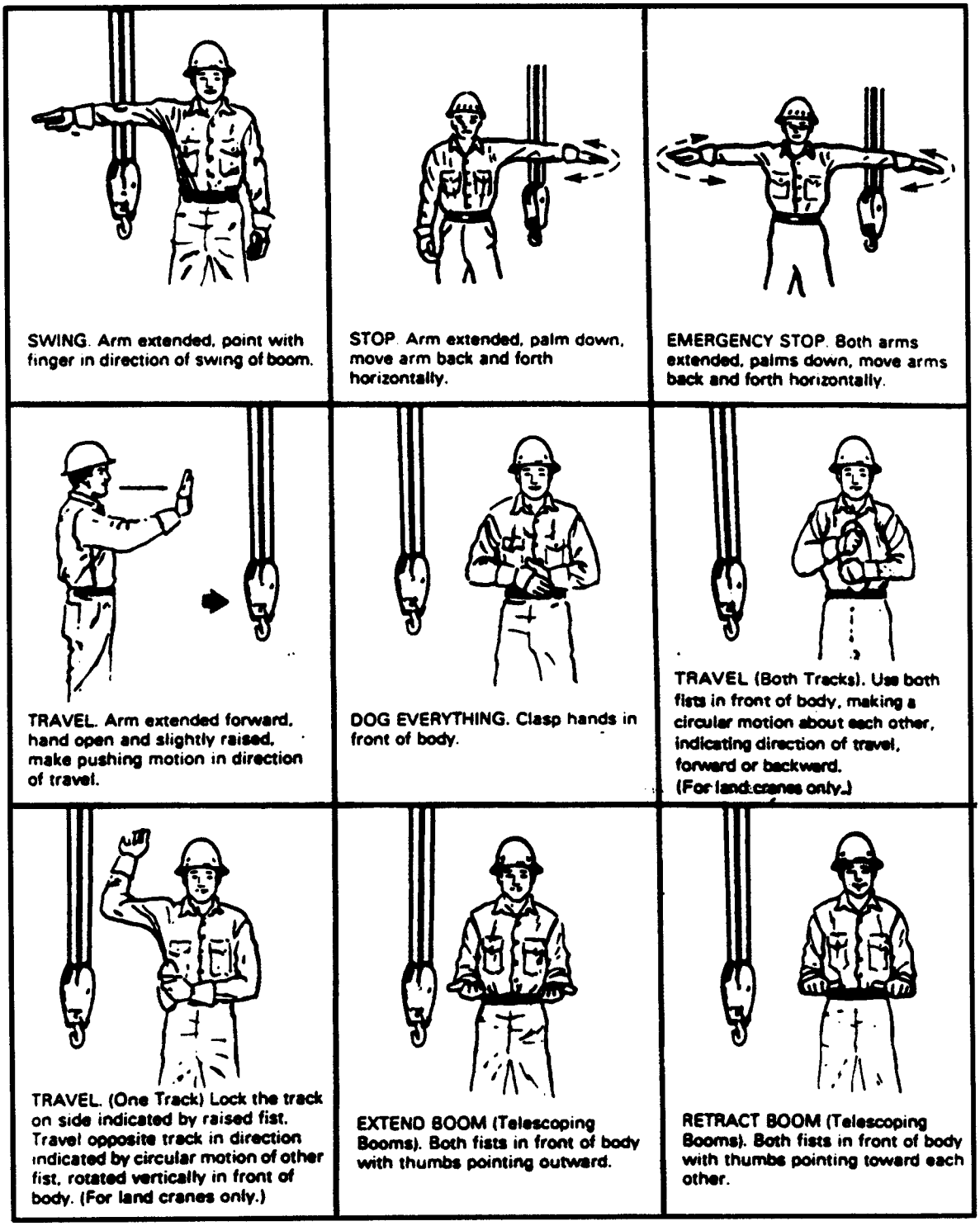

SWING. Arm extended, point with finger in direction of swing of boom.

STOP. Arm extended, palm down, move arm back and forth horizontally.

EMERGENCY STOP. Both arms extended, palms down, move arms back and forth horizontally.

TRAVEL. Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.

DOG EVERYTHING. Clasp hands in front of body.

TRAVEL (Both Tracks). Use both fists in front of body, making a circular motion about each other, indicating direction of travel, forward or backward. (For land cranes only.)

TRAVEL. (One Track) Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body. (For land cranes only.)

EXTEND BOOM (Telescoping Booms). Both fists in front of body with thumbs pointing outward.

RETRACT BOOM (Telescoping Booms). Both fists in front of body with thumbs pointing toward each other.

Extracted from American National Standard. Safety Code for Crawler, Locomotive and Truck Cranes. B30.5-1968 with the permission of the publisher. The American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017.

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IMPORTANT SAFETY, RATING CHART AND WARRANTY INFORMATION

⚠ WARNING

TO ALL USERS OF AMERICAN CRANE CORPORATION CRANES

AMERICAN CRANE CORPORATION has been made aware of attempts to duplicate and or repair certain types of American Crane booms. These booms may not be built or repaired to the rigid standards which control the manufacturing and repair of American Crane booms. These proprietary standards were developed from years of manufacturing experience in high strength boom fabrication and testing. They are far more stringent than any general manufacturing standards in use today. Extensive fixturing and inspection techniques are required to develop the full potential of American Crane boom designs. Further, to fully comply with the requirements of ANSI/ASME B30.5, American Crane booms have undergone extensive electronic strain gauge testing to verify the design and manufacturing procedures utilized in their production. Without the proper manufacturing controls even adequate materials cannot produce booms which will meet specified strength margins. For these reasons, American Crane Corporation must emphasize the following:

⚠ WARNING

THE USE OF ANY BOOM SECTIONS OTHER THAN THOSE SUPPLIED BY AMERICAN CRANE CORPORATION MAY CAUSE CATASTROPHIC FAILURE RESULTING IN PROPERTY DAMAGE, INJURY AND DEATH.

⚠ WARNING

THE USE OF ANY BOOM SECTIONS OTHER THAN THOSE SUPPLIED BY AMERICAN CRANE CORPORATION INVALIDATES THE CRANE'S RATING CHARTS.

⚠ WARNING

THE USE OF ANY BOOM SECTIONS OTHER THAN THOSE SUPPLIED BY AMERICAN CRANE CORPORATION MAY AFFECT ANY WARRANTIES ASSOCIATED WITH THE CRANE.

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IMPORTANT LOAD LIFTING RESTRICTIONS AND REGULATIONS

Crawlers and Truck Cranes

⚠ WARNING

**Study the following carefully.
Failure to observe any of the following limitations may result in serious structural or mechanical failure or accidents.**

Ratings have been established by American Crane on the basis of sound engineering methods and testing procedures. The machine complies with applicable U. S. Industry standards for stability and material strength factors. These standards require operation within rated capacities and in accordance with good operating practice, including the limitations shown on these pages and Page 100.

DO NOT EXCEED THE RATING OF THE MACHINE. Lifting loads greater than those shown on the rating chart or operation at positions not shown CAN CAUSE STRUCTURAL FAILURE, TIPPING OR COLLAPSE OF THE BOOM OR CRANE.

1. All ratings apply only to machines as originally manufactured and equipped but include machines on which repairs or replacements have been made in accordance with original specifications. American Crane shall have no responsibility for machines or components on which replacements have been made with parts or spares not manufactured by American Crane, or on which any unauthorized changes have been made, or which are operated after damage which has not been repaired. The safe handling of loads with a crane depends on ground conditions, boom length and radius. These factors as well as many others must be taken into consideration by the operator.

2. Ratings are based on the machine standing level on a firm, uniformly supporting surface. Level should be within 1/2% of true level and the supporting surface must be sufficiently firm to maintain this level under load. If the operating surface is not level, the crane should be removed and the foundation leveled before making a lift. If the operating surface is not sufficiently firm and stable, crane mats should be used to reduce soil loadings. If operation is necessary under adverse conditions, contact American Crane for further information before attempting operation.

3. For operation of land-based cranes (truck, crawler or wagon mounted) from a barge or other floating platform the above listed level requirements must be maintained throughout the lift cycle. In addition, other factors such as securing the crane to the platform must be considered by the user. Contact American Crane for further information.

4. Under certain conditions cranes can be overturned without a load. This can be prevented by observing the rating chart and avoiding boom positions which show no load ratings.

5. The rating charts apply up to maximum wind speeds as indicated in the table below. This table lists the maximum wind velocity for which ratings apply. These wind speeds refer to steady winds or gusts where the maximum wind speeds reached are the magnitudes stated. Velocities must be measured at a point equivalent to the highest boom or jib elevation and should be taken at some location in close proximity to the crane. **No account is taken of the wind force on the load.** This effect, which is substantial for loads with large surface areas, must be considered by the user and ratings reduced accordingly. For more information contact American Crane.

(Continued)

WIND SPEED LIMITATIONS

Boom Size	Boom or Boom Plus Jib	Operation	No operation. Lower boom to 50-60 degrees. Position rear of crane into wind.	Lower or secure boom
37"	0-140' (0-42.3m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
37"	Over 140' (0-42.3m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
46"-47"	0-170' (0-51.8m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
46"-47"	Over 170' (51.8m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
1K 1400	0-170' (0-51.8m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
1K 1400	Over 170' (51.8m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
58"-59"	0-220' (0-67.1m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
58"-59"	Over 220' (67.1m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
77"	0-290' (0-88.4m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
77"	Over 290' (88.4m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
92"-94"-118"	0-360' (0-109.8m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
92"-94"-118"	Over 360' (109.8m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
130"	0-400' (0-122m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
130'	Over 400' (122m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)

6. Crawler sideframes and truck or wagon crane outriggers must be fully extended and set to maximum width to obtain ratings listed for such on the chart. When operating in the "FREE" condition without outriggers on a truck or wagon crane, the boom must never be operated at radii for which no ratings are shown in the "Outriggers Free-Over The Side" area of the chart. Tires must be in good condition and properly inflated for operation. For truck cranes equipped with a front outrigger jack, the ratings designated "Outriggers Set-Over Side" can be used for 360 degree rotation.

7. Do not lift over the front of a truck crane either with or without outriggers. See diagrams on next page for definition of working areas with various types of cranes. If such a lift is unavoidable, consult American Crane for special instructions and suitably reduced ratings.

8. NEVER SIDELOAD THE BOOM. Such sideloading can cause structural failure or collapse. Always keep the boom point directly over the load to avoid sideloading. Operating the crane while out of level or in high winds as well as dragging a load sideways by swinging or pulling on a load while it is partially or fully attached to a structure are all causes of sideloading and must be avoided.

9. The A-Frame must be in the fully raised position for lifting all rated loads. (Sky Horse operation is an exception). Do not operate with the A-Frame in any intermediate (partially raised) position.

10. Check brakes, clutches, and rigging daily and before any heavy lifts. Brakes and clutches must be dry, well adjusted and free from oil. Do not lift load or bucket after the machine has been standing during damp weather without first riding the brakes to evaporate moisture. All wire rope should be checked for wear and stranding and should be replaced if it is defective.

11. Disengage the master clutch before leaving the machine.

12. Never lift or release a load when the boom is solid against the boom stops.

13. Do not leave the operator's seat with the bucket or load suspended. Cooling of the brakes and brake drum may release the brake bands allowing the load to fall. Avoid traveling with a suspended load. When such travel is necessary, keep the load from swinging. Keep feet on the brake pedals while propelling the machine. Jarring of the load may cause the brakes to slip. When the machine is equipped with spring-set, air-released auxiliary brake chambers, the control valve should be placed in the "Brake Set" position so the brakes are engaged by the springs when holding the load or traveling. Reduced ratings must be used when traveling on grades to compensate for changes in stability, load radius, and sideloading of the boom. When traveling uphill, lower the boom to prevent it from falling backward.

14. Lowering against the torque converter (whereby the load runs the machinery backwards) should only be used for inching down loads. Place the sprag clutch flipper valve in the "Sprag Out, Dog In" position and disconnect the tailshaft governor cable at the torque converter on machines so equipped. Excessive lowering speed must be controlled by increasing engine RPM. In extreme cases, it is possible to stall the engine and cause the load to free fall. Keep a foot on the hoist brake pedal and be prepared to apply the brake quickly and smoothly. Be sure to reconnect tailshaft governor cable for duty cycle operation.

15. Detailed instructions for operating and maintenance are given elsewhere in this manual. Read and study the operating instructions carefully.

16. Cranes can self-erect all boom or boom-jib combinations shown on the rating chart unless specifically stated otherwise. During erection the A-Frame must be fully raised and all load-carrying devices must be on the ground. On truck cranes the outriggers must be fully extended and set and the boom erected over the rear of the carrier to achieve maximum capability. On a crawler crane the boom must be erected directly over the idler end of the crawler sideframes with the idler tumblers securely blocked to achieve maximum capability. When erecting over the side of a crawler the sideframes must be fully extended.

17. When two cranes are making a lift together, both cranes must be level. The rigging must be designed so that each crane is lifting a share of the load which is well within its rating. The swing brakes of both machines must be released so that the boom points are free to remain directly over their load attachment points at all times. This can be a dangerous procedure and should be attempted only after substantial planning.

18. PERSONNEL LIFTING

⚠ WARNING

THIS MACHINE IS NOT INTENDED TO BE USED AS A PERSONNEL HOIST! IF SUCH USE IS ALLOWED BY LOCAL, STATE OR FEDERAL REGULATIONS, THE OWNER OR USER IS RESPONSIBLE FOR COMPLYING WITH SUCH REGULATIONS AND ANY OTHER APPLICABLE REQUIREMENTS.

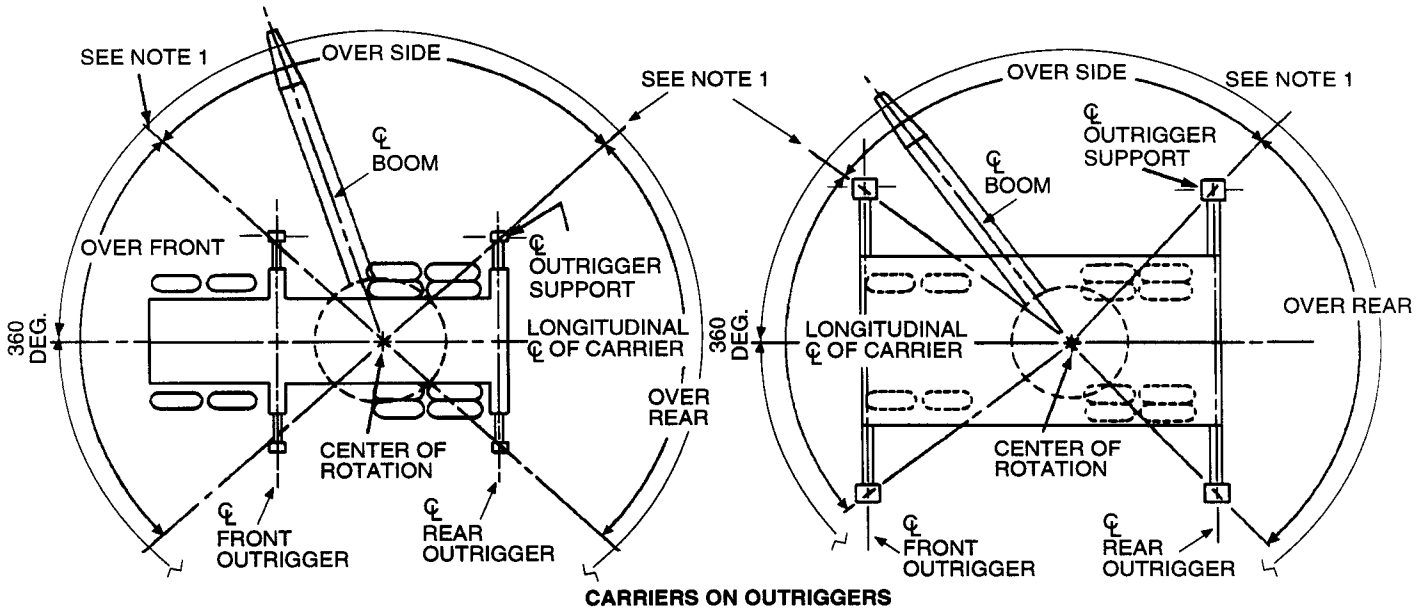
TO THE BEST OF OUR KNOWLEDGE, THIS WOULD REQUIRE THE CRANE TO BE EQUIPPED AS FOLLOWS TO MEET THE CURRENT ANSI/ASME B30.5-1982 OR LATEST REVISION.

1. **OVERHOISTING DEVICE TO PREVENT THE LOAD BLOCK/OVERHAUL BALL FROM HITTING THE BOOM POINT.**
2. **SINGLE LEVER CONTROL TO PREVENT ANY POSSIBILITY OF FREEFALL.**
3. **CONTROLLED LOAD LOWERING ON THE HOIST BEING UTILIZED TO LOWER THE MAN BASKET.**
4. **PERSONNEL SHALL NOT BE PERMITTED TO RIDE THE BARE HOOK OR LOAD SUSPENDED FROM THE HOOK.**

IMPORTANT: THE TOTAL WEIGHT OF THE LIFTED LOAD (INCLUDING PERSONNEL) SHALL NOT EXCEED 50% OF THE CRANE RATING WITH MACHINE EQUIPPED AS ABOVE; IT IS THE RESPONSIBILITY OF USER OF THIS CRANE TO ASSURE THAT THE FOOTING UNDER ALL THE OUTRIGGERS/CRAWLERS IS ADEQUATE TO SUPPORT THE CRANE AS ANY POSSIBILITY OF FREEFALLING THE LOAD HAS BEEN ELIMINATED.

19. BE SAFE. For any clarification or answers to additional questions contact American Crane before attempting operation.

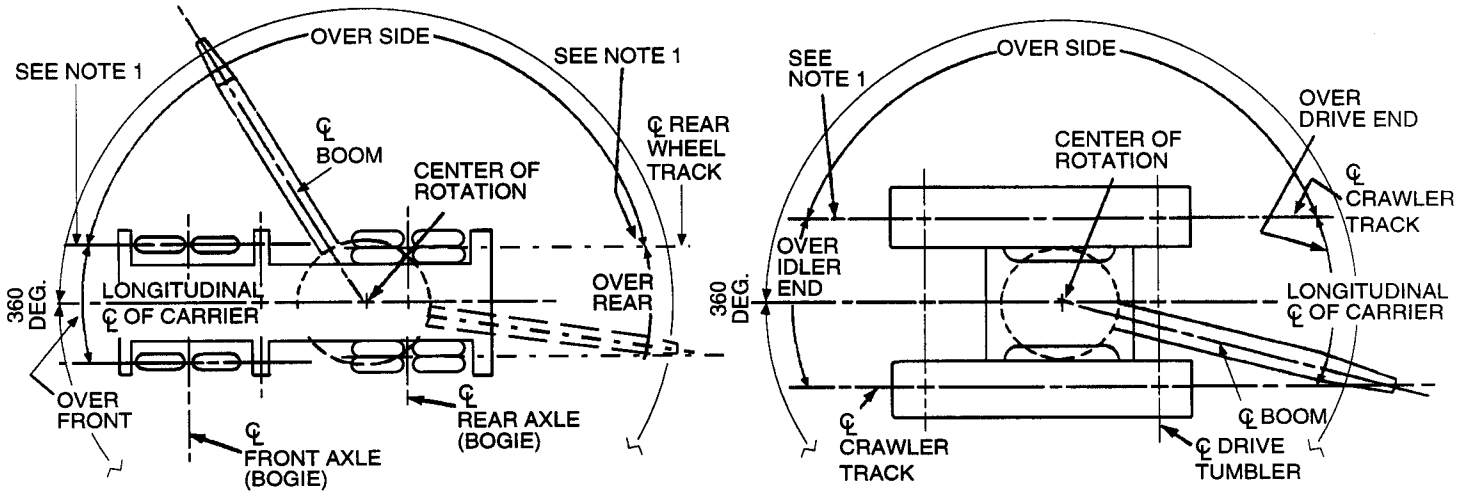
(Continued)



CARRIERS ON OUTRIGGERS

FRONT OUTRIGGER BEHIND FRONT WHEELS

FRONT OUTRIGGER AHEAD OF FRONT WHEELS



CARRIER ON TIRES

CRAWLER TYPE LOWER

WORKING AREA DEFINITIONS

NOTE 1

These lines determine the limiting position of any load for operation within working areas indicated.

CALCULATING TOTAL LOAD WEIGHT

Crane's Lifted Load on Main Fall Includes:

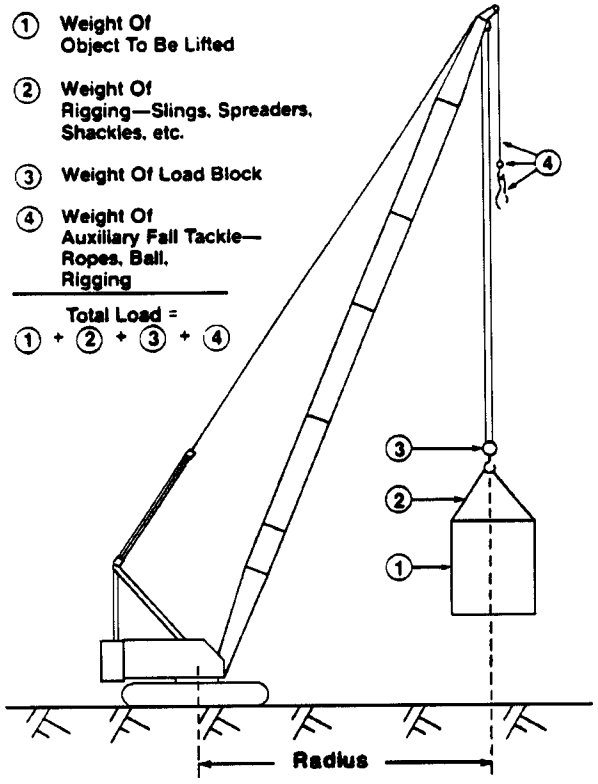
① Weight Of Object To Be Lifted

② Weight Of Rigging—Slings, Spreaders, Shackles, etc.

③ Weight Of Load Block

④ Weight Of Auxiliary Fall Tackle—Ropes, Ball, Rigging

Total Load = ① + ② + ③ + ④



Crane's Lifted Load on Main Fall Must Also Include Jib and Jib Tackle:

① Weight Of Object To Be Lifted

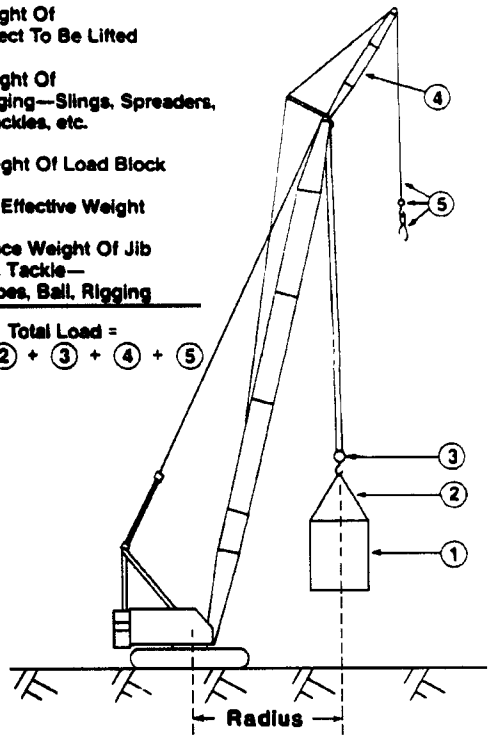
② Weight Of Rigging—Slings, Spreaders, Shackles, etc.

③ Weight Of Load Block

④ Jib Effective Weight

⑤ Twice Weight Of Jib Fall Tackle—Ropes, Ball, Rigging

Total Load = ① + ② + ③ + ④ + ⑤



Crane's Lifted Load on Jib Fall Includes:

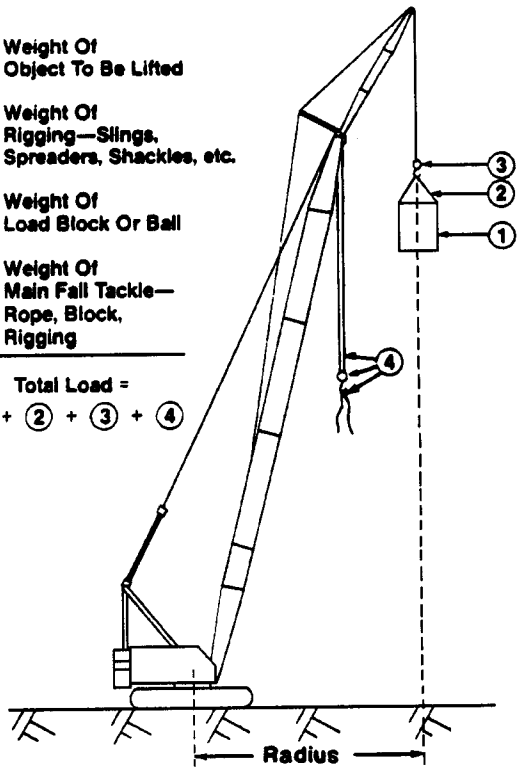
① Weight Of Object To Be Lifted

② Weight Of Rigging—Slings, Spreaders, Shackles, etc.

③ Weight Of Load Block Or Ball

④ Weight Of Main Fall Tackle—Rope, Block, Rigging

Total Load = ① + ② + ③ + ④



NOTE: The weight of the minimum parts of line required to lift the rated load has already been considered in this chart. It need not be added to the load. This applies only to the load fall being used. If additional parts of line are reeved beyond the minimum required to handle a rated load, or if a second fall is in place but not used, the weight of these ropes should be added to the weight lifted. Refer to the Crane Rating Chart and the Rope Weight Table on the back of this page for rope weight reference data.

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ROPE WEIGHT PER GIVEN LENGTH

Use the data in the table below when the total weight of the load being lifted is calculated according to one of the Total Load Formulas in Appendix "A", on the front side of this page.

For IPS, EIPS, or EEIPS Wire Ropes. For other ropes, consult specific chart or the rope manufacturer's own reference data or user's manual.

ROPE DIAMETER		WEIGHT OF ONE FOOT (OR ONE METER) OF ROPE	
IN MILLIMETERS	IN INCHES	LBS./FT.	Kg/M
12.7	1/2	.46	.68
15.9	5/8	.72	1.07
19.1	3/4	1.04	1.55
22.2	7/8	1.42	2.11
25.4	1	1.85	2.75
28.6	1-1/8	2.34	3.48
31.8	1-1/4	2.89	4.30
34.9	1-3/8	3.50	5.21
38.1	1-1/2	4.16	6.19
41.3	1-5/8	4.88	7.26
44.5	1-3/4	5.67	8.44
47.6	1-7/8	6.50	9.67
50.8	2	7.39	11.00
54.0	2-1/8	8.35	12.42
57.2	2-1/4	9.36	13.93
63.5	2-1/2	11.60	17.26
69.9	2-3/4	14.00	20.83

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Service Bulletin Number	Date
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Design Application	**Market Application**
All	All

Service Bulletin

Fuels for Cummins Engines

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Introduction

This bulletin covers information about Fuels for Cummins Engines. The purpose of this bulletin is to help the user understand proper fuel selection, and problems associated with fuel.

Diesel Fuel

Diesel fuel performs three major functions in a Cummins® diesel engine.

1. It supplies all the energy for the engine.
2. It cools and lubricates the precision parts of the engine's fuel pump and injectors.
3. It enables emissions controlled engines to meet regulated emissions levels.

Premium Diesel Fuel

Cummins® diesel engines will run on a great variety of fuels, but some fuels will give better performance, higher efficiency, improved reliability, or lower maintenance costs than others. Fuel **must** be selected based on overall operating costs, **not** just on the purchase price. Cummins Inc. recommends the use of premium fuels meeting the requirements of Category 1 through 4 as outlined in the Worldwide Fuel Charter (**www.engine-manufacturers.org/about/guidelines.cfm**). Operators **must** select fuels from these categories to optimize performance and emissions.

Category 1:

Markets with no or minimal requirements for emission controls.

Category 2:

Markets with stringent requirements for emission controls that requires the use of low sulfur fuel, for example, vehicles meeting United States and European on-highway standards. The maximum is 0.05 percent sulfur.

Category 3:

Markets with advanced requirements for emission controls that require ultra low sulfur fuel (less than 50 ppm) for after-treatment devices.

Category 4:

Markets with further advanced requirements for emission control to enable sophisticated NOx and PM after-treatment technologies. This normally requires no detectable sulfur in fuel.

Category 4:

Markets with further advanced requirements for emission control to enable sophisticated NOx and PM after-treatment technologies. This normally requires no detectable sulfur in fuel.

Required Diesel Fuel Specifications

This section presents the Cummins Inc. required fuel specifications.

Fuels meeting national and international specifications can be used if they observe the specifications listed in Table 1: Required Diesel Fuel Specifications. Cummins® engines will operate satisfactorily on fuels meeting all the properties listed in Table 1; however, fuels meeting **only** the required specifications will **not** give the same level of performance, efficiency, reliability or maintenance costs as premium fuels.

Table 1: Required Diesel Fuel Specifications	
Viscosity	1.3 to 5.8 centistokes (1.3 to 5.8 mm per second) at 40° C [104° F]
Cetane Number	42 minimum above 0° C [32° F]; 45 minimum below 0° C [32° F]
Sulfur Content	**Not** to exceed 0.5 mass-percent [1]
Active Sulfur	Copper Strip Corrosion **not** to exceed Number 2 rating after 3 hours at 50° C [122° F]
Water Sediment	**Not** to exceed 0.05 volume-percent
Carbon Residue	**Not** to exceed 0.35 mass-percent on 10 volume-percent residuum
Density	0.816 to 0.876 grams per cubic centimeter (g/cc) at 15° C [60° F]
Cloud Point	6° C [10° F] below lowest ambient temperature at which the fuel is expected to operate
Ash	**Not** to exceed 0.02 mass-percent (0.05 mass-percent with lubricating oil blending)
Distillation	The distillation curve **must** be smooth and continuous
Lubricity SLBOCLE, or HFRR	3100 grams or greater SLBOCLE, or 0.45 mm maximum: Wear Scar Diameter (WSD) at 60° C [140° F] HFRR

1. Regional, national, or international regulations can require a lower sulfur content than 0.5 percent. Consult all applicable regulations before selecting a fuel for a given engine application. Fuel with sulfur higher than 0.5 percent is **not** allowed without Cummins Inc. prior approval. Fuel system corrosion, heightened emissions, and reduced oil drain intervals are just some of the possible adverse effects of fuels with very high sulfur. Fuel **must** observe proper flash point requirements to satisfy local safety regulations.

Diesel Fuel Properties

- Viscosity
  - General Description - Proper viscosity provides adequate pumping and lubricating characteristics to fuel system components.
  - Test Method - ASTM D445, ISO 3104

- Cetane Number
  - General Description - Cetane number is a measure of the starting and warm-up characteristics of a fuel. In cold weather or in service with prolonged low loads, a higher cetane number is desirable.
  - Test Method - ASTM D613, ISO 5165
  - Fuel with a cetane number greater than 55 can cause increased torque peak smoke. Reference ASTM D613, ISO 5165.

- Sulfur Content
  - General Description - Diesel fuels contain varying amounts of various sulfur compounds. Fuel sulfur contributes to acid formation and exhaust particulates. Reduced sulfur is required to meet particulate emissions and to avoid poisoning after-treatment devices. Higher sulfur fuel also needs higher total base number (TBN) lubricants to compensate for acid corrosion.

    NOTE: Catalyst failures caused by the use of fuels with higher than recommended sulfur levels are not warrantable. High sulfur fuel will also shorten the life of certain components in the exhaust system, including the oxidation catalyst.

  - Test Method - ASTM D2622, ISO 4260

- Active Sulfur
  - General Description - Some sulfur compounds in fuel are actively corrosive.
  - Test Method - ASTM D130, ISO 2160

- Water and Sediment

    - General Description - The amount of water and solid debris in the fuel is generally classified as water and sediment. It is good practice to filter fuel while it is being put into the fuel tank. More water vapor condenses in partially filled tanks due to tank breathing caused by temperature changes. Filter elements, fuel screens in the fuel pump, and fuel inlet connections on injectors **must** be cleaned or replaced whenever they become dirty. These screens and filters, in performing their intended function, become clogged when using a poor or dirty fuel and will need to be changed more often.
    - Test Method - ASTM DI796

- Carbon Residue
    - General Description - The tendency of a diesel fuel to form carbon deposits in an engine can be estimated by determining the Ramsbottom or Conradson carbon residue of the fuel after 90 percent of the fuel has been evaporated.
    - Test Method - ASTM D524, ASTM D189, ISO 10370

- Density
    - General Description - Density is an indication of the energy content of the fuel. Higher density indicates more thermal energy and better fuel economy.
    - Test Method - ASTM D287, D4052, ISO 3675

- Cloud Point
    - General Description - The cloud point of the fuel is the temperature at which crystals of paraffin wax first appear. Crystals can be detected by the cloudiness of the fuel.
    - Test Method - ASTM D97, ISO 3015

- Cold Filter Plugging Point
    - General Description - The cold filter plugging point of the fuel is the lowest temperature at which fuel can still flow through a 45 micron wire mesh. This test method can be directly related to a fuel's tendency to plug fuel filters at reduced temperatures due to the formation of paraffin wax crystals.
    - Test Method - ASTM D6371

- Ash
    - General Description - The small amount of noncombustible metallic material found in almost all petroleum products commonly is called ash.
    - Test Method - ASTM D482, ISO 6245

- Distillation

  - General Description - At least 90 percent of the fuel **must** evaporate at less than 360°C [680°F]. All of the fuel **must** evaporate at less than 385°C [725°F].
  - Test Method - ASTM D86, ISO 3405

- Lubricity (ball on cylinder evaluator) BOCLE
  - General Description - Lubricity is the ability of a liquid to provide hydrodynamic and boundary lubrication to prevent wear between moving parts. Fuel with lower sulfur and viscosity tends to have lower lubricity. It can be measured by either one of two procedures.
  - Test Method: ASTM D6078, Scuffing Load Ball On Cylinder Evaluator (SLBOCLE), or ASTM D6079, ISO 12156, High Frequency Reciprocating Rig (HFRR)

Contingency Diesel Fuel Specifications

This section presents the specifications for fuels which are **only** to be used when fuel meeting the required specifications are **not** available. In the case that fuels meeting the Required Specifications in Table 1 are **not** available, Cummins Inc. has prepared contingency specifications to aid the user in choosing the most acceptable contingency fuel.

CAUTION

Fuels outside the recommended fuel specifications, but within the contingency specifications, are only meant to be used for short periods of time when no other fuels are available. Use of contingency fuels can have an adverse effect on engine performance and durability. Cummins assumes no warranty responsibility for repairs or increased costs of operation resulting from the use of fuels that do not conform to the specifications listed in Table 1.

Guidelines for The Use of Contingency Fuels

1. A calibration change of the fuel pump or injectors is **not** recommended when changing to a contingency fuel that meets all the specifications shown in Contingency Diesel Fuel Specifications, although changing to a contingency fuel can cause a slight power loss and can result in higher than normal wear of certain components. See the sections in this bulletin on Power Loss and Component Wear and Durability for additional information.

2. Although it is **not** anticipated that smoke levels will increase when fuels meeting the contingency fuel specifications are used for short periods of time, the user **must** make sure that the use of such fuels does **not** result in a smoke level which exceeds legal limits applied to the owner or operator. Continued use of fuels meeting the contingency fuel specifications can result in increased smoke levels.
3. Some jet fuel lubricities can be too low to provide the necessary lubrication for the fuel system components. If (based on the fuel supplier's specifications) a fuel does **not** have the minimum lubricity listed for contingency fuels in Contingency Diesel Fuel Specifications, a fuel additive **must** be added to the fuel to increase the lubricity and specially enhanced fuel system components **must** be used. Go to the section in this bulletin on fuel additives. Consult Cummins Inc. for available hardware options.

WARNING

Some contingency fuels, such as jet fuels and kerosene, are much more flammable than normal diesel fuel. Use extreme care to keep cigarettes, flames, pilot lights, sparks, arcing equipment and switches, and other sources of ignition away and out of areas sharing ventilation.

Additional maintenance can be required when using contingency fuels. Those using contingency fuels **must** consult with their fuel supplier to determine any problems which can result from using fuels meeting Contingency Diesel Fuel Specifications. If there is still a question, data on the fuel's physical properties **must** be submitted to Cummins Service Engineering Department for review before use in Cummins® engines.

Table 2: Contingency Diesel Fuel Specifications [1]	
Viscosity	1.3 to 13.1 centistokes
Cetane Number	35 minimum above 0° C [32° F]; 40 minimum below 0° C [32° F]
Sulfur Content	Less than 2.0 mass−percent. Catalyst equipped engines will **not** be able to use high sulfur fuel even for a short period of time without permanent damage to the catalyst.
Active Sulfur	Copper Strip Corrosion **not** to exceed Number 2

Table 2: Contingency Diesel Fuel Specifications [1]	
Water and Sediment	**Not** to exceed 0.5 volume-percent
Carbon Residue	**Not** to exceed 5.0 mass-percent on 10 volume-percent residuum
Density	0.750 to 0.965 g/cc at 15° C
Cloud Point	Lowest temperature at which fuel can be maintained without forming paraffin wax crystals.
Pour Point	Lowest temperature at which fuel can still flow.
Ash	**Not** to exceed 0.05 mass-percent
Distillation	90 volume-percent at 395° C [743° F]
Lubricity (ball on cylinder evaluator) SLBOCLE	Minimum of 2300 grams SLBOCLE, maximum of 0.6 mm Wear Scar Diameter WSD at 60° C [140° F] HFRR
Vanadium	5 ppm, maximum
Aluminum	1 ppm, maximum
Silicon	1 ppm, maximum
Sodium	10 ppm, maximum

1. Reference test methods in Diesel Fuel Properties

Effects of Contingency Diesel Fuels on Engine Operation

- Viscosity
  - Low viscosity causes rapid wear of fuel pump and injectors. High viscosity causes hard starting, white smoke when cold, injector cup cracking, and injector train failures. Governor wear on rotary fuel pumps can cause loss of regulation.

- Cetane Number
  - A cetane number below 42 can cause poor starting, excessive white smoke, and poor idling. A cetane number above 55 can increase smoke at peak torque conditions.

- Sulfur Content
  - High sulfur content increases wear in injectors, piston rings, and bearings. Use of fuels with sulfur content above 0.5 mass-percent requires the use of higher total base number (TBN) lubricants (TBN greater than 10) and shorter oil drain intervals.

NOTE: Catalyst failures caused by the use of fuels with higher than recommended sulfur levels are not warrantable. High sulfur fuel will also shorten the life of certain components in the exhaust system, including the oxidation catalyst.

- Active Sulfur
  - Excessive active sulfur increases the corrosive attack on the fuel pump, injectors, and other fuel system components.

- Water and Sediment
  - Contaminated fuels reduce filter life, fuel system life, and cause on-road failures.

- Carbon Residue
  - High carbon residue causes increased combustion chamber carbon deposits, more exhaust smoke, and higher soot contamination of the lubricating oil.

- Density
  - Lighter fuels contain less thermal energy per gallon and result in somewhat lower fuel economy. A fuel with a density of 0.876 g/cc contains about 3.5 percent more energy per gallon than a fuel with a density of 0.815 g/cc.

- Cloud Point
  - Operating below the cloud point temperature can cause the fuel filter to clog with wax crystals, restrict fuel flow, and cause loss of power. It is suggested that if fuels with cloud points above the expected ambient temperatures are purchased, the consumer **must** consult the fuel supplier and Cummins Inc. concerning fuel handling techniques. For more information, go to Common Issues With Winter Fuel.

- Pour Point
  - Operating near or below the pour point will cause start-up issues. It is doubtful that most fuel pumps can operate at the pour point. In fact, it is recommended that systems be operated at 10 to 15 degrees F above the pour point of a fuel.

- Cold Filter Plugging Point
  - Operating below the cold filter plugging point temperature will cause the fuel filter to clog with wax crystals, restrict fuel flow, and cause loss of power. If is suggested that if fuels with cold filter plugging points above the expected ambient temperatures are purchased, the consumer **must** consult the fuel supplier and

Cummins Inc. concerning fuel handling techniques. For more information, go to Common Issues with Winter Fuel.

- Ash
  - High ash content causes deposits of noncombustible metallic material in the combustion chamber and on the exhaust valves.

- Distillation, Maximum
  - Fuels with high distillation temperature can leave gummy deposits in the fuel system and result in poor fuel combustion.

- Lubricity
  - Fuels with low lubricity can cause increased wear or seizure of fuel system components.

- Vanadium
  - Fuels with high vanadium content can cause valve burning.

- Aluminum
  - Fuels with high levels of aluminum can cause premature ring and liner wear which can lead to excessive oil consumption.

- Silicon
  - Fuels with high levels of silicon can cause premature ring and liner wear which can lead to excessive oil consumption.

- Sodium
  - Fuels with high levels of sodium can cause premature ring and liner wear which can lead to excessive oil consumption. Sodium can combine with vanadium, if present, and catalyze, causing valve burning.

- Zinc
  - Fuels with high levels of zinc can cause injector spray hole carboning. Do **not** use galvanized pipe or fittings in the fuel system plumbing. Diesel fuel will leach zinc galvanized material.

Power Loss

This section gives guidelines on power loss to be expected when using recommended or contingency fuels, or fuels that are above normal temperature.

NOTE: The values given concerning power loss due to the use of contingency fuels are intended only to help estimate power loss. Power loss can vary greatly, depending on operating conditions, engine type, fuel

system type, fuel composition, and other factors. These guidelines can not be used to precisely calculate engine power loss.

The use of contingency fuels can cause a decrease in the power output of the engine due to differences in fuel density and viscosity. In addition, changes in fuel temperature also affect engine power output because temperature affects both viscosity and density.

Density

All engines will have a predictable variation in power output depending on the density of the fuel used. Engines using fuels with a high density will produce more power than those using fuels with a lower density because the thermal energy content of the fuel is higher. Since fuel is marketed by volume, lower density fuel carrying less thermal energy results in a proportional decrease in fuel economy or power output.

Viscosity

In general, lower viscosity results in lower power due to increased internal leakage in the fuel system. Also, lower viscosity fuels generally have lower thermal energy content. The effect viscosity has on power depends on the type of fuel system used.

Temperature

Temperature causes changes in engine power because it affects both viscosity and density. An increase in fuel temperature will cause a decrease in viscosity, which will reduce power due to internal leakage in the fuel system as described above. The maximum recommended fuel pump inlet temperature for Cummins® engines is 70°C [158°F].

An increase in fuel temperature will also cause a decrease in fuel density (increase in API gravity), which will reduce power due to lower energy content of the fuel. On Cummins® engines using the PT®, Quantum, or HPI fuel systems, the power loss due to increasing temperature is less than that on engines using the in-line, distributor, or CELECT™ systems (less than 1 percent per 5°C [10°F]), due to the inherent viscosity compensating characteristics of these systems.

Component Wear and Durability

This section shows the effects of contingency fuels on wear and durability of fuel systems components.

The use of contingency fuels can affect the wear and durability of both fuel pump and injector components within the fuel system. Many of these fuels are low in

viscosity and lubricity as measured in the Ball On Cylinder Lubricity Evaluator (BOCLE) tests. Fuels with lubricity values below 2300 grams are considered to have poor lubricity and can cause failure of fuel system components. Other factors that affect wear and durability are sulfur, water, and sediment content. High sulfur content increases wear of the fuel system components. Abnormal quantities of water and sediment in the fuel will also cause excessive wear, as well as other engine problems.

Fuel Blending

This section presents the effects of blending fuels with used and new lube oil, other fuels, and with gasoline, gasohol, or alcohol.

There are two different types of fuel blending processes referred to in this section. The first is the blending of used engine lubricating oil to reduce fuel costs and to aid in disposing of used engine oil. This section also discusses the blending of fuel and engine oil in on-highway applications. The second is the blending of heavier fuels with lighter fuels to lower the wax content, cloud point, and pour point, and thus improve cold weather operation. In addition, the effects and hazards of mixing alcohol with diesel fuel are discussed.

Blending Fuel and Lubricating Oil for On-Highway Applications

WARNING

Some state and federal agencies have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. If not reused, dispose of in accordance with local environmental regulations.

CAUTION

Engines equipped with an oxidation catalyst must not use fuel blended with lubricating oil. The lubricating oil causes deposits in the catalyst which will plug the catalyst and possibly cause higher emission levels and reduced engine performance.

CAUTION

Do not blend more than 5 percent used lubricating oil with the fuel. Do not blend other used oils with fuel, such as transmission fluid, gear case oil, and so forth.

Used engine lubricating oil can be blended with fuel using the Cummins Lube Oil Blender, Part Number 3376317 (110 volt, 60 Hz) or Part Number 3376362 (220 volt, 50 Hz). This process can be used to supplement fuel supply as well as provide a means of disposing of used lubricating oil.

To blend used engine oil with fuel, follow the instructions provided with the Cummins Lube Oil Blender.

Two rulings by the United States Environmental Protection Agency (EPA) affect the practice of blending lubricating oil with diesel fuel in the United States. First, on September 10, 1992, the Office of Solid Waste of the United States Environmental Protection Agency determined that used lubricating oil was **not** classified as hazardous waste. In addition, the blending of used lubricating oil with diesel fuel for burning in diesel powered vehicles was determined to be an acceptable method for disposing of used lubricating oil (57 Federal Register, R 41583, September 10, 1992). Second, beginning October 1, 1993, diesel fuel used in motor vehicles, as defined by the EPA, in on-highway applications **must** contain less than 0.055 percent sulfur by weight (Mandated in Section 211 of the 1990 Clean Air Amendments; 57 Federal Register, P. 19535, May 7,1992). Fuel blended with lubricating oil **must** also meet this specification.

Cummins Inc. allows the blending of lubricating oil with fuel used in their engines, except those equipped with an oxidation catalyst, often referred to as a catalytic converter (such as 1994 M11's and 1994 C8.3's used in urban transit buses, and 1994 B5.9's and C8.3's used in automotive applications). Cummins Inc. permits a maximum of 5 percent used lubricating oil to be blended with fuel. This helps to reduce operating costs and aids in the disposal of used engine oil. The blending of new lubricating oil to raise viscosity is also permissible. This helps to increase the viscosity of lighter fuels to acceptable levels. Cummins Inc. recommendations for the blending of lubricating oil with fuel used in its engines have **not** changed; however, if blended fuel used in motor vehicles, as defined by the EPA, in on-highway applications exceeds the maximum sulfur content, United States federal law has been violated and penalties can be assessed. To be sure that blended fuel complies with the law, the following procedure **must** be followed. Both the diesel fuel and lubricating oil **must** have their sulfur content measured by a qualified laboratory using the testing method specified in ASTM D2622 (American Society of Testing and Materials Standard, or ISO 4260). Once the correct blend factor has been determined, multiply this by the volume of fuel to be blended. The result is the amount of this oil that can be blended with this fuel

and remain within legal limits. Similar restrictions and processes **must** be followed worldwide where regional or national regulations can impose such sulfur limits.

As an example, consider 50,000 gallons of fuel with a sulfur content of 0.04 percent by weight and lubricating oil with a sulfur content of 0.5 percent by weight. Of this oil, 450 gallons can be blended with 50,000 gallons of this fuel and remain within legal limits for sulfur content in the United States. Margins **must** be allowed for measurement errors.

Blending Fuel with Fuel

Cummins Inc. recommends the use of a premium diesel fuel during winter (ambient conditions at -7°C [20°F] or below) operating conditions. See Additives section of this bulletin.

In cold-weather operation, the most common method of preventing fuel waxing problems is to dilute heavier, higher wax content fuels such as U.S. Number 2-D diesel fuel with lighter, lower wax content fuels such as Number 1-D diesel or jet fuel. This reduces the concentration of wax, and thereby reduces both the cloud point and pour point. Blended fuels of this nature are more expensive to use both because they cost more and because they have a lower thermal energy content. A typical blended fuel contains 30 to 60 volume-percent light distillate fuel, usually yielding a 3 to 7°C [5 to 12°F] drop in cloud point, and a 5 to 11°C [9 to 20°F] drop in pour point. Lower wax content fuels **must** be added BEFORE wax forms to be effective.

Blending Fuel with Gasoline, Gasohol, and Alcohol

WARNING

Under no circumstances must gasoline or alcohol be used to dilute diesel fuel. This practice creates an extreme fire hazard and under certain circumstances an explosive hazard. Gasoline dilution is not an effective way to lower cloud point (20 volume-percent gasoline only lowers cloud point 4° C [7° F] and it lowers the fuel viscosity, cetane number, and flash-point). Alcohol dilution will increase the cloud point.

Additives

This section gives information on the use of fuel additives in Cummins® engines including the use of bio-diesel and water emulsifiers.

Cummins Inc. neither approves nor disapproves of the use of any fuel additive, fuel extender, fuel system modification, or the use of any device **not** manufactured or sold by Cummins Inc. or its subsidiaries. Engine damage, service issues, or performance problems that occur due to the use of these products are **not** considered a defect in workmanship or material as supplied by Cummins Inc. and can **not** be compensated under the Cummins® warranty.

Fuel Additives

Cummins Inc. engines are designed, developed, rated, and built to operate on commercially available diesel fuel as listed in Required Diesel Fuel Specifications; therefore, it is **not** our policy to recommend fuel additives.

In extreme situations, when available fuels are of poor quality or problems exist which are peculiar to certain operations, additives can be used. However, Cummins Inc. recommends consultation with the fuel supplier or Cummins Service Engineering Department prior to use of fuel additives.

Among the situations where additives can prove useful are the following:

1. A cetane improver additive can be used with low cetane fuels.
2. A pour point depressant or flow improver additive can help with high pour point fuels.
3. A wax crystal modifier can help with fuels with high cold filter plugging points (CFPP).
4. An anti-icer can help prevent ice formation in wet fuel during cold weather.
5. An anti-oxidant or storage stability additive can help with fuel system deposits and poor storage stability.
6. A lubricity enhancer can be used to increase the lubricity of fuels so that they meet the requirements given in Table 1.
7. A biocide or fungicide can help when fuels are prone to contamination with bacteria or fungus. Although other additives can provide some performance benefits, Fleet-tech™ Microbicide (quart - CC2661 and gallon - CC2662) and Microbicide SP (pint - CC2671, quart - CC2672 and gallon - CC2673) are the **only** products recommended by Cummins Inc. to treat fuels with biological contamination problems.
8. Fleetguard's Fleet-tech™ Turbo Diesel All Season Fuel Additive (pint - CC2588) can be used with low cetane fuels to boost cetane values. Although other additives are available that will boost the cetane number, Fleetguard's Fleet-tech™ All Season Fuel Additive is the **only** diesel fuel additive recommended by Cummins Inc. for cetane number improvement.
9. Fleetguard's Fleet-tech™ Asphaltene Conditioner (quart - CC2597 and 2.5 gallon CC2596) or Fleetguard's Fleet-tech™ Turbo Diesel All Season Fuel

Additive (pint -CC2588) can be used to clean carbon deposits from injectors and improve lubricity in fuels that fall below the recommended lubricity specification in Table 1. Although other additives can provide some performance benefits, Fleet-tech™ Asphaltene Conditioner, and Turbo Diesel All Season Fuel Additive are the **only** diesel fuel additives recommended by Cummins Inc. for use with fuels that do **not** meet the lubricity specification in Table 1.

10. Fleetguard's Fleet-tech™ Winter Conditioner (pint - CC2591, quart - CC2592, 2.5 gallon - CC2595, 5 gallons - CC2593, 55 gallons - CC2594, and bulk - CC2590) and Turbo Diesel All Season Fuel Additive (pint - CC2588) can be used to improve the pour point and cold filter plugging point of diesel fuels in addition to preventing ice formation in wet fuels during cold storage. Although other additives are available that can provide some winter performance benefits, Fleet-tech™ Winter Conditioner and Turbo Diesel All Season Fuel Additive are the **only** diesel fuel additives recommended by Cummins Inc. for winter performance improvements.
11. Fleetguard's FS20000 lubricity enhancing fuel filter can also be used to improve the lubricity of fuels that fall below the recommended lubricity specification given in Table 1. The FS20000 is required for Tier 2 QSB engines running Jet A or JP8 Fuels.

Premium diesel fuels can possibly contain several additives that can accomplish the same as buying additives and adding them to lower quality diesel fuel. A premium diesel fuel is defined by the Worldwide Fuel Charter as described on page 1.

Cummins Inc. recommends the use of a premium diesel fuel during winter (ambient conditions at -7°C [20°F] or below) operating conditions.

Great care **must** be exercised in the choice and use of additives. Some fuel additives can be harmful to the engine. Fuel additives containing ash forming materials will cause combustion chamber deposits. Most legitimate fuel additives perform **only** one function. Multifunctional fuel additives are mixtures of several additives. All fuel additives perform differently in different fuels; therefore, the additive used **must** be one to which the fuel will respond. There are no known additives that increase the power or improve the efficiency of a properly maintained engine.

NOTE: Cummins Inc. accepts no liability for engine damage resulting from the use of fuel additives which are not specifically recommended.

Bio-Diesel Fuel

With increased interest in emissions and reducing the use of petroleum distillate based fuels, many governments and regulating bodies encourage the use of bio-fuels. Bio-diesel fuels **must** be considered experimental at this time.

Bio-diesel fuels are methyl/ethyl ester-based oxygenates derived from a broad variety of renewable sources such as vegetable oils, animal fats, and cooking oils. Their properties are similar to diesel fuel, as opposed to gasoline or gaseous fuels, and thus are capable of being used in compression ignition engines. Soy Methyl Ester (SME) or some SME Diesel is the most common bio-diesel in the United States and is derived from soybean oil. Soy Diesel is a bio-diesel or petro-diesel blend based on SME. Rape Methyl Ester (RME) Diesel is the most common bio-diesel in Europe and is derived from rapeseed oil. These fuels are collectively known as Fatty Acid Methyl Esters (FAME).

Cummins Inc. test data on the operating effects of bio-diesel fuels indicates that typically smoke, power, and fuel economy are all reduced. However, as there are no firm industry standards on the content and properties for bio-fuels, consistency and predictability of bio-diesel operation is **not** well documented. There are provisional specifications for FAME issued in Germany under DIN V 51 606 and also recently through ASTM as PS121; however, these standards are under development and are subject to change.

Cummins Inc. certifies its engines using the prescribed EPA and European Certification Fuels. Cummins Inc. does **not** certify engines on any other fuel. It is the user's responsibility to use the correct fuel as recommended by the manufacturer and allowed by EPA or other local regulatory agencies. In the United States, the EPA allows use of **only** registered fuels for on-highway applications. The EPA has additional alternative fuel information at: **http://www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm**.

It is the responsibility of the user to obtain the proper local, regional, or national exemptions required for the use of bio-diesel in any emissions regulated Cummins® engine.

Warranty and the Use of Bio-Diesel Fuel in Cummins Engines

Cummins Inc. neither approves nor disapproves of the use of bio-diesel fuel blends. There is a major difference between operating on pure (100 percent concentration) bio-diesel fuels and bio-diesel or petro-diesel fuel blends. Cummins Inc. is **not** in a position to evaluate the many variations of bio-diesel fuels, and the long-term effects on performance, durability or emissions compliance of Cummins® products. The use of bio-diesel fuel does **not** affect Cummins Inc. materials and workmanship warranty. Failures caused by the use of bio-diesel fuels or other fuel additives are **not** defects of Cummins Inc. parts or workmanship and therefore will **not** be covered by Cummins Inc. warranty.

Given the current industry understanding of bio-fuels and blending with quality diesel fuel, it can be expected that blending up to a 5 percent volume-concentration will **not** cause serious problems. This is consistent with the position taken by worldwide fuel system manufacturers.

For customers intent on blending bio-fuels above a 5 percent volume-concentration, the following concerns represent what is currently known in the industry. Concentrations beyond 5 percent by volume can have an adverse affect on the engine's performance and the fuel system integrity or durability. The affects are more serious with increasing concentration levels. Areas of concern when operating with bio-diesel fuels include low temperature operability (fuel gelation, filter plugging), heat content (poor fuel economy), and storage and thermal stability (filter plugging, injector deposits). In addition, from our fuel systems suppliers, the following issues are also noted:

- Swelling and hardening or cracking of some elastomer seals within the fuel system or engine
- Corrosion of fuel system and engine hardware, especially aluminum and zinc
- Solid particle blockage of fuel nozzles and passages
- Filter plugging
- Injector coking
- Higher injection pressures due to physical flow properties, reduced fuel system life
- Added stress and heat to injection components, especially rotary fuel pumps
- Increased pump seizures and early life failures
- Poor fuel spray atomization, reduced fuel economy
- Poor lubricity, reduced service life of fuel pump and fuel system.

Pure bio-diesel fuel is **not** stable and its acid content increases over time which can damage powdered metal components.

Operational Factors to Consider:

- The oil change interval can be affected by the use of bio-diesel fuel. End users are advised to use oil sampling to monitor the engine oil condition and to determine the optimum oil change interval. Pure bio-diesel fuel can cause a chemical reaction with lube oil resulting in oil sludging.
- Bio-diesel provides approximately five to seven percent less energy per gallon of fuel when compared to distillate fuels. To avoid engine problems when the engine is converted back to 100 percent distillate diesel fuel, do **not** change the engine rating to compensate for the power loss when operated with bio-diesel fuels.

- Elastomer compatibility with bio-diesel is still being monitored. The condition of seals, hoses, gaskets, and wire coatings **must** be monitored regularly.
- Bio-diesel fuels can pose low ambient temperature problems for both storage and operation. At low ambient temperatures, fuel can possibly need to be stored in a heated building or a heated storage tank. The fuel system can require heated fuel lines, filters, and tanks. Filters can plug and fuel in the tank can solidify at low ambient temperatures if precautions are **not** taken. Consult your bio-diesel supplier for assistance in the blending and attainment of the proper cloud point fuel.
- Bio-diesel has poor oxidation stability which can result in long term storage problems. The poor oxidation stability qualities can accelerate fuel oxidation in the fuel system. This is especially true in engines with electronic fuel systems because they operate at higher temperatures. Consult the fuel supplier for oxidation stability additives.
- Bio-diesel fuel is an excellent medium for microbial growth. Microbes cause fuel system corrosion and premature filter plugging. The effectiveness of conventional anti-microbial additives, when used in bio-diesel, is **not** known. Consult your fuel and additive supplier for assistance.
- Care **must** be taken to remove water from fuel tanks. Water accelerates microbial growth. Water is naturally more prevalent in bio-diesel fuels than in distillate fuels.

Water-Emulsions

Fuel Characteristics - Water-emulsified diesel fuel is an alternative fuel that is made by blending water and other additives (e.g. detergents) into diesel fuel.

Emissions - Water-emulsified diesel fuels have been verified by EPA and some state agencies as an emissions reduction technology.

Cummins Inc. does **not** certify engines with water-emulsified fuels. Cummins Inc. does **not** warranty any emissions improvements with the use of water-emulsified fuels.

Performance Issues - Water emulsified fuels have lower energy content than Number 2 diesel fuel. Customers **must** expect at least a 15 percent power reduction and a 15 percent fuel consumption increase when water-emulsified fuels are used. Because of the lower energy content in water-emulsified diesel fuels, engines running on water-emulsified diesel fuels can require idle governor adjustments to prevent engine stalling.

Durability Issues - Many fuel system components in Cummins® engines are made of materials that are susceptible to corrosion from water in fuel. Prolonged exposure to water in fuel can result in fuel system component failures from corrosion.

Vehicle System Issues - Some water-emulsified diesel fuel suppliers recommend the removal of the fuel water separator from the vehicle's fuel system. Removal of the fuel-water separator violates Cummins Inc. engine installation requirements.

Since water is a significant component of water-emulsified diesel fuels, conductivity sensors that detect water in fuel will **not** function properly with water-emulsified diesel fuels.

Some water-emulsified diesel fuels use a surfactant in the emulsifier. Surfactants can strip the fuel tank and fuel lines of deposits, resulting in fuel filter plugging. Fuel filters **must** be monitored closely during the initial use of water-emulsified diesel fuels.

Water-emulsified diesel fuels can **not** remain static for more than a month in storage or in vehicle fuel tanks. Most water-emulsified diesel fuel storage facilities are required to have circulation pumps for daily or weekly agitation. Engines operating on water-emulsified diesel fuel **must** be operating for a least 15 minutes every 30 days to avoid fuel-water separation in the vehicle fuel tank and in the engine fuel system.

Cummins Inc. Engine Warranty - Cummins Inc. Engine Warranty covers failures that are a result of defects in material or factory workmanship. Engine damage, service issues, and/or performance issues determined by Cummins Inc. to be caused by the use of water-emulsified diesel fuel are **not** considered to be defects in material or workmanship and are **not** covered under Cummins Inc. engine warranty.

Some water-emulsified fuel suppliers provide a comprehensive warranty for fuel system failures caused by the use of water-emulsified diesel fuel. Customers are encouraged to contact the water-emulsified diesel fuel supplier to determine the warranty provisions.

Oxy-Diesel or E-Diesel

WARNING

Do not mix gasoline, alcohol, or gasohol with diesel fuel. This mixture can cause an explosion.

WARNING

Under no circumstances must gasoline or alcohol be used to dilute diesel fuel. This practice creates an extreme fire hazard and under certain circumstances an explosive hazard. Gasoline dilution is not an effective way to lower cloud point (20 volume−percent gasoline only lowers cloud point 4° C [7° F] and it lowers the fuel viscosity, cetane number, and flash−point). Alcohol dilution will increase the cloud point.

Alcohol is considered a renewable energy source. Some suppliers integrate up to 15 percent alcohol in diesel fuel to form oxy-diesel or e-diesel. While the use of special additives addresses some of the problems with alcohol blending in diesel fuel, Cummins Inc. recommends against the use of such blends due to safety reasons. This kind of fuel is considered experimental and is **not** covered by warranty. Engine damage, service issues or performance problems that occur due to the use of these products are **not** considered a defect in workmanship or material as supplied by Cummins Inc. and can **not** be compensated under the Cummins® warranty.

Fuel Filters

This section explains the types of fuel filters and their uses.

Fuel filters are standard equipment on all Cummins Inc. engines. They are designed to remove water and harmful particles from the fuel before they damage the fuel pump and other engine components.

Effective September 1, 1991, Cummins Inc. requires a fuel-water separator or fuel filter and water separator combination be installed in the fuel supply system. This requirement applies to all 1991 and later automotive certified engines and all future automotive engines. In addition to this requirement, Cummins Inc. recommends that a fuel-water separator or fuel filter and water separator combination be installed in the fuel supply system on all Cummins Inc. engines regardless of application.

NOTE: It is strongly recommended that the "N" and "L" series engines, built with CELECT™ and STC prior to September 1, 1991, be up-fitted with a fuel-water separator.

Water can be introduced to a diesel engine's fuel system in two ways. Water can be present in the fuel and enter the engine's supply tank at fill-up or water that is normally in the air above the fuel can condense on the walls of the fuel tank.

Water in diesel fuel is normally present as both free and emulsified water. Free water settles to the fuel tank bottom where it can be drained. Emulsified water

stays in suspension where it can enter the fuel lines, fuel pump, and injectors. Once this suspended water is in the fuel system, it can cause corrosion and failure of key fuel system components.

Throw Away Canister

The standard fuel filter is the spin-on element. These filters contain a porous, pleated, chemically treated paper element that will pass fuel freely but trap impurities and sediment.

When the element is serviced, it is simply detached from the fuel filter head assembly, discarded, and replaced with a new element. The element **must** be tightened to the manufacturer's specifications.

NOTE: Do not pour fuel from an old fuel filter into a new filter in an effort to prime the fuel system. Use only clean fuel to prime the fuel system. It is not necessary to add fuel to a new fuel filter if the engine is equipped with an electric fuel transfer pump. Fuel systems on these engines can be primed by turning the vehicle keyswitch on and off several times to activate the fuel transfer pump.

CAUTION

Overtightening will distort the filter cartridge or crack the filter head. Do not use a filter element that has been dented or damaged prior to, or during, installation.

Replaceable Element Type

Another type of fuel filter used on Cummins® engines has a replaceable pleated paper element.

Pre-Filters

Midrange B and C series engines require the use of a fuel pre-filter (150 micron maximum).

Fuel-Water Separators

Free and emulsified water can be removed from the fuel. Integral fuel filter and water separators are available that remove both free and emulsified water with varying degrees of efficiency. The standard fuel filter (FF105, FF202, FF213, FF5052) does remove some free and emulsified water, but with low efficiency.

Due to the above facts and the requirement that a fuel-water separator or fuel filter and water separator be installed in the fuel supply system, Cummins Inc. has increased the requirements for free water and emulsified water removal. For engines with CELECT™ fuel systems, the fuel-water separator or fuel filter and water separator combination **must** remove a minimum of 95 percent of free water (per SAE J1839) and 95 percent of emulsified water (per SAE J1488). Fuel-water separator filters produced by Fleetguard® and most other major filter manufacturers meet or exceed these requirements.

Cummins® engines with CELECT™ fuel systems are factory fit with Fleetguard® fuel-water separators that utilize StrataPore™ filter media. These StrataPore™ filters provide high efficiency removal of harmful particles and both free and emulsified water.

The fuel-water separator requires daily draining. See Owner's Manual or Operation and Maintenance Manual for other regular service intervals of fuel filters.

NOTE: The drained fluids (mixture of water and fuel) must be properly disposed of according to regulations.

Table 1 lists the Cummins® and Fleetguard® fuel filters that are available from Cummins Inc. Distributors and Dealers. Change or clean the fuel pre-filter, if so equipped.

Fuel Filter Maintenance

Fuel filters **must** be changed periodically to prevent restriction of fuel flow from the fuel tank to the fuel pump. Change fuel filters as recommended by the appropriate Cummins Engine Operation and Maintenance Manual.

Check the fuel restriction when operating under severe conditions in order to determine if additional fuel filter changes are needed. These measurements **must** be taken at full load and peak power on engines with PT® and in-line fuel pumps or high idle with no load on Celect™ model engines. After checking the restriction a few times, a maintenance schedule for fuel filter changes can be established for each type of operation.

Table 3: Fuel Filter Part Numbers				
Fleetguard® Model Number	Cummins® Part Number	Length mm [in]	Outside Diameter mm [in]	Used On
FF-104	3315846*	107	94 [3.7]	L10, NT, Small Vee,

Table 3: Fuel Filter Part Numbers				
Fleetguard® Model Number	Cummins® Part Number	Length mm [in]	Outside Diameter mm [in]	Used On
		[4.2]		Medium Vee, K19 fuel filter
FF-105	3315844*	137 [5.4]	94 [3.7]	L10, NT, Small Vee, Medium Vee, K19 fuel filter
FF-105-D (with drain)	3315847*	152 [6.0]	94 [3.7]	L10, NT, Small Vee, Medium Vee, K19 fuel filter
FF-202	3313306*	286 [11.3]	118 [4.7]	V28, K38, K50 fuel filter
FF-213	3300901*	174 [6.9]	94 [3.7]	NT fuel filter
FF-5052	3931063*	116 [4.6]	77 [3.0]	Midrange fuel filter
FS-1280	3930942	162 [6.4]	94 [3.7]	Midrange fuel-water separator
FS-1212	3315843	174 [6.9]	94 [3.7]	L10, NT, and K19 and QSK19 fuel-water separator
FS-1216	3313304	308 [12.1]	118 [4.7]	V28 and KV fuel-water separator
FS-1251	3286503	141 [5.6]	77 [3.0]	Midrange fuel-water separator
FS-1232	3834656	115 [4.5]	77 [3.0]	Fuel-water separator for B-Series in pre-1994 Dodge Ram (distributor fuel pumps **only**)
FS-1232V	3912104	170 [6.7]	77 [3.0]	Fuel water separator for B-Series in pre-1994 Dodge Ram (distributor

Table 3: Fuel Filter Part Numbers				
Fleetguard® Model Number	Cummins® Part Number	Length mm [in]	Outside Diameter mm [in]	Used On
				fuel pumps **only**)
FS-1253	3923108	118 [4.6]	94 [3.7]	Fuel-water separator for B-Series in 1994 through 1996 Dodge Ram
FS-1253V	3865402	173 [6.8]	94 [3.7]	Fuel-water separator for B-Series in 1994 through 1996 Dodge Ram
FS-1000	3329289**	249 [9.8]	94 [3.7]	Fuel-water separator for M11, N14, ISM/QSM, and K19/QSK
FS-1001	3413084**	203 [8.0]	94 [3.7]	Short version of FS-1000
FS-1003	3406889**	250 [9.8]	94 [3.7]	ISM/QSM fuel-water separator
FS-1006	3089916**	310 [12.2]	120 [4.7]	QSK45/60/78 fuel-water separator
FS-1007	4010650**	298 [11.7]	119 [4.7]	ISX/QSX fuel-water separator
FS-1022	3800394**	238 [9.4]	94 [3.7]	ISC/QSC fuel-water separator
FS-1040	4010651**	298 [11.7]	119 [4.7]	ISX/QSX fuel-water separator
FS-19519	3942533**	148 [5.8]	94 [3.7]	ISB/QSB fuel-water separator
FS-19519V	3894519**	148 [5.8]	94 [3.7]	ISB/QSB fuel-water separator
FS-19528	3931476	110	105 [4.1]	Fuel-water separator for

Table 3: Fuel Filter Part Numbers				
Fleetguard® Model Number	Cummins® Part Number	Length mm [in]	Outside Diameter mm [in]	Used On
		[4.4]		B-Series in 1997 through 1999 Dodge Ram
FS-19579	3945213**	103 [4.1]	87 [3.4]	Fuel-water separator for 1996 through current midrange (2000 and 2001 Dodge Ram)
* These filters are recommended **only** when using a standalone water separator.				
** These filter utilize StrataPore™ filter media.				

Fuel restriction can be checked as follows. Go to the appropriate troubleshooting and repair manual for more detailed instructions.

1. On the PT® fuel system, measure the restriction at the suction side (inlet) of the fuel gear pump. Change the filter element if the restriction is above 203 mm Hg [8 in Hg].
2. On in-line or distributor fuel systems, measure the restriction at the inlet of the fuel lift pump. Also measure the pressure drop across the fuel filter and the pressure at the inlet to the fuel injection pump. Change the filter element if the pressure drop across the filter is more than 34 kPa [5 psi].
3. On the CELECT™ system, measure the restriction at the suction side (inlet) of the fuel gear pump. Change the filter element if the restriction is above 254 mm Hg [10 in Hg].
4. On the HPI-TP system (ISX/QSX/Signature) there are different test locations and limits depending on the engine option. See the engine Troubleshooting and Repair Manual for specific instructions.
5. On the CAPS system, measure the restriction at the inlet of the fuel gear pump. Change filter if restriction is above 254 mm Hg [10 in Hg].

6. On the Quantum system, there are different test locations and limits depending on the engine option. See the engine troubleshooting and repair manual for specific instructions.

NOTE: If the restriction exceeds these limits, the fuel flow to the pump will be reduced and engine power will decrease.

Hot Restarts

This section shows how contingency fuels affect the ability of the engine to restart while still hot.

On Cummins® engines which use a distributor type fuel system, the use of contingency fuels can cause difficulty restarting the engine while it is still hot. In addition, if excessive wear exists in the fuel pump, the same difficulty can occur even when using fuels within the range listed in Required Diesel Fuel Specifications. The problem is caused by excessive leakage of fuel around the internal components of the fuel pump. Fuel leakage becomes excessive due to the high temperatures and low viscosity of the fuel. Excessive wear of the fuel pump components will make the problem worse. The leakage can become so great that the pump will **not** produce the fuel rate necessary to restart the engine. If this problem is encountered, it can be corrected by using fuel which meets the specifications in the Required Diesel Fuel Specifications section of this bulletin. If this does **not** correct the problem, repair or replacement of worn fuel pump components is necessary.

Alternate or contingency fuels can cause difficulty restarting a hot engine. The hot restart complaint can be caused by fuel burning prematurely during the first compression stroke. Lighter alternate or contingency fuels can enter the cylinder through an open injector caused by the thermal expansion that occurs during the heat soak after engine shut down. The burning fuels increase the starting cylinder pressure and increase the amount of torque needed to start the engine. Lighter alternate or contingency fuels with lower flash points increase the probability of fuel entering and burning in the cylinder. This issue can, on occasion, occur when using fuels that meet the required properties listed in Table 1. Various Hot Restart kits (sometimes referred to as a Hot Start Knock kit) have been released by Cummins Inc. to address this issue.

If this complaint is encountered, it can be corrected by using fuels which meet the requirements in the Required Diesel Fuel Specifications section of this bulletin.

Common Issues With Winter Fuel

This section presents the various winter fuel issues and methods of dealing with them.

Two winter fuel handling issues, wax and ice, have annoyed diesel operators for years. There is no solution to either of these problems that is ideal for all situations, but the better one understands the problem, the less difficult the process of finding a solution becomes. Determining whether a low power complaint is due to fuel filter plugging complaint is fairly simple: replace the fuel filter with a new filter. If this allows the vehicle to operate normally even for a short period of time, then obviously something in the fuel is plugging the filter and causing the complaint. A simple way of determining whether the filter plugging is caused by wax or ice is to bring the plugged filter into a warm shop, drain out the liquid fuel, place the filter upside down on a piece of paper or in a shallow pan, and allow the filter to warm to room temperature. If there is ice in the filter, it will melt and run out of the filter and the water on the paper or in the pan will be obvious. Most petroleum wax, on the other hand, will **not** melt at room temperature. To speed the analysis process, the filter can be cut open and spread out. Once the cause of the low power complaint is determined, then a logical solution can be chosen.

Fuel Wax

All middle (or intermediate) distillate fuels, such as jet fuels, heating fuels, and diesel fuels, contain paraffin wax. Paraffin wax is a solid, crystalline mixture of straight-chain or normal hydrocarbons melting in the approximate range of 40 to 60°C [104 to 140°F]. This paraffin wax occurs naturally in the crude oil from which fuel oils are distilled. The wax content of a distillate fuel varies greatly, depending on the crude oil from which the fuel is produced and in the processing of the fuel. Generally, higher boiling distillate fuels, such as U.S. Number 2-D diesel fuel, have a higher concentration of paraffin wax than lower boiling distillate fuels, such as jet fuel.

Because of the strong relationship between temperature and solubility of wax, wax separation is a problem in handling and using diesel fuel during cold weather. As fuel cools, a temperature is reached at which the soluble paraffin wax in the fuel begins to come out of solution (Cloud Point); any further cooling will cause wax to separate out of solution. The temperature at which a certain fuel will become saturated with wax and causes filter plugging problems is termed the Cold Filter Plugging Point (ASTM D 6371). The temperature at which fuel will no longer flow is the Pour Point (ASTM D-97). At the pour point, most of the fuel is still liquid oil although it is very thick or viscous and trapped in a honeycomb-lick network of wax crystals.

Since diesel powered equipment is frequently used at temperatures low enough to cause wax to separate, a number of techniques have been devised to prevent the wax from causing problems by plugging fuel screens, lines, filter, and so on, and preventing fuel flow to the engine. Vehicles designed to operate at very low temperatures have provisions for heated fuel tanks, insulated fuel lines, heated fuel filters and other mechanisms to warm the fuel so that the wax does **not**

separate. These more elaborate systems are usually **not** practical in more temperate climates where they are needed **only** a few days a year.

Fuel Filters

Fuel filters have already been discussed in detail in the Fuel Filters section of this bulletin. The **only** additional consideration in terms of common issues with winter fuels is that using a large filter or multiple filters in parallel will allow more fuel wax to be filtered before a power loss occurs. Also, relocating the fuel lines and filter out of the wind-stream and wheel splash and into the engine compartment near the engine block will help keep them warm.

Engine Idling

CAUTION

Do not idle the engine for excessively long periods of time. Long periods of idling (more than 10 minutes) can damage an engine because combustion chamber temperatures drop so low the fuel can not burn completely. This will cause carbon to form in the injector spray holes and on the piston rings and can result in stuck valves.

Additives

There are a number of fuel additives available which reduce the pour point and cold filter plugging point (CFPP) of diesel fuel. These are commonly referred to as pour point depressant additives, cold flow improver additives, wax crystal modifiers, or fluidity improver additives (and can be collectively termed “Winter Additives”). Certain additives can reduce the Pour Point by as much as 70°F and the CFPP by as much as 30°F. A survey of winter blend fuels by the Bureau of Mines (now a part of the Energy Research and Development Administration) revealed that a large percentage of the commercially marketed diesel fuels had been treated with a winter additive. Before purchasing such an additive to treat fuel, ask the fuel supplier whether the fuel already contains a winter additive. Depending on the amount and type of additive already in the fuel, additional additives will or will **not** be necessary.

These additives alter the size and shape of wax crystals allowing pumping of fuel at lower temperatures. Although certain additives can be very effective, they are **not** a cure all. Their performance varies depending on the paraffin type and content of the fuel treated. Severe weather applications can require fuel warmers in addition to additives. Although other additives are available that can provide some benefits, Fleetguard's Fleet-tech™ Winter Conditioner and Turbo Diesel All

Season Fuel Additive are the **only** fuel additives recommended by Cummins Inc. to help prevent filter gelling in cold weather applications.

Fuel Warmers

Warming diesel fuel just prior to filtration is an excellent method of preventing fuel filter plugging. If cold fuel is warmed sufficiently, the wax crystals will dissolve in the fuel. The dissolving requires warming to a temperature of approximately 11 to 22°C [20 to 40°F] above the fuel's cold filter plugging point.

In order for a fuel warmer to reliably prevent fuel filter plugging due to wax, it **must** be capable of supplying enough heat to the fuel at the maximum fuel flow (**not** just fuel consumption) rate to raise the fuel temperature from the lowest expected fuel temperature (probably the lowest expected ambient temperature) to 11 to 22°C [20 to 40°F] above the fuel's cold filter plugging point. There are four different fuel warmers presently offered by Fleetguard® to raise the temperature of the inlet fuel.

1. Fuel Filter Heater - The Fleetguard® Positive Temperature Coefficient (PTC) fuel filter heats the fuel before the fuel flows into the fuel filter. The heater is installed on the fuel filter head. Most complaints of fuel waxing occur in the fuel filter. The heater uses ceramic discs that sense the fuel temperature and heats the fuel to a temperature just above the cloud point.

The PTC heater is self-regulating. Depending on battery voltage, the heaters use from 6 to 25 amps at maximum output. When no heat is required, the heater uses less than 0.5 amp. The heater can be left on during engine operation or it can be turned off with the cab switch. The heater reaches full heating capacity in about two minutes. The PTC heater kit is available (see Table 4).

Table 4: Fuel Filter Heaters	
Watts	Fleetguard® Part Number
300	3836029-S

A Fleetguard® kit, Part Number 3837317-S, adapts the heater to most fuel filter heads with 1 in-14 threads. Use to the following fuel filter list to identify fuel filter heads with 1 in-14 threads. The heater adds about one inch in height to the fuel filter head assembly.

Fuel Filter List with 1 in -14 Threads	
FF-104	FF-213
FF-105	FF-105C

FS-1242(B)	FS-1001
FS-1000	FS-1212
FF-105D	FS-1003

The Fleetguard® kit, Part Number 3832054-S, adapts to FS-1251 filter.

2. Recirculating Fuel Warmer - Part Number 3305782, can be used to warm inlet fuel for flow up to 9.5 l/pm [2.5 gpm]. The unit circulates engine coolant around the inlet fuel to warm the fuel. The unit is most effective when immersion or tank heaters are used to warm the coolant. An optional thermostat, Part Number 3305783, can be used to bypass fuel when 27°C [80°F] is reached. Use Table 5 to determine the performance capability of this fuel warmer for different operating conditions.

Table 5: Recirculating Fuel Warmer, Part Number 3305782 - Performance Data

Temperature Rise Chart			
Inlet Fuel Temperature (° F)	Outlet Fuel Temperature (° F) Fuel Flow Rate		
	2-1/2 GPM	1-1/2 GPM	1/2 GPM
-30	32	38	52
-10	39	45	55
10	47	53	59
30	60	62	67
50	71	74	77
70	85	87	88

3. Thermo Blend - The Fleetguard® Thermo Blend fuel warmer recirculates warm deaerated drain fuel from the engine to the filter and injection system, rather than allowing it to return to the tank. A 10 to 15 minute engine-running warm up period is usually necessary to provide successful operation. A built-in thermostat automatically bypasses fuel at 43°C [110°F]. Part Number 3310200 **must** be used for all Midrange and Heavy Duty diesel engines. Part Number 3308750 **must** be used for all heavy duty off-highway equipment (such as 12 and 16 cylinder engines).
4. Thermo Blend FM, Part Number 3310630 - The Fleetguard® Thermo Blend FM fuel warmer combines the return fuel heating principle with a special filter head. When used with Cummins® Part Number 3315843 (Fleetguard® Part Number FS-1212) fuel-water separator, it provides fuel dewaxing, water removal, and filtration. A built-in thermostat automatically

bypasses fuel at 21°C [70°F]. When using fuel warmers, do **not** overheat the fuel. The maximum fuel temperature at the inlet to the fuel pump is 70°C [158°F]. Alterations of heating devices **must** be reversible, or have some means to turn them off during warm weather operation. The fuel tank is heated by the injector return (drain) fuel from the engine. On typical installations, the cooling effect of the tank maintains fuel temperatures at an acceptable level.

On some installations, such as acoustically enclosed units, little cooling of the tank occurs because of the design. On these installations, a fuel oil cooler can be used to limit the temperature of the fuel at the fuel pump inlet to 70°C [158°F] or less.

Depending on the particular engine model involved, the engine horsepower will begin to decrease slightly above fuel inlet temperatures of 46°C [115°F]. The percent of power loss is **not** as great on engines with the Cummins PT® and HPI fuel system (less than 1 percent per 5°C [9°F]), due to the inherent viscosity compensating characteristics (see Power Loss section in this bulletin). Operation above 70°C [158°F] is **not** recommended due to the loss of the lubricating quality of the fuel with resultant wear to the fuel system components which depend on fuel for lubrication. A fuel warmer will **not** help if the fuel is below the pour point and can **not** be pumped to the warmer; therefore, in extremely cold conditions, fuel can be treated with light distillate fuel or treated with a pour point depressant to reduce the pour point, or it can be necessary to heat the fuel to allow it to flow.

When using fuel warmers that use engine coolant as a source of heat, some form of coolant heating during shutoff will allow the heater to become effective much more quickly after start-up. These fuel warmers **must** also be checked for leaks. Since the fuel warmer is on the suction side of the fuel pump and the cooling system is pressurized, any small leak will allow coolant to enter the fuel system.

Other Considerations

Wax in the fuel will deposit in any restriction or sharp bend in the fuel plumbing system. If fuel starvation occurs during cold-weather operation and plugged fuel filters are **not** found, look for plugging of tank pick-up screens, sharp bends in the fuel lines, fittings, and so forth.

Water Contamination

Free water (non-dissolved) in the fuel can freeze at low temperatures and the resulting ice crystals can plug fuel filters causing fuel starvation. Care **must** be taken to keep fuel storage tanks dry. Tanks can be “stuck” often with water detecting paste (usually obtainable from fuel suppliers) to be sure they are dry. If water is detected, it **must** be pumped out.

Keeping bulk fuel storage tanks dry has already been mentioned; however, if this is a persistent issue, a dryer (fuel-water separator) can be installed on the bulk fuel dispensing system.

Condensation in the vehicle fuel tank(s) occurs when the air in the fuel tank(s) cools down during a shutdown period. This moisture can be reduced by filling the vehicle fuel tank before engine shutdown to reduce the air space above the fuel.

Dissolved water comes out of solution as fuel cools. As fuel cools from 4 to -29°C, [40 to -20°F] the solubility of water in the fuel reduces 70 percent. Therefore, fuel pumped from a relatively warm underground tank into a vehicle which sits overnight in sub-zero temperatures can cause some free water to separate. However, this source of free water is almost negligible, because even at high temperatures fuel will dissolve very little water (0.1 mass-percent at 71°C) [160°F]).

Additives can be used to prevent fuel line freeze up. These additives work by lowering the freeze point of water so that it will **not** freeze and cause lines and filters to plug. Although other additives can provide some benefits, Fleetguard's Fleet-tech™ Winter Conditioner and Turbo Diesel All Season Fuel Additive are the **only** additives recommended by Cummins Inc. for this application.

NOTE: More cold weather engine operation recommendations are in Service Bulletin Number 3379009 and in the engine operation and maintenance manual.

Microbial Contamination of Fuel

WARNING

Although most of the microbes that will live in fuel tanks are common organisms to which humans are constantly exposed, contact with microbes or fungi from a fuel tank must be avoided. When a fuel system is contaminated and cleaning is necessary, workers must be protected. Remember that the fungi produce reproductive spores and when dry these can easily become airborne, so breathing protection must be provided or the microorganisms must be kept wet. Dispose of the water and sludge removed from fuel tanks properly. Never place these materials in sanitary sewer system since they can kill bacteria used in sewage treatment. Never place them in storm sewers or surface water streams since they can kill fish and other aquatic animals.

WARNING

The most common problem associated with exposure to these microbes is dermatitis which in some people can be quite serious. Any exposed skin must be thoroughly washed with warm, soapy water.

WARNING

Avoid eating, drinking and smoking while working with these microbes. Any ingestion of the microbes or exposure to broken skin must be considered serious. It is recommended that if this happens the worker be taken to a doctor, along with a sample of the microbes.

WARNING

Biocides are generally only mildly toxic to humans and animals but must still be handled carefully. In cases of ingestion or contact with the eye, follow manufacturer's recommendations. Seek medical attention.

This section covers the recognition of and solutions to microbial contamination of diesel fuel.

To protect against fuel shortages, many users have been storing fuel and, as a result, the frequency of microbial contamination has increased. Microbial contamination of fuel, though **not** a new concern, is more common in metalworking industries which use water- soluble oils as cutting fluids or in long-term storage of hydrocarbon fuels than it is in diesel fleet operations. All hydrocarbon fuels are essentially sterilized by the high temperatures encountered in the refining process; however, they can become contaminated soon after leaving the refinery by microorganisms. These microorganisms, primarily bacteria and fungi, exist rather harmlessly in moisture-free fuel, passing through fuel systems without having any negative effects.

However, in the presence of water, these microorganisms begin to grow and reproduce. The rate of growth depends on how well the environment suits the particular microorganism's needs.

The growth of a large colony of microorganisms in a fuel system can cause several issues. The first and usually most obvious is fuel filter plugging with a greenish-black or brown slime, frequently accompanied by a foul odor. This slimy, string-like colony can also plug sharp bends in fuel lines, fuel meters and other restrictions. The second issue these microorganisms can cause is corrosion due to the acid by-products some of them produce. It is also possible, if the microorganisms pass through the fuel filter, that they will form deposits and cause damage in the fuel pump and injectors.

Some indicators of microbial contamination are:

1. Slime deposits on tank walls, piping, or other surfaces which are exposed to fuel. These deposits are usually greenish-black or brown and are slick to the touch.
2. Black or brown "stringy" material suspended in tank water bottoms.
3. Swelling or blistering of any rubber surface (washers, hoses, connectors, and so forth) that comes in contact with fuel.
4. Sludge or slime deposits on filter surfaces.
5. Foul odor resembling that of rotten eggs (hydrogen sulfide).

A more conclusive approach is to routinely check the fuel by means of one of the several available test kits which are listed below. These can detect microorganisms long before there is any visible evidence of contamination.

The following list shows test kits of which we are aware. Listing of a kit can **not** be construed as a recommendation or approval; and, the fact that a kit is **not** listed **only** means we are unaware of it. Cummins Inc. has **not** tested any of these kits, but has **only** reviewed the manufacturer's literature. Users **must** evaluate the kits available to them and select one based on their own judgment.

1. Total Count Sampler, Catalog Number MTOO 000 25 for package of 25, from Millipore Corporation, Bedford, MA 01730, 1-800-645-5476. The Total Count Sampler contains a nutrient media specifically designed to encourage bacterial growth; however, many fungi will grow on it. Millipore recommends incubation at 35°C [95°F] for 24 hours; however, they can be incubated at room temperature for 36 to 48 hours. If the results on the Total Count Sampler are low and is still suspected, re-sample using Millipore's Yeast and Mold Sampler (Catalog Number MYOO 000 25 for package of 25). This sampler contains a nutrient media which suppresses the growth of most bacteria, but is rich in nutrients for fungi. For best results, use both samplers each time water bottoms are tested. These Millipore samplers are probably the most sensitive of those listed, and in

fact, can lead one to overtreat a fuel system. Millipore samplers are also available from Millipore in Australia, Belgium, Brazil, Canada, Denmark, England, Finland, France, Italy, Japan, Mexico, Norway, Spain, Sweden, Switzerland, and West Germany. Inquiries from other countries can be directed to Millipore Intertech, Inc., P.O. Box 255, Bedford, MA 01730 U.S.A.

2. Microbe Monitor Test Kit (From Air BP) British Petroleum Cleveland-Hopkins International Airport Cleveland, OH 44135 1-800-533-2340. One sample per kit. Incubates at room temperature.

When it has been established that microbial contamination is present and action **must** be taken, there are several approaches. The most obvious solution is prevention. Most of the bacteria and fungi involved are soil organisms which can become airborne or waterborne. Prevention of the entrance of microorganisms is **not** possible because these organisms can enter the fuel through many different routes.

Growth of these microorganisms can be prevented. Since all metabolic processes of an organism are conducted in water, denying the microorganism access to water will prevent growth, thus preventing the development of large, troublesome colonies. Therefore, the first and most important step in prevention is to keep fuel systems dry. Keeping a fuel system entirely dry is impossible. In cases where microbial contamination is a recurring issue, a microbicide can be used to chemically treat the fuel or the water.

There are three general classes of biocides: water-soluble, fuel-soluble, and universally soluble. Fuel-soluble biocides are best suited for treating fuels which are to pass through several storage steps in the distribution process. A fuel-soluble biocide injected into the fuel early in the distribution system is carried with the fuel through the entire downstream system, effectively sterilizing the fuel until usage. Fuel-soluble biocides are easier to add to the fuel system since the exact amount needed to treat a volume of fuel is easily determined and they have a low toxicity to human and other life forms. The obvious disadvantage to fuel-soluble biocides is cost; each batch of new fuel added to the system **must** be treated since the biocide is consumed as the fuel is consumed.

Water-soluble biocides are more economical for use in treating one step in a fuel distribution system, such as the end-user's storage tank. The water-soluble biocides, since they are insoluble in fuel, stay where they are placed until the water bottoms are pumped from the tank; therefore, the total amount of biocide purchased is less. There are a number of disadvantages to water soluble biocides. Since no biocide is carried downstream by the fuel, each successive tank in the system **must** be individually treated. There is some difficulty in determining how much biocide to place in a tank since that depends on how much water is in the tank. The biocide can **not** be thoroughly mixed with the water in the bottom of a tank. Water-soluble biocides are much more easily taken

in by humans and other life forms: and therefore, **must** be disposed of properly when water bottoms are pumped from a tank. Water bottoms containing a water-soluble biocide **must not** be placed in a sanitary sewer system because the biocide can destroy the bacteria used by sewage treatment plants. These water bottoms **must** be treated as an acidic, industrial oily waste.

Universally soluble biocides are soluble in both water and diesel fuel. They allow you to treat the entire downstream system. However, each subsequent load of fuel does **not** need to be treated. The biocide will remain in any water that has collected at the bottom of the storage tank and continue to inhibit microbial growth. With certain types of biocides, the interval between treatments can be as long as six months. Like water-soluble biocides, universally soluble biocides are more easily taken up by humans and other forms of life. They also tend to be more expensive than the other types of biocides.

Treating a fuel tank that is infested with a large population of microorganisms will kill the microorganisms, but it will **not** eliminate the filter plugging they can be causing. The water and sludge containing the microorganisms **must** be removed from the fuel systems. First, clean the fuel system thoroughly. Next, a fuel-soluble or universally-soluble biocide **must** be added to the next few batches of fuel to kill any remaining microorganisms. Finally, the addition of a water-soluble or universally-soluble biocide can be continued for at least several months to be sure the microorganisms are all dead. If microbial contamination is a recurring issue, it is recommended that use of the water-soluble or universally-soluble biocide be continued permanently since this will be the most cost effective solution to the problem. This can be done by determining the amount of water that accumulates in tank bottoms between pump outs and adding about double or triple the amount of water-soluble biocide recommended to treat that volume of water. For example: you normally pump out approximately 379 liters [100 gallons] of water bottoms. In this case, after pumping the bottoms, immediately add to the fuel tank two or three times the amount of biocide normally used to treat 379 liters [100 gallons] of water. Since the biocide is more dense than fuel, it will settle to the bottom of the tank and will dissolve in the water as it accumulates. After refilling a fuel tank, the biocide **must** be allowed to settle before drawing fuel from it to keep from pumping the biocide out with the fuel.

Although other products can provide some benefits, the **only** biocide recommended by Cummins Inc. is Fleetguard's Fleet-tech™ Microbiocide. It is a universally soluble biocide. For specific treatment recommendations, contact Fleetguard and Microbiocide SP Service Engineering department at 1-800-22FILTER.

Natural Gas (NG)

WARNING

Compressed natural gas is normally treated with an odor producing chemical so that users will be able to smell gas leaks. Always be alert for the smell of gas. If you enter a room or approach a vehicle and a smell of gas is present, immediately shut off all engines and ignition sources. Avoid sparks, arcing switches and equipment, cigarettes, pilot lights, flames, and other sources of ignition in the area and in areas with common ventilation. Provide extra ventilation to the area and do not start the equipment or nearby equipment until the leak is corrected and the area is ventilated. Avoid leaving natural gas fueled equipment in unventilated rooms overnight or for extended periods. Store and service natural gas fueled equipment in large well-ventilated areas or outside.

WARNING

If natural gas leaks are present, do not store the vehicle inside or in any area that is covered. Severe personal injury can result from asphyxiation or explosion.

WARNING

Natural gas is highly flammable. Keep all cigarettes, sparks, arcing switches and equipment, pilot lights, flames and other sources of ignition out of the work area and areas sharing ventilation.

WARNING

Not all types of Natural Gas are treated with an orderant. Gas leaks from a non-refined source, such as Landfill Gas, Biogas, Coal Bed Gas or Wellhead Gas, can not always be detected by smell.

WARNING

Do not troubleshoot or repair gas leaks while the engine is running.

CAUTION

Natural gas is lighter than air and can accumulate under the hood and awnings.

CAUTION

Always torque fasteners and fuel connections to the required specifications. Overtightening or under tightening can allow leakage. These connections are critical to the fuel and air systems.

CAUTION

Always test for fuel leaks as instructed, as odorant can fade.

CAUTION

Close the manual fuel valves prior to performing maintenance and repairs, and when storing the vehicle inside.

Specifications

This section presents the specifications for natural gas engines.

Cummins® spark-ignited engines that use natural gas as a fuel source provide a low emission alternative for various applications. In order for the engines to continually provide extremely low emission levels and provide the best durability and reliability, Cummins Inc. has developed several fuel standards. Cummins Engineering Standard (CES) 20067, Natural Gas Fuel; CES 14604, Natural Gas Fuel; and CES 14608 Wide Range Natural Gas Fuel define some of the natural gas specifications. Depending on the type of engine (rich-burn, lean-burn, or alternative fuel) and application (automotive, industrial, or generator), go to the

appropriate engine's operation and maintenance manual for the correct fuel specification. Operators of Cummins® natural gas engines **must** refer the standard or specification to the potential fuel suppliers and request confirmation as to local availability.

These specifications apply to fuel as it is delivered to the engine, regardless of whether its origin was liquid or gaseous. These specifications are **not** intended to cover certification requirements. Landfill gas and gas with chlorine additives are **not** permitted in standard rich-burn or lean-burn natural gas engines. **Only** engine that have been specifically designed, built, and approved by Cummins Inc. for use with alternative fuels (including Landfill and Biogas) can be operated with low energy or aggressive fuels. The fuel **must not** contain water, dust, sand, dirt, oils, or any other substance or component in an amount that is detrimental to the operation of the engine. More specifications and test methods are detailed in these standards. For alternative fuels information, contact a local Cummins Authorized Repair Location for assistance.

For CES 20067, the basic chemical composition for natural gas is detailed in Table 6: CES 20067 Chemical Composition. The Wobbe index **must** be between 1300 and 1377 as measured by ASTM D 3588. The Wobbe index is a calculated value. Go to CES 20067 for more information.

Table 6: CES 20067 Chemical Composition

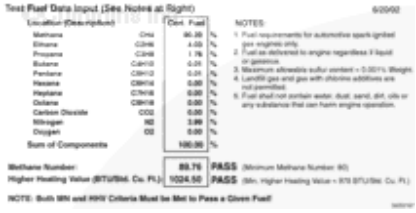
Constituents	Requirements	Test Method
Methane (CH_4)	90.0 percent volume minimum	ASTM D 1945
Ethane (C_2H_6)	4.0 percent volume maximum	ASTM D 1945
Propane (C_3H_8)	1.7 percent volume maximum	ASTM D 1945
Butane and Heavier ($C_4H_{10}+$)	0.7 percent volume maximum	ASTM D 1945
Carbon Dioxide and Nitrogen ($CO_2 + N_2$)	3.0 percent volume maximum	ASTM D 1945
Hydrogen (H_2)	0.1 percent volume maximum	ASTM D 2650
Carbon Monoxide (CO)	0.1 percent volume maximum	ASTM D 2650
Oxygen (O_2)	0.5 percent volume	ASTM D 1945

Table 6: CES 20067 Chemical Composition		
Constituents	Requirements	Test Method
	maximum	
Sulfur (S)	0.001 percent weight maximum	Title 17 CCR Section 94112 Method 16

For CES 14604, the methane number based on SAE 922359 **must not** be below 80 and the higher heating value **must not** be below 975 BTU/Standard Cubic Feet.

“Plus Technology” engines include knock sensing and control and Cummins® CORE hardware based control architecture (currently CM556B ECM). For approved ratings, CES 14608 can be used. The methane number based on SAE 922359 **must not** be below 65 and the lower heating value **must not** be below 16,100 BTU/lbm.

Contact a local Cummins Authorized Repair Location for information regarding calculating methane number, higher heating value, and lower heating values. The following is an example using CES 14604 to determine if the fuel is compliant.



Liquid natural gas (LNG) is an acceptable fuel provided the on-board fuel storage and supply system delivers proper pressure, temperature, and complete vaporization to the engine fuel system inlet.

Cummins Inc. natural gas engines are designed and adjusted to meet performance and emissions specifications with fuel meeting these specifications. The engine can operate on a wide range of fuel properties, but performance and emissions will be affected, and in extreme cases, fuel with characteristics out of these specifications can cause engine reliability or durability issues. Cummins Inc. assumes no responsibility for the use of fuels that do **not** meet this specification.

Engine damage caused by fuel **not** meeting this specification is **not** covered under warranty.

Operators **must** be alert for sudden changes in engine operation, power levels, or pre-ignition. Each of these can be a sign of substandard fuel. If you suspect an issue related to fuel quality, ask your fuel supplier to sample and analyze the fuel in the vehicle or the fuel being supplied to the engine in stationary applications, or contact a local Cummins Authorized Repair Location for assistance.

Fuel Filters

CAUTION

Gas is extremely flammable. Contents under pressure. Vent gas from the filter by opening the drain on the filter.

CAUTION

Overtightening will distort the filter cartridge, damage the filter seal, or crack the filter head. Do not use a filter element that has been dented or damaged prior to, or during, installation.

CAUTION

Oil getting inside of the gas mass flow sensor or on the screen pack will cause poor performance.

Fuel filters are required equipment on all Cummins® natural gas engines. They are designed to remove oil and harmful particles from the fuel before they damage the fuel system or other engine components. These filters are a coalescent type filter that will capture oil contaminants and moisture typically found in natural gas.

Oil can be introduced into a natural gas engine's fuel system in several ways. The most common is from the fueling station compressor. The oil can also be present in the station tank from the refining process. Oil in the fuel will cause the gas mass flow sensor and the heated oxygen sensor to read incorrectly. Engine performance will be affected.

The fuel filter, Fleetguard® NG 5900, needs to be drained as part of the daily or refueling maintenance check. The interval period for draining the fuel filter is dependent on the fueling station and varies for each location. The drain interval **must** be adjusted to the time required to accumulate no more than 30 milliliters [1 ounce] of oil in the fuel filter or daily, whichever occurs first.

Go to the engine operation and maintenance manual for fuel filter replacement intervals.

Liquefied Petroleum Gas (LPG)

WARNING

Liquefied Petroleum Gas (LPG) is normally treated with an odor producing chemical so that users will be able to smell gas leaks. Always be alert for the smell of gas. If you enter a room or approach a vehicle and a smell of gas is present, immediately shut off all engines and ignition sources. Avoid sparks, arcing switches and equipment, cigarettes, pilot lights, flames, and other sources of ignition in the area and in areas with common ventilation. Provide extra ventilation to the area and do not start the equipment or nearby equipment until the leak is corrected and the area is ventilated. Avoid leaving liquefied petroleum gas (LPG) fueled equipment in unventilated rooms overnight or for extended periods. Store and service liquefied petroleum gas (LPG) fueled equipment in large well-ventilated areas or outside.

WARNING

Do not troubleshoot or repair gas leaks while the engine is running.

CAUTION

Liquefied Petroleum Gas (LPG) is heavier than air and can accumulate near the floor, in sumps, and in low-lying areas.

CAUTION

Always torque fasteners and fuel connections to the required specifications. Overtightening or under tightening can allow leakage. These connections are critical to the fuel and air systems.

CAUTION

Always test for fuel leaks as instructed, as odorant can fade.

CAUTION

Close the manual fuel valves prior to performing maintenance and repairs and when storing the vehicle inside.

Specifications

This section presents the specifications for liquefied petroleum gas engines.

Liquefied Petroleum Gas (LPG) has been used as an engine fuel for many years. Modern technology and compliance with various emissions standards now mandate that certified engines be tuned to precise standards and operated on a more restrictive fuel specification for optimum performance and emissions control. Cummins Engineering Standard (CES) 20068 has been developed as a specification for liquefied petroleum gas (LPG) fueled engines. Depending on the type of engine and application (automotive, industrial, or generator), go to the appropriate engine's operation and maintenance manual for the correct fuel specification. Operators of Cummins® liquefied petroleum gas (LPG) engines **must** refer the standard/specification to the potential fuel suppliers and request confirmation as to local availability.

CES 20068 covers liquefied petroleum gas (LPG) fuel for use in automotive spark-ignited liquefied petroleum gas (LPG) engines. The requirements apply to fuel as it is delivered to the engine. This specification is **not** intended to cover certification requirements. The fuel **must not** contain water, dust, sand, dirt, oils, or any other substance or component in an amount that is detrimental to the operation of the engine. More specifications and testing methods are detailed in the standard.

Basic chemical composition is detailed in Table 7: CES 20068 Chemical Composition.

Table 7: CES 20068 Chemical Composition		
Constituents	Requirements	Test Method
Propane (C_3H_8)	90.0 percent volume minimum	ASTM D 2163
Propylene (C_3H_6)	5.0 percent volume maximum	ASTM D 2163
Butane and Heavier (C_4H_{10}+)	2.5 percent volume maximum	ASTM D 2163
Hydrogen Sulfide (H_2S)	Pass	ASTM D 2420
Sulfur (S)	123 ppmw	ASTM D 2784
Oxygen (O_2)	0.5 percent weight maximum	ASTM D 1945
Carbon Dioxide and Nitrogen ($CO_2 + N_2$)	3.0 percent volume maximum	ASTM D 1945

Cummins® liquefied petroleum gas (LPG) engines are designed and adjusted to meet performance and emissions specifications with fuel meeting these specifications. The engine can possibly operate on a wide range of fuel properties, but performance and emissions will be affected, and in extreme cases, fuel with characteristics out of these specifications can cause engine reliability or durability issues. Cummins Inc. assumes no responsibility for the use of fuels that do **not** meet this specification. Engine damage caused by fuel **not** meeting this specification is **not** covered under warranty.

Operators **must** be alert for sudden changes in engine operation, power levels, or pre-ignition. Each of these can be a sign of substandard fuel. If you suspect an issue related to fuel quality, ask your fuel supplier to sample and analyze the fuel in the vehicle, or contact a local Cummins Authorized Repair Location for assistance.

Fuel Filters

CAUTION

Gas is extremely flammable. Contents are under pressure. Vent gas from the filter by opening the drain on the filter.

CAUTION

Overtightening will distort the filter cartridge, damage the filter seal, or crack the filter head. Do not use a filter element that has been dented or damaged prior to, or during, installation.

CAUTION

Oil getting inside of the gas mass flow sensor or on the screen pack will cause poor performance.

Fuel filters are required equipment on all Cummins® natural gas engines. They are designed to remove oil and harmful particles from the fuel before they damage the fuel system or other engine components.

Oil can be introduced to a liquefied petroleum gas (LPG) engine's fuel system in several ways. The most common is from the fueling station compressor. Oil in the fuel will cause the gas mass flow sensor and the heated oxygen sensor to read incorrectly. Engine performance will be affected.

The fuel filter, Fleetguard® NG5900, needs to be drained as part of the daily or refueling maintenance checks. The interval period for draining the fuel filter is dependent on the fueling station and varies for each location. The drain interval **must** be adjusted to the time required to accumulate no more than 30 milliliters [1 ounce] of oil in the fuel filter or daily, whichever occurs first.

A liquid magnetic in-line filter is required on the liquefied petroleum gas (LPG) fueled engines between the liquefied petroleum gas (LPG) fuel tank(s) and the fuel inlet on the engine. The liquid magnetic in-line filter is **not** Cummins Inc. supplied and has a 5-micron requirement.

Go to the engine operation and maintenance manual for fuel filter replacement intervals.

Fuel Supply Hoses

The vehicle supply hose to the engine **must** be approved for use with liquid phase propane (CGA Type III Approved). Engine damage, service issues, or performance issues that occur due to the use of other products are **not** considered a defect in workmanship or material as supplied by Cummins Inc. and can **not** be compensated under the Cummins Inc. warranty.

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Section 1

ARRANGEMENT AND USAGE OF OPERATING EQUIPMENT

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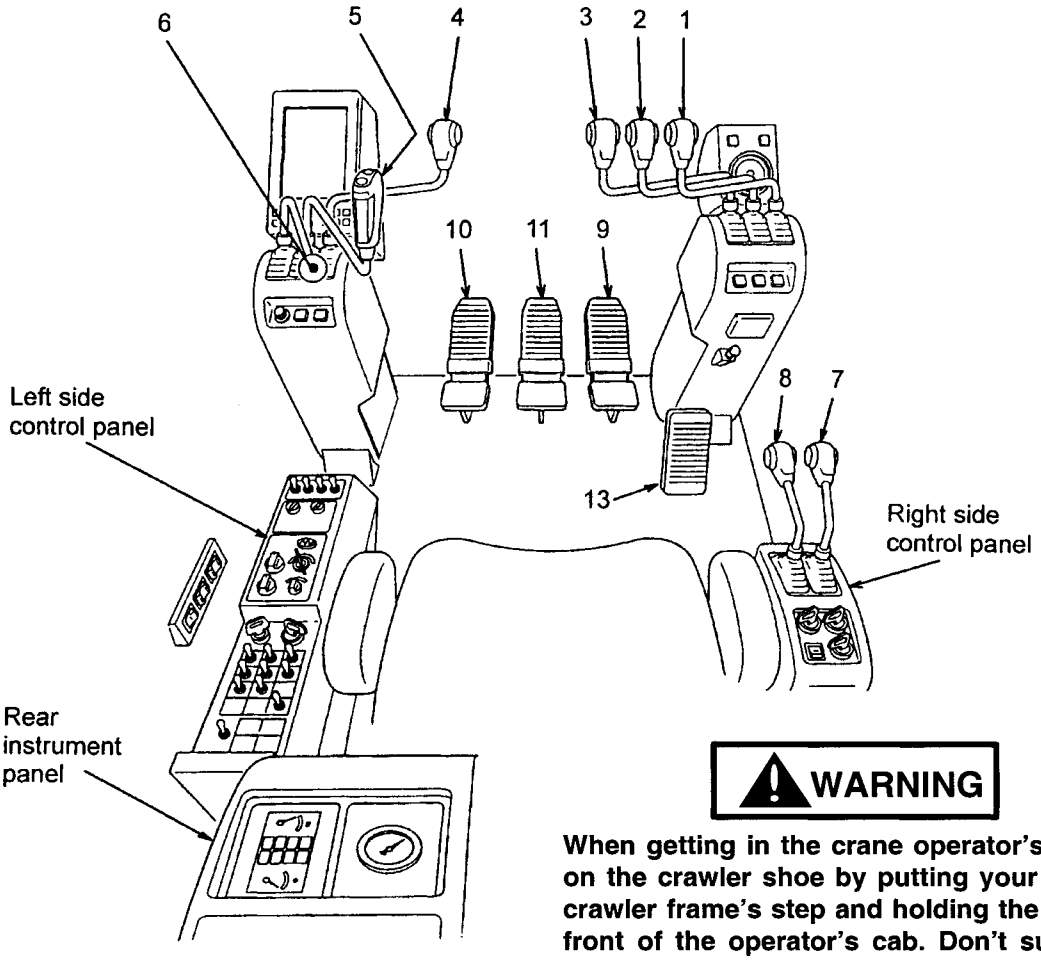
1. ARRANGEMENT AND USAGE OF OPERATING EQUIPMENT

1-1 Arrangement of control levers and pedals



WARNING

When getting in the crane operator's cab, stand on the crawler shoe by putting your feet on the crawler frame's step and holding the grip on the front of the operator's cab. Don't support your body by holding the control levers when getting in or out of the operator's cab. If the operation lock switch is at the release side, the crane will be moved by moving the lever.

No.	Name	No.	Name	No.	Name
1.	Boom hoist lever	6.	Spanner/Cwt. handling lever	11.	Third drum brake pedal (option)
2.	Main winch lever	7.	Right traction lever		
3.	Auxiliary winch lever	8.	Left traction lever	13.	Engine throttle pedal
4.	Luffing jib hoist lever or auxiliary power lever	9.	Main winch brake pedal		
		10.	Auxiliary winch brake pedal		
5.	Swing Lever				

1. When a luffing jib crane is used, the lever 1 is used for hoisting/lowering the boom and lever 4 for hoisting/lowering the jib.
2. When a standard crane is used, the lever 4 is used as a control lever for the third drum of optional specification and auxiliary power.
3. Lever 6 controls the spanner (extend sideframes)/counterweight handling cylinders.

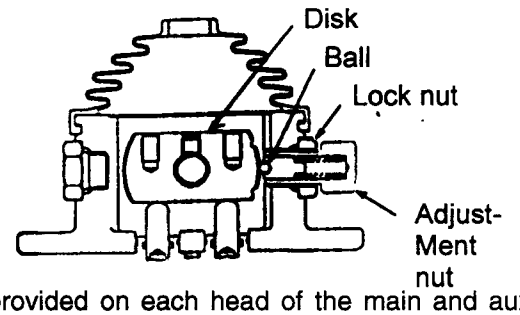
1-2 Outline of control levers

All operations are remotely controlled by manipulating the main control valve from the remote control valve.

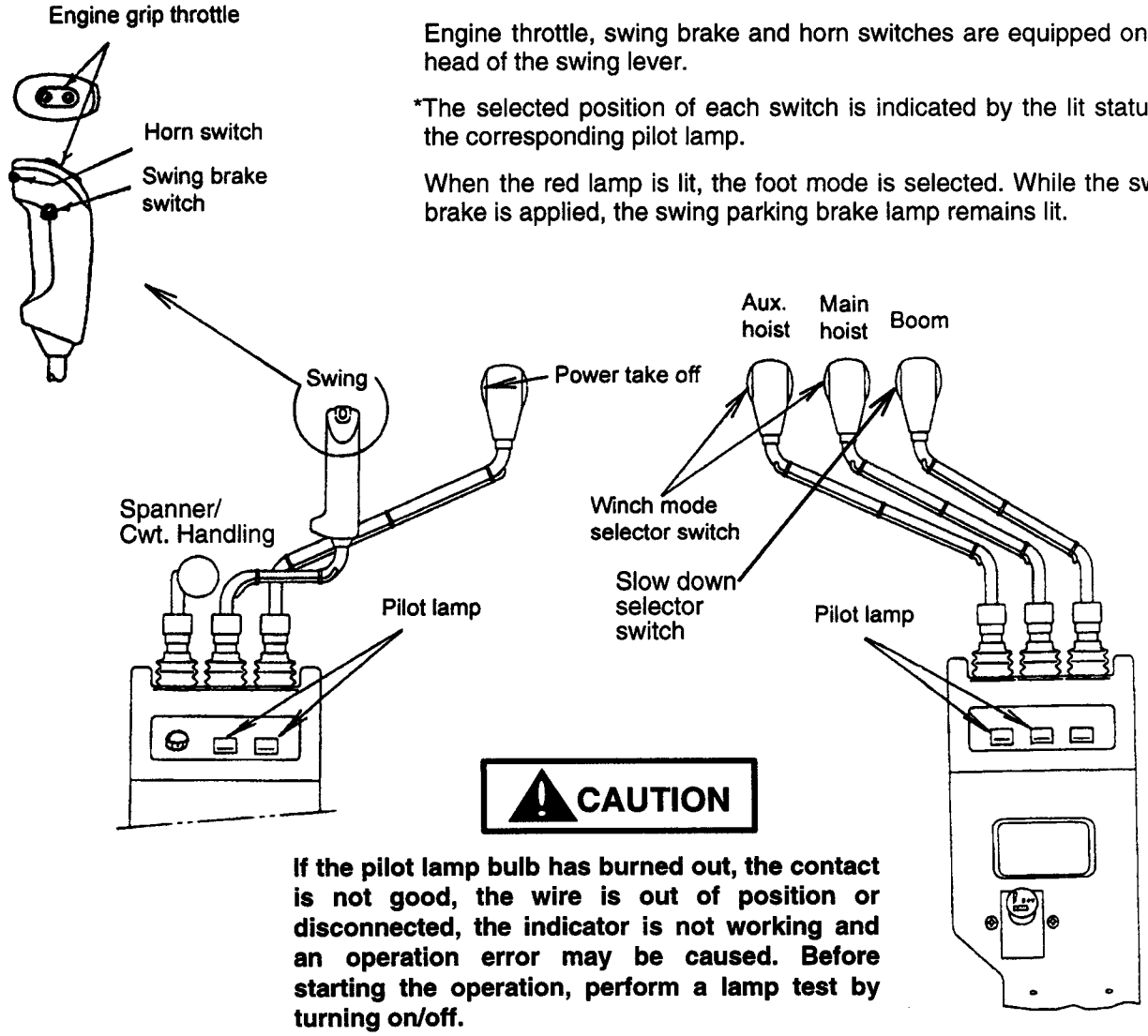
*Except for the swing lever and boom hoist pedal, each lever is provided with a lever holding device (detent) at the stroke end.

The strength of the detent is adjustable by turning the adjustment nut with the lock nut loosened. (See the figure at right.)

When tightening the nut, the detent stiffens, and it weakens when loosening the nut.



A push button switch for selection of the winch mode is provided on each head of the main and auxiliary winch levers. The automatic side and foot side are alternately selectable by pressing the switch when the winch mode selector switch on the right side control panel is set in the foot side. 3rd drum is option.



Engine throttle, swing brake and horn switches are equipped on the head of the swing lever.

*The selected position of each switch is indicated by the lit status of the corresponding pilot lamp.

When the red lamp is lit, the foot mode is selected. While the swing brake is applied, the swing parking brake lamp remains lit.

⚠ CAUTION

If the pilot lamp bulb has burned out, the contact is not good, the wire is out of position or disconnected, the indicator is not working and an operation error may be caused. Before starting the operation, perform a lamp test by turning on/off.

1-3 Function and releasing method of the operation lock device

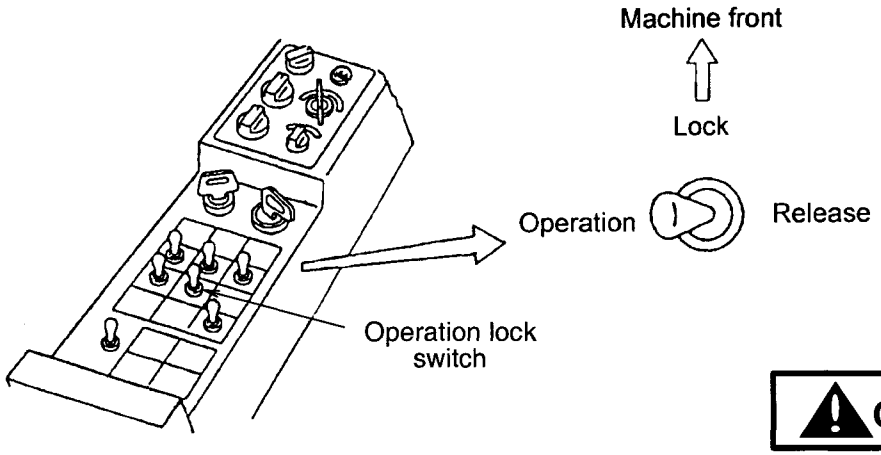
1. When turning the operation lock switch to the "LOCK" position, the operator cannot operate the machine even if sitting on the operator seat.

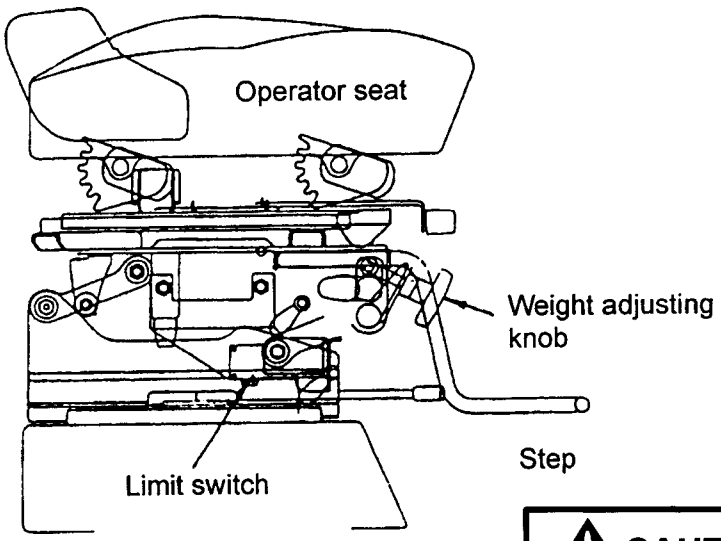
   When turning the operation lock switch to the "RELEASE" position, the operator can operate the machine even if he is not sitting on the seat.

   At the "RELEASE" position, the operation lock switch does not work. Be very careful.

   When the switch is at the "OPERATION" position and the operator sits on the operator seat, the seat moves down, the limit switch works, the oil pressure is supplied to the remote control valves and the machine can be operated by using the levers. If the operator leaves the seat when the operation lock switch is in the "OPERATION" position, the control oil pressure is cut to all the hydraulic remote controls and, after approximately 1.5 seconds, it is impossible to operate the machine even if actuating the lever.

2. If the operator has to stand up to operate the machine, he must get on the step. Always set the switch to the "OPERATION" position for safety. Only use the "RELEASE" position in very extreme conditions.





⚠ CAUTION

Before operation, make adjustment to operate the limit switch. Make adjustment so that the limit switch may operate at the value less than the operator's weight. Turn the knob for adjustment (see illustration.) The timer is set at 1.5 seconds. It is impossible to operate the levers 1.5 seconds after leaving the seat.

⚠ CAUTION

1. **This device does not function when the operation lock switch of the left operation box is turned to the "RELEASE" position. For safety this switch must be set to the "OPERATION" position.**
2. **The machine can travel even if the operation lock switch is in the "LOCK" position. If traveling operation needs to be locked, turn the travel lock switch to the "LOCK" position.**

1-4 Arrangement and operating method of switches, meters, etc.

Left side operation box

Key No.	Name	Reference Page
1	Main winch drum lock switch	1-6, 1-32
2	Auxiliary winch drum lock switch	1-6, 1-32
3	Boom drum lock switch	1-6, 1-33
4	Third drum lock switch (optional specification)	1-6, 1-39
5	Main winch drum speed selector switch	1-6, 1-29
6	Auxiliary winch drum speed selector switch	1-6, 1-29
7	- -	- -
8	- -	- -
9	Engine glow signal	1-7
10	Engine starting switch	1-7
11	Throttle mode selector switch	1-7, 1-20
12	Throttle dial	1-7, 1-20
13	Pump control dial	1-8, 1-20
14	Traction speed selector switch	1-8
15	Overload prevention device switch	1-8
16	Bypass switch	1-8
17	Crane/tower select switch (Luff)	1-8
18	Boom hoist lock switch (Luff)	1-9
19	Boom 85° alarm switch (Luff)	1-9
20	Pump control switch (slow speed)	1-9, 1-20
21	Operation lock switch	1-3, 1-9
22	Travel lock switch	1-9, 1-47
23	Travel alarm switch	1-10
24	- -	- -
25	Slowdown select switch	1-10
26	- -	- -
27	- -	- -
28	- -	- -
29	Power take off, luffing jib hoist select	1-10
30	- -	- -
31	- -	- -
32	- -	- -
33	- -	- -
46	Ctwt. handling light	1-14
47	Ctwt. handling ON/OFF switch	1-14

Operation panel on the left side of the cab

Key No.	Name	Reference Page
34	Front wiper switch	1-11
35	Roof wiper switch	1-11
36	Working lamp switch	1-11

Operation panel on the left side of the cab

Key No.	Name	Reference Page
37	OK monitor	1-11, 1-24
38	Control circuit oil pressure gauge	1-11

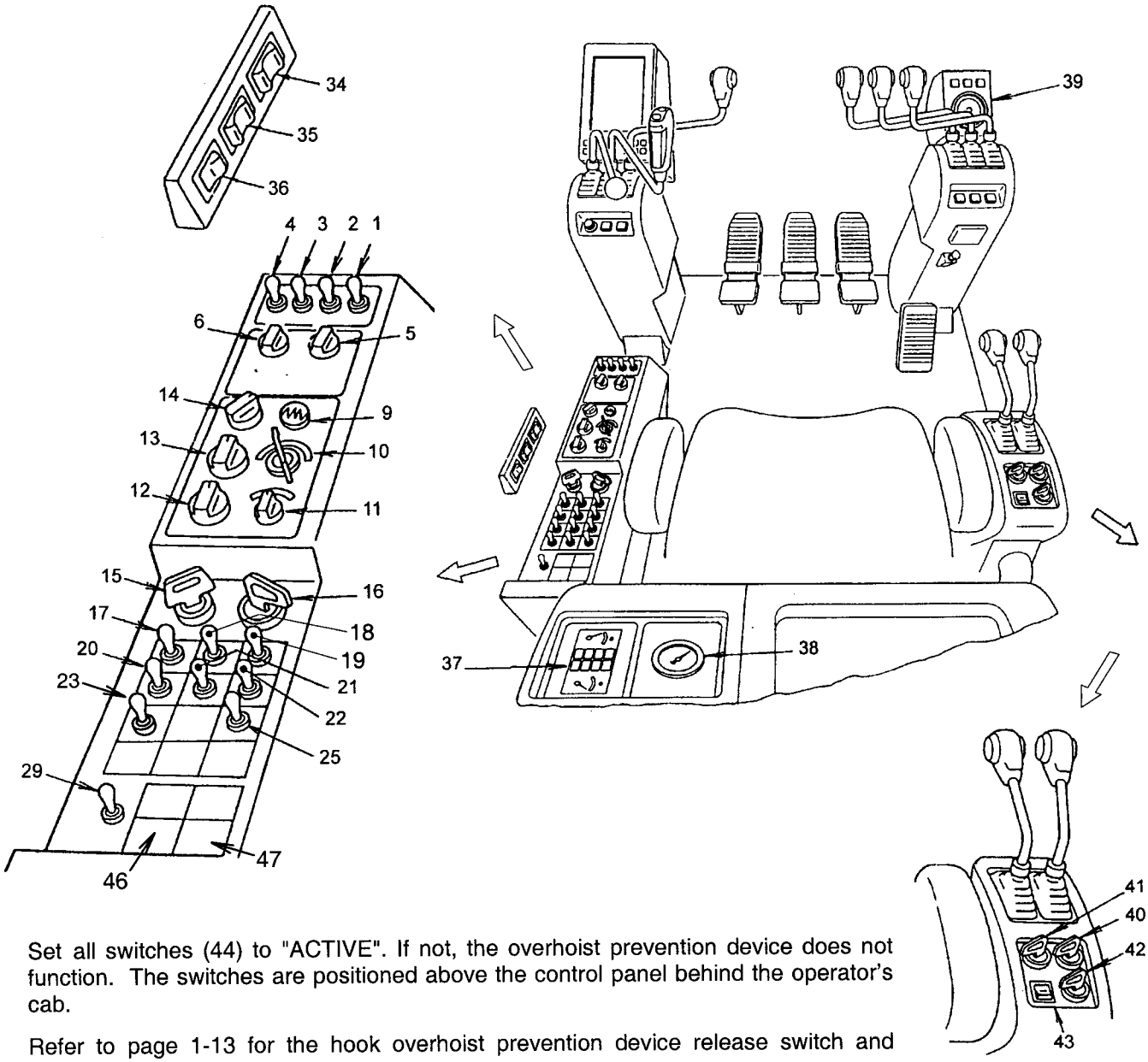
Right side lever stand

Key No.	Name	Reference Page
39	Engine tachometer	1-12

Right operation box

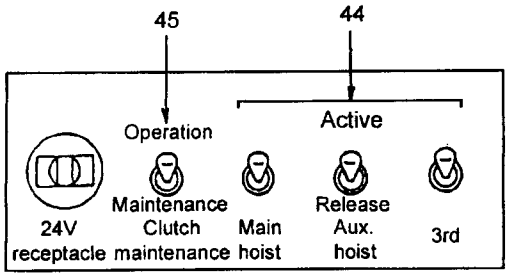
Key No.	Name	Reference Page
40	Main hoist winch mode selector switch	1-12, 1-29
41	Auxiliary hoist winch mode selector switch	1-12, 1-29
42	Third drum winch mode selector switch	1-12, 1-39
43	Swing lock switch	1-12, 1-44
44	Hook overhoist prevention device release switch	1-13
45	Clutch maintenance switch	1-13

Set the working conditions of the overload prevention device (Moment Limiter) correctly as referring to the setting method. See page 1-53.



Set all switches (44) to "ACTIVE". If not, the overhoist prevention device does not function. The switches are positioned above the control panel behind the operator's cab.

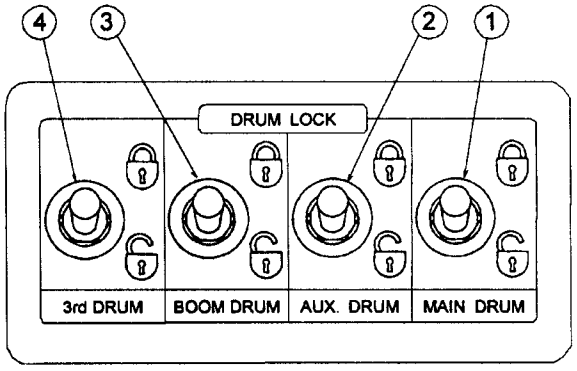
Refer to page 1-13 for the hook overhoist prevention device release switch and others.



Installed above the control panel.

Left side operation panel

Drum lock switches



(1) Main winch drum lock switch

(2) Auxiliary winch drum lock switch

(3) Boom drum lock switch

(4) Third drum lock switch (optional specification) Luffing jib drum lock switch.

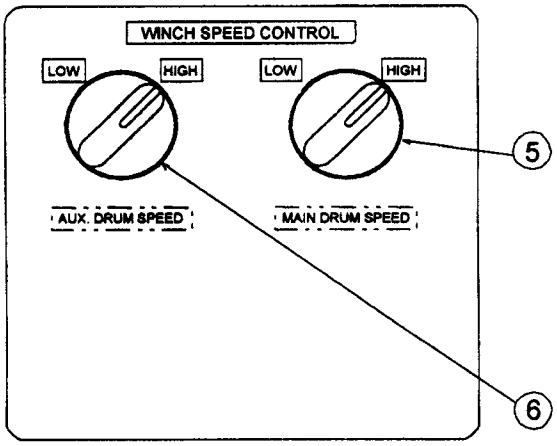
Note: Swing lock is located on right side operation panel

These are the drum lock switches for main hoist, auxiliary hoist, boom and third drums. Set the switch to the key release position, and the drum is unlocked. Hoist the drum a little if it is difficult to unlock the drum. Force is removed from the pawl and the drum is unlocked.

CAUTION

Do not move the switch to the lock position when the drum is rotating in lowering. If so, the pawl or drum may be damaged and shock load the crane.

Winch speed selector switches

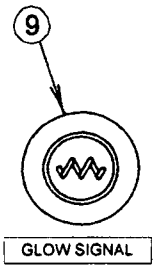


(5) Main winch drum speed selector switch

(6) Auxiliary winch drum speed selector switch

Set the switch to "LOW" , and the load hoist drum rotation is decelerated. Set it to "HIGH", and the load hoist drum rotation is accelerated. Don't change the hoisting speed during hoisting or lowering. Stop the load and apply the brake securely before changing the speed.

Note: Line pull is reduced in high speed.



(9) Engine glow plug signal

This signal shows the engine preheating condition.

(10) Engine starting switch

OFF: Engine stop position

The key can be inserted or removed. The complete electric circuit of the crane is "OFF".

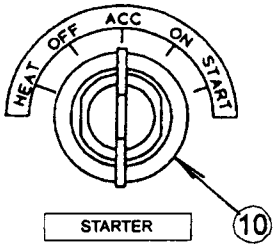
START: Engine start position

Do not operate the starter for more than 15 seconds at a time.

The use time of "START" is 15 seconds or less. Wait for 20 seconds before reusing the "START" position. Release the key at this position, and the switch returns to "ON" automatically.

ON: Engine run position

Don't move the switch to other positions except "ON" during operation to protect the electric components.

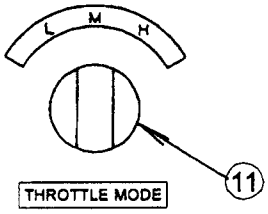


HEAT: Air heater position

In a cold climate, set the switch to "HEAT" to heat the suction air and to start easily. Approximately 60 seconds are necessary for preheating until the heater lamp glows. The preheating time is changed according to the battery capacity.

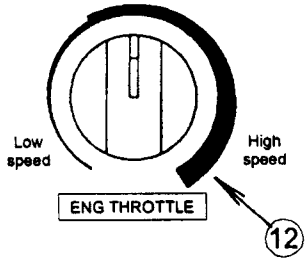
ACC: Used when listening to the radio, etc. when the engine stops.

NOTE: The engine cannot start if the main, auxiliary or third drum winch mode selector switch is not at the automatic position. In such a case, the interlock red lamp is lit above the engine tachometer when the key is turned to the "START" position.



(11) Throttle mode selector switch

This switch is used to select the engine's acceleration speed. When the operator accelerates the engine, the switch selects the time required to reach the selected speed. The time is longer at "L" and shorter at "H".

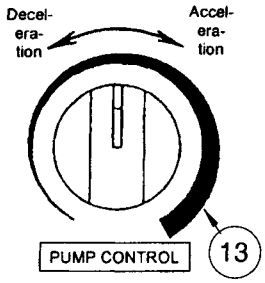


(12) Throttle dial

The operator can control the engine speed manually with this switch. Determine the minimum speed needed with this switch, and for higher speeds override this dial by using the hand throttle or foot throttle.

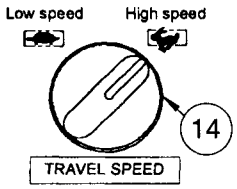
(13) Pump flow control dial

This dial is used to change the flow delivery of the hydraulic pump manually when the switch (20) is at "MANUAL". The delivery is not changed when the switch (20) is at "AUTO". The engine may stall if this dial is fully turned to the acceleration position when the engine speed is low. Be careful.



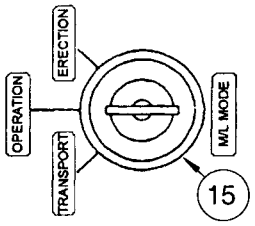
(14) Travel speed selector switch

This switch is used to select the travel speed. The high speed is selected at the rabbit position and the low speed is selected at the tortoise position. Stop traveling and then change the speed.



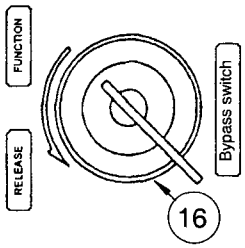
(15) Overload prevention device (moment limiter) mode switch

Position this switch to "OPERATION" during the crane operation. Position it to "ERECTION" when disassembling or assembling the attachment. The display unit of the overload prevention device blinks at "ERECTION" and at the same time the function of the device is canceled except "Boom Overhoist Prevention". Even at "ERECTION" it is possible to hoist or lower the boom but you must be careful because the overload prevention device does not work. One of the three-colored alarm lamps (the red one) is lit at "ERECTION". The electric power is "OFF" when the switch is at "TRANSPORT". You can remove the key at "OPERATION". Don't switch to "TRANSPORT" and "ERECTION" during the crane operation.



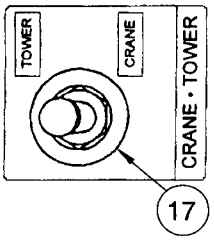
(16) Bypass switch (reset switch)

This switch can release the automatic stop or motion cut condition. Even when the machine stops automatically, you can operate it by positioning this switch to "RELEASE". But don't carry out operation to the dangerous side, or an accident may occur. Refer to Page 4-43 or 4-44 for how to release the stop condition with the reset switch. Position the switch to "FUNCTION" and remove the key for safety. When the hook overhoist prevention device operates, the reset switch cannot release the condition.



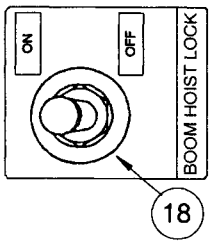
(17) Crane/tower selector switch (Optional)

Position this switch to the crane position in crane operation and to the tower position in luffing tower crane and luffing jib crane operation.



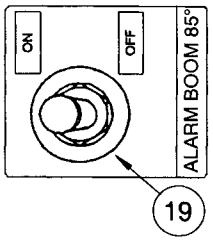
(18) Tower boom hoisting lock switch (Option)

This switch is used to stop the tower boom hoisting winch. Position it to "ON", and the boom (tower boom) cannot be hoisted. Refer to Page 1-112 for details of operation.



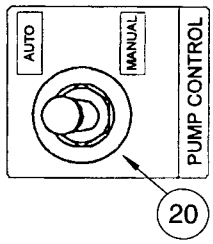
(19) Boom 85° alarm switch (Option)

The alarm buzzer sounds when the tower boom angle is 85° or more. The alarm does not sound if this switch is at "OFF". The alarm lamp is lit at the foot of the boom (boom) hoist lever when the buzzer sounds.



(20) Pump control selector switch

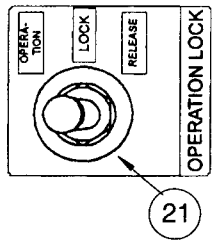
When this switch is at "AUTO", the pump delivery is automatically changed according to the change of the engine speed. When it is at "MANUAL", the delivery is set with the dial (13). Set this switch to "MANUAL" before operating the dial (13).



(21) Operation lock switch

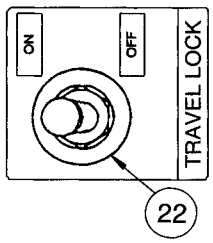
This is a safety device to lock the machine when actuating the lever accidentally. Position this switch to "LOCK" when leaving the operator's cab.

- The operation lock does not function when this switch is in "RELEASE".
- The machine does not function even if actuating the lever in "LOCK".
- In "OPERATION", the operator can operate the machine by actuating the lever only when sitting on the operator seat.
- It is possible to travel the machine even if the switch is at "LOCK" or "OPERATION".



(22) Travel lock switch

Position this switch to "ON", and the machine cannot travel even if actuating the lever. The travel lock switch is independent of the operation lock switch.

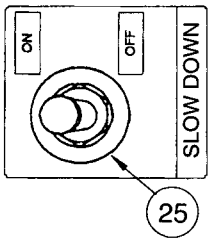


(23) Travel alarm switch

This switch alerts surrounding personnel with a voice or buzzer when the machine travels. The alarm stops when the switch is at "OFF".

(25) Slow down (Gentle Stop) switch

A shock occurs when the crane stops at the load ratio of 100%. A function is provided to reduce such a shock. The function decreases the hoisting speed beforehand when the moment limiter indicates that the load ratio is 90% or when the boom angle reaches the upper or lower limit. "Gentle Stop" can be released by using this switch. If "Gentle Stop" is released, a shock occurs when the crane stops. Refer to the description of the overload prevention device for the angles at which the hoisting speed of the boom or jib is to be decreased. (See Pages 1-86, 87 "Setting of Gentle Stop"). If "Gentle Stop" is necessary, set this switch to "ON". When the crane is working in "Slow Down Operation" condition, the slow speed lamp is lit on the engine tachometer.

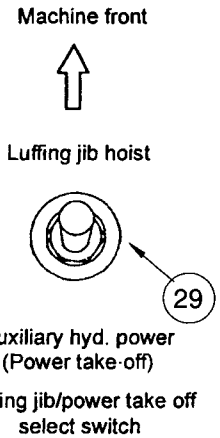


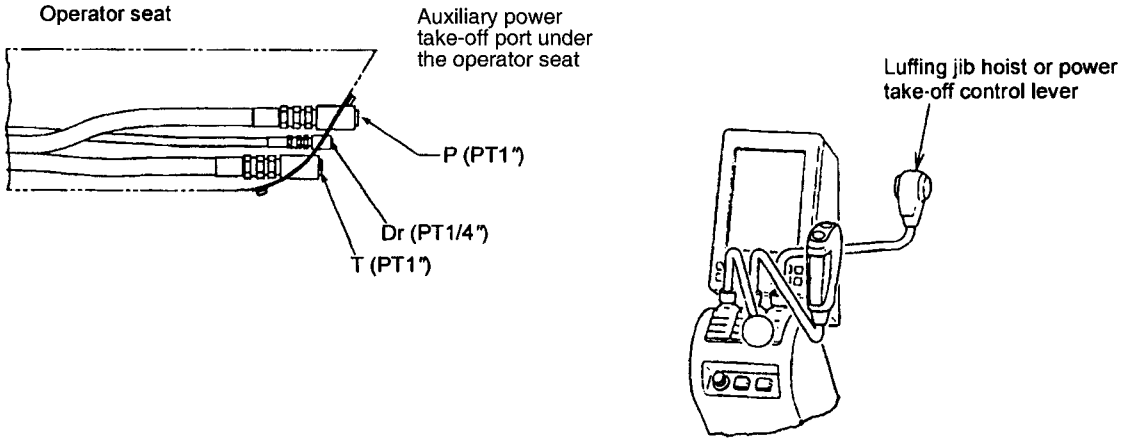
(29) Luffing jib hoist/power take-off select switch (2nd circuit selector) (Option)

Set the switch to the "LUFFING JIB HOIST" position, and the luffing jib can be operated by the lever as illustrated below.

Set the switch to the "POWER TAKE-OFF" position, and the auxiliary power can be used. When using the auxiliary power, connect the auxiliary power take-off port piping (which is under the operator seat) with the outside. Normally, set the switch to the "LUFFING JIB HOIST" position.

The power take-off port piping is arranged as illustrated below.

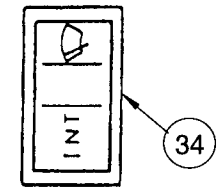




Operation panel on the upper left side of the cab

(34) Front wiper switch

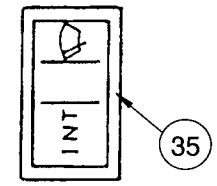
The intermittent or continuous operation can be selected. Press the "INT" side to select the intermittent operation.



Front wiper

(35) Roof wiper switch

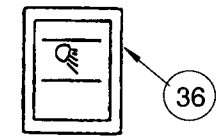
The intermittent or continuous operation can be selected. Press the "INT" side to select the intermittent operation.



Roof wiper

(36) Working lamp switch

This is the cab head lamp switch. Press the picture side, and the lamp is lit.

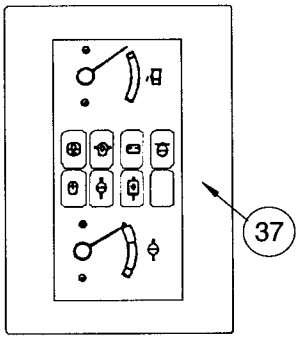


Working lamp

Rear instrument panel

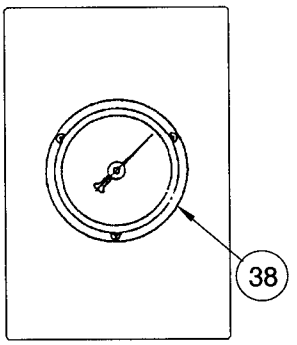
(37) OK Monitor

Refer to Page 1-24 for the details of the OK monitor, Engine & System Warning Lights.



(38) Control circuit oil pressure gauge

Make sure that the pointer is within the blue 850 to 1280 psi (60~90kgf/cm^2) zone. The blue zone shows the proper control pressure to brakes and clutches The alarm buzzer sounds when the pressure is lowered to 50kgf/cm^2 or less.

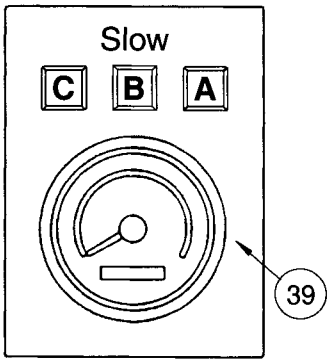


Blue : 850 to 1280psi
Red : 0 to 850psi
1280 to 2130psi

Right side lever stand

(39) Engine tachometer & hour meter

The pointer indicates the engine speed (R.P.M.). The lower 4-digit numerals indicate the accumulated operation time. The operation time should be a standard for maintenance of the machine.



The pilot lamps above the tachometer indicate as follows:

[A] Indicates engine start interlock. When the main, auxiliary and third drum winch mode selector switches are not at "Automatic", the lamp is lit if positioning the starting switch to "START". When it is lit, the engine cannot start.

[B] This lamp is energized when the Slow Speed Switch on the boom hoist control lever handle is depressed. The main pump flow is decreased for operation of the hoists, boom, 3rd drum and traveling functions.

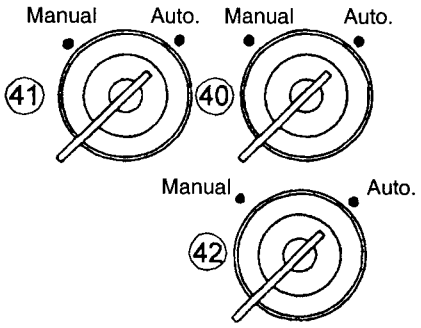
[C] This lamp is lit when the swing brake is applied.

Right side operation panel

(40) Main hoist winch mode selector switch

(41) Auxiliary hoist winch mode selector switch

(42) Third drum clutch mode selector switch

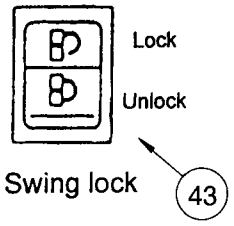


These switches are used to set the main, auxiliary and third drum winch operation to "Automatic" (automatic brake operation) or "Automatic" (brake pedal operation). The selection is linked with the grip switches of the main/auxiliary levers and foot brakes. Refer to Page 1-29 and after for details. When the main, auxiliary and third drum winch mode selector switches are not at "Automatic", the engine cannot start.

Right side box winch mode selector switches	Winch mode is selected by the push button switches on the levers.
Automatic	Automatic position is always set by the key switches.
Manual	Manual is selected by the push button keyswitch and foot brake depressed.

(43) Swing lock switch

Press this rocker switch to lock & unlock the swing. Before operating the swing lock, align the lock pin with the pin holder position accurately. After switch operation, make sure that the swing lock is securely applied. The machine can only be locked over the front or over the rear.



⚠CAUTION **Do not depress the lock rocker switch while the crane is swinging or damage can occur to the lock assembly.**

(44) Overhoist prevention device switches (Anti-two block)

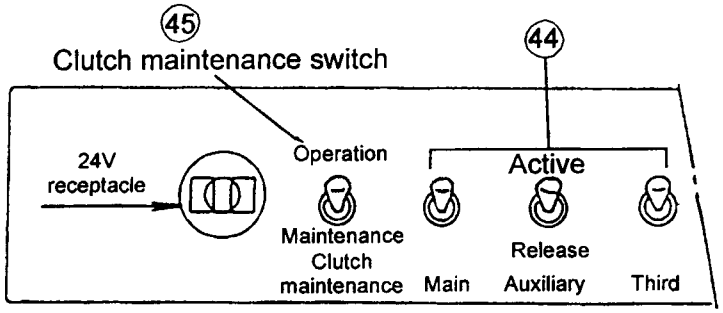
The switches are installed above the control panel.

Work	Switch Position		
	Main Hoist	Auxiliary Hoist	Third Hoist
Crane, clamshell and other works	Position the switch of the main hoist, auxiliary hoist or third hoist (third drum) winch which is used to "ACTIVE".		

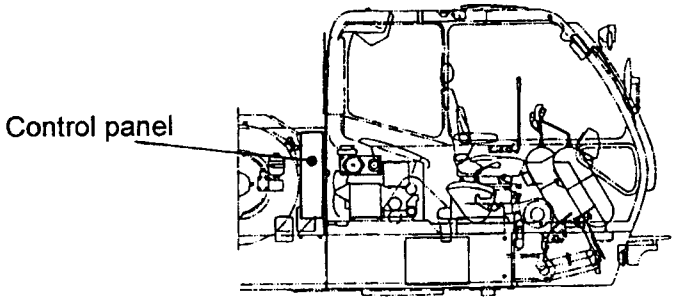
Position the switches of the main, auxiliary and third winches to "RELEASE" when disassembling or assembling. When starting crane operation after assembling, position the above switches to "ACTIVE". In clamshell or other operations, position them to "ACTIVE" if necessary.

⚠ WARNING

Position the overhoist prevention device switches to "ACTIVE" before operating the crane. If not, the overhoist prevention devices do not function and an accident such as overhoisting of the hook may occur.

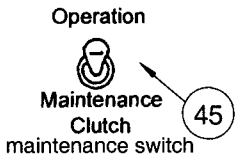


Above the control panel



(45) Clutch maintenance switch

When it is necessary to release the main and auxiliary clutches for adjustment or repair, position the clutch switch to "MAINTENANCE" while the winch mode is at "MANUAL". The main and auxiliary clutches are released at the same time. When checking or repairing the clutch, one person must sit in the operator's seat and turn the clutch to the proper position for maintenance.



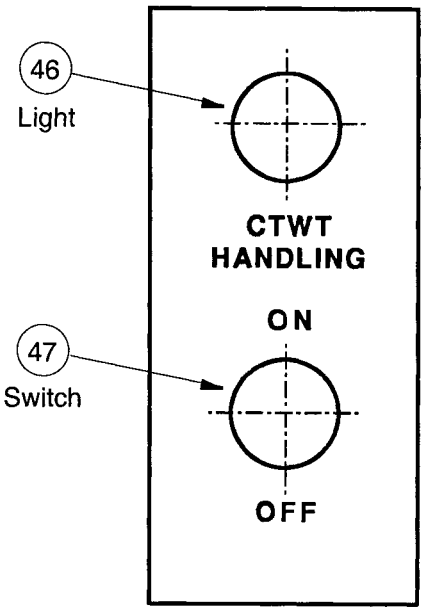
(46) Counterweight handling circuit "ON" light

This lamp is lit when counterweight handling circuit is activated. When lit, the #6 spanner/ctwt handling lever* operates the counterweight handling cylinders instead of the track extending cylinders. The (47) "ON/OFF" switch is turned to "ON".

(47) Counterweight handling switch

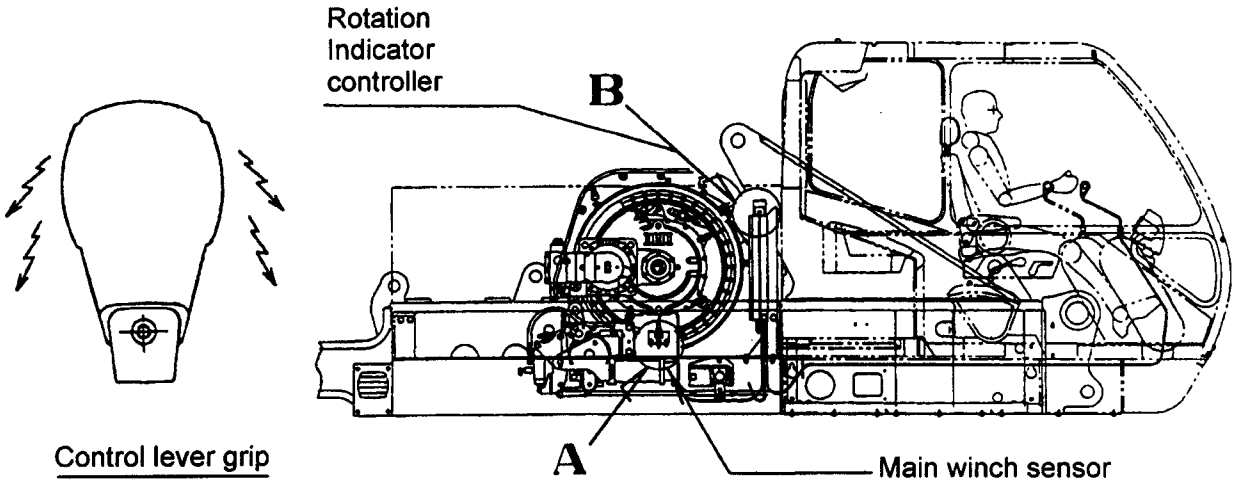
Switch to "ON" for operating the #6 spanner/ctwt handling lever* to activate the counterweight handling cylinders. Switch to "OFF" to use the #6 lever for extending or retracting the tracks.

*See page 1-1 for location of lever #6



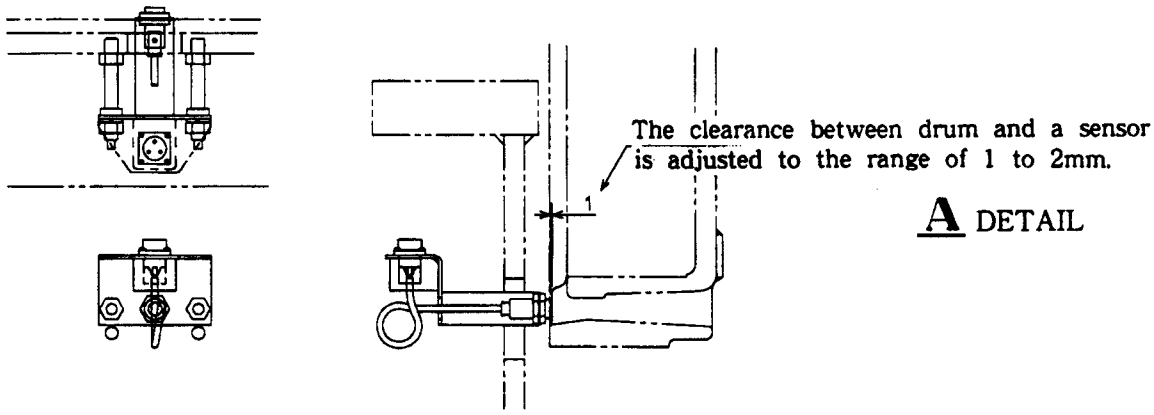
1-5 Drum rotation indicator (Optional specification)

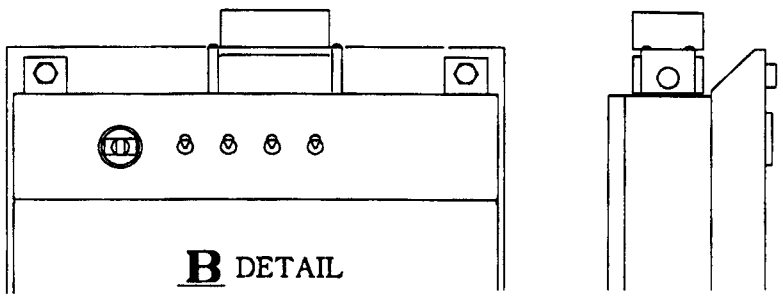
This device vibrates the hoist lever grip when the main or auxiliary winch drum rotates and so indicates the drum rotation for the operator. The vibration stops when the drum rotation reaches the specified or higher value.



- The operation power supply is constantly "ON".

  The power supply is connected when the engine key is "ON"





2. PREOPERATIONAL CHECK

2-1 Operator aids

⚠ WARNING

Check the operator aids according to the regulations before operation. If an operation aid malfunctions, the crane may tip or boom may collapse. Check the overhoisting prevention device in a very slow speed to stop the device if necessary.

1. **Operate the overhoisting prevention device and make sure that it operates smoothly. Make sure that the hook or boom stops automatically when hoisting it slowly in a low speed.**
2. **Operate the overload prevention device and make sure that it operates smoothly. Lower the boom with no load, and make sure that the buzzer sounds continuously, the boom stops automatically and the load ratio "100%" is displayed when it reaches the boom lower limit angle.**
3. **Operate the second throwout and make sure that the winch, boom and third drum stop automatically.**

⚠ WARNING

2-2 Inspection of wire rope

1. **If the boom hoist rope is cut, a serious accident such as the boom falling down may be caused. It is an obligation to check the boom hoist rope before operation. If the rope reaches the allowable limit, replace it at once.**
2. **If the suspension pendant rope for boom is cut, a serious accident such as the boom or boom falling down may be caused. It is an obligation to check the pendant rope before operation. Check carefully the corrosion of the metal fixtures in which vibration is reduced, and the cutting of the element wires. If the rope is damaged or any problem is found in the connecting section, replace the part at once.**
3. **Check the wire rope for lifting load, too. Refer to "Chapter 3 MAINTENANCE" for the standard of wire rope replacement.**

⚠ WARNING

If a lifting tool such as a sling wire rope is cut, a person may be injured by the dropped load. Check the lifting tools before operation. If there is a problem, replace the tool at once.

Replacement criteria for sling wire rope

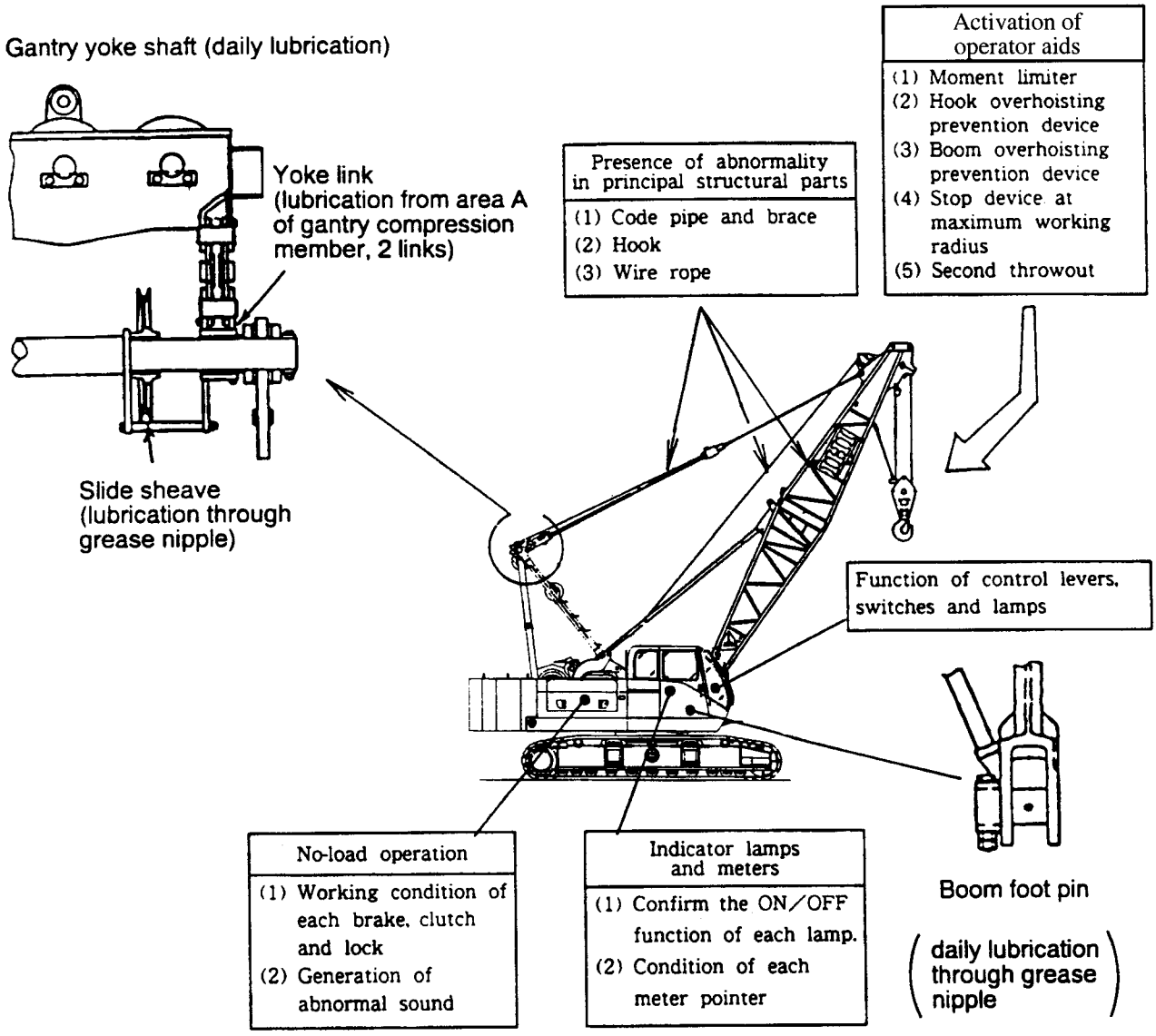
a. **The diameter is reduced by 7% or more than the nominal diameter.**
b. **10% or more wires (except fillers) are broken within one lay of the rope.**
c. **The rope is kinked.**
d. **The rope is extremely deformed or corroded.**

For other lifting tools, refer to the Regulations on Safety of Cranes.

2-3 Check points

The preoperational check must be performed.

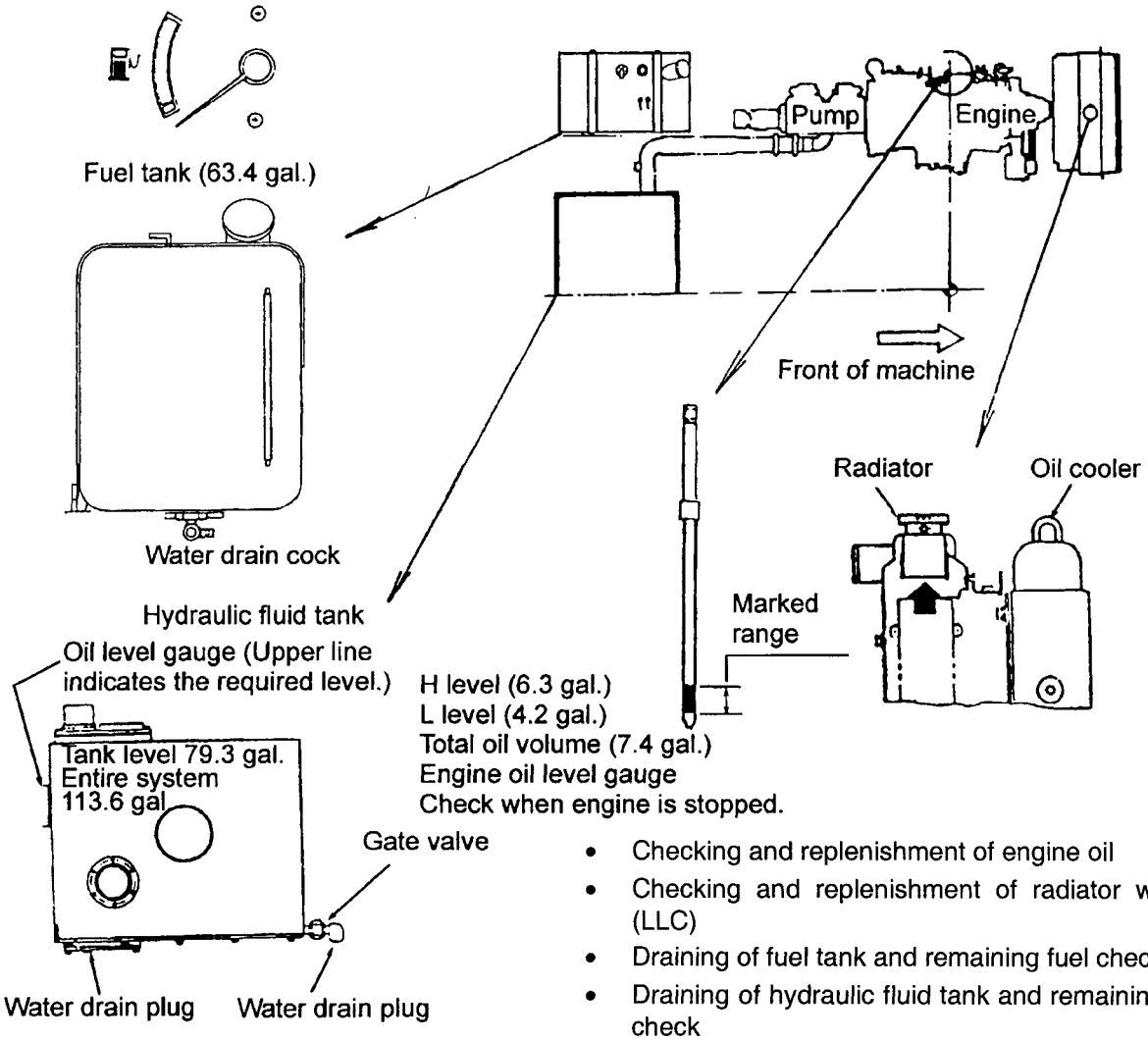
Carry out functional checking on the overhoisting prevention device, overload prevention device other operator aids, brakes, clutches and other operation-related devices.



⚠ CAUTION

1. **Actually operate each operator aid to confirm smooth operation.**
2. **If an abnormality is found, normalcy must be restored immediately by repair, etc.**
3. **When the engine is rotating, checking on the engine side calls for adequate attention to safety. Adequate attention should also be paid to safety when the machine is operated for checking.**
4. **Make sure that the winch mode changes correctly.**

Fuel gauge (on rear panel of operator's cab)



- Checking and replenishment of engine oil
- Checking and replenishment of radiator water (LLC)
- Draining of fuel tank and remaining fuel check
- Draining of hydraulic fluid tank and remaining oil check

⚠ CAUTION

1. **The fuel tank and hydraulic fluid tank should be drained before starting the engine because moisture has gathered at the bottom of each tank. After slight draining, check if water is mixed. If not mixed, the fuel or oil is normal. If mixed, complete draining is required. Water should be drained monthly.**

2. **After starting the engine, perform adequate warming-up of the engine and hydraulic system. Warming-up takes at least 5 minutes. During the warming-up period, gauges and meters should be checked.**

   There may be cases where no-load operation, short-interval relief operation or the like is required for raising the temperature of the hydraulic fluid. In winter or a cold area, a longer warm-up period is desirable.

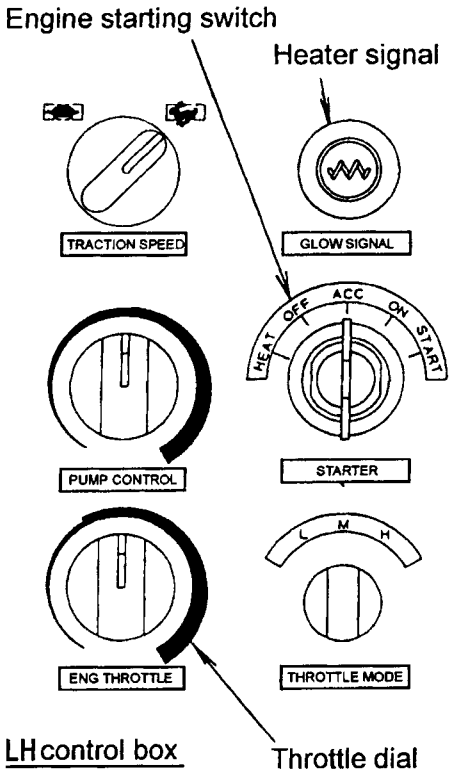
3. **Level of hydraulic oil has a regular upper limit level in the state of crawler retraction and A-frame folding. In the working state for crawler extension and A-frame raising, the oil level is below about 0.4" (10mm) from upper limit level.**

3. START OF ENGINE & USAGE OF ENGINE THROTTLE & EACH SWITCH

3-1 Engine start

CAUTION

1. **The engine cannot be started unless the main, auxiliary and 3rd winch mode selector switches (40), (41) and (42) on the right-side operation box are set at the "AUTOMATIC" position. In such a case, the interlock lamp above the engine tachometer is lit when the starting switch is at "START". In such a case, the interlock red lamp is lit above the engine tachometer when the key is at "START".**
2. **Turn the winch mode selector switches to the "AUTOMATIC" mode and depress all the brake pedals. In addition, make sure that each control lever is positioned at "NEUTRAL".**
3. **Before starting the engine, sound the horn or turn on the voice alarm switch to inform personnel of engine start.**



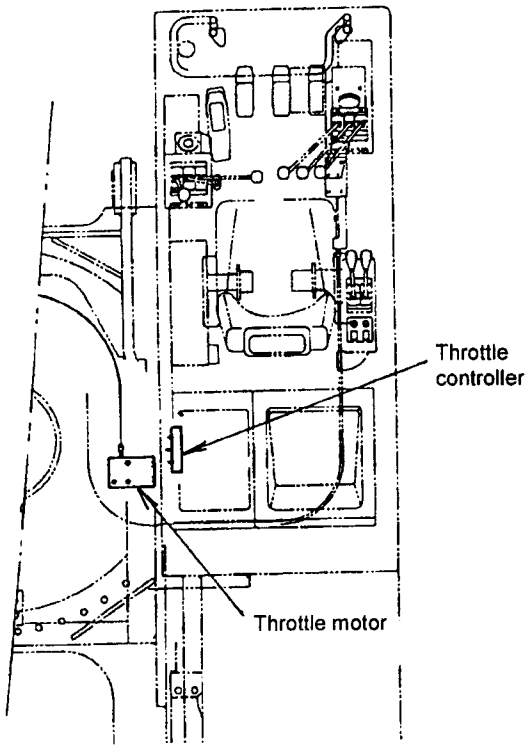
1. Turn "ON" the engine starting switch, and the battery relay will work to connect with the power supply.
2. Turn the throttle dial to the medium speed position.
3. Turn the key switch to the "START" position, and the engine will start.
4. If the key switch is released the moment the engine starts, it will return to the "ON" position automatically.
5. Return the throttle dial to the low speed position and carry out idling to warm up the engine.

NOTICE

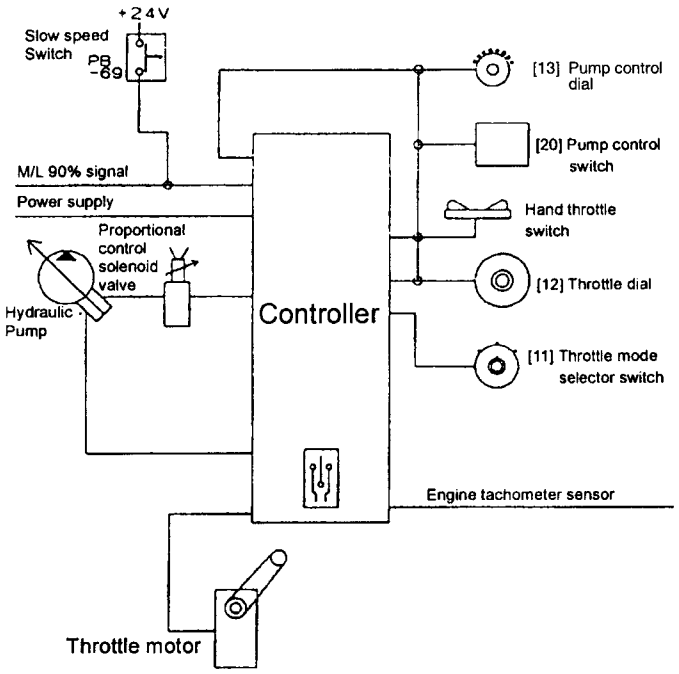
1. **Preheat the engine before starting in winter or a cold area.**
2. **Refer to Page 1-7 for handling the starter switch and heater signal.**
3. **While the engine is rotating, don't turn the starting switch to other positions except "ON". If so, an overvoltage will be applied to the electric circuit, which may damage this circuit.**
4. **Check the "OK" monitor and control circuit oil pressure gauge during warm-up running.**

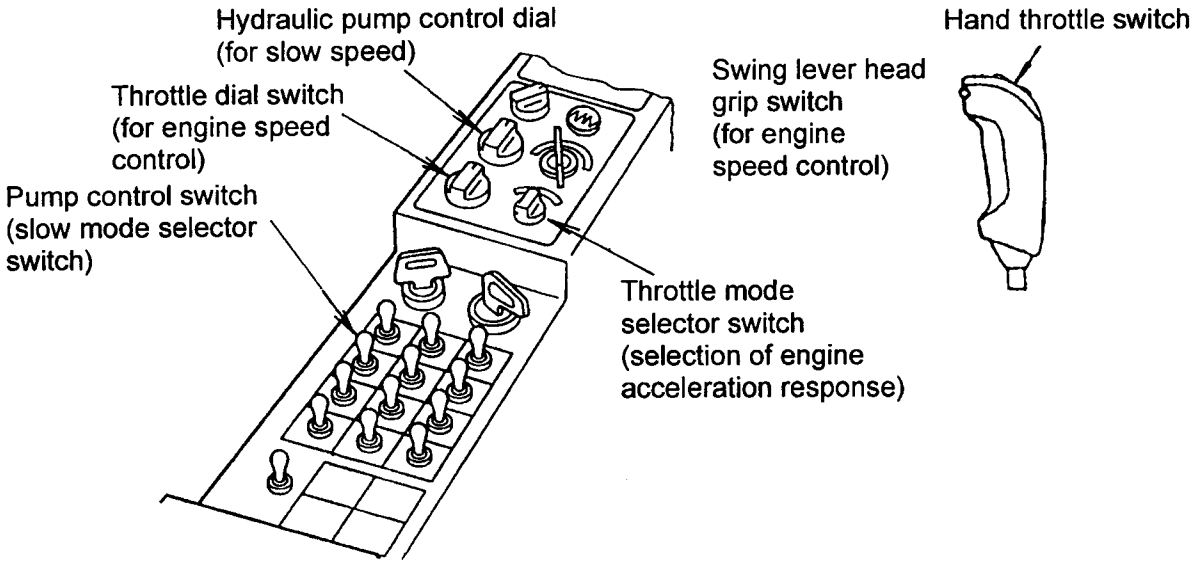
3-2 Handling of engine throttle

1. This is an electrical engine throttle dependant on a DC motor drive.
2. This is a remote control system. The rotation of throttle motor is increased or decreased by the command voltage from the throttle controller.
3. A proportional control solenoid valve is incorporated with the hydraulic mechanism. The delivery of hydraulic pump is controlled and engine stall is prevented by the command voltage from the throttle controller electrically.



Electric engine throttle system



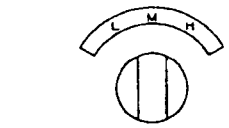


3-3 Method of operation

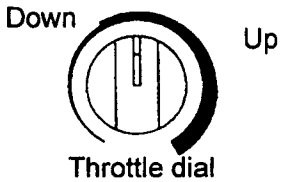
1. Position the throttle mode selector switch at any of 3 steps. A larger value signifies a quicker change of rotational speed.
2. When turning the throttle dial clockwise, the rotational speed increases, and it is reduced when turning the dial counter-clockwise. The hand throttle increases the speed when pressed forward and reduces the speed when pressed backward. (Current speed is retained with the switch at neutral.)
3. Set the desired rotational speed with the throttle dial in advance (minimum rotational speed.) For increasing or decreasing the rotational speed in the course of operation, the hand throttle switch is usable. However, this switch is effective only within a speed range higher than the level set by the throttle dial beforehand. When a lower speed is necessary, the setting of the throttle dial should be lowered.
4. An idling speed of 750 rpm is set by the engine governor. This means that the throttle dial cannot adjust the engine speed below the idling speed.

   Even when the engine is idling, the throttle dial can be further turned in the engine speed reduction direction. This reduces the tilt angle of the hydraulic pump, switch plate so cutting oil delivery from the pump and saving fuel.

   For operation within the range from idling to full speed, the time lag can be avoided by turning the throttle dial up to the point just before the engine speed increases, then using the grip throttle.
5. If a problem occurs in the control system, the engine speed can be increased and decreased by the manual increase and manual decrease switches after turning the auto/manual selector switch of the engine throttle controller to the manual side. If the engine speed cannot be changed, press the switch of the controller. The system returns to the original condition.



Throttle mode selection

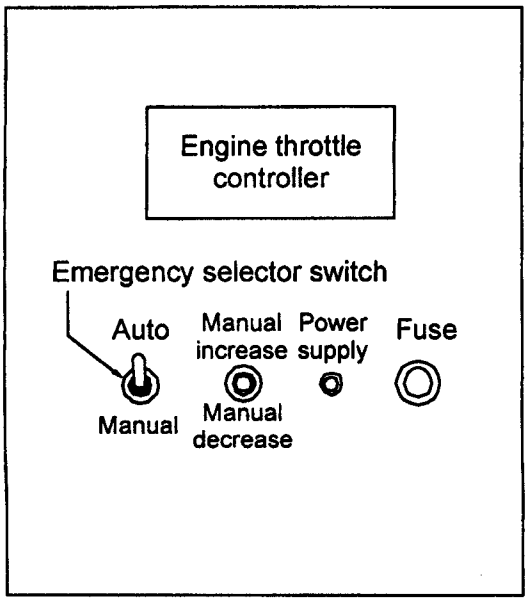


Throttle dial

Backward Forward

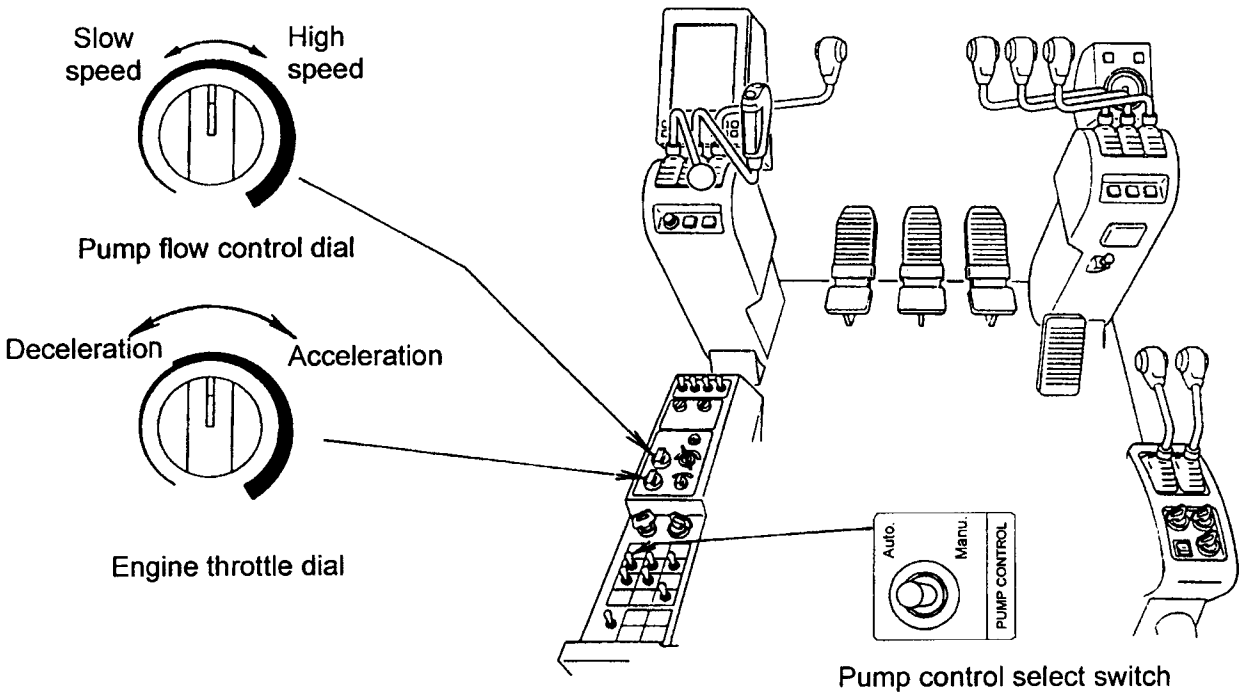
Hand throttle

Foot throttle
(special specification)



- The emergency selector switch on the front face of the engine throttle controller should normally be turned to the "AUTO" position. In the event the throttle dial or throttle controller becomes faulty, manual operation is allowed with the selector switch turned to the "MANUAL" position.
- Minimum rotational speed of the engine can be set by the throttle dial on the left-side box. Beyond the set rotational speed, the hand throttle or foot throttle is used for control.

3-4 Pump flow control (slow speed operation)



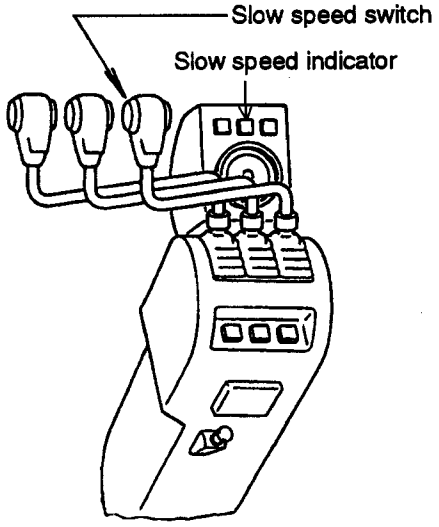
1. When normal operation is done:
   Pump control switch to the "AUTO" position. Adjust the engine rotational speed directly by the engine throttle dial.
2. When slow speed operation is done:
   Set the pump control selector switch to the "MANUAL" position. Turn the pump flow control dial to the "SLOW SPEED" position, reduce the delivery of the 1st and 2nd pumps and perform a slow operation. (Main/auxiliary hoist, 3rd drum, boom hoist and travel). If the pump flow control dial is set to the "HIGH SPEED" position when the engine speed is low, an engine stall may occur. Be careful!

⚠ CAUTION

Don't change the pump control selector switch during operation. It is dangerous because the speed is decreased or increased rapidly. Stop the machine, make sure of safety and then change the switch.

3-5 Slow speed switch

When the slow speed switch is "ON" at the boom hoist lever grip and the winch drum rotates at slow speed, the slow speed indicator lamp is lit at the lever stand to show that the drum rotation is at slow speed. This switch slows pump flow for slow operation of the main/auxiliary hoist, 3rd drum, boom hoist and travel functions. Swing is not affected.



Right-side lever stand

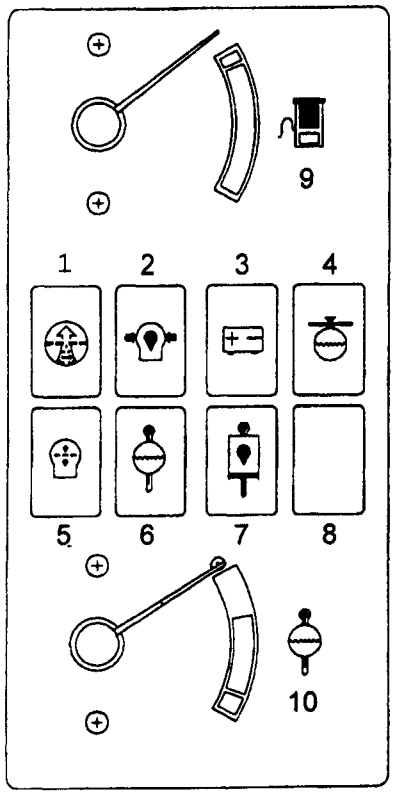
4. OK MONITOR

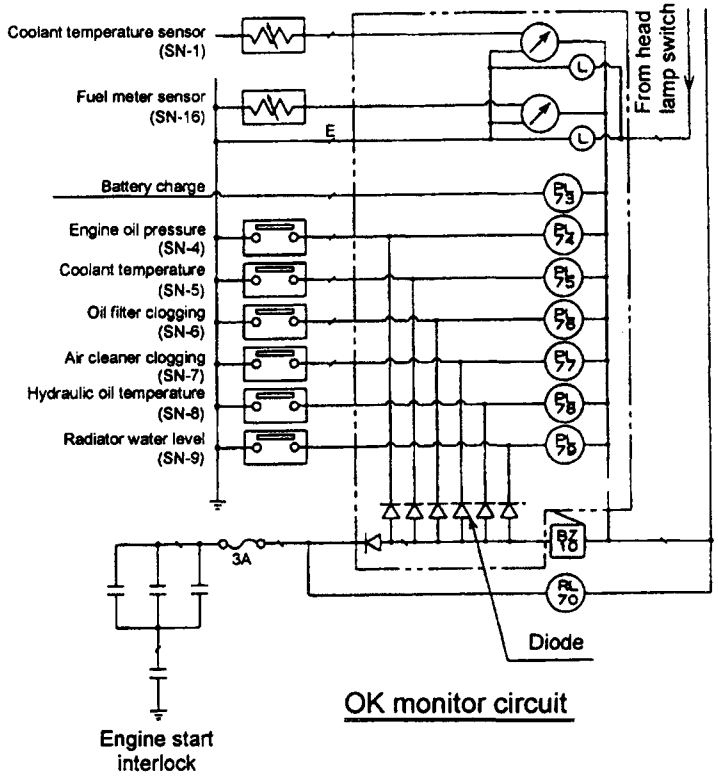
(37) Details of OK monitor

When the engine starting switch is at "ON", all the monitor lamps are lit. After the engine starts, check the monitor lamps. Start the work when all the lamps are turned off and the symbol marks disappear in the display units.

NOTICE

If there is trouble in one of the following display units, the monitor "red" lamp is lit. When the buzzer sounds and the red lamp is lit before or during operation, stop the operation, stop the engine and repair the part causing the trouble.





OK monitor circuit

Key No.	Name	Key No.	Name
1	Air cleaner clogging	6	Coolant temperature
2	Engine oil pressure	7	Hydraulic oil temperature
3	Battery charge	8	---
4	Radiator water level	9	Fuel meter
5	Oil filter clogging	10	Engine coolant temperature

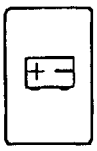
Operation of monitor lamp and buzzer

1. Air cleaner clogging

   When the air cleaner is clogged, the lamp is lit and the buzzer sounds. Clean the element.

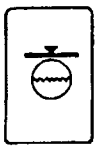
2. Engine oil pressure

   When the pressure exceeds 6kgf/cm^2, (85 psi) the lamp is lit and the buzzer sounds. When the pressure is lowered abnormally, the lamp is lit and the buzzer sounds.



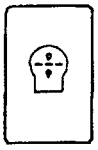
3. Battery charge

   When the battery is not normally charged, the lamp is lit and the buzzer sounds. (Excessive discharge or insufficient charge).



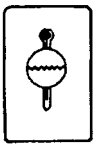
4. Radiator water level

   When the radiator water is not full, the lamp is lit and the buzzer sounds. The sensor is in the overflow reservoir.



5. Oil filter clogging

   When the engine oil filter is clogged, the lamp is lit and the buzzer sounds. Replace the filter element regardless of the replacing time of the engine oil.



6. Coolant temperature

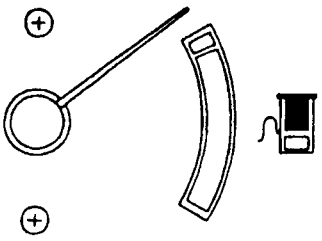
   When the coolant temperature is 100°C (212°F) or higher, the lamp is lit and the buzzer sounds. Set the engine at the idling speed to lower the temperature. Then, stop the engine and search for the cause.

7. Hydraulic oil temperature

   When the hydraulic oil temperature is 90°C (194°F) or higher, the lamp is lit and the buzzer sounds. If the high temperature continues, stop the operation and decrease the engine speed to lower the oil temperature.

⚠ CAUTION

1. **When the monitor lamp is lit and the buzzer sounds, stop crane operation, check the machine and remove the cause of the error indication.**
2. **Don't resume crane operation after lowering the coolant or oil temperature without removing the cause of the error indication.**

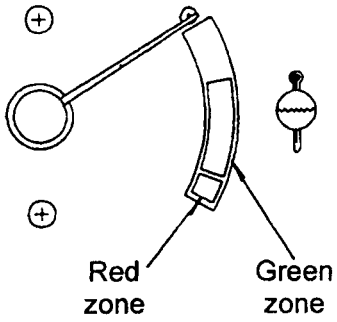


9. Fuel meter

   F: Fuel tank full side

   E: Fuel tank empty side

   Water drops can easily be generated as the space is larger in the fuel tank. Being careful to supply oil constantly will help not to make a space.



10. Water temperature gauge

    Make sure that the pointer shows the green zone. When the pointer shows the red zone, the symbol mark is lit and the buzzer sounds.

NOTICE

The OK monitor does not always show the machine condition. Refer to the indication of the monitor and carry out the daily or periodical check of the following:

1. **Check visually the remaining quantity or contamination of the engine oil, coolant, fuel tank and the hydraulic oil tank.**
2. **Check the lamps, connectors and wires periodically for the operation.**
3. **Replace the filter element when it has reached the replacing time regardless of the alarm indication. The element cannot always be used until the alarm lamp lights.**
4. **When the engine oil temperature is low, the oil pressure is high and so the lamp may be lit. The lamp is turned off by warm-up. If the lamp is not turned off after warm-up, it is an abnormal condition and it is necessary to check and repair.**

5. BASIC OPERATION

5-1 Safety precautions for crane operation

1. Prohibition of overload

⚠ DANGER

Unless the following items are observed, the machine may tip over or boom may be damaged to cause an accident resulting in injury or death.

1. **Don't lift a load over the allowable limit (rated load).**
2. **Don't perform the crane work if the overload prevention device switch is at other positions except "OPERATION".**
3. **Don't operate a crane while the reset switch remains released.**
4. **Don't continue to operate the crane by overriding an operator aid which stops the crane automatically.**

2. Maintenance of firm level ground

⚠ WARNING

A mobile crane can demonstrate its ability on firm, level ground. It may tip over on soft ground. Use the following procedure:

1. **Examine the ground supporting force where a crane is to be set beforehand.**
2. **Calculate the load applied to the crawler when the rated load is applied to the crane.**
3. **Make the ground sufficiently firm and level to support the applied load.**

3. Prevention of contact during operation

⚠ WARNING

If a boom contacts with a building or other object, the boom may be broken and cause a serious accident. It is very dangerous when lifting a heavy load.

1. **Understand the working environment fully beforehand and make a safe working plan.**
2. **Place a watchman. Operate the crane carefully not to contact with buildings.**

⚠ WARNING

If a load collides with a boom or building, the boom may be broken or the building may be damaged. Take a countermeasure to prevent collision.

1. **Take off the guide rope not to sway or turn the load.**
2. **Make a working radius as large as possible.**
3. **When operating the machine near a building, place a watchman to prevent collision.**

4. Countermeasure against jamming

⚠ WARNING

When operating the machine near the broadcasting (TV or radio) high output electric wave source, an induced current is generated in the hook, wire rope, crane structure, etc. and the worker is sometimes injured. The moment limiter may malfunction or a fall accident may occur when operation is done in a high place.

1. **The worker must wear rubber or leather shoes and gloves to prevent an electric shock when operating the machine near an electric wave source.**
2. **Avoid the electric wave path if possible when positioning a crane. Make the influence of the electric wave as small as possible.**
3. **Don't turn off the moment limiter because of the electric wave.**

5. Precautions for handling the control levers

⚠ CAUTION

If handling the lever rapidly, swing, travel or hoisting is started or stopped rapidly. In addition, an excessive force is applied to the boom. Observe the following items for safe operation:

1. **Move the control lever slowly and gently. Return it to the neutral position slowly and gently.**
2. **If moving the lever rapidly, the crane may not show a desirable action. It is very dangerous. Operate the lever slightly and check the machine action. Then, carry out the normal lever operation. It is very dangerous to start or stop swinging sharply.**

⚠ CAUTION

If operating the lever erroneously, unexpected or rapid crane action will cause a load collision, etc. Set the engine to a low speed, operate the lever gently and check the crane action. Then, carry out the normal crane operation. Operate the levers gently even after the machine action has been checked.

⚠ CAUTION

6. Prohibition of inapplicable use

Don't perform lateral drawing or slant lifting by a crane. The boom may be broken or the crane may tip over.

1. **Lift a load vertically according to an applicable signal.**
2. **Don't perform a lifting operation if the working radius is increased or if a horizontal load is applied to the boom.**

⚠ CAUTION

Don't use a crane for other purposes except the proper ones. An accident may occur. Wrong operations are stated below:

1. **Pulling operation by letting out the wire rope from the winch, which is different from the normal lifting operation.**
2. **Lifting a worker, transporting a worker, using the boom for a ladder or footing, etc.**

NOTICE

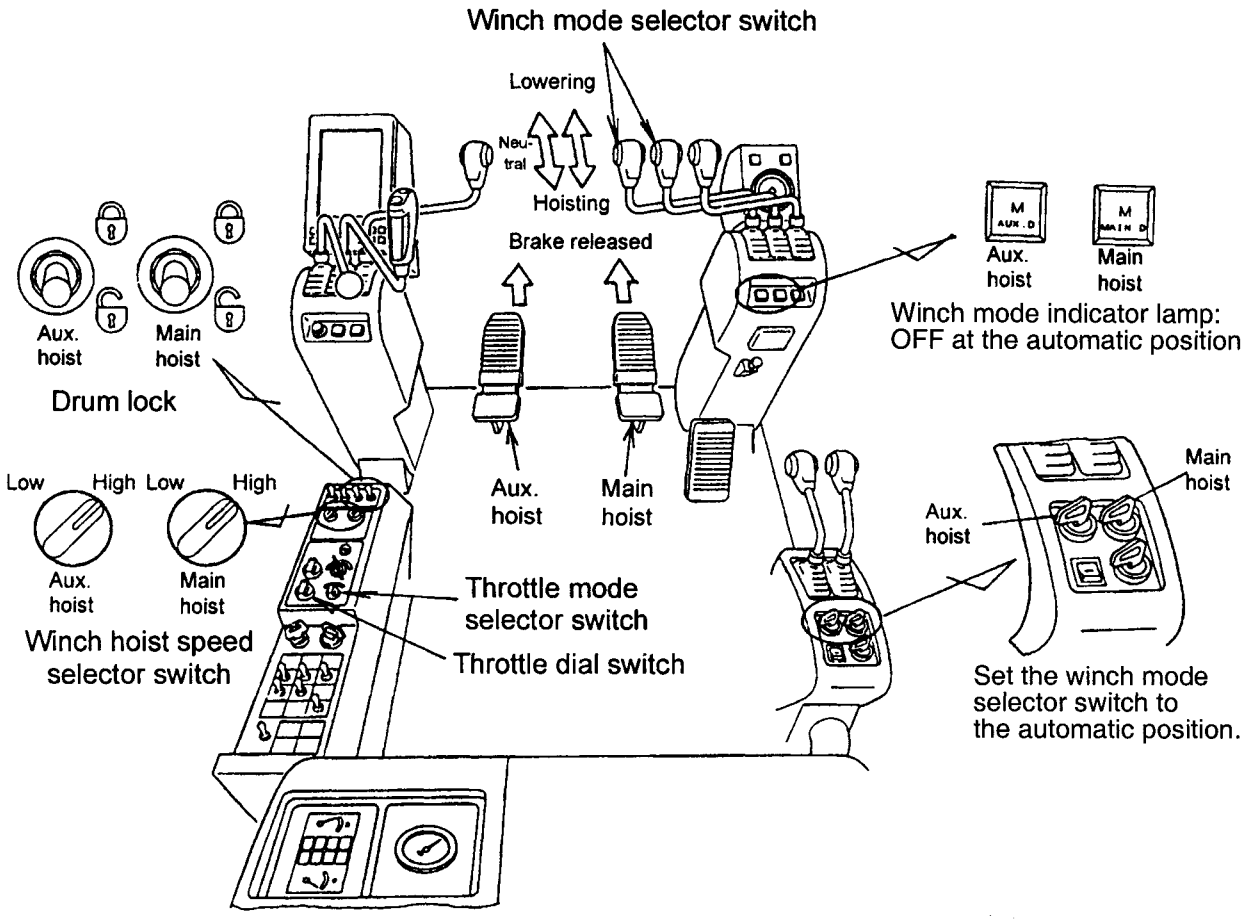
If the auxiliary hoisting is set at the 2nd speed while the main hoisting is at the 1st speed, the main hoisting stops. Keep this fact in mind when operating the machine.

In addition to the above, there are precautions for each operation. Observe them in the same way.

There are also safety precautions in the chapters of "DISASSEMBLY, ASSEMBLY AND TRANSPORTATION" and "MAINTENANCE". Observe them.

5-2 Load hoisting and lowering with automatic brake (free fall of load disabled)

Explanation is given assuming that the engine is already started.



Operating Procedure

1. Determine either the main drum or auxiliary drum to be used.
2. Then, with the brake pedal depressed, turn the winch mode selector switch of the main or auxiliary winch on the right side box to the "AUTOMATIC" position. Make sure that the mode indicator lamp at the foot of the lever is turned off.
3. Turn the hoisting speed selector switch to the "HIGH" or "LOW" position. When the load is heavy, "LOW" speed is recommended for ensuring safety.
4. Determine the engine speed changing rate by the throttle mode switch, and minimum engine speed by the throttle dial switch. Engine speed beyond the minimum speed is controllable by the grip throttle of the swing lever, or foot throttle.
5. Release the winch drum lock. Tilt the toggle switch in the direction of the "KEY RELEASED" figure.

Operating Procedure (continued)

6. Raise the brake pedal to release the corresponding brake. The pedal must always be kept in the "up" status during hoisting and lowering operations. When turning the winch lever to "NEUTRAL", the brake is automatically applied.
7. For hoisting a load, pull the main or auxiliary winch lever backward. When returning the lever to "NEUTRAL", hoisting stops. For lowering the load, push the lever forward. When returning the lever to "NEUTRAL", lowering stops.

   The lever should be returned gradually to "NEUTRAL" in order to slow the movement of the load, thereby avoiding shock on stopping of the load.

   Each of the main and auxiliary winch levers is provided with a detent between the neutral position and stroke end. The detent position corresponds to the first speed, and the stroke end to the second speed.

⚠ CAUTION

1. **The hoisting speed selector switch must not be moved during the course of hoisting or lowering. Be sure to stop the load before changing over the switch position.**
2. **When the winch mode is selected to the "AUTOMATIC" position, the foot brake pedal must be kept released at the top. Perform the operation as you are ready to depress the pedal.**
3. **Never turn the drum lock switch to the lock position while the load is lowered. Otherwise, the drum or its locking pawl may be damaged.**
4. **Never change over the winch mode while any winch is operating. Before changing over winch mode, set the winch lever at neutral and depress the foot brake.**
5. **The overhoisting prevention device switch of the winch to be used must be set at the "ACTIVE" position without fail. Unless set at the "ACTIVE" position, the over hoist prevention device does not move.**

8. For the rated load, follow the rated overall load table and indications given by the moment limiter.
   Note, however, that the following relation between the load and hook part of line must be observed.

LOAD HOISTING INFORMATION - 7/8" EIPS ROPE
47HI (1.19m) BOOM, 4 SHEAVE TIP WITH EXTENDED AXLE

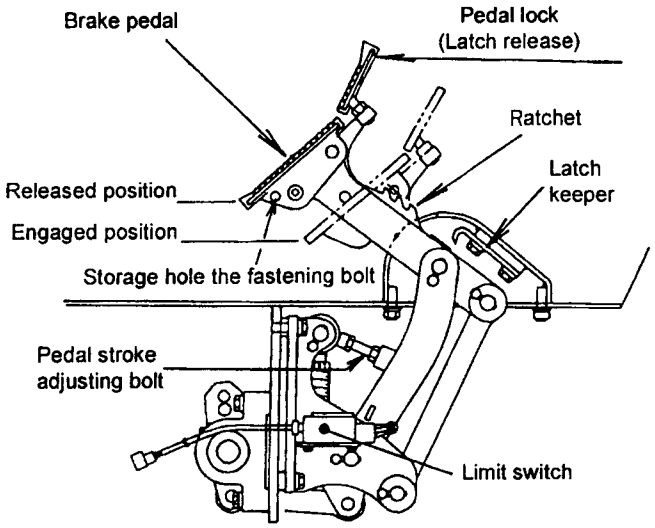
Maximum Lifting Capacity - Lbs.	Minimum Parts of Line	Maximum Hoisting Distance - Feet	
		Main - (Right)	Auxiliary - (Left)
160,000	8	73	73
159,180	7	84	84
136,440	6	98	98
113,700	5	117	117
90,960	4	147	147
68,220	3	196	196
45,480	2	294	294
22,740	1	588	588

Operating Procedure (continued)

9. Winch mode selector switches should be used in the following combinations. Unless the main and auxiliary winches are set in the manual mode, the grip switch of the winch lever is not capable of selection.

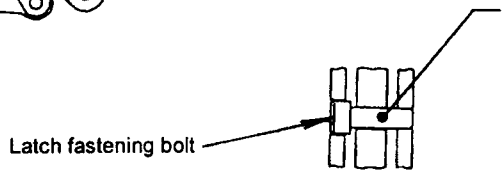
Right side box winch mode selector switches	Winch mode is selected by the push button switches on the levers.
Automatic	Automatic position is always set by the key switches.
Manual	Manual is selected by the push button keyswitch and foot brake depressed.

- Operation of brake pedal (main and auxiliary winches share the same brake structure)



For releasing the brake, separate the ratchet from the latch keeper by depressing the latch release and allow the pedal to rise. Usually, the pedal is moved up and down while depressing the latch release.

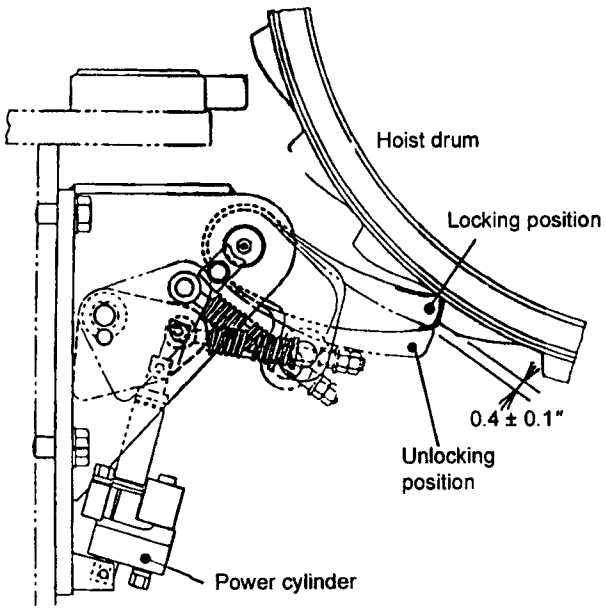
When depressing the pedal and taking your foot off, the pedal should be depressed down to the innermost pawl (down to the pawl closest to the pedal). If the drum is hot, the pedal should be depressed down to the second pawl.

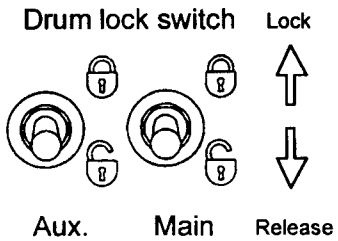


When the ratchet need not be engaged in clamshell operation, etc., set the latch release at the release position and mount this bolt.

In normal operation, remove the bolt and put it in the hole.

- Operation of drum lock (main and auxiliary winches share the same lock structure)





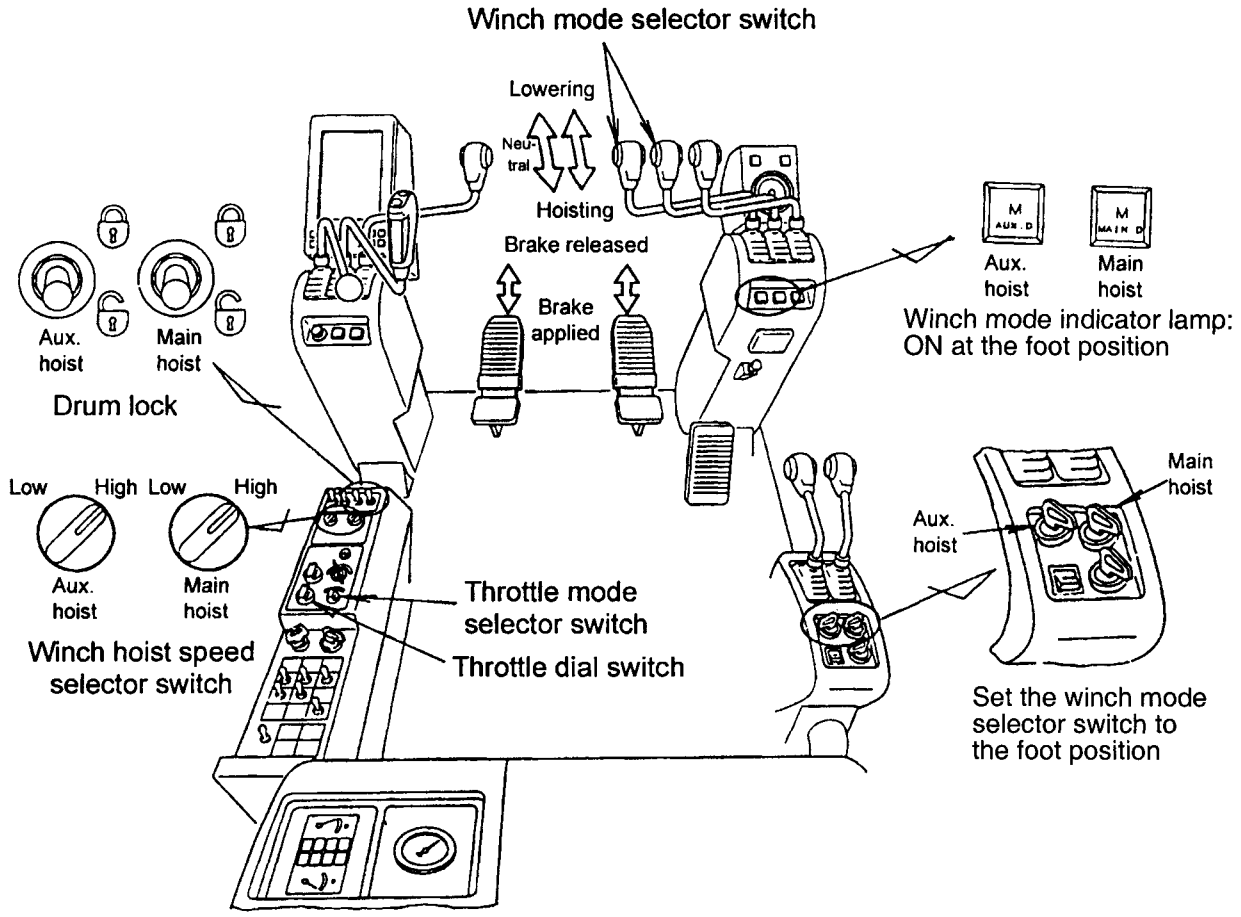
Before hoisting or lowering, the lock must be disengaged. When tilting the release position of the lock switch on the left control panel, the relevant drum is unlocked. Upon turning the switch to the unlock position, to energize the power cylinder the pawl is separated from the drum.

If the pawl cannot be separated because of a force applied by the drum, it is recommended to rotate the drum slightly in the hoisting direction. The pawl will be separated immediately.

If locking operation is attempted while the drum is rotating in the lowering direction, the drum or pawl will be damaged due to shock. To prevent this, never try to engage drum lock while lowering.

5-3 Load hoisting and lowering with foot brake (used when free fall of load desired)

Explanation is given assuming that the engine is already started.



Operating Procedure

1. Determine either the main drum or auxiliary drum to be used.
2. Then, with the brake pedal depressed, turn the winch mode selector switch of the main or auxiliary winch on the right side box to the "FOOT" position. Press the selector switch at the head of the winch lever. Check the selected status through the lighting of the mode indicator lamp at the foot of the lever.
3. Turn the hoisting speed selector switch to the "HIGH" or "LOW" position. When the load is heavy, "LOW" speed is recommended for ensuring safety.
4. Determine the engine speed changing rate by the throttle mode switch, and minimum engine speed with the throttle dial switch. Engine speed beyond the minimum speed is controllable by the grip throttle of the swing lever, or foot throttle.
5. Unlock the winch drum lock. Tilt the toggle switch in the direction of the "KEY RELEASED" figure.

Operating Procedure (continued)

6. Gradually move the lever in the hoisting or lowering direction. As soon as the clutch is engaged, release the brake pedal so that it rises up to the top. If the brake is released too early, the lifted load will drop. A heavier load, in particular, will drop by a larger distance. Before actual operation, the timing of brake releasing in combination with lever operation must be learned by practice. If releasing of the brake is delayed, an excessive force will be applied to the brake drum, etc., and the hydraulic system may be adversely affected.
7. In contrast, for stopping the hoisting or lowering operation, the brake pedal should be depressed at a slightly earlier timing, then return the lever to the neutral position immediately. If this timing is lost, the lifted load will drop as in the aforementioned start of hoisting or lowering.

   Hoisting and lowering can select the first or second speed through inclination of the lever.
8. For free fall of the load, set the winch lever at neutral and gradually raise the brake pedal. In response to this operation, the load will fall gradually. If the brake is loosened excessively at one time, the load will fall rapidly. So, the brake must be operated carefully.

⚠ CAUTION

1. **The winch speed selector switch must not be moved during the course of hoisting or lowering. Be sure to lower the load to the ground before changing over the switch position.**
2. **Dropping of the load to the ground or abrupt stopping of a falling load involves great danger. Be careful not to allow the load to fall spontaneously through inadequate understanding of the clutch and brake operation timing.**
3. **Never turn the drum lock switch to the lock position while the load is lowered. Otherwise, the drum or its locking pawl may be damaged.**
4. **Never change over the winch mode while any winch is operating. Before changing over the winch mode, set the winch lever at neutral and depress the foot brake.**
5. **When the winch mode is changed to "FOOT", make sure that the pilot lamp is lit and then carry out hoisting and lowering without a load to ensure the mode is at "FOOT".**
6. **The overhoisting prevention device switch of the winch to be used must be set at the "ACTIVE" position without fail. Unless set at the "ACTIVE" position, the overhoisting prevention device does not move.**
7. **Do not leave from the operator's seat during operation of a winch. When leaving the operator's seat, be sure load is lowered down on the ground.**

Operating Procedure (continued)

9. Selecting free fall must be performed in the following operating order:
   A. Depress foot brake for the winch to be selected.
   B. Turn key on winch mode selector to manual position for that drum.
   C. Depress and release grip switch on corresponding control lever.

   Note: The light below the corresponding lever will be activated for manual mode.

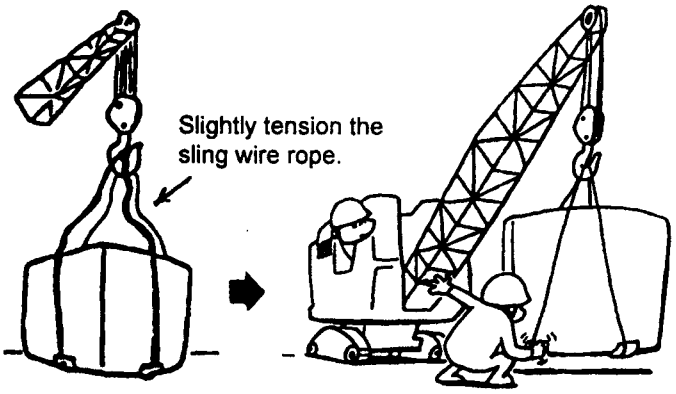
LOAD HOISTING INFORMATION - 7/8" EIPS ROPE
47HI (1.19m) BOOM, 4 SHEAVE TIP WITH EXTENDED AXLE

Maximum Lifting Capacity - Lbs.	Minimum Parts of Line	Maximum Hoisting Distance - Feet	
		Main - (Right)	Auxiliary - (Left)
160,000	8	73	73
159,180	7	84	84
136,440	6	98	98
113,700	5	117	117
90,960	4	147	147
68,220	3	196	196
45,480	2	294	294
22,740	1	588	588

Caution at lifting load just off the ground

CAUTION

1. **Before lifting a load just off the ground, confirm the position and condition of the sling wire rope.**
2. **After lifting a load just off the ground, stop swaying of the load, check the wire status and then proceed to the hoisting operation.**

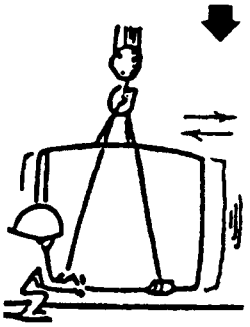


Confirm slinging position.

The sling rope should be tensed gradually while repeating hoisting and stop. Just before the rope is tensed completely, stop hoisting and check the position of rope patches.

Immediately after a load is lifted just off the ground, interrupt lifting and stop swaying of the load. If slinging is improper, lower the load to the ground and perform slinging again. Slinging workers must have their certificate of training completion with them when engaging in slinging work.

Shortly after lifting the load just off the ground, the working radius tends to widen due to expansion of the boom hoist rope, etc. This tendency is conspicuous when hoisting a heavy load or using a longer boom. Therefore, hoisting should be carried out with adequate care. The resulting working radius corresponds to the actual working radius indicated in the rated overall load table.

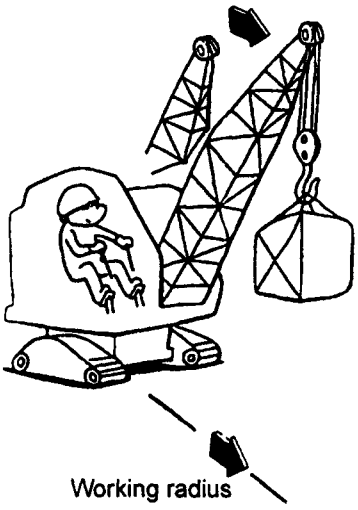


Stop swaying of load.

CAUTION

Though the sling wire rope is normal, the slinging method, etc., may be improper. In such a case, the wire rope will be cut or come off to drop a load. A qualified person must perform slinging. A crane must be operated safely according to a clear signal.

- **Select a lifting tool having a specified safety ratio in consideration of the lifting angle and tension of the rope.**
- **Use a pad where the rope is liable to be damaged.**
- **Don't lift only one rope. Use a guide rope.**
- **Lift the load just off the ground and check how to apply the wire rope.**

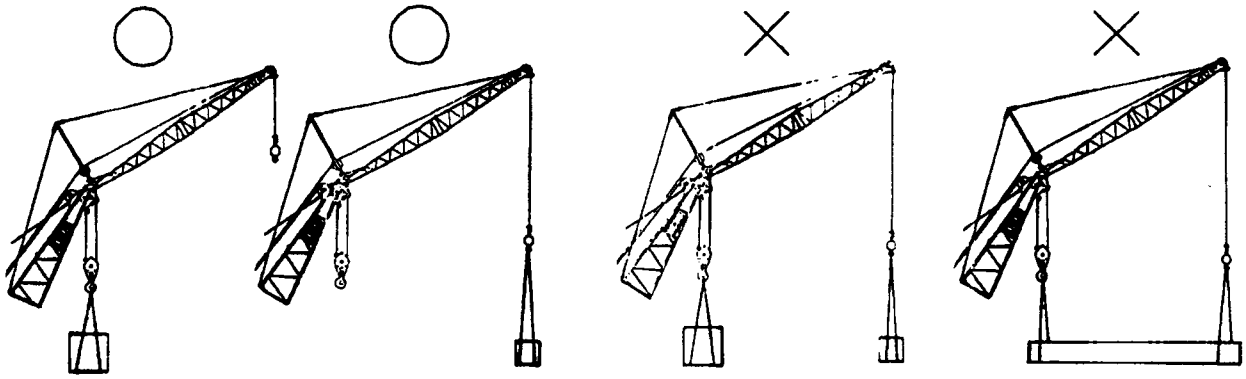


If the load is lowered onto the ground in working at the upper limit boom angle (80°), the automatic boom stopper may be activated. Pay attention!

Don't operate the main and auxiliary winches simultaneously

⚠ CAUTION

1. **It is not permitted in the crane specifications to lift a load by using the main and auxiliary winches simultaneously during crane operation. Carry out the crane operation by using one of main or auxiliary winches.**
2. **Hoist the hook of the unused winch (main or auxiliary) near to the minimum clearance during crane operation. The hook may be swayed and collide with the load or boom.**



⚠ DANGER

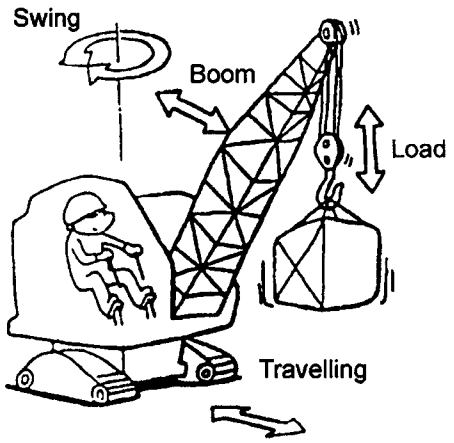
1. **When the lifted load has to be kept stationary for a long time, apply the foot brake and drum lock regardless of the winch mode position.**
2. **Don't leave the operator's cab when the lifted load is stationary in the air. If the operator leaves the operator's cab, lower the load to the ground and apply the foot brake.**

⚠ CAUTION

1. **As a rule, traveling with a lifted load is prohibited. Don't perform traveling with a lifted load if the crane is not specified for such operation.**
2. **If traveling with a lifted load is done, the traveling shock will affect the boom or each mechanical section to cause damage. In addition, the machine life will be shortened.**
3. **The machine may lose stability and tip over during traveling with a load. The machine cannot be quick in action during traveling with a load.**

Precautions for combined operation

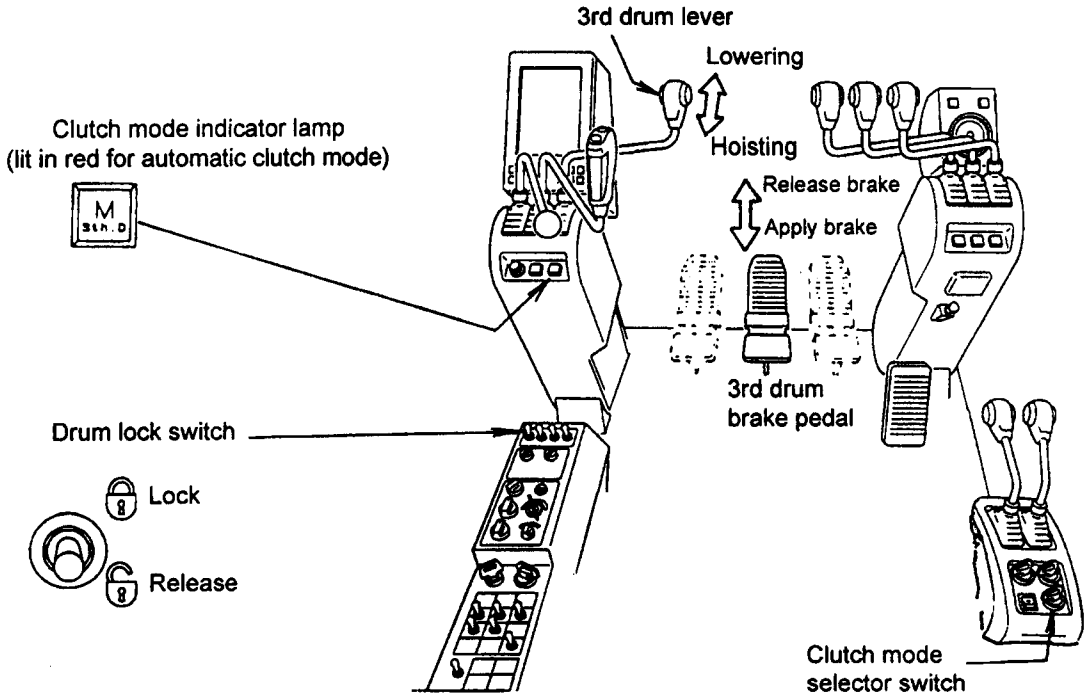
"Combined operation" means the combination of winch hoisting (or lowering), boom hoisting, swing, traveling, etc. If the operator is careful only for one operation, the other is sometimes in dangerous status. Be very careful for both of them.



⚠ CAUTION

A combination of three or more operations may cause unexpected danger. Avoid such combination if possible.

5-4 Third drum winch operation (special specification)



5-4-1 Kinds of third drum

A - specification	With clutch and brake (master cylinder control) (The above figure shows the controllers for A - specification.)	Free fall of load possible Power fall of load possible
B - specification	Winch drum directly coupled hydraulic motor through reduction gear	Free fall of load possible Power fall of load possible

5-4-2 Operating procedure for A - specification (clutch and brake equipped)

Automatic clutch mode (Foot brake side):

1. Apply the brake securely by depressing the brake pedal.
2. Select the clutch mode selector switch on the right control panel to set the automatic clutch mode. Then press the switch at the head of the third drum lever for its change over to the automatic clutch mode (the lever switch is turned to "ON"). Selection is confirmable by the lit status of the pilot lamp at the root of the lever.
3. Manipulate the drum lock switch so as to unlock the drum. If the drum cannot be unlocked, it is advisable to rotate the drum slightly in the hoisting direction. The drum will then be unlocked.
4. In the automatic clutch mode, the clutch expands to transmit power from the hydraulic motor to the wire drum only when the clutch is operated on the hoist or lower side. Therefore, when the lever is set at neutral, the brake must be kept depressed because the clutch is not expanded.

   For hoisting, set the lever at the hoisting position followed by releasing the brake pedal. To stop hoisting, return the lever to neutral while depressing the brake pedal. Be careful, since the lifted load will drop if the above timing is wrong. For lowering, the lever and brake pedal must be operated at the same timing as above. Adjust the timing properly so as not to allow the load to drop.

   When free fall of the load is desired, gradually release the brake pedal with the winch lever set at neutral. The load falling speed is adjusted according to the degree of brake releasing.

Clutch mode (Automatic side):

1. Apply the brake securely by depressing the brake pedal.
2. Select the clutch mode selector switch on the right-side operation panel to set the clutch mode. The clutch mode is also selectable by the switch at the head of the winch lever. However, if the selector switch on the left-side operation panel is turned to the clutch mode side, the automatic clutch mode cannot be selected even if the lever-head switch is pressed in error.
3. Manipulate the drum lock switch to unlock the drum.
4. In the clutch mode, the clutch is always expanded so that the load is held by the braking force of the hydraulic motor. Therefore, the brake pedal need not be depressed. However, depress the brake for ensuring safety when holding the load for a long time. For hoisting or lowering operation, release the brake pedal and then operate the lever in the hoisting or lowering direction. Operation stops on returning the lever to neutral.
5. The mode is selected as listed in the table below. When the pilot lamp remains extinguished, the automatic clutch mode is not selected.

Switch position on right operation panel	Select by control lever grip switch	Pilot lamp
Clutch mode side (Automatic side)	Clutch is always engaged (No change made by pressing grip switch repeatedly)	OFF
Automatic clutch mode side (Foot side)	Changed over when pressed	ON

When the pilot lamp remains extinguished, the automatic clutch side (Foot side) is not selected.

⚠ CAUTION

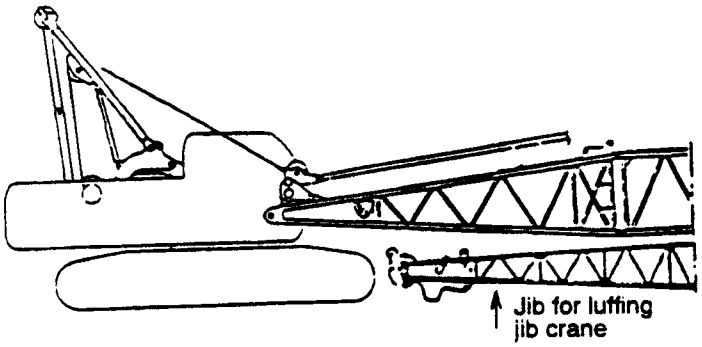
1. **Check ON/OFF of the pilot lamp for each combination by turning the clutch mode selector switch on the right operation panel and the control lever grip switch. Check the operation for the clutch modes by hoisting or lowering without load.**
2. **Don't change the clutch mode while hoisting or lowering the third drum winch. Turn the lever to neutral and depress the brake pedal to stop the drum rotation before changing the clutch mode.**
3. **Turn the overhoisting prevention device switch to the active side on the control panel in the mechanical room. If not, the overhoisting prevention device for the third winch will not work.**
4. **Never turn the drum lock switch to the lock side while the load is lowered. Otherwise, the drum or its locking pawl may be damaged.**

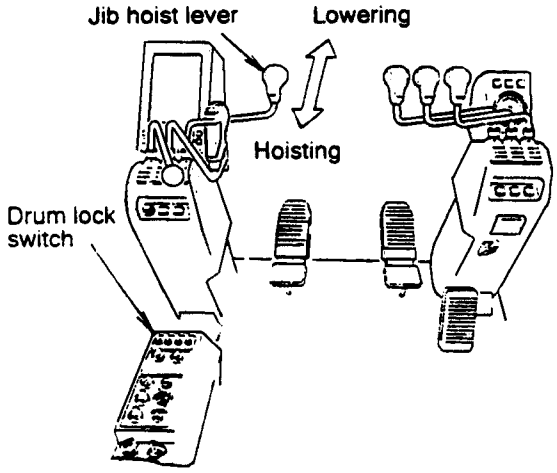
5-4-3 Operating procedure for B- specification (wire drum and hydraulic motor directly coupled type)

1. Manipulate the drum lock switch on the left operation panel so as to unlock the drum.
2. Hoist or lower the load with the lever turned to the hoisting or lowering side. When returning the lever to neutral, the multi-disc brake in the hydraulic motor operates so that the brake is automatically applied.

5-4-4 Operation of luffing jib crane and luffing tower crane

Use the third drum winch for B - specifications for hoisting or lowering the tower jib. The disc brake built in the hydraulic motor is automatically released when hoisting or lowering the jib. The brake is automatically applied to keep the jib stationary when the lever is at neutral.





1. Unlock the jib drum by using the tower jib drum lock switch. If it is difficult to unlock, turn the drum a little to the hoisting side.

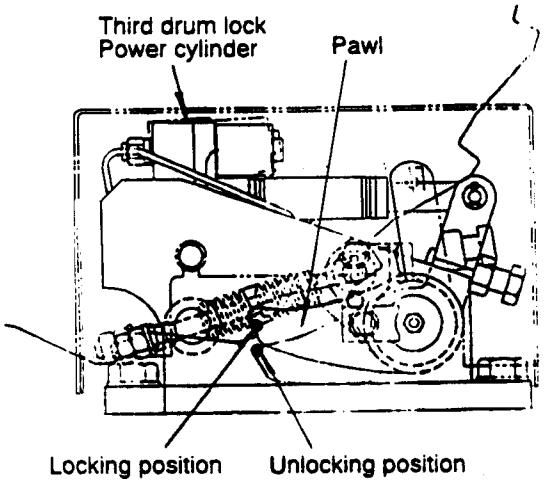
2. Hoist the jib if pulling the tower jib hoist lever to your side. Lower the jib by pushing it forward.

3. Start or stop the operation slowly in a low speed so as not to sway the tower jib.

⚠ CAUTION

The jib hoisting range is limited by the boom tilt angle. Take the load, working radius and lifting height into consideration and determine a working range with sufficient allowance before starting operation.

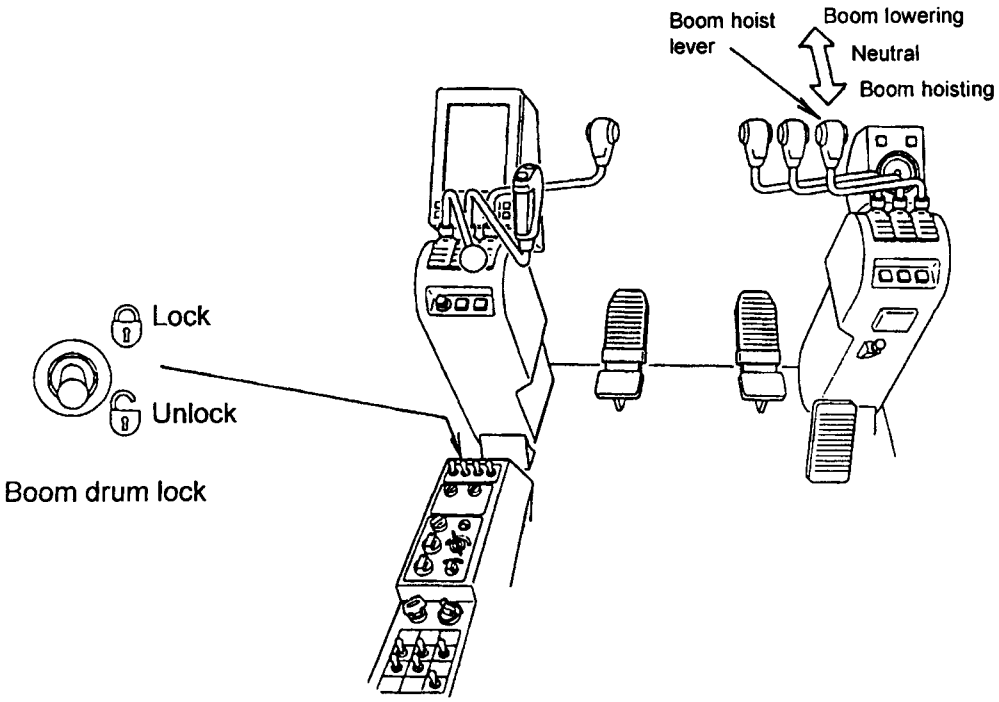
Don't perform such operation as the boom or tower jib stops automatically.



NOTICE

Don't apply the jib drum lock while lowering the tower jib. If so, the drum or pawl will be damaged.

5-5 Boom hoisting/lowering



While the boom is hoisted or lowered, the disc brake built into the hydraulic motor is automatically released and the brake is automatically applied to stop and hold the boom when the lever is set at neutral.

Operating Procedure

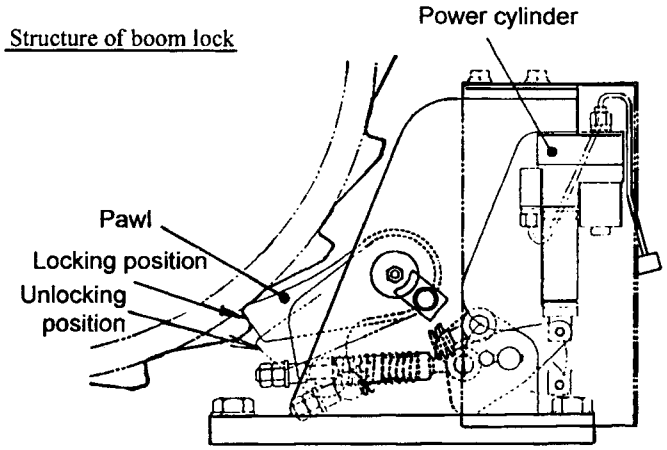
1. Manipulate the boom lock switch to unlock the boom drum. The drum lock operates on the same principle as that of the main and auxiliary winches. However, if the lock is difficult to release, rotate the drum slightly on the boom hoisting side. The lock will be released easily.
2. When pulling the boom hoist lever, the boom rises, and it lowers when pushing the lever forward. Upon returning the lever to neutral, the boom stops.

⚠ CAUTION

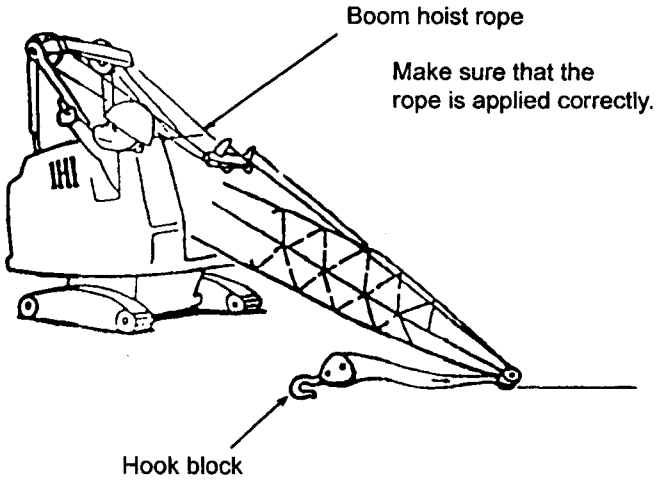
1. **Make sure that there are no workers or obstacles in the boom hoisting range.**
2. **Hoist or lower the crane boom in the range shown in the crane specifications.**
3. **Don't stop the action suddenly when lowering the boom. Hoist or lower the boom smoothly and slowly so as not to sway the load.**
4. **When lowering the boom, stop lowering temporarily at horizontal, make sure of safety, and then put it on the ground at a low speed.**

NOTICE

Never attempt to lock the boom drum while the boom is lowered. Otherwise, the drum or pawl will be damaged.



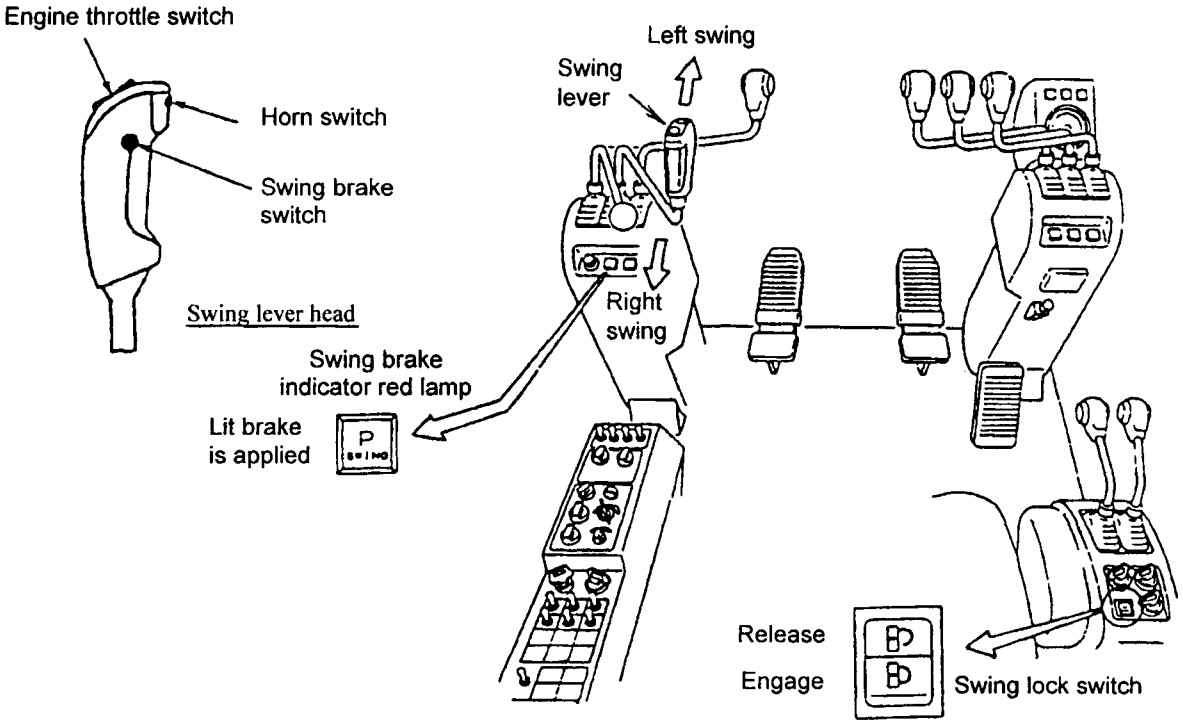
Precautions for hoisting or lowering the boom



CAUTION

1. **When the boom is lifted from or is lowered to the ground, it stops automatically if the overload prevention device switch is in the "OPERATION" position. Turn the overload prevention device switch to "ERECTION" position when lifting or lowering the boom from or to the ground. Turn it to "OPERATION" position as soon as the boom is in working status.**
2. **When the boom is lifted just off the ground or is lowered to the ground, great stress is applied to the boom and boom hoist rope. Hoist or lower the boom slowly and smoothly. If the hoist rope is tensed, stop hoisting temporarily and run the engine in a low speed. Hoist the boom to its angle 20°~30° slowly in a low speed while the hook is put on the ground.**

5-6 Swing operation



Operating Procedure

1. Manipulate the swing lock switch to release the swing lock. This switch is located at the rear of the right-side operation panel. When pressing the top part of the switch, the unlocking position is selected. If the lock is difficult to release, it is recommended to swing slightly in the clockwise or counterclockwise direction. The lock will be released the moment the lock pin is separated from the pin receptacle of the car body.
2. Release the swing brake. When pressing the swing brake switch shown in the figure above, the swing brake is released. When pressing the switch again, the swing brake is applied. While the swing brake is applied, the pilot lamp at the root of the lever remains lit. Make sure that the lamp is turned off.
3. For clockwise swing, pull the lever gradually. For counterclockwise swing, push the lever gradually. The swing lever does not have a holding mechanism. Therefore, when releasing the lever, it automatically returns to neutral. Since the swing brake action is unavailable with the lever at neutral, the crane swings due to inertia.

   The swing can be stopped at the desired point by two methods:

   - One method is a swing operation taking the drift of the swing due to inertia into account, and
   - The other method is stopping by slight swing operation in the reverse direction just before the desired point.

⚠ WARNING

Before starting the operation, check the following points and take the necessary precautions:

1. **Check ON/OFF of the pilot lamp by pressing the swing brake switch. If the bulb has burned out or if the wiring is disconnected, repair it at once.**
2. **Check how far the operator can check visually in the rear swing radius with a rear mirror, etc. Show "Keep Out" or place a watchman if necessary.**
3. **Don't let a person go into the swing range during operation. If there is a passer-by, withdraw the load and stop the operation. Restart after the passer-by leaves the swing range.**

Be careful not to be caught by the crane or between the crane and other equipment during swing. It will cause an accident resulting in injury or death.

When two or more persons repair the machine, start the engine or perform the swing operation according to the director's instructions and signals. Don't approach the crane when it is operating.

1. **Be careful not to be caught between the superstructure and crawler.**
2. **Be careful not to be caught between the counterweight and other equipment.**

⚠ DANGER

1. **The swing brake is used not to stop swinging, but to stop the swing drift when on tilted ground or when there is a high wind. If swinging is stopped by the swing brake, the machine will stop abruptly and the lifted load will sway violently. Don't use the swing brake to do so.**
2. **If the swing lock is applied during swinging, the car body or turntable will be damaged. Don't apply the swing lock during swinging. After swinging is stopped, align the lock pin with the pin holder accurately and then apply the lock.**

4. Start and stop swinging slowly

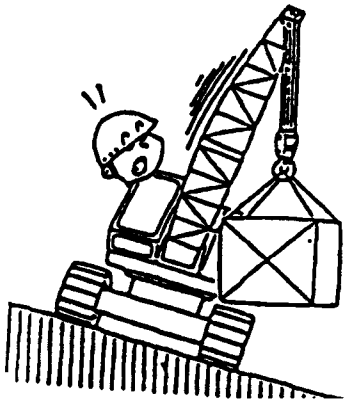
   If swing is done abruptly, a lateral load will be applied to the boom. The machine may tip over because the working radius is increased or the lifted load may collide with others.

5. Avoid operating the crane on tilted ground if possible, because a lateral load is applied to the boom.

⚠ WARNING

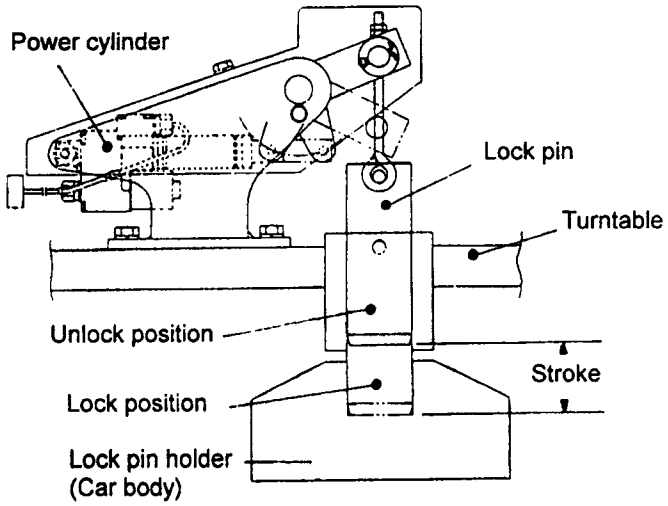
When swinging is done downward on tilted ground, an overload is generated by increasing the working radius or by the centrifugal force due to the increased swing speed. The crane may tip over because of the overload. Moreover, the boom may be damaged because a horizontal load is applied.

1. **Don't operate the crane on tilted ground.**
2. **If the crane has to be operated on tilted ground, level the crane by using a footing board, etc.**
3. **There is no specification for the operation on tilted ground.**



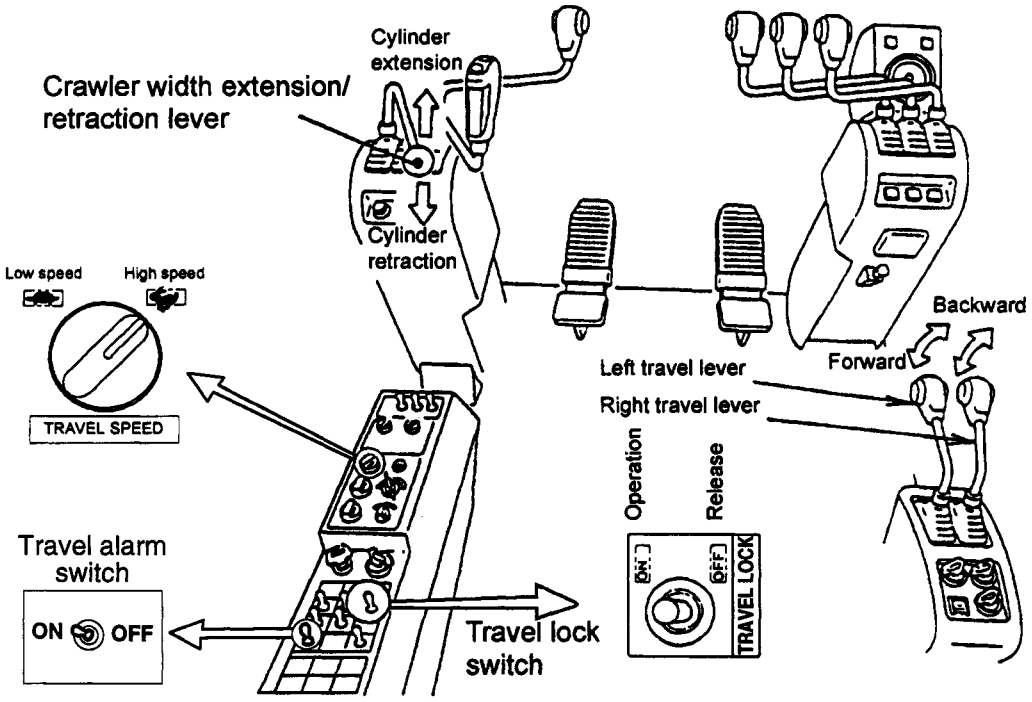
6. Handling of swing lock

   This is a device to lock the superstructure and undercarriage when the operation is ended, when traveling a long distance, when transported by trailer, when a strong wind is anticipated, etc. Swing the superstructure so that the lock pin may be fit to the pin holder of the car body, and then actuate the switch.



Structure of swing lock

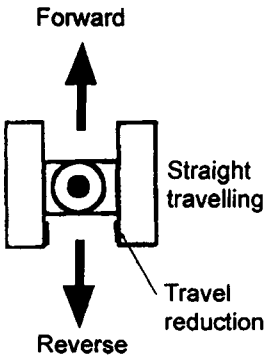
5-7 Procedures for traveling and crawler width change



5-7-1 Traveling procedure

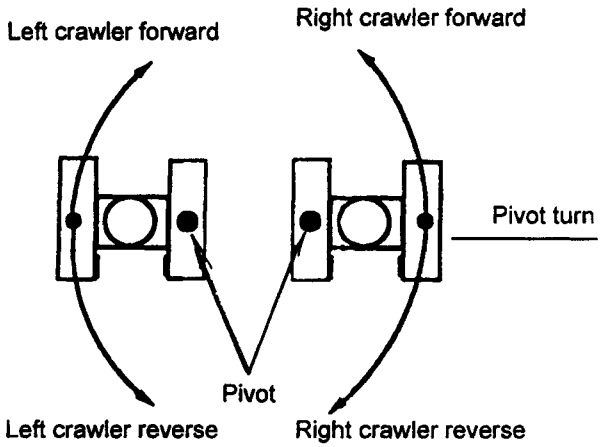
1. Straight traveling

   Turn the travel lock switch to the "OFF" side. The released status is set by tilting to the "OFF" side of the switch. The left and right levers move the left and right crawlers, respectively. The location of the traveling reduction gear corresponds to the rear of the crawlers. Traveling with the traveling reduction gear positioned at the front means reverse traveling actually. This positional relationship remains the same irrespective of the direction in which the superstructure faces. When pushing down both levers, the machine moves forward. When pulling up both levers, the machine reverses. Upon releasing the levers, the brake in the traveling motor automatically functions to stop the machine.



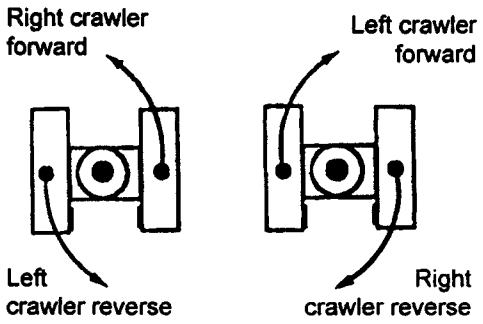
2. Pivot turn (steering with either crawler alone fixed)

   Either crawler alone is fixed for pivot turn. The fixed crawler serves as a pivot (center of steering). Four kinds of pivot turns are possible: 2 kinds each in the forward and reverse directions.



3. Spin turn (steering on the spot)

   Spin turn is caused by moving the two travel levers in different directions. At this time the center of steering is that of the machine.



⚠ CAUTION

Check or observe the following points to prevent an accident during traveling:

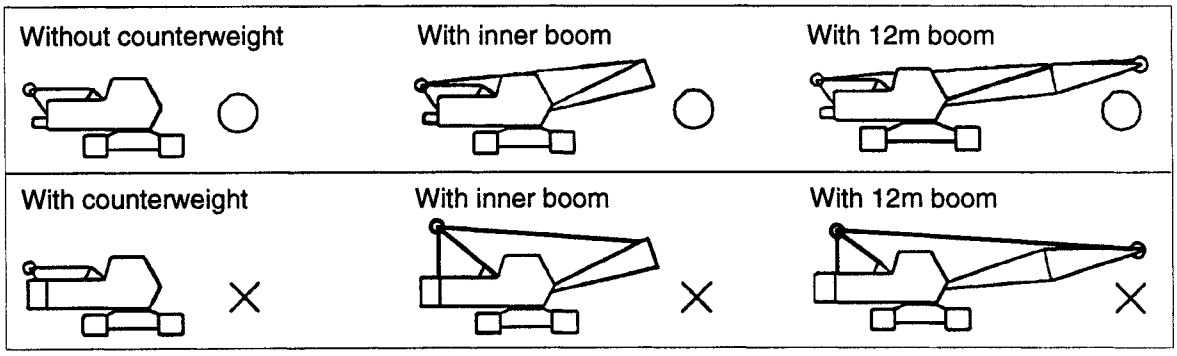
1. **Check the environment and make sure that there is no person or obstacle on the traveling path. Place a signal man if necessary.**
2. **Sound the horn to inform personnel nearby that the machine will travel.**
3. **Avoid abrupt steering and carry out forward traveling.**
4. **Be careful about the machine stability when the boom is long, the boom working radius is low or the ground condition is not good.**
5. **Perform traveling at a safe speed applicable to the machine equipment and its path.**
6. **Apply the swing brake and swing lock.**
7. **Don't walk with a lifted load. The boom may be damaged or the machine may tip over.**

⚠ CAUTION

Don't approach a crane unnecessarily during traveling. The crane may run over a person unless the operator notices him/her, even though it is traveling at a low speed. Let the operator notice the person in the distance if necessary. Approach the crane after it stops.

5-7-2 Procedure for changing crawler width

For transporting this machine with a trailer or passing through a narrow place, the crawler width can be reduced. The crawler width can be extended or retracted in the crane posture as shown below.

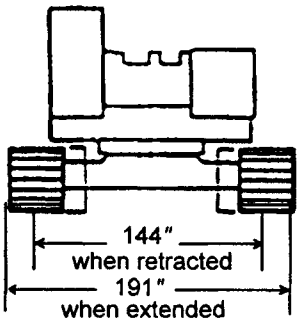


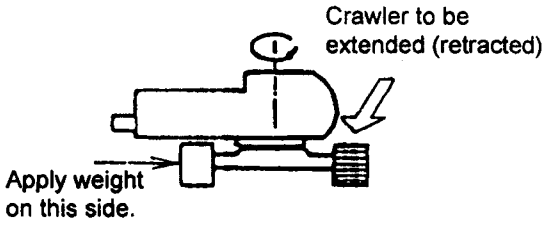
○ = Crawler width changeable **× = Crawler width unchangeable**

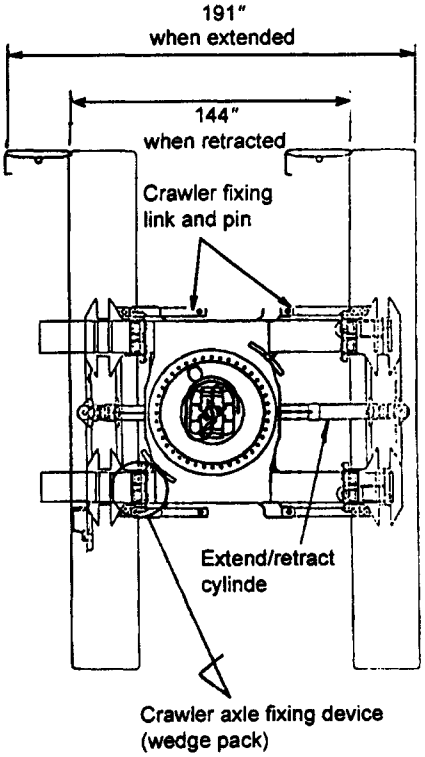
Although the front attachment and counterweight must be removed as a rule, the crawler width is changeable in the position shown above, when unavoidable.

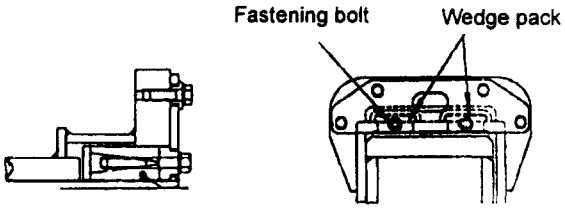
5-7-2 Procedure for changing crawler width (Continued)

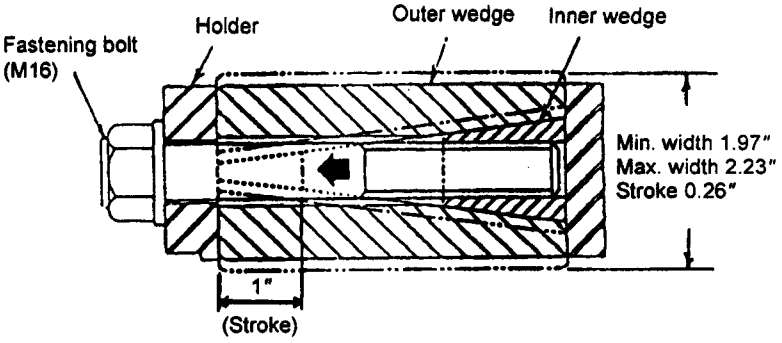
1. Move the crane to level ground. Operation tends to be easier on muddy ground rather than concrete. Each crawler is extendable by 600 mm as shown in the figure at right.
2. In order to reduce the weight applied to the crawler to be shifted, swing the superstructure toward the opposite crawler so as to apply the weight of the superstructure, thereby facilitating crawler extension/retraction. The superstructure must be swung gradually with utmost care.
3. Check ground conditions that may cause a problem in extension or retraction of crawler.
4. Loosen the wedge pack fastening bolt at 4 points front and rear to release the fixed status of the crawler frame and axle. Or, remove the wedge pack.











When tightening the fastening bolt (turning clockwise), the inner wedge moves as directed by the arrow to expend the outer wedge vertically, thereby fixing the crawler frame and axle.

When loosening the fastening bolt (turning counterclockwise), a gap is made between the axle and crawler frame. If the wedge pack cannot be slackened by loosening the bolt, the bolt head should be tapped.

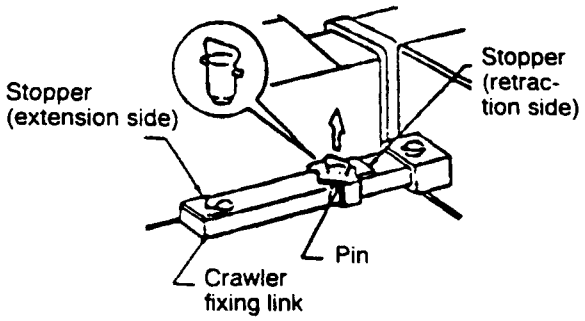
5. Pull out the two crawler fixing link pins at the front and rear (pins of the crawler to be extended or retracted). The crawler fixing link pins of the opposite crawler must be kept inserted.

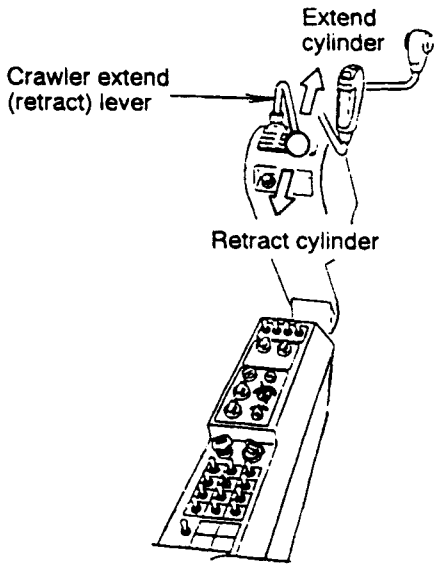
6. Adjust the engine speed to about 1,200 rpm and increase or decrease the crawler width by manipulating the crawler extend/retract lever. If the crawler is difficult to be shifted because of resistance applied on it, the crawler extend/retract lever should be manipulated while driving (traveling) the crawler to be extended or retracted at a very slow speed. This measure may be required particularly for retracting the crawler.

7. After the crawler has been extended or retracted up to the stopper of the crawler link, the pin must be inserted to fix the crawler frame and axle.

8. Tighten the wedge pack fastening bolts, which were loosened in previous step (4), in order to fix the crawler frame and axle.

9. Repeat steps (2) through (8) for changing the width of the opposite crawler.





CAUTION

For crane work, the crawlers must be extended fully without fail. The moment limiter LMI does not work for retracted side frames.

PRECAUTIONS FOR HANDLING THE MOMENT LIMITERS

⚠ WARNING

If the working conditions of the moment limiter are set incorrectly, the crane may tip over because of overload, etc. It is also dangerous to perform the operation while the moment limiter is "OFF" or bypassed.

1. **Display the setting screen and make sure the crane status is set to the proper values. If you set the Moment Limiter to a shorter boom length than what you are using, the allowable load is displayed with large letters. (The crane may tip over before the actual load reaches the allowable load.)**
2. **Make sure that the crane is set to the values displayed on the screen for every item and then start the operation.**

⚠ CAUTION

The overload prevention device may malfunction because of various causes such as the wrong setting of working conditions, improper electric current in the electric wires, disconnection, wet wires, malfunction of angle indicator, malfunction of load detector, deterioration of components, electric wave jamming, voltage drop, improper ambient temperature, defective IC card, etc.

1. **Check if the working conditions are set correctly, if the electric wiring is correct or if the wiring is wet.**
2. **Move the crane to minimize the electric wave jamming.**
3. **The overload prevention device does not operate normally under extreme high or low temperature. Keep the cab temperature 30~120°F (0~50°C) by using a room heater or cooler. Don't expose the device to the direct sunlight. For other cases, ask the Company or service shop to repair the device.**

⚠ CAUTION

The moment limiter must usually be ready to operate normally. Check the following items:

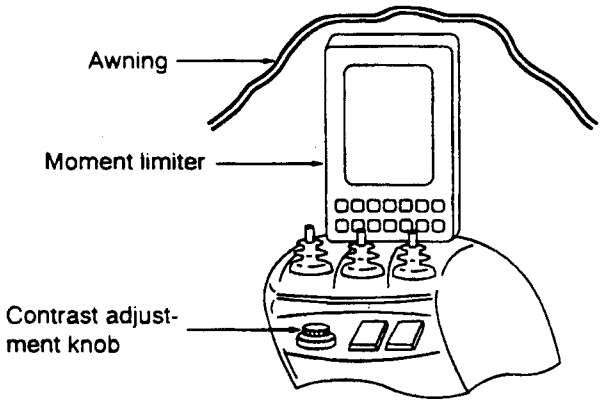
1. **Hoist a load for which actual weight is known. Add the hook weight value to the load value and then compare the value with the displayed load value.**
2. **While only the hook is hoisted, measure the working radius with a tape measure and compare it with the displayed value. If the values are different from the displayed ones, adjustment is necessary. Contact the Company or nearest service shop.**

Precautions on operational environment (temperature, and so on) of the moment limiters

Since the moment limiter is a precision electronic product, its operational environment is limited as follows. Avoid operation and preservation over the limit.

1. Operational environment of moment limiter
   - Operational temperature: 30°F ~120°F (0~50°C)
   - Preservation temperature: -5°F ~185°F (-20°C~60°C)
   - Preservation ambient humidity: 10% to 95% RH, no condensed water

   If the display unit is subjected to direct sunlight and heated up, it will result in damage of the moment limiter. It is also required to warm up the temperature when the cab is lower than temperature minimum. If the room temperature is higher than operational temperature maximum, turn off the moment limiter power supply and lower the temperature of the operator's cab and moment limiter, then turn on the power again. If the cab temperature is lower, warm it up to higher than 30°F (0°C). If the liquid crystal on the display unit is exposed to direct sunlight for a long time, it is heated up and turns black. In this case, try to keep it away from sunlight and lower the temperature.



Reference:

The contrast adjustment knob enables you to adjust the contrast (shading) of the display unit. Turn the knob into position according to ambient brightness for the most clear display.

2. Prevention of rain water leak in, lightning strike, etc.

   Make sure that the water prevention cap is correctly set at the connected parts of wire harness and waterproof process is properly done, which assures prevention of water leak-in. If water leaks in, the LMI will short circuit and you will not be able to use the moment limiter.

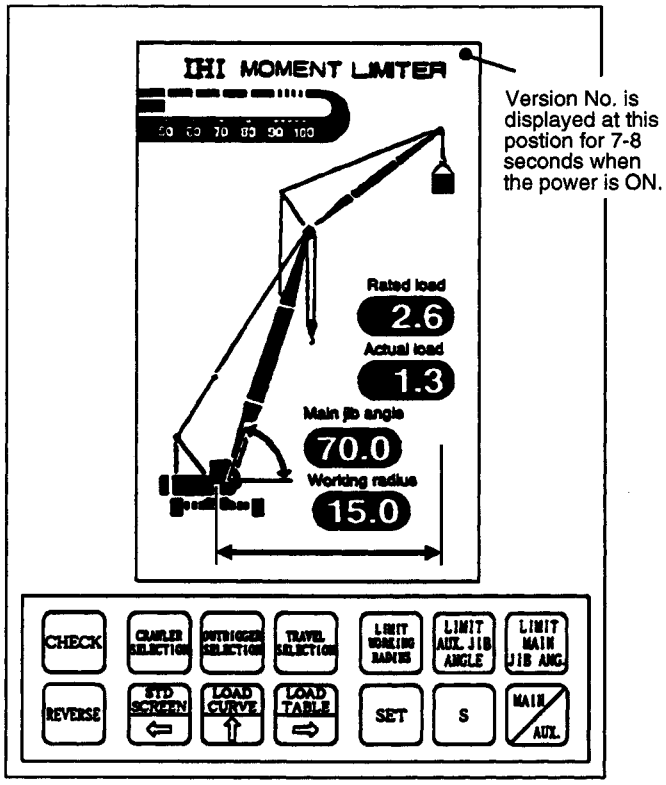
   If the moment limiter is struck by lightning, it will be damaged. If lightning is forecasted or observed, keep the moment limiter away from lightning by lowering the boom on the ground or other necessary action. Be careful not to spill any solvent such as gasoline, alcohol etc. over the moment limiter body. In particular, take care that no solvent will be on the display unit. You must disconnect LMI before welding on crane.

HC 80 MOMENT LIMITERS

There are 2 different models of Moment Limiters, depending whether the crane is a standard lift crane or equipped to use a luffing attachment.

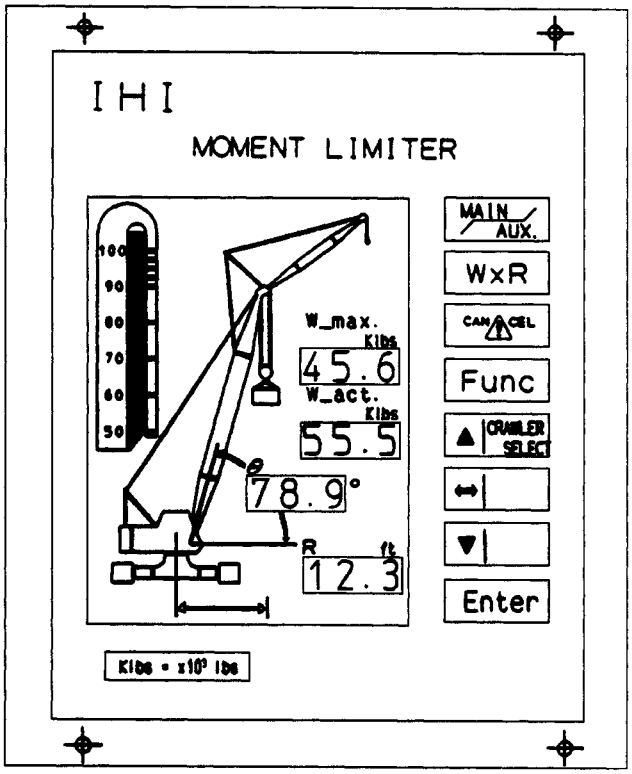
The screens of the Moment Limiters below show the difference.

MODEL ML-E
For crane with luffing attachment capabilities



See Page 1-79 for operation.

MODEL ML-D2A
For standard crane

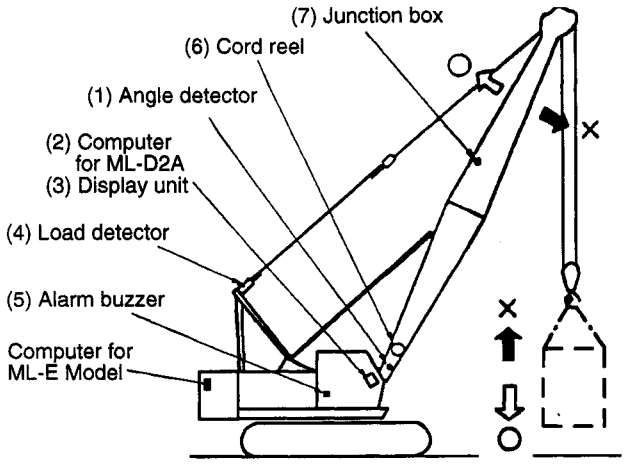


See Page 1-57 for operation.

MOMENT LIMITER
MODEL ML D2A FOR STANDARD CRANE

NOTE: For Luffing Crane, see Model ML-E Moment Limiter beginning on Page 1-79

Outline of moment limiter (overload prevention unit)



O : Safe side

X : Dangerous side

This safety device stops dangerous operation (boom lowering and load hoisting) and sounds the alarm buzzer when an actual load beyond the rated load is applied to the hook. Note, however, operations can be performed on the safe side (boom hoisting and load lowering) even if this safety device is activated.

Function of each unit:

1. Angle detector

   This detector sends a voltage, which varies with boom angle, to the computer.

2. Computer (CPU)

   It calculates the permissible load in the present working position according to a voltage signal from the angle detector. Moreover, it calculates the actual load through the reception of a voltage signal applicable to the weight of the lifted load. The load in the load detector is compared with the weight of the lifted load. When the value by comparison reaches 90%, the buzzer sounds intermittently. When the value by comparison reaches 100%, the buzzer sounds continuously and the functions, hoisting and boom down stop automatically.

3. Display unit

   This unit displays working radius, main jib angle, actual load, permissible load and offset angle. In addition, this unit is capable of setting working limits.

4. Load detector

   This is a strain gauge type detector mounted on the gantry yoke. This detector sends a voltage signal, which responds to the change of load, to the computer unit.

5. Alarm buzzer

   90% and 100% signal levels in the computer unit are informed by the intermittent and continuous sounds of a piezoelectric buzzer, respectively, as a warning to the operator.

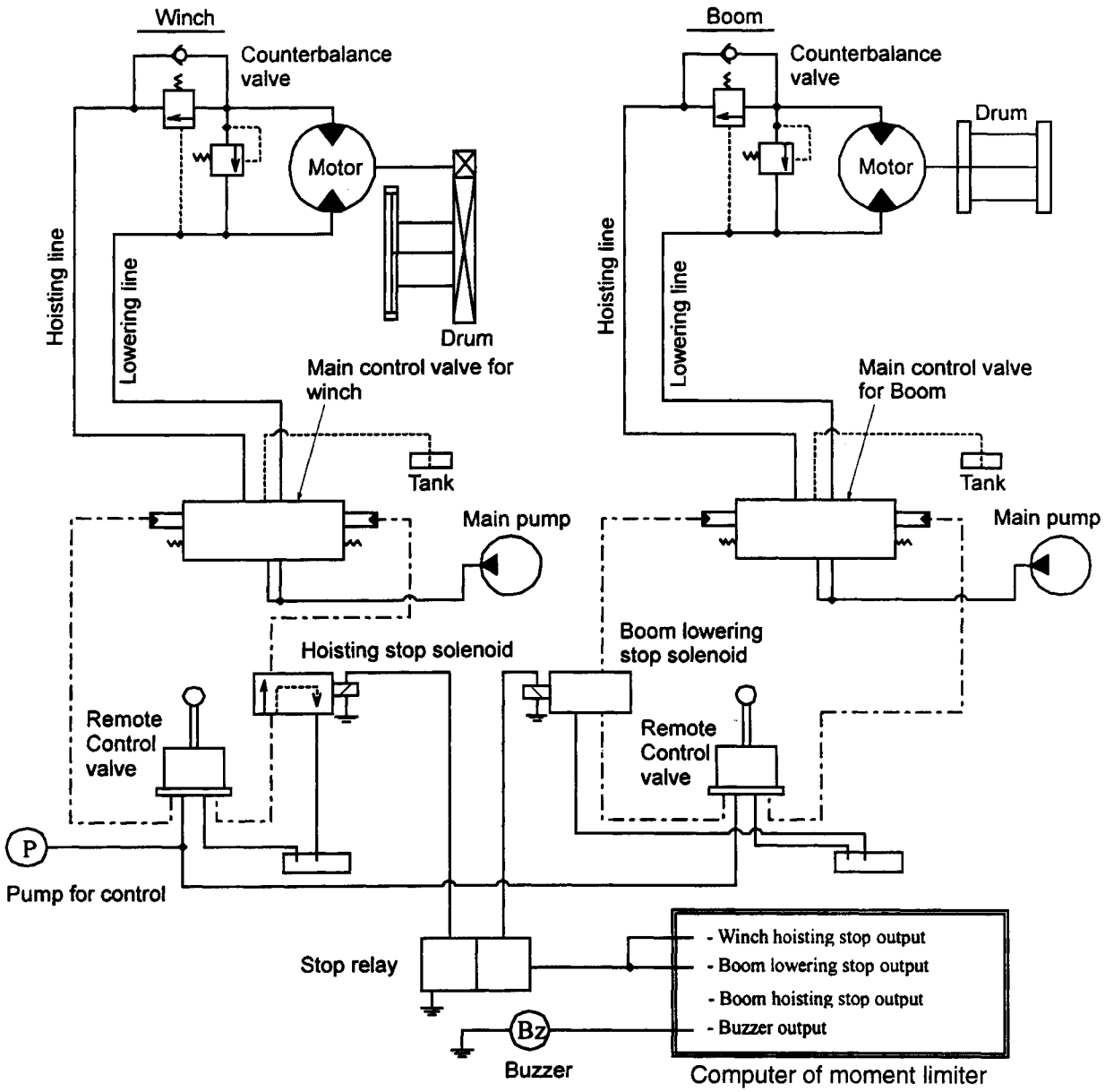
6. Cord reel

   This is a wiring cord winding drum used to wind excess cord on it depending on boom length.

7. Junction box

   The junction box of outer boom houses cables for the jib hook and main hook overwind (anti-two-block) detector. The wiring of the boom hoisting kick-out is independent of the junction box.

Stop mechanism



When the stop relay is de-energized in response to 100% of permissible load, power supply to the winch hoisting stop solenoid and boom lowering stop solenoid is turned off. As a result, the solenoid valve is shifted. Pressurized fluid from the Hydraulic Remote Control (HRC) valve normally passes through the solenoid valve and acts on the end of spool of the main control valve. When the stop solenoid is shifted, the pressurized fluid from the main control valve spool returns to the tank. Consequently, the main control valve returns to the neutral position.

When the main control valve has returned to the neutral position, the pressurized fluid from the main pump is no longer supplied to the winch motor and boom motor. Therefore, winch hoisting and boom lowering are stopped by the counter balance valve and disc brake. With or without a load, boom lowering stop output and buzzer output are issued when the maximum working radius is reached. When the boom is hoisted at 80°, boom hoisting stops and alarm outputs are activated.

Automatic stop device for overload and anti-two-block

On activation of the automatic stop device, a relay is de-energized due to activation of the microswitch (for boom throw-out or hook overwind prevention) or stop command from the moment limiter. When the relay contacts open, power supply to each solenoid valve in the load hoisting circuit and the boom hoisting/lowering circuit is turned off. When power supply to the solenoid valve is turned off, the valve is shifted.

Control pressure via the remote control valve passes through the solenoid valve and flows into each main control valve. The fluid presses the end of spool of the main control valve until the valve is shifted.

The pressurized fluid of the main pump passes through the control valve and flows into each motor. When the solenoid valve is shifted as mentioned above, the controlling fluid, which was led from the remote control valve to main control valve, returns to the tank. Therefore, the main control valve returns to the neutral position. When the main control valve has returned to the neutral position, the pressurized fluid of the main pump is no longer led to each hoisting motor. Consequently, the hoisting motor stops to disable load hoisting, boom hoisting or boom lowering.

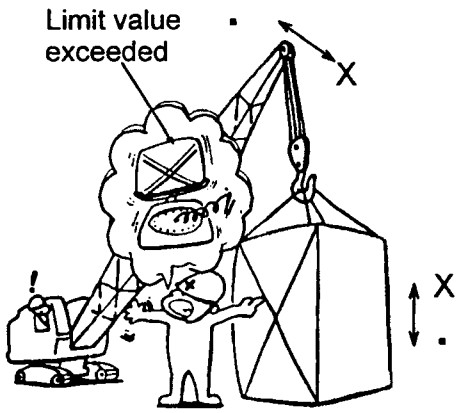
Note: If the overload prevention stops the functions when machine is started, reset the Load Moment Limiter by moving the Bypass Switch to release.

Activation of overload prevention device and method of its release

When the actual value exceeds 90% of the limit value, the buzzer beeps intermittently. When the actual value exceeds 100%, the buzzer beeps continuously.

The hoisting and boom down functions automatically stop according to the stop signal from the moment limiter.

In case the functions are automatically stopped according to the stop command from the moment limiter, the working distance should be shortened by hoisting the boom or the load should be reduced by lowering the load to the ground. Once the machine has returned to the safe area, the buzzer stops beeping. Return the crane to a safe radius, and the automatic stop is released in about 2 seconds and all the operation can be resumed.



⚠ CAUTION

1. **If crane operation is carried out with the reset switch kept released for any reason, there is a risk of machine tip-over, backward boom turn-over (boom hoist), etc. because the overload prevention device will not function. Do not release the overload prevention device to overload the crane.**
2. **During crane operation, never turn off the power supply of overload prevention device.**

Automatic stop device for overload and anti-two-block

On activation of the automatic stop device, a relay is de-energized due to activation of the microswitch (for boom throw-out or hook overwind prevention) or stop command from the moment limiter. When the relay contacts open, power supply to each solenoid valve in the load hoisting circuit and the boom hoisting/lowering circuit is turned off. When power supply to the solenoid valve is turned off, the valve is shifted.

Control pressure via the remote control valve passes through the solenoid valve and flows into each main control valve. The fluid presses the end of spool of the main control valve until the valve is shifted.

The pressurized fluid of the main pump passes through the control valve and flows into each motor. When the solenoid valve is shifted as mentioned above, the controlling fluid, which was led from the remote control valve to main control valve, returns to the tank. Therefore, the main control valve returns to the neutral position. When the main control valve has returned to the neutral position, the pressurized fluid of the main pump is no longer led to each hoisting motor. Consequently, the hoisting motor stops to disable load hoisting, boom hoisting or boom lowering.

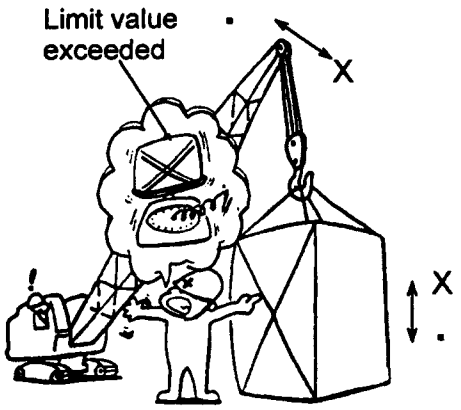
Note: If the overload prevention stops the functions when machine is started, reset the Load Moment Limiter by moving the Safety Release Switch to release.

Activation of overload prevention device and method of its release

When the actual value exceeds 90% of the limit value, the buzzer beeps intermittently. When the actual value exceeds 100%, the buzzer beeps continuously.

The hoisting and boom down functions automatically stop according to the stop signal from the moment limiter.

In case the functions are automatically stopped according to the stop command from the moment limiter, the working distance should be shortened by hoisting the boom or the load should be reduced by lowering the load to the ground. Once the machine has returned to the safe area, the buzzer stops beeping. Return the crane to a safe radius, and the automatic stop is released in about 2 seconds and all the operation can be resumed.



CAUTION

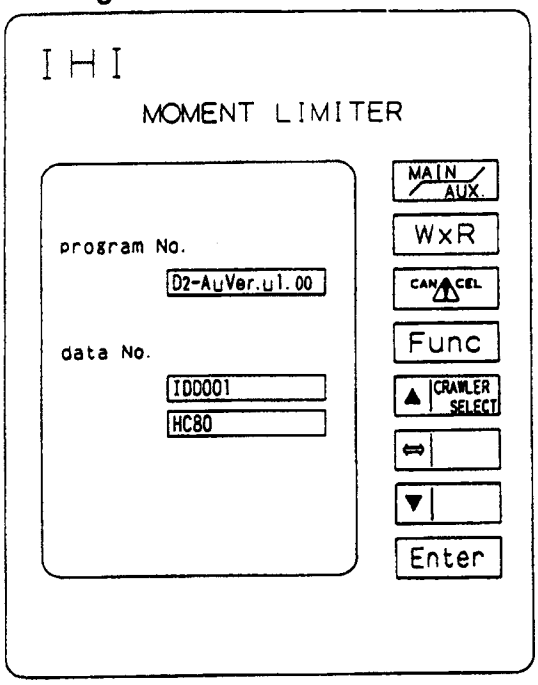
1. **If crane operation is carried out with the reset switch kept released for any reason, there is a risk of machine tip-over, backward boom turn-over (boom hoist), etc. because the safety device will not function. Do not release the safety device to overload the crane.**
2. **During crane operation, never turn off the power supply of overload prevention device.**

ML-D2A

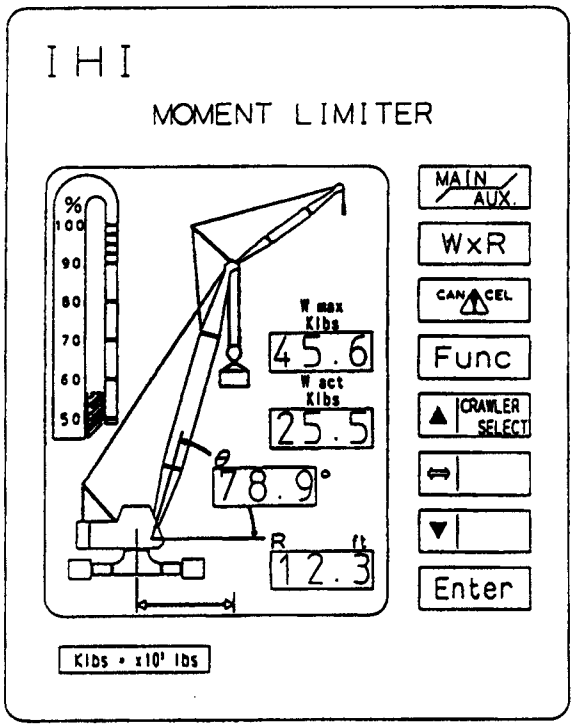
How to operate the ML-D2A type overload prevention device (Moment Limiter)

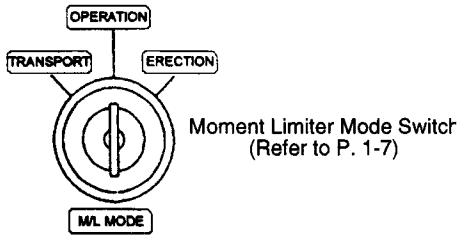
1. Turning on the power and display of the standard menu

Starting Menu



Standard Menu (boom work)





Moment Limiter Mode Switch
(Refer to P. 1-7)

(1) Make sure that the moment limiter mode switch is at "OPERATION".

(2) Start the engine, and the moment limiter is automatically turned on.

(3) After approximately 5 seconds, the starting menu (as illustrated at left) is displayed. In the starting menu, "Program No.", "Data No." and the model name are displayed. Check the displayed data.

(4) After 5 seconds since the starting menu was displayed, the menu is changed to the standard menu. The standard menu shows the following items:

- Load ratio . . . . . .%
- Rated overall lifting load . . . . .Klbs. (allowable load)
- Actual load . . . . . .Klbs.
- Boom angle. . . . . .°
- Working radius . . . . . .Ft.

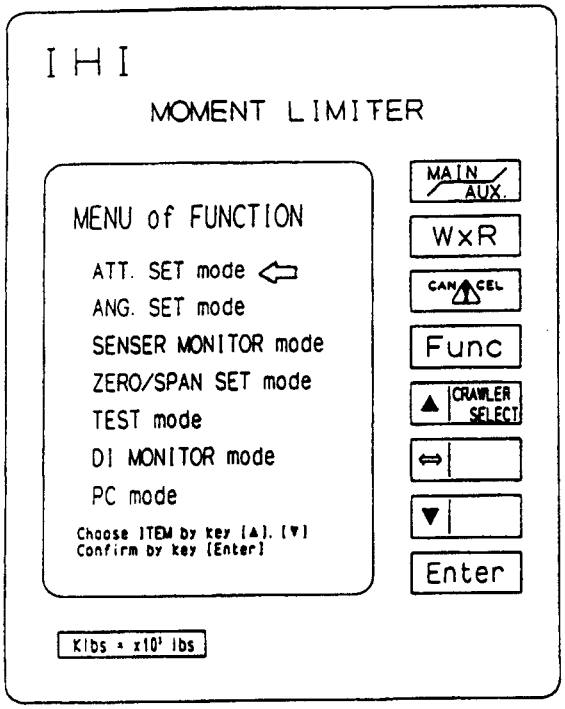
Note: 45.6 Klbs = 45,600 lbs.

(5) The standard menu is displayed for "boom (main) lifting". If the operator has to change to "jib (auxiliary) lifting", press the MAIN AUX key switch. The load of "boom lifting" as illustrated left moves to the jib.

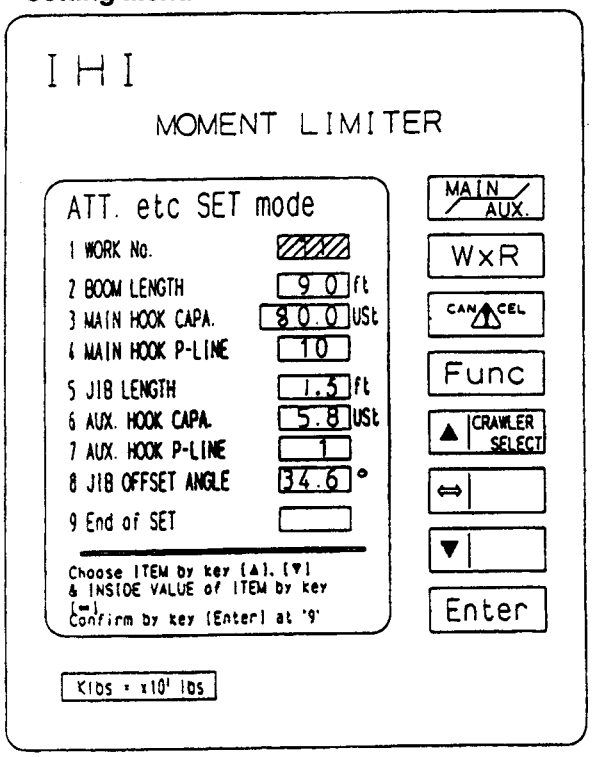
(6) If the sensor malfunctions or if the working radius is set wrong, an error No. is displayed in the column of the working radius. Make sure that an error No. is not displayed.

2. Setting of the working conditions

Function Selection Menu



Setting Menu



(1) Press the Func key once in the standard menu, and the function selection menu as illustrated left is displayed. If you want to return to the standard menu, press the Func or CANCEL key once.

(2) Proceed to the setting menu from the function selection menu.

In the function selection menu, press the CRAWLER SELECT ▲ or ▼ key to move the cursor to "ATT. SET mode". Normally, the cursor is at "ATT. SET mode" when the function selection menu is displayed.

Press the Enter key once.

When pressing the Enter key, the menu is changed to the following setting menu.

(3) Set the Working No. radius on the setting menu. Press the CRAWLER SELECT ▲ or ▼ key to move the cursor to "WORK NO."

[1] Press the ⇔ key to set the value of the current attachment for "WORK NO."

Work No.	Work Mode	Boom Length (Ft.)	Work No.	Work Mode	Boom Length (Ft.)
11	Crane	40, 50, 60, 70, 80, 90, 180, 190, 200	16	Crane	140
12	Crane	100	17	Crane	150
13	Crane	110	18	Crane	160
14	Crane	120	19	Crane	170
15	Crane	130			

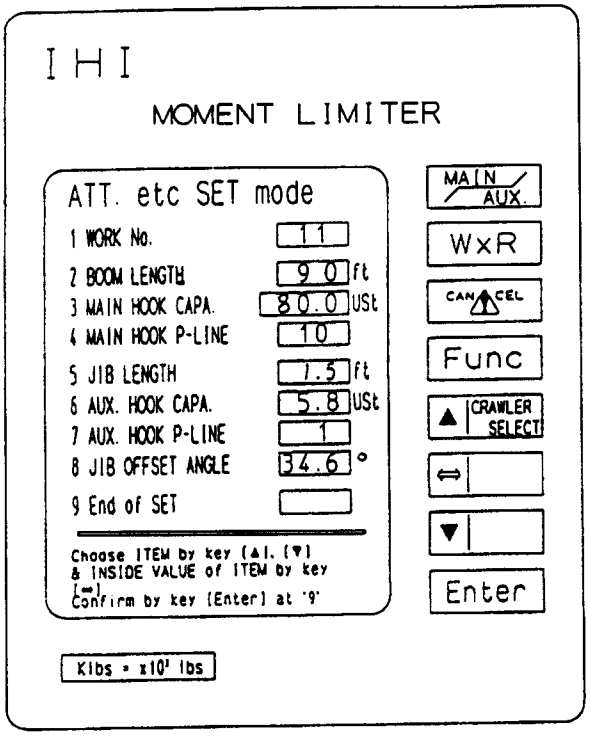
Each time the ⇔ key is pressed, the data included in the specification are displayed in order. Select the proper work number.

[2] Setting of the boom length

Press the CRAWLER SELECT ▲ or ▼ key to move the cursor to "BOOM LENGTH". Press the ⇔ key to set the proper value for the length of the current boom. Each time the ⇔ key is pressed, the boom length data included in the specification are displayed in order.

ML-D2A

Setting Menu



[3] Setting of the main hook capacity

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "MAIN HOOK CAPA." Press the ⇔ key to set the value of the current hook capacity.

Each time the ⇔ key is pressed, the main hook capacity data included in the specification are displayed in order. If the main hook is not installed, select "0.0".

[4] Setting of the parts of line for the main hook

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "MAIN HOOK P-LINE". Press the ⇔ key to set the parts of line for the current main hook.

Each time the ⇔ key is pressed, the "parts of line" data included in the specification are displayed in order. If the main hook is not installed, select "1".

[5] Setting of the jib length

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "JIB LENGTH". Press the ⇔ key to set the value of the current jib length.

Each time the ⇔ key is pressed, the jib length data included in the specification are displayed in order. If the jib is not installed, select "0.0".

[6] Setting of the auxiliary hook capacity

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "AUX. HOOK CAPA.". Press the ⇔ key to set the value of the current auxiliary hook capacity.

Each time the ⇔ key is pressed, the auxiliary hook capacity data included in the specification are displayed in order. If the auxiliary hook is not installed, select "0.0".

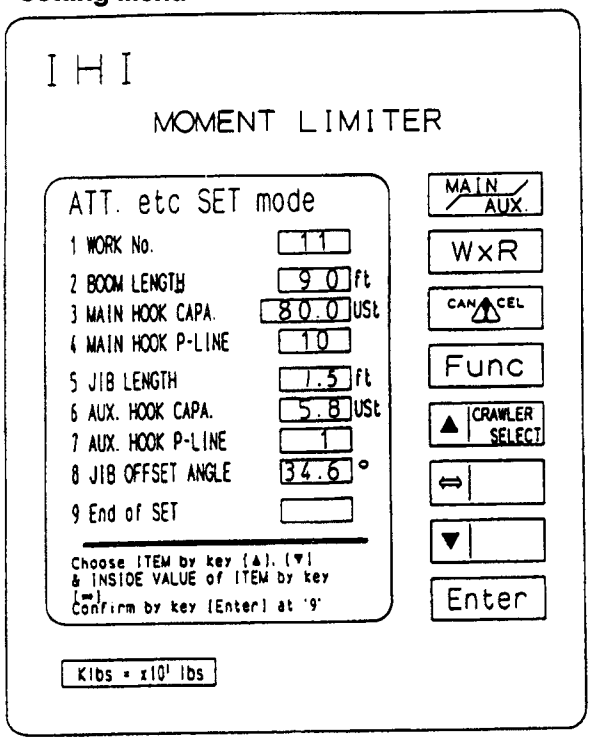
[7] Setting of the part of line for the auxiliary hook

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "AUX. HOOK P-LINE". Press the ⇔ key to set the parts of line for the current auxiliary hook.

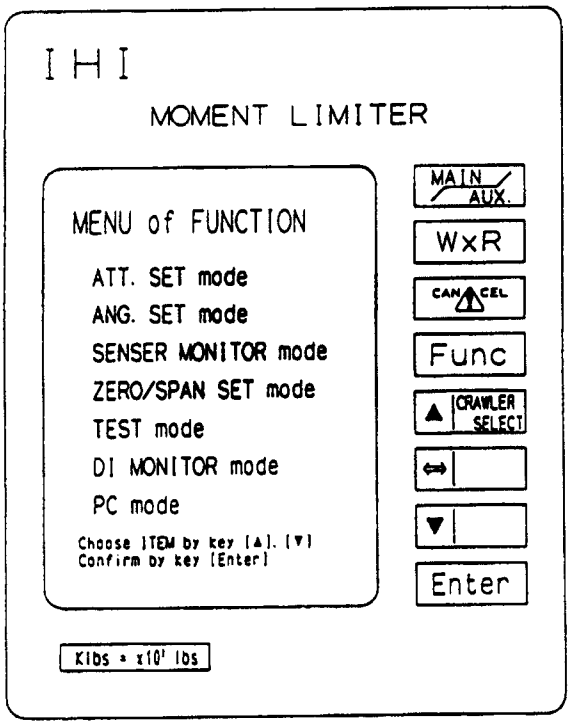
Each time the ⇔ key is pressed, the "parts of line" data included in the specification are displayed in order. If the auxiliary hook is not installed, select "1".

ML-D2A

Setting Menu



Function Selection Menu



[8] Setting of the jib offset angle

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "JIB OFF SET ANGLE". Press the ⇔ key to set the offset angle of the current auxiliary jib. Each time the ⇔ key is pressed, the offset angle data included in the specification are displayed in order. For the auxiliary jib of the nominal 1m, the offset angle is automatically selected. If "0.0" is inputted to the jib length in the aforementioned [5], the offset angle is "0.0" and, even if the ⇔ key is pressed, the menu is not changed.

(4) Check of the set values

Make sure that the values set at the aforementioned [1] ~ [8] are fit to the crane configuration.

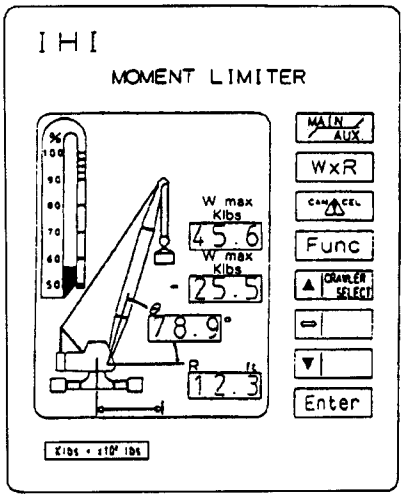
Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET" and press the Enter key twice slowly. When pressing the Enter key twice slowly, the displayed values are stored as the new set data and the function selection menu is automatically displayed.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [1] ~ [8] are ignored and the function selection menu is automatically set without the data change. When the CANCEL key is pressed, the working conditions are not changed. Be careful.

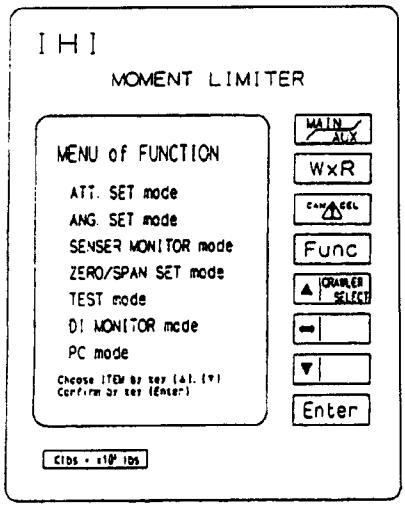
Press the Func or CANCEL key once to return from the function selection menu to the standard menu.

ML-D2A

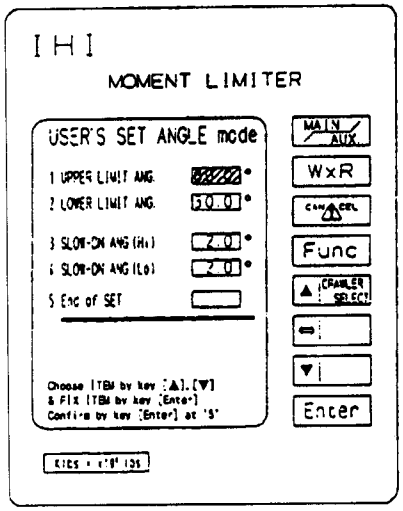
Standard Menu



Function Selection Menu



Optional Angle Setting Menu



3. Optional auto stop or alarm angle setting

   If you desire to set an optional angle, proceed from the function selection menu to the optional angle setting menu.

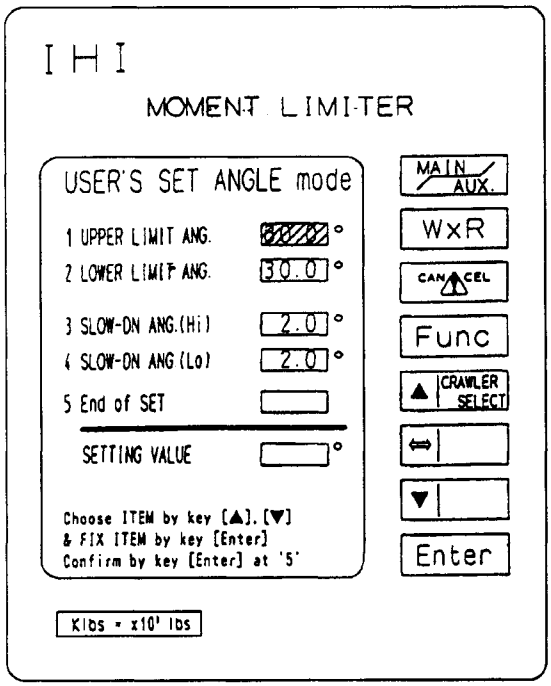
   Press the [Func] key once if changing from the standard menu to the function selection menu.

   Press the [Func] or [CANCEL] key once if changing from the function selection menu to the standard menu.

   (1) If changing from the function selection menu to the optional angle setting menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor to "ANG. SET mode". Then, press the [Enter] key.

ML-D2A

Optional Angle Setting Menu



(2) Setting of the boom optional upper limit angle

[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "UPPER LIMIT ANG." Normally, the cursor is at "UPPER LIMIT ANG." when the optional angle setting menu is displayed.

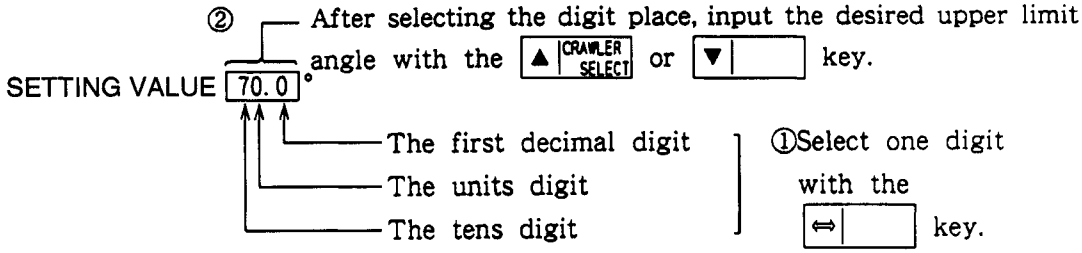
[2] Press the Enter key once. The editing mode for setting the optional angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

In case in editing mode change menu by key ⇔ choose value by **[▲], [▼]** provisional decision by Enter

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



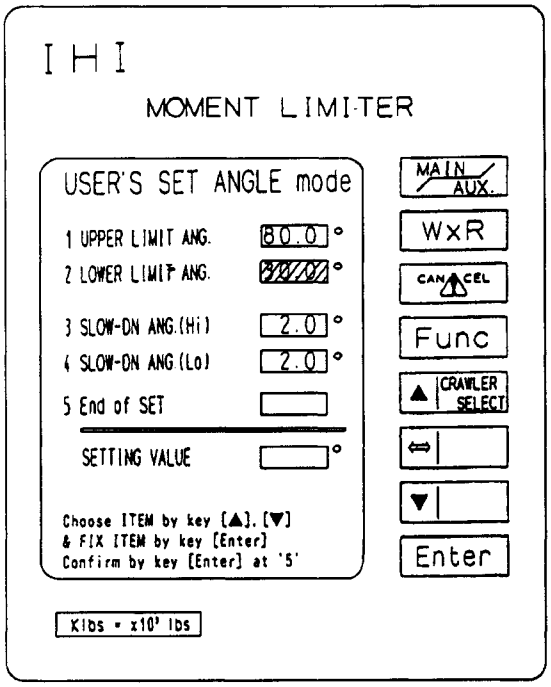
In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "7" to the tens digit, and so the boom optional upper limit angle is set to 70.0° . Maximum upper limit angle is 80.0° .

[5] After setting the boom optional upper limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "UPPER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the boom has reached the set upper limit angle (70° in the above example), the alarm sounds and the boom hoisting stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached 80°, the boom stops automatically and the alarm sounds.

ML-D2A

Optional Angle Setting Menu



(3) Setting of the boom optional lower limit angle

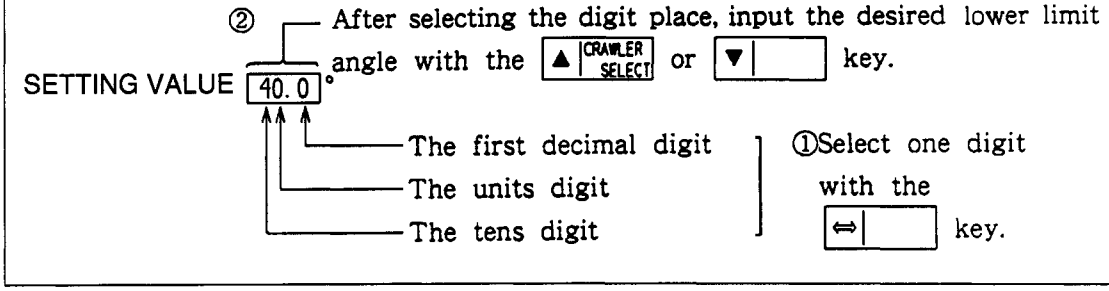
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "LOWER LIMIT ANG."

[2] Press the Enter key once. The editing mode for setting the optional angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



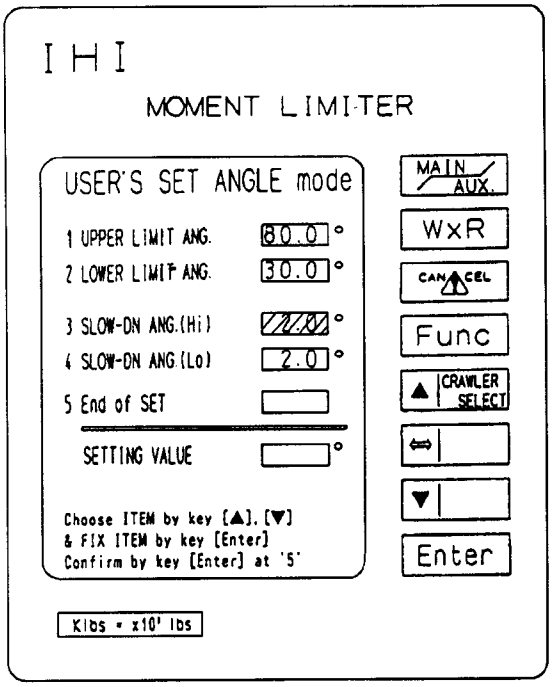
In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "4" to the tens digit, and so the boom optional lower limit angle is set to 40.0° . Minimum lower limit angle is 30.0° .

[5] After setting the boom optional lower limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "LOWER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the boom has reached the set lower limit angle (40° in the above example), the alarm sounds and the boom lowering stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached 30°, the boom stops automatically and the alarm sounds.

ML-D2A

Optional Angle Setting Menu



(4) Setting of the upper limit angle of gentle stop

This function sets the optional approach angle at which the slow-down starts before the boom stops automatically when the boom is hoisting.

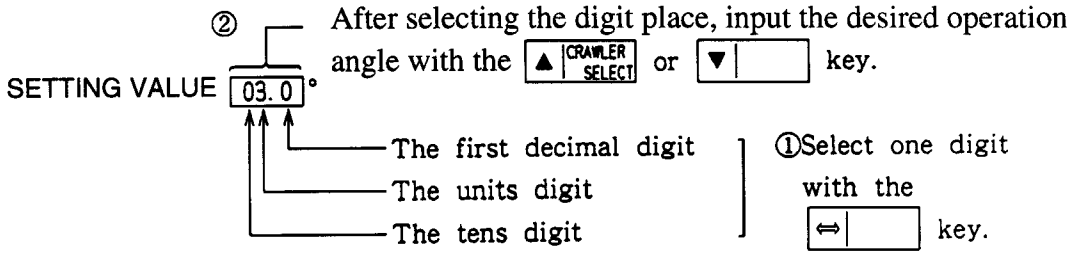
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "SLOW-DN ANG. (Hi)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



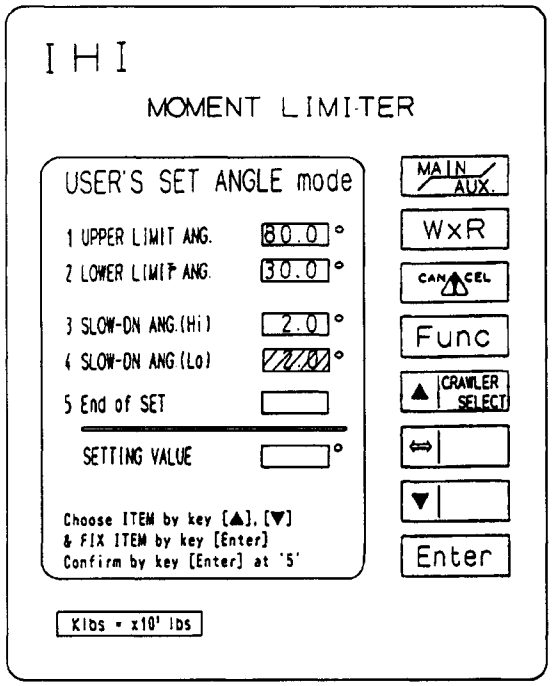
In the above example, "0" is inputted to the first decimal digit, "3" to the units digit and "0" to the tens digit, and so the upper limit slow-down angle is set to 3.0° . Standard minimum slow-down angle is 2.0° .

[5] After setting the upper limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Hi)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (2), the boom optional upper limit angle is set to 70°, and in the above example, the upper limit slow-down operation angle is set to 3°. In such a case, the boom hoisting speed slows down when the boom angle is 67° and the boom hoisting stops automatically and the alarm sounds when the boom angle is 70°.

If the machine is without the automatic stop function, the hoisting speed slows down at the boom angle 67° and the alarm sounds at the boom angle 70°. The boom hoisting stops automatically at the boom angle 80°.

ML-D2A

Optional Angle Setting Menu



(5) Setting of the lower limit angle of gentle stop

This function sets the optional approach angle at which the slow-down starts before the boom stops automatically when the boom is lowering.

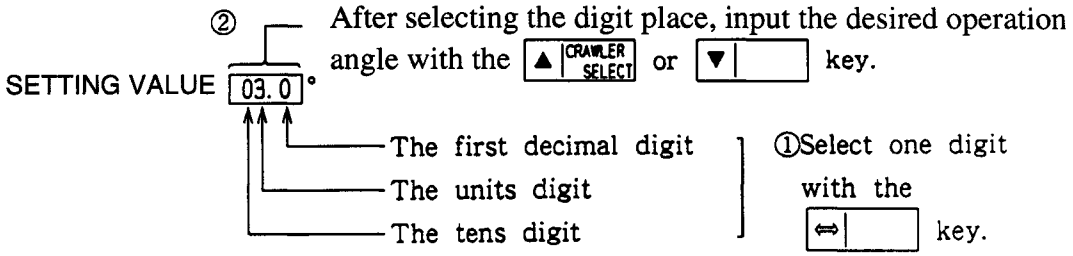
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "SLOW-DN ANG. (Lo)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



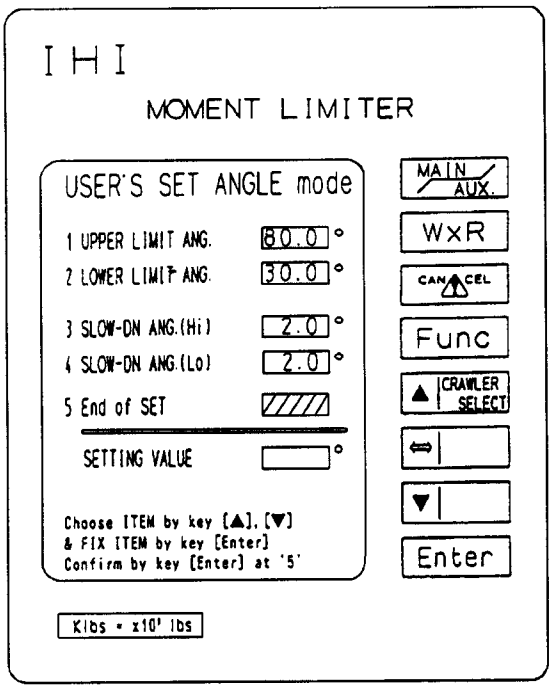
In the above example, "0" is inputted to the first decimal digit, "3" to the units digit and "0" to the tens digit, and so the lower limit slow-down angle is set to 3.0° . Standard minimum slow-down angle is 2.0° .

[5] After setting the optional lower limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Lo)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (3), the optional lower limit angle is set to 40°, and in the above example, the lower limit slow-down operation angle is set to 3°. In such a case, the lowering speed slows down when the boom angle is 43° and the boom lowering stops automatically and the alarm sounds when the boom angle is 40°.

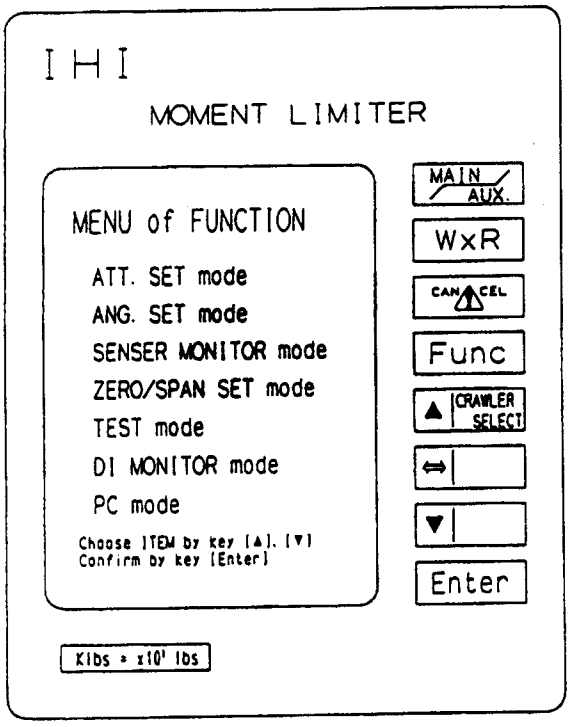
If the machine is without the automatic stop function, the lowering speed slows down at the boom angle 43° and the alarm sounds at the boom angle 40°. The boom lowering stops automatically at the boom angle 30°.

ML-D2A

Optional Angle Setting Menu



Function Selection Menu



(6) Decision for angle setting

[1] Make sure that the proper values are set in the above setting procedure of the items (2) ~ (5):
- The value of the boom upper limit angle
- The value of the boom lower limit angle
- The value of the upper limit slow-down operation angle
- The value of the lower limit slow-down operation angle

[2] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET".

[3] Press the Enter key twice slowly. The data on the screen are updated and the menu is automatically returned to the function selection menu.

[4] If you desire to stop setting, press the CANCEL key before pressing the Enter key.

If you desire to change the function selection menu to the standard menu, press the Enter or CANCEL key once.

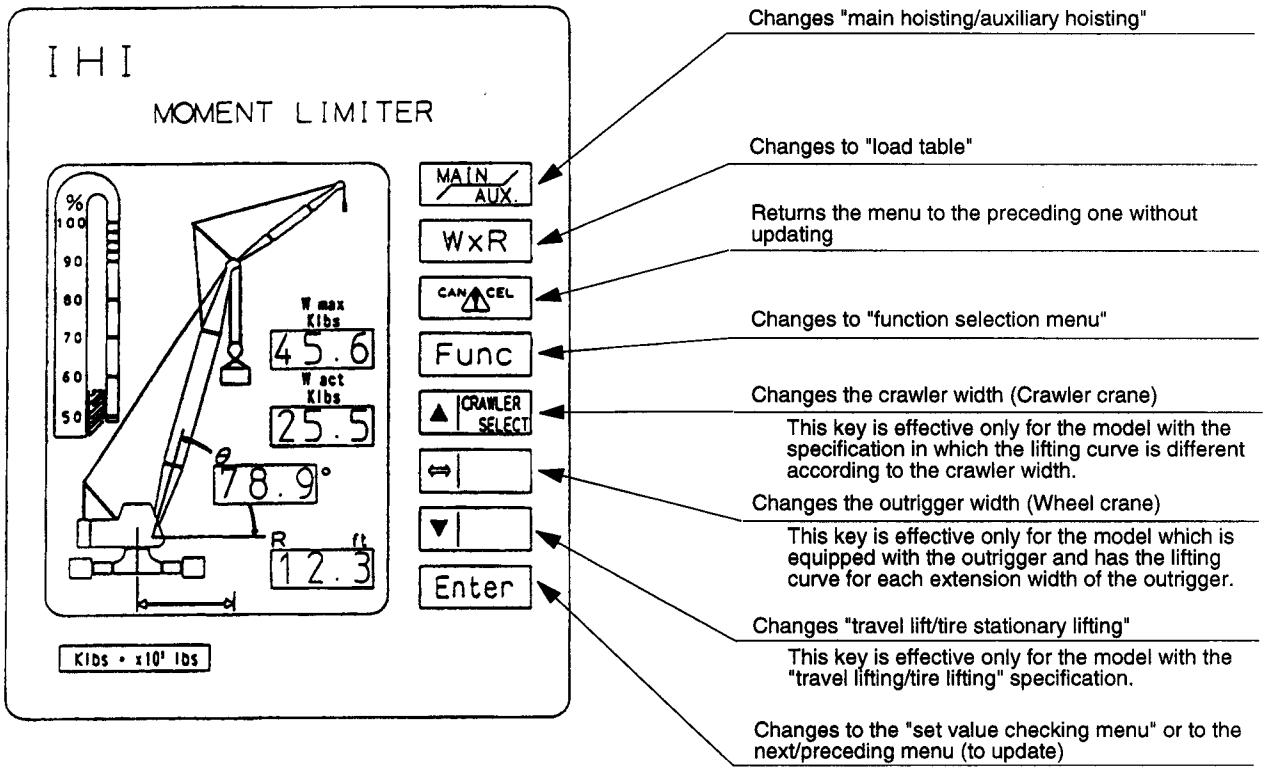
Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [1] ~ [8] are ignored and the function selection menu is automatically set without the data change.

When the CANCEL key is pressed, the working conditions are not changed. Be careful.

ML-D2A

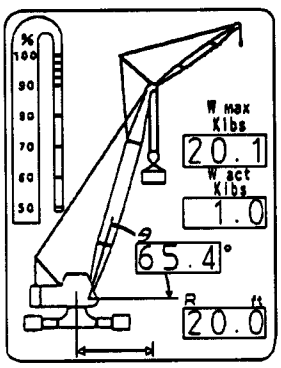
4. Standard menu and operation keys

Standard Menu

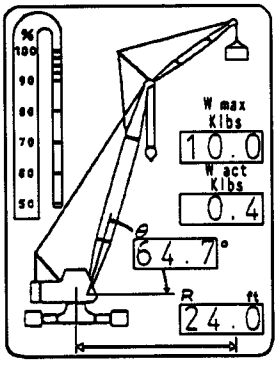


(1) Main/auxiliary selector key switch [MAIN AUX]

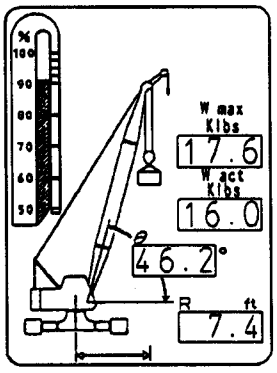
Press the main/auxiliary selector key switch [MAIN AUX], the main hoisting work menu is changed to the auxiliary hoisting work menu. Press the [MAIN AUX] key again, and the menu is changed to the main hoisting work menu. Select a proper menu according to the actual crane configuration. It is not permitted to lift loads with the main hook and the jib or auxiliary hook at the same time.



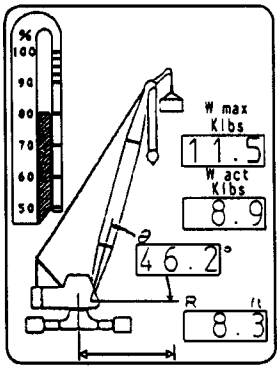
Main hoisting work with jib



Jib work



Main hoisting work with 1m jib

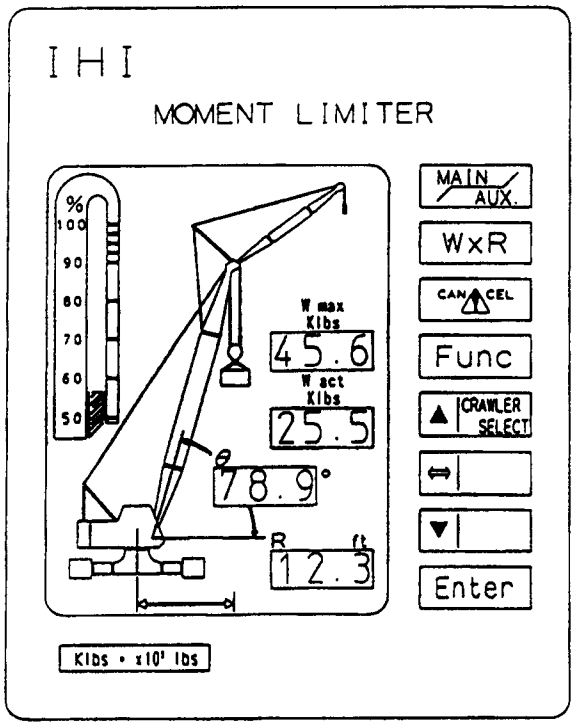


1m jib work

The values in the display unit are reference values required for the explanation. They have nothing to do with an actual lift.

ML-D2A

Standard Menu



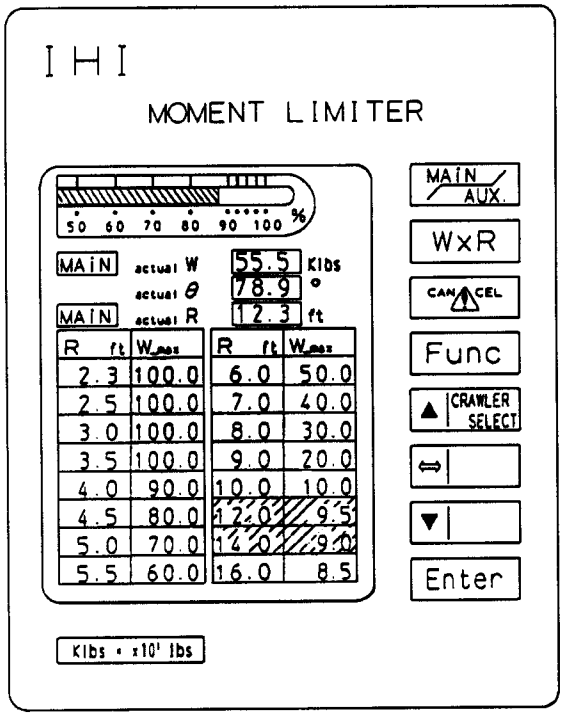
(2) The selector switch to the load table WxR

[1] Press the WxR switch once on the standard menu, and the load table is displayed. On the load table display, press the WxR or CANCEL key once, and the standard menu appears.

The load table displays the following four items:

- Actual load for the main or auxiliary hoisting. . . . . Klbs
- Boom angle . . . . . °
- Working radius for the main or auxiliary hoisting. . . . . Ft.
- Working radius/allowable load table . . . . . Ft. Klbs

Load Table (for "MAIN")



The following illustration is the "MAIN" table. If you want the "AUX." table, press the MAIN AUX. key switch.

[2] Working radius/allowable load table

In the load table, the shaded area of the working radius/allowable load table indicates the current crane working radius and allowable load.

The actual working radius is 12.3 ft. and is within the shaded area, 12.0 ft. ~ 14.0 ft. The operator can view the current working radius and allowable load according to this table.

To display the data after 16.0 ft. for the working radius, press the ⇔ key once. The next data is displayed. To return to the original data, press the ⇔ key.

[3] The upper bar graph on the screen indicates the ratio (load ratio) of the crane's current load (actual value) and to the allowable safe working load.

(3) Cancel key [CANCEL]

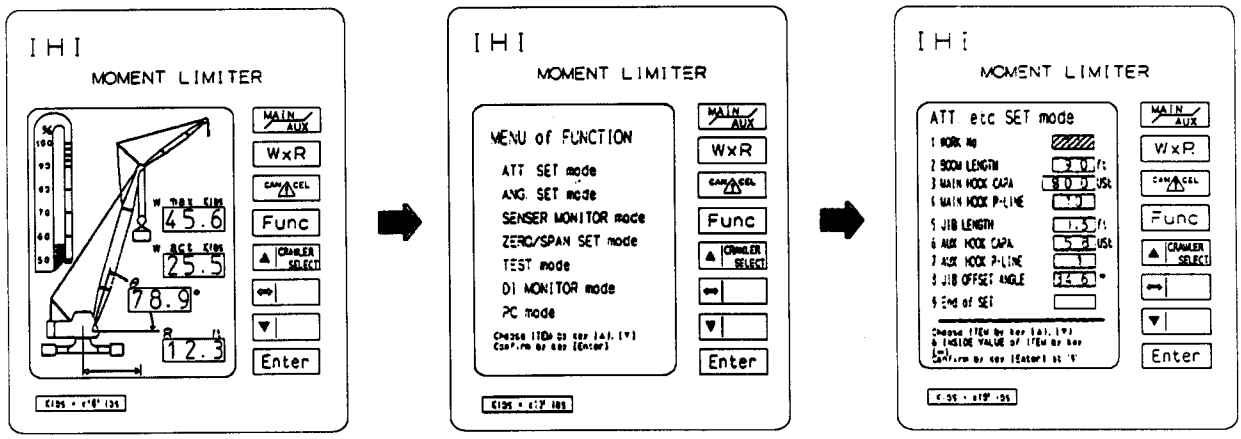
Press this key in the middle of setting for the crane working conditions or optional angle as mentioned, the setting operation stops and the original condition before setting is restored.

(4) Function key - to change to the function selection menu [Func]

When the working conditions have to be set, change the standard menu to the function selection menu and then select the desired items in the function selection menu with the cursor.

Press the [Func] once in the standard menu and the function selection menu is displayed. In the function selection menu, press the [CRAWLER SELECT] or [▼] key to move the cursor to the desired item.

For example, move the cursor to "ATT. SET mode" and press the [Enter] key once. The, "ATT. etc. SET mode" (working radius setting mode) is displayed.



Standard Menu | **Function Selection Menu** | **Setting Menu (ATT. etc. SET mode)**

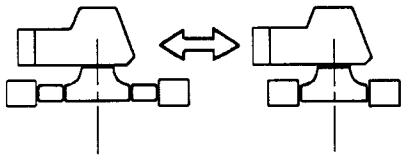
Refer to "(2) Setting of the working conditions" for how to set the working conditions and how to return from the setting menu to the function selection menu. If the function selection menu has to be changed to the standard menu, press the [Func] or [CANCEL] key once.

(5) Crawler select key - to change the crawler width [CRAWLER SELECT]

In the crawler crane, this key is effective only for the model which rated overall lifting load is changed according to the crawler width.

Press the [CRAWLER SELECT] key once in the standard menu, and the illustrated crawler width is retracted. Press the key again, and the crawler width is extended.

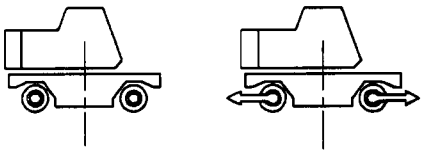
Change of Crawler Width



When extended (EXT.) **When retracted (RET.)**

On the machine without the crawler width change specification, set the crawler width to the extended condition. If the crawler width is retracted, "E114" is displayed and the alarm sounds.

(6) [⇔] This key is used for setting the working conditions and changing information.



Tire Stationary Lifting **Travel Lifting**

(7) [▼] This key is used for setting the working conditions and scrolling down through the menus.

(8) This key is used to change to "set value checking menu" or to the next/preceding menu (to update)

Press the [Enter] key once in the standard menu, and the "Attachment setting" menu, which was set in the above-mentioned "ATT etc. SET mode" menu, is displayed.

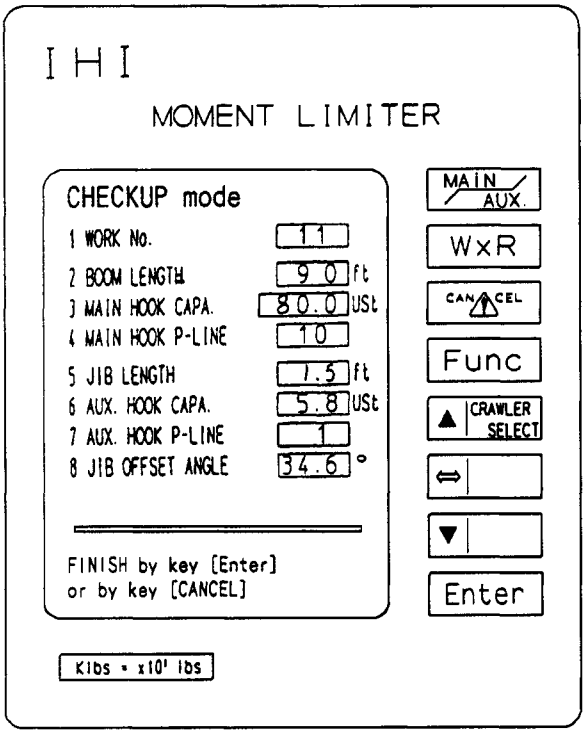
Press the [Enter] or [CANCEL] key in the setting menu, and the standard menu is restored.

In the set value checking menu, the operator can check the following values which were set in "Setting of the working conditions":

1. Work No.
2. Boom length
3. Main hook capacity
4. Part of line for main hook
5. Jib length
6. Auxiliary hook capacity
7. Part of line for auxiliary hook
8. Jib offset angle

ML-D2A

Set Value Checking Menu



In this menu, the operator can check the following eight items which are set currently:

1. Work No.
2. Boom length
3. Main hook capacity
4. Part of line for main hook
5. Jib length
6. Auxiliary hook capacity
7. Part of line for auxiliary hook
8. Jib offset angle

After checking the data, press the Enter or CANCEL key. The standard menu is restored.

4. Error messages and error codes

If a working condition inapplicable to the specification is set or if the sensor output is defective in the overload prevention device (moment limiter), the error is displayed on the screen.

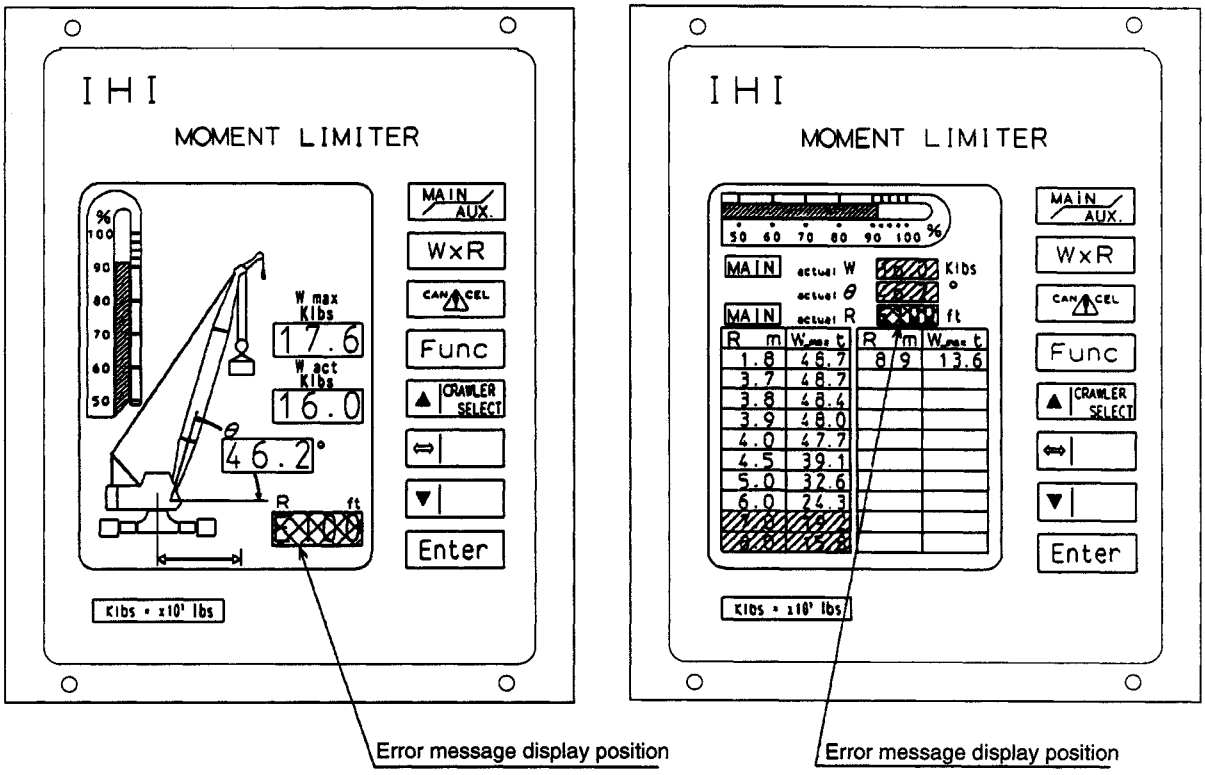
The error is displayed as "Exxx" in the working radius column. The error display blinks and an alarm is heard. Refer to the illustrations on the next page.

The error codes and remedial measures are shown in the following table.

Error Code Table

Error No.	Causes	Check and Remedial Measures
EEEE	DSP (CPU) is defective.	Should repair or replace
E100	Boom angle detector is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the angle meter
E102	The load cell sensor is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the load cell
E114	The load table does not exist.	Check the set data Check the crawler width, etc.
E120	The communication is not proper between the CPU and the display unit.	Should repair or replace
E121	The memory is defective in the CPU.	Should repair or replace
E122	The internal mode selector LS is defective.	Should repair or replace

ML-D2A



In both of the above illustrations, the error message is displayed as "E100" in the working radius column. "E100" blinks and an alarm is heard. Refer to "Error Code Table" for the causes and remedial measures of the errors.

PRE-OPERATIONAL CALIBRATION PROCEDURE FOR ML-D2A MOMENT LIMITER (STANDARD CRANE)

IF THIS IS A NEW INSTALLATION, THE FOLLOWING NEEDS TO BE PERFORMED.

IMPORTANT - If the steps are not followed properly and in exact order, the Moment Limiter will **not** function properly.

CRANE NEEDS TO BE LEVEL ON FIRM GROUND

1. Installation
   A. Install electric angle indicator to the boom inner.
   B. Connect the cable for the angle indicator to the connector box between the boom feet (see Figure 1).
   C. Install the anti-two-block switch and cable.
   D. Turn the "M/L MODE" switch to "OPERATION" position. Start the engine.

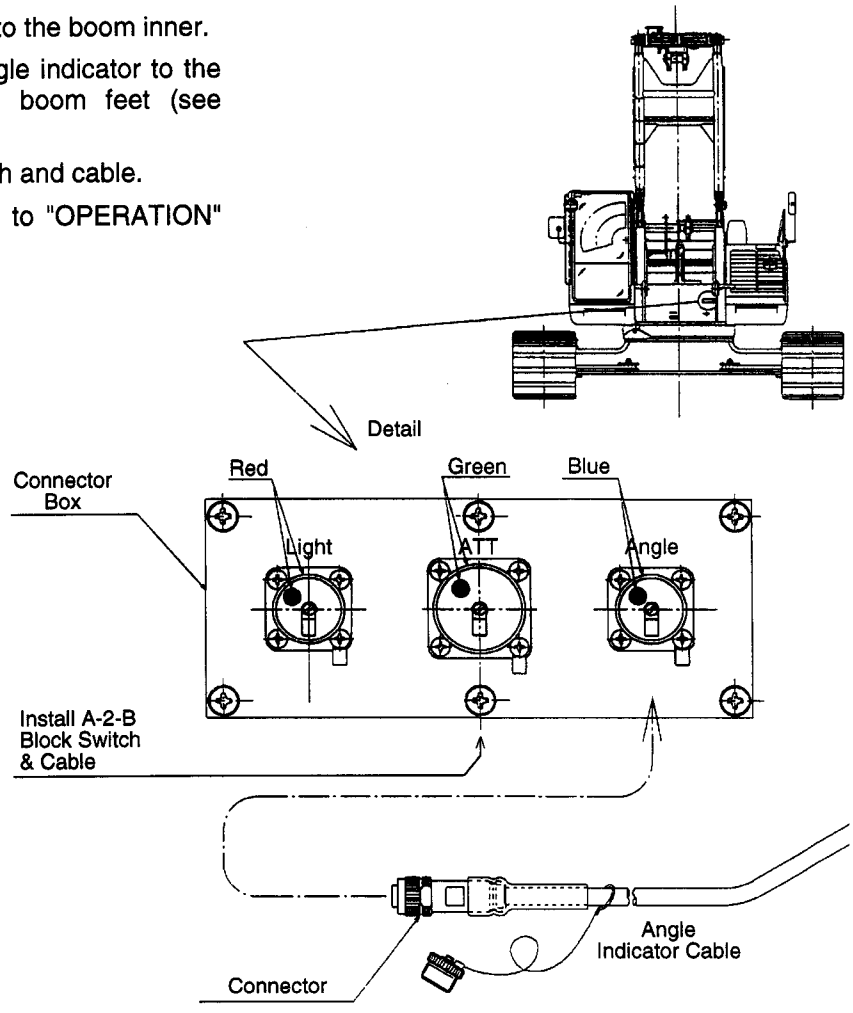


Figure 1

READ OPERATOR'S MANUAL FOR THE MOMENT LIMITER OPERATION, PAGE 1-57.

2. Program Moment Limiter for working conditions and crane configuration.
   A. Bring the ATT. SET mode screen up on the Moment Limiter (see Figure 2).

      1.) Enter the WORK NO. from table below.

Work No.	Work Mode	Boom Length (Ft.)	Work No.	Work Mode	Boom Length (Ft.)
11	Crane	40, 50, 60, 70. 80, 90, 180, 190, 200	16	Crane	140
12	Crane	100	17	Crane	150
13	Crane	110	18	Crane	160
14	Crane	120	19	Crane	170
15	Crane	130			

      2.) Enter BOOM LENGTH.

      3.) Enter MAIN HOOK CAPACITY (See capacity plate on load block).

      4.) Enter MAIN HOOK NUMBER OF PARTS OF LINE.

      5.) Enter JIB LENGTH (if no jib, enter 0).

      6.) Enter AUXILIARY HOOK CAPACITY (See capacity plate on overhaul ball).

      7.) Enter AUXILIARY HOOK PARTS OF LINE.

      8.) Enter the JIB OFFSET ANGLE.

ATT SET mode

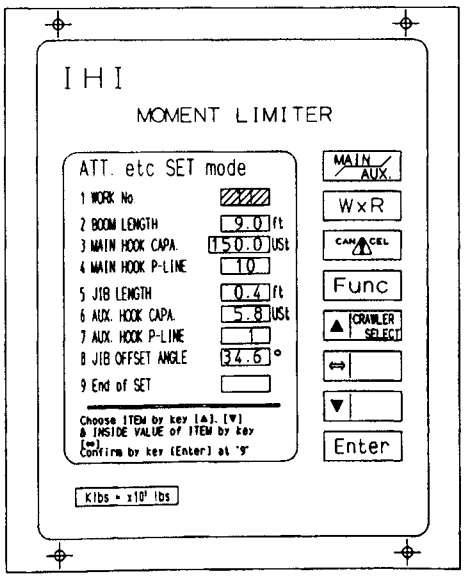


Figure 2

3. Program Moment Limiter for Boom Angle Limits.
   A. Bring the ANGLE SET mode screen up (see Figure 3).
      1.) Enter the maximum boom UPPER LIMIT ANGLE desired. (80° is maximum available).
      2.) Enter the minimum boom LOWER LIMIT ANGLE (see load chart for minimum boom angle with a load rating for the boom length installed).
      3.) Enter the SLOW DOWN ANGLE (HI). (This slows the boom up speed before it reaches the limit. Standard setting is 2°).
      4.) Enter the SLOW DOWN ANGLE (LO). (This slows the boom down speed before it reaches the limit. Standard setting is 2°).

ANGLE SETTING MENU

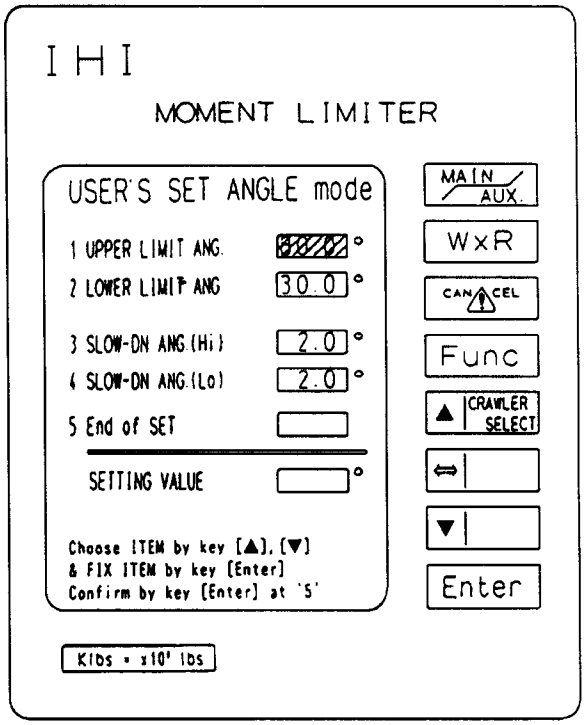


Figure 3

4. Calibration for the Angle Indicators
   A. Set zero adjustment and span of boom angle indicators.
      1.) Level boom to zero by using a plumb bob on the boom inner pins (see Figure 4).
      2.) Adjust the manual boom angle indicator to zero.

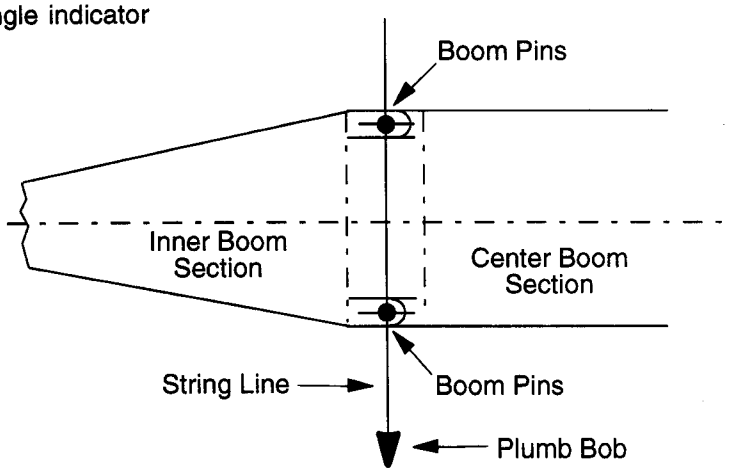


Figure 4

4. Calibration for the Angle Indicators (Continued)
   3.) Bring the ZERO ADJUSTMENT OF ANGLE mode screen up on the Moment Limiter (see Figure 5).
   4.) Input the ANGLE to 0.0°. (Push Enter Key twice slowly) by entering into SETTING VALUE θ.

   Note: Do not be concerned with the COUNT VALUE.
   5.) Raise the boom to 70° and measure the radius from the center of rotation (swivel) to the center of the load block to verify angle. Use the Table below to get the exact radius with the parts of line reeved on the load block. You will have to boom up or down to get the radius exact.

ZERO ADJUSTMENT of ANGLE

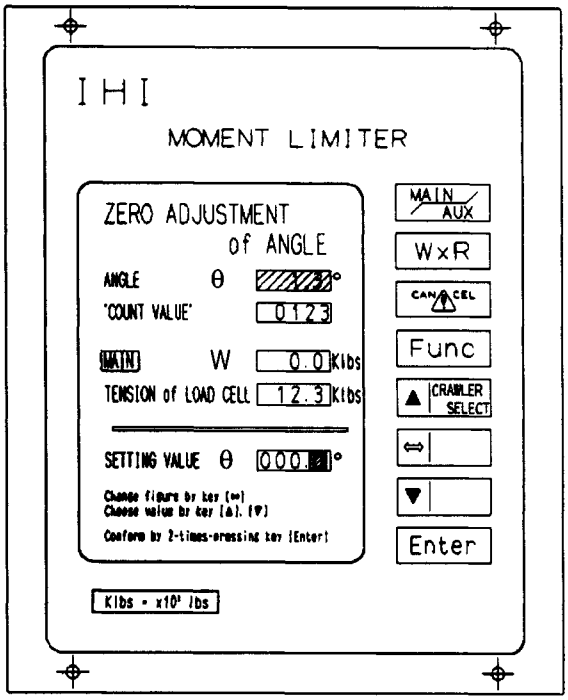


Figure 5

Table is for Boom Angle of 70° and Radii for Boom Lengths of 40 ft. (12192mm) through 200 ft. (60960mm).

	Radius		
Boom Length	**1 Part Line**	**2 Part Line**	**3 Part Line**
40 Ft. (12192mm)	18.386 Ft. (5.604m)	17.365 Ft. (5.293m)	17.677 Ft. (5.388m)
50 Ft. (15240mm)	21.804 Ft. (6.646m)	20.784 Ft. (6.335m)	21.096 Ft. (6.430m)
60 Ft. (18288mm)	25.226 Ft. (7.689m)	24.206 Ft. (7.378m)	24.518 Ft. (7.473m)
70 Ft. (21336mm)	28.645 Ft. (8.731m)	27.625 Ft. (8.420m)	27.936 Ft. (8.515m)
80 Ft. (24384mm)	32.067 Ft. (9.774m)	31.047 Ft. (9.463m)	31.358 Ft. (9.558m)
90 Ft. (27432mm)	35.486 Ft. (10.816m)	34.465 Ft. (10.505m)	34.777 Ft. (10.600m)
100 Ft. (30480mm)	38.907 Ft. (11.859m)	37.887 Ft. (11.548m)	38.199 Ft. (11.643m)
110 Ft. (33528mm)	42.326 Ft. (12.901m)	41.306 Ft. (12.590m)	41.617 Ft. (12.685m)
120 Ft. (36576mm)	45.748 Ft. (13.944m)	44.728 Ft. (13.633m)	45.039 Ft. (13.728m)
130 Ft. (39624mm)	49.167 Ft. (14.986m)	48.146 Ft. (14.675m)	48.458 Ft. (14.770m)
140 Ft. (42672mm)	52.589 Ft. (16.029m)	51.568 Ft. (15.718m)	51.880 Ft. (15.813m)
150 Ft. (45720mm)	56.007 Ft. (17.071m)	54.987 Ft. (16.760m)	55.299 Ft. (16.855m)
160 Ft. (48768mm)	59.429 Ft. (18.114m)	58.409 Ft. (17.803m)	58.720 Ft. (17.898m)
170 Ft. (51816mm)	62.848 Ft. (19.156m)	61.827 Ft. (18.845m)	62.139 Ft. (18.940m)
180 Ft. (54864mm)	66.270 Ft. (20.199m)	65.249 Ft. (19.888m)	65.561 Ft. (19.983m)
190 Ft. (57912mm)	69.688 Ft. (21.241m)	68.668 Ft. (20.930m)	68.980 Ft. (21.025m)
200 Ft. (60960mm)	73.110 Ft. (22.284m)	72.090 Ft. (21.973m)	72.402 Ft. (22.068m)

4. Calibration for the Angle Indicators (Continued)

   6.) Bring the SPAN ADJUSTMENT OF ANGLE screen up on the Moment Limiter (see Figure 6).

   7.) Enter the SETTING VALUE of 70.0° (push the Enter Key twice slowly).

SPAN ADJUSTMENT of ANGLE

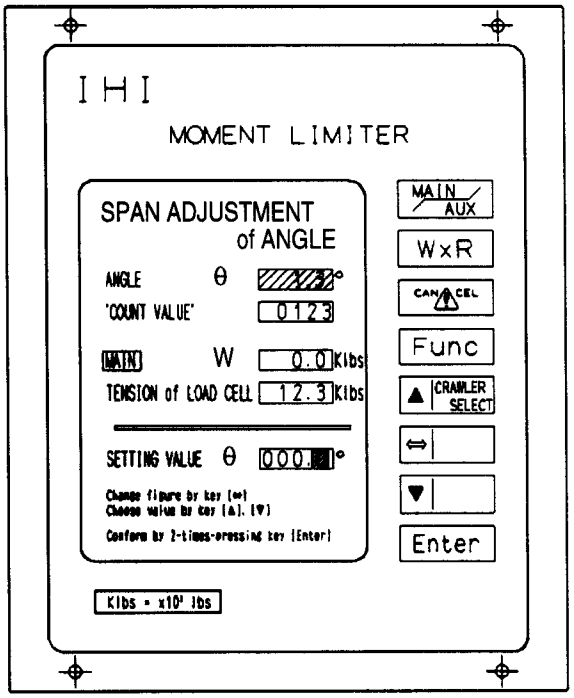


Figure 6

5. Calibration for Load Cell

   A. Zero and Span Adjustment for the load cell at boom angle of 70°.

   Note: Boom angle must be at 70°.

   1.) Bring the ZERO ADJUSTMENT OF LOAD CELL screen up on the Moment Limiter (see Figure 7).

   2.) Hoist the load block or ball (no load on the hook) off the ground.

   3.) Enter the known weight and the weight of the load block or ball and rigging into the SETTING VALUE.

   Example: The block weight is 1,500 lbs. (or 1.5 Klbs), and the rigging is 200 lbs (or 0.2 Klbs.) and the known weight is 20,000 lbs. (or 20.0 Klbs). The NUMBER TO ENTER is 21.7 Klb).

   Push the Enter Key twice slowly.

ZERO ADJUSTMENT of LOAD CELL

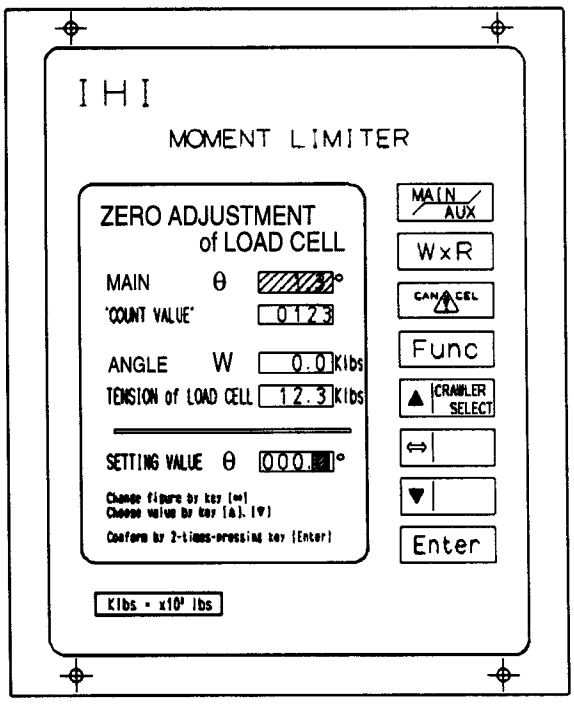


Figure 7

5. Calibration for Load Cell (Continued)

   4.) Bring the ZERO SPAN OF LOAD CELL screen up on the Moment Limiter (see Figure 8).

   5.) Hoist a **known** weight of approximately 20,000 lbs. at 70° boom angle.

⚠ CAUTION

USING A SMALLER KNOWN WEIGHT THAN 20,000 LBS. TO SPAN THE LOAD, OR AN INACCURATE ACCOUNT OF THE WEIGHT WILL GIVE AN INCORRECT CALIBRATION OF THE MOMENT LIMITER.

ZERO SPAN of LOAD CELL

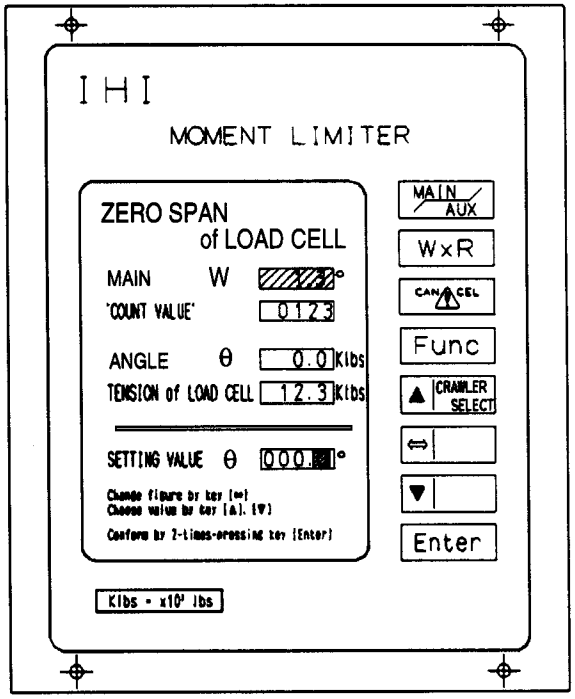


Figure 8

   6.) Enter the known weight and the weight of the load block or ball and rigging into the SETTING VALUE.

   Example: The block weight is 1,500 lbs. (or 1.5 Klbs), and the rigging is 200 lbs (or 0.2 Klbs.) and the known weight is 20,000 lbs. (or 20.0 Klbs). The NUMBER TO ENTER is 21.7 Klb).

   Push the Enter Key twice slowly.

Note: If the crane is using a boom tip extension or a jib, the calibration must be performed on each load block or ball for Zero and Span Adjustments of the Load Cell. Depress the MAIN AUX key once. The Zero or Span screen is displayed to change to AUX. for calibration.

6. Setting the Boom Up Shut Limit Switch (boom throw-out) on left boom foot

   A. Set the switch to stop the boom up function at 82°.

   Note: At 81° boom hoist function will stop but can be overridden by safety device key switch in left hand console.

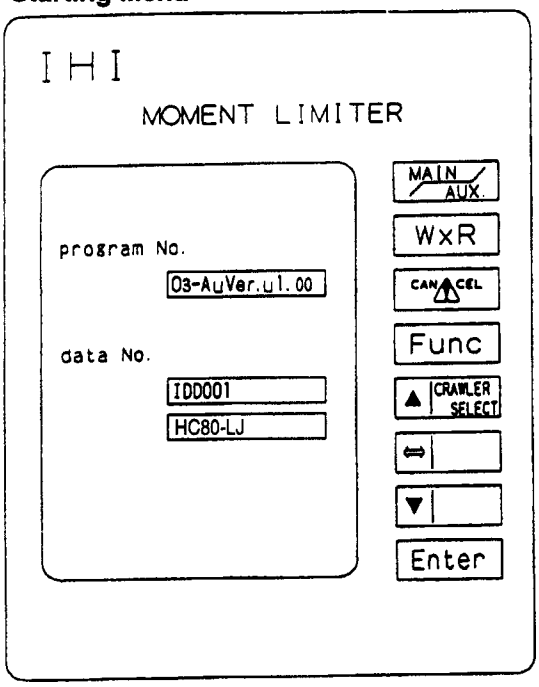
ML-D3A

How to operate the ML-D3A type overload prevention device (Moment Limiter)

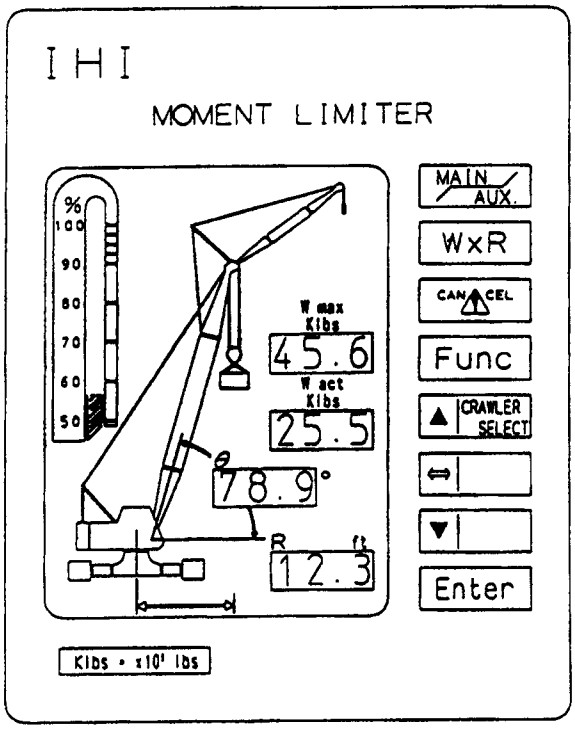
Setting of working conditions at work No. 1 1 (Standard Crane)

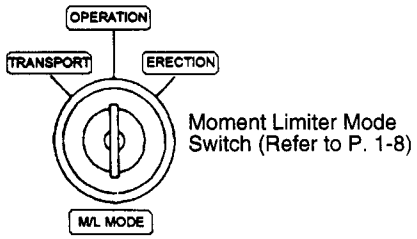
1. Turning on the power and display of the standard menu

Starting Menu



Standard Menu (boom work)





Moment Limiter Mode Switch (Refer to P. 1-8)

(1) Make sure that the moment limiter mode switch is at "OPERATION".

(2) Start the engine, and the moment limiter is automatically turned on.

(3) After approximately 5 seconds, the starting menu (as illustrated at left) is displayed. In the starting menu, "Program No.", "Data No." and the model name are displayed. Check the displayed data.

(4) After 5 seconds since the starting menu was displayed, the menu is changed to the standard menu. The standard menu shows the following items:

- Load ratio . . . . . .%
- Rated overall lifting load . . . . .Klbs. (allowable load)
- Actual load . . . . . .Klbs.
- Boom angle. . . . . .°
- Working radius . . . . . .Ft.

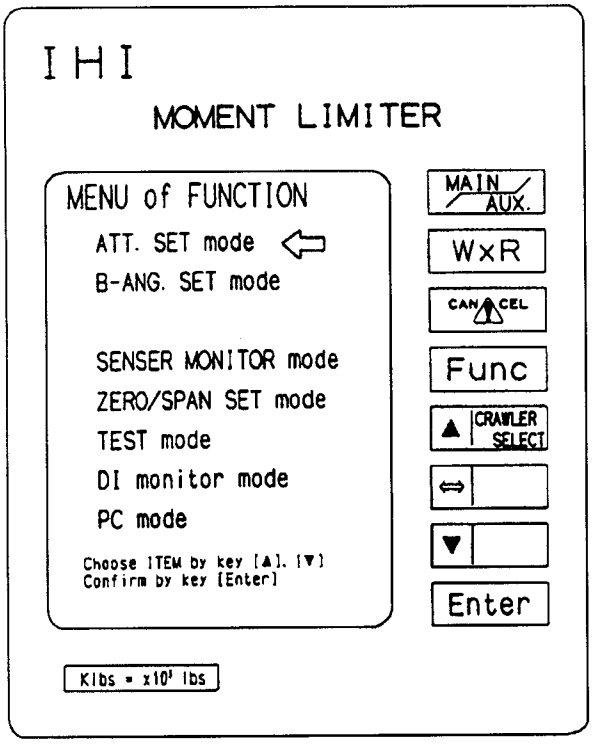
Note: 45.6 Klbs = 45,600 lbs.

(5) The standard menu is displayed for "boom lifting". If the operator has to change to "jib lifting", press the MAIN AUX key switch. The load of "boom lifting" as illustrated left moves to the jib side.

(6) If the sensor malfunctions or if the working conditions are set wrong, an error No. is displayed in the column of the working radius. Make sure that an error No. is not displayed.

2. Setting of the working conditions

Function Selection Menu



(1) Press the Func key once in the standard menu, and the function selection menu as illustrated left is displayed. If you want to return to the standard menu, press the Func or CANCEL key once.

(2) Proceed to the setting menu from the function selection menu.

In the function selection menu, press the CRAWLER SELECT or ▼ key to move the cursor to "ATT. SET mode". Normally, the cursor is at "ATT. SET mode" when the function selection menu is displayed.

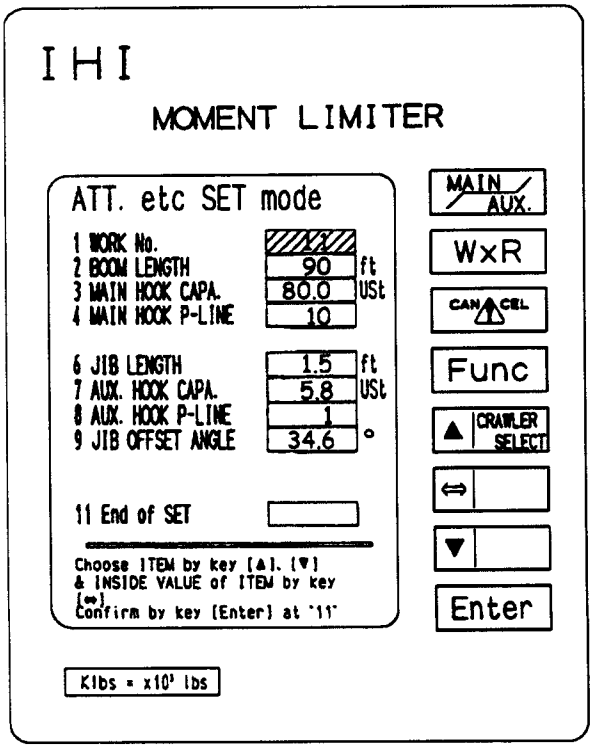
Press the Enter key once.

When pressing the Enter key, the menu is changed to the following setting menu.

(3) Set the Working condition on the setting menu. Press the CRAWLER SELECT or ▼ key to move the cursor to "WORK NO." The item with the cell is reversed.

[1] Press the ⇔ key to set the value of the current attachment for "WORK NO."

Setting Menu



Work No. Standard crane 11

See Work Number Chart on page 1-53.1

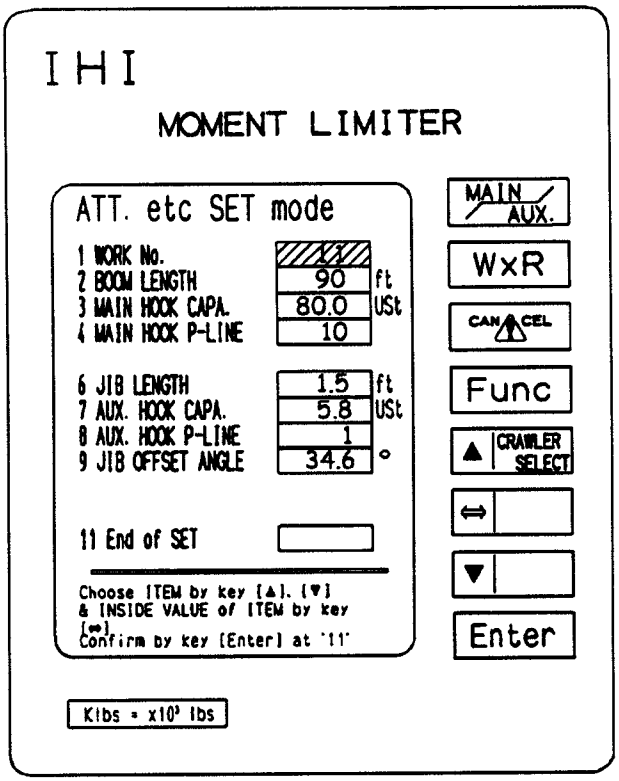
Each time the ⇔ key is pressed, the data included in the specification are displayed in order. Select the proper work number.

[2] Setting of the boom length

Press the CRAWLER SELECT or ▼ key to move the cursor to "BOOM LENGTH". Press the ⇔ key to set the proper value for the length of the current boom. Each time the ⇔ key is pressed, the boom length data included in the specification are displayed in order.

ML-D3A

Setting Menu



[3] Setting of the main hook capacity

Press the CRAWLER SELECT ▲ or ▼ key to move the cursor to "MAIN HOOK CAPA." Press the ⇔ key to set the value of the current hook capacity.

Each time the ⇔ key is pressed, the main hook capacity data included in the specification are displayed in order. If the main hook is not installed, select "0.0".

[4] Setting of the parts of line for the main hook

Press the CRAWLER SELECT ▲ or ▼ key to move the cursor to "MAIN HOOK P-LINE". Press the ⇔ key to set the parts of line for the current main hook.

Each time the ⇔ key is pressed, the "parts of line" data included in the specification are displayed in order. If the main hook is not installed, select "1".

[5] Setting of the jib length

Press the CRAWLER SELECT ▲ or ▼ key to move the cursor (reversed cell) to "JIB LENGTH". Press the ⇔ key to set the value of the current jib length.

Each time the ⇔ key is pressed, the jib length data included in the specification are displayed in order. If the jib is not installed, select "0.0".

[6] Setting of the auxiliary hook capacity

Press the CRAWLER SELECT ▲ or ▼ key to move the cursor to "AUX. HOOK CAPA.". Press the ⇔ key to set the value of the current auxiliary hook capacity.

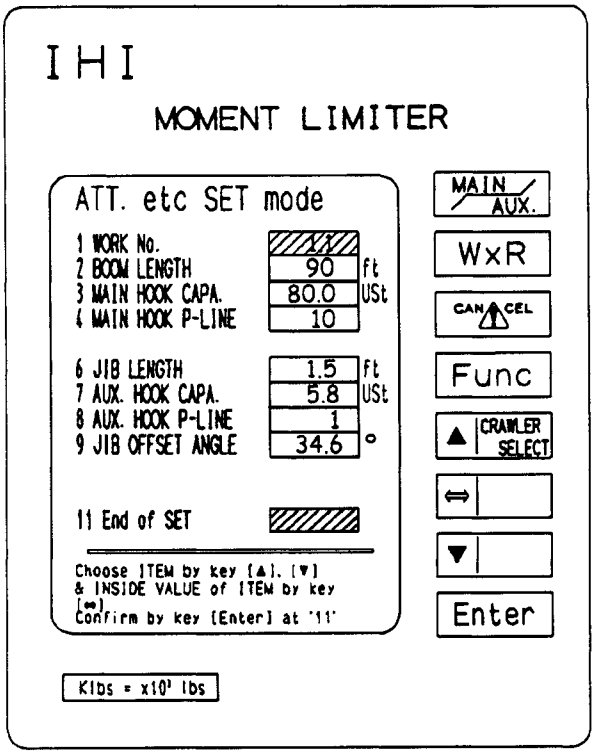
Each time the ⇔ key is pressed, the auxiliary hook capacity data included in the specification are displayed in order. If the auxiliary hook is not installed, select "0.0".

[7] Setting of the part of line for the auxiliary hook

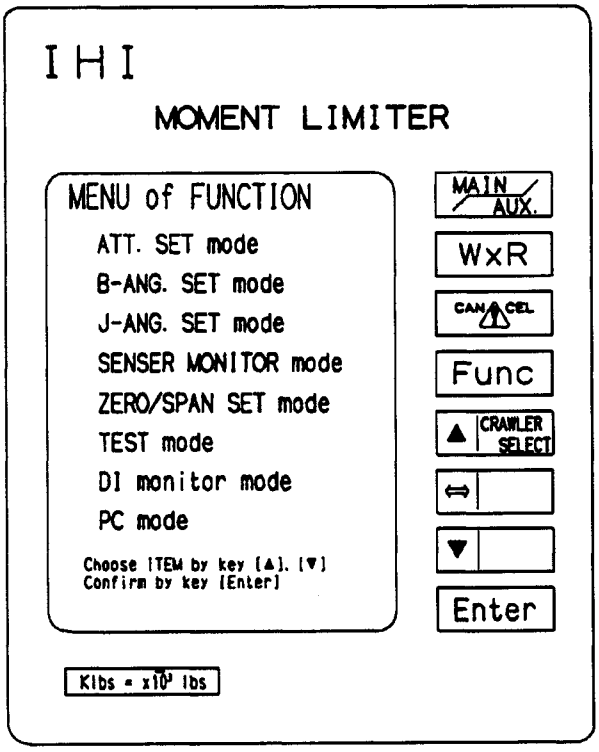
Press the CRAWLER SELECT ▲ or ▼ key to move the cursor (reversed cell) to "AUX. HOOK P-LINE". Press ⇔ the key to set the parts of line for the current auxiliary hook.

Each time the ⇔ key is pressed, the "parts of line" data included in the specification are displayed in order. If the auxiliary hook is not installed, select "1".

Setting Menu



Function Selection Menu



[8] Setting of the jib offset angle

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "JIB OFFSET ANGLE". Press the ⇔ key to set the offset angle of the current auxiliary jib. Each time the ⇔ key is pressed, the offset angle data included in the specification are displayed in order. For the auxiliary jib of the nominal 1m, the offset angle is automatically selected. If "0.0" is inputted to the jib length in the aforementioned [5], the offset angle is "0.0" and, even if the ⇔ key is pressed, the menu is not changed.

(4) Check of the set values

Make sure that the values set at the aforementioned [1] ~ [8] are set to the crane configuration.

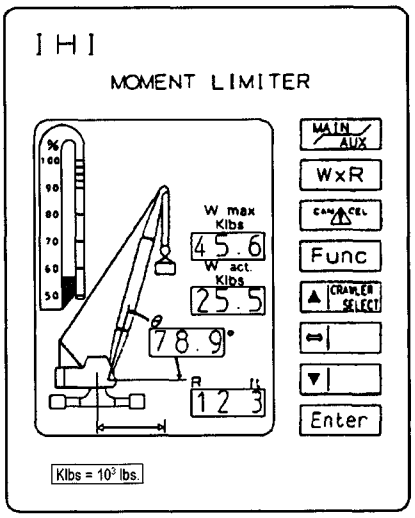
Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET" and press the Enter key. When pressing the Enter key, the displayed values are stored as the new set data and the function selection menu is automatically displayed. When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated) Press the Enter key again.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [1] ~ [8] are ignored and the function selection menu is automatically set without the data change. When the CANCEL key is pressed, the working conditions are not changed. Be careful.

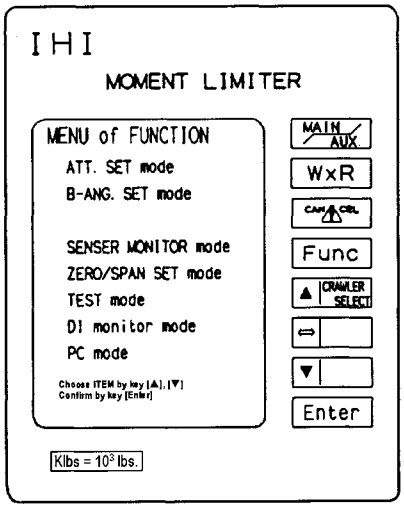
Press the Func or CANCEL key once to return from the function selection menu to the standard menu.

3. Optional auto stop or alarm angle setting

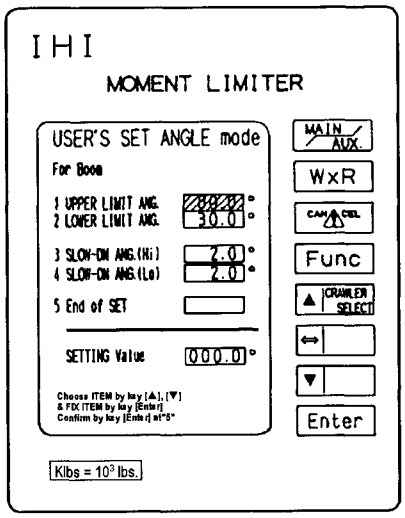
Standard Menu



Function Selection Menu



Optional Angle Setting Menu



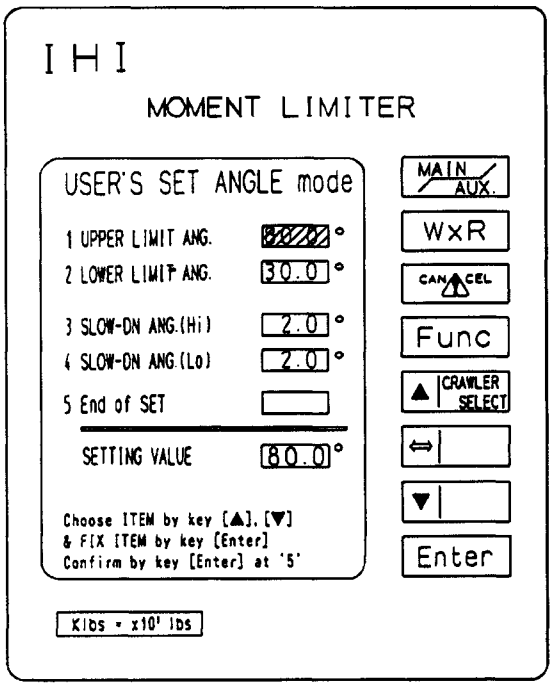
If you desire to set an optional angle, proceed from the function selection menu to the optional angle setting menu.

Press the [Func] key once if changing from the standard menu to the function selection menu.

Press the [Func] or [CANCEL] key once if changing from the function selection menu to the standard menu.

(1) If changing from the function selection menu to the optional angle setting menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor (reverse display) to "B-ANG. SET mode". Then, press the [Enter] key.

Optional Angle Setting Menu



(2) Setting of the boom optional upper limit angle

[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "UPPER LIMIT ANG." Normally, the cursor is at "UPPER LIMIT ANG." when the optional angle setting menu is displayed.

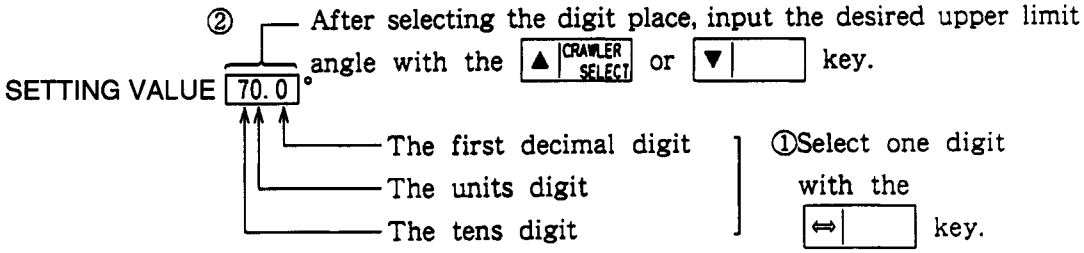
[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

In case in editing mode change menu by key ⇔ choose value by **[▲], [▼]** provisional decision by Enter

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



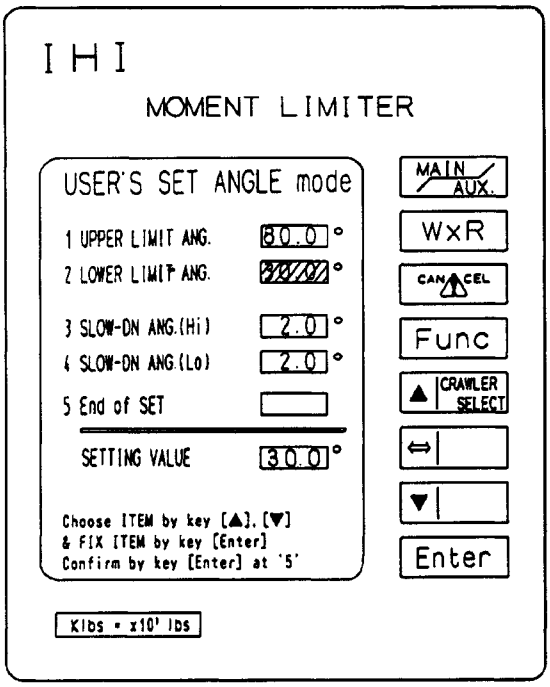
In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "7" to the tens digit, and so the boom optional upper limit angle is set to 70.0° . Maximum upper limit angle is 80.0° .

[5] After setting the boom optional upper limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "UPPER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the boom has reached the set upper limit angle (70° in the above example), the alarm sounds and the boom hoisting stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached 80°, the boom stops automatically at the rated boom upper limit angle (that is set for this machine). The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

ML-D3A

Optional Angle Setting Menu



(3) Setting of the boom optional lower limit angle

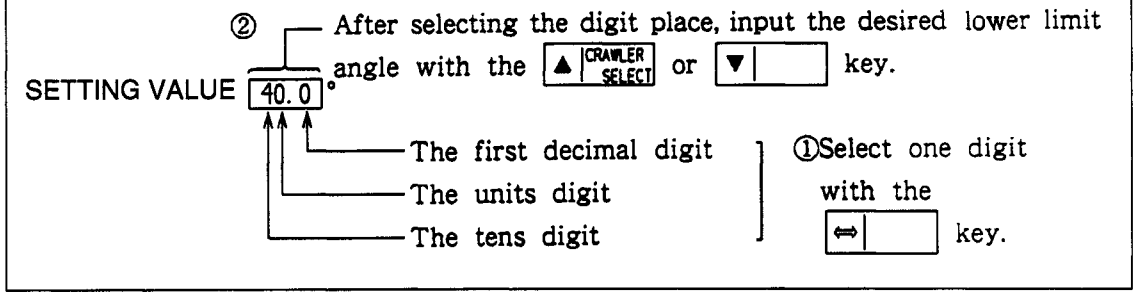
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "LOWER LIMIT ANG."

[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "4" to the tens digit, and so the boom optional lower limit angle is set to 40.0° . Minimum lower limit angle is 30.0° .

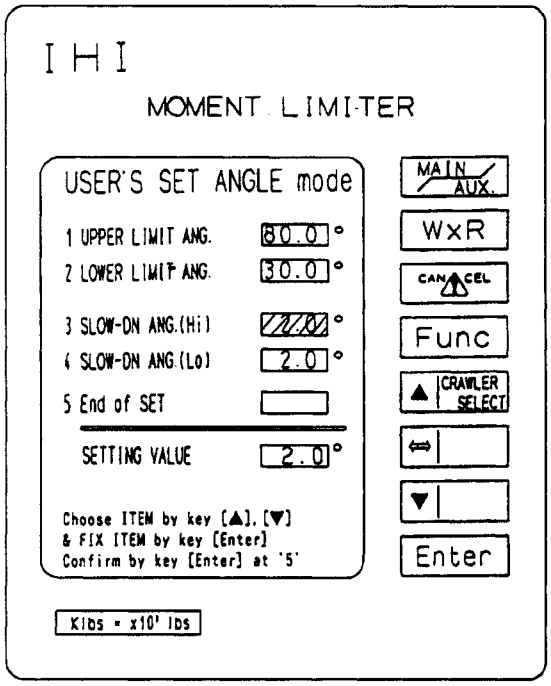
[5] After setting the boom optional lower limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "LOWER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the boom has reached the set lower limit angle (40° in the above example), the alarm sounds and the boom lowering stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached 30°, the boom stops automatically at the rated boom lower limit angle (almost 30°).

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

ML-D3A

Optional Angle Setting Menu



(4) Setting of the upper limit angle of gentle stop

This function sets the optional approach angle at which the slow-down starts before the boom stops automatically when the boom is hoisting.

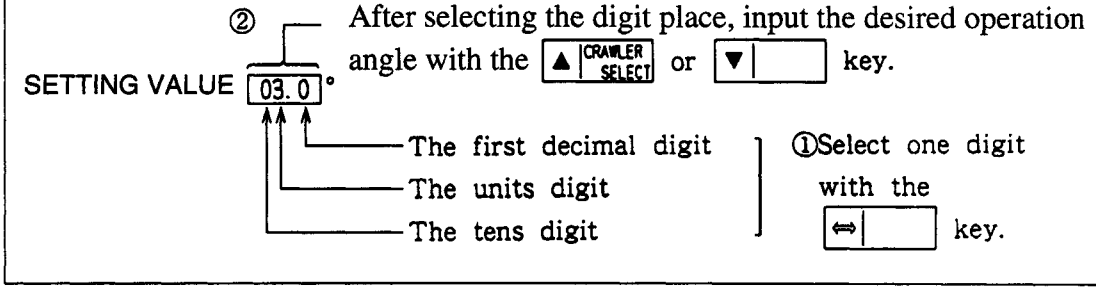
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Hi)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



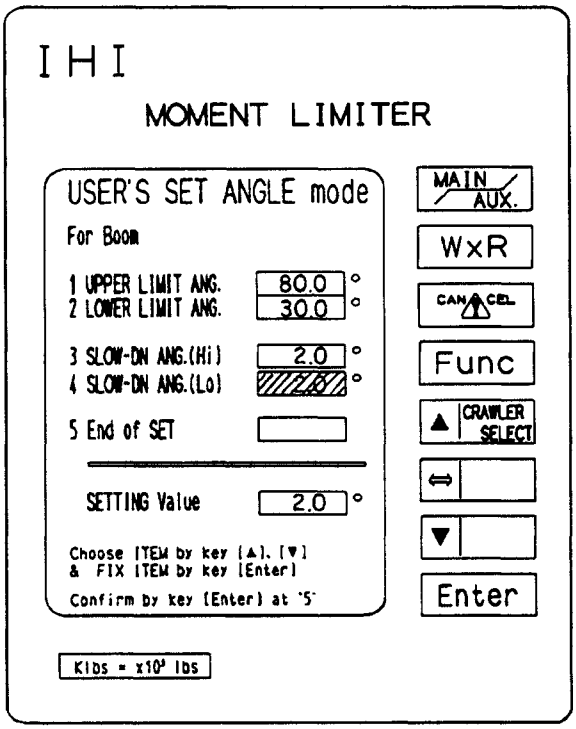
In the above example, "0" is inputted to the first decimal digit, "3" to the units digit and "0" to the tens digit, and so the upper limit slow-down angle is set to 3.0° . If the slow-down operation is not necessary, set the angle 0.00 Standard minimum slow-down angle is 2.0° .

[5] After setting the upper limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Hi)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (2), the boom optional upper limit angle is set to 70°, and in the above example, the upper limit slow-down operation angle is set to 3°. In such a case, the boom hoisting speed slows down when the boom angle is 67° and the boom hoisting stops automatically and the alarm sounds when the boom angle is 70°.

If the machine is without the automatic stop function, the hoisting speed slows down at the boom angle 67° and the alarm sounds at the boom angle 70°. The boom hoisting stops automatically at the boom angle 80°. Rated boom upper limit angle is 80°.

On the machine without the automatic stop and slow-down function, only the alarm sounds.

Optional Angle Setting Menu



(5) Setting of the lower limit angle of gentle stop

This function sets the optional approach angle at which the slow-down starts before the boom stops automatically when the boom is lowering.

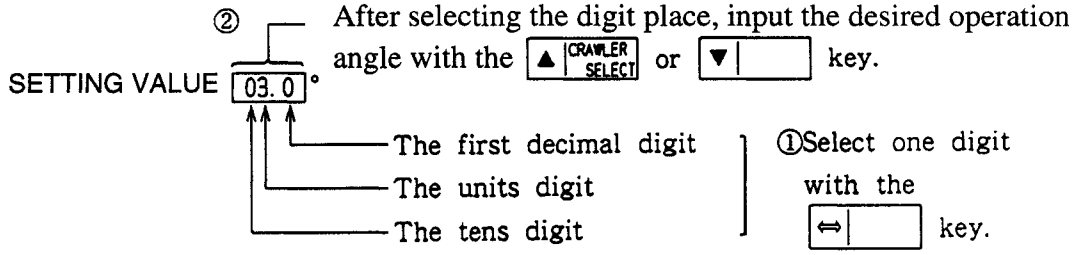
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Lo)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



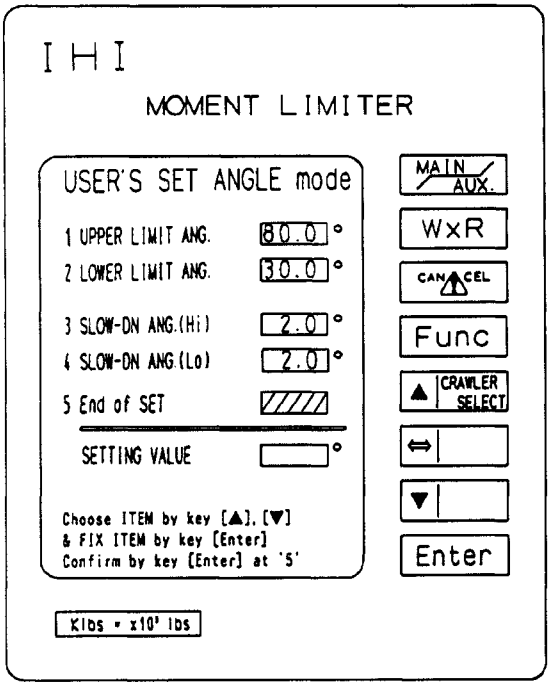
In the above example, "0" is inputted to the first decimal digit, "3" to the units digit and "0" to the tens digit, and so the boom lower limit slow-down angle is set to 3.0° . If the slow-down operation is not necessary, set the angle 0.00 Standard minimum slow-down angle is approximately 2.0° .

[5] After setting the optional lower limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Lo)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (3), the optional lower limit angle is set to 40°, and in the above example, the lower limit slow-down operation angle is set to 3°. In such a case, the lowering speed slows down when the boom angle is 43° and the boom lowering stops automatically and the alarm sounds when the boom angle is 40°.

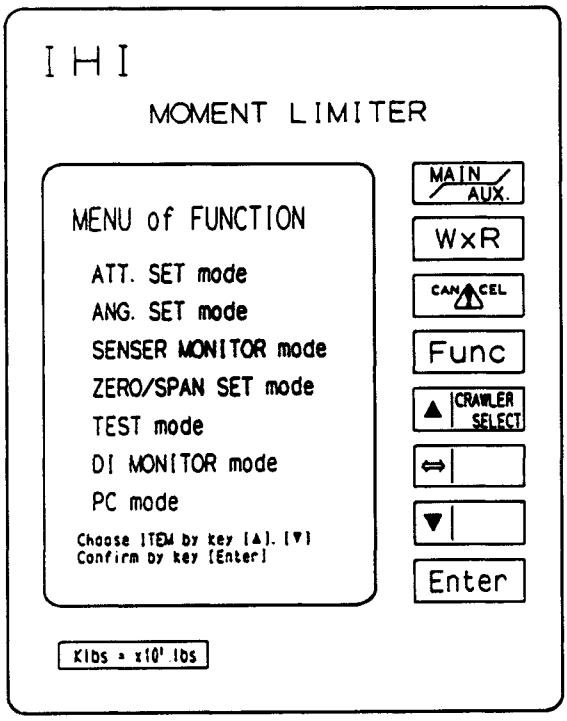
If the machine is without the automatic stop function, the lowering speed slows down at the boom angle 43° and the alarm sounds at the boom angle 40°. The boom lowering stops automatically at the rated boom lower limit angle (almost 30°).

ML-D3A

Optional Angle Setting Menu



Function Selection Menu



(6) Decision for angle setting

[1] Make sure that the proper values are set in the above setting procedure of the items (2) ~ (5):
- The value of the boom upper limit angle
- The value of the boom lower limit angle
- The value of the upper limit slow-down operation angle
- The value of the lower limit slow-down operation angle

[2] Press the [▲ CRAWLER SELECT] or [▼] key to move the cursor to "End of SET".

[3] Press the [Enter] key. The data on the screen are updated and the menu is automatically returned to the function selection menu.

[4] If you desire to stop setting, press the [CANCEL] key before pressing the [Enter] key.

Before pressing the [Func] key, if the [CANCEL] key is pressed, the values set in the aforementioned [2] ~ [5] (USER'S SET ANGLE mode for Boom) are ignored and the function selection menu is automatically set without the data change.

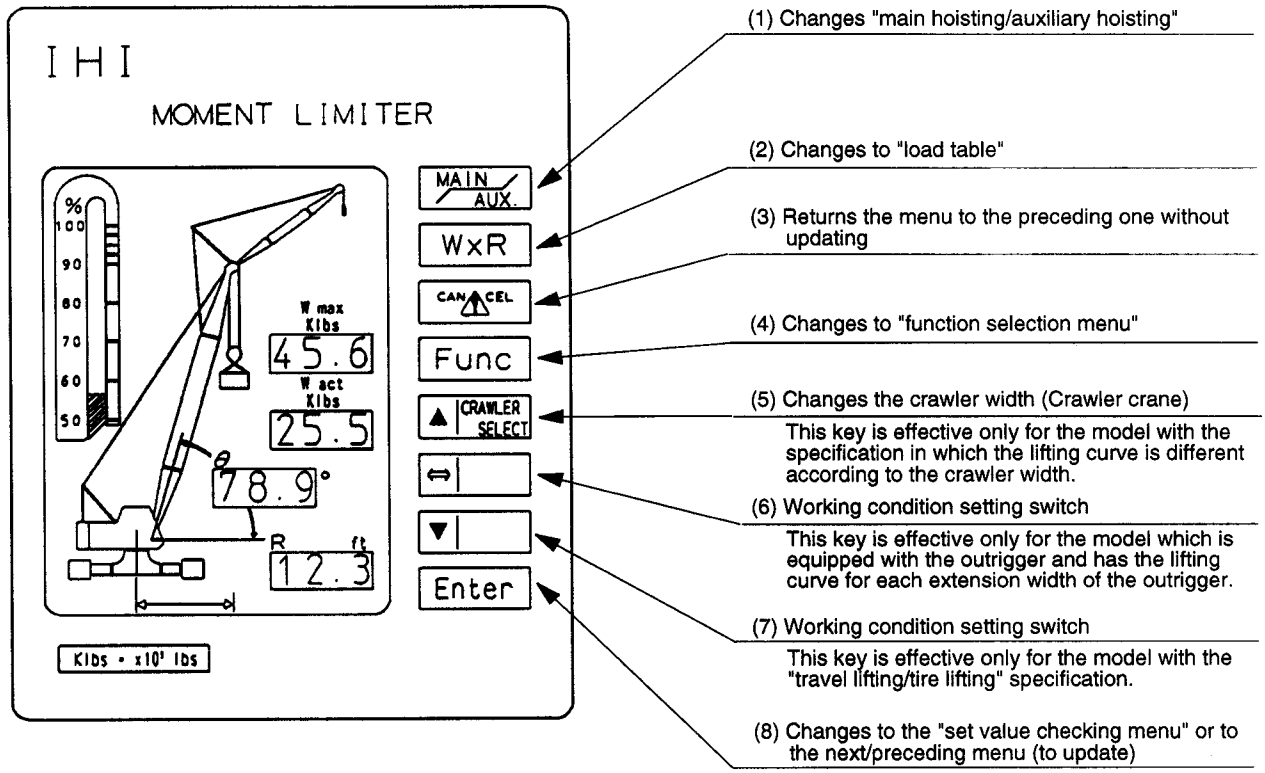
When the [CANCEL] key is pressed, the working conditions are not changed. Be careful.

If you desire to change the function selection menu to the standard menu, press the [Enter] or [CANCEL] key once.

When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated). Press the [Enter] key again.

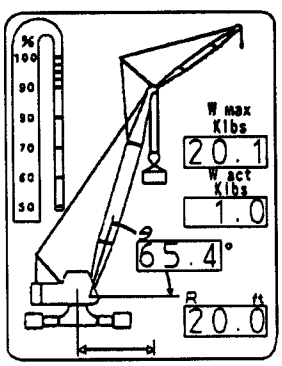
4. Standard menu and operation keys

Standard Menu

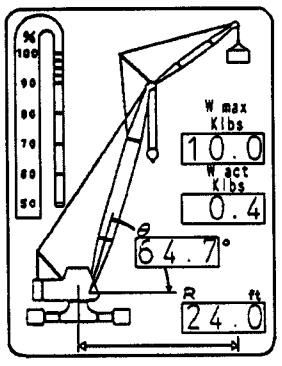


(1) Main/auxiliary selector key switch [MAIN AUX]

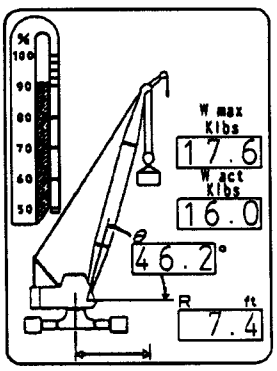
Press the main/auxiliary selector key switch [MAIN AUX], the main hoisting work menu is changed to the auxiliary hoisting work menu. Press the [MAIN AUX] key again, and the menu is changed to the main hoisting work menu. Select a proper menu according to the actual crane configuration. It is not permitted to lift loads with the main hook and the jib or auxiliary hook at the same time.



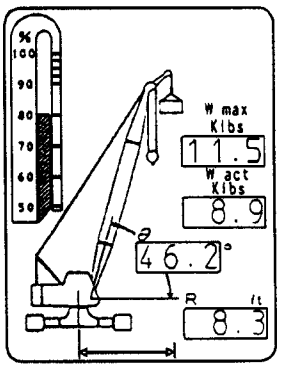
Main hoisting work with jib



Jib work



Main hoisting work with 1m jib

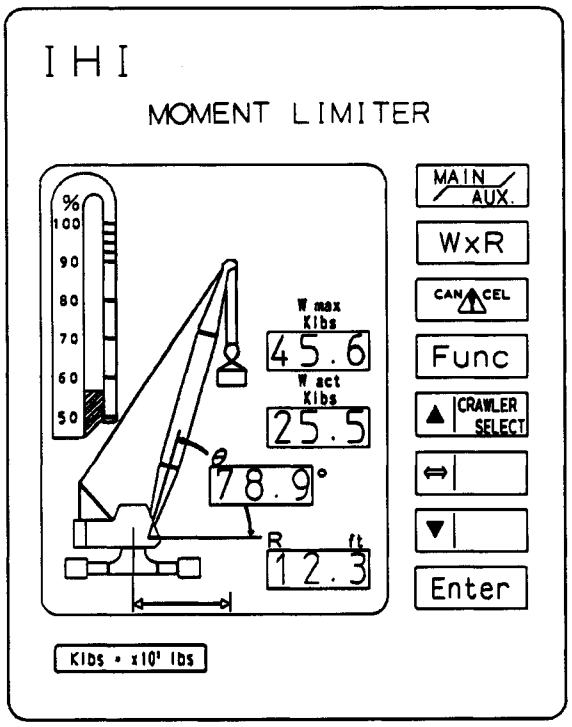


1m jib work

The values in the display unit are reference values required for the explanation. They have nothing to do with an actual lift.

ML-D3A

Standard Menu



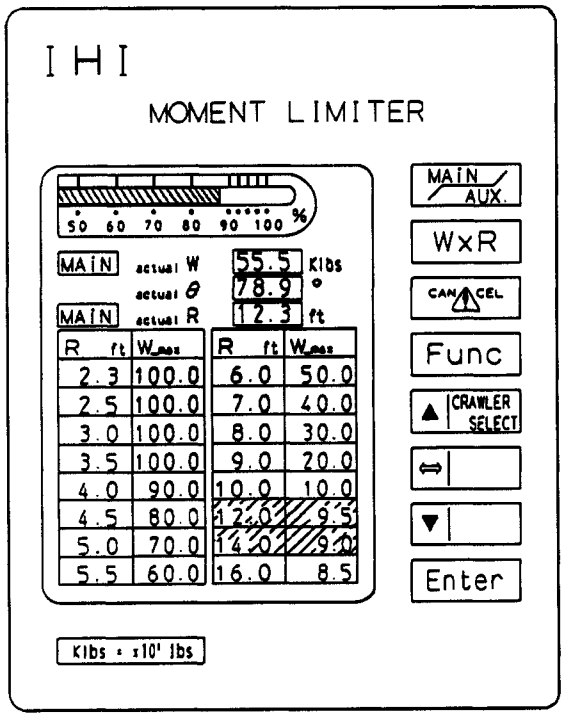
(2) The selector switch to the load table [WxR]

[1] Press the [WxR] switch once on the standard menu, and the load table is displayed. On the load table display, press the [WxR] or [CANCEL] key once, and the standard menu appears.

The load table displays the following five items:

- Load rate ..... %
- Actual load for the main or auxiliary hoisting..... Klbs
- Boom angle ..... °
- Working radius for the main or auxiliary hoisting..... Ft.
- Working radius/allowable load table..... Ft. Klbs

Load Table (for "MAIN")



The following illustration is the "MAIN" table. If you want the "AUX." table, press the [MAIN AUX] key switch.

[2] Working radius/allowable load table

In the load table, the shaded area of the working radius/allowable load table indicates the current crane working radius and allowable load.

The actual working radius is 12.3 ft. and is within the shaded area, 12.0 ft. ~ 14.0 ft. The operator can view the current working radius and allowable load according to this table.

To display the data after 16.0 ft. for the working radius, press the [⇔] key once. The next data is displayed. To return to the original data, press the [⇔] key.

[3] The upper bar graph on the screen indicates the ratio (load ratio) of the crane's current load (actual value) and to the allowable safe working load.

(3) Cancel key [CANCEL]

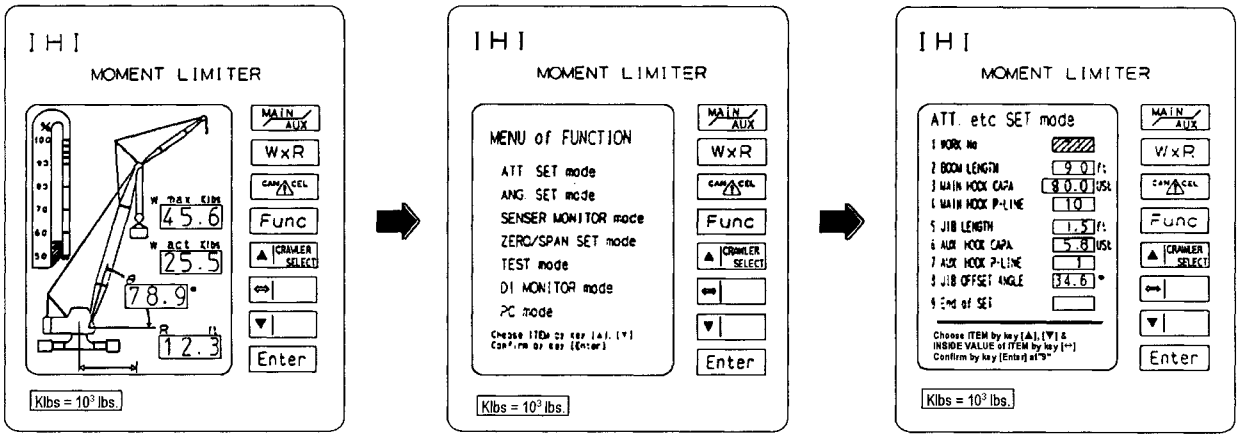
Press this key in the middle of setting for the crane working conditions or optional angle as mentioned, the setting operation stops and the original condition before setting is restored.

(4) Function key - to change to the function selection menu [Func]

When the working conditions have to be set, change the standard menu to the function selection menu and then select the desired items in the function selection menu with the cursor.

Press the [Func] once in the standard menu and the function selection menu is displayed. In the function selection menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor (reversed cell) to the desired item.

For example, move the cursor to "ATT. SET mode" and press the [Enter] key once. The, "ATT. etc. SET mode" (working radius setting mode) is displayed.



Standard Menu | **Function Selection Menu** | **Setting Menu (ATT. etc. SET mode)**

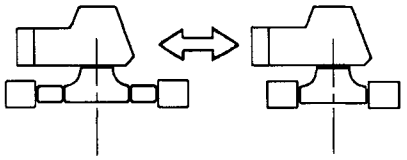
Refer to "(2) Setting of the working conditions" for how to set the working conditions and how to return from the setting menu to the function selection menu. If the function selection menu has to be changed to the standard menu, press the [Func] or [CANCEL] key once.

(5) Crawler select key - to change the crawler width [▲ CRAWLER SELECT]

In the crawler crane, this key is effective only for the model which rated overall lifting load is changed according to the crawler width.

Press the [▲ CRAWLER SELECT] key once in the standard menu, and the illustrated crawler width is retracted. Press the key again, and the crawler width is extended.

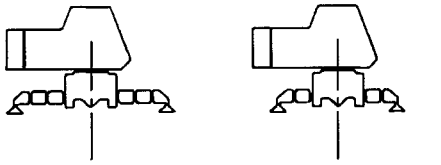
Change of Crawler Width



When extended (EXT.) **When retracted (RET.)**

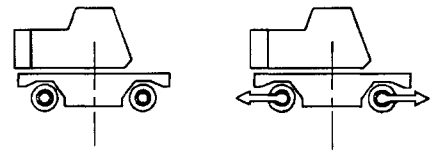
On the machine without the crawler width change specification, set the crawler width to the extended condition. If the crawler width is retracted, Error Code "E114" is displayed and the alarm sounds. This key switch does not work on the wheel type.

Change of Outrigger Width



When extended (EXT.) **When retracted (RET.)**

(6) [⇔] This key is used for setting the working conditions and changing information. This key switch works when tires are used for the travelling unit. Press the key once, and the illustrated outrigger width is retracted. Press the key again, and the outrigger width is extended. On the machine with outriggers, set the displayed picture to the machine current condition. On the crawler crane, this switch is used for setting the working conditions, etc.



Tire Stationary Lifting **Travel Lifting**

(7) [▼] This key is used for setting the working conditions and scrolling down through the menus. This key switch works when tires are used for the travelling unit. Press the key once, and the displayed picture is changed to "travel lifting". Press the key again, and the displayed picture is changed to "tire stationary lifting". On the crawler crane, this switch is used for setting the working conditions, etc.

(8) This key is used to change to "set value checking menu" or to the next/preceding menu (to update)

Press the [Enter] key once in the standard menu, and the "Attachment setting" menu, which was set in the above-mentioned "ATT etc. SET mode" menu, is displayed.

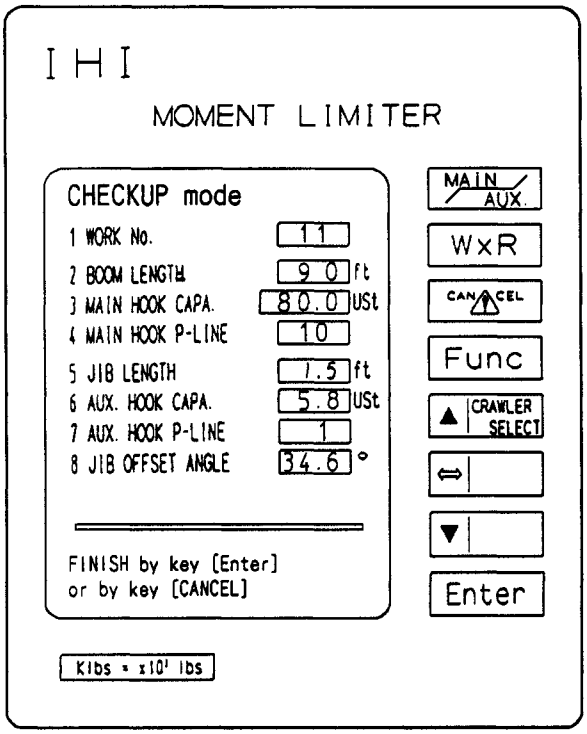
Press the [Enter] or [CANCEL] key in the setting menu, and the standard menu is restored.

In the set value checking menu, the operator can check the following values which were set in "Setting of the working conditions":

1. Work No.
2. Boom length
3. Main hook capacity
4. Part of line for main hook
5. Jib length
6. Auxiliary hook capacity
7. Part of line for auxiliary hook
8. Jib offset angle

ML-D3A

Set Value Checking Menu



In this menu, the operator can check the following eight items which are set currently:

1. Work No.
2. Boom length
3. Main hook capacity
4. Part of line for main hook
5. Jib length
6. Auxiliary hook capacity
7. Part of line for auxiliary hook
8. Jib offset angle

After checking the data, press the Enter or CANCEL key. The standard menu is restored.

4. Error messages and error codes

If a working condition inapplicable to the specification is set or if the sensor output is defective in the overload prevention device (moment limiter), the error is displayed on the screen.

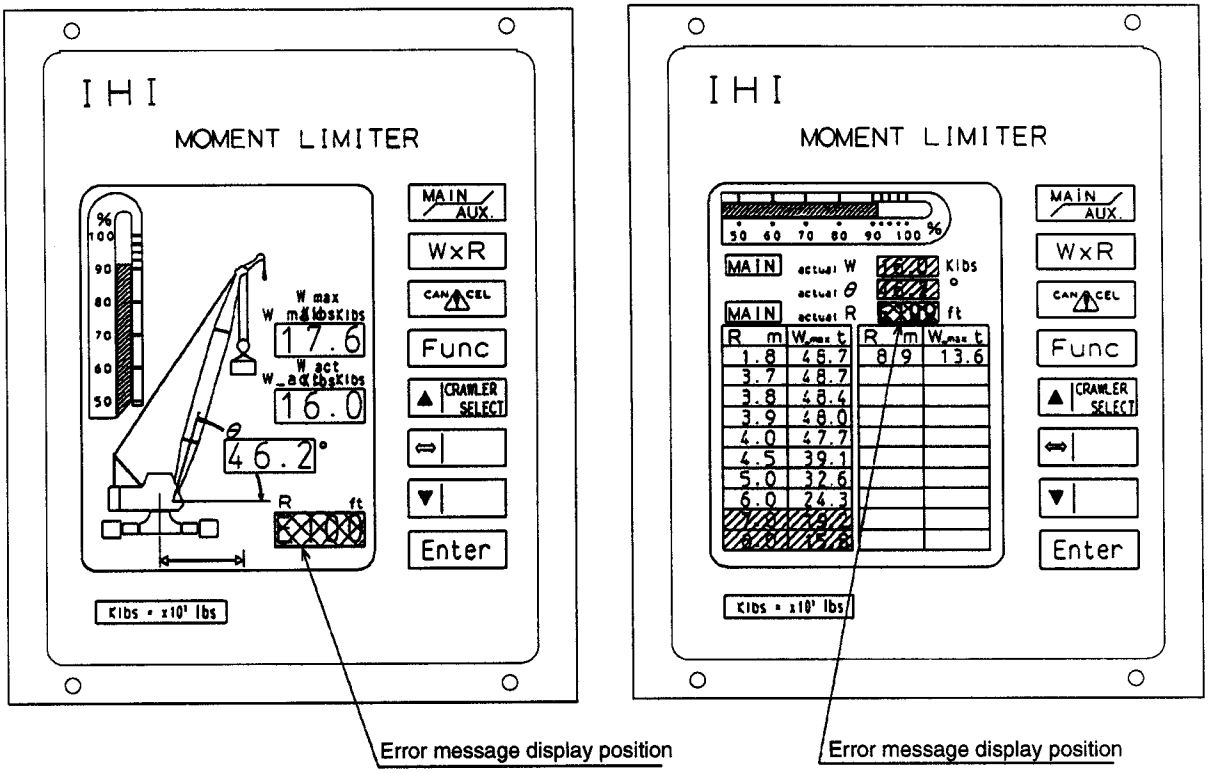
The error is displayed as "Exxx" in the working radius column. The error display blinks and an alarm is heard. Refer to the illustrations on the next page.

The error codes and remedial measures are shown in the following table.

Error Code Table

Error No.	Causes	Check and Remedial Measures
EEEE	DSP (CPU) is defective.	Should repair or replace
E100	Boom angle detector is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the angle meter
E102	The load cell sensor is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the load cell
E114	The load table does not exist.	Check the set data Check the crawler width, etc.
E120	The communication is not proper between the CPU and the display unit.	Should repair or replace
E121	The memory is defective in the CPU.	Should repair or replace
E122	The internal mode selector LS is defective.	Should repair or replace

ML-D3A

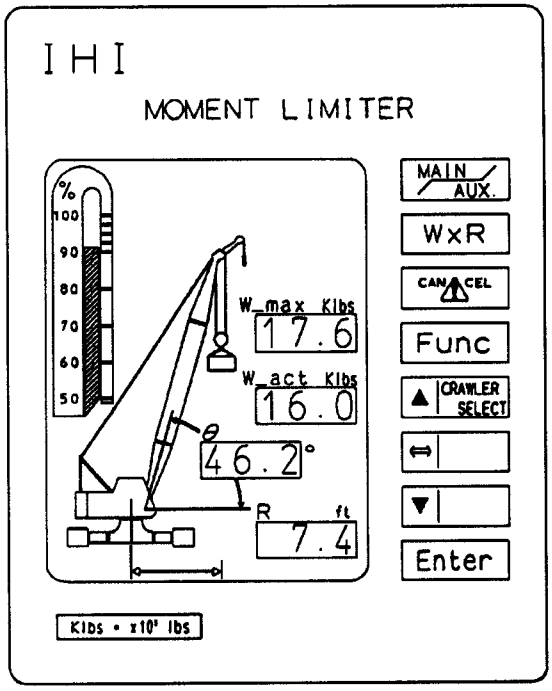


In both of the above illustrations, the error message is displayed as "E100" on the working radius column. "E100" blinks and an alarm is heard. Refer to "Error Code Table" for the causes and remedial measures of the errors.

Setting of working conditions at work No. 19 (Boom Crane)

1. Turning on the power and display of the standard menu - The "power on" and subsequent procedure up to the display of the standard menu for handling the moment limiter mode switches (1) - (4) is the same as the standard crane. But the display contents show the items of the boom crane.

Standard Menu (boom work)



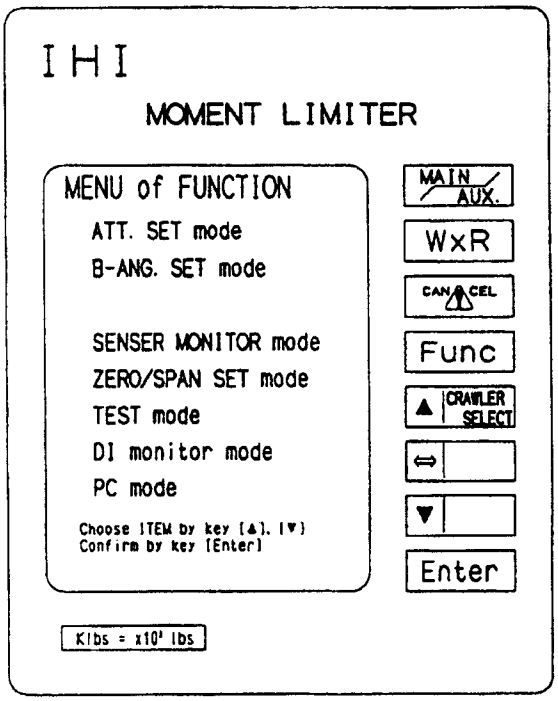
(4) After 5 seconds since the starting menu was displayed, the menu is changed to the standard menu. The standard menu shows the following items:

- Load ratio . . . . . .%
- Rated overall lifting load . . . . .Klbs. (allowable load)
- Actual load . . . . . .Klbs.
- Boom angle. . . . . .°
- Working radius . . . . . .Ft.

(5) The standard menu is displayed for "boom lifting". If the operator has to change to "jib lifting", press the MAIN AUX key switch. The load of "boom lifting" as illustrated left moves to the jib side.

(6) If the sensor malfunctions or if the working conditions are set wrong, an error No. is displayed in the column of the working radius. Make sure that an error No. is not displayed.

Function Selection Menu



2. Setting of the working conditions

(1) Press the Func key once in the standard menu, and the function selection menu as illustrated left is displayed. If you want to return to the standard menu, press the Func or CANCEL key once.

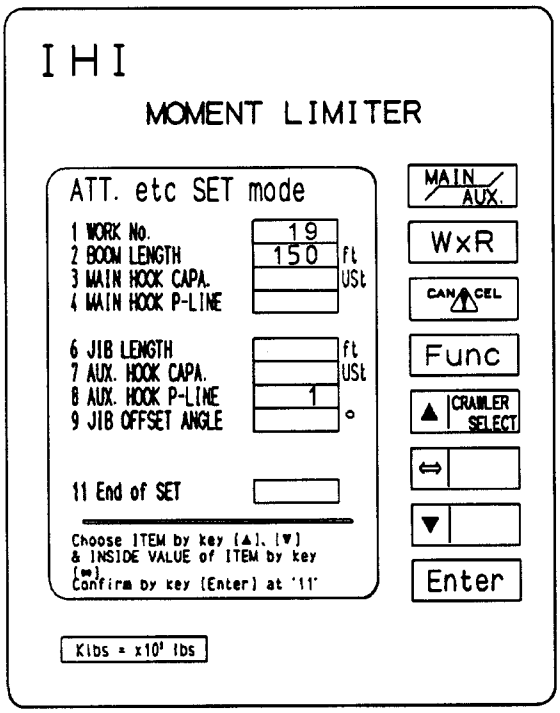
(2) Proceed to the setting menu from the function selection menu.

In the function selection menu, press the CRAWLER SELECT or ▼ key to move the cursor (reversed display) to "ATT. SET mode". Normally, the cursor is at "ATT. SET mode" when the function selection menu is displayed.

Press the Enter key once.

When pressing the Enter key, the menu is changed to the following setting menu.

Setting Menu



(3) Set the Working condition on the setting menu. Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "WORK NO." The item with the cell is reversed.

[1] Press the ⇔ key to set the value of the current attachment for "WORK NO."

Work No. Post crane 19

See Work Number Chart on page 1-53.1

Each time the ⇔ key is pressed, the data included in the specification are displayed in order. Select the proper work number.

[2] Setting of the boom length

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "BOOM LENGTH". Press the ⇔ key to set the proper value for the length of the current boom. Each time the ⇔ key is pressed, the boom length data included in the specification are displayed in order.

[3] Setting of the main hook capacity

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "MAIN HOOK CAPA." Press the ⇔ key to set the value of the current hook capacity.

Each time the ⇔ key is pressed, the main hook capacity data included in the specification are displayed in order. If the main hook is not installed, select "0.0".

[4] Setting of the parts of line for the main hook

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "MAIN HOOK P-LINE". Press the ⇔ key to set the parts of line for the current main hook. Each time the ⇔ key is pressed, the "parts of line" data included in the specification are displayed in order. If the main hook is not installed, select "1".

[6] Setting of the jib length

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "JIB LENGTH". Press the ⇔ key to set the value of the current jib length.

Each time the ⇔ key is pressed, the jib length data included in the specification are displayed in order. If the jib is not installed, select "0.0".

[7] Setting of the auxiliary hook capacity

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "AUX. HOOK CAPA.". Press the ⇔ key to set the value of the current auxiliary hook capacity.

Each time the ⇔ key is pressed, the auxiliary hook capacity data included in the specification are displayed in order. If the auxiliary hook is not installed, select "0.0".

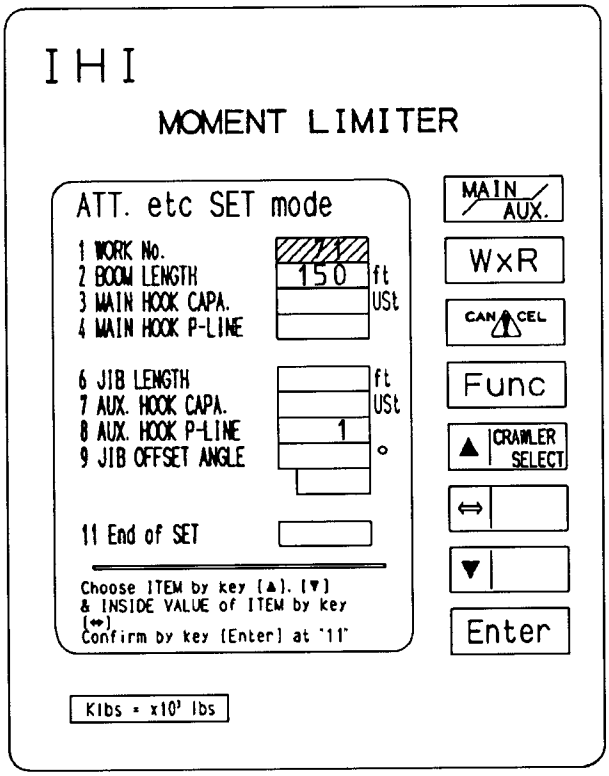
[8] Setting of the part of line for the auxiliary hook

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "AUX. HOOK P-LINE". Press ⇔ the key to set the parts of line for the current auxiliary hook.

Each time the ⇔ key is pressed, the "parts of line" data included in the specification are displayed in order. If the auxiliary hook is not installed, select "1".

[9] Setting of the jib offset angle

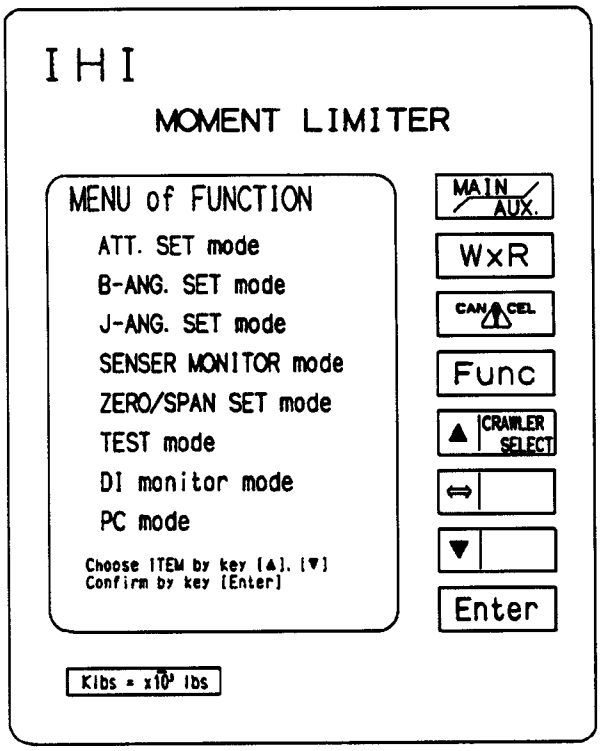
Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "JIB OFFSET ANGLE". For the auxiliary jib of the nominal 1m, the offset angle is automatically selected. If "0.0" is inputted to the jib length in the aforementioned [6], the offset angle is "0.0" and, even if the ⇔ key is pressed, the menu is not changed.



(4) Check of the set values

Make sure that the values set at the aforementioned [1] ~ [9] are set to the crane configuration.

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET" and press the Enter key twice slowly.



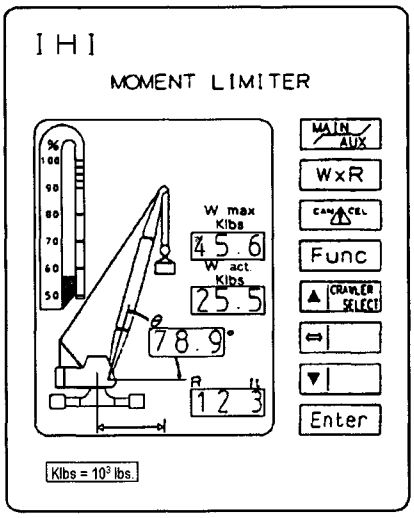
(4) Check of the set values (continued)

When pressing the Enter key , the displayed values are stored as the new set data and the function selection menu is automatically displayed. When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated). Press the Enter key again. Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [1] ~ [9] are ignored and the function selection menu is automatically set without the data change. When the CANCEL key is pressed, the working conditions are not changed. Be careful.

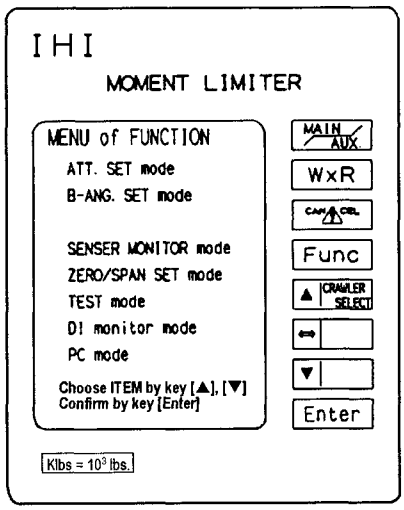
Press the Func or CANCEL key once to return from the function selection menu to the standard menu.

3. Optional auto stop or alarm angle setting

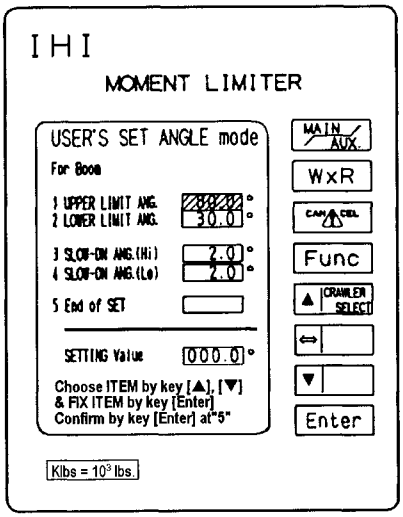
Standard Menu



Function Selection Menu



Optional Angle Setting Menu



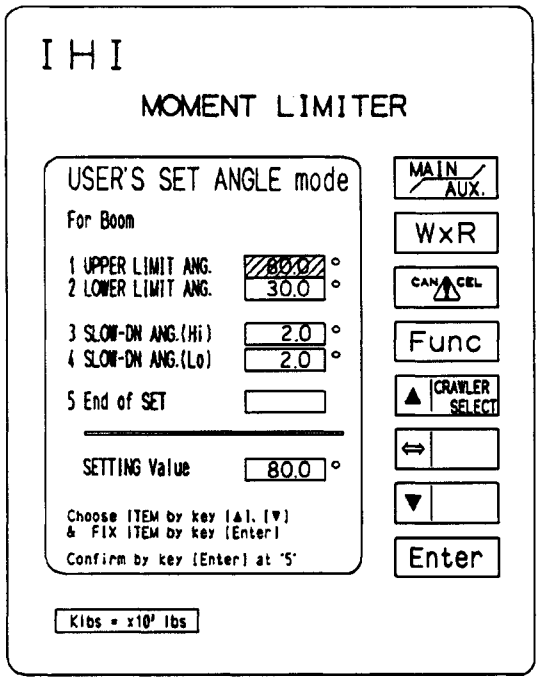
If you desire to set an optional angle, proceed from the function selection menu to the optional angle setting menu.

Press the Func key once if changing from the standard menu to the function selection menu.

Press the Func or CANCEL key once if changing from the function selection menu to the standard menu.

(1) If changing from the function selection menu to the optional angle setting menu, press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed display) to "B-ANG. SET mode". Then, press the Enter key.

Optional Angle Setting Menu



(2) Setting of the boom optional upper limit angle

[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "UPPER LIMIT ANG." Normally, the cursor is at "UPPER LIMIT ANG." when the optional angle setting menu is displayed.

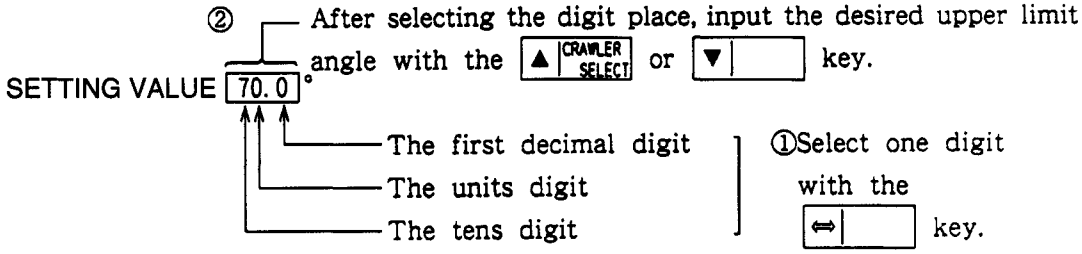
[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

In case in editing mode, change menu by key ⇔ choose value by [▲], [▼] provisional decision by Enter

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "7" to the tens digit, and so the boom optional upper limit angle is set to 70.0°. Maximum upper limit angle is 80.0° .

[5] After setting the boom optional upper limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "UPPER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the boom has reached the set upper limit angle (70° in the above example), the alarm sounds and the boom hoisting stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached 80°, the boom stops automatically at the rated boom upper limit angle.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

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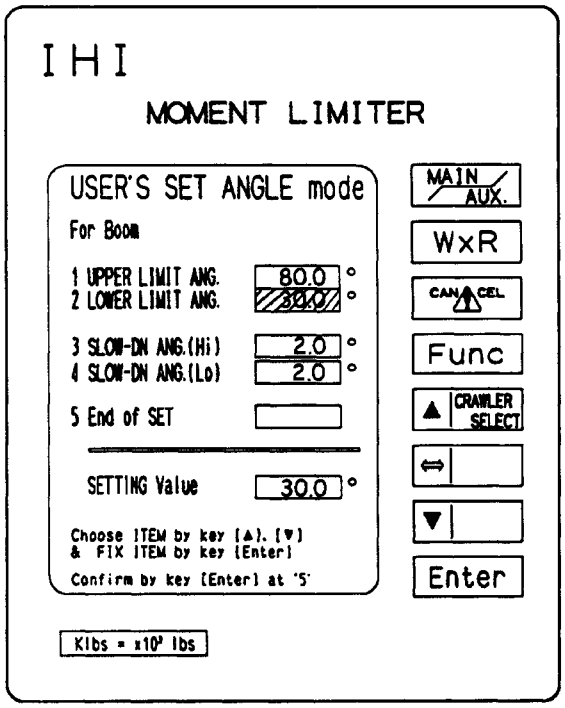
Optional Angle Setting Menu



(3) Setting of the boom optional lower limit angle

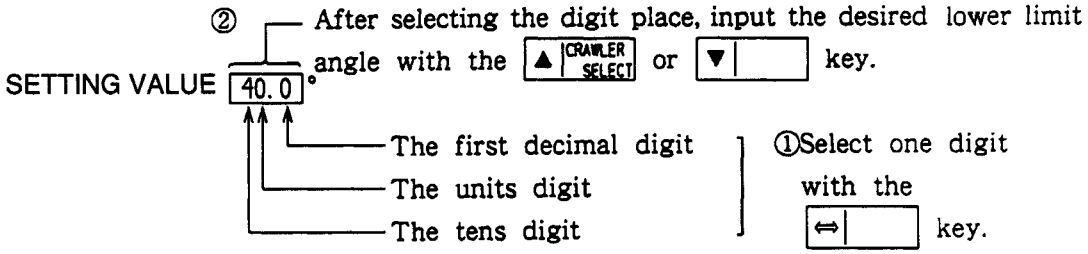
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "LOWER LIMIT ANG."

[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



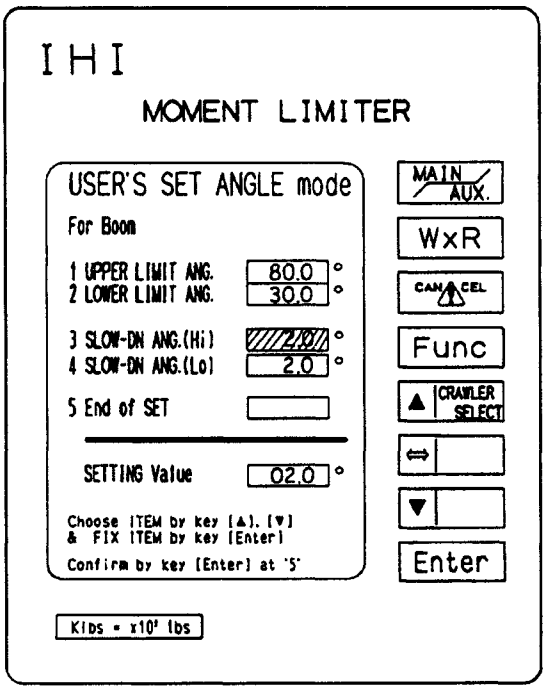
In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "4" to the tens digit, and so the boom optional lower limit angle is set to 40.0° . Minimum lower limit angle is 30.0° .

[5] After setting the boom optional lower limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "LOWER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the boom has reached the set lower limit angle (40° in the above example), the alarm sounds and the boom lowering stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached 30°, the boom stops automatically at the rated boom lower limit angle (almost 30°).

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

Optional Angle Setting Menu



(4) Setting of the upper limit angle of gentle stop

This function sets the optional approach angle at which the slow-down starts before the boom stops automatically when the boom is hoisting.

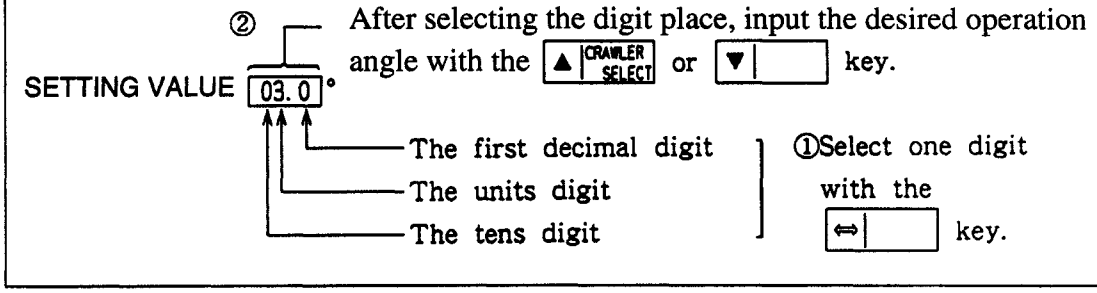
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Hi)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



In the above example, "0" is inputted to the first decimal digit, "3" to the units digit and "0" to the tens digit, and so the upper limit slow-down angle is set to 3.0° . If the slow-down operation is not necessary, set the angle 0.00 Standard minimum slow-down angle is 2.0° .

[5] After setting the upper limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Hi)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (2), the boom optional upper limit angle is set to 70°, and in the above example, the upper limit slow-down operation angle is set to 3°. In such a case, the boom hoisting speed slows down when the boom angle is 67° and the boom hoisting stops automatically and the alarm sounds when the boom angle is 70°.

If the machine is without the automatic stop function, the hoisting speed slows down at the boom angle 67° and the alarm sounds at the boom angle 70°. The boom hoisting stops automatically at the boom angle 80°. Rated boom upper limit angle is 80°.

On the machine without the automatic stop and slow-down function, only the alarm sounds.

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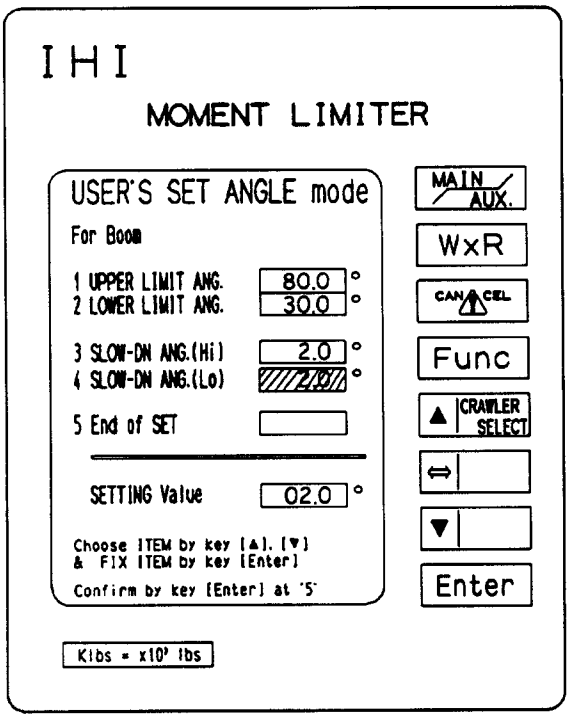
Optional Angle Setting Menu



(5) Setting of the lower limit angle of gentle stop

This function sets the optional approach angle at which the slow-down starts before the boom stops automatically when the boom is lowering.

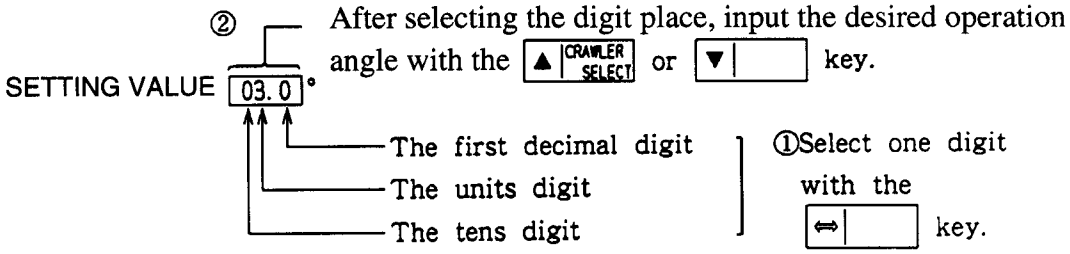
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Lo)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:

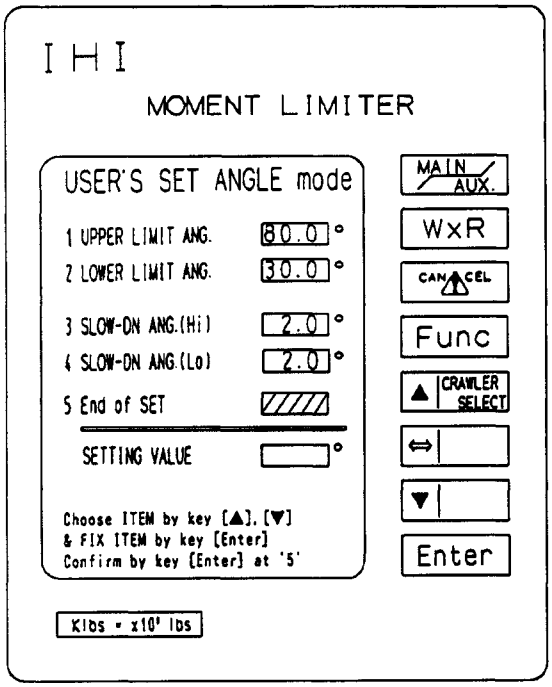


In the above example, "0" is inputted to the first decimal digit, "3" to the units digit and "0" to the tens digit, and so the boom lower limit slow-down angle is set to 3.0° . If the slow-down operation is not necessary, set the angle 0.00 Standard minimum slow-down angle is approximately 2.0° .

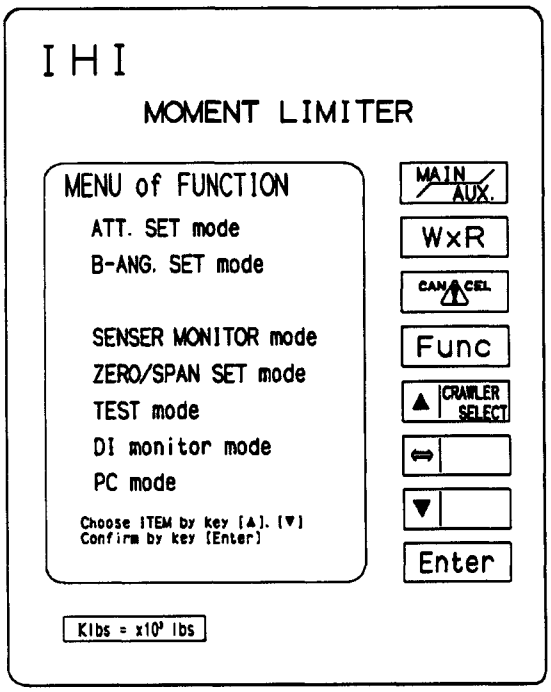
[5] After setting the optional lower limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Lo)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (3), the optional lower limit angle is set to 40°, and in the above example, the lower limit slow-down operation angle is set to 3°. In such a case, the lowering speed slows down when the boom angle is 43° and the boom lowering stops automatically and the alarm sounds when the boom angle is 40°.

If the machine is without the automatic stop function, the lowering speed slows down at the boom angle 43° and the alarm sounds at the boom angle 40°. The boom lowering stops automatically at the rated boom lower limit angle (almost 30°).

Optional Angle Setting Menu



Function Selection Menu



(6) Decision for angle setting

[1] Make sure that the proper values are set in the above setting procedure of the items (2) ~ (5):
- The value of the boom upper limit angle
- The value of the boom lower limit angle
- The value of the upper limit slow-down operation angle
- The value of the lower limit slow-down operation angle

[2] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET".

[3] Press the Enter key. The data on the screen are updated and the menu is automatically returned to the function selection menu.

[4] If you desire to stop setting, press the CANCEL key before pressing the Enter key.

Before pressing the Func key, if the CANCEL key is pressed, the values set in the aforementioned [2] ~ [5] (USER'S SET ANGLE mode for Boom) are ignored and the function selection menu is automatically set without the data change.

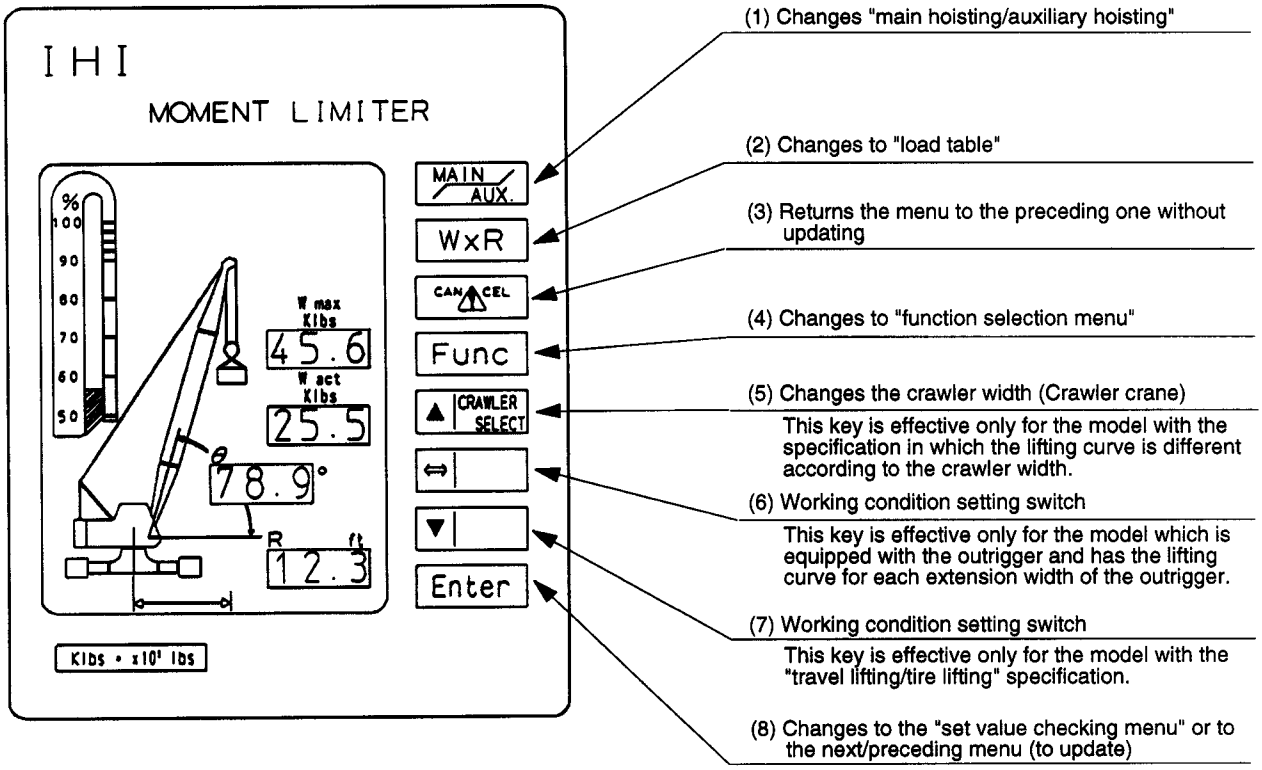
When the CANCEL key is pressed, the working conditions are not changed. Be careful.

If you desire to change the function selection menu to the standard menu, press the Enter or CANCEL key once.

When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated). Press the Enter key again.

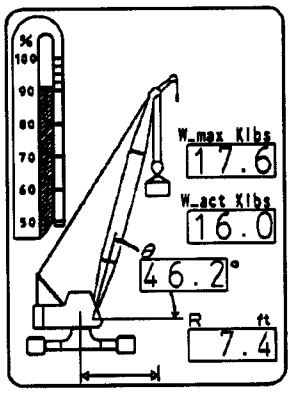
4. Standard menu and operation keys

Standard Menu

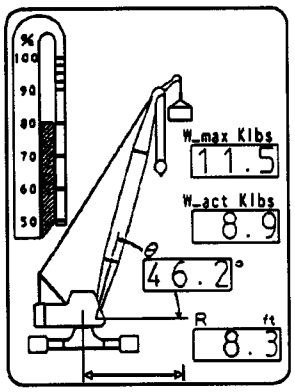


(1) Main/auxiliary selector key switch [MAIN AUX]

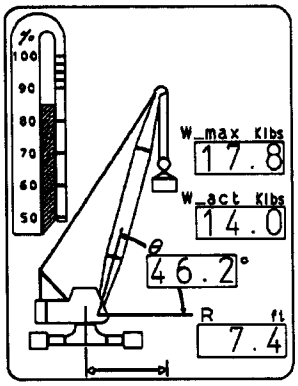
Press the main/auxiliary selector key switch [MAIN AUX], the main hoisting work menu is changed to the auxiliary hoisting work menu. Press the [MAIN AUX] key again, and the menu is changed to the main hoisting work menu. Select a proper menu according to the actual crane configuration. It is not permitted to lift loads with the main hook and the jib or auxiliary hook at the same time.



Main hoisting work with jib



Jib hoisting work with main hook



Main hoisting work without jib

The values in the display unit are reference values required for the explanation. They have nothing to do with an actual lift.

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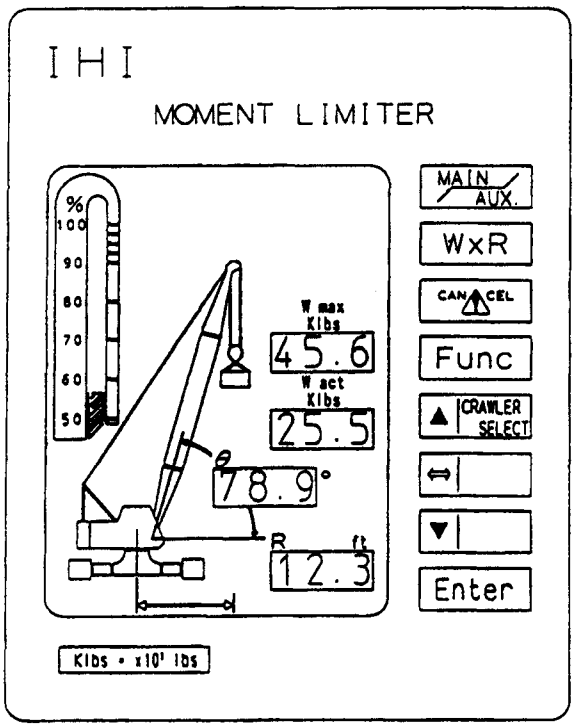
Standard Menu



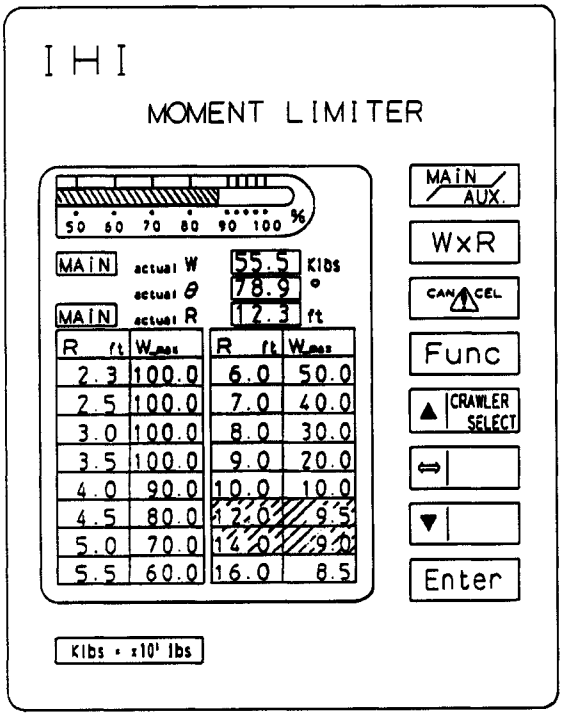
(2) The selector switch to the load table [WxR]

[1] Press the [WxR] switch once on the standard menu, and the load table is displayed. On the load table display, press the [WxR] or [CANCEL] key once, and the standard menu appears.

The load table displays the following five items:

- Load ratio . . . . . %
- Actual load for the main or auxiliary hoisting . . . . . Klbs
- Boom angle . . . . . °
- Working radius for the main or auxiliary hoisting . . . . . Ft.
- Working radius/allowable load table . . . . . Ft. Klbs

Load Table (for "MAIN")



The following illustration is the "MAIN" table. If you want the "AUX." table, press the [MAIN AUX.] key switch.

[2] Working radius/allowable load table

In the load table, the shaded area of the working radius/allowable load table indicates the current crane working radius and allowable load.

The actual working radius is 12.3 ft. and is within the shaded area, 12.0 ft. ~ 14.0 ft. The operator can view the current working radius and allowable load according to this table.

To display the data after 16.0 ft. for the working radius, press the [⇔] key once. The next data is displayed. To return to the original data, press the [⇔] key.

[3] The upper bar graph on the screen indicates the ratio (load ratio) of the crane's current load (actual value) and to the allowable safe working load.

(3) Cancel key [CANCEL]

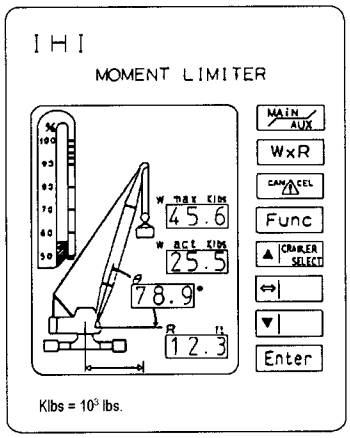
Press this key in the middle of setting for the crane working conditions or optional angle as mentioned, the setting operation stops and the original condition before setting is restored.

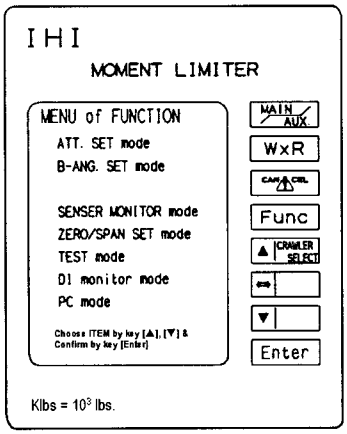
(4) Function key - to change to the function selection menu [Func]

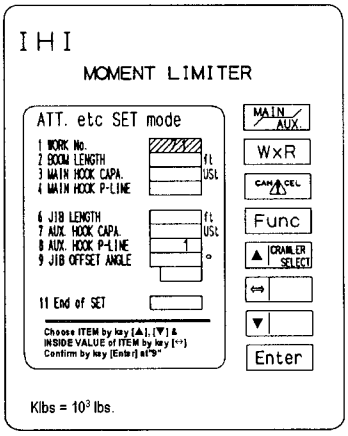
When the working conditions have to be set, change the standard menu to the function selection menu and then select the desired items in the function selection menu with the cursor.

Press the [Func] once in the standard menu and the function selection menu is displayed. In the function selection menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor (reversed cell) to the desired item.

For example, move the cursor to "ATT. SET mode" and press the [Enter] key once. The, "ATT. etc. SET mode" (working condition setting mode) is displayed.







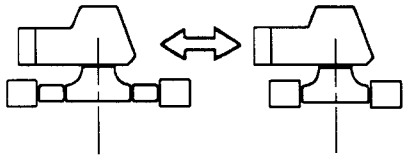
Refer to "(2) Setting of the working conditions" for how to set the working conditions and how to return from the setting menu to the function selection menu. If the function selection menu has to be changed to the standard menu, press the [Func] or [CANCEL] key once.

(5) Crawler select key - to change the crawler width [▲ CRAWLER SELECT]

In the crawler crane, this key is effective only for the model which rated overall lifting load is changed according to the crawler width.

Press the [▲ CRAWLER SELECT] key once in the standard menu, and the illustrated crawler width is retracted. Press the key again, and the crawler width is extended.

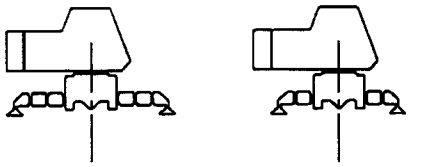
Change of Crawler Width



When extended (EXT.) **When retracted (RET.)**

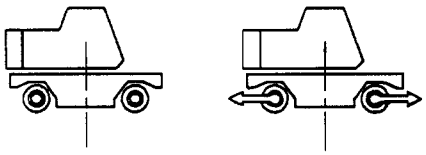
On the machine without the crawler width change specification, set the crawler width to the extended condition. If the crawler width is retracted, "E114" is displayed and the alarm sounds. This key switch does not work on the wheel type.

Change of Outrigger Width



When extended (EXT.) **When retracted (RET.)**

(6) [⇔] This key is used for setting the working conditions and changing information. This key switch works when tires are used for the travelling unit. Press the key once, and the illustrated outrigger width is retracted. Press the key again, and the outrigger width is extended. On the machine with outriggers, set the displayed picture to the machine current condition. On the crawler crane, this switch is used for setting the working conditions, etc.



Tire Stationary Lifting **Travel Lifting**

(7) [▼] This key is used for setting the working conditions and scrolling down through the menus. This key switch works when tires are used for the travelling unit. Press the key once, and the displayed picture is changed to "travel lifting". Press the key again, and the displayed picture is changed to "tire stationary lifting". On the crawler crane, this switch is used for setting the working conditions, etc.

(8) This key is used to change to "set value checking menu" or to the next/preceding menu (to update)

Press the [Enter] key once in the standard menu, and the "Attachment setting" menu, which was set in the above-mentioned "ATT etc. SET mode" menu, is displayed.

Press the [Enter] or [CANCEL] key in the setting menu, and the standard menu is restored.

In the set value checking menu, the operator can check the following values which were set in "Setting of the working conditions":

1. Work No.
2. Boom length
3. Main hook capacity
4. Part of line for main hook
5. Jib length
6. Auxiliary hook capacity
7. Part of line for auxiliary hook
8. Jib offset angle

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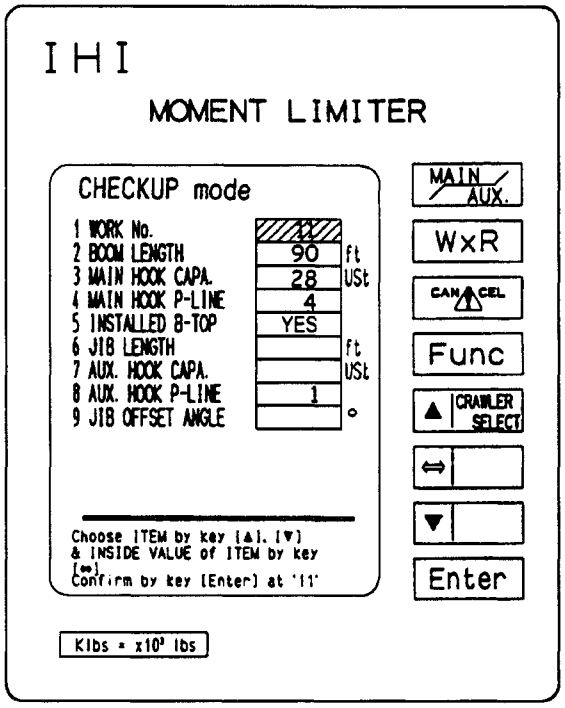
Set Value Checking Menu



In this menu, the operator can check the following eight items which are set currently:

1. Work No.
2. Boom length
3. Main hook capacity
4. Part of line for main hook
5. Jib length
6. Auxiliary hook capacity
7. Part of line for auxiliary hook
8. Jib offset angle

After checking the data, press the Enter or CANCEL key. The standard menu is restored.

4. Error messages and error codes

If a working condition inapplicable to the specification is set or if the sensor output is defective in the overload prevention device (moment limiter), the error is displayed on the screen.

The error is displayed as "Exxx" in the working radius column. The error display blinks and an alarm is heard. Refer to the illustrations on the next page.

The error codes and remedial measures are shown in the following table.

Error Code Table

Error No.	Causes	Check and Remedial Measures
EEEE	DSP (CPU) is defective.	Should repair or replace
E100	Boom angle detector is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the angle meter
E102	The load cell sensor is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the load cell
E114	The load table does not exist.	Check the set data Check the crawler width, etc.
E120	The communication is not proper between the CPU and the display unit.	Should repair or replace
E121	The memory is defective in the CPU.	Should repair or replace
E122	The internal mode selector LS is defective.	Should repair or replace

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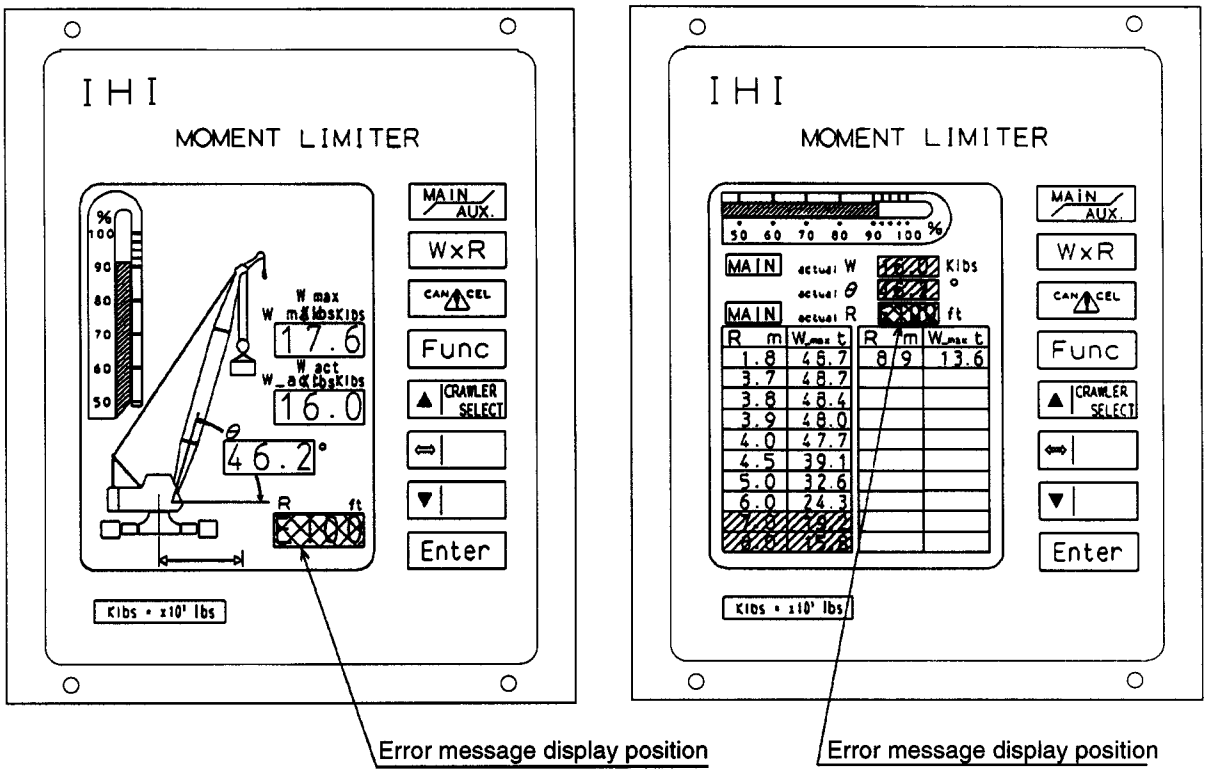


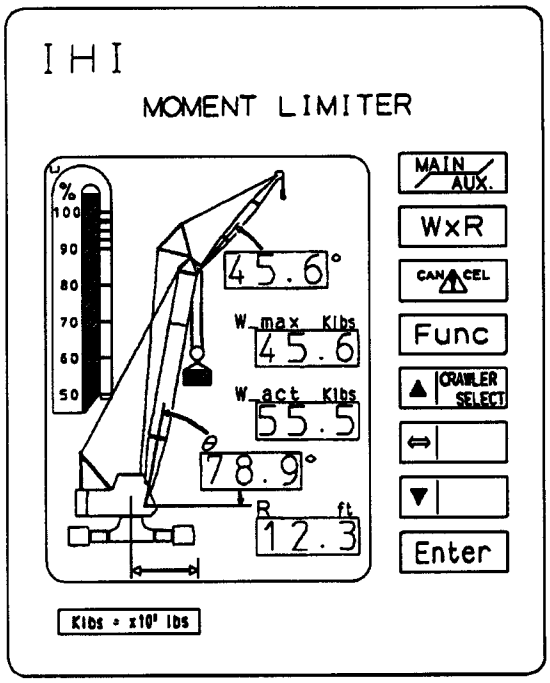
In both of the above illustrations, the error message is displayed as "E100" on the working radius column. "E100" blinks and an alarm is heard. Refer to "Error Code Table" for the causes and remedial measures of the errors.

ML-D3A

Setting of working conditions at work No. 71 (Luffing Jib Crane)

1. The "power on" and subsequent procedure up to the display of the standard menu for handling the moment limiter mode switches (1) - (4) is the same as the standard crane. But the display contents show the items of the luffing jib crane.

Standard Menu (Luffing Jib Crane)



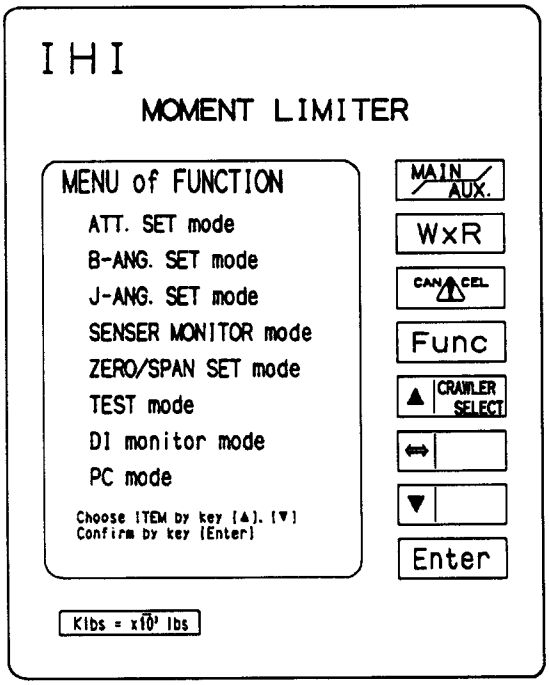
(4) After 5 seconds since the starting menu was displayed, the menu is changed to the standard menu. The standard menu shows the following items:

- Load ratio . . . . . .%
- Jib angle . . . . . .°
- Rated overall lifting load . . . . .Klbs. (allowable load)
- Actual load . . . . . .Klbs.
- Boom angle. . . . . .°
- Working radius . . . . . .Ft.

(5) The standard menu is displayed for "boom lifting". If the operator has to change to "jib lifting", press the MAIN AUX key switch. The load of "boom lifting" as illustrated left moves to the jib side.

(6) If the sensor malfunctions or if the working conditions are set wrong, an error No. is displayed in the column of the working radius. Make sure that an error No. is not displayed.

Function Selection Menu



2. Setting of the working conditions

(1) Press the Func key once in the standard menu, and the function selection menu as illustrated left is displayed. If you want to return to the standard menu, press the Func or CANCEL key once.

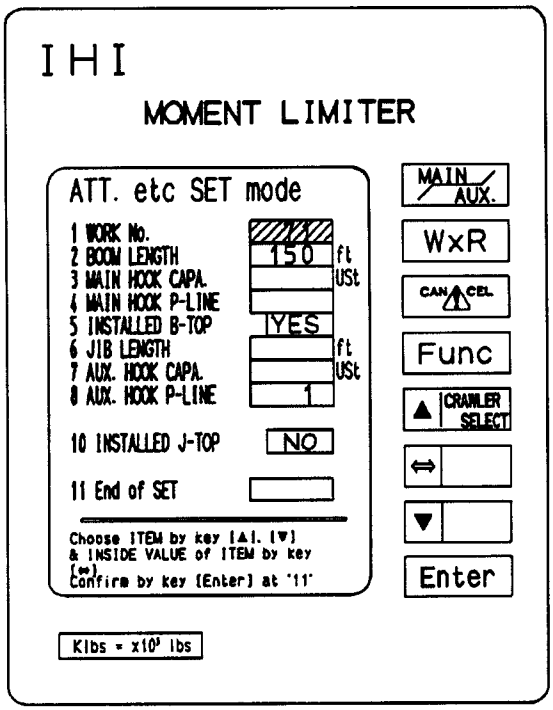
(2) Proceed to the setting menu from the function selection menu.

In the function selection menu, press the CRAWLER SELECT or ▼ key to move the cursor (reversed display) to "ATT. SET mode". Normally, the cursor is at "ATT. SET mode" when the function selection menu is displayed.

Press the Enter key once.

When pressing the Enter key, the menu is changed to the following setting menu.

Setting Menu



(3) Set the Working condition on the setting menu. Press the CRAWLER SELECT or ▼ key to move the cursor to "WORK NO." The item with the cell is reversed.

[1] Press the ⇔ key to set the value of the current attachment for "WORK NO."

Work No. Standard crane 71

See Work Number Chart on page 1-53.1

Each time the ⇔ key is pressed, the data included in the specification are displayed in order. Select the proper work number.

[2] Setting of the boom length

Press the CRAWLER SELECT or ▼ key to move the cursor to "BOOM LENGTH". Press the ⇔ key to set the proper value for the length of the current boom. Each time the ⇔ key is pressed, the boom length data included in the specification are displayed in order.

[3] Setting of the main hook capacity

Press the CRAWLER SELECT or ▼ key to move the cursor to "MAIN HOOK CAPA." Press the ⇔ key to set the value of the current hook capacity.

Each time the ⇔ key is pressed, the main hook capacity data included in the specification are displayed in order. If the main hook is not installed, select "0.0".

[4] Setting of the parts of line for the main hook

Press the CRAWLER SELECT or ▼ key to move the cursor to "MAIN HOOK P-LINE". Press the ⇔ key to set the parts of line for the current main hook. Each time the ⇔ key is pressed, the "parts of line" data included in the specification are displayed in order. If the main hook is not installed, select "1".

[5] Setting of the boom top sheave

When work No. 71 is set, "INSTALLED B-TOP" is automatically selected "YES", and the cursor moves to "JIB LENGTH".

[6] Setting of the jib length

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "JIB LENGTH". Press the ⇔ key to set the value of the current jib length.

Each time the ⇔ key is pressed, the jib length data included in the specification are displayed in order. On the luffing jib crane, the hook which is mounted on the tower jib is the auxiliary hook.

[7] Setting of the auxiliary hook capacity

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "AUX. HOOK CAPA.". Press the ⇔ key to set the value of the current auxiliary hook capacity.

Each time the ⇔ key is pressed, the auxiliary hook capacity data included in the specification are displayed in order. If the auxiliary hook is not installed, select "0.0". When the auxiliary jib length is already set as in (6), set the hook capacity of auxiliary.

[8] Setting of the parts of line for the auxiliary hook

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "AUX. HOOK P-LINE". Press ⇔ the key to set the parts of line for the current auxiliary hook.

Each time the ⇔ key is pressed, the "parts of line" data included in the specification are displayed in order. If the auxiliary hook is not installed, select "1". When auxiliary jib length is already set as in (6), set the parts of line of auxiliary hook.

[9] Setting of the jib top

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "INSTALLED J-TOP". Press the ⇔ key to set the "NO". Jib top cannot be set.

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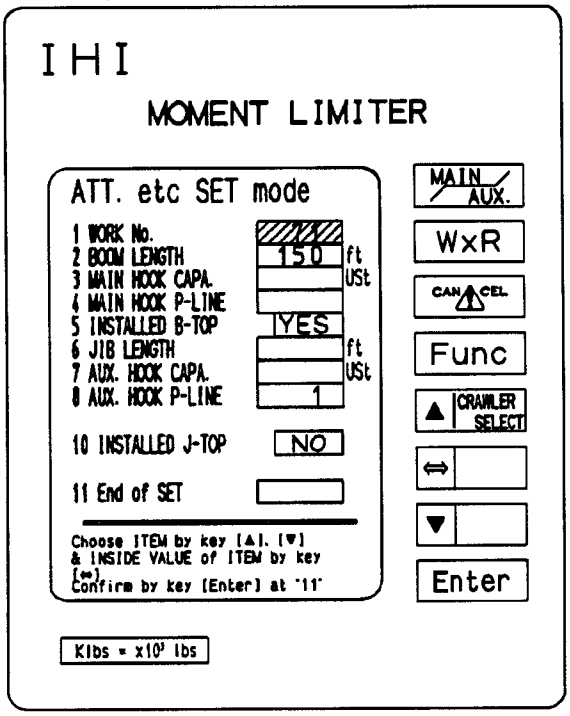
Setting Menu



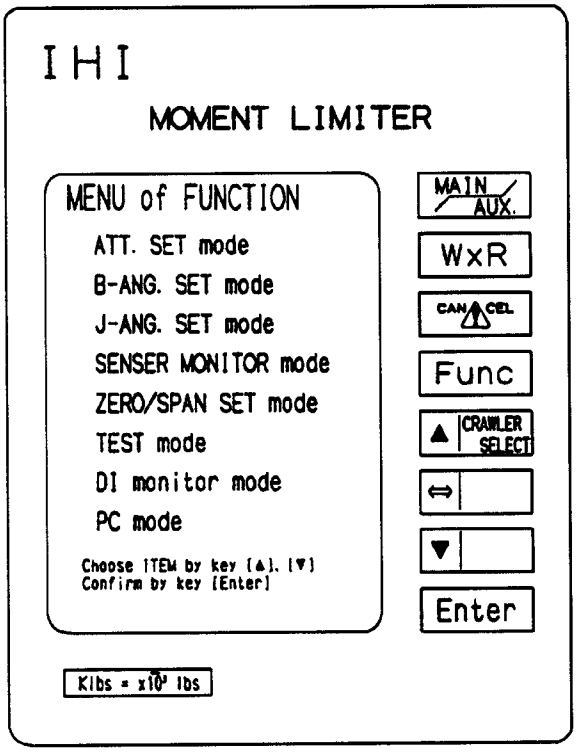
(4) Check of the set values

Make sure that the values set at the aforementioned [1] ~ [9] are set to the crane configuration.

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET" and press the Enter key.

When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated) Press the Enter key again.

Function selection menu



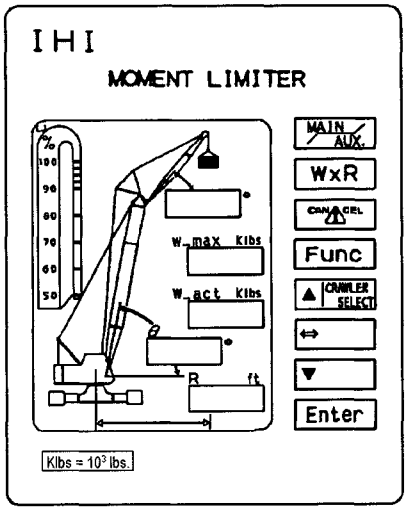
When pressing the Enter key, the displayed values are stored as the new set data and the function selection menu is automatically displayed. When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated) Press the Enter key again.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [1] ~ [9] are ignored and the function selection menu is automatically set without the data change. When the CANCEL key is pressed, the working conditions are not changed. Be careful.

Press the Func or CANCEL key once to return from the function selection menu to the standard menu.

3. Optional auto stop or alarm angle setting

Standard Menu



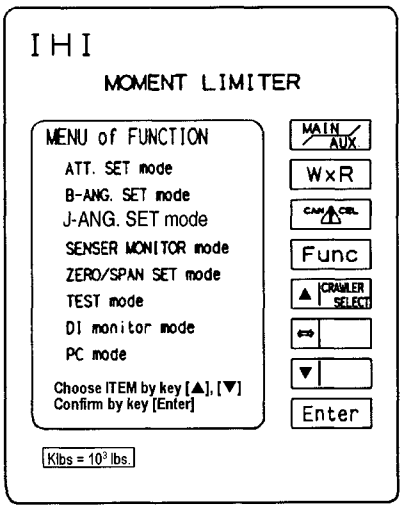
If you desire to set an optional angle, proceed from the function selection menu to the optional angle setting menu.

Press the [Func] key once if changing from the standard menu to the function selection menu.

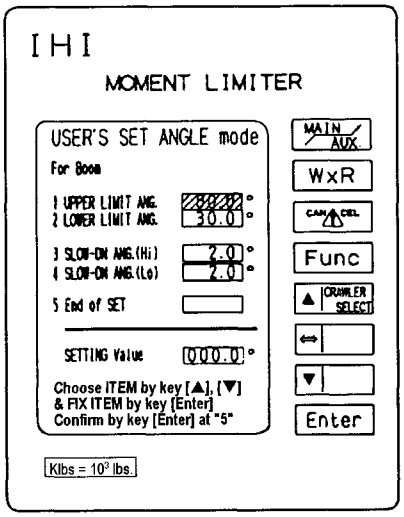
Press the [Func] or [CANCEL] key once if changing from the function selection menu to the standard menu.

(1) If changing from the function selection menu to the optional angle setting menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor (reverse display) to "B-ANG. SET mode". Then, press the [Enter] key.

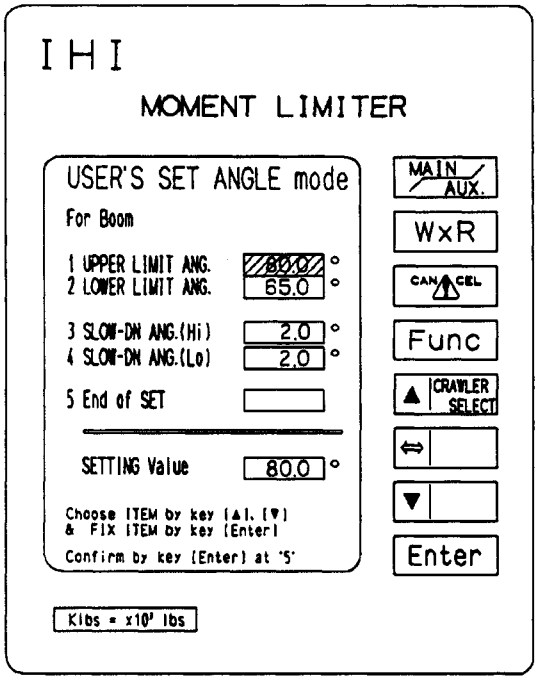
Function Selection Menu



Optional Angle Setting Menu (for Boom)



Optional Angle Setting Menu



(2) Setting of the boom optional upper limit angle

[1] Press the ▲CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "UPPER LIMIT ANG." Normally, the cursor is at "UPPER LIMIT ANG." when the optional angle setting menu is displayed.

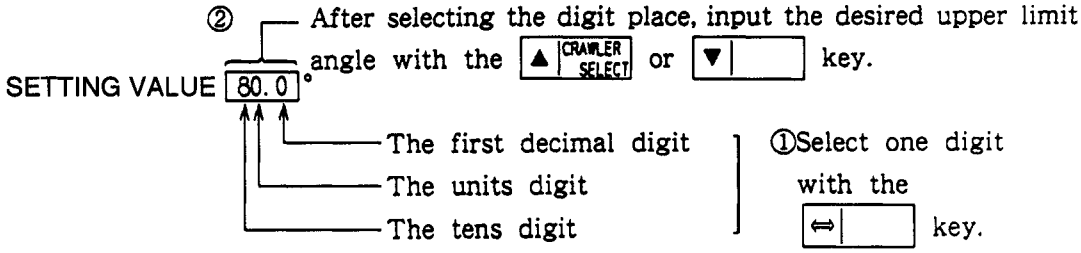
[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

In case in editing mode, change menu by key ⇔ choose value by [▲], [▼] provisional decision by Enter

[4] After moving the cursor to the desired digit, press the ▲CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "8" to the tens digit, and so the boom optional upper limit angle is set to 80.0°. Maximum upper limit angle is 90.0° .

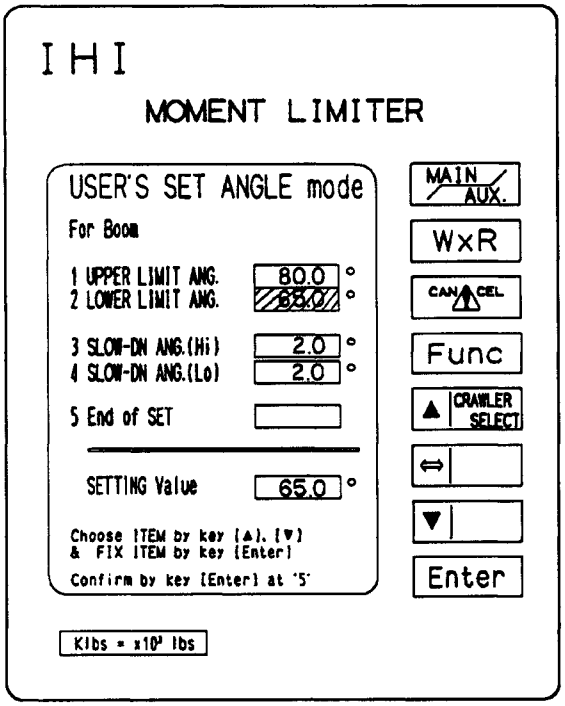
[5] After setting the boom optional upper limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "UPPER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the boom has reached the set upper limit angle (80° in the above example), the alarm sounds and the boom hoisting stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached 85° in case of main hoisting work, or 90° in case of jib hoisting work, the boom stops automatically.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

ML-D3A

Optional Angle Setting Menu



(3) Setting of the boom optional lower limit angle

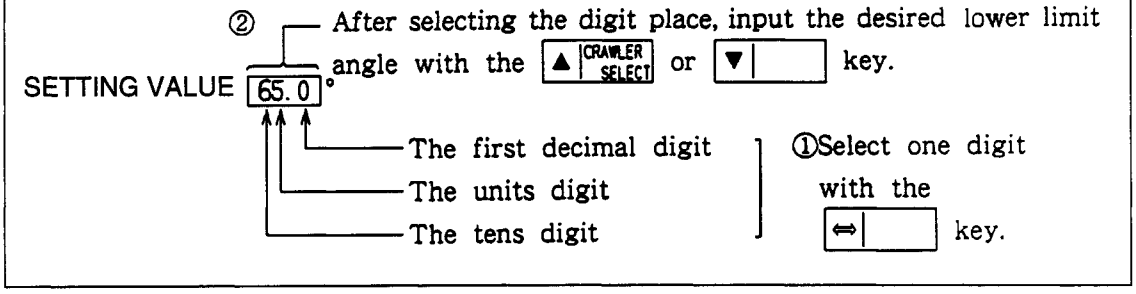
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "LOWER LIMIT ANG."

[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



In the above example, "0" is inputted to the first decimal digit, "5" to the units digit and "6" to the tens digit, and so the boom optional lower limit angle is set to 65.0° . Minimum lower limit angle is 30.0° .

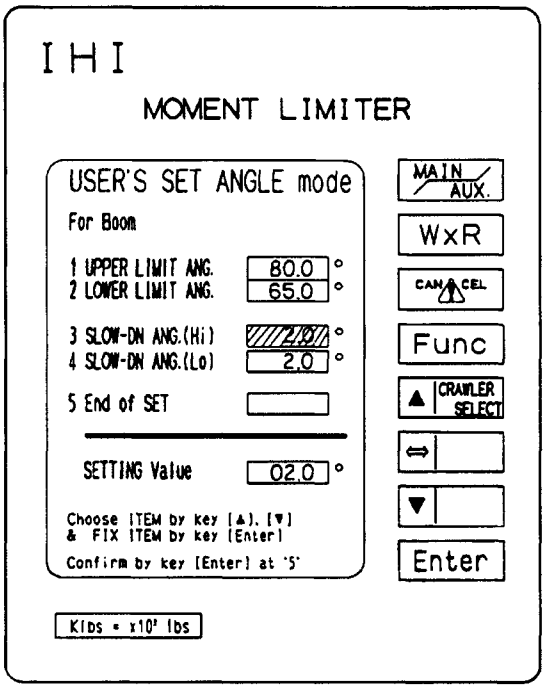
[5] After setting the boom optional lower limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "LOWER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the boom has reached the set lower limit angle (65° in the above example), the alarm sounds and the boom lowering stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached the rated lower limit angle the boom stops automatically. (Almost of 30° in case of main hoisting, almost 60° in case of jib hoisting).

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

ML-D3A

Optional Angle Setting Menu



(4) Setting of the upper limit angle of gentle stop

This function sets the optional approach angle at which the slow-down starts before the boom stops automatically when the boom is hoisting.

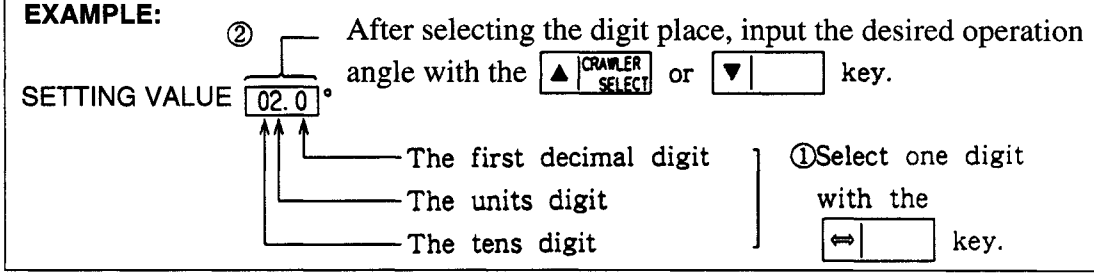
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Hi)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



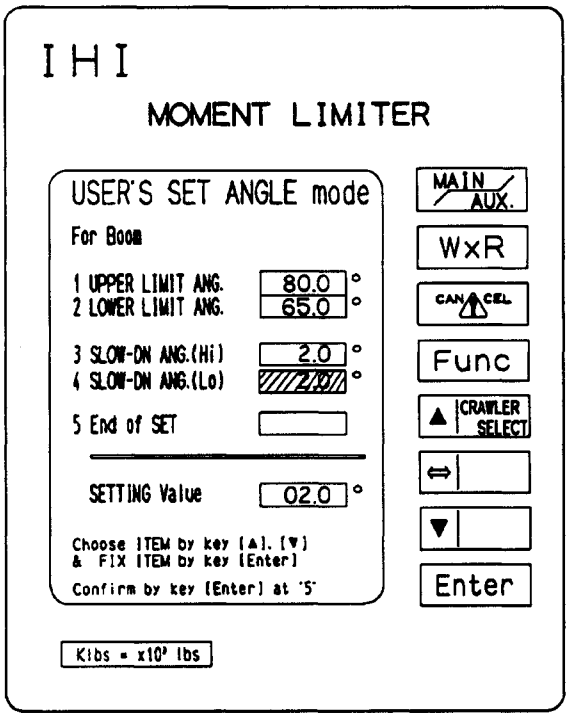
In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit, and so the upper limit slow-down angle is set to 2.0°. If the slow-down operation is not necessary, set the angle 0.00 Standard minimum slow-down angle is 2.0°.

[5] After setting the upper limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Hi)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (2), the boom optional upper limit angle is set to 80°, and in the above example, the upper limit slow-down operation angle is set to 2°. In such a case, the boom hoisting speed slows down when the boom angle is 78° and the boom hoisting stops automatically and the alarm sounds when the boom angle is 80°.

If the machine is without the automatic stop function, the hoisting speed slows down at the boom angle 78° and the alarm sounds at the boom angle 80°. The boom hoisting stops automatically at the boom angle 85° in case of main hoisting work, or 90° in case of jib hoisting work.

ML-D3A

Optional Angle Setting Menu



(5) Setting of the lower limit angle of gentle stop

This function sets the optional approach angle at which the slow-down starts before the boom stops automatically when the boom is lowering.

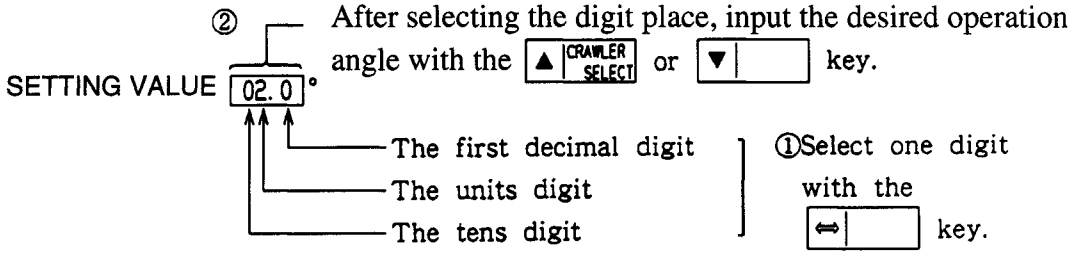
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Lo)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:

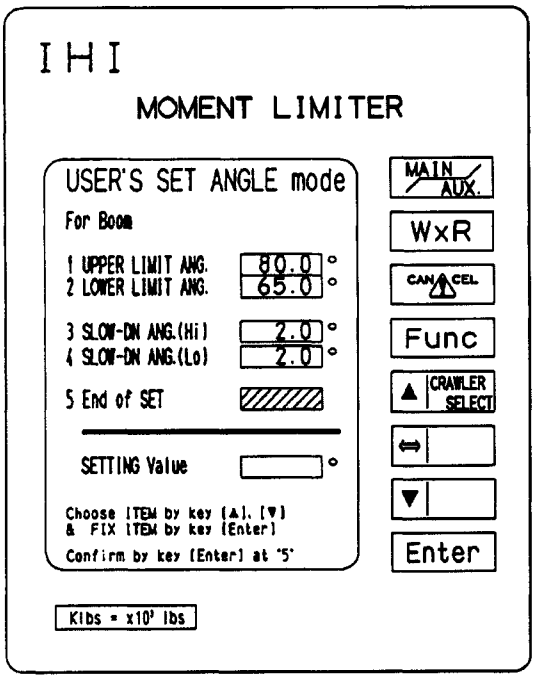


In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit, and so the boom lower limit slow-down angle is set to 2.0° . If the slow-down operation is not necessary, set the angle 0.00 Standard minimum slow-down angle is approximately 2.0° .

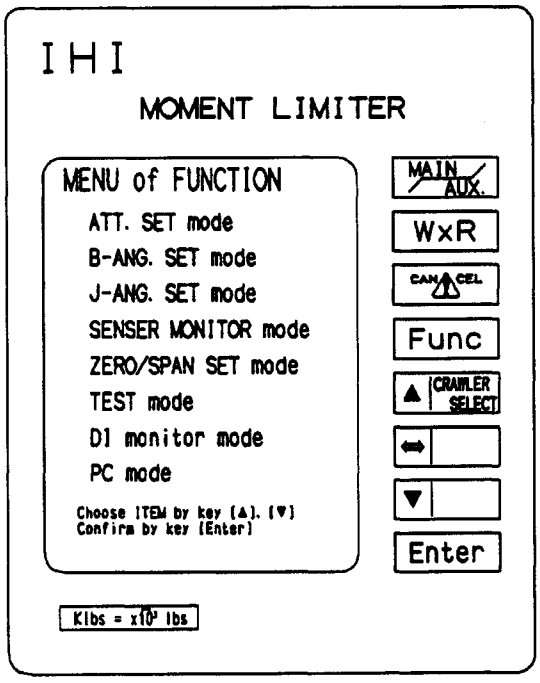
[5] After setting the optional lower limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Lo)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (3), the optional lower limit angle is set to 65°, and in the above example, the lower limit slow-down operation angle is set to 2°. In such a case, the lowering speed slows down when the boom angle is 67° and the boom lowering stops automatically and the alarm sounds when the boom angle is 65°.

If the machine is without the automatic stop function, the lowering speed slows down at the boom angle 67° and the alarm sounds at the boom angle 65°. The boom lowering stops automatically at the rated boom lower limit angle.

Optional Angle Setting Menu



Function Selection Menu



(6) Decision for angle setting

[1] Make sure that the proper values are set in the above setting procedure of the items (2) ~ (5):

- The value of the boom upper limit angle
- The value of the boom lower limit angle
- The value of the upper limit slow-down operation angle
- The value of the lower limit slow-down operation angle

[2] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET".

[3] Press the Enter key. The data on the screen are updated and the menu is automatically returned to the function selection menu.

[4] If you desire to stop setting, press the CANCEL key before pressing the Enter key.

If you desire to change the function selection menu to the standard menu, press the Func or CANCEL key once.

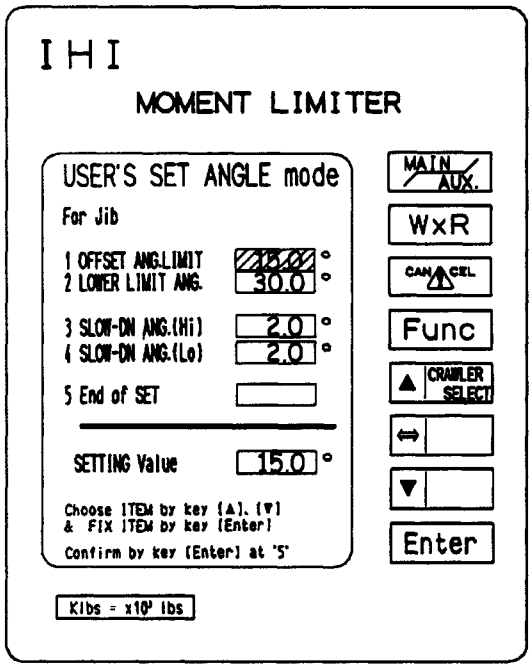
Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [2] ~ [5] (USER'S SET ANGLE mode for Boom) are ignored and the function selection menu is automatically set without the data change.

When the CANCEL key is pressed, the working conditions are not changed. Be careful.

When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated). Press the Enter key again.

ML-D3A

Optional Angle Setting Menu



(7) Setting of the optional offset angle limit for jib

[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "OFFSET ANG. LIMIT" Normally, the cursor is at "OFFSET ANG. LIMIT" when the optional angle setting menu is displayed.

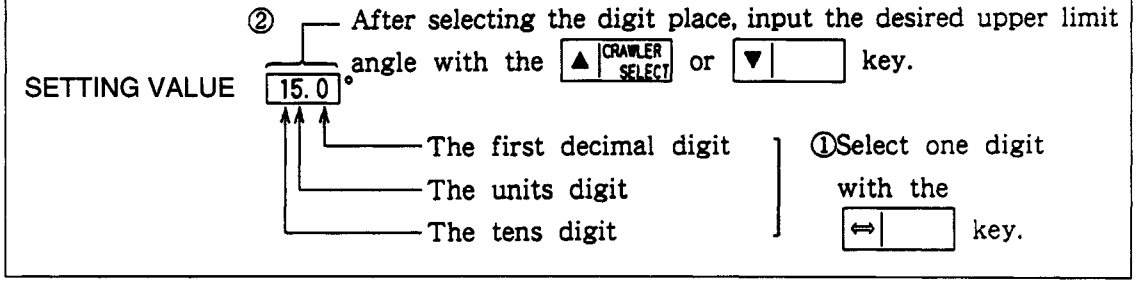
[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

In case in editing mode, change menu by key ⇔ choose value by **[▲], [▼]** provisional decision by Enter

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



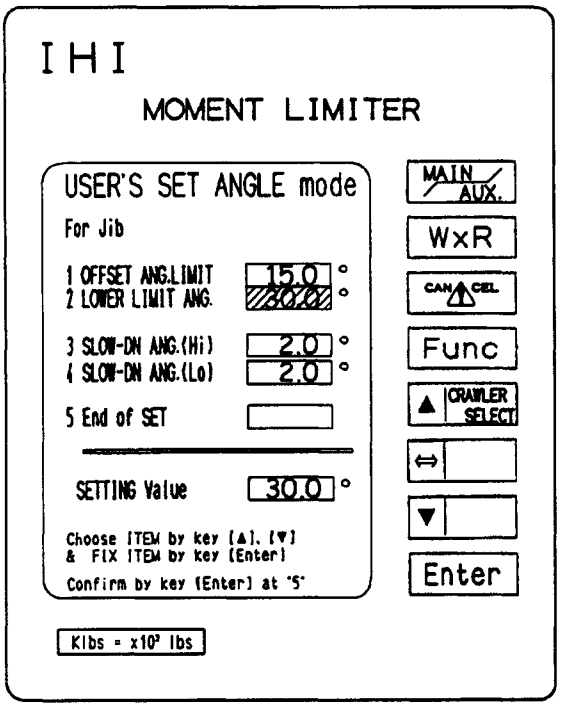
In the above example, "0" is inputted to the first decimal digit, "5" to the units digit and "1" to the tens digit, and so the jib optional offset upper limit angle is set to 15.0°. Set this angle to 10.0° if not necessary.

[5] After setting the jib optional offset upper limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "OFFSET ANG. LIMIT" column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the jib has reached the set jib offset limit angle (15° in the above example), the alarm sounds and the jib hoisting stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the jib has reached the jib offset angle of 10°, the jib stops automatically.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

Optional Angle Setting Menu



(8) Setting of the jib optional lower limit angle

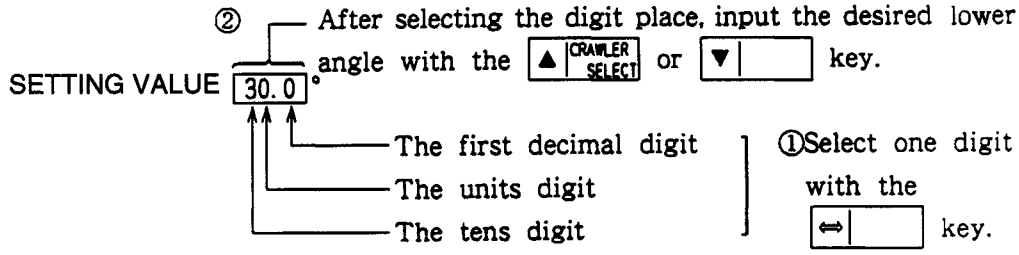
[1] Press the CRAWLER SELECT or ▼ key to move the cursor (reversed display) to "LOWER LIMIT ANG."

[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



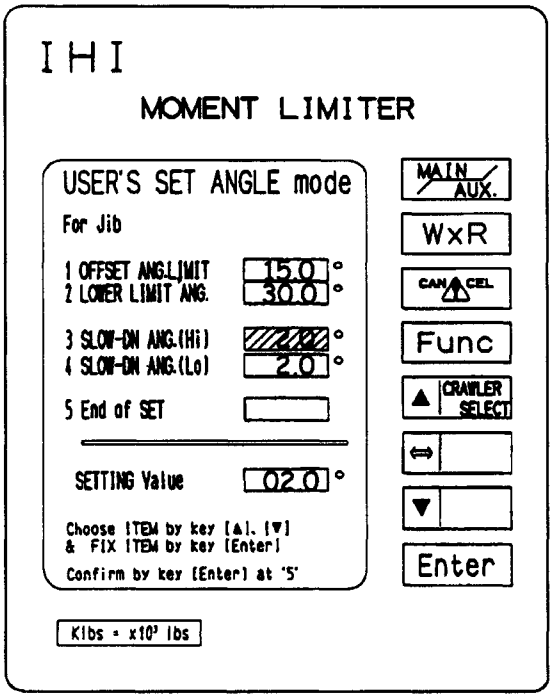
In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "3" to the tens digit, and so the jib optional lower limit angle is set to 30.0° . Set this angle to 15.0° or lower if not necessary.

[5] After setting the jib optional lower limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "LOWER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the jib has reached the set lower limit angle (30° in the above example), the alarm sounds and the jib lowering stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the jib has reached 15°, the jib stops automatically. When the jib has reached the jib rated lower limit angle regardless of the jib optional lower limit angle, it stops automatically. The jib rated lower limit angle is different according to the combination of the boom length and jib length.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

Optional Angle Setting Menu



(9) Setting of the upper limit gentle operation angle of jib

This function sets the optional approach angle at which the slow-down starts before the jib stops automatically when the jib is hoisting.

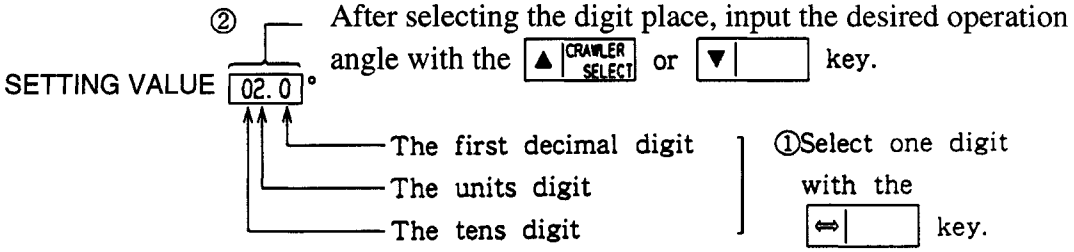
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Hi)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:

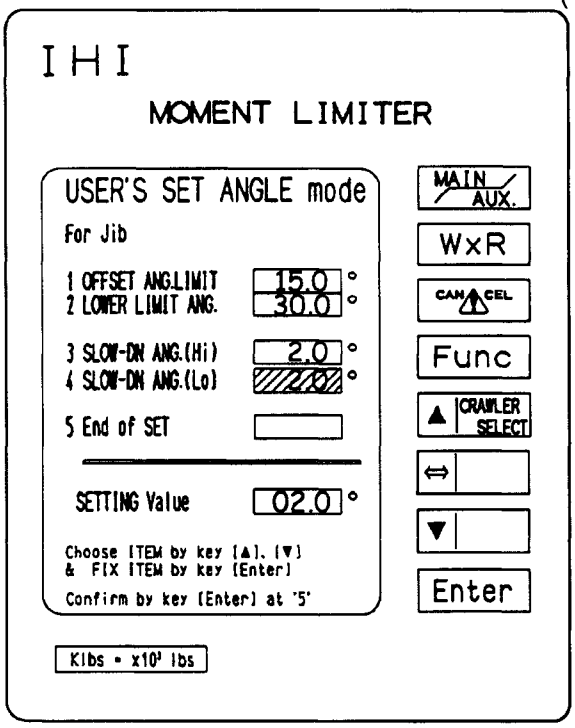


In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit, and so the upper limit slow-down angle is set to 2.0° . If the slow-down operation is not necessary, set the angle 0.00 Standard minimum slow-down angle is 2.0° .

[5] After setting the upper limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Hi)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (7), the jib optional offset angle is set to 15°, and in the above example, the upper limit slow-down operation angle is set to 2°. In such a case, the jib hoisting speed slows down when the jib offset angle is 17° and the jib hoisting stops automatically and the alarm sounds when the jib offset angle is 15°.

If the machine is without the automatic stop function, both the hoisting speed slows down and the alarm sounds. But when the jib offset angle has reached 10°, the jib hoisting stops automatically.

Optional Angle Setting Menu



(10) Setting the lower limit of gentle operation angle of jib

This function sets the optional approach angle at which the slow-down starts before the jib stops automatically when the jib is lowering.

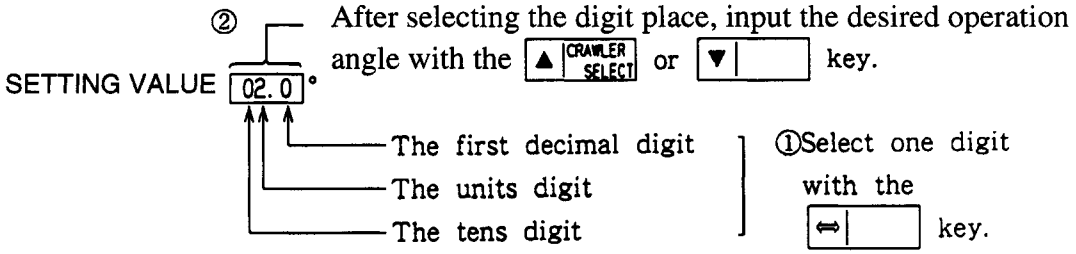
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Lo)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit, and so the boom lower limit slow-down angle is set to 2.0° . If the slow-down operation is not necessary, set the angle 0.00 Standard minimum slow-down angle is approximately 2.0° .

[5] After setting the optional lower limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Lo)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (8), the optional lower limit angle is set to 30°, and in the above example, the lower limit slow-down operation angle is set to 2°. In such a case, the lowering speed slows down when the jib angle is 32° and the jib lowering stops automatically and the alarm sounds when the jib angle is 30°.

If the machine is without the automatic stop function, the lowering speed slows down at the jib angle 32° and the alarm sounds at the jib angle 30°. The jib lowering stops automatically at the rated jib lower limit angle.

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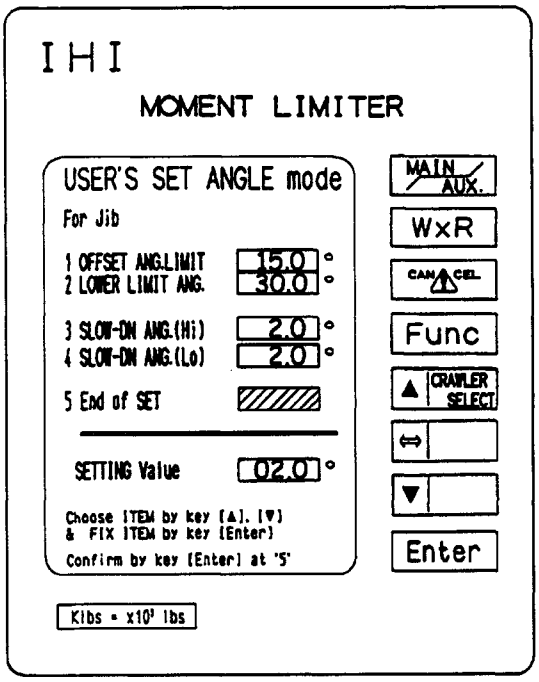
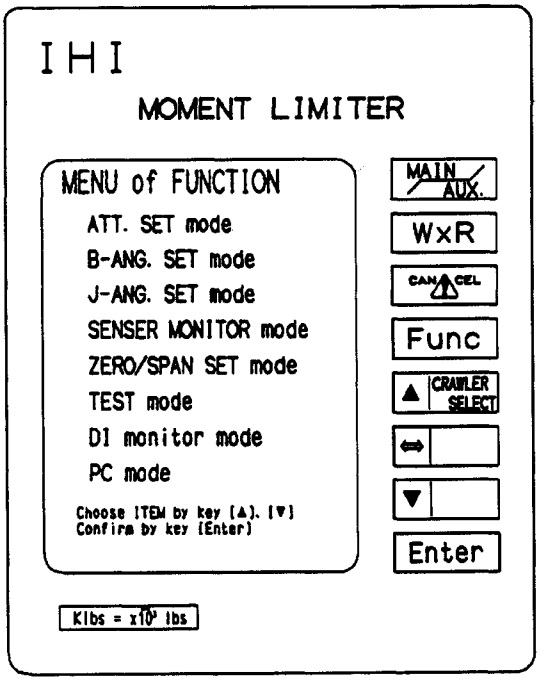
Optional Angle Setting Menu



Function Selection Menu



(11) Decision for angle setting

[1] Make sure that the proper values are set in the above setting procedure of the items (7) ~ (10):

- The value of the jib offset limit angle
- The value of the jib lower limit angle
- The value of the jib slow-down operation angle (Hi)
- The value of the jib slow-down operation angle (Lo)

[2] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET".

[3] Press the Enter key. The data on the screen are updated and the menu is automatically returned to the function selection menu.

[4] If you desire to stop setting, press the CANCEL key before pressing the Enter key.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [7] ~ [10] (USER'S SET ANGLE mode for Jib) are ignored and the function selection menu is automatically set without the data change.

When the CANCEL key is pressed, the working conditions are not changed. Be careful.

If you desire to change the function selection menu to the standard menu, press the Func or CANCEL key once.

When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated). Press the Enter key again.

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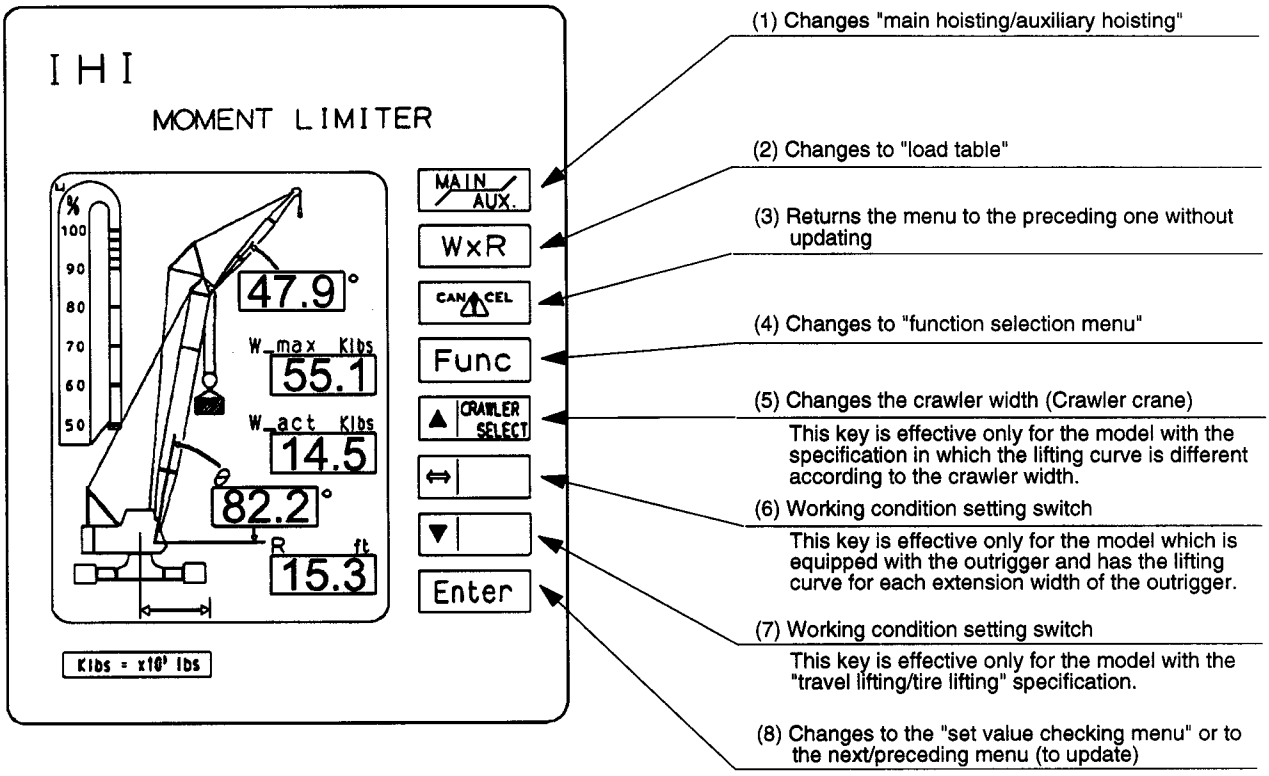
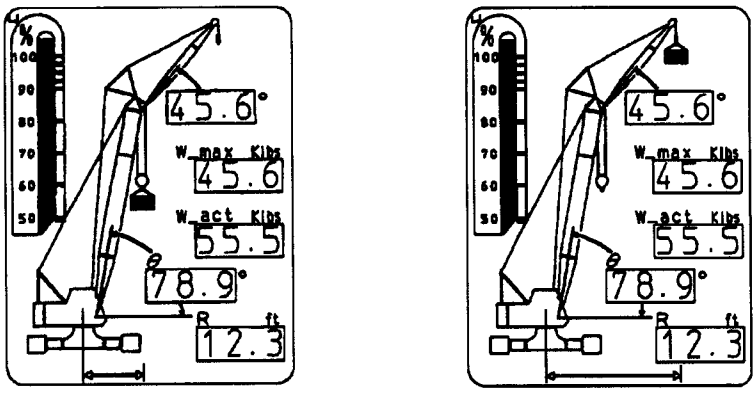
4. Standard menu and operation keys

Standard Menu



(1) Main/auxiliary selector key switch [MAIN AUX]

Press the main/auxiliary selector key switch [MAIN AUX], the main hoisting work menu is changed to the auxiliary hoisting work menu. Press the [MAIN AUX] key again, and the menu is changed to the main hoisting work menu. Select a proper menu according to the actual crane configuration. It is not permitted to lift loads with the main hook and the jib or auxiliary hook at the same time.



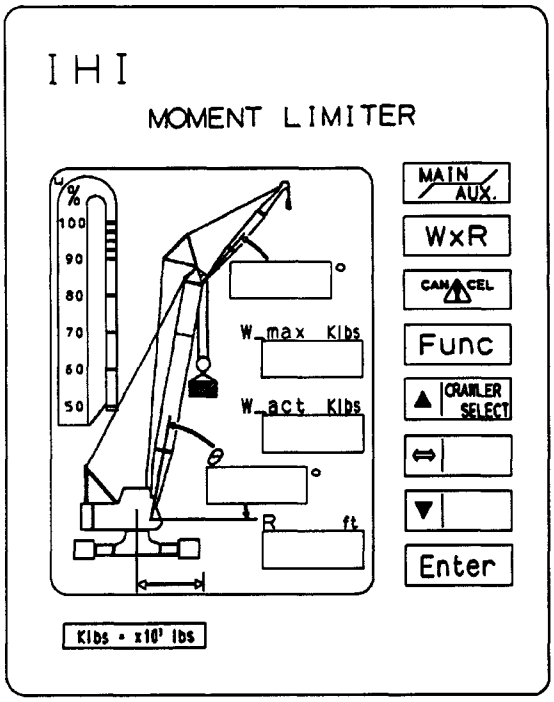
Main hoisting work **Jib hoisting work**

Luffing Jib Crane

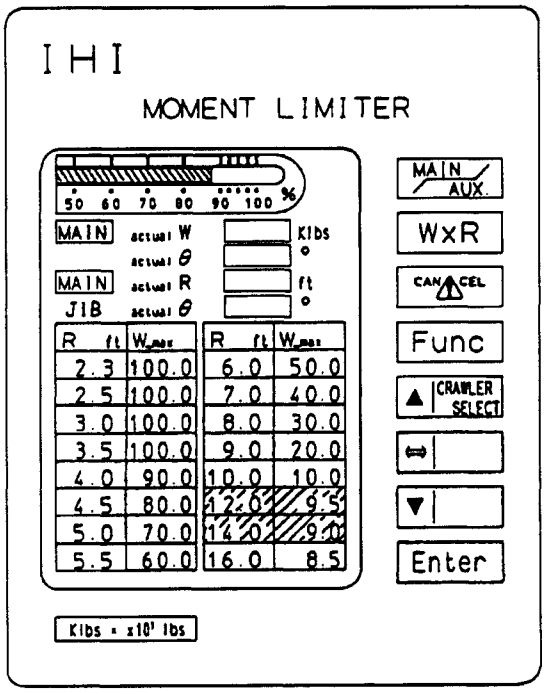
The values in the display unit are reference values required for the explanation. They have nothing to do with an actual lift.

ML-D3A

Standard Menu



Load Table (for "MAIN")



(2) The selector switch to the load table [WxR]

[1] Press the [WxR] switch once on the standard menu, and the load table is displayed. On the load table display, press the [WxR] or [CANCEL] key once, and the standard menu appears.

The load table displays the following six items:

- Load ratio ..... %
- Actual load for the main or auxiliary hoisting ..... Klbs
- Boom angle ..... °
- Working radius for the main or auxiliary hoisting ..... Ft.
- Jib angle ..... °
- Working radius/allowable load table ..... Ft. Klbs

The following illustration is the "MAIN" table. If you want the "AUX." table, press the [MAIN AUX] key switch.

[2] Working radius/allowable load table

In the load table, the shaded area of the working radius/allowable load table indicates the current crane working radius and allowable load.

The actual working radius is 12.3 ft. and is within the shaded area, 12.0 ft. ~ 14.0 ft. The operator can view the current working radius and allowable load according to this table.

To display the data after 16.0 ft. for the working radius, press the [⇔] key once. The next data are displayed. To return to the original data, press the [⇔] key.

[3] The upper bar graph on the screen indicates the ratio (load ratio) of the crane's current load (actual value) and to the allowable safe working load.

(3) Cancel key [CANCEL]

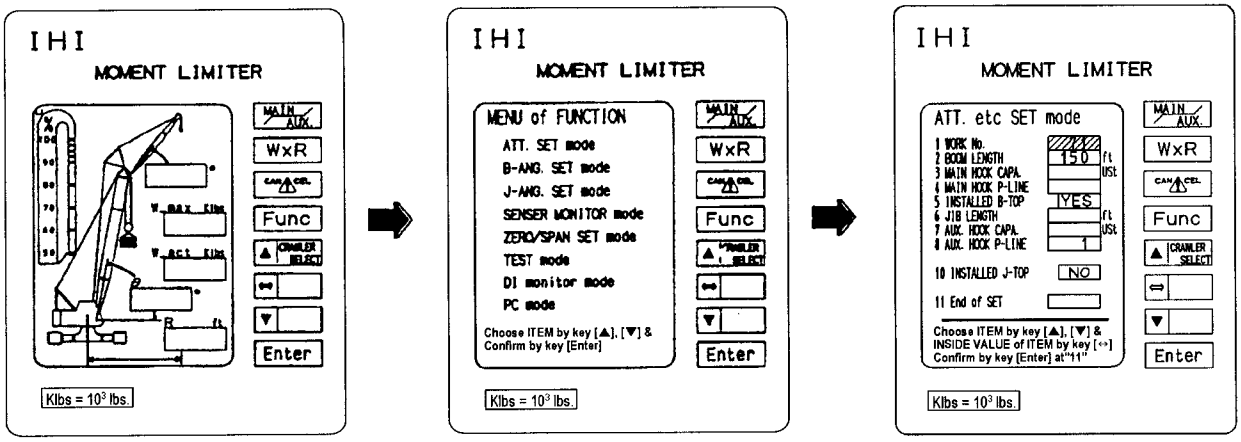
Press this key in the middle of setting for the crane working conditions or optional angle as mentioned above, the setting operation stops and the original condition before setting is restored.

(4) Function key - to change to the function selection menu [Func]

When the working conditions have to be set, change the standard menu to the function selection menu and then select the desired items in the function selection menu with the cursor.

Press the [Func] once in the standard menu and the function selection menu is displayed. In the function selection menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor (reversed cell) to the desired item.

For example, move the cursor to "ATT. SET mode" and press the [Enter] key once. Then, "ATT. etc. SET mode" (working radius setting mode) is displayed.



Standard Menu **Function Selection Menu** **Setting Menu (ATT. etc. SET mode)**

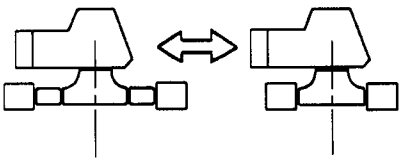
Refer to "(2) Setting of the working conditions" for how to set the working conditions and how to return from the setting menu to the function selection menu. If the function selection menu has to be changed to the standard menu, press the [Func] or [CANCEL] key once.

(5) Crawler select key - to change the crawler width [▲ CRAWLER SELECT]

In the crawler crane, this key is effective only for the model which rated overall lifting load is changed according to the crawler width.

Press the [▲ CRAWLER SELECT] key once in the standard menu, and the illustrated crawler width is retracted. Press the key again, and the crawler width is extended.

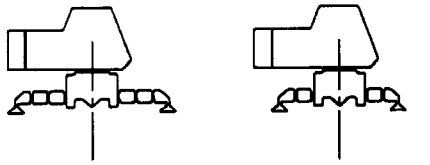
Change of Crawler Width



When extended (EXT.) **When retracted (RET.)**

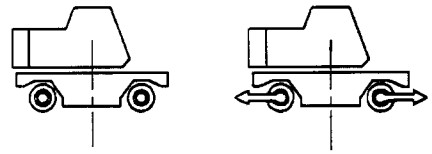
On the machine without the crawler width change specification, set the crawler width to the extended condition. If the crawler width is retracted, "E114" is displayed and the alarm sounds. This key switch does not work on the wheel type.

Change of Outrigger Width



When extended (EXT.) **When retracted (RET.)**

(6) [⇔] This key is used for setting the working conditions and changing information. This key switch works when tires are used for the travelling unit. Press the key once, and the illustrated outrigger width is retracted. Press the key again, and the outrigger width is extended. On the machine with outriggers, set the displayed picture to the machine current condition. On the crawler crane, this switch is used for setting the working conditions, etc.



Tire Stationary Lifting **Travel Lifting**

(7) [▼] This key is used for setting the working conditions and scrolling down through the menus. This key switch works when tires are used for the travelling unit. Press the key once, and the displayed picture is changed to "travel lifting". Press the key again, and the displayed picture is changed to "tire stationary lifting". On the crawler crane, this switch is used for setting the working conditions, etc.

(8) This key is used to change to "set value checking menu" or to the next/preceding menu (to update)

Press the [Enter] key once in the standard menu, and the "Attachment setting" menu, which was set in the above-mentioned "ATT etc. SET mode" menu, is displayed.

Press the [Enter] or [CAN/CEL] key in the setting menu, and the standard menu is restored.

In the set value checking menu, the operator can check the following values which were set in "Setting of the working conditions":

1. Work No.
2. Boom length
3. Main hook capacity
4. Part of line for main hook
5. Jib length
6. Auxiliary hook capacity
7. Part of line for auxiliary hook
8. Jib offset angle

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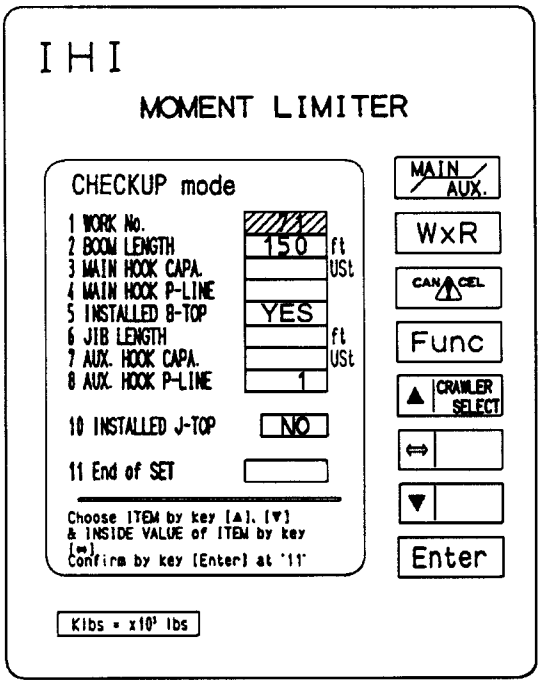
Set Value Checking Menu



In this menu, the operator can check the following nine items which are set currently:

1. Work No.
2. Boom length
3. Main hook capacity
4. Part of line for main hook
5. Installed boom top (YES)
6. Jib length
7. Auxiliary hook capacity
8. Part of line for auxiliary hook
9.
10. Installed jib top (NO)

After checking the data, press the Enter or CANCEL key. The standard menu is restored.

4. Error messages and error codes

If a working condition inapplicable to the specification is set or if the sensor output is defective in the overload prevention device (moment limiter), the error is displayed on the screen.

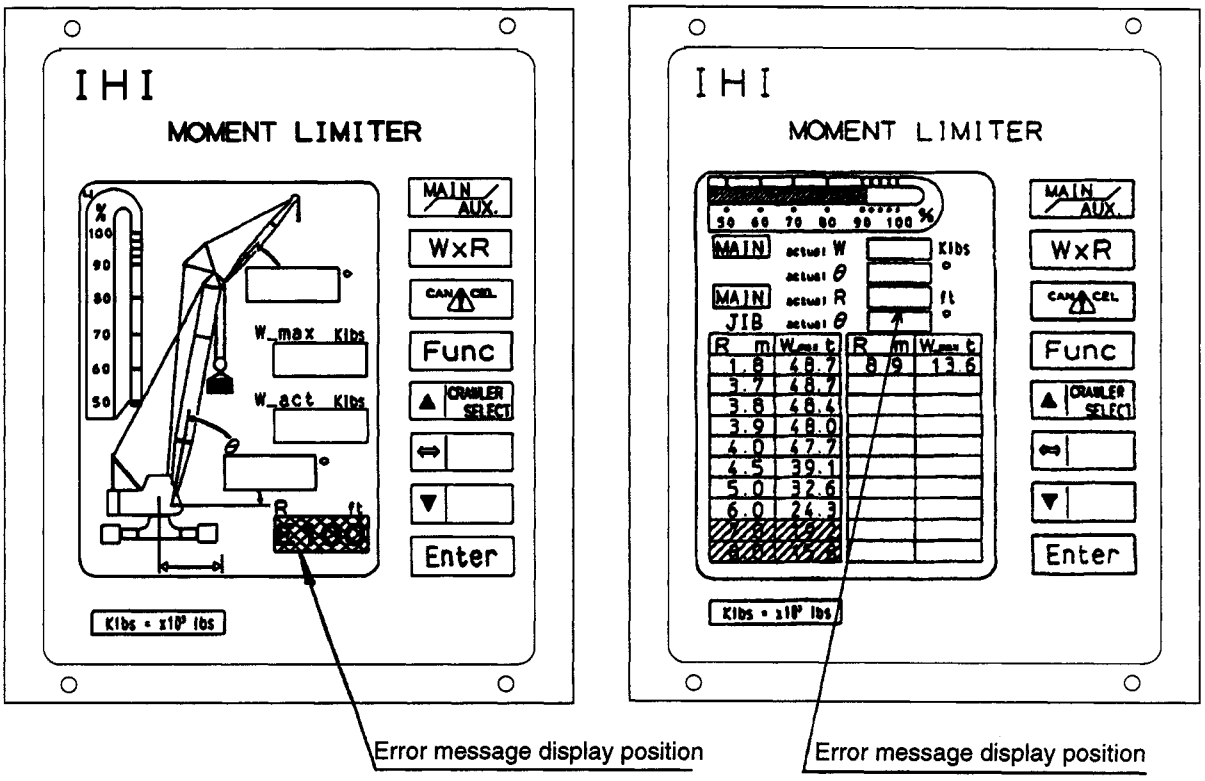
The error is displayed as "Exxx" in the working radius column. The error display blinks and an alarm is heard. Refer to the illustrations on the next page.

The error codes and remedial measures are shown in the following table.

Error Code Table

Error No.	Causes	Check and Remedial Measures
EEEE	DSP (CPU) is defective.	Should repair or replace
E100	Boom angle detector is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the angle meter
E102	The load cell sensor is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the load cell
E114	The load table does not exist.	Check the set data Check the crawler width, etc.
E120	The communication is not proper between the CPU and the display unit.	Should repair or replace
E121	The memory is defective in the CPU.	Should repair or replace
E122	The internal mode selector LS is defective.	Should repair or replace

ML-D3A

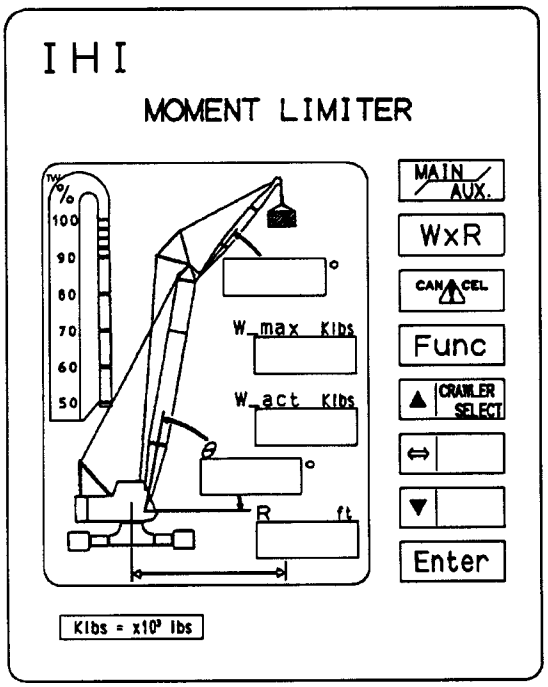


In both of the above illustrations, the error message is displayed as "E100" on the working radius column. "E100" blinks and an alarm is heard. Refer to "Error Code Table" for the causes and remedial measures of the errors.

Setting of working conditions at work No. 81 (Luffing Tower Crane)

1. The "power on" and subsequent procedure up to the display of the standard menu for handling the moment limiter mode switches (1) - (4) is the same as the standard crane. But the display contents show the items of the luffing tower crane.

Standard Menu (Luffing Tower Crane)



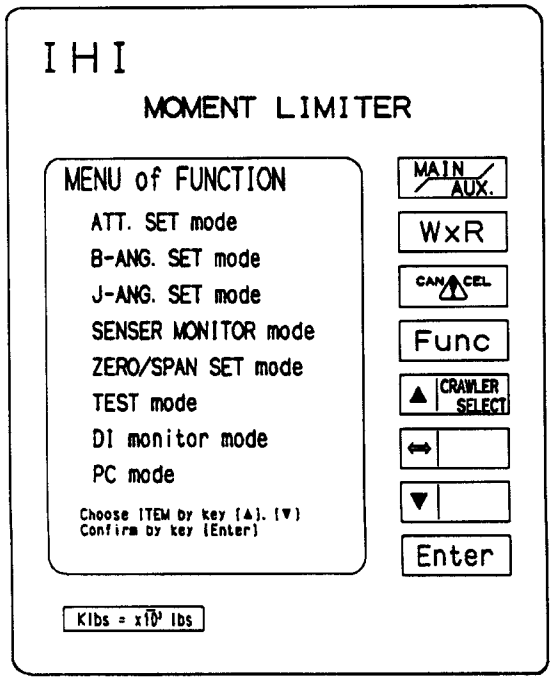
(4) After 5 seconds since the starting menu was displayed, the menu is changed to the standard menu. The standard menu shows the following items:

- Load ratio . . . . . .%
- Jib angle . . . . . .°
- Rated overall lifting load . . . . .Klbs. (allowable load)
- Actual load . . . . . .Klbs.
- Boom angle. . . . . .°
- Working radius . . . . . .Ft.

(5) The standard menu is displayed for "boom lifting". If the operator has to change to "jib lifting", press the MAIN AUX key switch. The load of "boom lifting" as illustrated left moves to the jib side.

(6) If the sensor malfunctions or if the working conditions are set wrong, an error No. is displayed in the column of the working radius. Make sure that an error No. is not displayed.

Function Selection Menu



2. Setting of the working conditions

(1) Press the Func key once in the standard menu, and the function selection menu as illustrated left is displayed. If you want to return to the standard menu, press the Func or CANCEL key once.

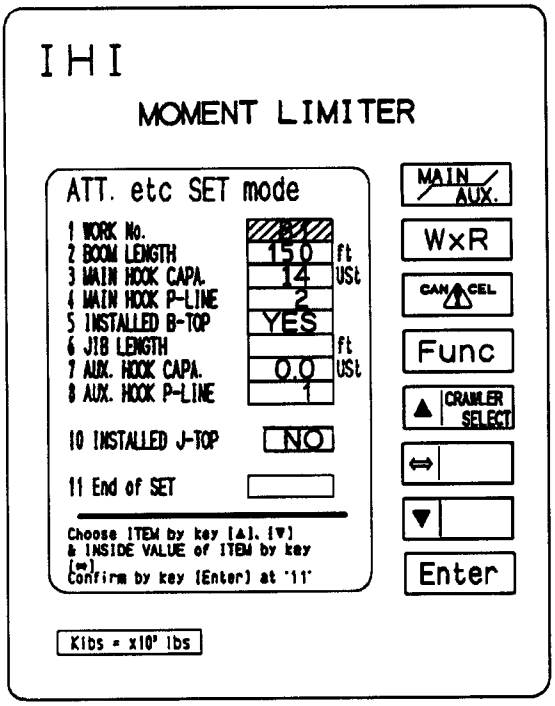
(2) Proceed to the setting menu from the function selection menu.

In the function selection menu, press the CRAWLER SELECT or ▼ key to move the cursor (reversed display) to "ATT. SET mode". Normally, the cursor is at "ATT. SET mode" when the function selection menu is displayed.

Press the Enter key once.

When pressing the Enter key, the menu is changed to the following setting menu.

Setting Menu



(3) Set the Working condition on the setting menu. Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "WORK NO." The item with the cell is reversed.

[1] Press the ⇔ key to set the value of the current attachment for "WORK NO."

Work No. Luffing tower crane 81

See Work Number Chart on page 1-53.1

Each time the ⇔ key is pressed, the data included in the specification are displayed in order. Select the proper work number.

[2] Setting of the boom length

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "BOOM LENGTH". Press the ⇔ key to set the proper value for the length of the current boom. Each time the ⇔ key is pressed, the boom length data included in the specification are displayed in order.

[3] Setting of the main hook capacity

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "MAIN HOOK CAPA." Press the ⇔ key to set the value of the current hook capacity.

Each time the ⇔ key is pressed, the main hook capacity data included in the specification are displayed in order. If the main hook is not installed, select "0.0".

[4] Setting of the parts of line for the main hook

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "MAIN HOOK P-LINE". Press the ⇔ key to set the parts of line for the current main hook. Each time the ⇔ key is pressed, the "parts of line" data included in the specification are displayed in order. If the main hook is not installed, select "1".

[5] Setting of the boom top sheave

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "INSTALLED B-TOP". If the top sheave is mounted, select "YES". If the top sheave is not mounted, select "NO". Whether the top sheave is used or not affects the rated overall lifting load. Select the condition appropriate to the actual machine.

[6] Setting of the jib length

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "JIB LENGTH". Press the ⇔ key to set the value of the current jib length.

Each time the ⇔ key is pressed, the jib length data included in the specification are displayed in order. On the luffing tower crane, the hook which is mounted on the tower jib is the main hook.

[7] Setting of the auxiliary hook capacity

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "AUX. HOOK CAPA.". Press the ⇔ key to set the "0.0".

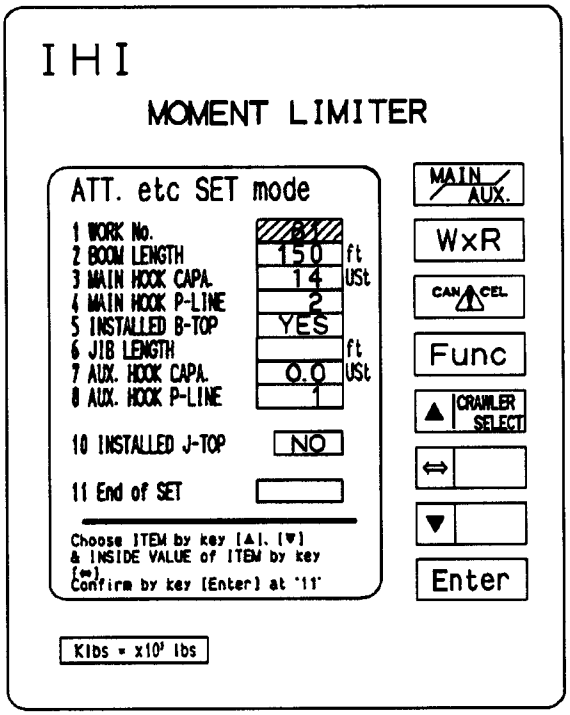
[8] Setting of the parts of line for the auxiliary hook

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "AUX. HOOK P-LINE". Press ⇔ the key to set the "1" part of line.

[10] Setting of the jib top

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "INSTALLED J-TOP". Press the ⇔ key to set the "NO". Jib top cannot be set.

Setting Menu



(4) Check of the set values

Make sure that the values set at the aforementioned [1] ~ [10] are set to the crane configuration.

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET" and press the Enter key.

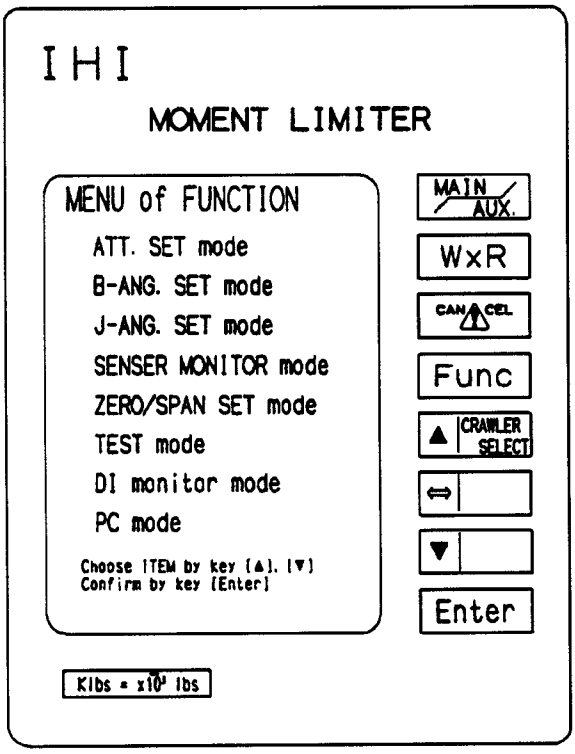
When pressing the Enter key, the displayed values are stored as the new set data and the function selection menu is automatically displayed.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [1] ~ [10] are ignored and the function selection menu is automatically set without the data change.

When the CANCEL key is pressed, the working conditions are not changed. Be careful.

When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated) Press the Enter key again.

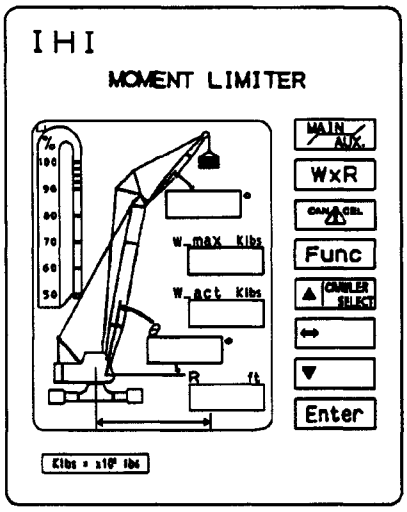
Function selection menu



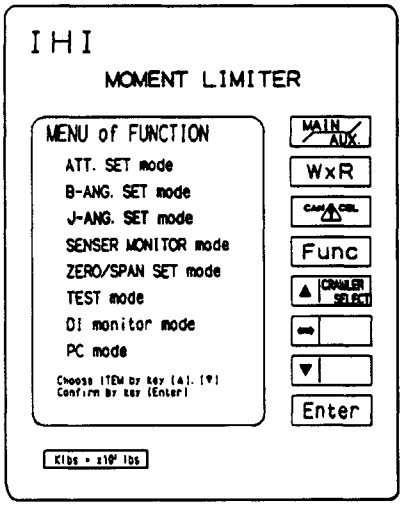
Press the Func or CANCEL key once to return from the function selection menu to the standard menu.

3. Optional auto stop or alarm angle setting

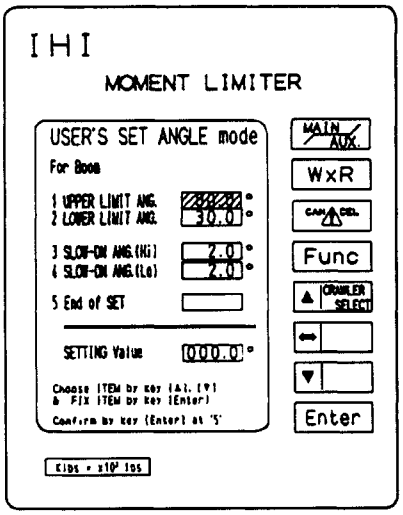
Standard Menu



Function Selection Menu



Optional Angle Setting Menu



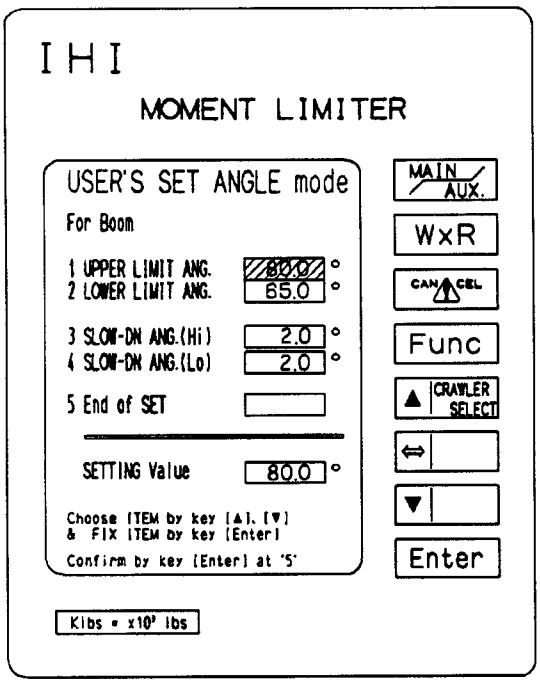
If you desire to set an optional angle, proceed from the function selection menu to the optional angle setting menu.

Press the [Func] key once if changing from the standard menu to the function selection menu.

Press the [CANCEL] or [Func] key once if changing from the function selection menu to the standard menu.

(1) If changing from the function selection menu to the optional angle setting menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor (reverse display) to "B-ANG. SET mode". Then, press the [Enter] key.

Optional Angle Setting Menu



(2) Setting of the boom optional upper limit angle

[1] Press the ▲CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "UPPER LIMIT ANG." Normally, the cursor is at "UPPER LIMIT ANG." when the optional angle setting menu is displayed.

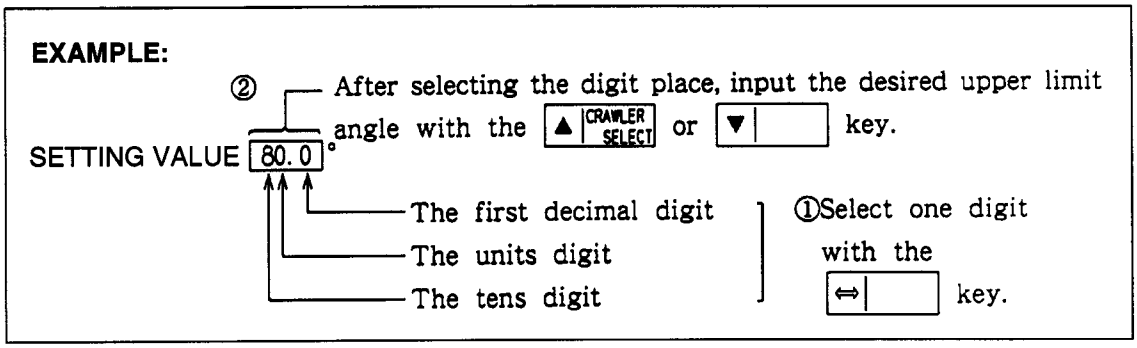
[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

In case in editing mode, change menu by key ⇔ choose value by **[▲], [▼]** provisional decision by Enter

[4] After moving the cursor to the desired digit, press the ▲CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "8" to the tens digit, and so the boom optional upper limit angle is set to 80.0°. Maximum upper limit angle is 90.0° .

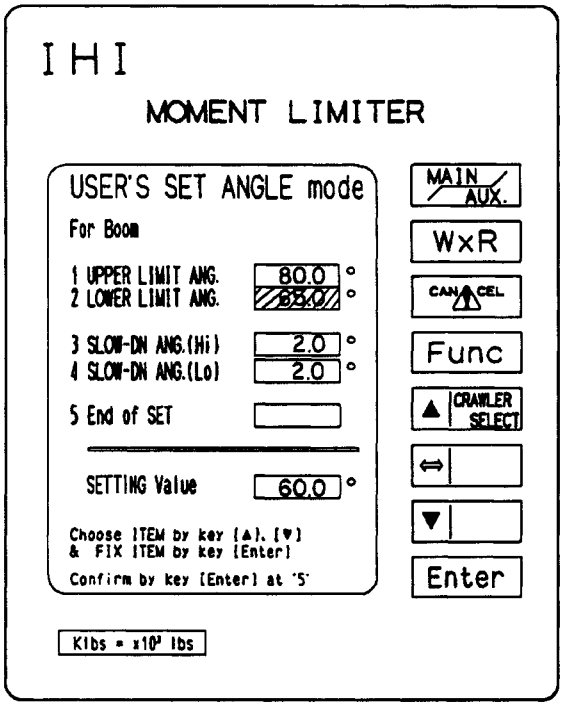
[5] After setting the boom optional upper limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "UPPER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the boom has reached the set upper limit angle (80° in the above example), the alarm sounds and the boom hoisting stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached 90°, the boom stops automatically.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

ML-D3A

Optional Angle Setting Menu



(3) Setting of the boom optional lower limit angle

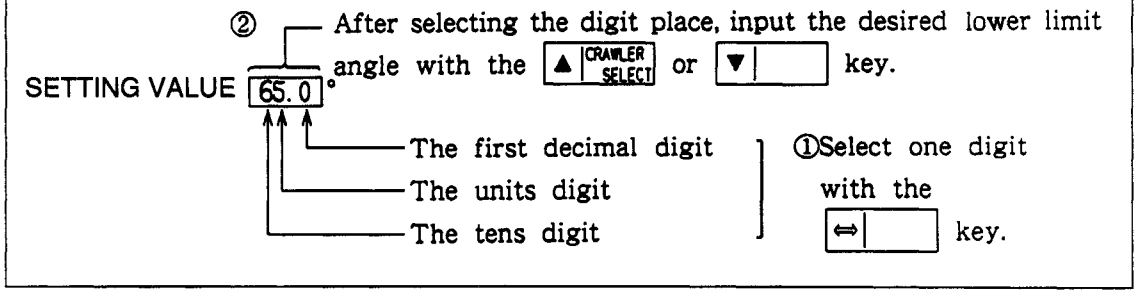
[1] Press the CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "LOWER LIMIT ANG."

[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



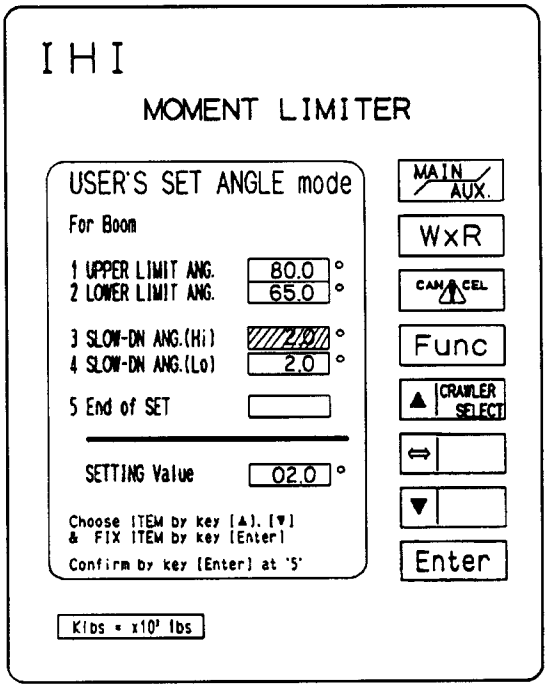
In the above example, "0" is inputted to the first decimal digit, "5" to the units digit and "6" to the tens digit, and so the boom optional lower limit angle is set to 65.0° . Minimum lower limit angle is 60.0° .

[5] After setting the boom optional lower limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "LOWER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the boom has reached the set lower limit angle (65° in the above example), the alarm sounds and the boom lowering stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached the lower limit angle of 60°, the boom stops automatically.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

Optional Angle Setting Menu



(4) Setting of the upper limit gentle operation angle of boom

This function sets the optional angle at which the gentle operation (slow-down) starts before the boom stops automatically when the boom is hoisting.

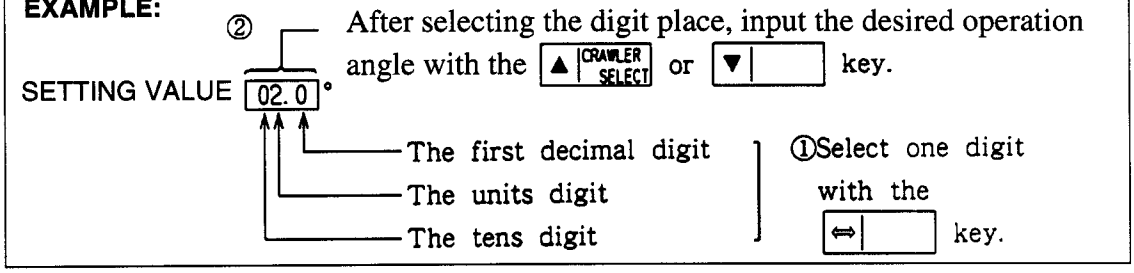
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Hi)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



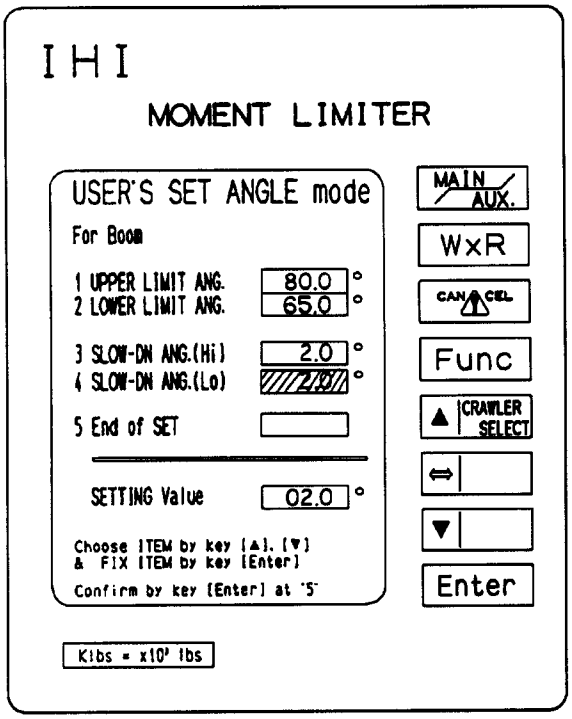
In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit, and so the upper limit slow-down angle is set to 2.0°. If the slow-down operation is not necessary, set the angle 0.00 Standard minimum slow-down angle is 2.0°.

[5] After setting the upper limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Hi)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (2), the boom optional upper limit angle is set to 80°, and in the above example, the upper limit slow-down operation angle is set to 2°. In such a case, the boom hoisting speed slows down when the boom angle is 78° and the boom hoisting stops automatically and the alarm sounds when the boom angle is 80°.

If the machine is without the automatic stop function, the hoisting speed slows down at the boom angle 78° and the alarm sounds at the boom angle 80°. The boom hoisting stops automatically at the boom angle 90°.

ML-D3A

Optional Angle Setting Menu



(5) Setting of the lower limit gentle operation angle of boom

This function sets the optional approach angle at which the gentle operation (slow-down) starts before the boom stops automatically when the boom is lowering.

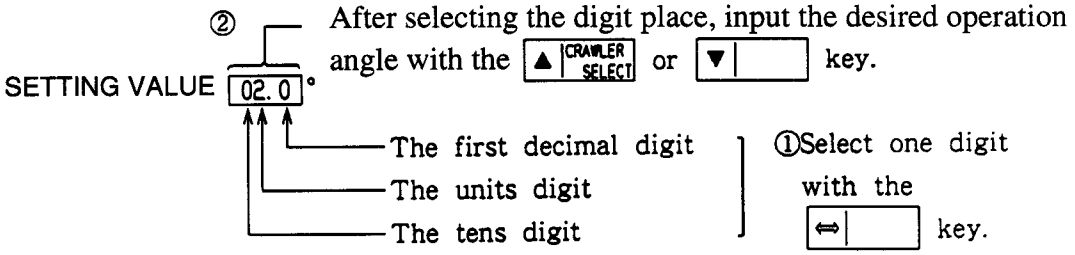
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Lo)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:

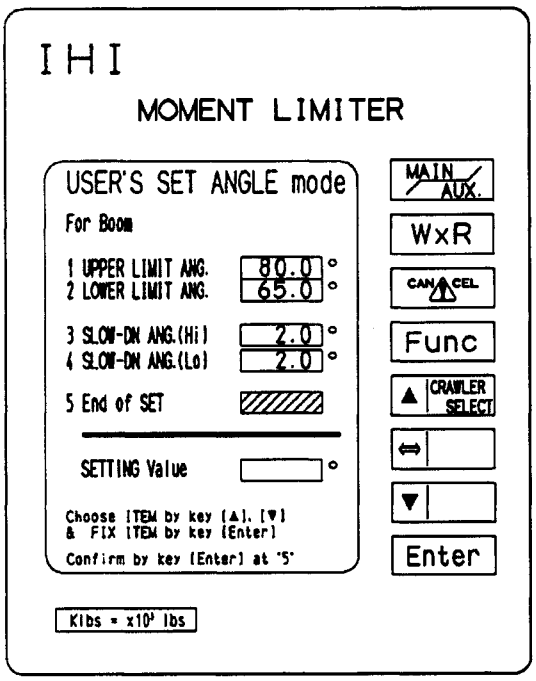


In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit, and so the boom lower limit slow-down angle is set to 2.0° . If the slow-down operation is not necessary, set the angle 0.00 Standard minimum slow-down angle is approximately 2.0° .

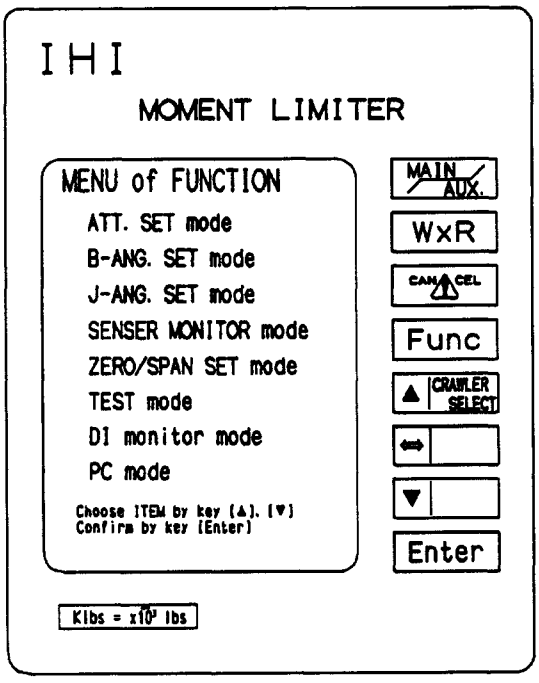
[5] After setting the optional lower limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Lo)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (3), the optional lower limit angle is set to 65°, and in the above example, the lower limit slow-down operation angle is set to 2°. In such a case, the lowering speed slows down when the boom angle is 67° and the boom lowering stops automatically and the alarm sounds when the boom angle is 65°.

If the machine is without the automatic stop function, the lowering speed slows down at the boom angle 67° and the alarm sounds at the boom angle 65°. The boom lowering stops automatically at the rated boom lower limit angle.

Optional Angle Setting Menu



Function Selection Menu



(6) Decision for angle setting

[1] Make sure that the proper values are set in the above setting procedure of the items (2) ~ (5):

- The value of the boom upper limit angle
- The value of the boom lower limit angle
- The value of the upper limit slow-down operation angle
- The value of the lower limit slow-down operation angle

[2] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET".

[3] Press the Enter key. The data on the screen are updated and the menu is automatically returned to the function selection menu.

[4] If you desire to stop setting, press the CANCEL key before pressing the Enter key.

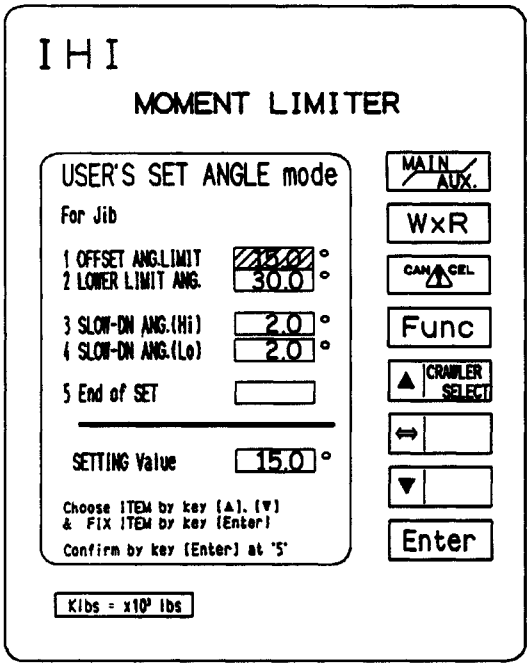
If you desire to change the function selection menu to the standard menu, press the Func or CANCEL key once.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [2] ~ [5] (USER'S SET ANGLE mode for Boom) are ignored and the function selection menu is automatically set without the data change.

When the CANCEL key is pressed, the working conditions are not changed. Be careful.

When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated). Press the Enter key again.

Optional Angle Setting Menu



(7) Setting of the optional offset angle limit for jib

[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "OFFSET ANG. LIMIT" Normally, the cursor is at "OFFSET ANG. LIMIT" when the optional angle setting menu is displayed.

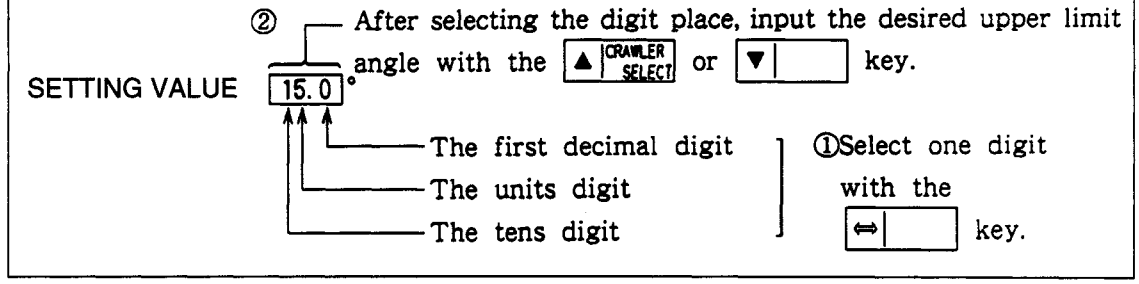
[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

In case in editing mode, change menu by key ⇔ choose value by [▲], [▼] provisional decision by Enter

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



In the above example, "0" is inputted to the first decimal digit, "5" to the units digit and "1" to the tens digit, and so the jib optional offset limit angle is set to 15.0°. Set this angle to 10.0° if not necessary.

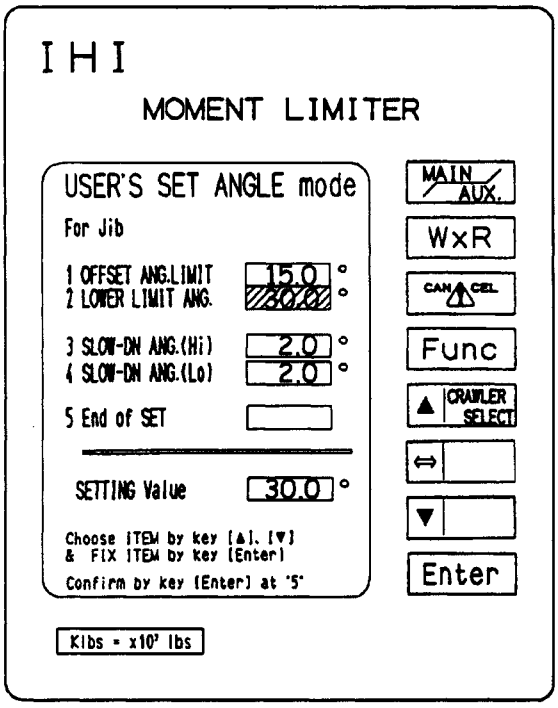
[5] After setting the jib optional offset limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "OFFSET ANG. LIMIT" column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the jib has reached the set jib offset limit angle (15° in the above example), the alarm sounds and the jib hoisting stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the jib has reached the rated jib offset angle of 10°, the jib stops automatically.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

ML-D3A

Optional Angle Setting Menu



(8) Setting of the jib optional lower limit angle

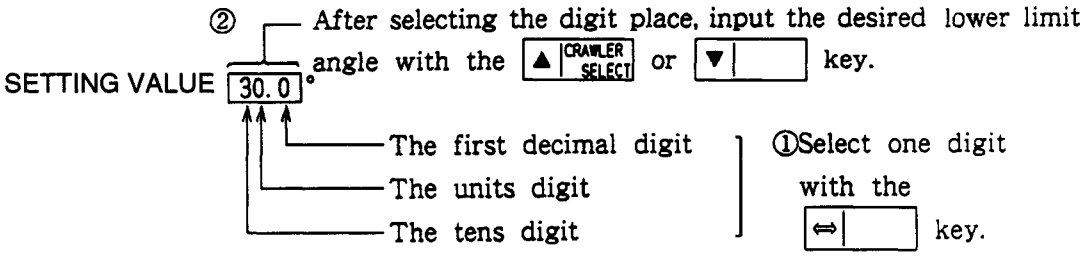
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed display) to "LOWER LIMIT ANG."

[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



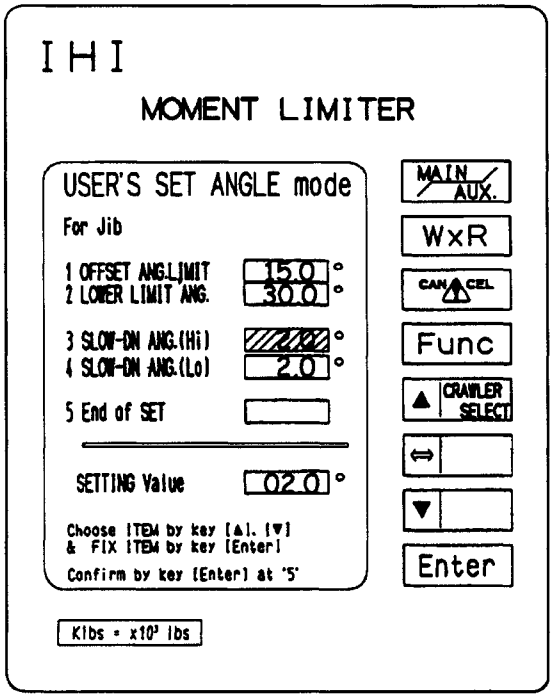
In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "3" to the tens digit, and so the jib optional lower limit angle is set to 30.0° . Set this angle to 15.0° or lower if not necessary.

[5] After setting the jib optional lower limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "LOWER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the jib has reached the set lower limit angle (30° in the above example), the alarm sounds and the jib lowering stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the jib has reached the rated 15°, the jib stops automatically. When the jib has reached the jib rated lower limit angle regardless of the jib optional lower limit angle, it stops automatically. The jib rated lower limit angle is different according to the combination of the boom length and jib length.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

Optional Angle Setting Menu



(9) Setting of the upper limit gentle operation angle of jib

This function sets the optional approach angle at which the gentle operation (slow-down) starts before the jib stops automatically when the jib is hoisting.

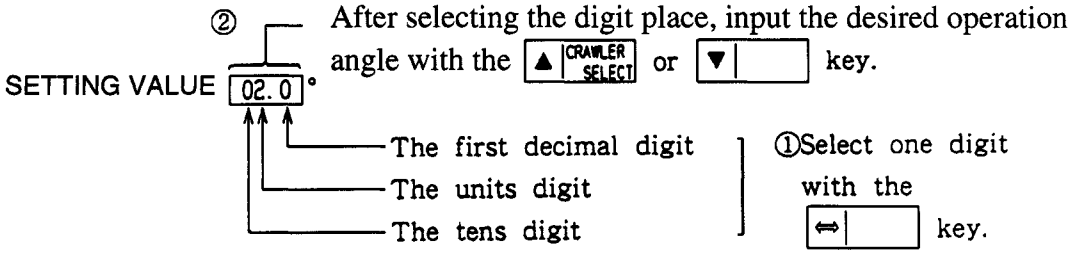
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Hi)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:

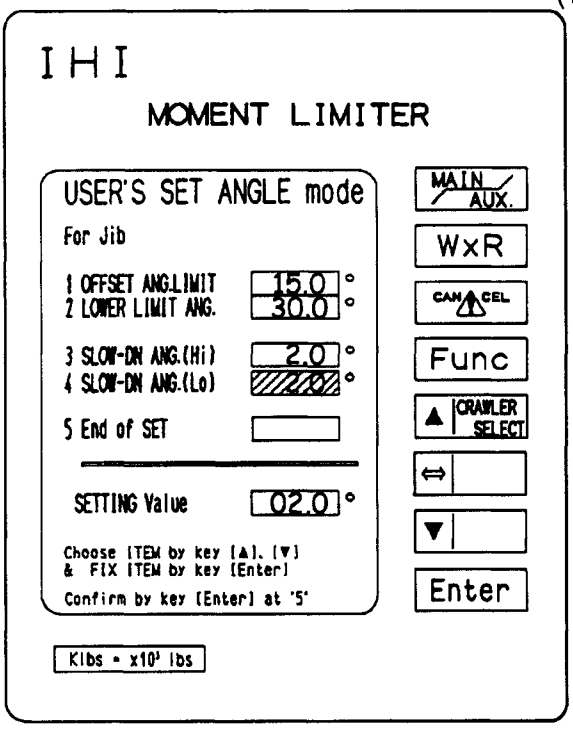


In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit, and so the upper limit slow-down angle is set to 2.0° . If the slow-down operation is not necessary, set the angle 0.00 Standard minimum slow-down angle is 2.0° .

[5] After setting the upper limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Hi)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (7), the jib optional offset angle is set to 15°, and in the above example, the upper limit slow-down operation angle is set to 2°. In such a case, the jib hoisting speed slows down when the jib offset angle is 17° and the jib hoisting stops automatically and the alarm sounds when the jib offset angle is 15°.

If the machine is without the automatic stop function, both the hoisting speed slows down at the jib offset angle of 17° and the alarm sounds. But when the jib offset angle has reached 10°, the jib hoisting stops automatically.

Optional Angle Setting Menu



(10) Setting the lower limit of gentle operation angle of jib

This function sets the optional approach angle at which the gentle operation (slow-down) starts before the jib stops automatically when the jib is lowering.

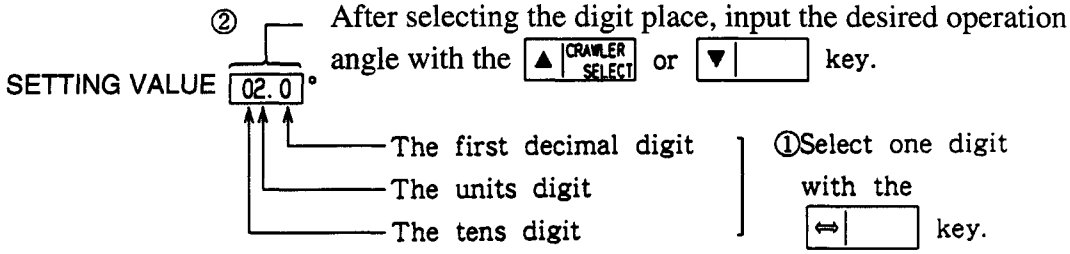
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Lo)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



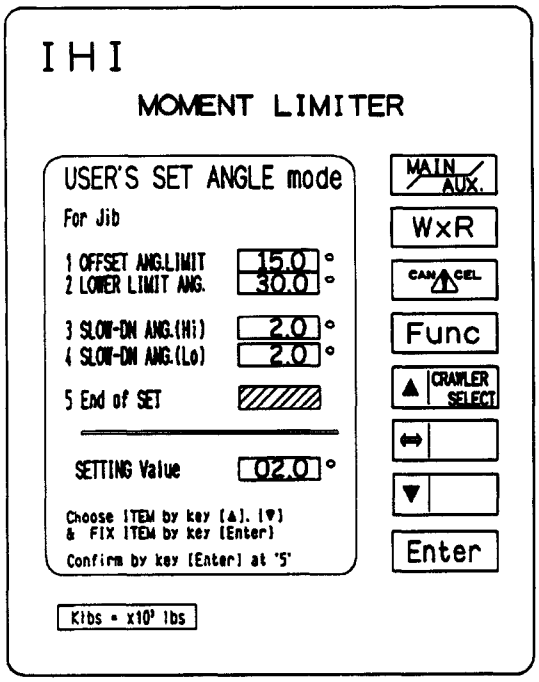
In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit, and so the boom lower limit slow-down angle is set to 2.0° . If the slow-down operation is not necessary, set the angle 0.00 Standard minimum slow-down angle is approximately 2.0° .

[5] After setting the optional lower limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Lo)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (8), the optional lower limit angle is set to 30°, and in the above example, the lower limit slow-down operation angle is set to 2°. In such a case, the lowering speed slows down when the jib angle is 32° and the jib lowering stops automatically when the jib angle is 30°.

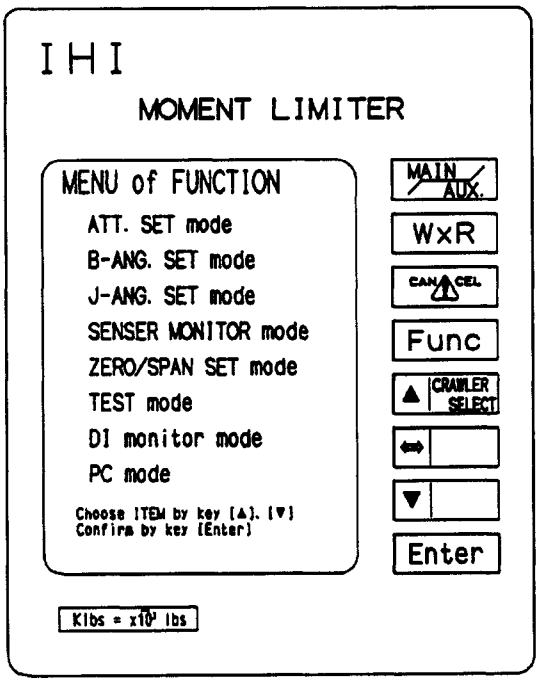
If the machine is without the automatic stop function, the lowering speed slows down at the jib angle 32° and the alarm sounds at the jib angle 30°. When the jib angle has reached the rated jib lower limit angle, the jib lowering stops automatically.

ML-D3A

Optional Angle Setting Menu



Function Selection Menu



(11) Decision for angle setting

[1] Make sure that the proper values are set in the above setting procedure of the items (7) ~ (10):
- The value of the jib offset limit angle
- The value of the jib lower limit angle
- The value of the jib slow-down operation angle (Hi)
- The value of the jib slow-down operation angle (Lo)

[2] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET".

[3] Press the Enter key. The data on the screen are updated and the menu is automatically returned to the function selection menu.

[4] If you desire to stop setting, press the CANCEL key before pressing the Enter key.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [7] ~ [10] (USER'S SET ANGLE mode for Jib) are ignored and the function selection menu is automatically set without the data change.

When the CANCEL key is pressed, the working conditions are not changed. Be careful.

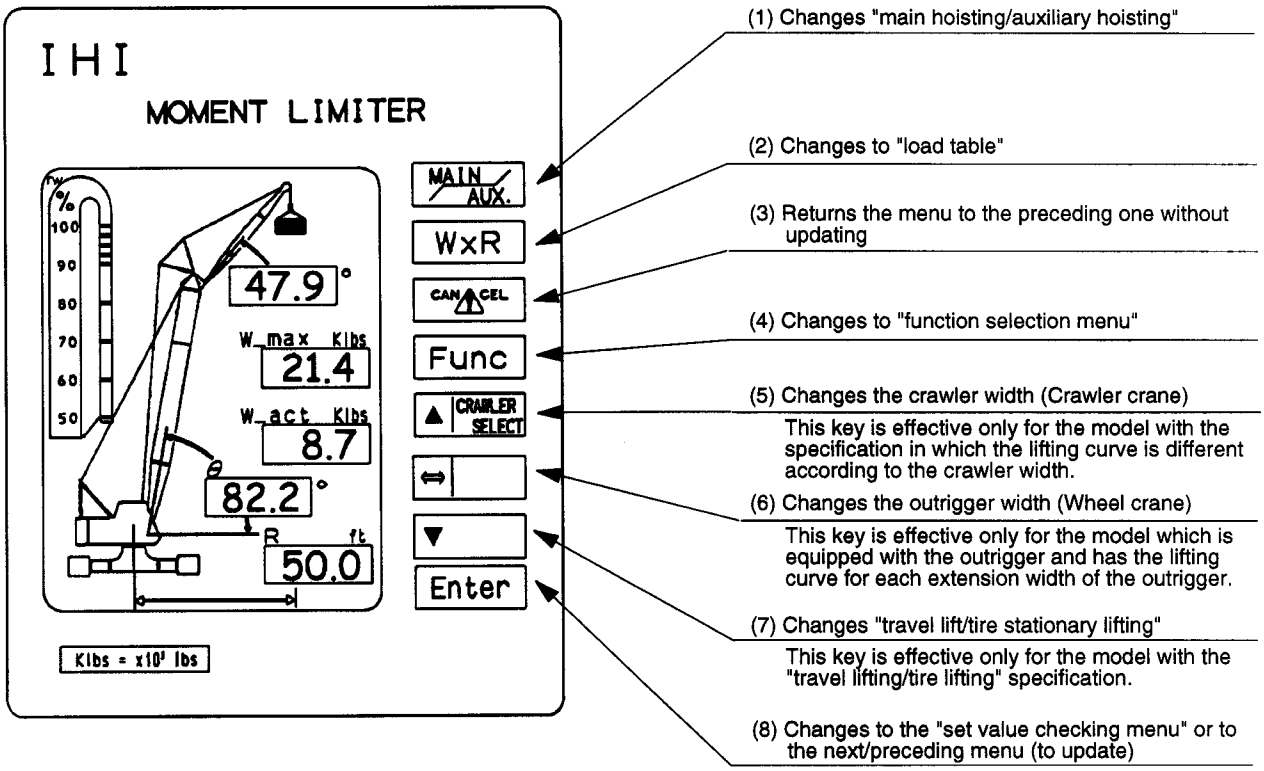
If you desire to change the function selection menu to the standard menu, press the Func or CANCEL key once.

When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated). Press the Enter key again.

ML-D3A

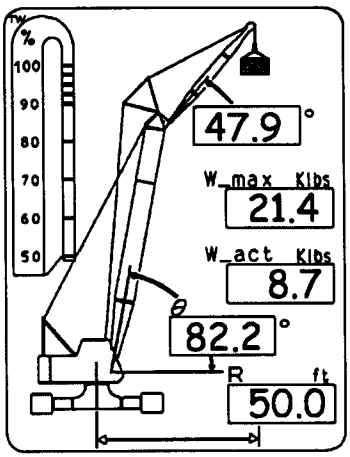
4. Standard menu and operation keys

Standard Menu



(1) Main/auxiliary selector key switch [MAIN AUX]

Press the main/auxiliary selector key switch [MAIN AUX], the main hoisting work menu is changed to the auxiliary hoisting work menu. Press the [MAIN AUX] key again, and the menu is changed to the main hoisting work menu. Select a proper menu according to the actual crane configuration. It is not permitted to lift loads with the main hook and the jib or auxiliary hook at the same time. There is no change of the main hoist and auxiliary hoist at the tower crane.

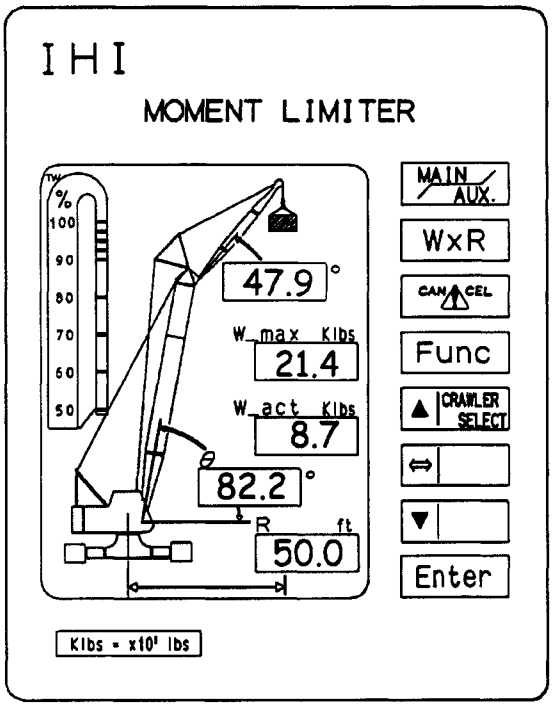


Tower crane work

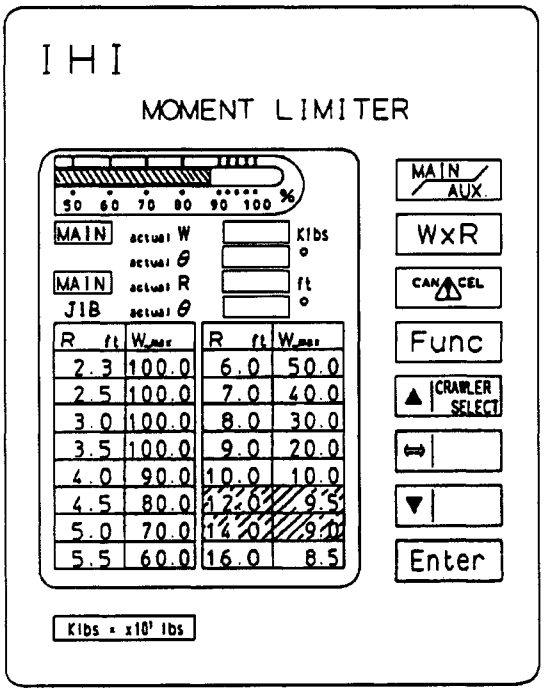
The values in the display unit are reference values required for the explanation. They have nothing to do with an actual lift.

ML-D3A

Standard Menu



Load Table (for "MAIN")



(2) The selector switch to the load table [WxR]

[1] Press the [WxR] switch once on the standard menu, and the load table is displayed. On the load table display, press the [WxR] or [CANCEL] key once, and the standard menu appears.

The load table displays the following six items:

- Actual load for the main or auxiliary hoisting . . . . . Klbs
- Boom angle . . . . . °
- Working radius for the main or auxiliary hoisting . . . . . Ft.
- Jib angle . . . . . °
- Working radius/allowable load table . . . . . Ft. Klbs
- Load ratio . . . . . %

The following illustration is the "MAIN" table. If you want the "AUX." table, press the [MAIN AUX] key switch.

[2] Working radius/allowable load table

In the load table, the shaded area of the working radius/allowable load table indicates the current crane working radius and allowable load.

The actual working radius is 12.3 ft. and is within the shaded area, 12.0 ft. ~ 14.0 ft. The operator can view the current working radius and allowable load according to this table.

To display the data after 16.0 ft. for the working radius, press the [⇔] key once. The next data are displayed. To return to the original data, press the [⇔] key.

[3] The upper bar graph on the screen indicates the ratio (load ratio) of the crane's current load (actual value) and to the allowable safe working load.

(3) Cancel key [CANCEL]

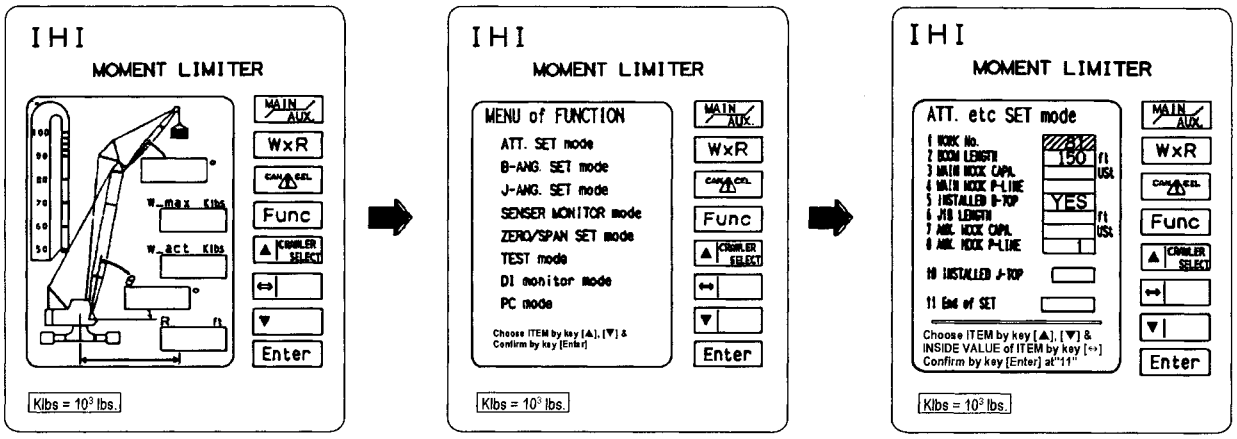
Press this key in the middle of setting for the crane working conditions or optional angle as mentioned above, the setting operation stops and the original condition before setting is restored.

(4) Function key - to change to the function selection menu [Func]

When the working conditions have to be set, change the standard menu to the function selection menu and then select the desired items in the function selection menu with the cursor.

Press the [Func] once in the standard menu and the function selection menu is displayed. In the function selection menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor (reversed cell) to the desired item.

For example, move the cursor to "ATT. SET mode" and press the [Enter] key once. Then, "ATT. etc. SET mode" (working radius setting mode) is displayed.



Standard Menu **Function Selection Menu** **Setting Menu (ATT. etc. SET mode)**

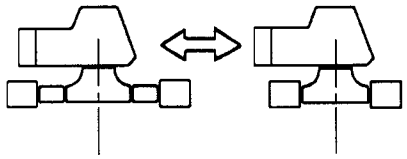
Refer to "(2) Setting of the working conditions" for how to set the working conditions and how to return from the setting menu to the function selection menu. If the function selection menu has to be changed to the standard menu, press the [Func] or [CANCEL] key once.

(5) Crawler select key - to change the crawler width [▲ CRAWLER SELECT]

In the crawler crane, this key is effective only for the model which rated overall lifting load is changed according to the crawler width.

Press the [▲ CRAWLER SELECT] key once in the standard menu, and the illustrated crawler width is retracted. Press the key again, and the crawler width is extended.

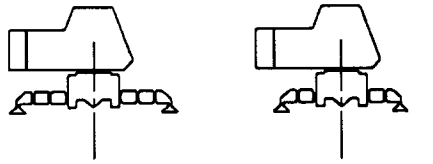
Change of Crawler Width



When extended (EXT.) **When retracted (RET.)**

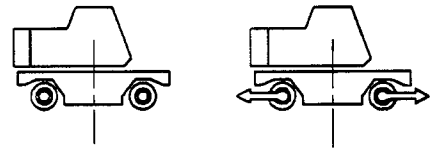
On the machine without the crawler width change specification, set the crawler width to the extended condition. If the crawler width is retracted, "E114" is displayed and the alarm sounds. This key switch does not work on the wheel type.

Change of Outrigger Width



When extended (EXT.) **When retracted (RET.)**

(6) [⇔] This key is used for setting the working conditions and changing information. This key switch works when tires are used for the travelling unit. Press the key once, and the illustrated outrigger width is retracted. Press the key again, and the outrigger width is extended. On the machine with outriggers, set the displayed picture to the machine current condition. On the crawler crane, this switch is used for setting the working conditions, etc.



Tire Stationary Lifting **Travel Lifting**

(7) [▼] This key is used for setting the working conditions and scrolling down through the menus. This key switch works when tires are used for the travelling unit. Press the key once, and the displayed picture is changed to "travel lifting". Press the key again, and the displayed picture is changed to "tire stationary lifting". On the crawler crane, this switch is used for setting the working conditions, etc.

(8) This key is used to change to "set value checking menu" or to the next/preceding menu (to update)

Press the [Enter] key once in the standard menu, and the "Attachment setting" menu, which was set in the above-mentioned "ATT etc. SET mode" menu, is displayed.

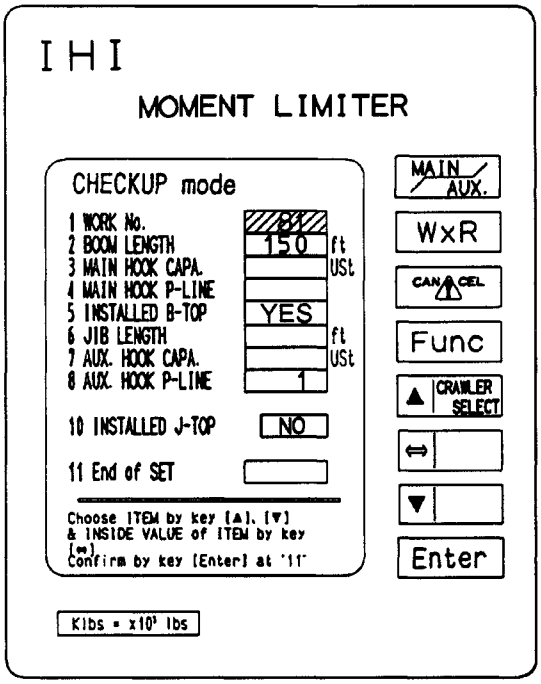
Press the [Enter] or [CANCEL] key in the setting menu, and the standard menu is restored.

In the "Set value checking" menu, the operator can check the following values which were set in "Setting of the working conditions":

1. Work No.
2. Boom length
3. Main hook capacity
4. Part of line for main hook
5. Jib length
6. Auxiliary hook capacity
7. Part of line for auxiliary hook
8. Jib offset angle

ML-D3A

Set Value Checking Menu



In this menu, the operator can check the following nine items which are set currently:

1. Work No.
2. Boom length
3. Main hook capacity
4. Part of line for main hook
5. Installed boom top (YES)
6. Jib length
7. Auxiliary hook capacity
8. Part of line for auxiliary hook
9.
10. Installed jib top (NO)

After checking the data, press the Enter or CANCEL key. The standard menu is restored.

4. Error messages and error codes

If a working condition inapplicable to the specification is set or if the sensor output is defective in the overload prevention device (moment limiter), the error is displayed on the screen.

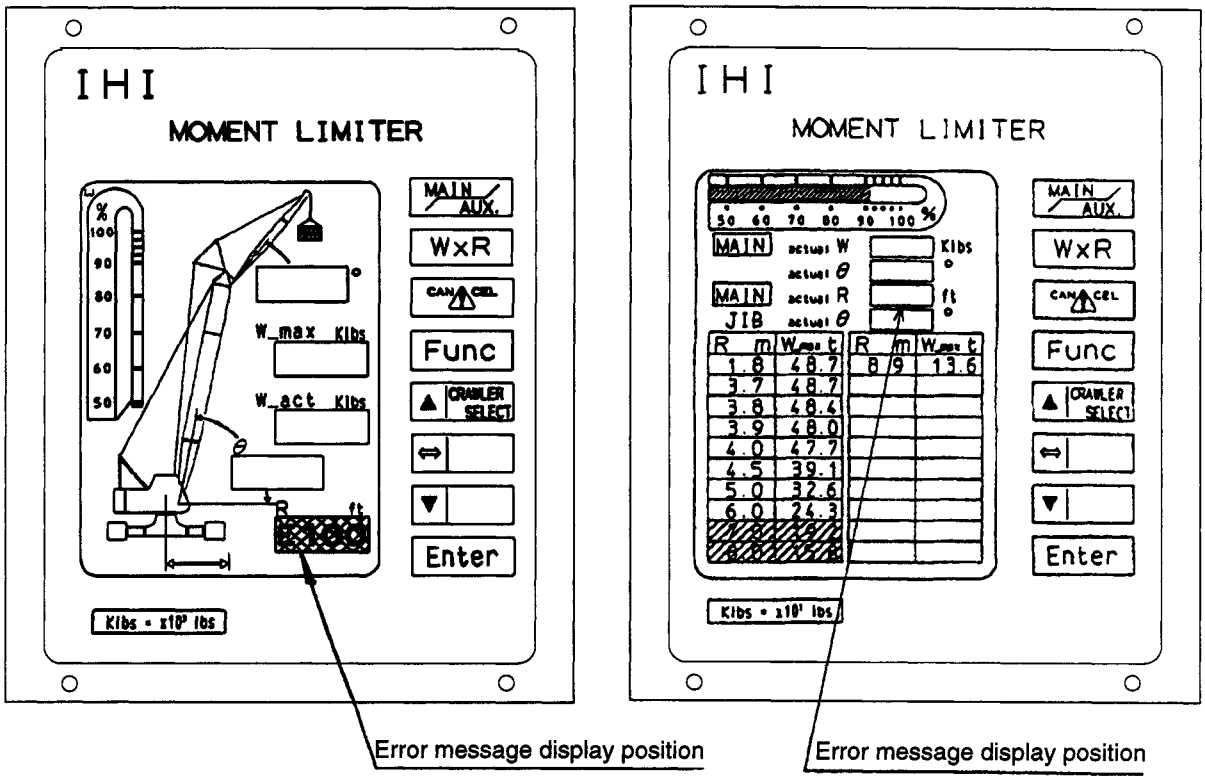
The error is displayed as "Exxx" in the working radius column. The error display blinks and an alarm is heard. Refer to the illustrations on the next page.

The error codes and remedial measures are shown in the following table.

Error Code Table

Error No.	Causes	Check and Remedial Measures
EEEE	DSP (CPU) is defective.	Should repair or replace
E100	Boom angle detector is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the angle meter
E102	The load cell sensor is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the load cell
E114	The load table does not exist.	Check the set data Check the crawler width, etc.
E120	The communication is not proper between the CPU and the display unit.	Should repair or replace
E121	The memory is defective in the CPU.	Should repair or replace
E122	The internal mode selector LS is defective.	Should repair or replace

ML-D3A



In both of the above illustrations, the error message is displayed as "E100" on the working radius column. "E100" blinks and an alarm is heard. Refer to "Error Code Table" for the causes and remedial measures of the errors.

Caution handling overload prevention device (moment limiter)

1. When starting the machine, auto stop sometimes works. Turn the bypass switch to released side once and start the work.
2. If load reaches 90% of the allowable value, the warning buzzer sounds intermittently.
3. If load exceeds the allowable value, the warning buzzer sounds continuously and the auto stop device works. The operation for the dangerous side, namely, hoisting the load and lowering of the main boom (jib) cannot be done.
4. When the auto stop device works, return the crane to the safe area, the automatic stop is released in about 2 seconds and all the operations can be done.
5. If the boom is positioned over the upper limit angle or beneath lower limit angle set optionally, a warning sound occurs.
6. If the boom is beneath the specified angle, the buzzer sounds and the crane stops automatically, even if a load is not suspended.
7. Set the overload prevention device according to the working conditions.

   (1) Select the Work No. of the setting screen according to the following table:

Work No.	Work Mode
11	Crane
19	Crane (post)
71	Luffing jib crane
81	Luffing tower crane

   (2) Select the item mode according to the machine actual conditions.

   (3) After setting is ended, return to the standard screen.

8. The boom/jib selector switch returns to the boom lifting side automatically if the power of the overload prevention device is turned off. Check the machine and set the mode.
9. Refer to the description for handling the moment limiter for details.

NOTICE

1. **Before starting operation, change the display to the setting screen and make sure that the crane status is set to the proper set values.**
2. **Check the operation of the auto stop device without load.**
3. **With alarm type overload prevention device, if buzzer sound becomes continuous, the crane should be immediately returned to a safe area.**

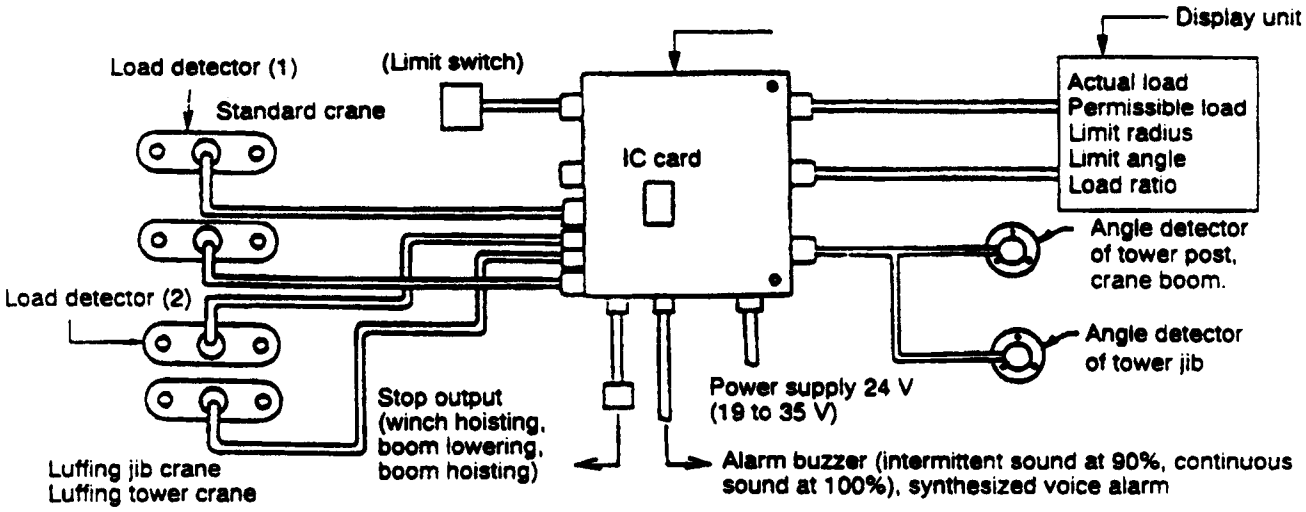
OPERATION OF OVER LOAD PREVENTION DEVICE ML-E MODEL (MOMENT LIMITER) OPTION FOR LUFFING MACHINE

Outline (ML-E automatic stop type/alarm type)

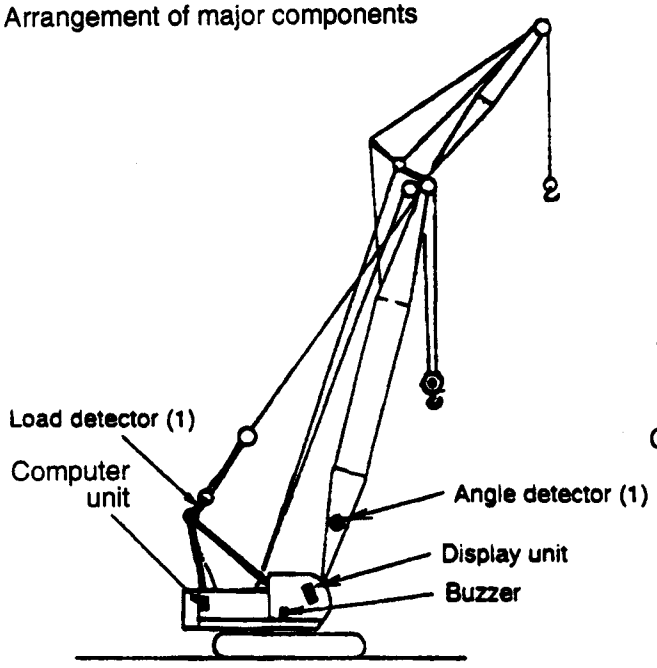
The moment limiter consists of a computer unit, a display unit, various sensors such as an angle detector and a load detector, an alarm buzzer, an automatic stop circuit etc. When the actual load reaches 90% of the permissible load, the buzzer generates an intermittent sound as an alarm. If the actual load reaches 100% of the permissible load, the buzzer generates a continuous sound. At the same time, load hoisting or boom lowering of the crane is stopped. In the alarm type, automatic stop is not done.

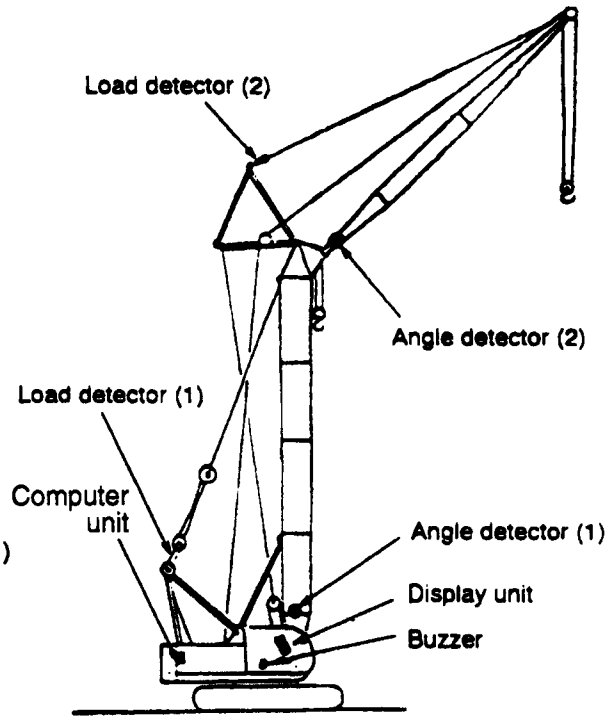
For releasing the automatic stop status, lower the load or hoist the boom until the crane returns to the safe zone, then press the reset button. Even in the automatic stop status, load lowering and boom are allowed.

In the alarm type, when the buzzer generates a continuous sound, hoist the boom and lower the load at once.

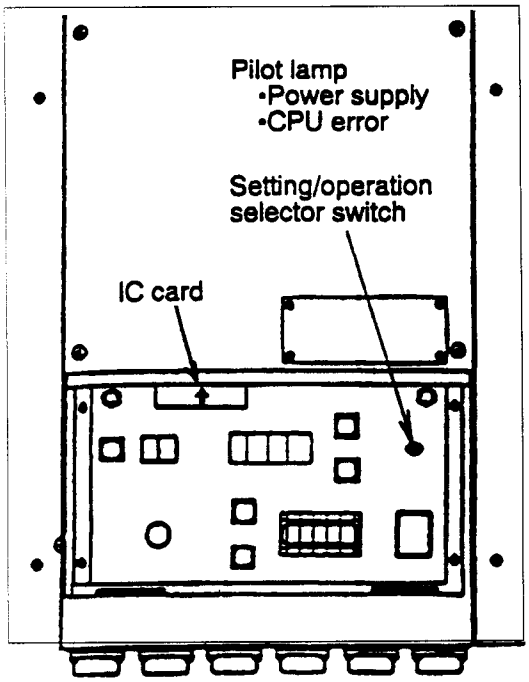


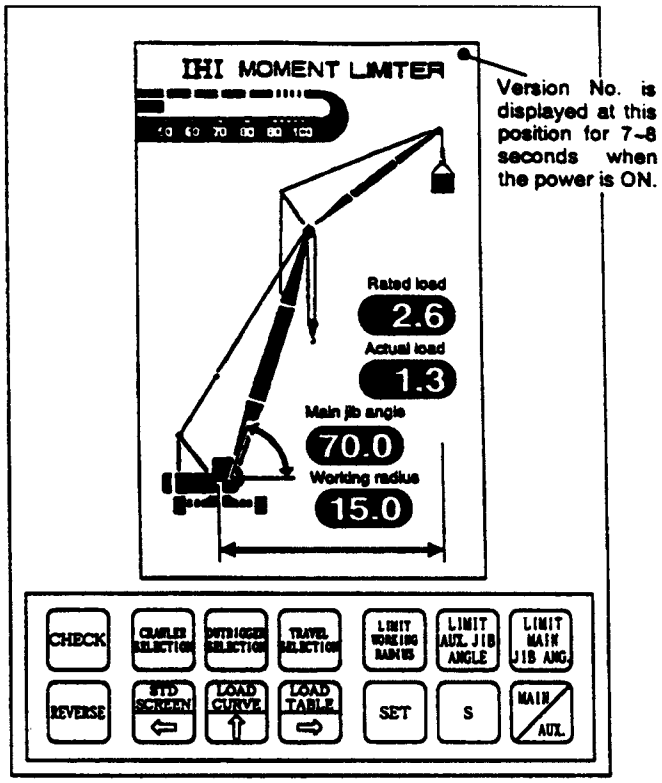
Arrangement of major components





Computer and display units





Standard screen

Operating procedure

For New Setting		For Partial Change of Setting		Once Power Supply is Turned Off	
①	Cut off the power supply (with the engine key or moment limiter switch) and insert the IC card into the computer unit.	①	Set the crane work mode (work setting mode).	①	Once the power supply has been cut off in the auxiliary winch hoisting status, the main winch hoisting status is automatically set when turning on the power supply again. Auxiliary winch hoisting, selection must be made each time.
②	Turn on the power supply and set the setting/operation selector switch to the operation side.	②	Make changes in any item mode.	②	Select the following as required: Crawler selection (crawler width) Outrigger selection (wheel) Traveling condition (wheel)
③	On the display unit, set the following item modes: 01 Boom length 02 Main hook capacity 03 Part line of main hook 04 Top sheave 05 Jib length 06 Auxiliary hook capacity 07 Part line of auxiliary hook 08 CR jib offset angle 09 TW auxiliary jib 10 Boom upper limit angle 11 Boom lower limit angle 12 TW jib offset angle 13 TW jib lower limit angle 14 Boom upper limit gentle operation angle 15 Boom lower limit gentle operation angle 16 TW jib upper limit gentle operation angle 17 TW jib lower limit gentle operation angle	③	Press the CHECK switch.		
④	Press the CHECK switch.	④	Select the following as required: Crawler selection (crawler width) Outrigger selection (wheel) Traveling condition (wheel)		
⑤	Select the following as required: Crawler selection (crawler width) Outrigger selection (wheel) Traveling condition selection (wheel) Main/Aux. selection				

How to set crane Work No. and Item Mode

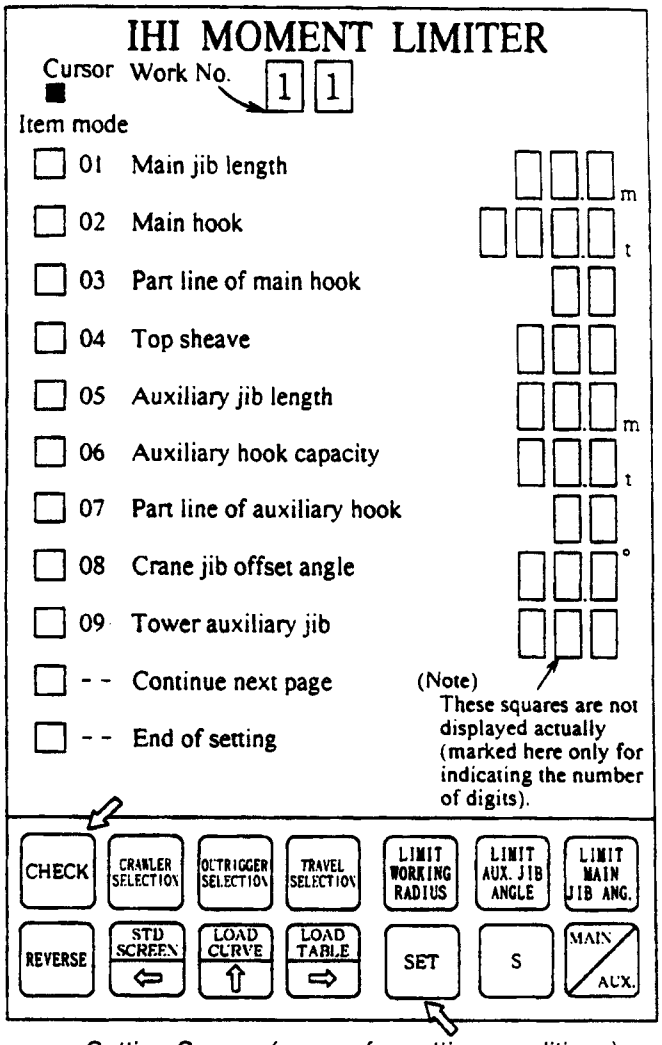
This operation is required without fail after boom or jib is changed, etc. However, attention should be paid during the mode setting operation because the moment limiter does not provide its original functions for ensuring safety.

1. Operation of switches in display unit:
   a. When pressing the [SET] and [CHECK] switches of the display unit in succession, the working condition setting screen appears. (If a time period of 5 seconds elapses between pressing of the "SET" switch and the "CHECK" switch, nothing takes place. So, press these switches in order again.)
   b. When the screen display is changed over to the crane Work No., the cursor is positioned at the topmost position and the Work Mode No. at the left end is usually at [1] [1]
2. Work No. setting method:

   If the work No. indicated on the caution plate of the operator seat does not match that of the actual machine, priority should be given to the latter. For No. matching, the [⇦] or [⇨] switch in the figure at right should be pressed.

   When pressing [⇦], the numeric value decreases by 1 at a time. When pressing [⇨], the numeric value increases by 1.

   (The numeric value remains the same even when keeping the switch pressed. Press the switch once at a time.)



Setting Screen (screen for setting conditions)

When pressing [⇨] once at [ ] [ ], the display changes to a larger work No. value sequentially.

When pressing [⇦] once at [ ] [ ], the display changes in reverse to the above.

Work No.	Work Mode	Work No.	Work Mode	Work No.	Work Mode
11	Crane 1	21	Clamshell	51	Floating clamshell
13	Crane (3rd drum use)	31	Lifting magnet crane	71	Luffing jib crane 1
19	Boom crane	41	Floating crane	81	Luffing tower crane luffing jib crane 2

Preparation for setting the working conditions

1. Confirmation of IC Card No.

   Usually, each machine has a single IC card in the computer unit. Only when the machine has two or more IC cards, the number of each IC card should be checked against the caution plate attached to the lid of the computer unit. Before introducing or taking out an IC card, be sure to cut off the power supply (with the engine key or auxiliary power switch). If an IC card is introduced or taken out without turning off the power supply, the card may be damaged.

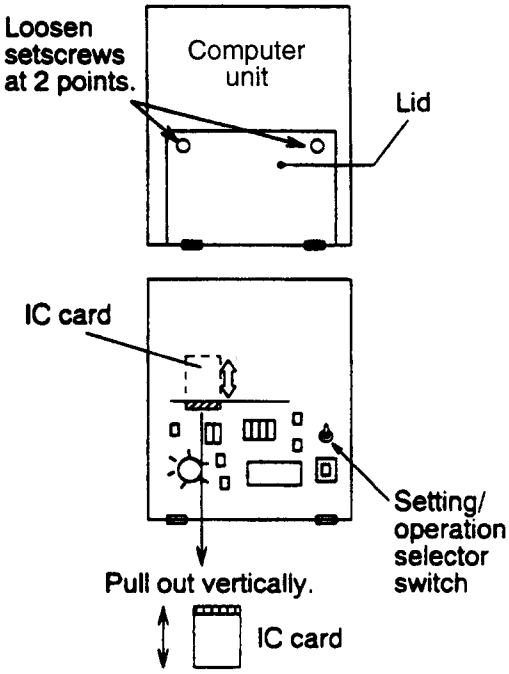
   a. Open the lid of the computer unit. Loosen the 2 setscrews and open the lid upward. The setscrews cannot be removed from the lid.

   b. Remove the screw and then remove the holding plate which prevents the IC card from falling off.

   c. Pull down the IC card vertically. Make sure that the code number attached to the IC card coincides with the marking in the caution plate attached to the back face of the opened lid.

   d. Return the IC card to the original position. Insert the IC card vertically. When the card is inserted to a certain point, set the holding plate with the screw to prevent the IC card from falling off. The leading end of each IC card serves as a plug-in connector. So, be sure to insert the card completely.

   e. The setting/operation selector switch at the right of the IC card must usually be turned to the operation side without fail.



2. After confirmation of the IC card number, turn on the power switch.

⚠ CAUTION

1. **Be sure to turn off the power supply before plugging in or unplugging the IC card.**
2. **In case the IC card is removed from the computer unit:**

   The leading end of the IC card serves as a connector to be plugged into the computer unit. The card must be handled carefully so as to be protected from dust, etc., as well as water. Please put into storage case and avoid direct sunlight or magnetic source.

3. **If a wrong IC is inserted is inserted, a serious accident such as tipping over or damage of the crane may occur. Make sure that the IC card is fit to the model and serial number. If there are two IC cards, use the one applicable to the specification of the machine.**

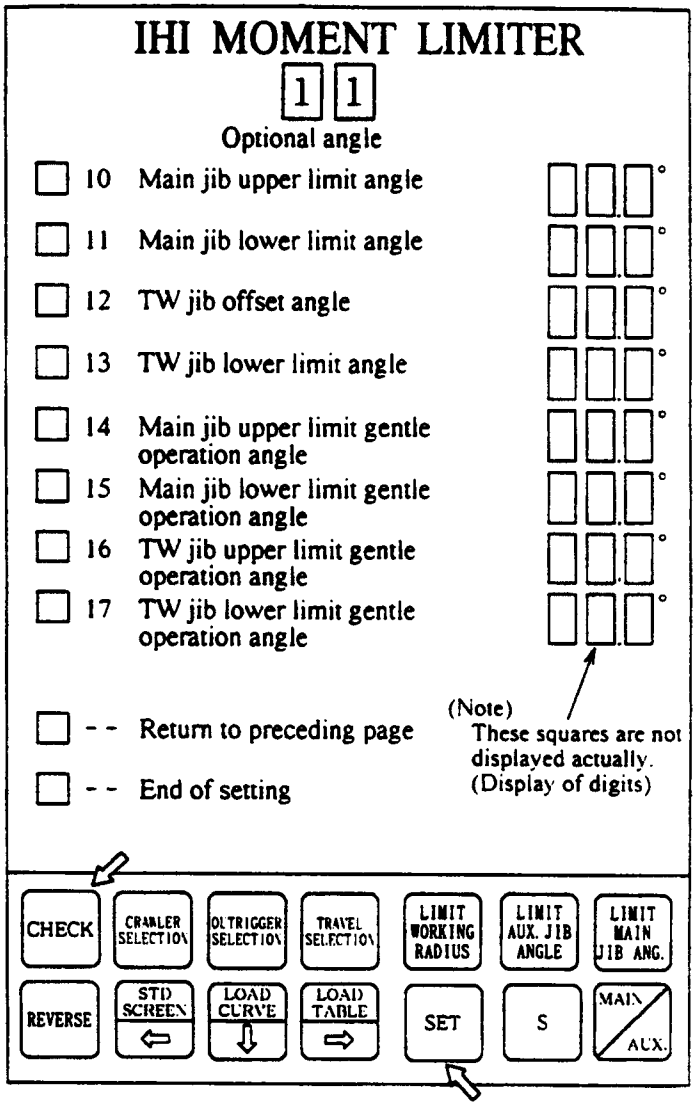
(Although the mark ☐ is not displayed, it is utilized for easier understanding of the explanation given below).

When Work No. is set, set the individual working condition.

Press the ⇩ to move the cursor to "01". It takes 3~4 seconds for the cursor to move from Work No. to "01", the boom length. Press the ⇩ twice, and the cursor moves to "02". When the cursor moves to "02", press the ⇩ to move it to Work. No. again.

Set the boom length. Set the boom length which is currently used in the machine. By pressing the switch, the value is indicated at each item in response to the initial Work No. Set the value on the right squares of the display unit in response to the working condition by pressing the ⇦ or ⇨.

Move the cursor downward by pressing the ⇩ and set the conditions in turn. Set the cursor to "Continued on Next Page" and press the CHECK switch, and the next page is displayed. Move the cursor downward by pressing the ⇩ and, at each item, set the working conditions by pressing the ⇦ or ⇨. At last, move the cursor to "End of Setting" and press the CHECK switch, and the standard menu is displayed. If you must return to the preceding page, set the cursor to "Return to Preceding Page" and press the CHECK switch.



Setting Screen (screen for setting conditions)

3. Work No., condition setting items and how to set the working condition:

Work No. is classified to 11~51 for the crane system, 71~81 for the luffing jib crane and luffing tower crane system. 01~17 are the items for the working conditions and, depending on Work No., it is not necessary to set some items. Two pages are prepared for setting. How to set the working conditions for Work No. 11 standard crane is explained on the next page and after. Directly move the ⇩ cursor to the desirable item if its set value is changed. After the cursor is set at the desirable item, as the above step #2, press the ⇦ or ⇨ once to fit the right ☐☐☐ displayed value to the real machine. Only the values which are applicable to the specification of the machine are displayed. Correctly fit the value to the machine's current conditions.

[1] Setting of the working conditions at Work No. [1] [9] (Tower boom crane)

This is Work No. when the jib and tower strut are removed from the luffing jib crane.

Setting of Work No.:

Make sure that the engine starting switch is at "ON" and the moment limiter (overload prevention device) switch is at "OPERATION". Press the [SET] and [CHECK] switches continuously at the bottom of the display unit to call the setting menu.

Cursor ▨ Work No. ➡ [1] [9]

Press the [⇦] or [⇨] switch to set Work No. to [1] [9].

Press the [⇩] to move the cursor to "01 boom length". It takes 3~4 seconds to move the cursor from beside Work No. to "01 boom length". If pressing the [⇩] without waiting the full time, the cursor moves to "02" or "03" over "01". In such a case, press the [⇩] to move the cursor to the top and then move it downward.

1) Setting of "01" boom length:

Cursor [ ] 01 boom length [ ][ ].[ ] m Example: 36.0 m ➡ [3] [6].[0] m

Press the [⇦] or [⇨] to set the tower boom length in three digits. The boom length is increased or decreased by 3m each time the switch is pressed. The length is changed from the basic boom to the longest one. Select the value according to the current condition of the crane. Press the [⇩] to move the cursor the "02 Main hook capacity".

2) Setting of "02" Main hook capacity:

[ ] 02 Main hook capacity [ ][ ][ ].[ ] t Example: 25 ton ➡ [2] [5].[0] t

Press the [⇦] or [⇨] to set the main hook capacity in the unit of "ton". Press the switch, and the capacity of the mountable hook is displayed in turn. When the current hook capacity is displayed, press the [⇩] to move the cursor to "03 Part line of main hook".

3) Setting of "03" Part line of main hook:

[ ] 03 Part line of main hook [ ][ ] Example: 4-part line ➡ [0] [4]

No main hook ➡ [0] [1]

Press the [⇦] or [⇨] to set the part line of rope. Press the switch, and values inputted in the IC card are displayed in turn. When the current part line is selected, press the [⇩] to move the cursor to "Continued to next page". "YES" is automatically set for "04 Top sheave". The cursor moves to "Continued on next page" automatically because "04" ~ "09" are provided for the jib.

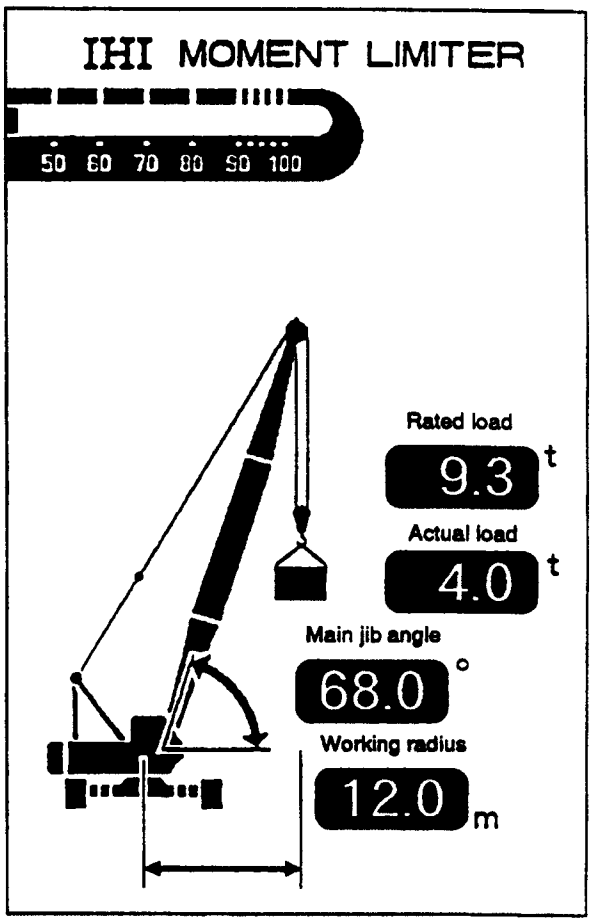
The following items are not displayed at Work No. [1] [9] because it is not necessary to set them:

04	Top sheave	□□.□
05	Jib length	□□.□
06	Auxiliary hook capacity	□□.□ m
07	Part line of auxiliary hook	□.□ t
08	Crane jib offset angle	□□.□
09	Tower jib	□□.□ °

-- Continued to next page

-- End of setting

When the cursor is at "Continued to next page", press the [CHECK] switch to display the next setting menu.



10) Setting of "10" Boom upper limit angle:

Work No. [1] [9] is displayed on the top of the next setting menu image.

[1] [9]
This is displayed ↘

Cursor
□ 10 Boom upper limit angle Optional setting angle □□.□ °

Example: [7] [5] . [0] °

Press the [⇦] or [⇨] to set an optional angle. The angle is increased or decreased by 1° each time the switch is pressed. Set this optional angle as the upper limit angle when the operator has to know that the boom (tower boom) angle has reached the already-set angle.

When the tower boom has reached this set angle, the displayed value of the boom angle blinks.

The tower boom does not stop automatically.

If it is not necessary to set the upper limit angle, set the crane jib at 80° or more. This upper limit angle is useful when there is an obstacle above the crane or when it is repeated to set up the boom up to a set angle. When setting is ended, press the ⇩ to move the cursor to "11 Boom lower limit angle".

The rated upper limit angle of the tower boom crane is 80°. When the tower boom has reached 80°, the automatic stop of the boom throw-out and moment limiter operates to stop hoisting the boom.

11) Setting of "11" Boom lower limit angle:

☐ 11 Boom lower limit angle ☐☐.☐° Example: 35.0°

Press the ⇦ or ⇨ to set an optional angle. The angle is increased or decreased by 1° each time the switch is pressed. Set this optional angle as the lower limit angle when the operator has to know that the boom (tower boom) has lowered to the already-set angle.

When the tower boom has reached this set angle, the displayed value of the boom angle blinks.

The boom does not stop automatically.

If it is not necessary to set the lower limit angle when a crane is used, set the angle at 30° or less.

The jib stops automatically when it reaches the maximum working radius whether a load is lifted or not. Refer to the chapter of "SPECIFICATIONS". When setting is ended, press the ⇩ to move the cursor to "14 Boom upper limit gentle operation angle". The cursor moves to "14" by skipping the following two items:

☐ 12 TW jib offset angle ☐☐.☐°

☐ 13 TW jib lower limit angle ☐☐.☐°

These are not displayed at Work No. 19 because it is not necessary to set them.

14) Setting of "14" Boom upper limit gentle operation angle:

It is not necessary to set this item.

15) Setting of "15" Boom lower limit gentle operation angle:

It is not necessary to set this item.

☐	16	TW jib upper limit gentle operation angle	☐☐.☐°
☐	17	TW jib lower limit angle gentle operation angle	☐☐.☐°

These are not displayed at Work No. 1 9 because it is not necessary to set them.

☐ - - Return to preceding page

☐ - - End of setting

Press the CHECK switch when the cursor is at "End of setting", and the setting menu is changed to the standard menu. It takes 7~8 seconds to change the menu. The above picture of tower boom is displayed. Setting of the working conditions at Work No. 1 9 is ended.

If it is necessary to change part of the setting, press the SET and CHECK switches in turn to display the setting menu. Then, set the conditions as mentioned above.

[2] Setting of the working conditions at Work No. [7] [1] (Luffing jib crane 1)

Setting of Work No.:

Make sure that the engine starting switch is at "ON" and the moment limiter (overload prevention device) switch is at "OPERATION". Press the [SET] and [CHECK] switches continuously at the bottom of the display unit to call the setting menu.

Cursor ▨ Work No. ➡ [7] [1]

Press the [⇦] or [⇨] to set Work No. to [7] [1]

Press the [⇩] to move the cursor to "01 boom length". It takes 3~4 seconds to move the cursor from beside Work No. to "01 boom length". If pressing the [⇩] without waiting the full time, the cursor moves to "02" or "03" over "01". In such a case, press the [⇩] to move the cursor to the top and then move it downward.

1) Setting of "01" boom length:

Cursor ☐ 01 boom length ☐☐.☐ m Example: 42.0 m ➡ [4] [2].[0] m

Press the [⇦] or [⇨] to set the tower boom length in three digits. The boom length is increased or decreased by 3m each time the switch is pressed. The length is changed from the basic boom to the longest one. Select the value according to the current condition of the crane. Refer to the chapter "DISASSEMBLY, ASSEMBLY AND TRANSPORTATION" or "SPECIFICATIONS". Press the [⇩] to move the cursor the "02 Main hook capacity".

2) Setting of "02" Main hook capacity:

☐ 02 Main hook capacity ☐☐☐.☐ t Example: 25 ton ➡ [2] [5].[0] t

Press the [⇦] or [⇨] to select the main hook capacity in the unit of "ton". If the main hook is not mounted, set [0] [0].[0] Press the switch, and the capacity of the mountable hook is displayed in turn. When the current hook capacity is displayed, press the [⇩] to move the cursor to "03 Part line of main hook".

3) Setting of "03" Part line of main hook:

☐ 03 Part line of main hook ☐☐ Example: 4-part line ➡ [0] [4]

No main hook ➡ [0] [1]

Press the [⇦] or [⇨] to set the part line of rope. Press the switch, and values inputted in the IC card are displayed in turn. When the current part line is selected, press the [⇩] to move the cursor to "05". "04" is used to select the top sheave of " [7] [1] Luffing jib crane". "04" is not displayed. If Work No. is at [7] [1], the cursor moves from "03" to "05" and "YES" is automatically selected for "Top sheave".

4) "04" is not displayed at Work No. [7] [1] and the cursor moves to "05"

[ ] 04 Top sheave [ ][ ].[ ]

This is not displayed at Work No. [7] [1] "YES" is automatically selected and the cursor moves to "05".

5) Setting of "05" Jib length:

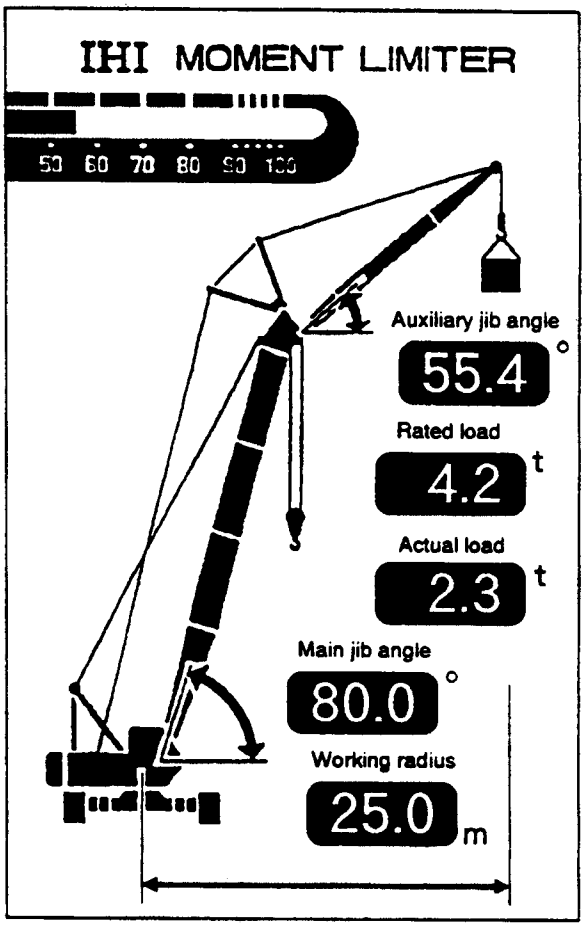
Cursor

[ ] 05 Jib length [ ][ ].[ ] m

Press the ⇦ or ⇨ to select the jib length.

Press the switch, and the jib length is displayed in turn.

Select the jib length according to the current condition of the crane. When the jib length is set, press the ⇩ to move the cursor to "06 Auxiliary hook capacity". In the luffing jib crane, the hook mounted on the tower jib is an auxiliary hook.



6) Setting of "06" Auxiliary hook capacity:

[ ] 06 Auxiliary hook capacity [ ][ ].[ ] t

Press the ⇦ or ⇨ to select the auxiliary hook capacity in the unit of "ton".

If the jib length is set, set the auxiliary hook capacity.

If the auxiliary hook is not mounted, set [0] [0].[0].

When the auxiliary hook capacity is set, press the ⇩ to move the cursor to "07 Part line of auxiliary hook".

Example: 13 ton ➡ [1] [3].[0] t

7) Setting of "07" Part line of auxiliary hook

☐ 07 Part line of auxiliary hook ☐☐ Example: 2-part line 0 2

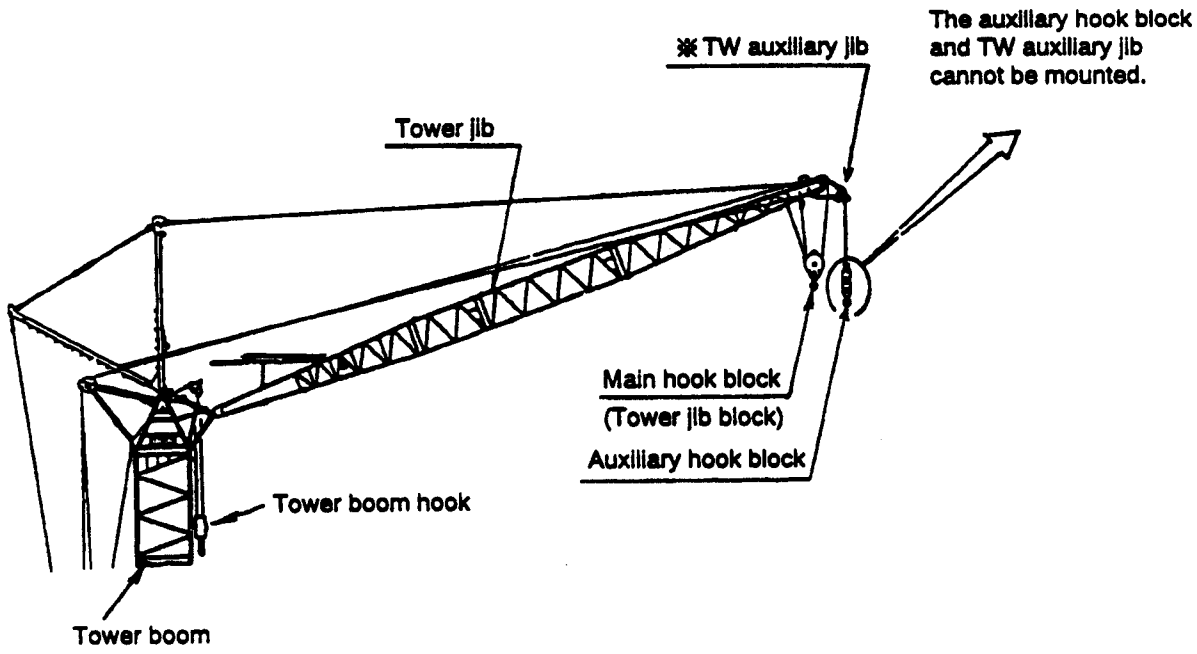
Press the ⇦ or ⇨ to select the part line of the auxiliary hook. Set 0 1 if the auxiliary hook is not mounted or if the rope is 1-part line. If "05 Jib length" is set, set the part line of auxiliary hook. When the part line of the auxiliary hook is set, press the ⇩ to move the cursor to "09 Tower jib". "08 CR jib offset angle" is an item for the standard crane. Press the switch when the cursor is at "07", and the cursor moves to "09"

☐ 08 CR jib offset angle ☐☐.☐ ° This is not displayed because it is not necessary to set this item at Work No. 7 1

9) Setting of "09" TW jib:

☐ 09 TW jib ☐☐☐

TW jib cannot be set.
Press the ⇦ or ⇨ , and "YES" and "NO" are displayed repeatedly. Select "NO".



At Work No. 7 1 , the tower boom hook and tower jib hook can be set.

Move the cursor to "Continued to next page".

[ ] -- Continued on next page

[ ] -- End of setting

Press the [CHECK] switch when the cursor is at "Continued on next page", and the displayed menu is changed to the next page for setting the working condition. Press the [CHECK] switch when the cursor is at "End of setting" and setting is ended. If some of "01" ~ "08" must be changed after setting is ended to the second page, press the [CHECK] switch while the cursor is at this position.

10) Setting of "10" Boom upper limit angle:

[7] [1]

Work No. [7] [1] is displayed on the top of the following setting menu.

This is displayed

Cursor

Optional setting angle

[ ] 10 Boom upper limit angle [ ][ ].[ ]° Example: [8] [0].[0]°

Press the [⇦] or [⇨] to set an optional angle. The angle is increased or decreased by 1° each time the switch is pressed. Set this optional angle as the upper limit angle when the operator has to know the boom (tower boom) angle has reached the already-set angle.

When the bower boom has reached this set angle, the displayed value of the boom angle blinks.

The tower boom does not stop automatically.

If it is not necessary to set the upper limit angle, set the tower boom at 90° or more. This upper limit angle is useful when there is an obstacle above the crane or when it is repeated to set up the boom up to a set angle.

When setting is ended, press the [⇩] to move the cursor to "11 Boom lower limit angle".

11) Setting of "11" Boom lower limit angle:

[ ] 11 Boom upper limit angle [ ][ ].[ ]° Example: [6] [5].[0]°

Press the [⇦] or [⇨] to set an optional angle. The angle is increased or decreased by 1° each time the switch is pressed. Set this optional angle as the lower limit angle when the operator has to know that the boom (tower boom) has lowered to the already-set angle.

When the tower boom has reached this set angle, the displayed value of the boom angle blinks.

The tower boom does not stop automatically.

If it is not necessary to set the lower limit angle, set the tower boom to 60° or less. The operation angle of the tower boom is 90°~60° and this angle is changed according to the length of the mounted tower jib. If the tower jib is longer, the tower boom stops automatically at a higher angle than 60°. Refer to the chapter "SPECIFICATION" for details.

When setting is ended, press the ⇩ switch to move the cursor to "12 TW jib offset angle".

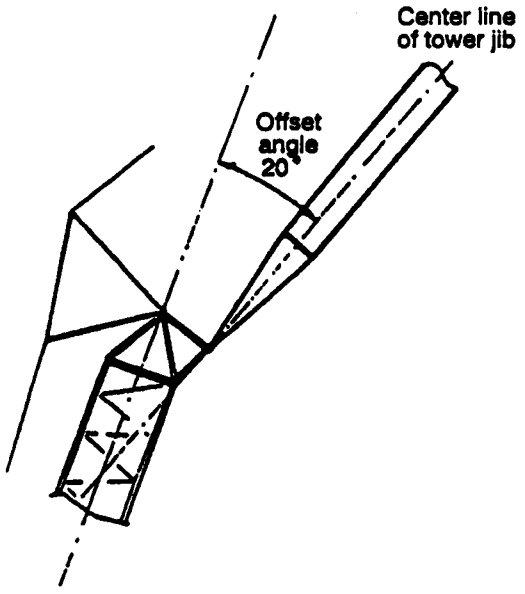
12) Setting of "12" TW jib offset angle:

□ 12 TW jib offset angle □□.□° Example: 20° ➡ 2 0 . 0 °

Set this optional angle as the offset angle when the operator has to know that the tower jib has reached the already-set angle.

When the tower jib has reached this set angle, the displayed value of the main jib angle blinks. The tower jib does not stop automatically. Even if the tower jib has reached the jib offset angle, the jib does not stop automatically though the alarm is outputted. Set 10° if it is not necessary to set this offset angle. Whatever value is set, the tower jib stops at 10° automatically.

Press the ⇦ or ⇨ to set an optional angle.



⚠ CAUTION

The offset angle is an angle against the tower boom. The jib is set up by 80° when the tower boom is erect. If the tower boom is at a low angle, the tower jib stops automatically at an unexpected low angle. Operate the crane carefully.

When setting is ended, press the ⇩ to move the cursor to "13 Tower jib lower limit angle".

13) Setting of "13" Tower jib lower limit angle:

[ ] 13 TW jib lower limit angle [ ][ ].[ ]°

Set this optional angle as the lower limit angle when the operator has to know that the tower jib has lowered to the already-set angle.

When the tower jib has reached this set angle, the displayed value of the boom angle blinks. The tower jib does not stop automatically. Set 10° if it is not necessary to set the lower limit angle.

14) Setting of "14" Boom upper limit gentle operation angle

15) Setting of "15" Boom lower limit gentle operation angle

16) Setting of "16" TW jib upper limit gentle operation angle

17) Setting of "17" TW jib lower limit gentle operation angle

It is not necessary to set these items.

When setting is ended, press the [↓] to move the cursor to "End of setting".

[ ] -- Return to preceding page

[ ] -- End of setting

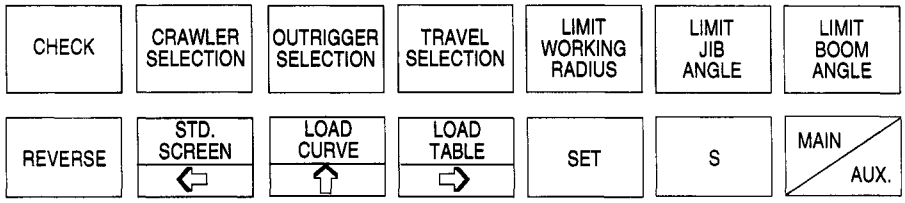
Press the [CHECK] switch when the cursor is at "End of setting", and the setting menu is changed to the standard menu. It takes 7~8 seconds to change the menu.

The picture for setting the jib length is displayed. Setting of the working conditions at Work No. [7][1] is ended.

If it is necessary to change part of the setting, press the [SET] and [CHECK] switches in turn to call the setting menu. Then, set the conditions as mentioned above.

Types and operation of key switches

Arrangement of key switches



1) CHECK Check switch

Used to set the working conditions. On pressing this switch, the following working conditions of the ones set in advance are displayed as a check screen.

- Main hook part of line
- Auxiliary hook part of line
- Main hook capacity
- Auxiliary hook capacity
- Boom length
- Jib length
- Offset angle

On pressing this CHECK switch during display of the standard screen, the items listed at left can be confirmed as a check screen.

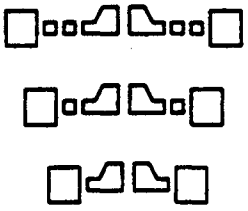
Notes: 1. For checking the rope line parts and hook capacity of main and aux. hoisting, press the "Main/Aux." selector switch.

2. The upper and lower limit angles of main and aux. hoistings, which are freely settable, will not be displayed.

For returning from the check screen to the standard screen, press the CHECK switch again. The standard screen cannot be displayed by the STD SCREEN switch in this case. When the check screen is displayed, other switches (except for the Main/Aux. selector switch) will not call the assigned display though pressed. Before using another switch, return to the standard screen.

2) CRAWLER SELECTION Crawler selection switch

Used to select crawler extension width. Whenever pressing this key, the crawler width value changes between EXT, MID and RET to be followed by selection of the limit load. In the case of a machine incapable of changing the crawler width, it has EXT specification. On changing to other MID/RET, error message No. 114 will be displayed. This switch does not function for the wheel type.



EXT (extended)

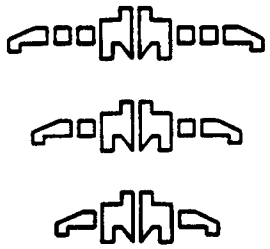
MID (mid-point)

RET (retracted)

If setting of this switch does not match the actual status of the machine, danger may be caused. Hence, be sure to set the switch so as to match the actual status. If this switch is set at MID or EXT though the machine is in the RET status, there is a risk of the machine turning over before the moment limiter functions (Select EXT position for CCH700).

3) OUTRIGGER SELECTION Outrigger selection switch

Activated when the traveling equipment employs tires. Whenever pressing the key, the position changes in the order of EXT, MID and RET to be followed by selection of the limit load. The display cannot be changed by pressing this switch if the machine is not provided with outriggers.



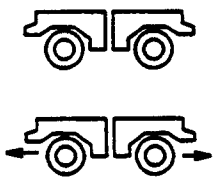
If setting of this switch does not match the actual status of the machine, danger may be caused. Hence, be sure to match the setting.

When selecting the outrigger extension width switch which does not match the machine specifications, error message No. 114 will be displayed.

4) TRAVEL SELECTION Traveling conditions selection switch

Activated when the traveling equipment employs tires. Whenever pressing the key, pick and carry mode or stationary lifting mode is selected alternately to be followed by selection of the limit load. Because the limit load is selected, be sure to match the switch setting with the actual status of the crane.

In case of crawler crane, this switch need not be operated.



5) LIMIT WORKING RADIUS Limit working radius switch

When pressing this switch on the standard screen, display will change from the present working radius (actual working radius) to the maximum working radius possible under the present load (actual load). While the maximum working radius is displayed, the LED lamp at the top left corner is lit. For return to the display of actual working radius, press this switch again.

6) LIMIT JIB ANGLE Limit jib angle switch

This switch functions not for the standard crane, but for the tower crane. The limit jib angle refers to the minimum angle at which the tower jib can be inclined with the present load for operation with the boom fixed. When pressing this switch, the display of the actual jib angle on the standard screen is changed over to that of the limit jib angle. While the limit jib angle is displayed, the LED lamp at the top left corner is lit. For return to the display of actual jib angle, press this switch again.

7) LIMIT BOOM ANGLE Limit boom angle switch

Displays the minimum angle at which the boom can be inclined with the present load lifted and the minimum angle at which the boom can be inclined with the present load lifted, at operation with the tower jib fixed. When pressing this switch, the display of the actual jib angle on the standard screen is changed over to that of the limit boom angle.

In the case of a tower crane, calculation is made on the assumption that the tower jib angle (with respect to the ground) is the same. When inclining the boom alone, the tower jib angle changes. Therefore, the display value will change.

While the limit boom angle is displayed, the LED lamp at the top left corner is lit. For return to the display of actual boom angle, press this switch again.

8) REVERSE Reverse switch

The screen background is reversed between black and white by pressing this switch.

9) STD. SCREEN ⇦ Standard screen and ⇦ switch

This switch is used to display the standard screen (main screen), the LOAD CURVE screen or LOAD TABLE screen is changed over to the standard screen when pressing this switch. The arrow mark at the bottom of the key top is used for setting in work mode and item mode.

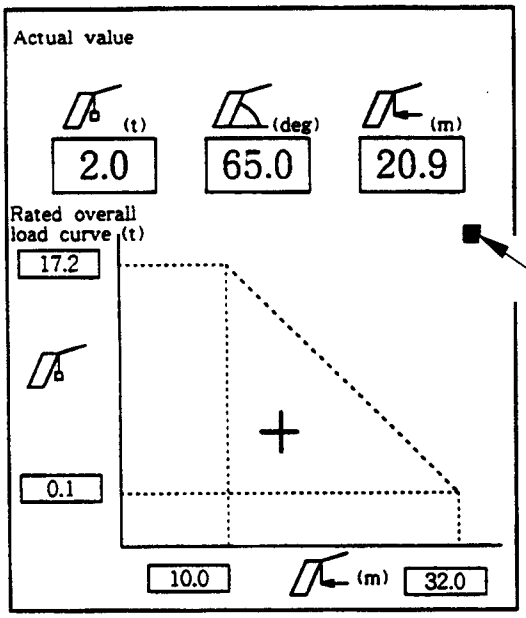
On starting the moment limiter, the standard screen appears. This screen also appears after setting a condition. When turning on the power supply of the moment limiter, "IHI MOMENT LIMITER" appears on the display unit. After about 20 seconds, the standard screen emerges and the moment limiter starts functioning.

10) LOAD CURVE ⇧ Overall load curve and ⇩ switch

Selects the overall load curve screen. This switch is operable only when the STD SCREEN, LOAD TABLE, REVERSE OR MAIN/AUX switch is active.

The arrow mark is used for setting a working condition.

Overall load curve (Boom)

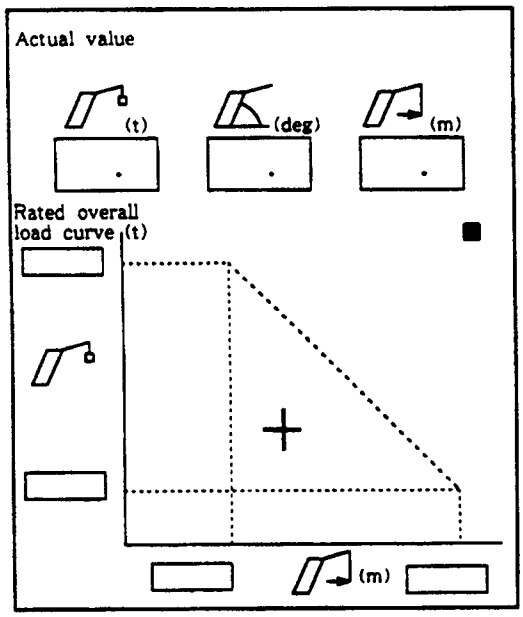


When the crisscross mark in the figure is at the inside of the curve, working is allowed. If the crisscross mark is at the outside of the curve, the buzzer sounds and the machine automatically stops. (A rated overall load of 0.0 t does not meet the machine specification.) In this case, the actual load becomes 0.0 t.)

If the limit radius is unobtainable, the crisscross mark is placed at this position.

The figure at left shows lifting with the boom to which a jib is attached. The figure indicates a load of 2.0 tons, a jib angle of 65.0° and a working radius of 20.9 m.

Overall load curve (Jib)



The figure at left shows lifting with the jib.

Operation of the moment limiter is the same as in lifting with the boom.

11) LOAD TABLE Overall load table switch

Selects the overall load table. If the contents of the display overflow one screen, the remainder can be displayed by pressing this switch again.

Overall load table

Actual value

(t)	(deg)	(m)
14.0	60.0	30.0

Rated overall load curve (m·t)

10.0	50.0	24.0	30.0
11.0	50.0	26.0	28.5
12.0	50.0	28.0	26.0
13.0	50.0	30.0	24.0
14.0	48.5		
15.0	46.0		
16.0	44.2		
17.0	40.0		
18.0	38.5		
19.0	36.2		
20.0	34.0		
22.0	32.5		

For return from the overall load table to the standard screen, press the STD screen switch. The arrow mark is used for setting the working mode and item mode.

Outside the permissible range of working radius, the display of actual load becomes 0.0 and the topmost row of the rated overall load table flickers.

- A single screen contains 24 rows. For display beyond 24 rows, press the switch again. The remainder will be displayed.
- The display position corresponding to the working radius flickers.

←— If two positions flicker, the present working radius is between two values.

12) SET Setting switch

Used for setting the work mode and item mode.

When pressing the SET and CHECK switches in succession, the setting mode screen appears.

13) S S switch

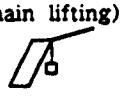
Not used ordinarily.

15) AUX./MAIN Main/auxiliary lifting selection switch

Selects lifting with the boom or jib. This switch is effective when the jib is mounted.

Main lifting

Actual load (main lifting)

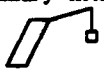


Main jib angle

Working radius (main lifting)

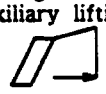
Aux. lifting

Actual load (auxiliary lifting)



Auxiliary jib angle (jib angle)

Working radius (auxiliary lifting)



While the jib lifting is selected, the LED lamp at the top left corner is lit. Once power supply is turned off, the boom lifting side is automatically selected. Bear this in mind.

⚠ CAUTION

If the main/auxiliary lifting switch is not selected correctly, a serious accident may occur. Make sure that the position of the switch is selected correctly.

Error messages

Errors detectable in the computer unit can be outputted to the display unit. However, an error occurring in the setting mode will not be outputted.

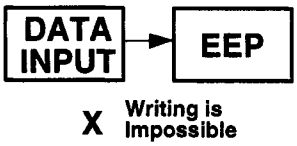
An error is indicated as a 3-digit number at the working radius display position of the standard screen.

Although displays other than the 3-digit error display are normally made, the machine automatically stops because the moment limiter performs processing based on a load ratio of 100%.

⚠ WARNING

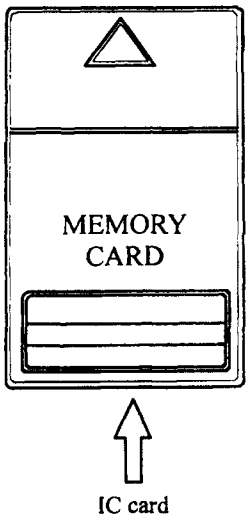
1. **If an error message appears during the crane operation, put the load on the ground and stop the operation at once. Find out its cause and return the moment limiter to the normal status.**
2. **Don't continue the operation while the power of the moment limiter is "OFF". The crane may tip over.**

Error No.	Contents of Error	Cause	Necessary Measure
100	"100" is displayed when 5V or more is inputted from the crane boom/tower boom angle detector and the monitor count value is 4080~4095.	The angle detector outputs approx. 0~5V in -5~90° when 12V is impressed. In many cases, short circuit occurs in the 12V line and the angle detector output line.	1) "100", "101", "102" and "103" are displayed in turn. When "100" is displayed, other errors may occur. Monitor the input modes from the detector, 01, 02, 03 and 04 in the computer 2) unit. Measure the resistance between the input/output lines of the sensors. Remove the connectors in turn and check the change of conditions. Use a simulator to check an error of the computer unit. Replace or repair the problem unit.
101	"101" is displayed when 5V or more is inputted from the luffing jib/luffing tower jib angle detector and the monitor count value is 4080~4095.	Even during the standard crane operation, "101" is displayed if trouble occurs because wiring is done in this machine.	As "100", remove all the input connectors from the sensors. Check if short circuit has occurred in the computer unit or if trouble has occurred outside the computer unit, and then take a necessary measure.
102	1) "102" is displayed when 5V or more is inputted from the load detector mounted on the high A frame and the count value is 4080~4095. 2) "102" is displayed when the allowable range of the load cell (load detector) is exceeded because the crane lifts an overload.	The load cell inputs 0 ton~maximum allowable load at 0~5V when +12V or -12V is impressed. In many cases, the input line is short-circuited. When the load is put on the ground, "102" disappears and the crane operates normally.	Same as the above. Check after removing one side of the load cell connector. When one side is removed, the monitor value is reduced to 1/2. Replace or repair the problem unit.

Error No.	Contents of Error	Cause	Necessary Measure
103	"103" is displayed when 5V or more is inputted from the load cell mounted on the A strut and the monitor count value is 4085~4095.	Same as "102".	Same as "102".
105	"105" is displayed when the IC card data cannot be read.	1) The IC card is not inserted properly. (The card terminal unit does not contact properly.) 2) The IC card is defective, the IC card is not inserted, etc. 3) Disconnection occurs in the computer unit.	1) Insert the IC card again. 2) Replace the IC card. 3) Replace the computer unit.
106	"106" is displayed when EEPROM (in which zero, span adjustment and operation specifications are stored) punctures or malfunctions or when operation failure such as writing error occurs.		Set the operation specifications in the computer unit again. If the problem is not solved by resetting, replace ROM. ("106" has never been displayed.)
109	"109" is displayed if a problem is found when checking IC card. "109", "110" and "111" are displayed when replacing the computer unit with a link part.		If the problem is not solved by resetting, replace the IC card. Replace the computer unit if the problem is not solved although the IC card is replaced.
110	"110" is displayed if the specification of the IC card is different from the conventional one. (When the IC card is replaced)		Set the operation specifications in the computer unit again.
111	Same as "110".		Same as "110".
112	When the computer unit sends a signal to the display unit, the display unit returns a signal to the computer unit. "112" is displayed when there is not a signal to be returned.		1) Check if the cursor blinks at the lower right of the display unit. It blinks normally and does not blink if a communication error occurs. 2) Check the wiring between the computer unit and display unit and, if there is a problem, repair or replace. 3) If there is no problem in 1) and 2), replace the computer unit or display unit.

Error No.	Contents of Error	Cause	Necessary Measure
114	"114" is displayed when a proper rated overall lifting load is not found for the current operation specification. (It is displayed when the crawler selection switch is not at "EXT", when the boom angle is below the allowable range while the luffing tower or luffing jib is used, etc.)		1) Check the crawler selection and press the selector switch to extend maximally. 2) Check the display of the boom angle and, if it is below the allowable range, return it within the range. When "0" or "span" , adjustment is not correct. 3) If "114" is displayed although the boom angle is within the allowable range, it is possible that the boom angle detection is not good.

6-6 Caution handling overload prevention device (moment limiter)



1. When starting the machine, auto stop sometimes works. Turn the safety device switch to released side once and start the work.
2. If load reaches 90% of the allowable value, the warning buzzer sounds intermittently.
3. If load exceeds the allowable value, the warning buzzer sounds continuously and the auto stop device works. The operation for the dangerous side, namely, hoisting the load and lowering of the boom (jib) cannot be done.
4. When the auto stop device works, return the crane to the safe area, the automatic stop is released in about 2 seconds and all the operations can be done.
5. If the boom is positioned over the upper limit angle or beneath lower limit angle set optionally, a warning sound occurs.
6. If the boom is beneath the specified angle, the buzzer sounds and the crane stops automatically, even if a load is not suspended.
7. Set the overload prevention device according to the working conditions.

(7-1) Select the Work No. of the setting screen according to the following table:

Work No.	Work Mode	Work No.	Work Mode	Work No.	Work Mode
11	Crane 1	21	Clamshell	51	Floating clamshell
13	Crane (3rd drum use)	31	Lifting magnet crane	71	Luffing jib crane 1
19	Boom crane	41	Floating crane	81	Luffing tower crane luffing jib crane 2

(7-2) Select the item mode according to the machine actual conditions.

(7-3) After setting is ended, return to the standard screen.

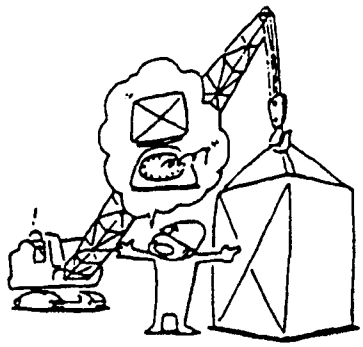
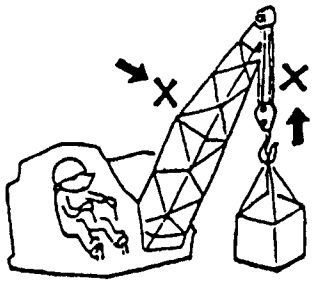
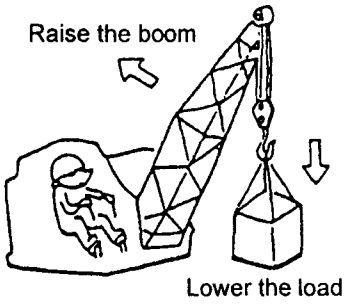
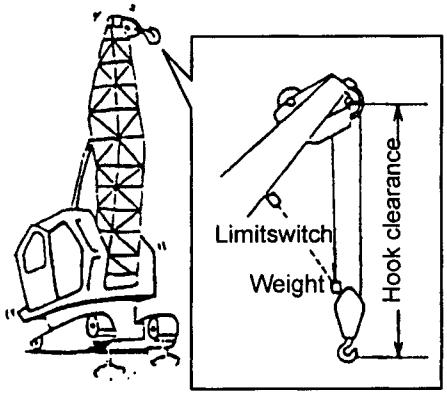
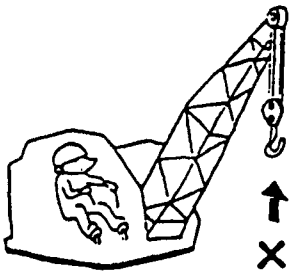
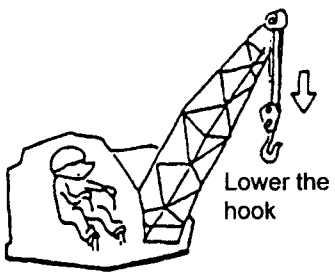
8. The main/auxiliary selector switch returns to the boom lifting side automatically if the power of the overload prevention device is turned off. Check the machine and set the mode.
9. Refer to the description for handling the moment limiter for details.

NOTICE

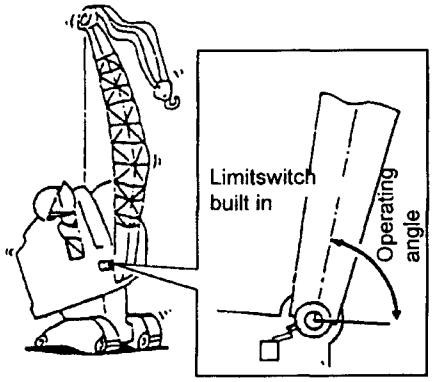
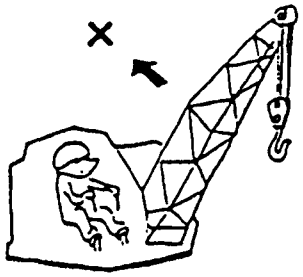
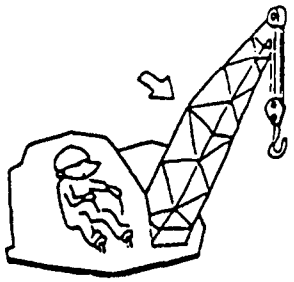
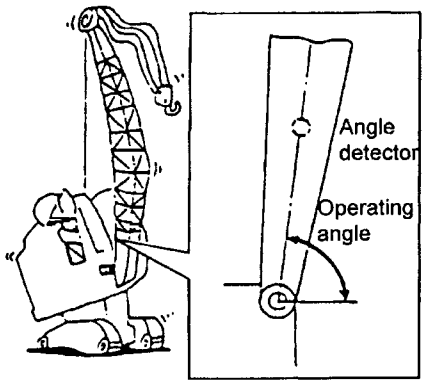
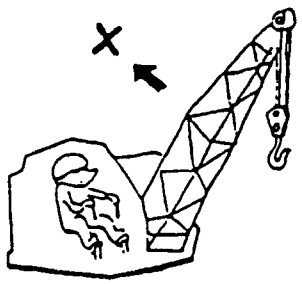
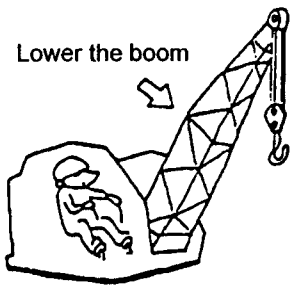
1. **Before starting operation, change the display to the setting screen and make sure that the crane status is set to the proper set values.**
2. **Check the operation of the auto stop device without load.**
3. **With alarm type overload prevention device, if buzzer sound becomes continuous, the crane should be immediately returned to a safe area.**

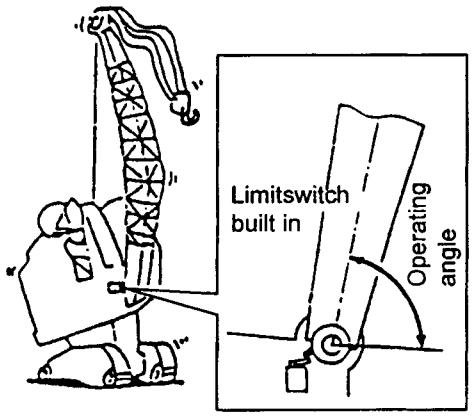
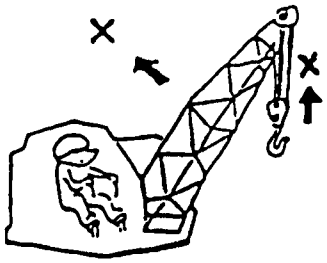
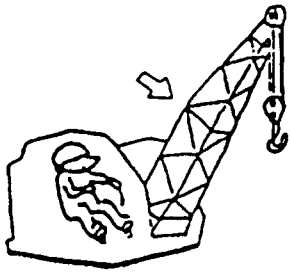
7. RELEASE OF SAFETY DEVICE ON ITS ACTIVATION

7-1 Overload prevention device, hook over hoisting prevention device

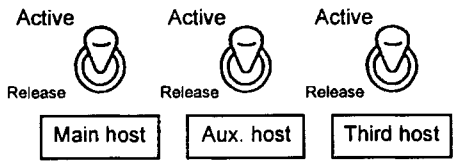
Device	Function	Releasing Method
1 Moment limiter (Overload prevention device) 		
The computer unit compares the actual load with the permissible load (rated overall load). At 90% of the permissible load, the warning buzzer sounds intermittently. At 100% of the permissible load, the warning buzzer sounds continuously.	1 Operations on the dangerous side (boom lowering and load hoisting) stop and remain impossible. 2 The warning buzzer sounds ●Moment limiter warning buzzer	1 Raise the boom or lower the load until the machine returns to the safe zone (moment limiter warning buzzer stops). 2 Return the crane to the safe area, an automatic stop is released in about 2 seconds and operation may be resumed.
2 Hook overhoisting prevention device 		
If the hook is hoisted beyond the specified height, the limit switch will be activated. Minimum hook clearance: Standard crane main boom operation..... 4.00m Standard crane jib operation .. 3.70m Tower jib operation ..... 3.90m Tower boom operation..... 2.80m	1 Hook hoisting operation stops. 2 The warning buzzer sounds.	1 Lower the hook. *This device is reset when the warning buzzer sound stops.

7-2 Boom overhoisting prevention device, upper limit stop device

Device	Function	Releasing Method
3 Boom overhoisting prevention device (Boom hoisting throwout unit)  When the boom is overhoisted beyond the specified angle, the limit switch will be activated Maximum operating angle with 1400 IK boom: Crane . . . . . 80° Crane w/46" or 47" HI boom. . . . 81° Tower crane . . . . . 85° (alarm)	 1 Boom hoisting is stopped. 2 The warning buzzer sounds. Warning sound is emitted with a tower boom angle of 85°.	 1 Lower the boom *This device is reset when the warning buzzer sound stops.
4 Boom high-angle stopper Tower jib  When the boom overhoisting stopping device is not activated, the computer unit operates in response to angle detection with the angle detector. Maximum operating angle with 1400 IK boom: Crane . . . . . 80° Tower jib . . . . . 80° Tower jib w/46" or 47" HI boom . 81°	 1 Boom or tower jib hoisting is stopped. 2 The warning buzzer sounds.	 1 Lower the boom or tower jib. *This device is reset when the warning buzzer sound stops.

Device	Function	Releasing Method
5 Second throwout unit 		
When the boom is hoisted beyond the specified angle, the limit switch at the left boom foot will be activated. Operating angle: Crane . . . . . 82° Clamshell . . . . . 78°	1 Boom hoisting is stopped. 2 Winding of the main and auxiliary winches is stopped. 3 Winding of the third drum is stopped. *Simultaneously, the warning buzzer sounds.	1 Lower the boom. *This device is reset when the warning buzzer sound stops.

7-3 Hook overhoist prevention device switch



(Mounted above the right control panel against the main hoist clutch)

- The main, auxiliary and third hoist switches shown at left must be turned to the "ACTIVE" side without fail.

⚠ CAUTION

1. If the boom is lowered to the ground at the time of disassembly or assembly of the attachment, hook over wind prevention device switches should be turned to the "RELEASE" side. These switches should be turned to the "ACTIVE" side after lifting the boom off the ground.
   For lowering the boom, these switches should be turned to the "RELEASE" side just before the overhoisting status is detected. The hook overhoisting prevention device switches are located above the control panel in the right hand machinery cab.
2. During operation, all overhoisting prevention device switches (shown in the figure above) must always be turned to the "ACTIVE" side. If it is not at the "ACTIVE" side, the hook overhoisting prevention device does not operate.

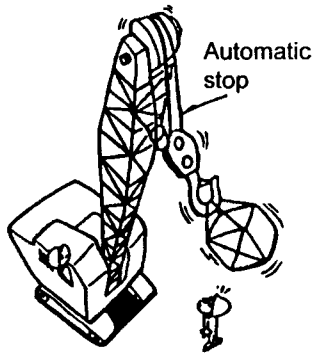
8. HANDLING OF OPERATION AIDS

1. Avoid reliance on use of operator aids.
2. Operations should be carried out within a range where function cutouts will not activate. Operations should be based on recognition that the operator aids are provided as a final emergency means. Avoid such operations which frequently activate the hook overhoisting prevention device or boom overhoisting prevention device.

   a. For safe and efficient crane operation, it is recommended to utilize the overload prevention device for checking the current load ratio and working radius and avoid a condition which triggers automatic stop.

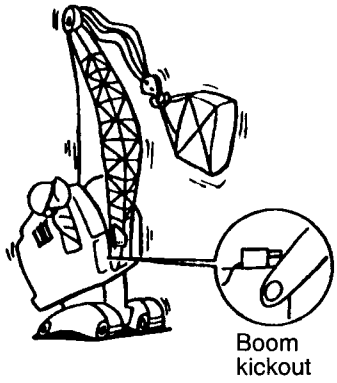
   b. In operation, crane functions should be used with an adequate margin secured against a condition where automatic stop is caused.

   c. If the machine stops due to activation of the function cutouts, first apply the drum brake securely, then take the subsequent step for restoring normalcy.



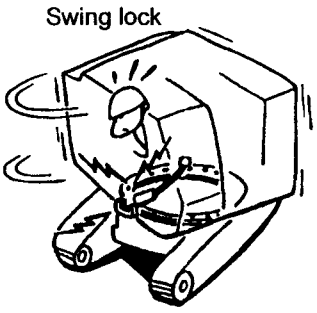
⚠ CAUTION

When a heavy load is suspended, avoid hoisting the boom at a high angle close to the boom kickout activation angle when possible. This is required because as the load is set down, the tension on the boom suspension is relieved. As the tension is relieved, the boom angle will increase which may cause the boom kickout switch to activate.



When equipped with 1400 IK boom:

- Boom kickout activation angle. . . . . 80°
- Second kickout . . . . . 82°
  (Clamshell etc., 78°)
- Automatic stop due to moment limiter . . 80°
  (Rated upper limit angle)



When equipped with 46" or 47" HI boom:

- Automatic stop due to moment limiter . . 81°
  (Rated upper limit angle)
- Second kickout . . . . . 82°

⚠ DANGER

1. **If the crane is operated while the overload prevention device switch is in the erection or transportation position, the overload prevention device does not function and overload may turn over the crane. When the crane is disassembled or assembled, the overload prevention device switch is temporarily at "ERECTION". If the crane is operating, set the switch at "OPERATION".**
2. **If the overload prevention device in the moment limiter is activated (hoist & boom functions stop) because of overload, do not turn the bypass key switch to the released position and continue to hoist or boom down. The crane may tip over or structural failure or damage could occur.**

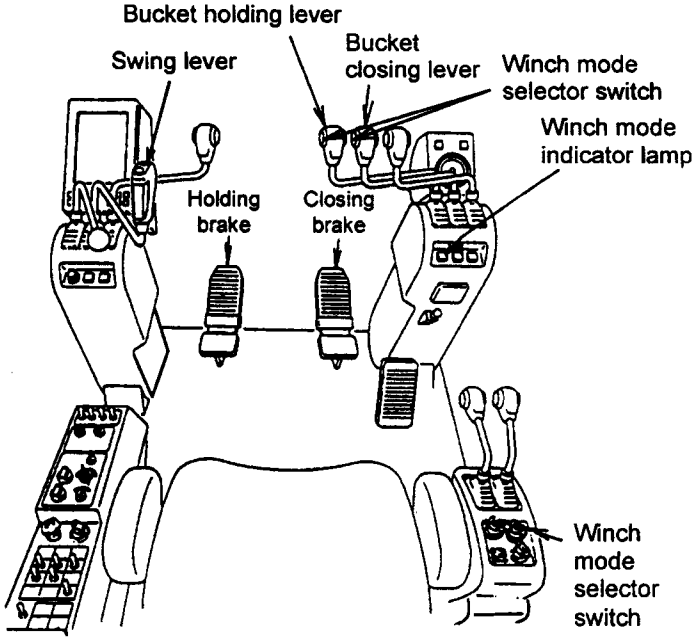
9. CLAMSHELL OPERATION

Operating procedure

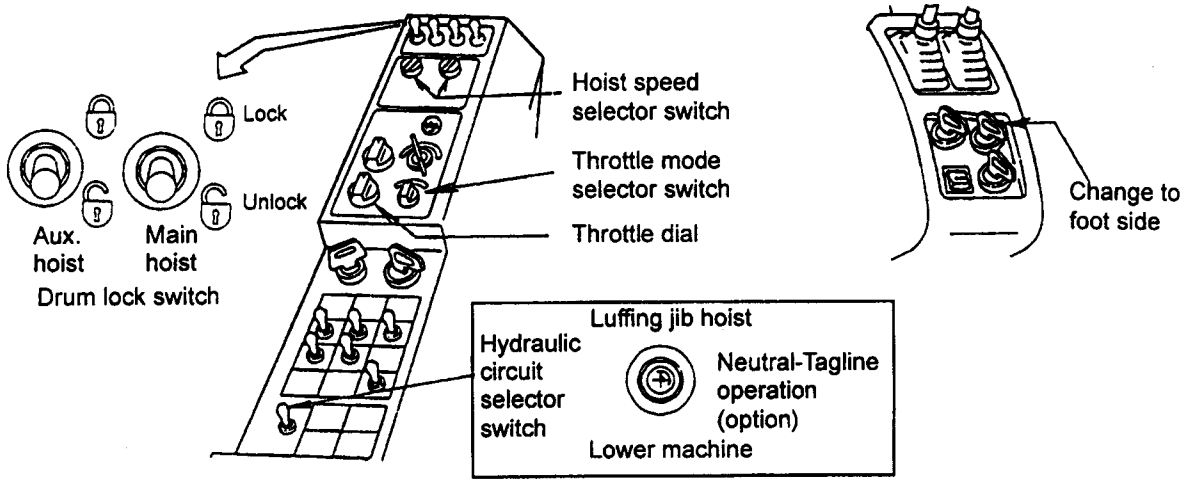
Since the usual operation is mostly carried out with the foot brake, explanation is given here in the foot mode. If the digging depth is large or overheating of the brake drum is expected, the automatic brake mode may be employed.

1. With the brake depressed, change over the winch mode selector switch of the right-side box to the foot mode.

2. Change over the selector switch at the head of the hoist lever to the foot mode side. Make sure that the mode indicator lamp at the root of the lever is lit.



3. Turn the hoisting speed selector switch to the "Low" speed.



4. Determine the engine speed changing rate with the throttle mode switch, and the minimum engine speed with the throttle dial switch. The engine speed range above the minimum speed is controlled by the grip throttle of the swing lever.

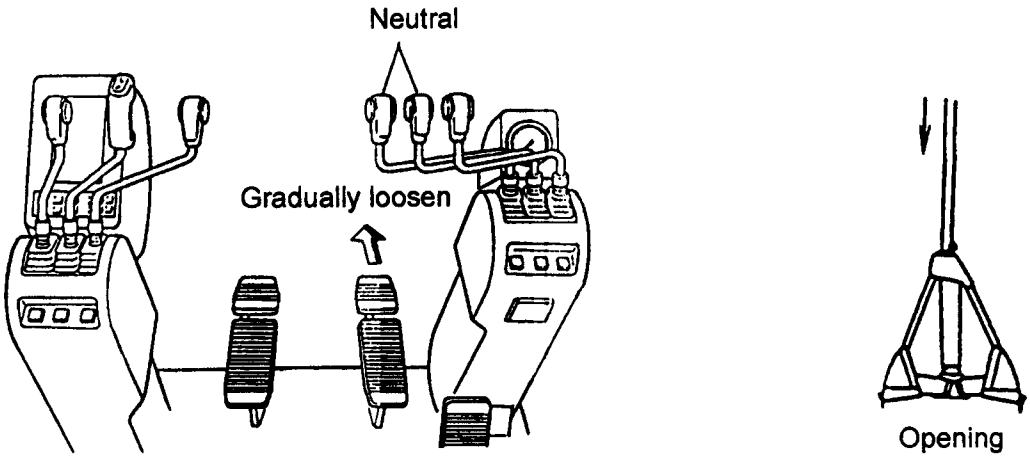
5. Release the drum lock of both the main and auxiliary winches. Press the side where the unlocked status is drawn. Next, select the neutral position of the hydraulic circuit change switch. Now, operate the tagline.

6. Opening the bucket:

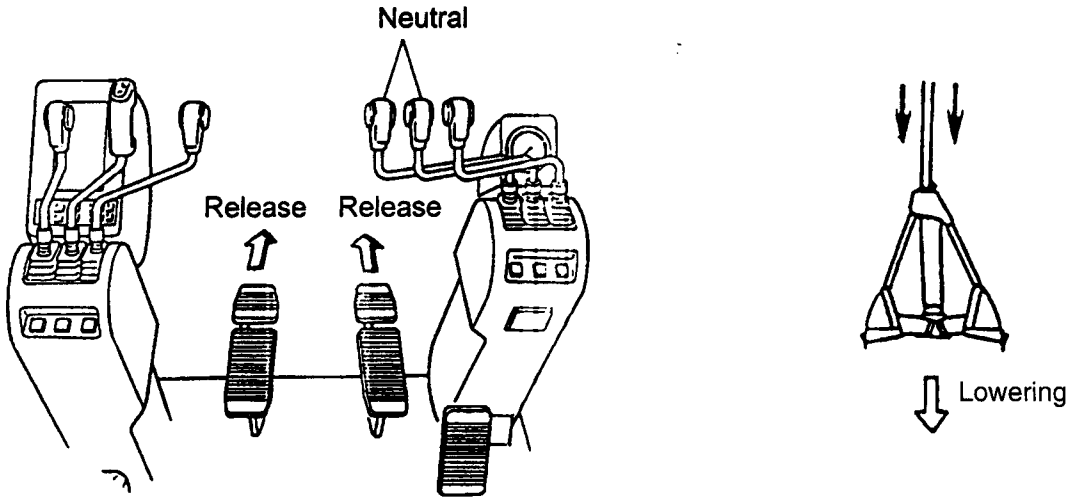
   Set the bucket closing lever and holding lever at neutral. Both brake pedals should be kept depressed.

   Then, release the closing brake pedal slowly to open the bucket.

   Pay attention not to release the closing brake excessively, otherwise the closing rope may be wound irregularly.



7. Lowering the bucket:



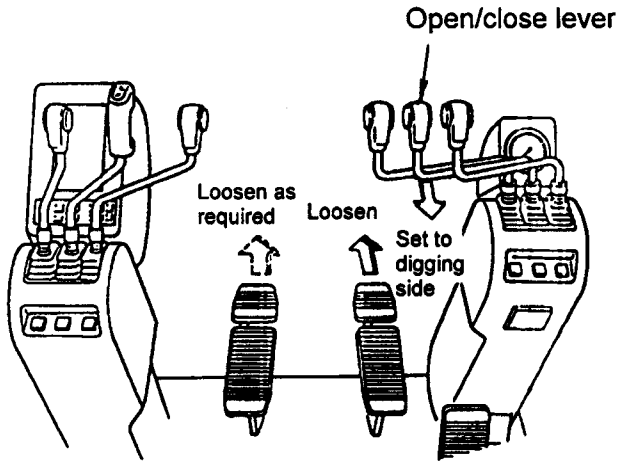
   Release both the closing brake and the holding brake, and gently lower the bucket onto the substance to be dug.

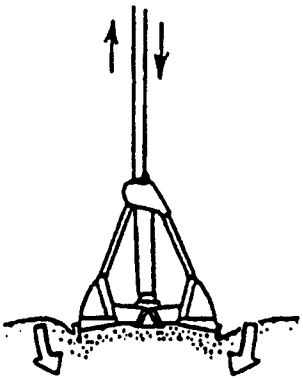
   Release both ropes by the same amount so as not to close the bucket. Adjust the holding side with reference to the rope on the closing side.

   Lower the bucket in the open status. It is desirable to master the skill of operating the left and right foot brakes as early as possible.

8. Digging:

   With the closing brake released, set the closing lever to the digging side. Loosen the holding brake gradually in response to the capacity and digging depth of the bucket.



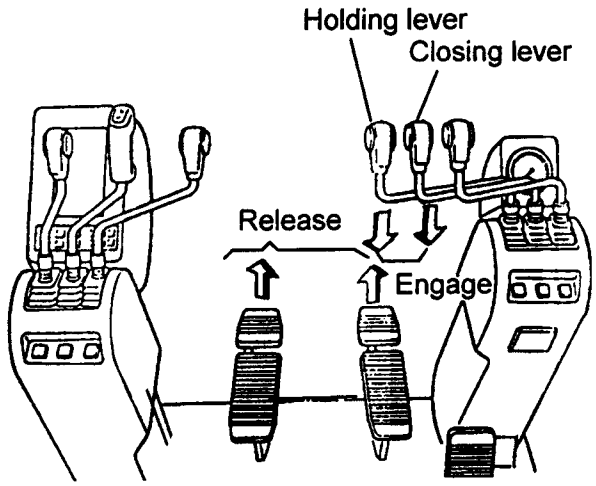


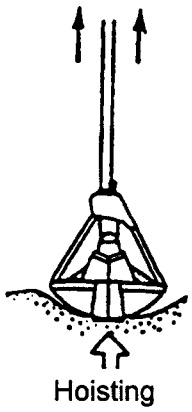
9. Hoisting the bucket:

   As soon as the bucket closes on completion of digging, pull the holding lever toward you in order to hoist the bucket via the digging and holding ropes.

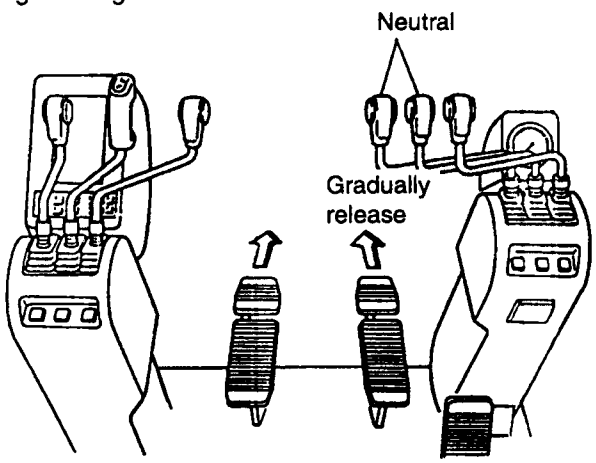
   If winding is uneven between the two ropes, the winding speed is reduced on the tenser side. Careful operation is required so as not to drop the held material (priority should be given to the closing rope).

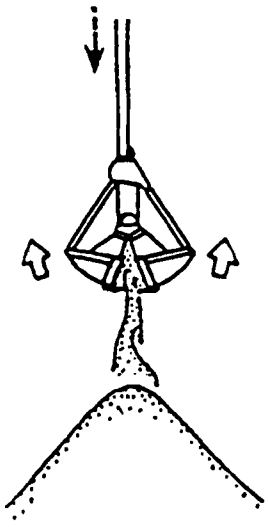
   Swing the superstructure to the determined discharge position. Swing operation should be carried out slowly. Abrupt swinging will cause the load to swing outside due to a centrifugal force. Therefore, the working distance will increase, causing danger.





10. Discharge of dug material:





When the bucket comes to the determined position, return both levers to neutral with the closing and support brake pedals depressed. Discharge the dug material by gradually loosening the closing brake. Pay attention not to loosen the brake excessively, otherwise the wire rope is loosened unnecessarily, causing irregular winding.

NOTICE

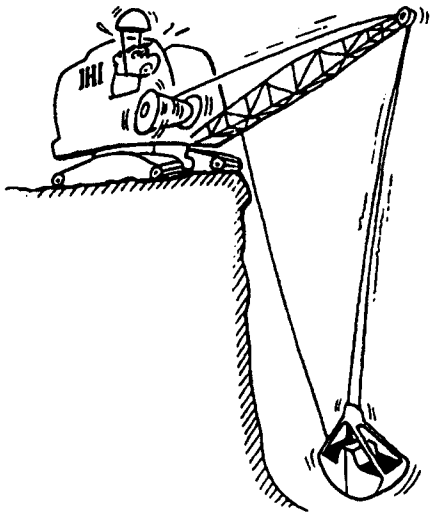
1. If the wire rope is short, it is paid out completely from the drum before the bucket reaches the digging point. In this case, there is a risk of the drum being broken or the wire rope being cut off.

   For any kind of work, the rope should be left on the drum by two or more windings.

2. If the wire rope is too long, it is apt to be wound irregularly because of winding in many layers. As a result, the rope may be damaged and reach the end of its service life earlier.

3. Always check the condition of the ground and perform the swing operation as slowly as possible. During the swing operation, take care not to hit the bucket against other equipment.

4. Cargo handling work is classified as the one by mobile crane.



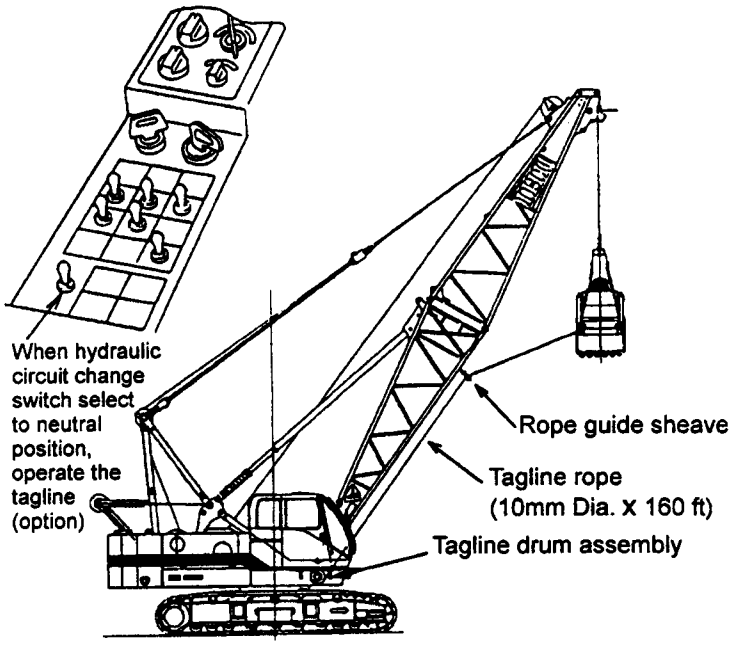
10. HANDLING OF HYDRAULIC TAGLINE (OPTIONAL SPECIFICATION)

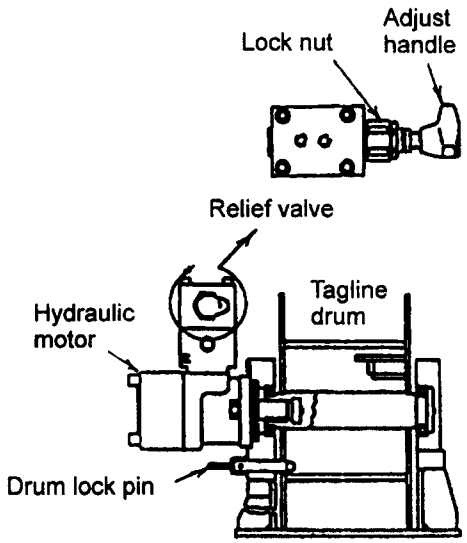
10-1 Outline

This equipment is used to prevent the bucket from swaying during clamshell operation. The bucket tensile force is adjusted by matching the relief valve pressure with the present work.

10-2 How to adjust tensile force (adjustment of relief valve in hydraulic motor section)

When screwing in the adjust handle with the lock nut loosened, the pressure rises to increase the tensile force, and the force weakens when turning back the adjust handle. (Adjustable range: 0 to 100 kgf/cm^2). After adjustment, lock the nut securely.





If the tensile force is excessive, the bucket is pulled toward the operator, and it is swung outside if the force is inadequate. It will be an overload, if a work radius increased, so be careful. Adjust the tensile force so as to match the working state.

The pump for the tagline pump (P5 pump) is used for delivering pressurized fluid to the tagline hydraulic motor. Therefore, when the tagline is unused, energy can be saved by turning back the relief valve to 0 kg/cm^2 and lock the drum by inserting the lock pin into the tagline drum.

⚠ CAUTION

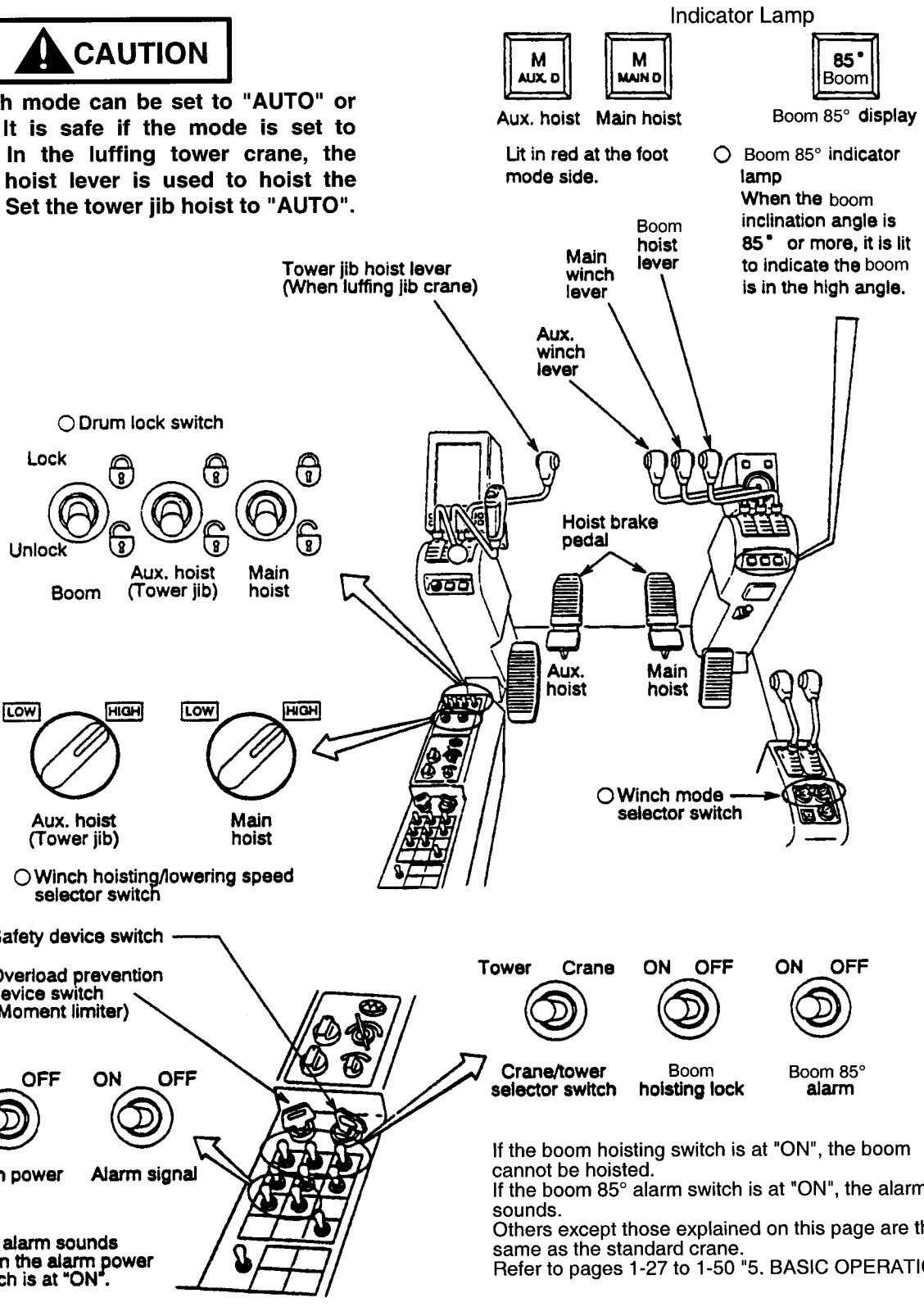
1. When use of the hydraulic tagline is not intended for a long time, fully loosen the relief valve and lock the drum by inserting the lock pin into the tagline drum to prevent danger. Set the pressure of the tagline motor to "0" by adjusting the tagline motor.
2. When the tagline drum is rotating in the rope winding direction, be careful not to be caught by the tagline if you work near it.
3. When the engine starts, in hydraulic circuit select switch to neutral, the rope is pulled suddenly by the tagline operation. Be careful.

11. OPERATION OF LUFFING JIB CRANE & LUFFING TOWER CRANE

11-1 Arrangement and function of levers and switches

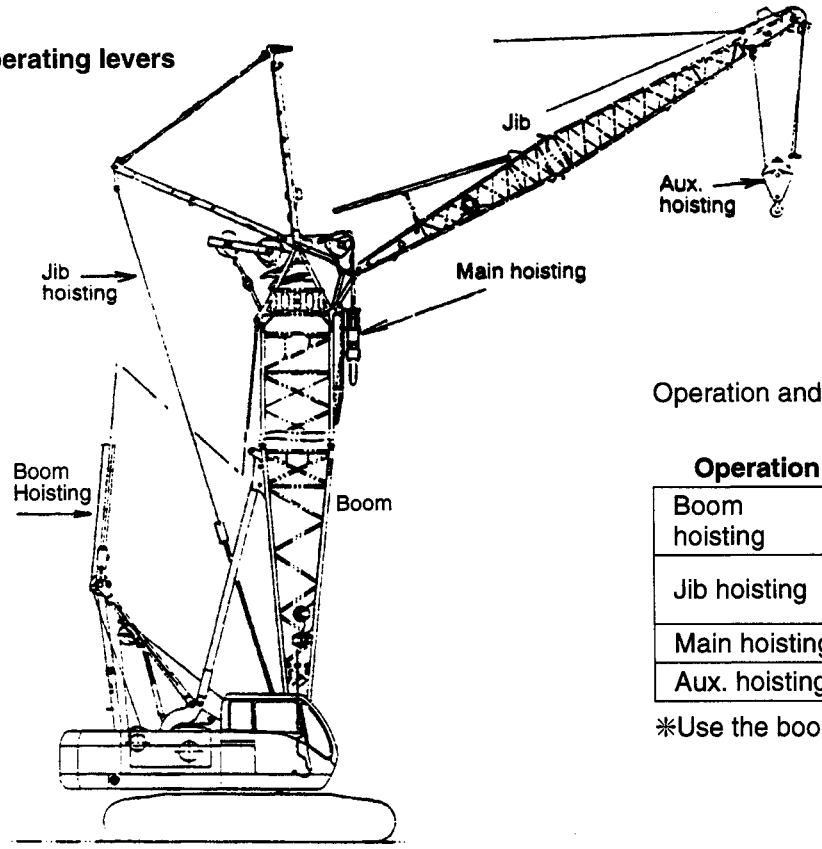
CAUTION

The winch mode can be set to "AUTO" or "FOOT". It is safe if the mode is set to "AUTO". In the luffing tower crane, the auxiliary hoist lever is used to hoist the tower jib. Set the tower jib hoist to "AUTO".



If the boom hoisting switch is at "ON", the boom cannot be hoisted.
If the boom 85° alarm switch is at "ON", the alarm sounds.
Others except those explained on this page are the same as the standard crane.
Refer to pages 1-27 to 1-50 "5. BASIC OPERATION"

Operating levers

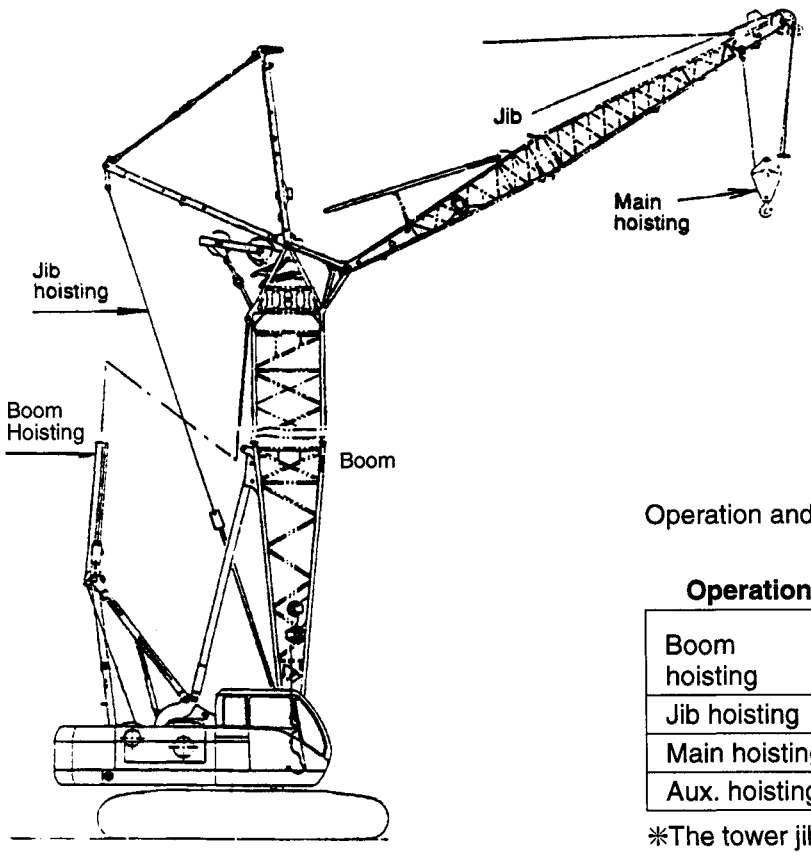


1. Luffing jib crane:
   It is equipped with the main hoist hook and the boom hoisting is possible. The tower jib is hoisted or lowered by the third drum.

Operation and levers

Operation	Levers and other: Drum	Levers and other: Lever
Boom hoisting	Boom drum	Boom hoist lever
Jib hoisting	Third drum	Third drum lever or jib hoist pedal
Main hoisting	Main hoist drum	Main winch lever
Aux. hoisting	Aux. hoist drum	Aux. winch lever

*Use the boom hoist pedal as the tower jib hoist pedal.



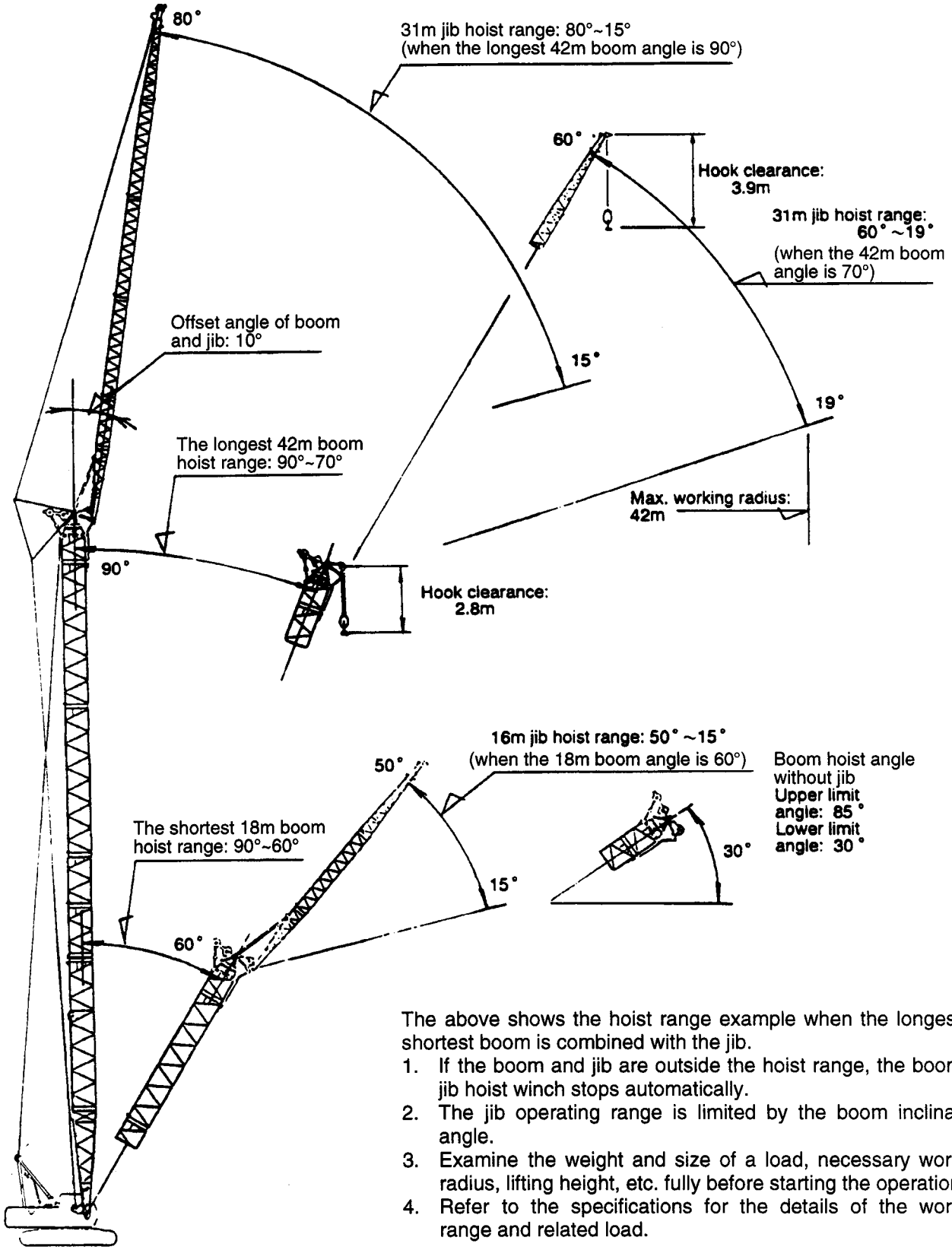
2. Luffing tower crane:
   It is not equipped with the main hoist hook. The tower jib is hoisted or lowered by the auxiliary hoist drum.

Operation and levers

Operation	Levers and other: Drum	Levers and other: Lever
Boom hoisting	Boom drum	Boom hoist lever Boom hoist pedal
Jib hoisting	Aux. hoist drum	Aux. winch lever
Main hoisting	Main hoist drum	Main winch lever
Aux. hoisting	- -	- -

*The tower jib hook is called Main hoist hook.

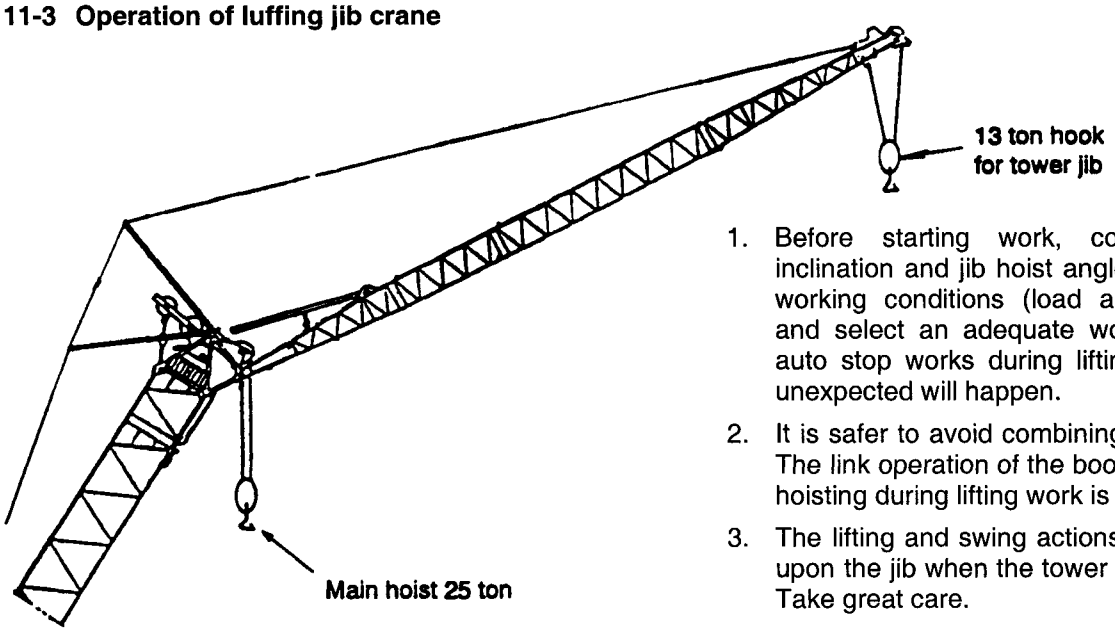
11-2 Hoist range of boom and jib



The above shows the hoist range example when the longest or shortest boom is combined with the jib.

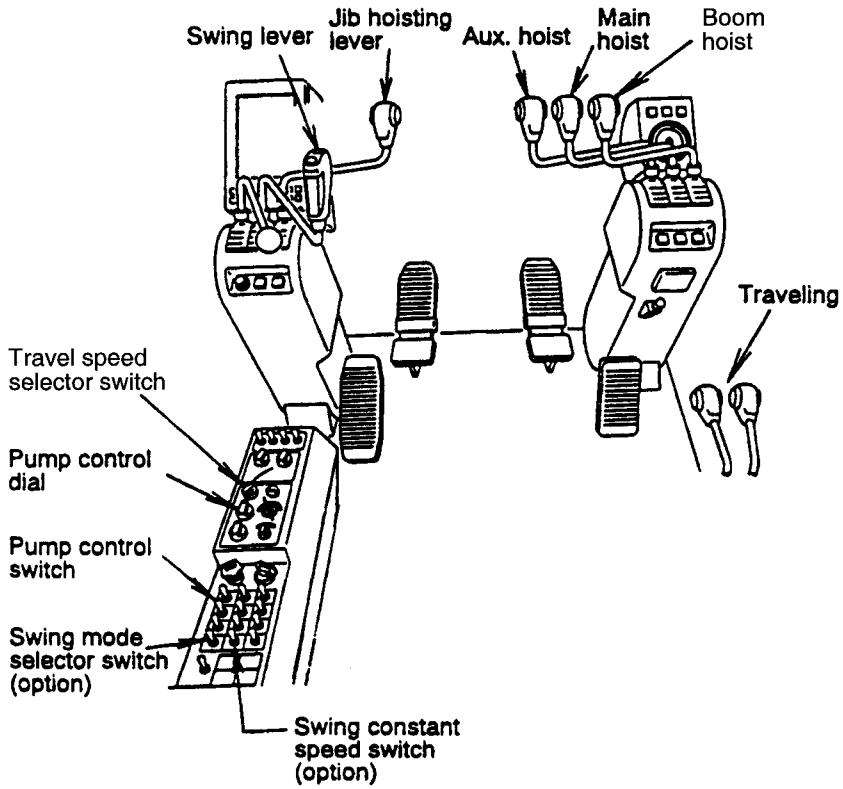
1. If the boom and jib are outside the hoist range, the boom or jib hoist winch stops automatically.
2. The jib operating range is limited by the boom inclination angle.
3. Examine the weight and size of a load, necessary working radius, lifting height, etc. fully before starting the operation.
4. Refer to the specifications for the details of the working range and related load.

11-3 Operation of luffing jib crane



1. Before starting work, consider the boom inclination and jib hoist angles applicable to the working conditions (load and working radius) and select an adequate working range. If the auto stop works during lifting work, something unexpected will happen.
2. It is safer to avoid combining 3 or more actions. The link operation of the boom inclination and jib hoisting during lifting work is unstable.
3. The lifting and swing actions often give a shock upon the jib when the tower jib is at a low angle. Take great care.

4. When load is at a high position, be careful about the machine stabilization and operate gently.
5. Don't travel while lifting a load. Overload is applied to each mechanical section.
6. Make sure that the overload prevention device switch is in operation position and that the tower/crane selector switch is set at the tower side.
7. Make sure that the indication of the overload prevention device display is set to the machine's actual condition. Select the switch positions as shown below for table operation.



1. Select the swing constant speed control not to be affected by other operations. (Option)
2. Select the low speed traveling so as not to sway the attachment.

⚠ DANGER

It is prohibited to use the main and auxiliary hoisting simultaneously. Do not do that. The moment limiter does not operate correctly.

⚠ CAUTION

When the auxiliary hoisting is set at the second speed while the main hoisting is at the first speed, the main hoisting stops. Keep this in mind while operating the machine.

11-4 Operation of luffing tower crane

When a tower crane is used, exclude the boom main hoist suspension from the luffing jib crane operation and set the jib hoist wire on the auxiliary hoist drum.

1. The luffing tower crane does not have the specification for boom main hoist suspension. Therefore it does not have a main hoist rope, 25 ton hook and tower top's sheave block.
2. Use the main winch lever for hoisting a load and the auxiliary winch lever for hoisting the tower jib.
3. Change the Work Mode No. of the overload prevention device from 71 (luffing jib crane) to 81 (luffing tower crane).

The precautions are shown below for handling the luffing jib/luffing tower crane.

⚠ CAUTION

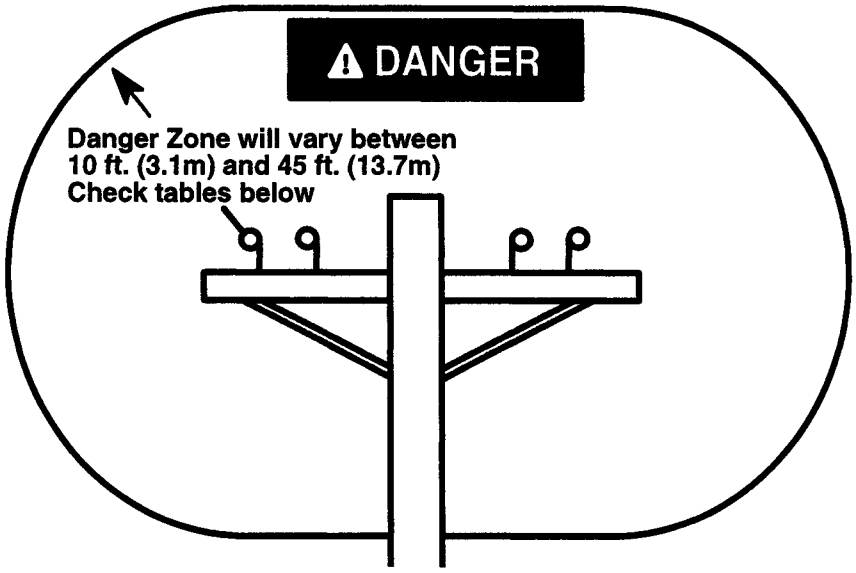
1. **Check the following items before starting the operation:**
   - **Make sure that the overload prevention device is in operation position.**
   - **Make sure that the indication of the overload prevention device is fit to the machine's actual condition.**
   - **Make sure that the crane/tower selector switch is on the tower side.**
2. **Before starting the operation, actuate the switches and make sure that the devices, indicator lamps and alarms operate correctly.**
3. **Make sure that the safety device limit switches operate correctly by actuating them manually.**
4. **Start or stop the machine slowly and carefully so as not to sway the attachment.**
5. **When wind exceeds the average maximum velocity of 22 mph (10 m/sec), stop the operation at once and put the tower attachment or crane attachment on the ground.**
6. **When the boom crane is operated while the middle equalizer is stored in the inner boom, the middle equalizer's wire rope is tensed by lowering the boom. The equalizer mounting bracket or boom may be damaged. Make sure that the equalizer's wire rope is not tensed when the boom is put on the ground.**

⚠ WARNING

Observe the following items to operate the tower crane safely.

1. **Use the crane in the range of the tower allowable angle. If the crane exceeds the allowable angle, it may lose stability and tip over.**
2. **Make sure that there is no person or obstacle in the tower crane moving range.**

DANGER ZONE NEAR ELECTRICAL TRANSMISSIONS LINES



When operating near high voltage power lines:

NORMAL VOLTAGE (Phase to Phase)					MINIMUM REQUIRED CLEARANCE	
From	0	to	50	KV	10 Ft.	(3.1m)
Over	50	to	200	KV	15 Ft.	(4.6m)
Over	200	to	350	KV	20 Ft.	(6.1m)
Over	350	to	500	KV	25 Ft.	(7.6m)
Over	500	to	750	KV	35 Ft.	(10.7m)
Over	750	to	1,000	KV	45 Ft.	(13.7m)

While in transit with no load and boom or mast lowered:

NORMAL VOLTAGE (Phase to Phase)					MINIMUM REQUIRED CLEARANCE	
From	0	to	.75	KV	4 Ft.	(1.2m)
Over	.75	to	50	KV	6 Ft.	(1.8m)
Over	50	to	345	KV	10 Ft.	(3.1m)
Over	345	to	750	KV	16 Ft.	(4.9m)
Over	750	to	1,000	KV	20 Ft.	(6.1m)

NOTE: Consult local power company for specific (on site) recommendations. Always be aware of and observe applicable ordinances.

12-3 Precautions for lightning

DANGER

1. **Lightning damages a crane and injures the persons around. If lightning is going to occur, stop the crane operation and put the boom on the ground. If lightning has struck a crane, check every section carefully and make sure that there is no problem. Then, start the crane. Also, check the inside of the wire ropes.**
2. **If the weather forecast says that lightning is approaching, stop the crane operation and engine. Then, disconnect the electrical cables for the boom from the harness for the base machine and relay connector. If this is done, damage can be minimized if lightning strikes the crane.**

Section 2

DISASSEMBLY, ASSEMBLY AND TRANSPORTATION

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3/00

IMPORTANT NOTES CONCERNING RIGGING

The information given in this section of the book covers many different combinations of booms and jibs applicable to the general cranes.

Because we manufacture machines which are extremely specialized, we recommend that you check your ratings charts which are provided with your machine before attempting some type of combination your machine may not be equipped for.

All limitations are very clearly explained in our ratings charts. Use the following information with these limitations in mind.

Performance data according to model is given in the "Machinery Plan and Elevation" section. However, this is not intended to take the place of a rating.

Should any questions arise, feel free to contact the American Crane Customer Service Department for prompt assistance.

American Crane Corporation assumes no responsibility for misuse of data supplied in the operator's manual as a general guide.

BOOM ASSEMBLY, DISASSEMBLY, AND BOOM LENGTH CHANGES

This set of procedures is organized according to the following outline:

I. Assembly and Boom Raising Procedures
   - A. Essential Safety Precautions
   - B. Boom Assembly with Service Crane On-Site Assembly (Method "A")
   - C. Boom Assembly with Service Crane Pre-Assembly (Method "B")
   - D. Boom Assembly without Service Crane

II. Disassembly and Boom Lowering Procedures
   - A. Essential Safety Precautions
   - B. Boom Disassembly with Service Crane
   - C. Boom Disassembly without Service Crane

III. Boom Shortening or Lengthening

These procedures are intended for all standard booms (excluding only those booms used with a floating mast) which are approved for American Crane crawler, self-propelled and truck-mounted cranes. Requirements for locomotive and pedestal cranes are specialized and will vary somewhat from the recommended procedures given here.

Depending upon the type of assist equipment available at the job site, and the specific task to be performed, any one of the working procedures listed above may be called for at any given time. It is the responsibility of the crane owner and operator to determine the adequacy of available service equipment, and the method of assembly or disassembly to be used. Along with following the correct set of step-by-step procedures, it is vital that the appropriate general safety precautions (I-A. or II-A., above) are observed.

COLORS:

RED

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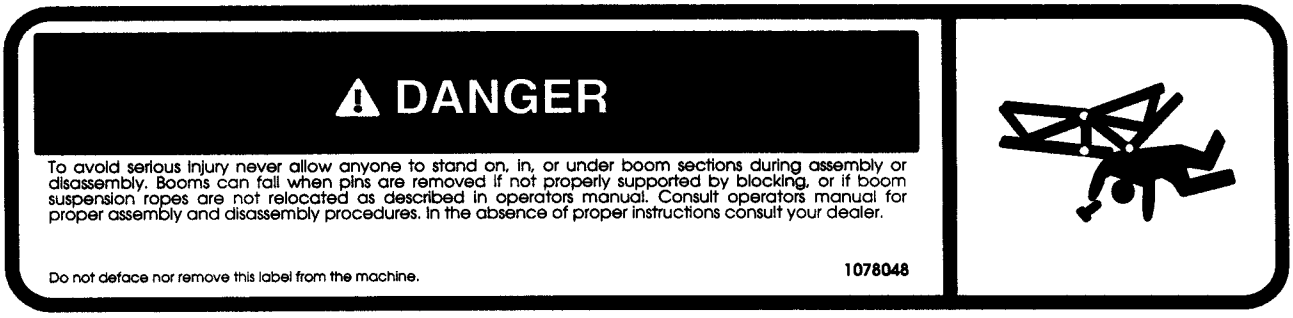


Figure 1

I. Assembly and Boom Raising Procedures

A. Essential Safety Precautions for Assembly and Boom Raising

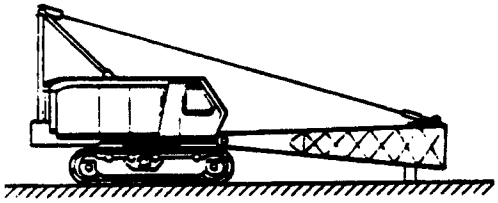
1. Before starting any procedure, make sure the crane and boom are standing level on a firm, uniformly supporting surface. Attempting to work over uneven and unstable terrain can produce accidents. Sudden loss of support and unexpected weight shifts can cause injury to personnel and damage to components. If the operating surface is not level or adequately supporting, crane mats must be used.
2. Keep the boom off the ground. Always rest the boom - or individual boom sections - on blocking rather than on the ground, to avoid damaging chords, sheaves, or load line. Never ride in or on the boom during any part of the assembly or raising procedure.
3. Before assembling the boom, inspect all chords, lacing and splice connections for damaged or bent areas. Any cracks, deep scratches, gouges on the chords, or dented or deformed lacings will severely weaken the structural integrity of the boom. If damage is found, the boom section involved must not be used until repairs are made.
4. Damage to boom sections occurs most often during handling, either before or after transport or during assembly. Take care when attaching slings. Never attach slings to light lacing members, only to chords or plated areas. Use synthetic web slings whenever possible to avoid cutting or scratching chords. If wire rope slings are used, protect the chords with softeners - for example, 2" x 4" wood splints placed between the sling and boom.
5. The A-frame must always be fully raised whenever the outer bail is pinned to the boom inner for handling boom sections or whenever the completed boom is raised for work.
6. The force of the wind on individual boom sections can be dangerously unpredictable, depending upon the direction and speed of the wind as well as on the individual length of the section and its angle to the wind. Postpone completing the boom assembly and erection procedure whenever wind gusts are creating hazardous conditions.
7. Never stand underneath a boom section while driving pins in or out. Never remove any pin from between boom sections unless you are certain all boom sections are adequately supported and cannot fall, scissor or jerk when the pin is removed. Always stand well clear of boom pins being removed! When the boom is on the ground on blocking, ready for disassembly, there may still be some load on individual pin connections. Under pressure from the weight of one or both of the adjoining sections, pins may fly out of their bores, as they are driven out, with explosive force.
8. It is vital that, no matter which boom assembly procedure is used, the correct sequence of steps is followed, in the specified order, to prevent injury or death to personnel and damage to equipment. American cranes self-erect all boom or boom-jib combinations shown on the machine's Rating Chart, unless specifically stated otherwise. In general, the erection (or lowering) of near maximum boom or boom-and-jib combinations can only be accomplished over the end of the crane's lower works. On crawler cranes the boom must be erected (or lowered) directly over the idler end of the crawler lower with idler tumblers securely blocked. On rubber tired cranes the outriggers must be fully extended and set, and the boom erected or lowered directly over the rear of the carrier. Keep this in mind when laying out boom for assembly, and especially before lowering a boom for disassembly. Follow the boom-jib erection table and the boom-jib composition table on the crane's Rating Chart for maximum erection capability (and reduced capability of erection performed over the side), as well as the proper boom-jib sections to be used and their order of composition. Erection or lowering boom over the side of the machine must only be performed with the crawler sideframes fully extended or with outriggers fully extended and set.

Note: Near maximum erection capability on truck cranes may require bumper counterweight.

9. Never attempt to raise an assembled boom from the ground when wind speeds exceed those listed in the boom combination/wind speed table on Page 3499.1.
10. Before a boom is raised, always look it over carefully to make sure no lines or pendants are hung up on the boom. Look at all boom and pendant pins to see that they are completely installed with keeper pins secured. Also look out for loose timbers or rigging hardware left on or in the boom. As the boom is raised these will fall and could injure or kill someone.
11. When raising (or lowering) a boom, pay out load line so that the load block and any suspended tackle is on the ground whenever the boom is below the lowest boom angle shown on the crane's Rating Charts. Before lowering a boom, lay tackle and block to one side or the other to prevent interference with the boom when it is lowered down to blocking.
12. The weight of accessories added in the field such as lights, cables or timbers fastened to the boom will reduce the crane's self-erection capability. Consult American Crane to determine the effect of such accessories.

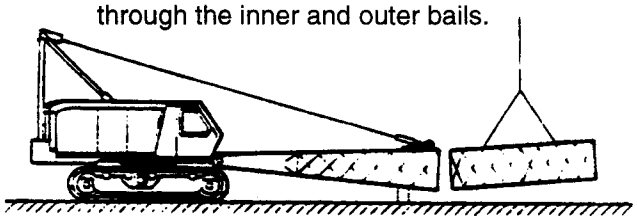
I. Assembly and Boom Raising Procedures

B. Boom Assembly with a Service Crane - On-Site Assembly Method (Method "A").



1. Make sure all safety precautions (Section I-A.) are observed before starting the assembly sequence. Use the service crane to pin the boom inner section to the machinery deck.

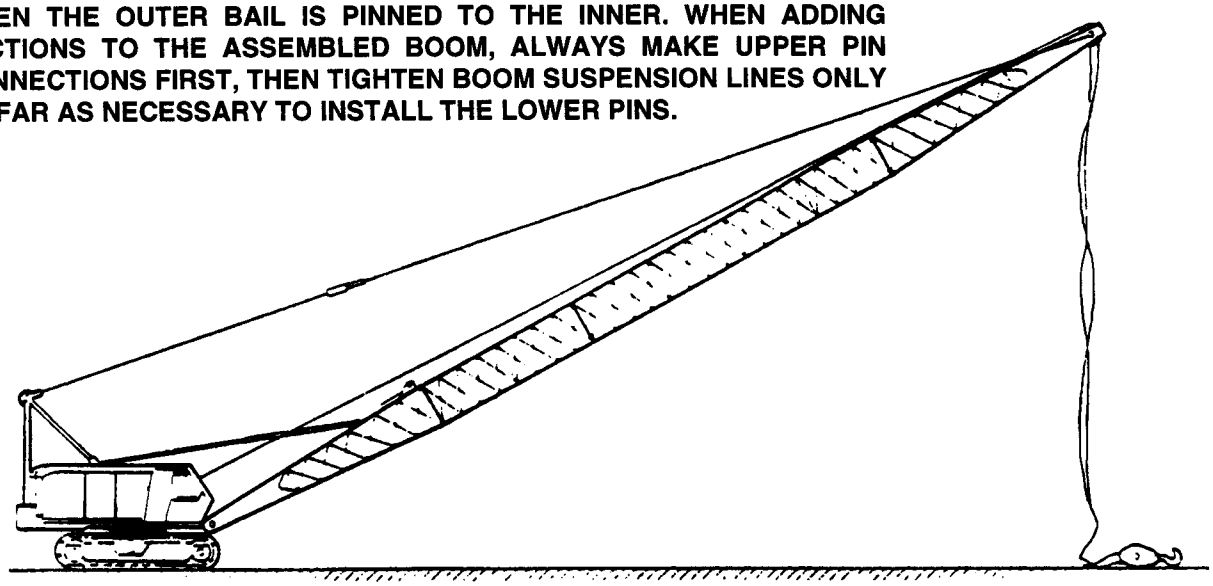
Place enough blocking under the outer end of the section to allow the next section to be pinned on without hitting the ground. Connect the outer bail to the ears on the end of inner section, using required adapter links where necessary. Reeve the boom hoist line from the boom hoist drum through the inner and outer bails.



2. Using the service crane, bring in the next adjoining section and pin it to the inner. Follow the boom composition table included with the crane's Rating Chart for the proper sequence of assembly. To allow upper pin connections to be made more easily, place slings so that the boom section is tipped slightly. (Refer to the illustration above.) To assist in making the lower pin connection, after upper pins have been installed, release the service crane slightly, allowing boom section to pivot on the upper pins until lower connection holes line up. Before setting the boom down, lift the connected sections up and move blocking out to the far end of the last installed section. Repeat this procedure, one section at a time, all the way out to the boom tip. Always move the blocking to the far end of the boom before adding the next section.
3. After the tip section has been pinned to the rest of the boom, measure all pendants carefully to make sure the total length of both and the right and left side pendants will be equal. Connect the appropriate pendants between the outer bail and boom tip. Disconnect the bail from the inner when pendants have been connected.
4. Install boom stops. Before raising the boom to working position, read through the checklist of safety precautions (Section I-A, Items 1-12). The boom can be raised to working height when all safety precautions have been observed. Watch suspension ropes and pendants to make sure they don't catch on boom pins or cotter pins.

⚠ WARNING

NEVER ATTEMPT TO RAISE THE WHOLE BOOM UP OFF OF BLOCKING WHEN THE OUTER BAIL IS PINNED TO THE INNER. WHEN ADDING SECTIONS TO THE ASSEMBLED BOOM, ALWAYS MAKE UPPER PIN CONNECTIONS FIRST, THEN TIGHTEN BOOM SUSPENSION LINES ONLY AS FAR AS NECESSARY TO INSTALL THE LOWER PINS.



I. Assembly and Boom Raising Procedures

C. Boom Assembly with a Service Crane - Pre-Assembly Method (Method "B").

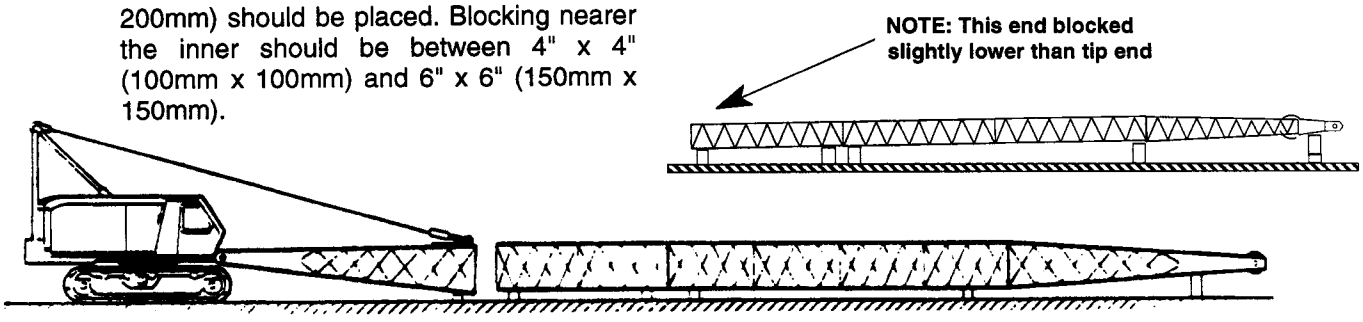
1. If the crane is not at the same location as the boom, but is to arrive at the job site later, the boom may be pre-assembled on blocking ahead of time, using an on-site service crane. This can also be done with longer combinations, to avoid the need for moving blocking out to the end each time another section is added (as in Method A). Except for the boom inner section, which is always pinned to the machinery deck before the pin connections are made to the first center section, the boom should be pre-assembled on blocking that is slightly higher out towards the tip section than it is near the first center section. The illustration below shows the approximate location where taller blocking (minimum recommended size 8" x 8", or 200mm x 200mm) should be placed. Blocking nearer the inner should be between 4" x 4" (100mm x 100mm) and 6" x 6" (150mm x 150mm).

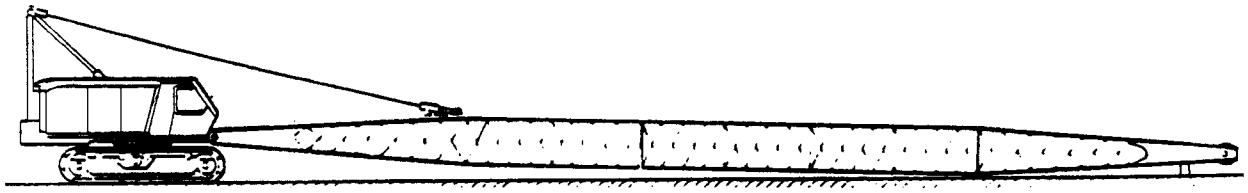
   Follow the boom composition table on the crane's Rating Chart for the proper sequence of boom sections to be assembled.

2. Pin the boom inner section to the machinery deck of the crane. Lower the inner section down to blocking in front of the machine, so that the outer bail can be connected to the ears on the end of the inner section. Reeve the boom hoist line from the boom hoist drum through the inner and outer bails.

3. Move the crane forward and connect the two top pins of the inner section to the adjacent center section. The weight of the boom must be entirely supported on blocking as the pins are installed.

Note: It will be easier to make this connection if the blocking has been arranged as recommended in C.1, above; higher toward the tip and lower under the first center section.





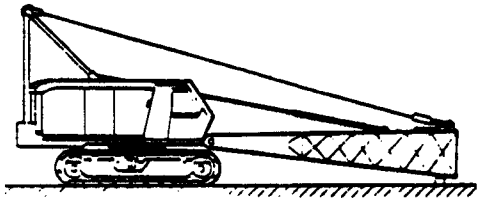
WARNING

DO NOT ATTEMPT TO PICK THE COMPLETE BOOM OFF THE BLOCKING. THE WEIGHT OF THE BOOM SHOULD SAFELY PIVOT ON THE UPPER PIN CONNECTIONS AND THE TALLER BOOM BLOCKING NEAR THE TIP SECTION.

4. Raise the boom slightly, using the boom suspension lines, so that the bottom two splice pins can be inserted.
5. Lower the boom down on blocking until bail lines are slack, and the outer bail is laying flat supported on the bail rest. Repeat Steps B 3 and B 4 from the previous procedure (I-B) to install pendants and boom stops.

I. Assembly and Boom Raising Procedures

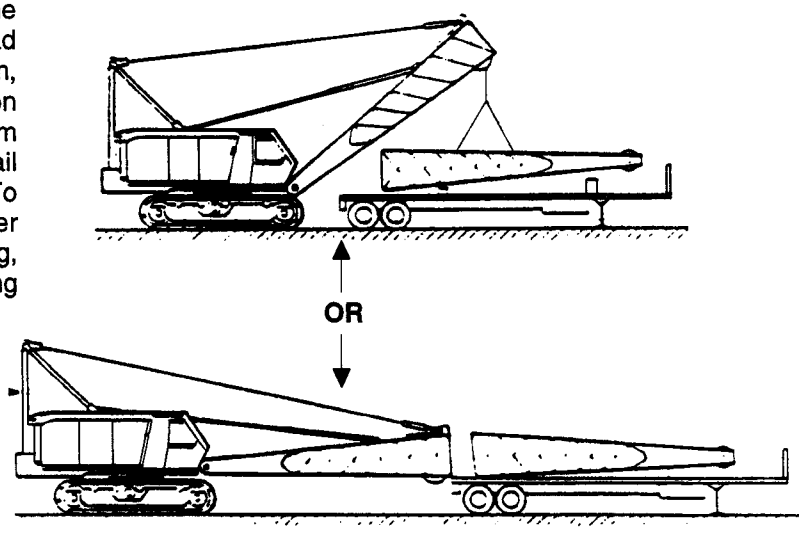
D. Boom Assembly without Service Crane

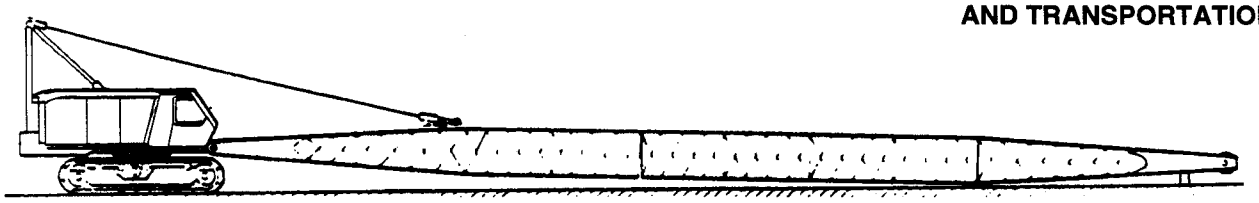


1. When no service crane is available to assist with boom assembly, the crane can use its own inner section to unload and assemble the complete boom, section by section. The inner section must already be in place, the boom suspension line reeved and the outer bail pinned to the end of the inner section. To prevent pulling the inner section over backwards while raising and lowering, install crane boom stops before handling other boom sections.
2. Remove the boom tip section from the transporting truck. This can be done either with the counterweight handling sheaves in the boom inner (if available) or by pinning the tip directly to the boom inner. Move the tip to a clear area where the boom can be assembled and lay it on blocking. Unpin the tip from the inner if it was carried in that way.
3. When joining new sections to the tip, or to whatever length of boom has already been assembled on blocking, the blocking should be supporting the weight of the boom sections at all times.

WARNING

NEVER ATTEMPT TO RAISE THE WHOLE BOOM FROM OFF BLOCKING WHEN THE OUTER BAIL IS PINNED TO THE INNER. WHEN ADDING SECTIONS TO THE ASSEMBLED BOOM, ALWAYS MAKE UPPER PIN CONNECTIONS FIRST, THEN TIGHTEN BOOM SUSPENSION LINES ONLY AS FAR AS NECESSARY TO INSTALL THE LOWER PINS.





4. Unload the next boom section (working back from the tip) by repeating whichever procedure was used in the previous step. Follow the boom composition table on the crane's Rating Chart for the proper sequence and move the next specified adjacent section to the tip and pin the two together on blocking. If there are no counterweight handling sheaves in the inner section of the boom, careful disassembly is required each time the inner is unpinned from the last assembled section. After lower pin connections are assembled to the boom sections on blocking, do not slack off on the boom suspension lines. Take a strain into the boom suspension lines to remove the load from the bottom pins on the end of the inner section. Take these pins out first, then disassemble the upper pin connections. Repeat this procedure with each succeeding boom section. Always lift the blocked sections only enough to assemble (or disassemble) lower pin connections.
5. After the last section has been pinned in place, measure all pendants carefully to make sure the total length of the right and left side pendants will be equal. Connect the appropriate pendants between the outer bail and the boom tip. Disconnect the bail from the boom inner. Before raising the boom to working position read through the checklist of safety precautions (Section I-A, Items 1-12). The boom can be raised to working height when all safety precautions have been observed. Watch suspension ropes and pendants to make sure they don't catch on boom pins or cotter pins.

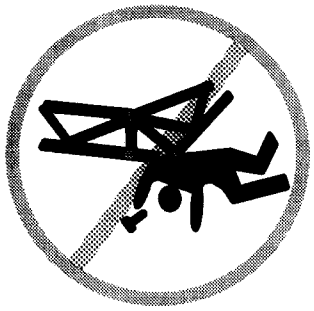
II. Disassembly and Boom Lowering Procedures

A. Essential Safety Precautions for Boom Lowering and Disassembly

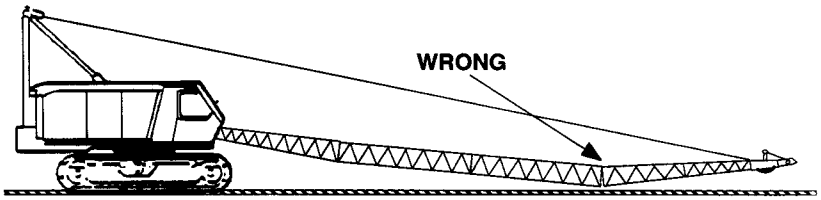
1. When preparing to lower and disassemble the boom, observe all of the precautions that apply to boom raising. Read through the list of safety procedures (Section I-A). In addition:
2. Never attempt to lower near maximum boom or boom-jib combinations when wind speeds or gusts are approaching the limits shown for that boom combination in the wind speed table (Page 3499.1). Be especially careful when winds are blowing from behind the crane, in the same direction that the boom tip is pointing.
3. Never attempt to lower near the maximum amount of boom or boom-jib combination if there is a heavy accumulation of ice or snow on the boom.
4. When lowering a boom past the longest radius on the crane's Rating Chart, reduce the boom lowering speed gradually to prevent a possible shock load on the boom or tipping. When lowering the boom on all friction machines, boom lowering speed can be reduced by setting the main hoist brake and slightly engaging the main hoist clutch. This will slow the gear train and retard the boom speed, as the clutch tries to turn the drum with the brake set. On Model HC-80, select slow speed by depressing the switch located on the left side of the boom lever grip.

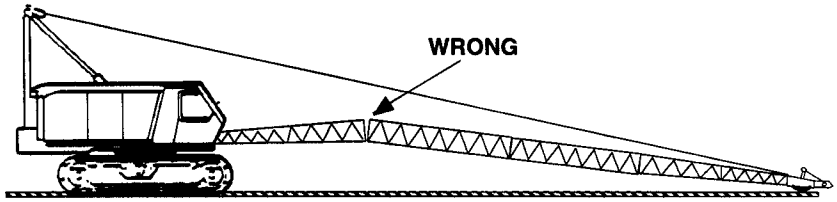
⚠ WARNING

5. **NEVER REMOVE ANY PIN FROM A BOOM SECTION UNLESS YOU ARE ABSOLUTELY CERTAIN THE BOOM IS ADEQUATELY SUPPORTED AND CANNOT FALL, SCISSOR OR JERK WHEN THE PIN IS REMOVED. NEVER STAND UNDERNEATH A BOOM SECTION WHILE DRIVING PINS IN OR OUT.**



6. Always stand well clear of boom pins being removed! When the boom is on the ground on blocking, ready for disassembly, there may still be some load on individual pin connections. Under pressure from the weight of one or both of the adjoining sections, pins may fly out of their bores as they are driven out, with explosive force.
7. Disassembly of any pin-connected boom can be hazardous. Never remove upper or lower pins until boom is lowered to the ground on secure blocking and the outer bail has been pinned to the inner section. The illustrations show what will happen if pin connections are broken in the wrong places.



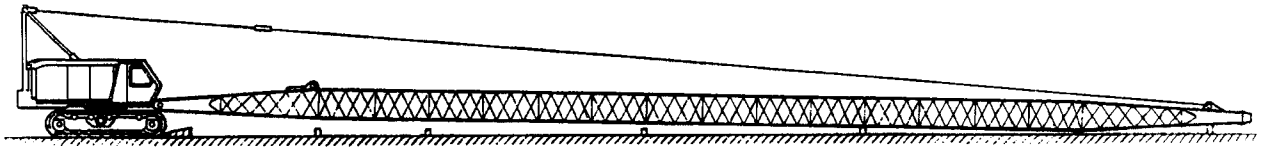


B. Boom Disassembly with Service Crane

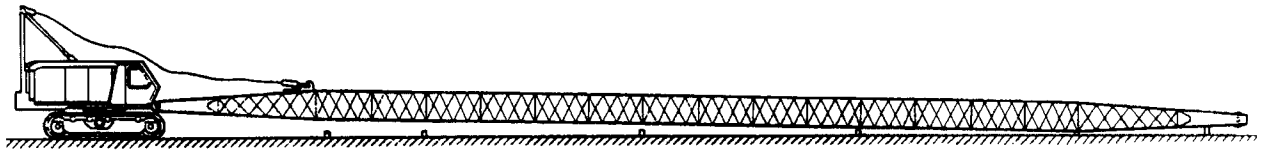
Note: All boom disassembly procedures begin with the next two steps B-1 and B-2. Refer to these steps when disassembling the boom without a service crane, or when lowering the boom to change composition.

1. After making sure that all general safety precautions pertaining to boom disassembly have been observed, lower the boom onto blocking. There should be enough blocking available for completely supporting the boom - and individual boom sections - when the boom is lowered and disassembled. For lowering the boom, blocking will be adequate if the tip is just off the ground - the rest of the boom will then be safely above ground level, at a good working height.

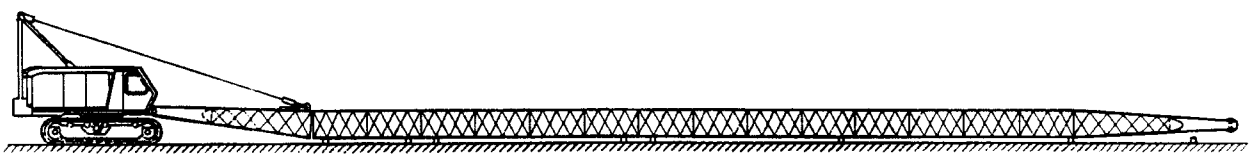
   With a few inches of clearance between the blocking and the boom chords just ahead of the inner section, there will be working room, if required, to take the load off the lower pin connections.



2. When the boom is completely down on blocking, slack the boom suspension lines completely and pin the outer bail to the boom inner section. Use appropriate links where necessary. Remove all boom pendants.

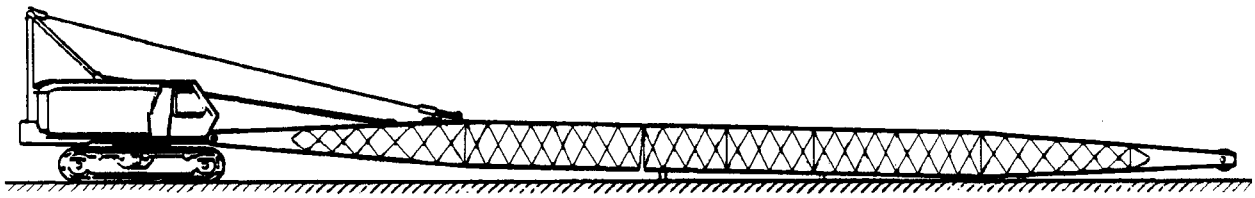


3. With the boom tip supported on blocking, take a strain into the boom suspension line which is attached to the boom inner. This will remove the load from the bottom pins between the inner and the first center section. Remove the bottom pins between the inner and the first center section and allow the center sections to lower onto the prepared blocking.



WARNING

DO NOT ATTEMPT TO RAISE THE WHOLE BOOM OFF THE BLOCKING WITH THE BAIL PINNED TO THE INNER SECTION.

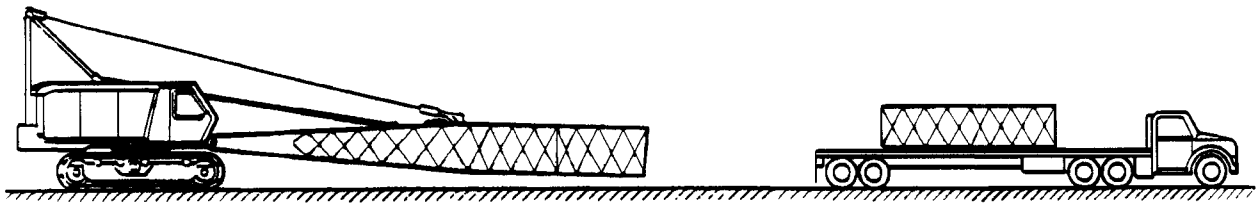


4. Remove the top pins between the inner and the first center section and back the crane away from the remainder of the assembled boom. Use the service crane to disassemble the boom center sections and tip. The service crane can then remove the inner section from the crane after the bail has been unreeved.

C. Boom Disassembly without Service Crane

1. The boom lowering procedure and blocking requirements are the same whether or not a service crane is available to assist with boom disassembly. Begin this procedure by following Steps 1 and 2 in the previous section (II-B1 and II-B2).
2. With the boom tip supported on blocking, take a strain into the boom suspension line which is attached to the boom inner. This will remove the load from the bottom pins between the first two center sections. Remove the bottom pins and lower the boom down on prepared blocking.
3. When there are no counterweight handling sheaves on the inner, lower the boom all the way down on blocking and remove the upper pins between the first two center sections. Carry the first center section away pinned to the inner and unload it for transport by unpinning it from the inner. (This is the reverse of the Procedure for Assembly without a Service Crane.)

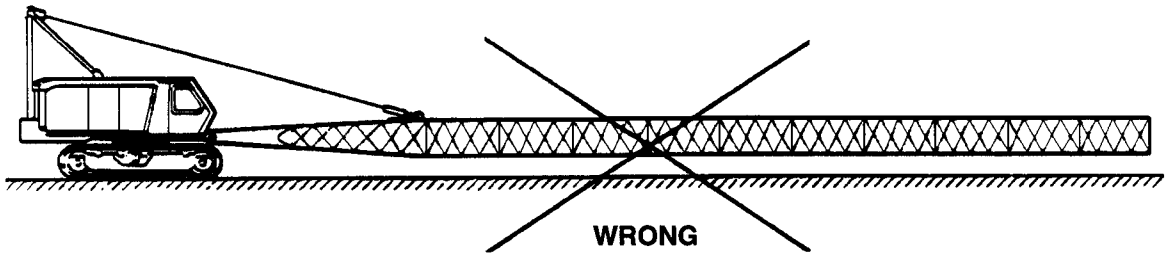
Note: If the boom can be disassembled using the counterweight handling sheaves in the boom inner, then repeat the first <u>three</u> steps of the previous procedure and disassemble the lower pin connection between the inner and the first center section. Lower the boom all the way down on blocking and remove the upper pins. Proceed with disassembly using the counterweight handling sheaves on the inner section.



4. Return with the crane and re-pin the top pins of the inner to the next center section. Take a strain into the boom suspension until the bottom pin holes are aligned and the bottom pins can be installed, then remove the bottom (and after them, the top pins) between the first two center sections to remove the boom section. Carry the boom section to the unloading point and repeat the process until all boom sections have been disassembled.

⚠ WARNING

UNDER NO CIRCUMSTANCES SHOULD MORE THAN TWO CENTER SECTIONS BE CANTILEVERED BEYOND THE BOOM INNER AT ANY ONE TIME. NEVER TRY TO LIFT THE ENTIRE BOOM WITH THE OUTER BAIL PINNED TO THE INNER SECTION.



WRONG

III. Boom Shortening or Lengthening

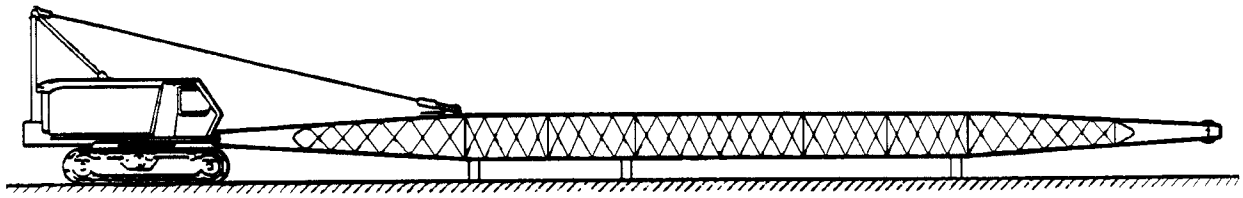
1. The boom must be fully lowered down to solid blocking every time boom composition is changed, to add or remove sections.

   The boom lowering procedure and blocking requirements are the same whether the boom is being lowered for disassembly or to change composition. Begin this procedure by following steps 1 and 2 for Disassembly with Service Crane (II B1 and II B2).

2. With the boom tip supported on blocking just above ground level, take a strain in the boom suspension line to remove some of the load in the boom bottom pins.

⚠ WARNING

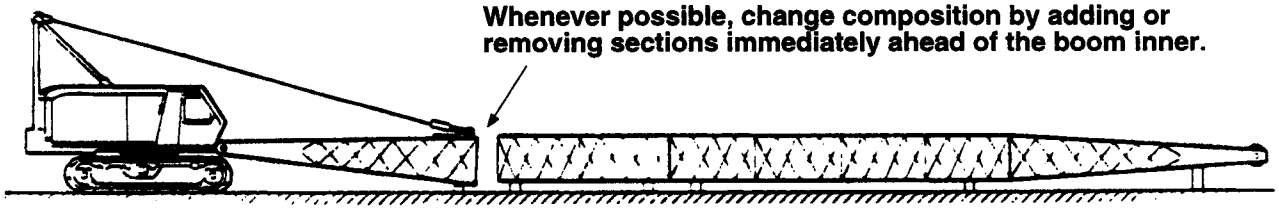
DO NOT ATTEMPT TO RAISE THE WHOLE BOOM OFF THE BLOCKING WITH THE BAIL PINNED TO THE INNER SECTION.



WARNING

THE PROPER WAY TO DISASSEMBLE PIN-CONNECTED BOOMS IS WITH THE OUTER BAIL CONNECTED TO THE INNER SECTIONS. WITH THE BAIL IN THIS POSITION THE BOOM IS SUPPORTED ONLY ON ONE END (OR CANTILEVERED). MAXIMUM BOOM LIFTING CAPABILITY IS REDUCED TO AT MOST THE BOOM INNER SECTION AND THE NEXT TWO CENTER SECTIONS.

1. Follow the boom composition chart (p.2-27.07) to make sure of the sequence of new boom assembly and to identify the splice points at which pin connections must be disassembled to add or remove sections. Unpin one pair of lower pins first, then remove the pins above them after the boom is all the way down on blocking.
2. Use an assist crane for changing boom composition if available. If no assist crane is available to perform this function, the crane must use its own inner section to change boom composition as required.



3. After changes are made, travel the crane back and pin the upper pins to the boom sections still on the ground. Take a strain of the boom suspension so that bottom pins can be inserted and then add or remove pendants as needed. The bail can then be unpinned from the boom inner section. The boom can now be raised following the procedures outlined in Section I, "Assembly and Boom Raising Procedures" for safe boom assembly and raising.

WARNING

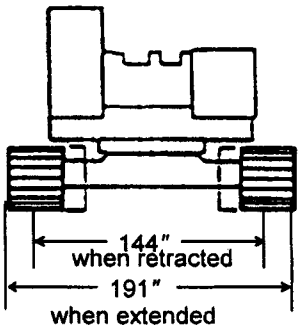
ALWAYS OBSERVE THE WIND SPEED LIMITATIONS (SHOWN IN THE TABLE ON PAGE 3499.1, "IMPORTANT LOAD LIFTING RESTRICTIONS AND REGULATIONS" SECTION IN THE FRONT OF THIS MANUAL) WHEN PERFORMING ANY BOOM ASSEMBLY OR DISASSEMBLY PROCEDURE.

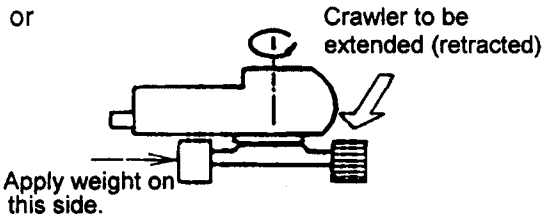
1. CHANGE OF CRAWLER WIDTH

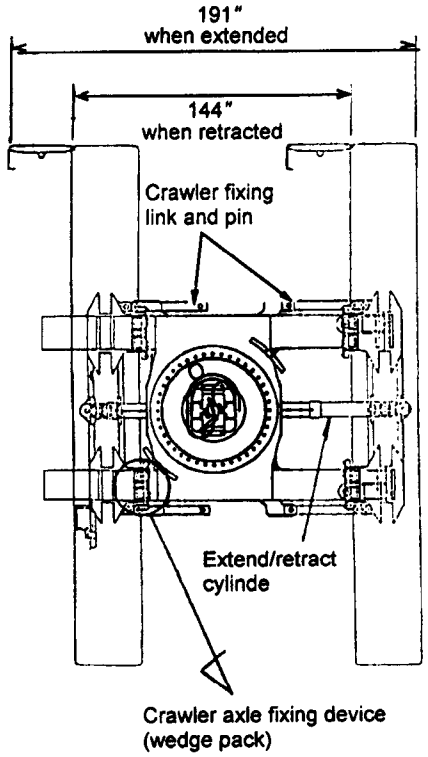
Although the front attachment and counterweight must be dismounted preliminarily as a rule, the crawler width may be changeable (when unavoidable) in the positions shown on the next page.

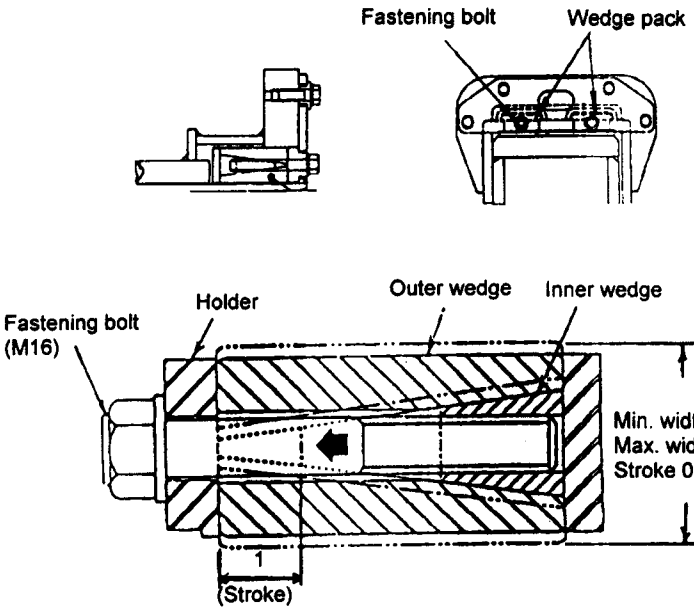
1. Move the crane to level ground. Operation tends to be easier on muddy ground rather than a concrete base. The crawler on each side is shiftable by 720 mm as shown in the figure at right.
2. In order to reduce the weight applied to the crawler to be shifted, swing the superstructure toward the opposite crawler so as to apply the weight of the superstructure, thereby facilitating crawler extension/retraction.

   The superstructure must be swung gradually with utmost care.
3. Check that the ground condition does not create a problem in the extension or retraction of crawler.
4. Loosen the wedge pack fastening bolt at 4 points of front and rear to release the fixed status of the crawler frame and axle, or remove the wedge pack.







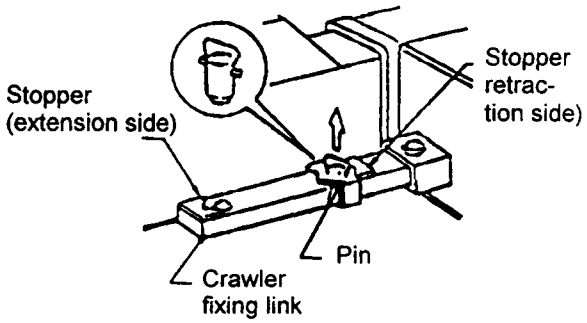


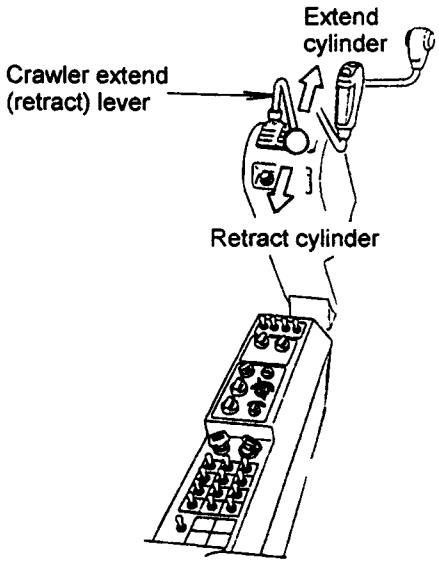
When tightening the fastening bolt (turning clockwise), the inner wedge moves as directed by the arrow to expand the outer wedge vertically, thereby fixing the crawler frame and axle.

When loosening the fastening bolt (turning counterclockwise), a gap is made between the axle and crawler frame. If the wedge pack cannot be slackened by loosening the bolt, the bolt head should be tapped.

5. Pull out the two crawler fixing link pins at the front and rear (pins of the crawler to be extended or retracted). The crawler fixing link pins of the opposite crawler must be kept inserted.
6. Adjust the engine speed to about 1,200 rpm and increase or decrease the crawler width by manipulating the crawler extend/retract lever.

   If the crawler is difficult to be shifted because of resistance applied on it, the crawler extend/retract lever should be manipulated while driving (traveling) the crawler to be extended or retracted at a very slow speed. This measure may be required particularly for retracting the crawler.
7. After the crawler has been extended or retracted up to the stopper of the crawler link, the pin must be inserted to fix the crawler frame and axle.
8. Tighten the wedge pack fastening bolts, which were loosened in previous step (4), in order to fix the crawler frame and axle.
9. Repeat steps (2) through (8) for changing the width of the opposite crawler.

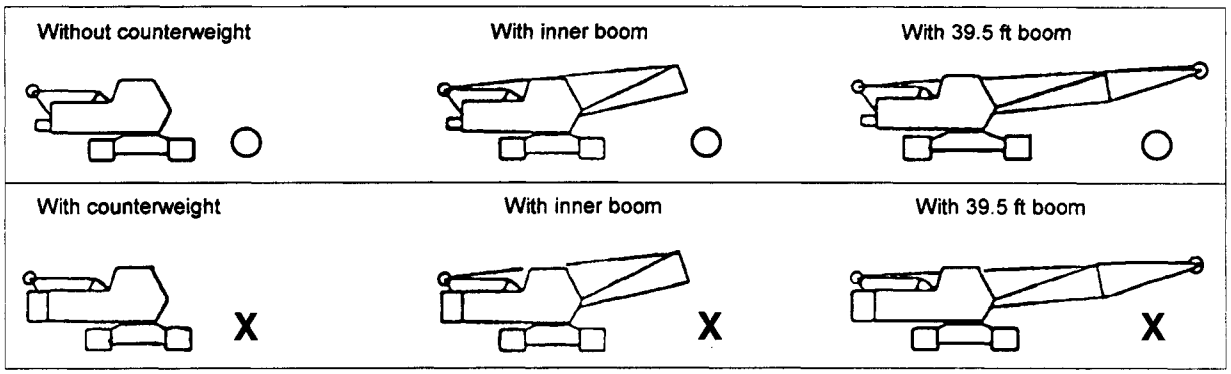




CAUTION

The crawler width can or cannot be extended or retracted in the crane positions shown below.

○ = Crawler width changeable **× = Crawler width unchangeable**

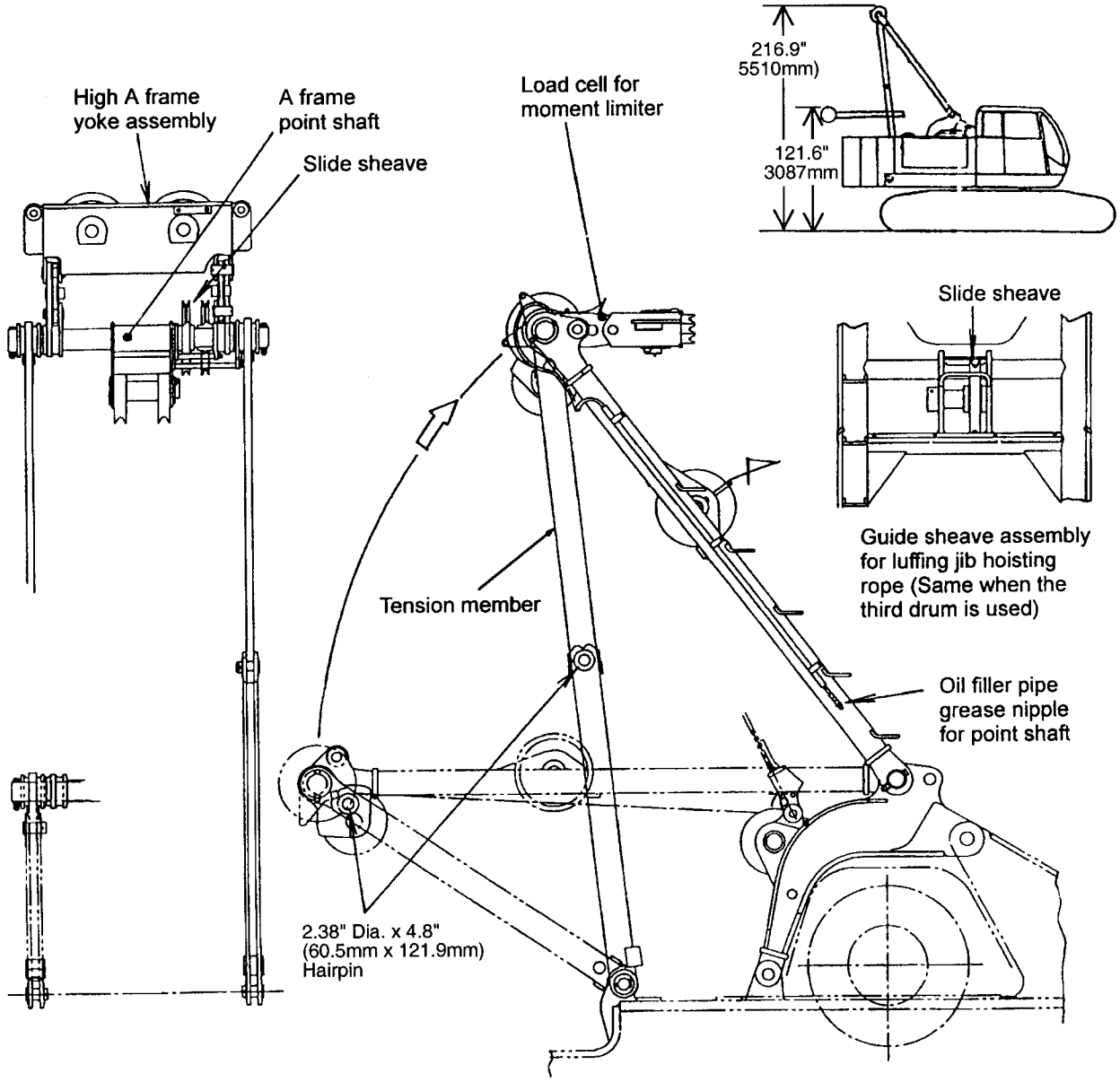


2. HANDLING OF A FRAME

The illustration shows the luffing jib crane specifications.

	Purpose of change
When folded	Transportation by trailer
When hoisted	Operation

2-1 Structure of A-frame



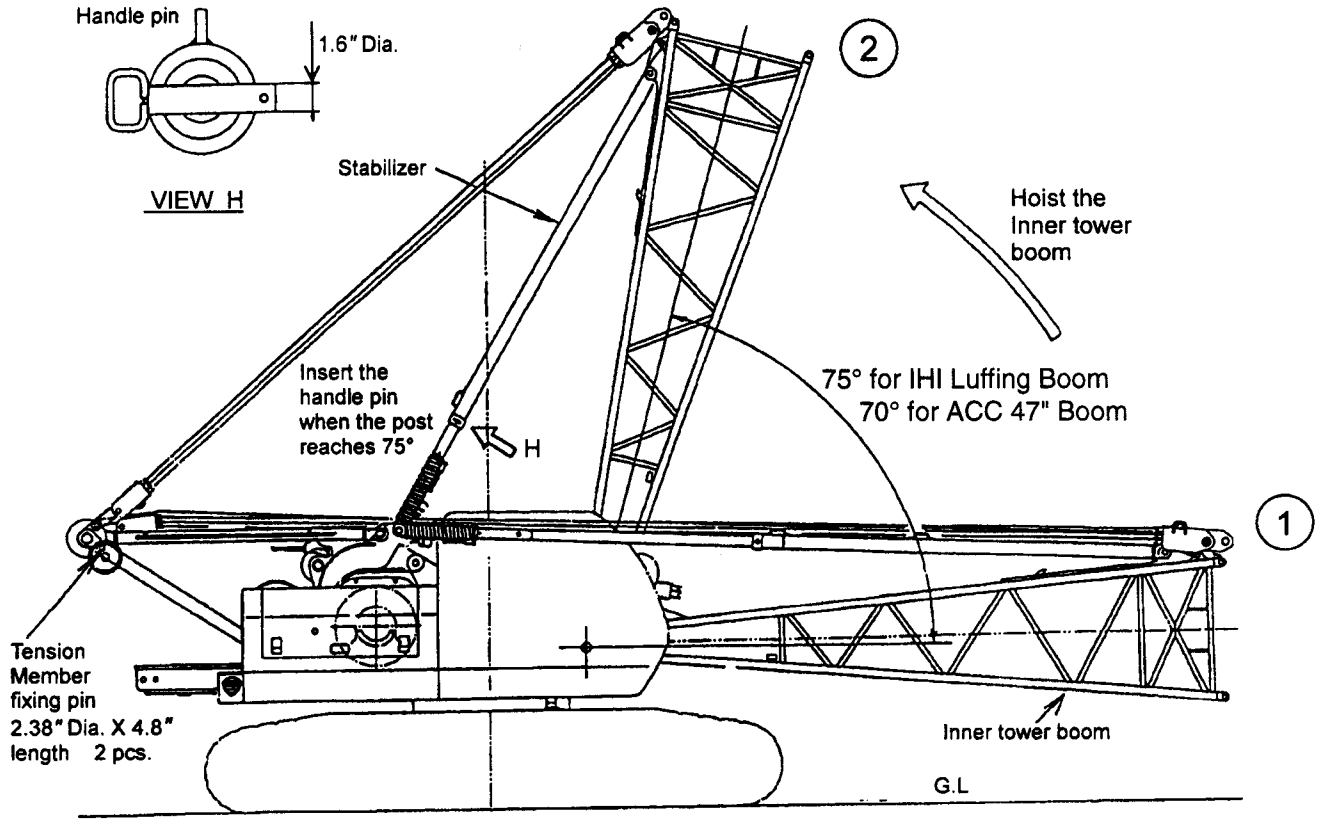
NOTICE

Operate a crane while the A-frame is being hoisted. If it is operated with the A-frame folded, an excessive force will be applied to the member and boom hoist rope. They may be damaged.

2-2 Change of A-frame height

The following figure shows the crane's transportation posture. The A-frame (gantry) is folded and lowered. The inner boom is supported by the equalizer and the crane's overall height is lowered.

1. Wind up the boom hoist cable to hoist the boom to the angle 75° for IHI luffing boom, 70° for ACC 47" boom ① ➡ ②
2. Insert the handle pin shown below to fix the inner and outer of the stabilizer. Set the ring pin as a stopper on the handle pin.
3. Remove the tension member fixing pin and hoist the boom to raise the A-frame. Raise the A-frame to the position where it is easy to mount the counterweight.



⚠ WARNING

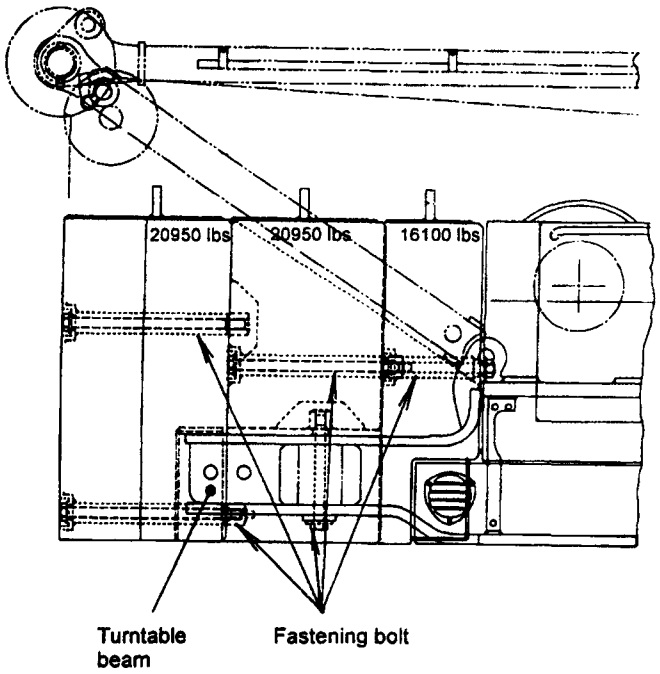
Observe the following items to avoid danger:

1. **When handling the A-frame, never enter the A-frame moving range. You may be caught by the A-frame.**
2. **Before hoisting the gantry, make sure that the wire harness for the load detector (load cell) of the moment limiter has an adequate length. If the wire harness is short, it may be cut or damaged.**
3. **Insert or pull out the pins from the outside of the A-frame after maintaining the footing.**
4. **Don't put your finger or hand into the pin hole.**
5. **When hoisting the folded A-frame, the wire rope for the middle equalizer will be pulled by about 1 m. Loosen the wire rope fully beforehand.**

3. MOUNTING OF COUNTERWEIGHT

Ref. No.	Mounting Position	Weight
1	Inner	5.0
2	Center	10.0
3	Outer	9.5
Total Weight		**24.5**

Unit: Ton



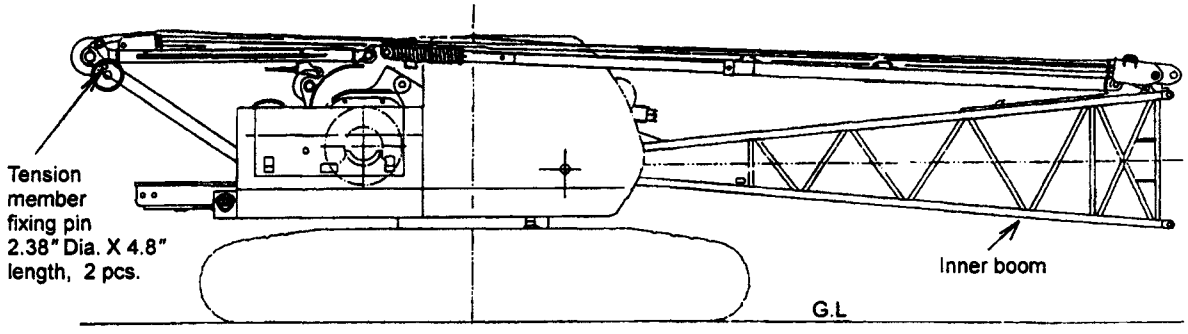
3-1 Mounting order

As illustrated below, in the transportation posture, the A-frame is lowered and the inner boom is mounted.

The counterweights are arranged as shown right: 5 ton at the inner side, 10 ton at the center and 9.5 ton at the outer side.

Counterweight installation method of luffing jib crane

1. Lift the three counterweights with the auxiliary wire rope by using the A-frame as a support. Move the counterweights horizontally by hoisting/lowering the A-frame. Move the counterweights vertically by winding up/off off the auxiliary wire rope.
2. The stabilizer is set on the inner boom point and the low A-frame. (Bind the stabilizer from swaying right and left due to vibration during transportation. If the stabilizer sways right and left, it touches the operator's cab.)



Transportation posture

3. Raise the inner boom to 75° as illustrated on the next page.

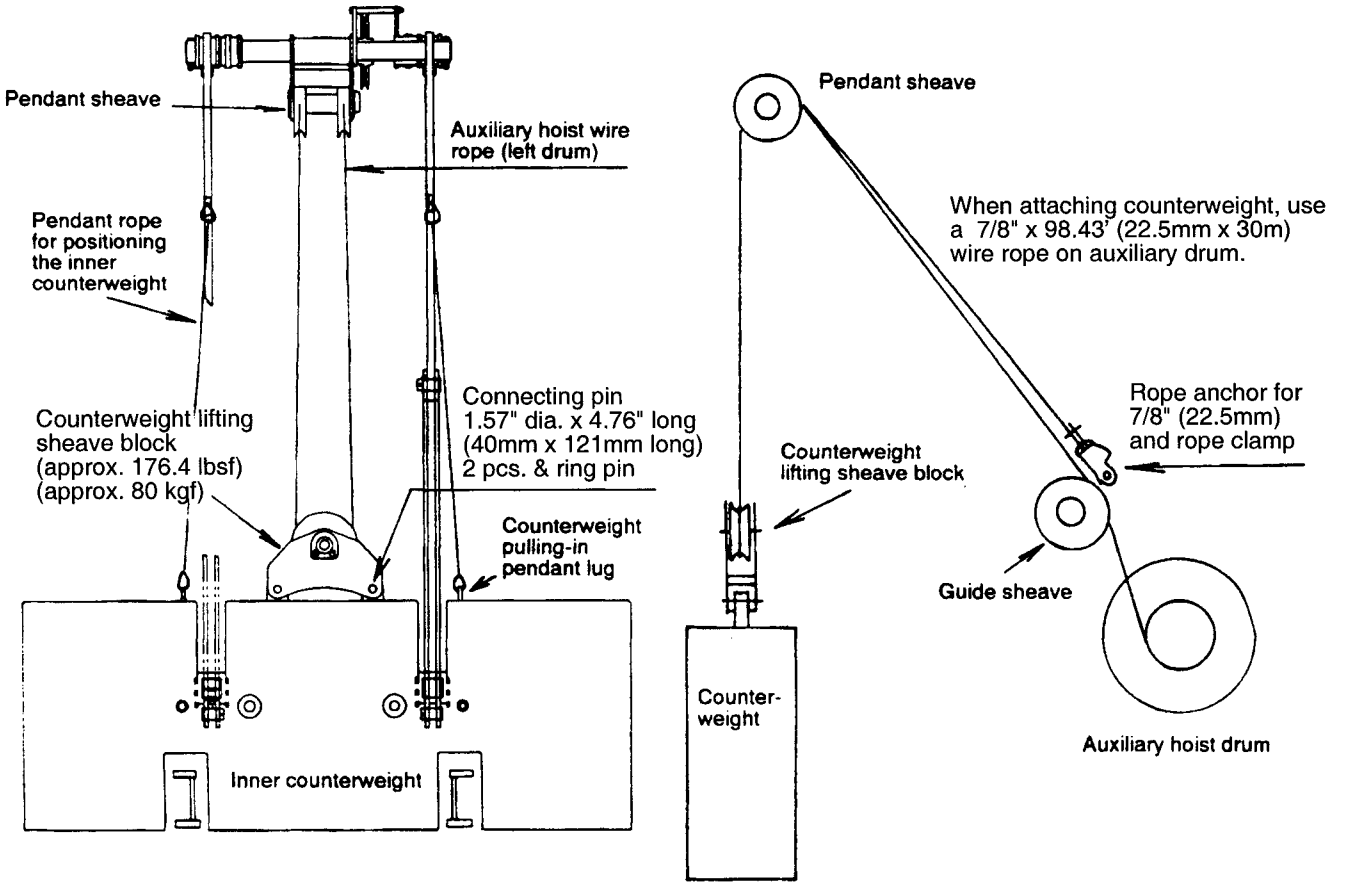
3-2 How to lift the counterweight and sling tools

1. Set the counterweight lifting sheave block. Pull out the wire rope from the auxiliary hoist wire drum. Pass the pulled-out rope through the guide sheave and then through the left side of the pendant sheave and lead it to the counterweight lifting sheave block. After passing the wire rope through the sheave block, pass it through the right side of the pendant sheave and fix it on the rope anchor.
2. Use a rope of 7/8" x 98.43' (22.5mm x 30m) in auxiliary drum. Arrange the sling rope to be 2-part line.

CAUTION

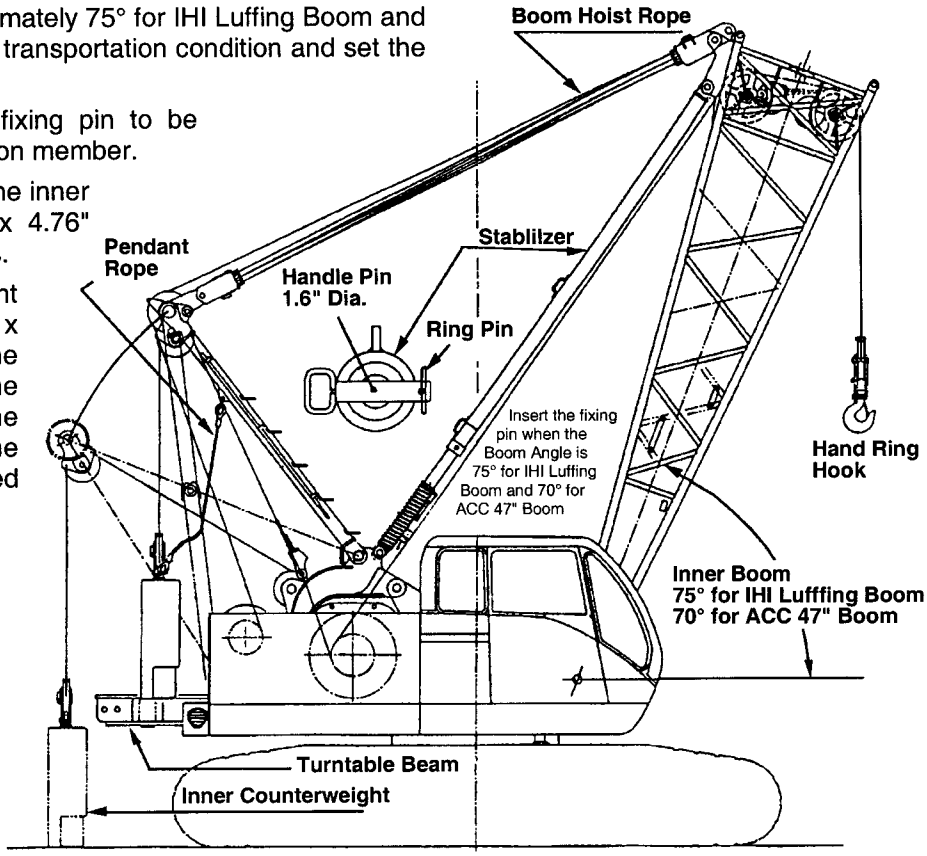
Mount the counterweight accurately.

1. **Unless a specified counterweight is mounted, the crane cannot demonstrate its performance fully. Mount a counterweight as specified.**
2. **Don't mount an extra counterweight inapplicable to the specifications. The crane's backward stability will be deteriorated causing crane to fall backward or be damaged.**

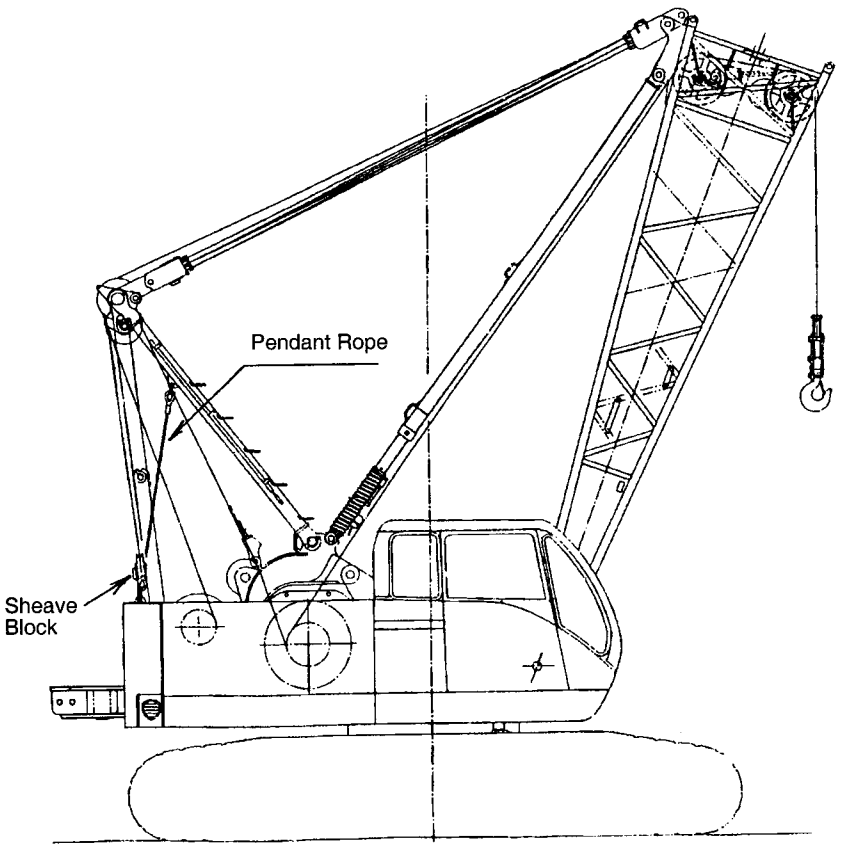


1. **Don't mount the counterweight while the crawler width is retracted. The machine may fall backward.**
2. **Don't mount the counterweight when machine is at the bottom of an inclined slope.**
3. **When lifting the counterweight, carry out mounting in a safe place where you cannot be caught between the counterweight and machine.**

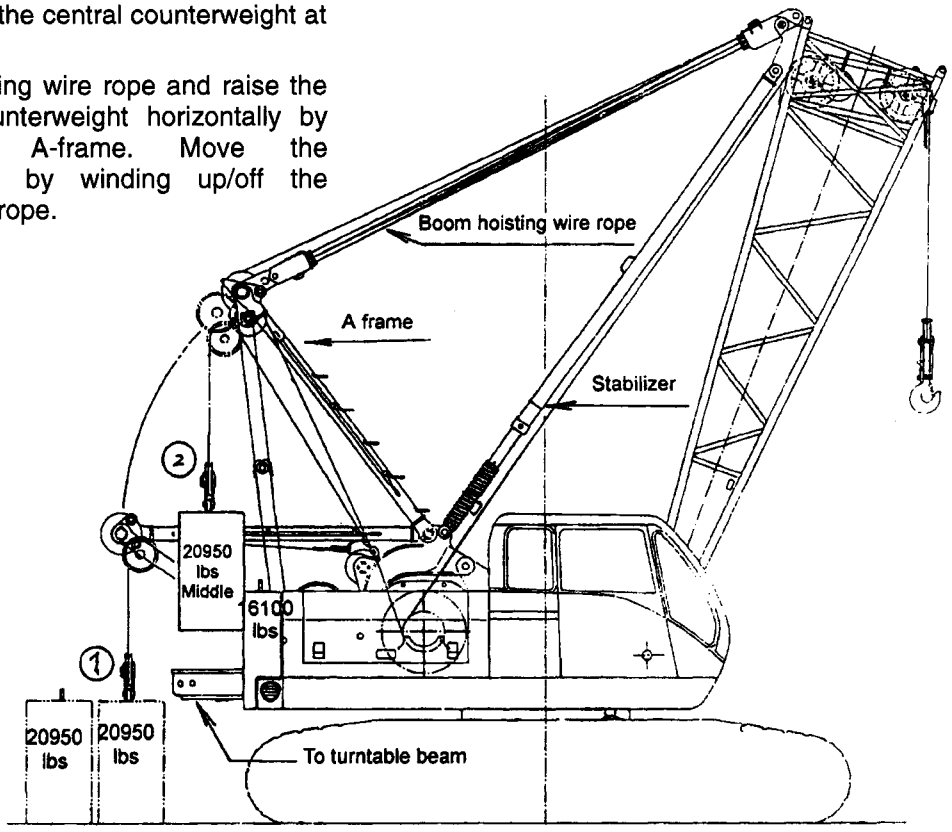
3. Raise the inner boom to approximately 75° for IHI Luffing Boom and 70° for ACC 47" boom from the transportation condition and set the stabilizer fixing handle pin.
4. Remove the tension member fixing pin to be able to hoist and lower the tension member.
5. Set the lifting sheave block on the inner counterweight. Pin 1.57" dia. x 4.76" long (40mm x 121mm), 2 pieces.
6. Hoist the inner counterweight with 7/8" dia. x 98.43' (22.5mm x 30m) hoist wire rope. Raise the A-frame to prevent the counterweight from hitting the turntable beam and move the counterweight to the illustrated position.



7. Set the two pendant ropes on the counterweight.
8. Wind off the auxiliary wire rope to contact the counterweight with the turntable beam.
9. Lower the A-frame a little, and the counterweight is lowered to the specified position.
10. Fix the inner counterweight on the turntable with the inner counterweight fixing bolts (M36 x 400-2 pcs.), nuts (2 pcs.) and plain washers (4 pcs.).
11. Remove the counterweight lifting sheave block and pendant rope.



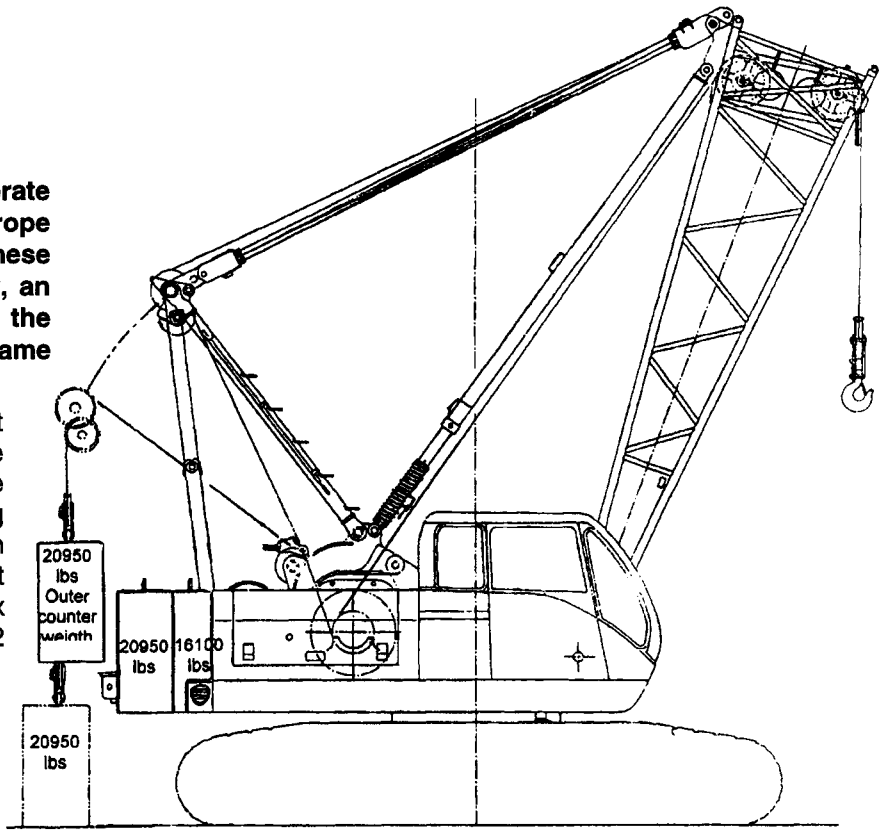
12. Set the sheave block on the central counterweight at the ① position.
13. Wind up the boom hoisting wire rope and raise the A-frame. Move the counterweight horizontally by hoisting/lowering the A-frame. Move the counterweight vertically by winding up/off the auxiliary hoist drum wire rope.



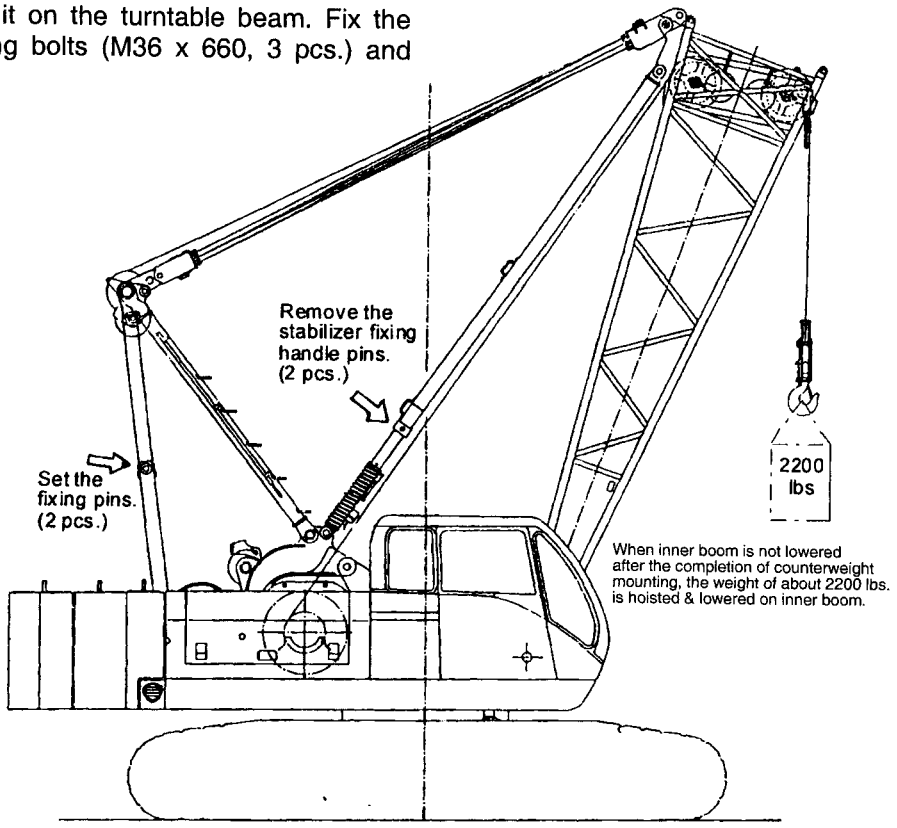
⚠ CAUTION

Hoist/lower the A-frame and operate the auxiliary hoist drum wore rope gently and slowly. If these operations are performed rapidly, an excessive force is applied to the compression member of the A-frame and stabilizer.

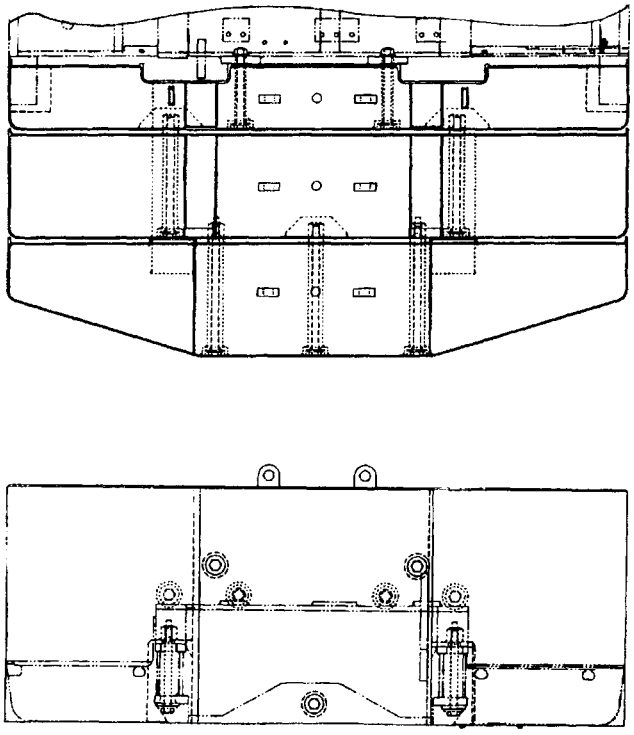
14. Lower the central counterweight on the turntable beam along the inner counterweight. Fix the counterweight with the mounting bolts (M36 x 610) and plain washers. Fix the counterweight with the mounting bolts (M36 x 400) and plain washers. (Bolt: 2 pcs., plain washer: 2 pcs.)
15. Move the machine backward a little to lift the outer counterweight easily.

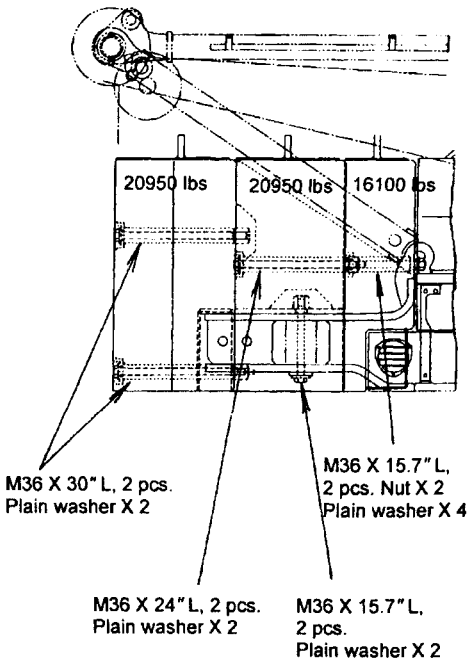


16. Lift the outer counterweight and put it on the turntable beam. Fix the outer counterweight with the mounting bolts (M36 x 660, 3 pcs.) and plain washers (2 pcs.).
17. Raise the A-frame fully and insert the A-frame tension member pins 2.38" dia. x 4.80 long (60.5mm x 122mm), (2 pcs.) to fix the A-frame. Set the fixing pins and hairpins. Remove the stabilizer fixing handle pin. Now the inner boom can be hoisted and lowered freely.



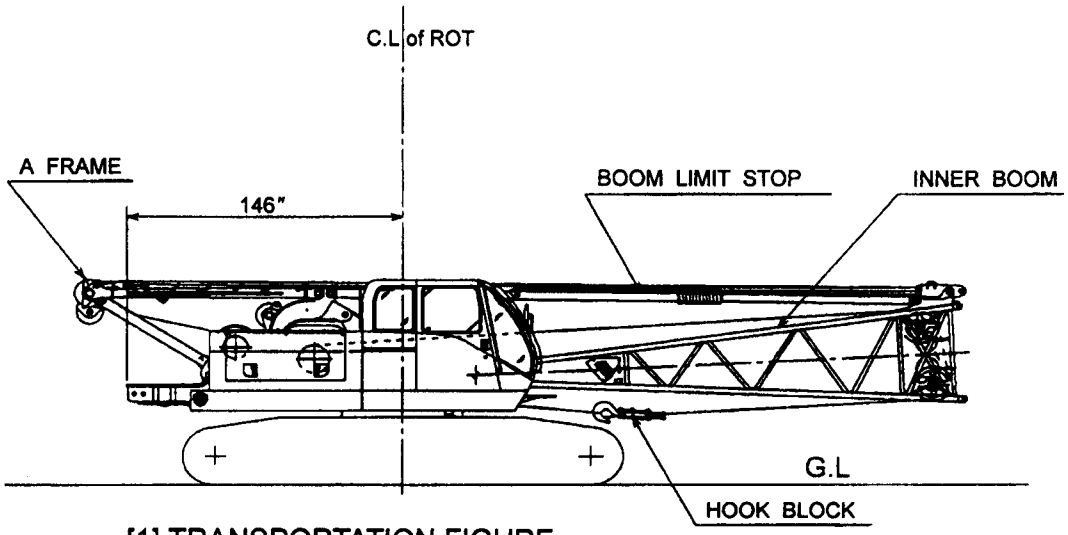
Detail of the counterweight mounting bolt





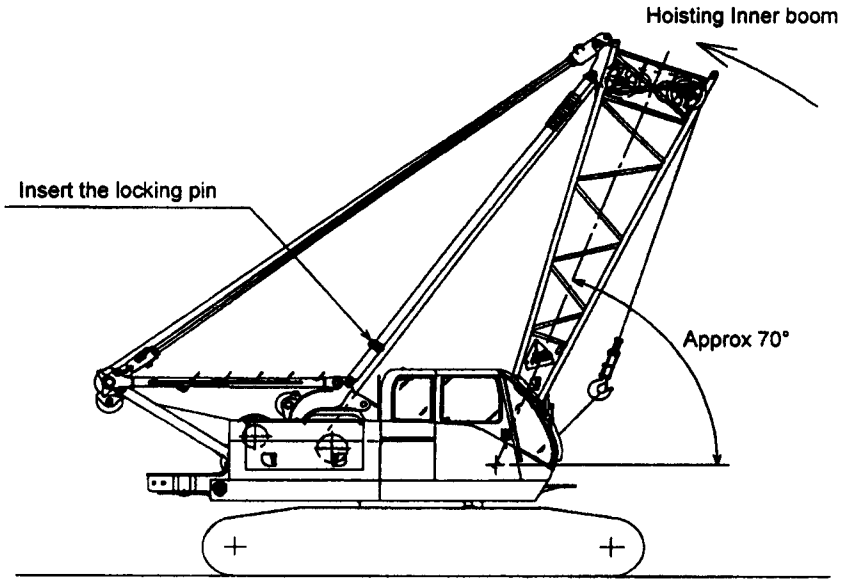
NOTE: Counterweight can be removed in reverse order of this description.

Counterweight installation method of standard crane



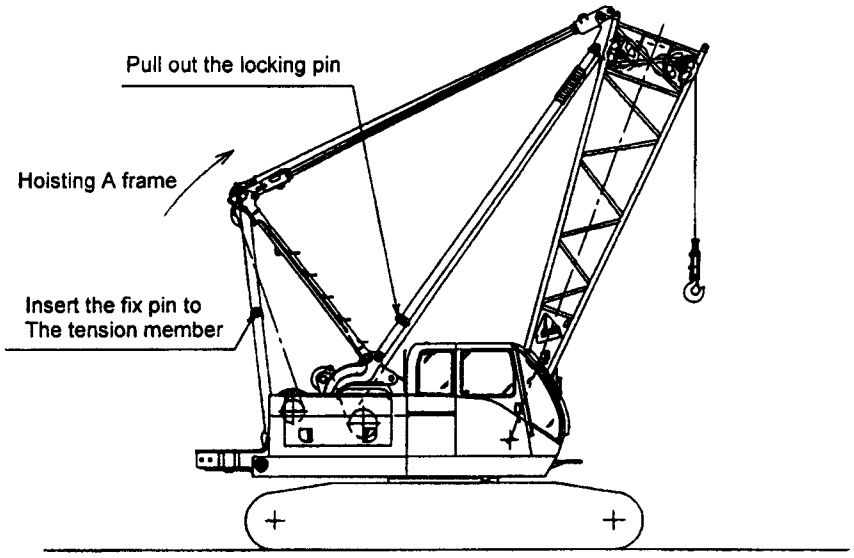
[1] TRANSPORTATION FIGURE

WEIGHT: 84900 lbs
Including
Base machine
Inner boom
Main & Aux. Hoist ropes



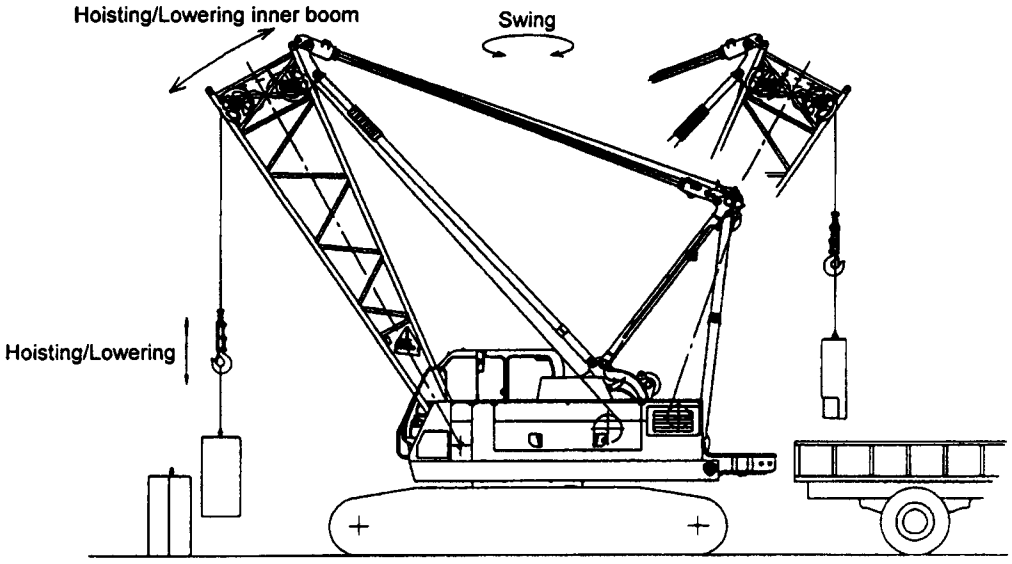
[2] INNER BOOM HOISTING

1. Extend both crawler frame.
2. Hoist the inner boom up to the angle of 70 degrees.
3. Insert the locking pin to the boom limit stop in order to fix the length of it.
4. Pull the fix pin out of the tension member
5. Remove the lashing ropes for the sheave block and the hook block



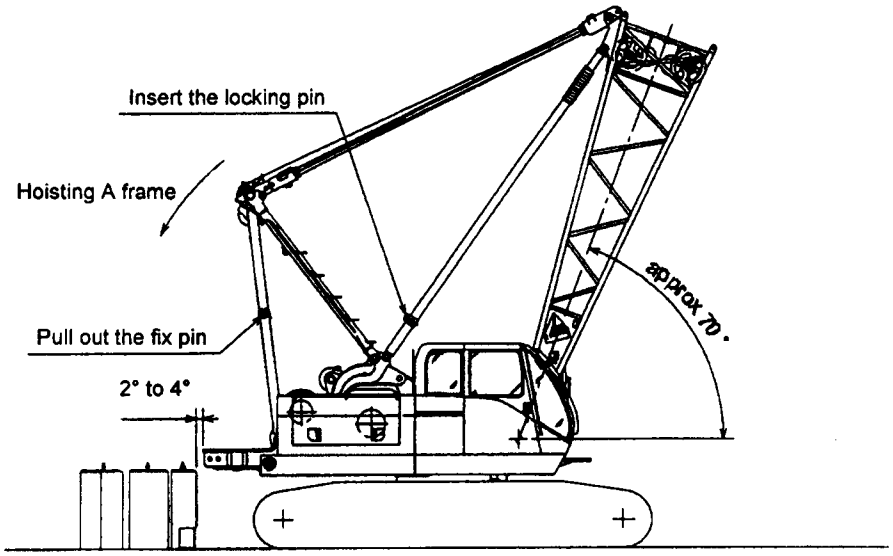
[3] A FRAME HOISTING

1. Hoist the A frame and insert the fix pin to the tension member.
2. Pull the locking pin out of the boom limit stop for hoisting the inner boom.



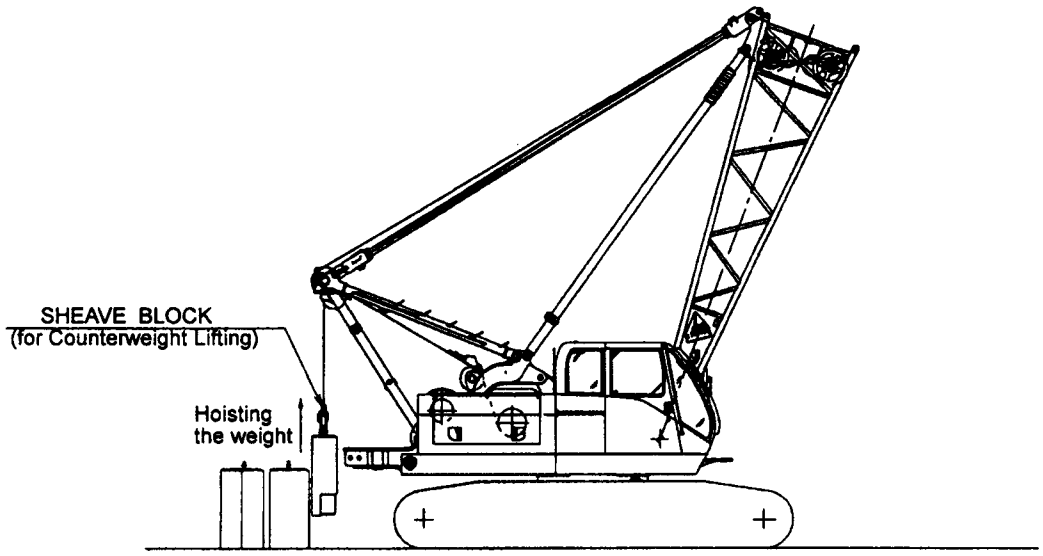
[4] UNLOADING THE COUNTERWEIGHT

1. Unload the counterweights and attachment.
2. Put them at the suitable place on the ground for better loading work.



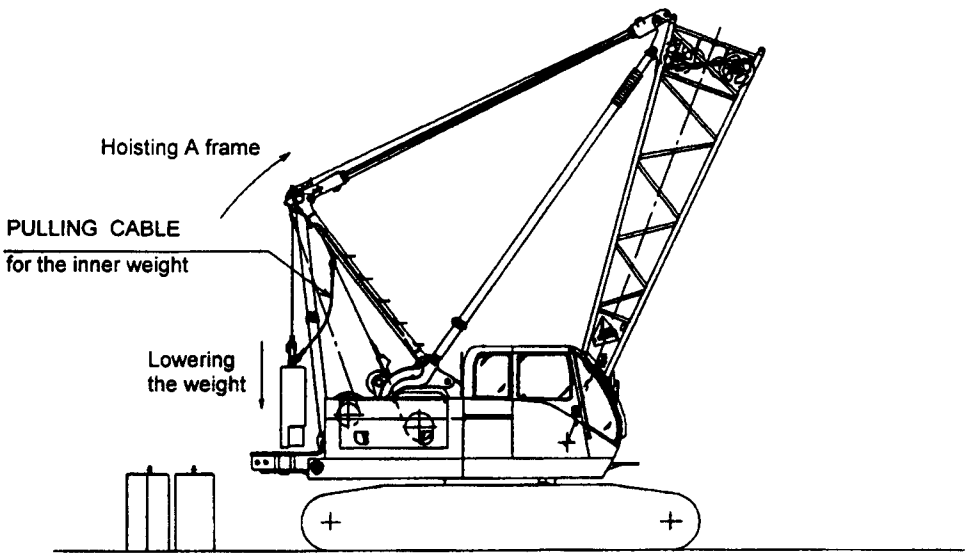
[5] PREPARATION FOR HOISTING THE COUNTERWEIGHT

1. After preparation for hoisting weights remove the front hook block and wind aux. drum wire rope again.
2. Hoist again the inner boom up to the angle of 70 degrees.
3. Pull the fix pin out of the tension member for hoisting/lowering the A frame.
4. Lower the A frame and install the sheave block with aux. wire rope.



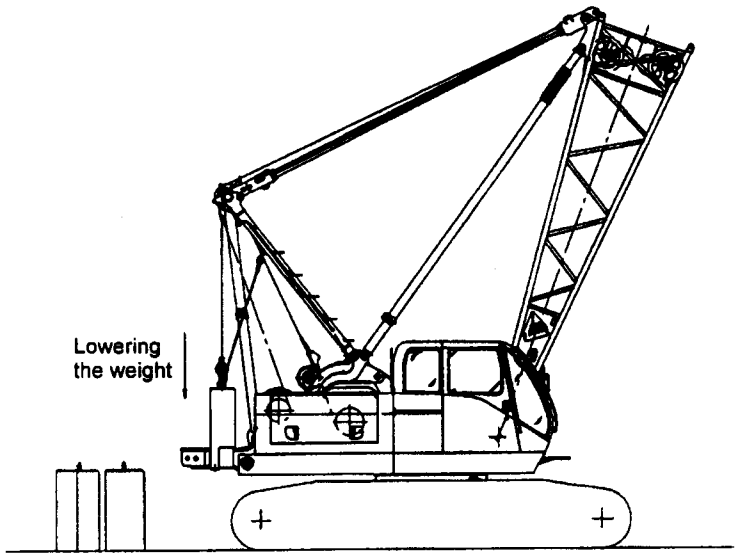
[6] HOISTING THE INNER WEIGHT

1. Lower the A frame to the suitable position and install the sheave block to the inner weight.
2. Start hoisting the inner weight in moderate and cautious operation.



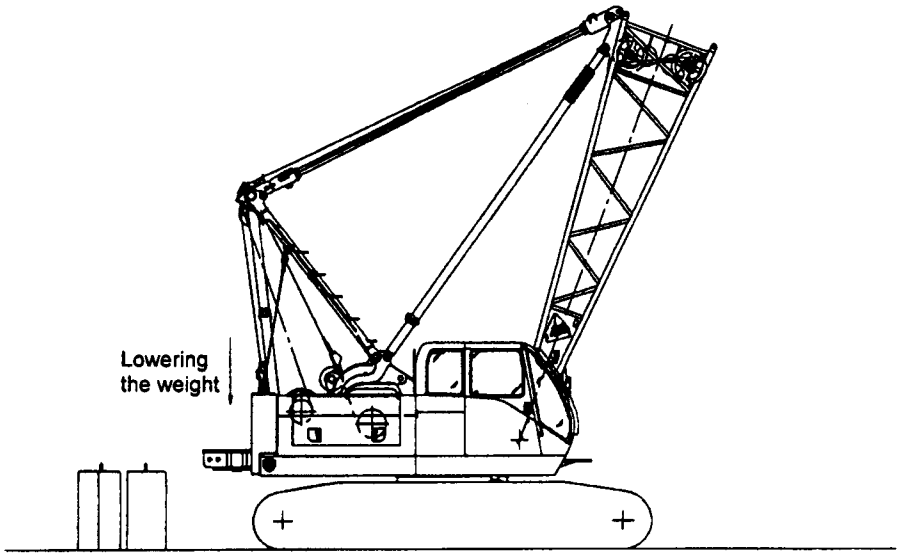
[7] INSTALLATION THE PULLING CABLE FOR THE INNER WEIGHT

1. Shift the weight to the suitable position by hoisting and lowering operation on A frame.
2. Install the pulling cable on the inner weight at the about highest position of the A frame.



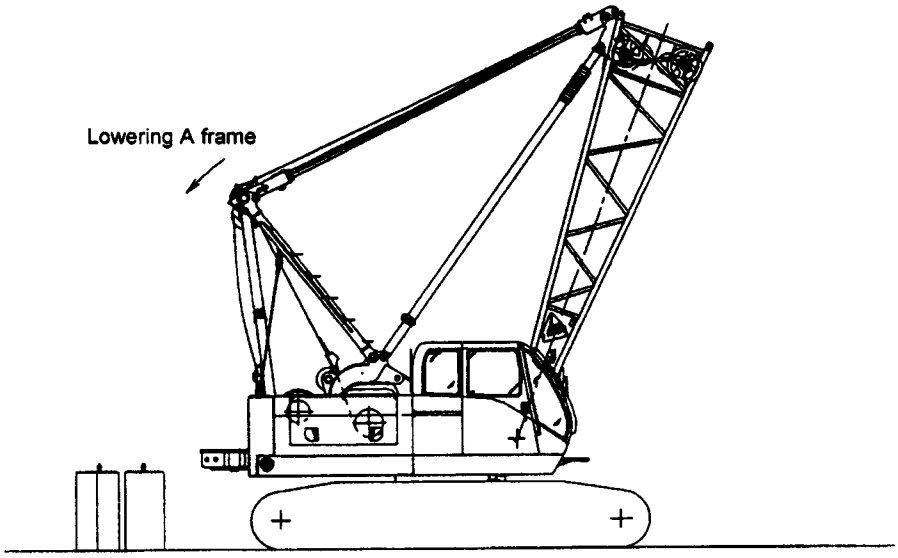
[8] LOWERING THE INNER WEIGHT

1. Lower the weight quietly.



[9] PULLING THE INNER WEIGHT

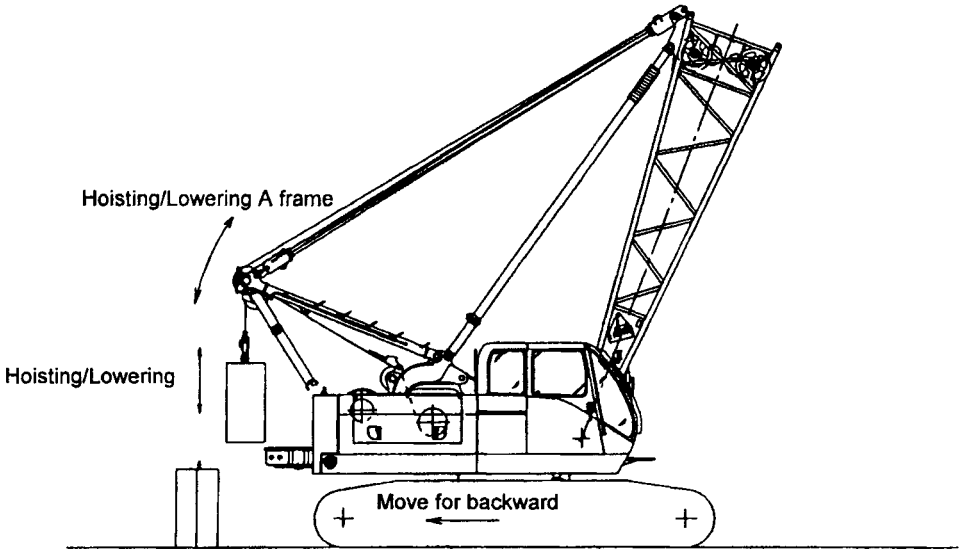
1. Move the weight toward the turntable by further lowering even if the cable is tensed.
2. Stop lowering the weight at the position that the setting face is touched rear part of the turntable.



[10] INSTALLATION THE INNER WEIGHT

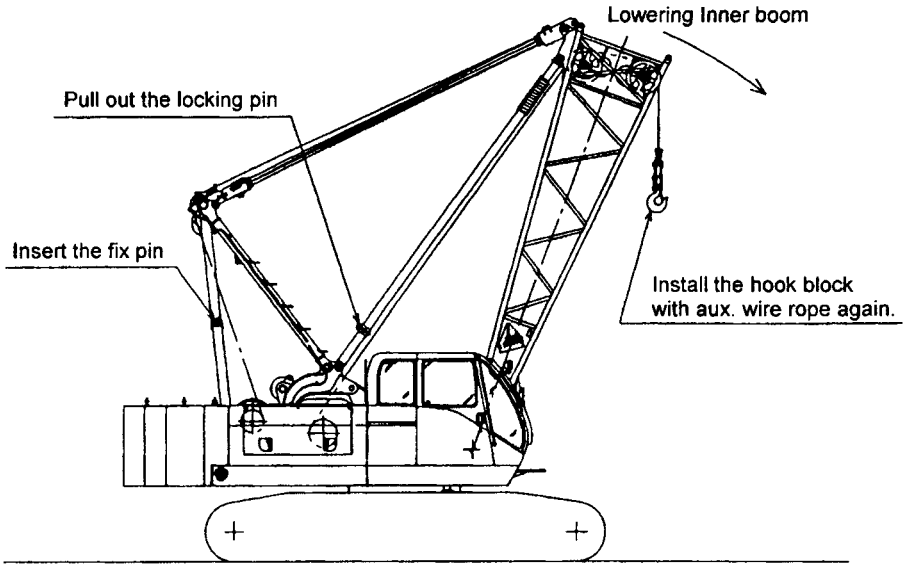
1. Lower the inner weight at the suitable position by lowering the A frame.
2. Fix the weight by two bolts.
3. Remove the pulling cable from the weight.

NOTE: Counterweight can be removed in reverse order of this description.



[11] INSTALLATION THE MIDDLE AND OUTER WEIGHT

1. Move the base machine to the position that the middle and outer weight can be hoisted.
2. Hoist the weights by lowering/hoisting the A frame and the winch, then fix them by the bolts.
3. Remove the sheave block and the aux. wire rope.



[12] COMPLETION OF THE COUNTERWEIGHTS NSTALLATION

1. Insert the fix pin to the tension member after hoisting the A frame.
2. Pull out the locking pin and lower the inner boom.
3. Install the hook block in the inner boom with aux. wire rope again, then start assembling boom. jib etc.

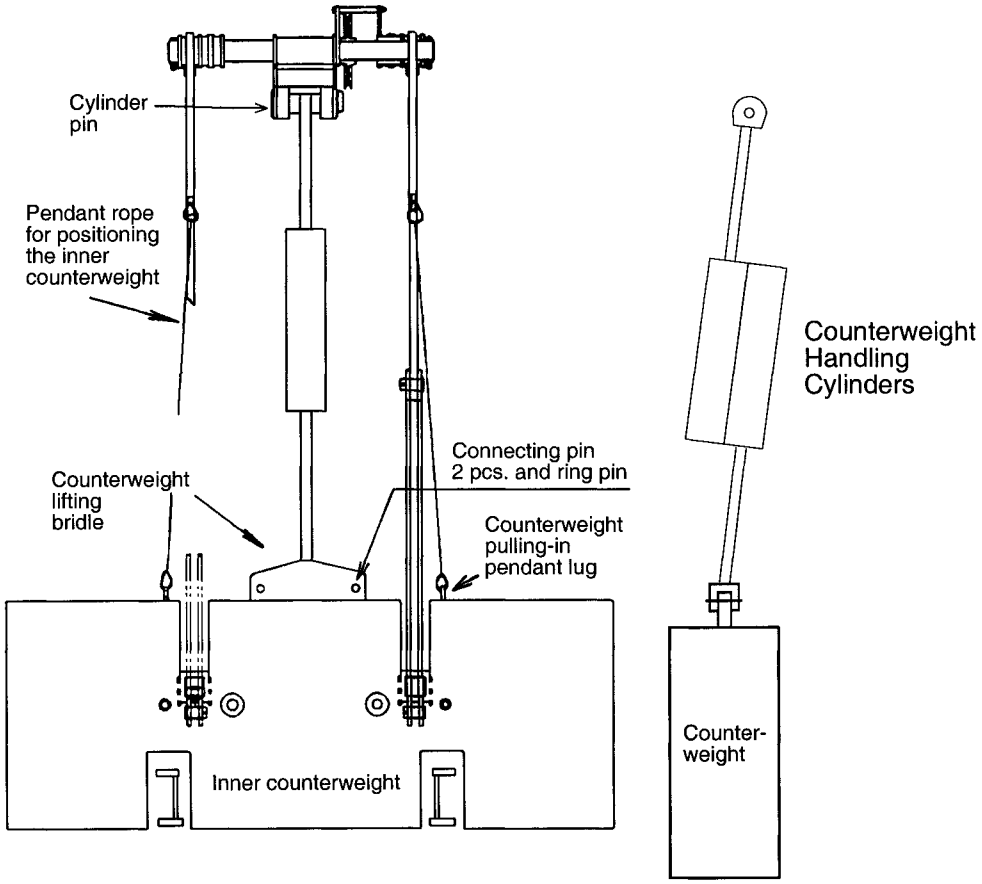
COUNTERWEIGHT HANDLING USING CYLINDERS

How to assemble and disassemble the counterweight

CAUTION

Mount the counterweight corrrectly.

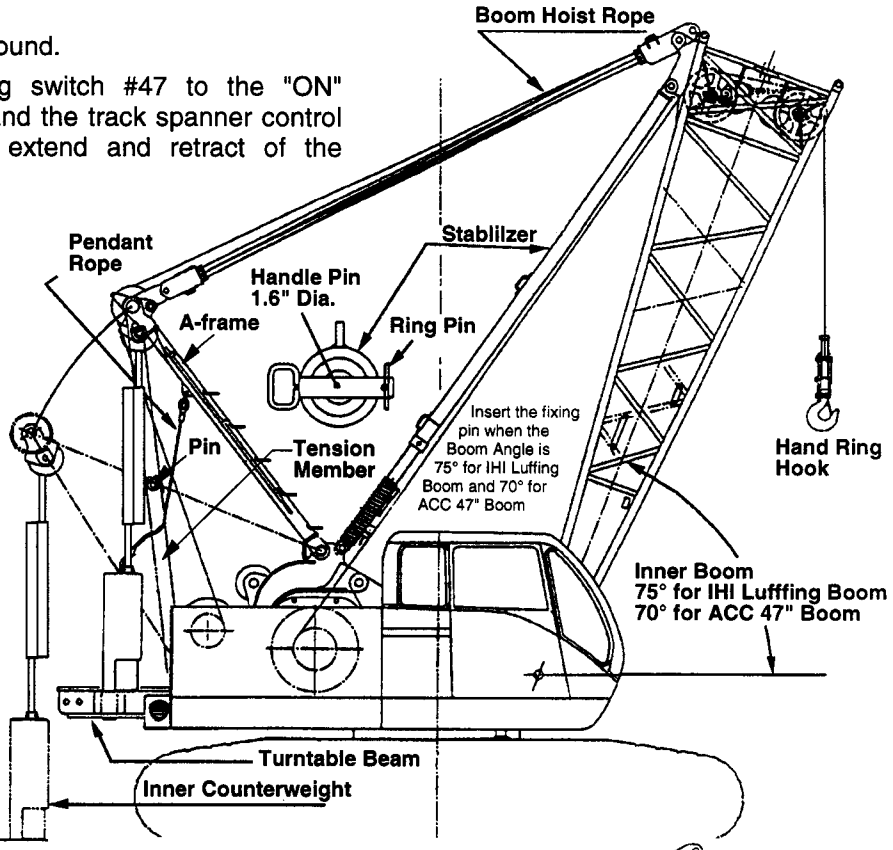
1. **Unless the specified counterweight is mounted, the crane cannot demonstrate its performance fully. Mount a counterweight as specified.**
2. **Don't mount an extra counterweight inapplicable to the specifications. The crane's backward stability will be deteriorated to cause falling backward or damage.**



1. **Do not mount a counterweight while the crawler width is retracted. The machine may fall backward.**
2. **Do not mount a counterweight on unlevel ground where a machine position is inclined.**
3. **When lifting a counterweight, keep personnel from between the counterweight and machine.**

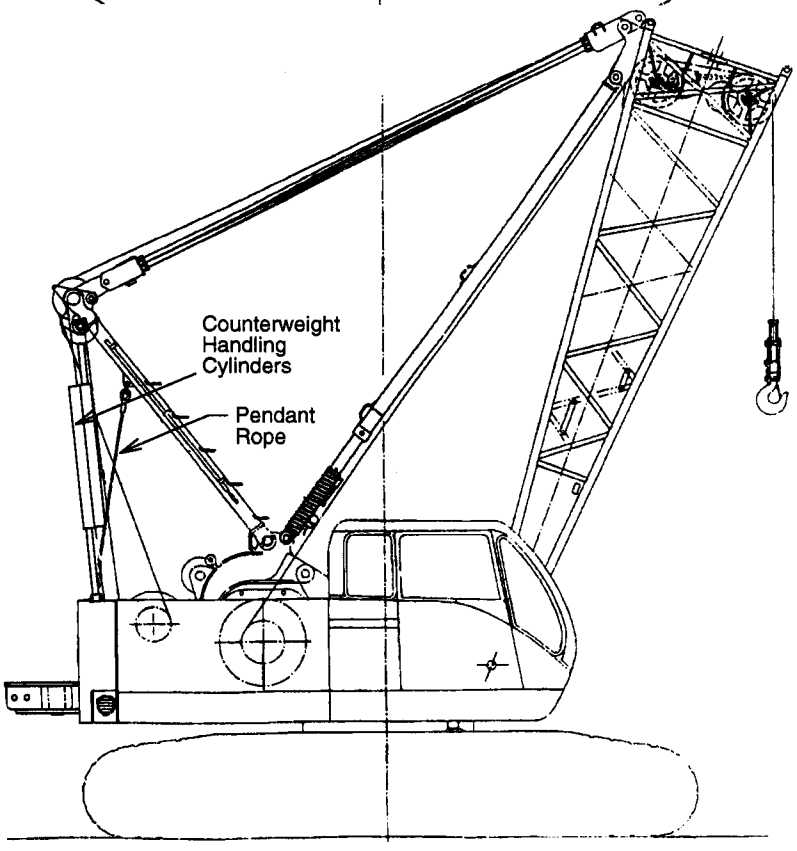
Counterweight Installation

1. Crane must be on firm and level ground.
2. Place the counterweight handling switch #47 to the "ON" position. Light #46 will illuminate and the track spanner control Lever #6 will now operate the extend and retract of the counterweight handling cylinders.
3. Remove counterweight handling cylinder assembly from the storage position.
4. Raise the tension member (A-frame) to the fully extended position.
5. Raise the inner boom to approximately 75° for IHI Luffing Boom and 70° for ACC 47" boom from the transportation condition and install the stabilizer fixing handle pin.
6. Remove the tension member pin to be able to hoist and lower the tension member (A-frame).
7. Lower the tension member (A-frame) and extend the counterweight handling cylinder to attach the cylinder to the inner counterweight by pinning the bridle.

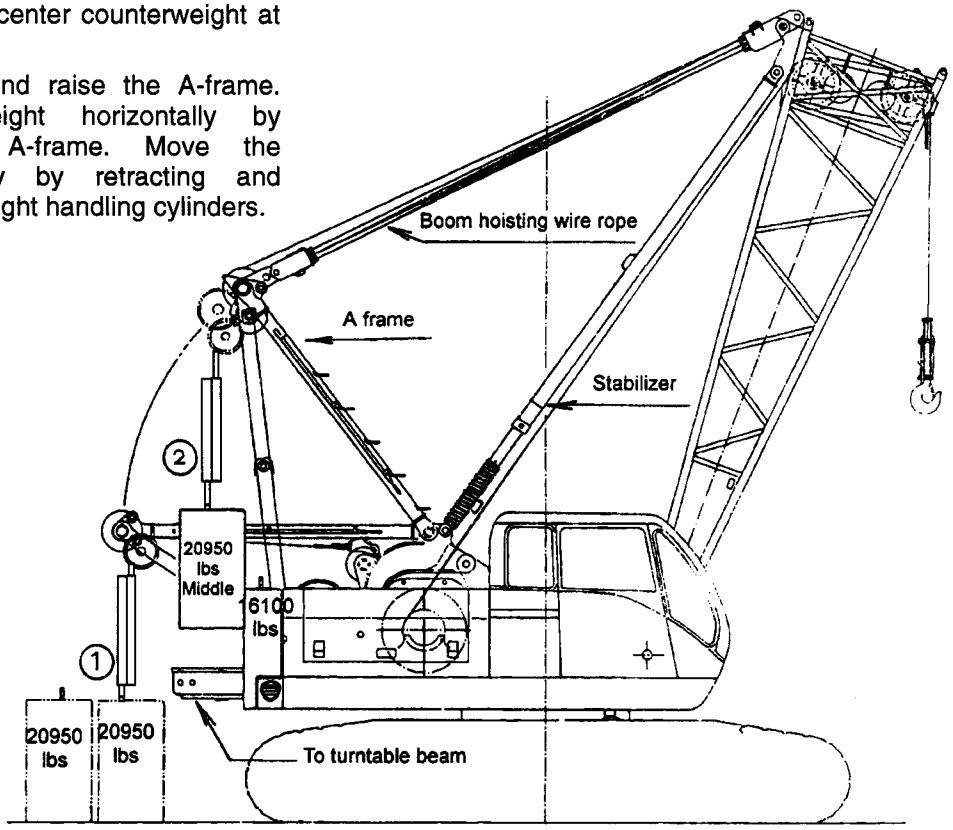


8. Attach the two pendant ropes to the inner counterweight and A-frame.
9. Raise the counterweight to position by booming up and operating the handling cylinders.

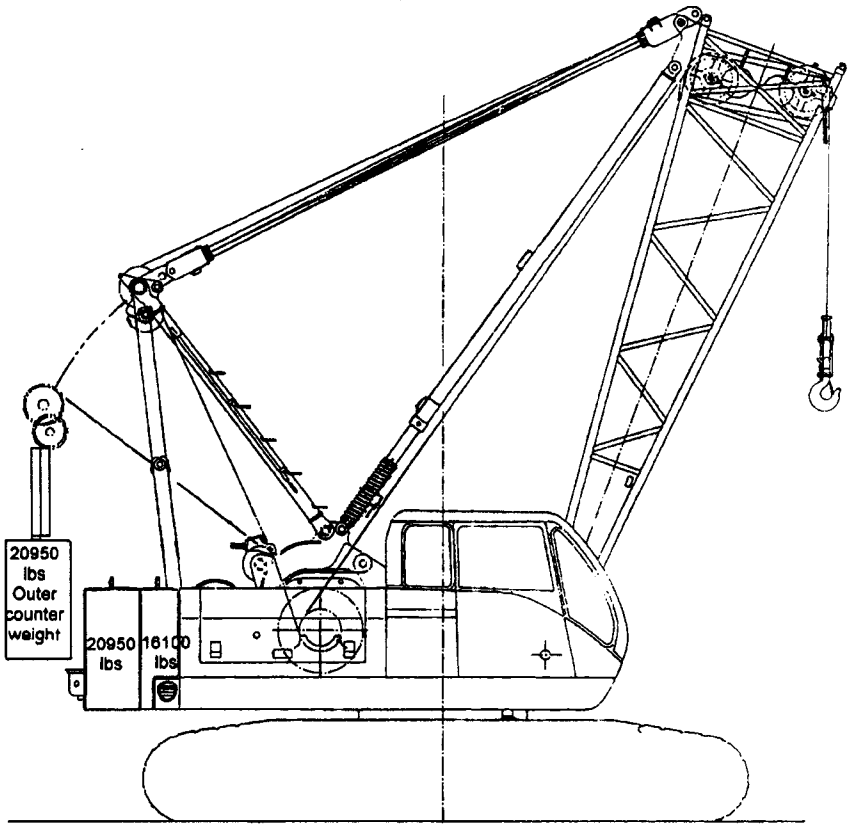
   Note: Move the counterweight horizontally by raising or lowering the A-frame. Move the counterweight vertically by extending or retracting the cylinders.
10. Fix the inner counterweight on the turntable with the inner counterweight bolts (M36 x 400-2 pcs.), nuts (2 pcs.) and plain washers (4 pcs.).
11. Remove the counterweight lifting bridle and pendant rope from the counterweight.



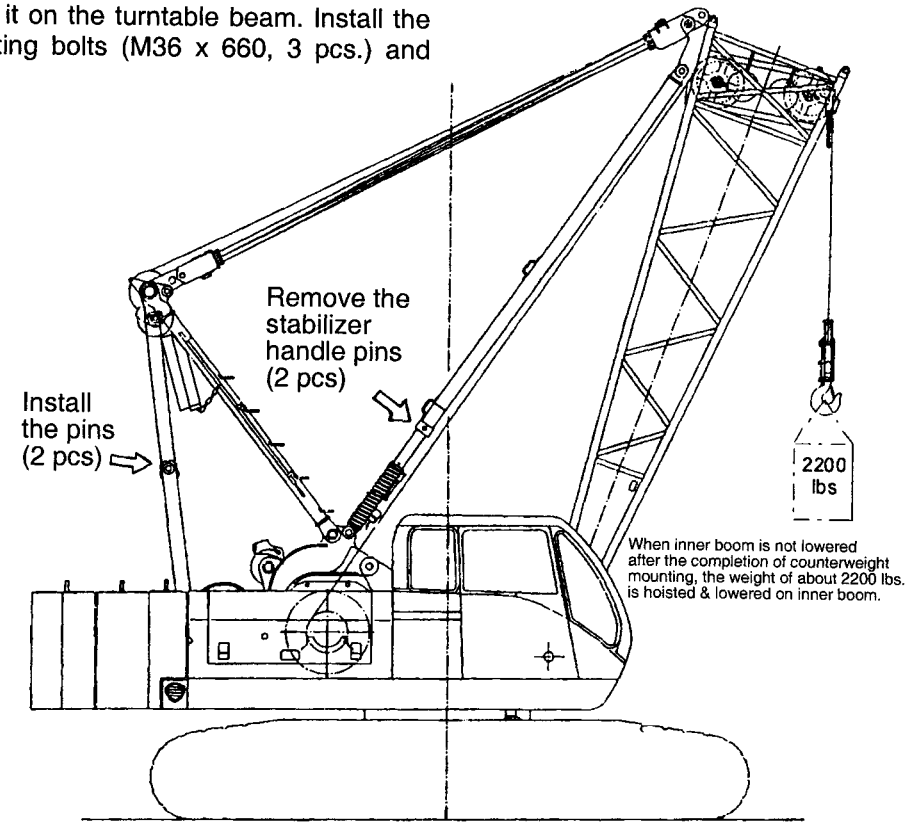
12. Attach the bridle to the center counterweight at the ① position.
13. Retract the cylinders and raise the A-frame. Move the counterweight horizontally by hoisting/lowering the A-frame. Move the counterweight vertically by retracting and extending the counterweight handling cylinders.



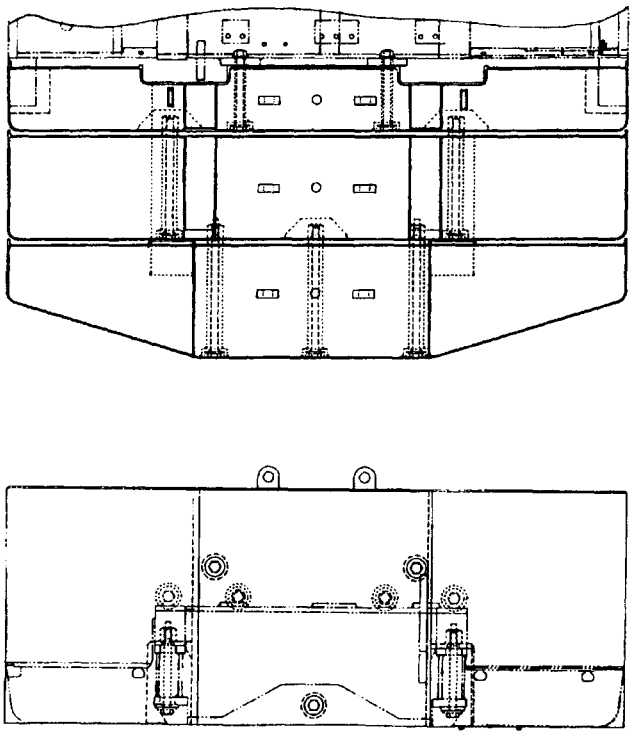
14. Lower the central counterweight on the turntable beam along the inner counterweight. Install the counterweight with the mounting bolts (M36 x 610) and plain washers. Install the counterweight with the mounting bolts (M36 x 400) and plain washers. (Bolt: 2 pcs., plain washer: 2 pcs.)
15. Move the machine backward to reach the outer counterweight easily.

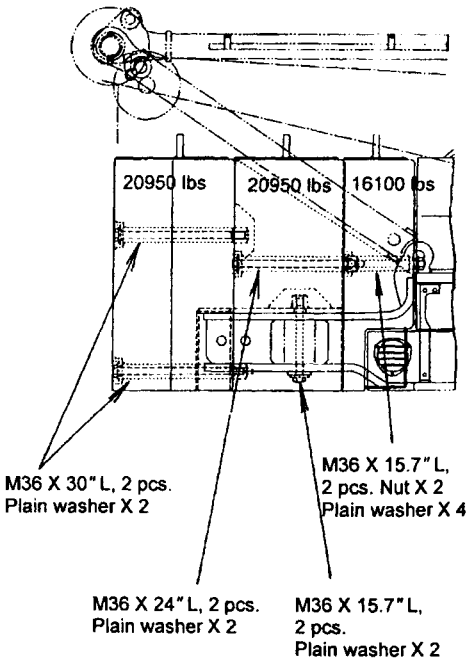


16. Lift the outer counterweight and put it on the turntable beam. Install the outer counterweight with the mounting bolts (M36 x 660, 3 pcs.) and plain washers (2 pcs.).
17. Raise the A-frame fully and insert the A-frame tension member pins 2.38" dia. x 4.80 long (60.5mm x 122mm) to fix the A-frame. Install the pins and hairpins. Remove the stabilizer handle pins. Now the inner boom can be hoisted and lowered freely.



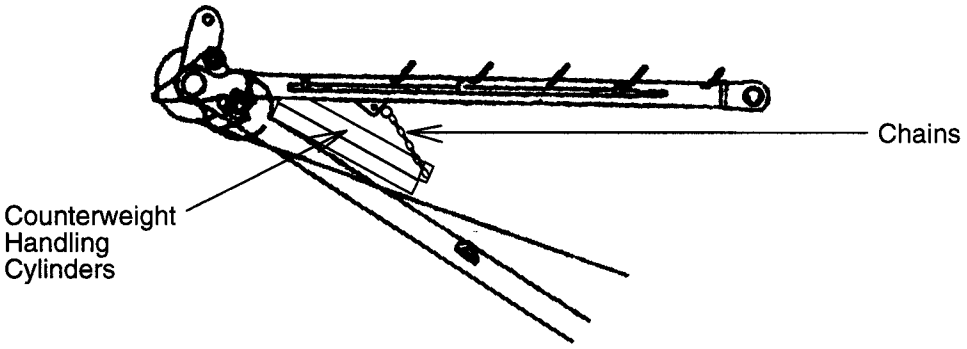
Detail of the counterweight mounting bolt



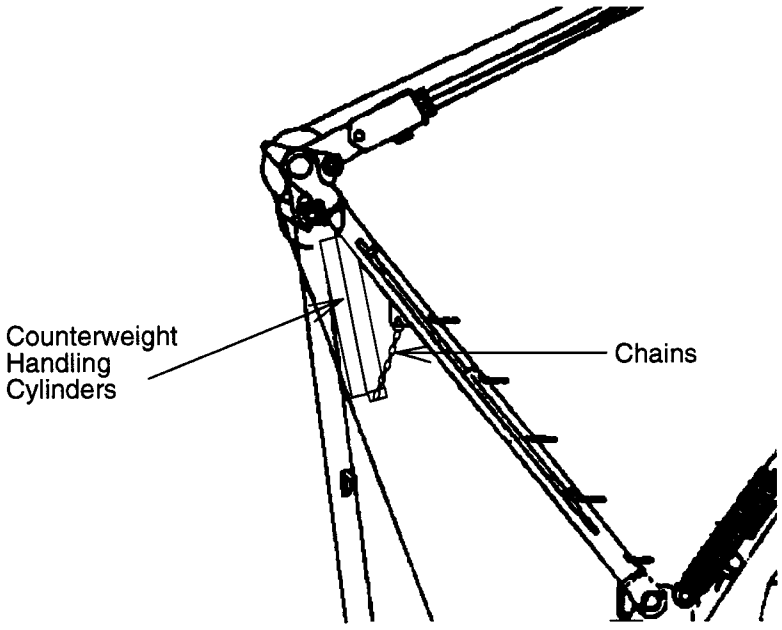


NOTE: Counterweight can be removed in reverse order of this description.

**COUNTERWEIGHT HANDLING CYLINDERS
IN STORAGE POSITION FOR TRANSPORTING**



**COUNTERWEIGHT HANDLING CYLINDERS
IN STORAGE POSITION FOR OPERATION**



4. TABLE OF ATTACHMENT COMPOSITION

Tower boom crane

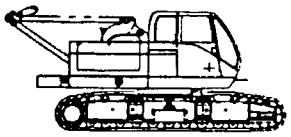
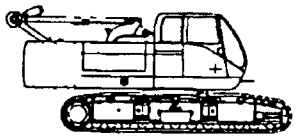
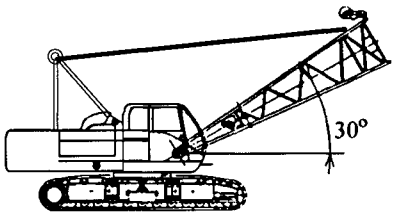
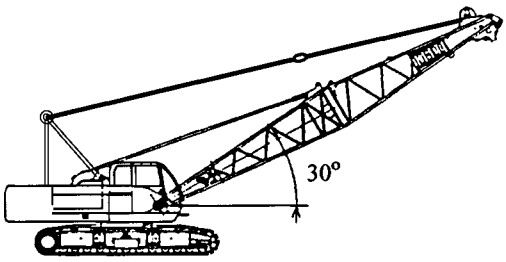
Basic boom	21.33' + 8.20' = 29.53' (6.5m + 2.5m = 9m)	Inner, outer (tower top) Inner boom yoke bracket with rail
Intermediate boom	Use the special insert exclusively for 29.53' (9m) tower at the lower end. Use the boom for others. If length is over 137.79' (42m), add one of 9.84' (3m), 19.69' (6m) and 29.53' (9m).	With rail and guide sheave. The tower crane is not equipped with a 19.69' (6m) intermediate boom.
Longest boom	177.17' (54m)	Intermediate boom is the same as the standard intermediate boom except the 9m special boom.

Luffing jib crane

Basic boom length	21.33' + 29.53' + 8.20' = 59.06' 6.5m + 9m + 2.5m = 18m (Luffing jib crane is equipped with the main hoist sheave block at the tower top.)	Inner, insert, outer (tower top) The 29.53' (9m) tower special insert is equipped with guide sheave & equalizer rail.
Intermediate boom	9.84', 29.53' (3m, 9m)	
Longest boom	137.80' (42m)	
Basic tower jib Longest tower jib	14.76' + 19.69' + 18.04' = 52.49' (4.5m + 6m + 5.5m = 16m) 14.76' + 9.84' + 19.69' x 3 + 18.04' = 101.71' 4.5m + 3m + 6m x 3 + 5.5m = 31m	
Main hoist hook for boom Aux. hoist hook for jib	25 ton 3 sheaves 13 ton 1 sheave	Boom main hoist lifting: 2~4 part line Aux. hoist/tower jib lifting: 1~2 part line

5. ALLOWABLENESS OF SELF-TRAVELING AND ASCENDING/DESCENDING ON TRAILER RAMP BOARD

5-1 Allowableness of self-traveling on level ground

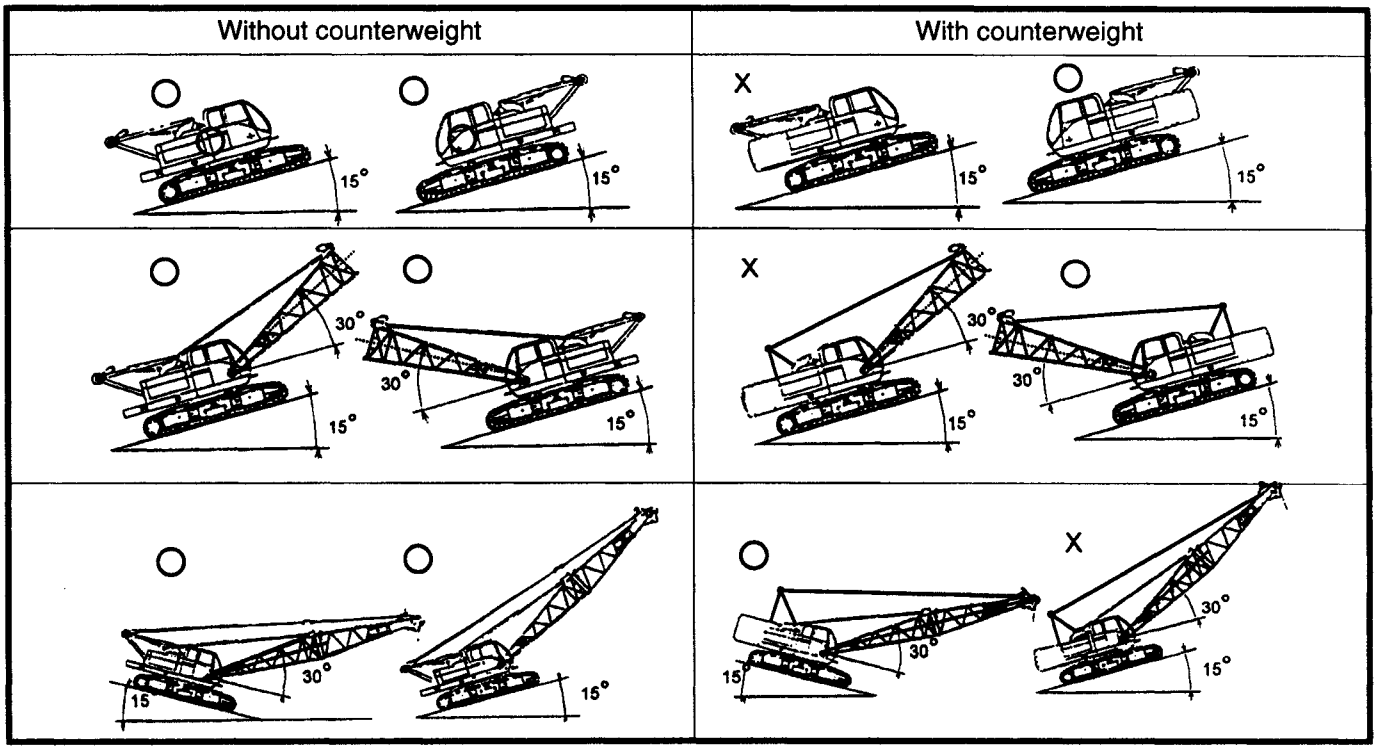
	Self-traveling position	Conditions	Allowableness of self-travel	
①		Base machine condition	○ Allow-able	
②		With counterweight	○ Allow-able	Don't swing while the crawler width is retracted. If so, the machine will fall backward.
③		With counterweight and inner boom	○ Allow-able	
④		With 39.37' (12m) boom	○ Allow-able	

Caution on self-traveling:

1. For traveling, apply the swing brake and engage the swing lock, and select as flat a course as possible.
2. Travel in the forward direction (with travel motor at the rear). Locate the travel motor at the front only for ②.
3. Low speed is mandatory for traveling on soft or uneven ground and for wide steering.
4. Before self-traveling in the crane work position, the hook should be hoisted close to the boom point. For traveling with a boom of 98.43' (30m) or longer, the boom angle should be set at about 60°.
   In the case of a tower crane, set the tower jib at about 50°.
5. When traveling on a slope without the attachment, safety is ensured by removing the counterweight in both uphill and downhill directions. Even when the attachment is mounted, the machine becomes unstable if the attachment (boom length) is short. Adequate attention should be paid.
6. Check the traveling route in advance. When crossing a bridge, its strength should be checked. If the strength is inadequate, reinforcement is necessary.
7. When crossing railways, do not allow the crawlers to touch the rails directly.

5-2 Allowableness of ascending/descending on trailer ramp board

○ = Allowable × = Unallowable



Allowableness is shown for the machine with counterweight and without counterweight. When the counterweight is dismounted, ascending and descending are allowed in all machine positions and with or without the attachment. Transporting the machine by board while the counterweight is still mounted is prohibited.

- In all the sketches shown above, the ramp board angle is 15°. The boom angle must not exceed 30°.
- Allowable or unallowable judgement is based on crane stability at ascending and descending.
- The reaction when returning from the inclined state to level state is not considered. Also, the judgement standard may differ depending on the shape of trailer.

⚠ WARNING

When ascending/descending:

1. Park the trailer on level ground and place chocks behind the wheels.
2. Confirm the driving direction in advance so that steering will not be required on the ramp board of the trailer.
3. With the swing brake applied and the swing lock engaged, drive the machine at a slow speed.
4. Never try the swing operation during ascending or descending.
5. If there is a risk of slippage due to rain or snow, the machine should be protected from slippage by using sand, mats, etc.
6. Keep the allowable posture (with or without counterweight) during ascending/descending on ramp board.

After loading:

1. Before swinging on the trailer, support the trailer frame with wood blocks or the like for preventing the trailer from inclining.
2. Apply the swing brake and engage the swing lock securely.
3. Secure the machine to the trailer by means of wires, chains, etc., for preventing the machine from moving in any direction during transportation. Unless the above points are observed, the machine may tip over or fall.

5-3 Allowableness of swing

The table shows the swing allowableness when the machine is stationary on level ground.

○ = **Allowable** × = **Unallowable**

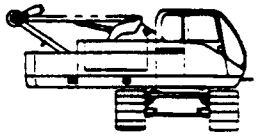
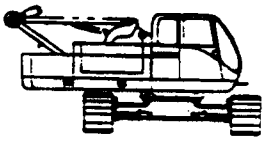
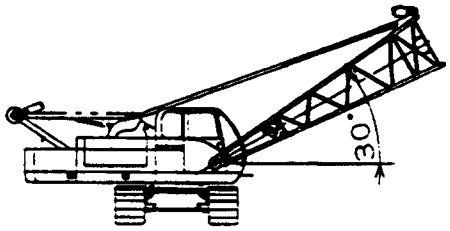
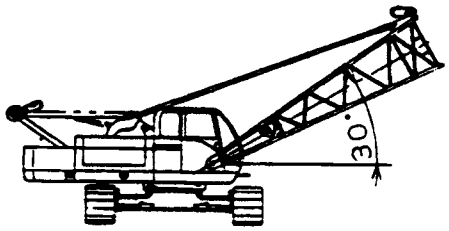
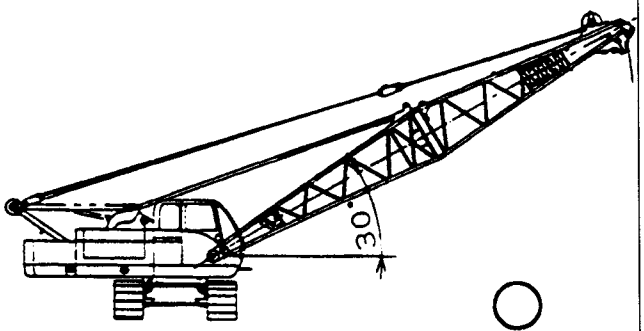
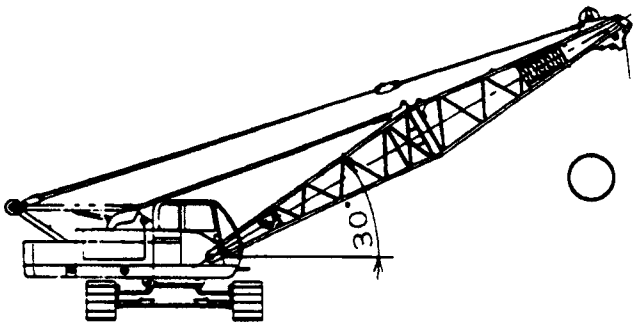
Without counterweight	With counterweight
○ ○	× ○
○ 30° ○ 30°	× 30° ○ 30°
○ 30° ○ 30°	× 30° ○ 30°

CAUTION

1. The above illustrations are all based on rear stability when the superstructure is faced in the overside direction on level and firm ground. If swinging the machine in unallowable posture, it will fall backward.
2. The above illustrations show the stability when the machine is stationary. Don't swing the machine during traveling. Before traveling, the superstructure should be aligned in the overend direction of the crawlers.
3. Be very careful when changing the crawler width just before loading onto a trailer or just after unloading from a trailer for transportation.

The table shows the swing allowableness when the machine is stationary on level ground.

○ = **Allowable** × = **Unallowable**

Allowableness when an upper weight (8.1T) is removed	
When crawler width is retracted	When crawler width is extended
 ×	 ○
 ×	 ○
 ○	 ○

CAUTION

1. The above illustrations are all based on rear stability when the superstructure is faced in the overside direction on level and firm ground. If swinging the machine in unallowable posture, it will fall backward.
2. The above illustrations show the stability when the machine is stationary. Don't swing the machine during traveling. Before traveling, the superstructure should be aligned in the overend direction of the crawlers.
3. Be very careful when changing the crawler width just before loading onto a trailer or just after unloading from a trailer for transportation.

6. REEVING OF WIRE ROPE

6-1 Precautions for handling the wire rope

⚠ WARNING

Be careful about the following points to prevent your body or hand from being caught by the machine when setting the wire rope on the wire drum or when correcting the rope that has not spooled on the drum properly. Be careful in the same way when reeving the rope on the sheave.

1. **Always wear leather gloves when handling wire rope.**
2. **Guide the rope in the position approximately 1m away from the drum.**
3. **Don't slip the wire rope in your hands. Pass the rope from the left hand to the right and wind it at such a speed as you can stop winding immediately.**
4. **Give the correct signal to start or stop winding.**
5. **Don't touch a rotary section such as a sheave or drum when setting or removing the wire rope. Your hand may be caught by the machine.**
6. **Be careful for the rope reaction when setting or removing the wire rope on the drum. You may be injured.**

⚠ CAUTION

1. **If the wire rope is too long, it may not spool on the drum. The rope will be damaged and its life will be shortened. Use a rope of the specified length.**
2. **If the wire rope is too short, it will be used up before the hook or bucket reaches the destination, and also the drum may be damaged or wire rope may be cut. Leave the rope by two turns or more on the drum for every kind of work.**
3. **A lifting load is specified for one load hoist wire rope. Select a hook capacity and ropes part of line applicable to the load.**

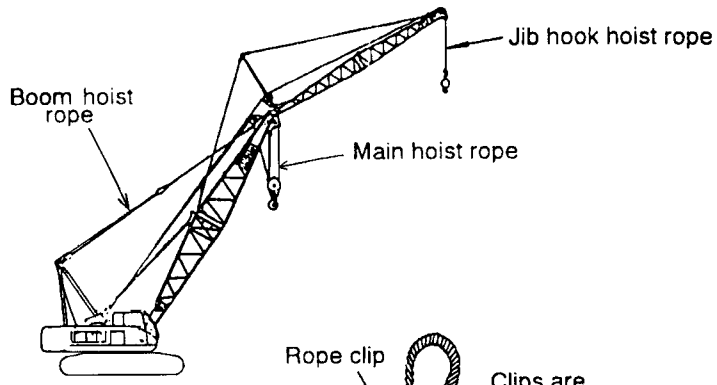
⚠ CAUTION

If the end of wire rope comes off from the fixed section, a serious accident may occur. When setting the wire rope on the wire drum or wedge socket, use a wedge (cotter) with the correct size and make sure that the length of the contact between the wedge and wire rope is proper and the tightening allowance is correct. When inserting into the socket, attach a rope clamp accurately.

⚠ WARNING

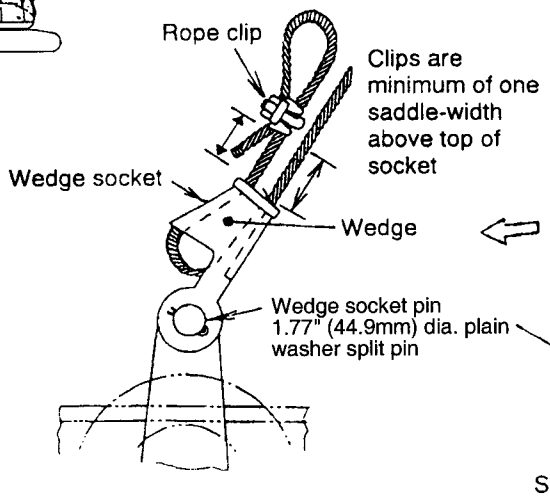
1. **Insert and attach the split pin (for pendant rope connecting pin) and hairpin (for boom joint pin) correctly. If the pin falls off, an accident resulting in injury or death may occur.**

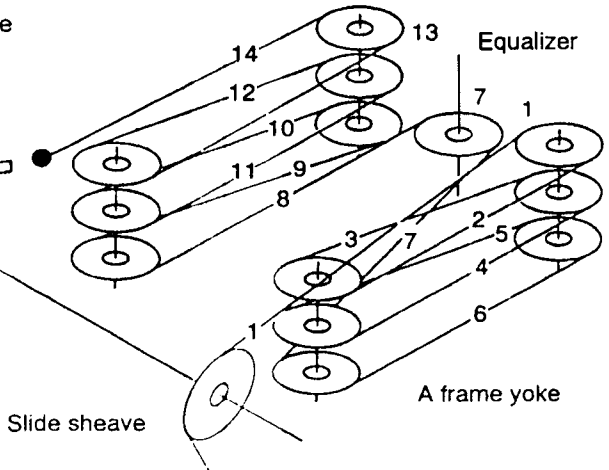
Precautions for handling the wire rope - Boom Hoist Rope



WARNING

Reeve a specified wire rope correctly. If a rope not specified is used or if a rope is reeved incorrectly, it is worn earlier than usual. Check the wire rope periodically.





CAUTION

Observe the space and direction as illustrated when mounting the cable clamp.

Insert the wedge socket pin while its head is upside down. Insert and open the split pin accurately. If the clamp position is too far from the socket, the wedge may come off.

16mm Dia. x 550' (167.64m)
6 x WS (31) XP IWRC

Spool off the wire rope while turning the reel to prevent twisting. Wind the rope around the sheave without crossing it. When winding the wire rope around the boom hoist drum, give prestress to the rope and wind it correctly for the first layer on the drum.

SECURING THE LOAD LINE DEAD END

Always use an open wedge socket and the correct type of adapter link when securing the dead end of the load line to the boom tip. Figure 1 (right) and Figure 2 (following page) show exploded-view illustrations of both types of adapter links. With these links in place, free movement of the dead end line is possible through two axes of rotation. The pin connection parallel to the boom center line allows lateral stresses to be disseminated safely, while the adapter link pin connection perpendicular to the boom distributes longitudinal stresses. The freedom of movement provided by the wedge socket and adapter link protects the dead end connection from abuse and fatigue much more effectively than a thimble and clips, or other methods.

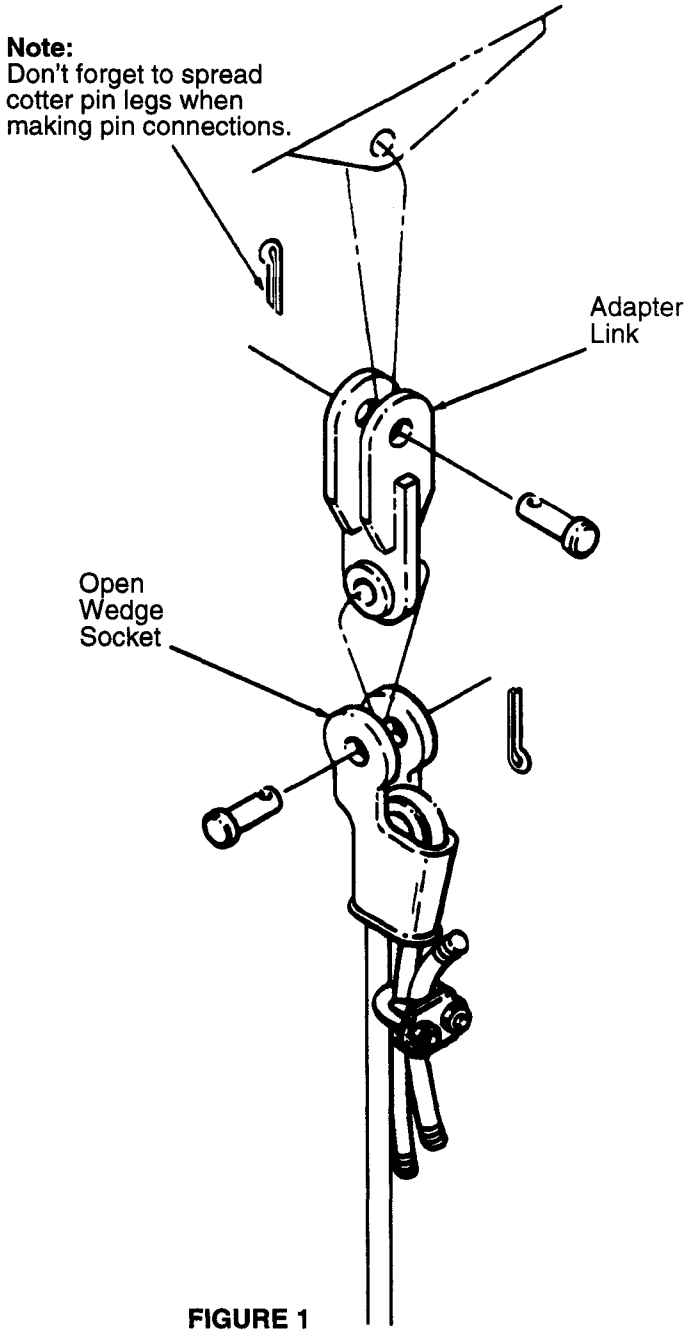


FIGURE 1

CAUTION

REFER TO THE PROCEDURE FOR "SECURING THE DEAD END OF A ROPE WHEN USING A WEDGE SOCKET" ON PAGES 2-27.03 TO 2-27.06 IN THIS MANUAL.

SECURING THE LOAD LINE DEAD END

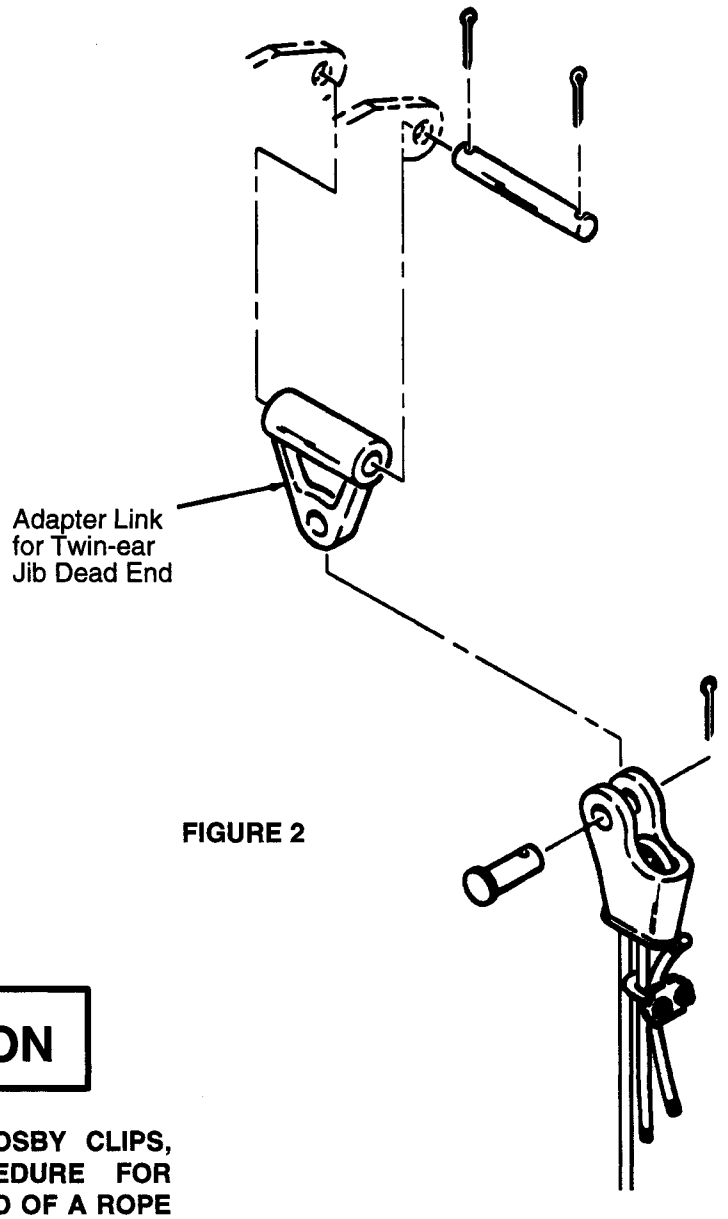


FIGURE 2

CAUTION

BEFORE INSTALLING CROSBY CLIPS, REFER TO THE PROCEDURE FOR "SECURING THE DEAD END OF A ROPE WHEN USING A WEDGE SOCKET" ON THE FOLLOWING THREE PAGES.

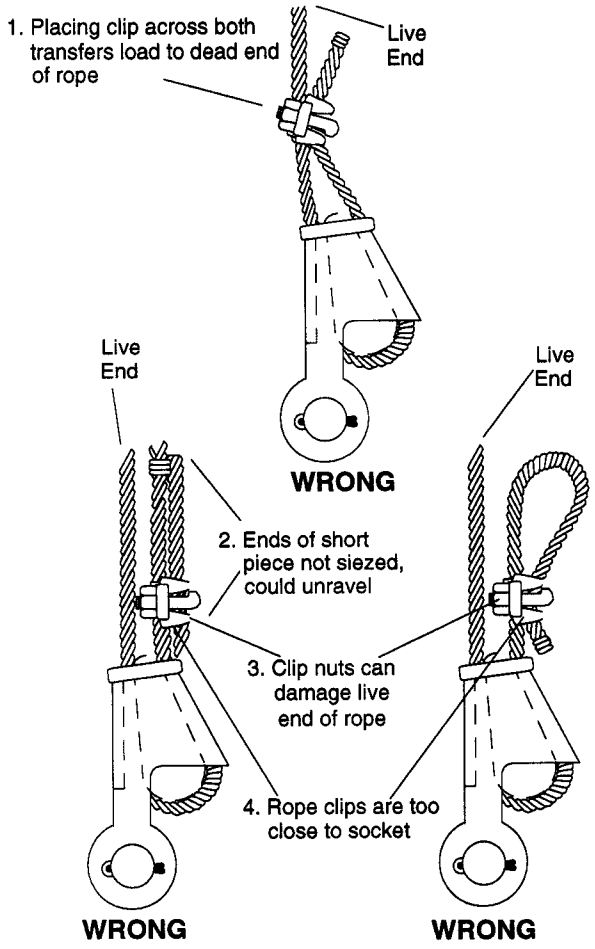
SECURING THE DEAD END OF A ROPE WHEN USING A WEDGE SOCKET

The dead end of a rope is the left-over end, the short piece that comes back out of the wedge socket. The dead end **must** be secured by a wire rope clip. Enough rope should be extended through the socket to allow the end to be doubled back on itself. Then, a rope clip should be attached over the loop with the saddle placed a minimum of one saddle-width above the top of the socket.

WARNING

DO NOT ATTACH THE CLIP ACROSS BOTH ENDS OF THE ROPE AT ONCE. (IT IS THE JOB OF THE WEDGE SOCKET TO HOLD BOTH ENDS OF THE ROPE. THE CROSBY CLIP IS ONLY FOR SECURING THE DEAD END.)

Four **WRONG** ways to secure dead-end.:

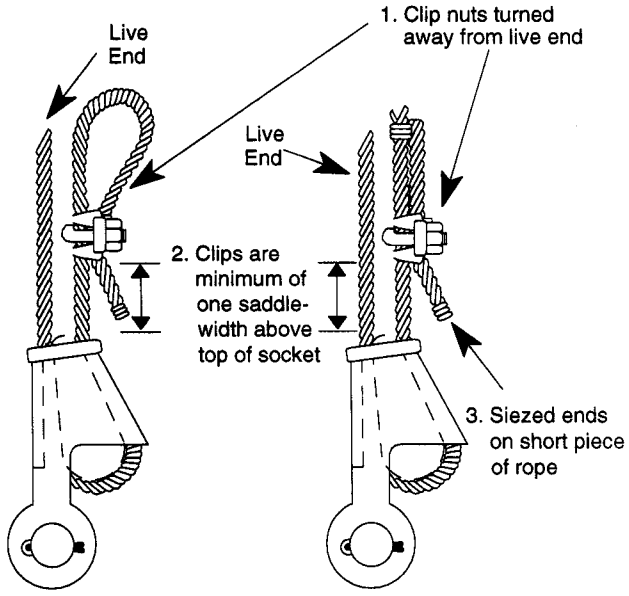


There are two correct ways to dead-end a rope in a socket. Generally, smaller diameter rope, such as 3/4" (19mm) or smaller, can be looped back on itself and clipped as shown in the lower left illustration. Larger diameter rope makes large loops which may foul in use. Therefore, it is recommended that no loop be formed. Instead, a short piece (4" to 6" long) of tope of the same diameter should be placed against the dead end so that the clip may be drawn up tight as shown in the lower right illustration. Both ends of the short piece of rope should be seized to prevent unraveling. Place the clip at least the width of the clip saddle above the socket.

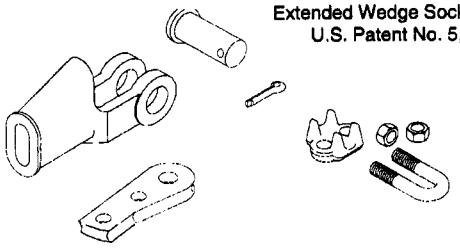
WARNING

NEVER FACE SADDLE END OF CLIP TOWARD LIVE END OF ROPE IN A WEDGE SOCKET. THE CLIP NUTS MAY RUB AGAINST LIVE END OF THE ROPE. THE RESULTING ABRASION COULD EVENTUALLY CUT INTO THE LIVE END OF THE ROPE, SERIOUSLY WEAKENING IT.

RIGHT WAY:



"TERMINATOR" WEDGE SOCKET WARNING & APPLICATION INSTRUCTIONS



Extended Wedge Socket Assembly
U.S. Patent No. 5,553,360

S-421T
"TERMINATOR"™

NOTE: Existing Crosby S-421 Wedge Sockets can be retrofitted with the New Terminator Wedge.

New **QUIC CHECK**™ "Go" and "No-Go" features cast into wedge. The proper size wire rope is determined when the following criteria are met: 1. The wire rope shall pass thru the "Go" hole in the wedge. 2. The wire rope shall NOT pass thru the "No-Go" hole in the wedge.

QUIC-CHECK™

Important Safety Information - Read and Follow

Inspection/Maintenance Safety

- Always inspect socket, wedge and pin before using.
- Do not use part showing cracks.
- Do not use modified or substitute parts.
- Repair minor nicks or gouges to socket or pin by lightly grinding until surfaces are smooth. Do not reduce original dimension more than 10%. Do not repair by welding.
- Inspect permanent assemblies annually, or more often in severe operating conditions.

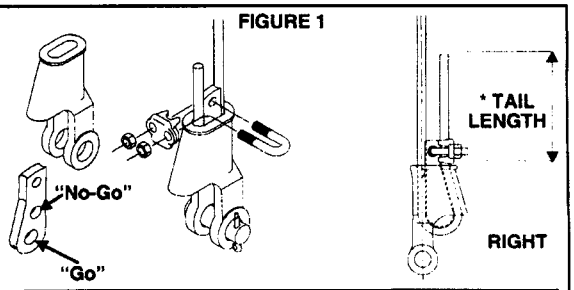
Assembly Safety

- Use only with standard 6 to 8 strand wire rope of designated size. For intermediate size rope, use next larger size socket. For example: When using 9/16" diameter wire rope use a 5/8" size Wedge Socket Assembly. Welding of the tail on standard wire rope is not recommended. The tail length of the dead end should be a minimum of 6 rope diameters but not less than 6" (See Figure 1).
- **To use with Rotation Resistant wire rope** (special wire rope constructions with 8 or more outer strands) ensure that the dead end is welded, brazed or seized before inserting the wire rope into the wedge socket to prevent core slippage or loss of rope lay. The tail length of the dead end should be a minimum of 20 rope diameters but not less than 6" (See Figure 1).
- Properly match socket, wedge and clip (See Table 1) to wire rope size.
- Align live end of rope, with center line of pin. (See Figure 1)
- Secure dead end section of rope. (See Figure 1)
- Tighten nuts on clip to recommended torque. (Table 1)
- Do not attach dead end to live end or install wedge backwards. (See Figure 2)
- **Use a hammer to seat Wedge and Rope as deep into socket as possible before applying first load.**

⚠ WARNING

- **Loads may slip or fail if the Wedge Socket is not properly installed.**
- **A falling load can seriously injure or kill.**
- **Read and understand these instructions before installing the Wedge Socket.**
- **Do not side load the Wedge Socket.**
- **Apply first load to fully seat the Wedge and Wire Rope in the socket. This load should be of equal or greater weight than loads expected in use.**

FIGURE 1



*Tail Length	
Standard 6 to 8 strand wire rope	**Rotation Resistant Wire Rope**
A minimum of 6 rope diameters, but not less than 6"	A minimum of 20 rope diameters, but not less than 6".

TABLE 1

Rope Size	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/8	1 1/4
Clip Size	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/8	1 1/4
*Torque Ft./lbs.	45	65	65	95	95	130	225	225	225	360

* The tightening torque values shown are based upon the threads being clean, dry, and free of lubrication.

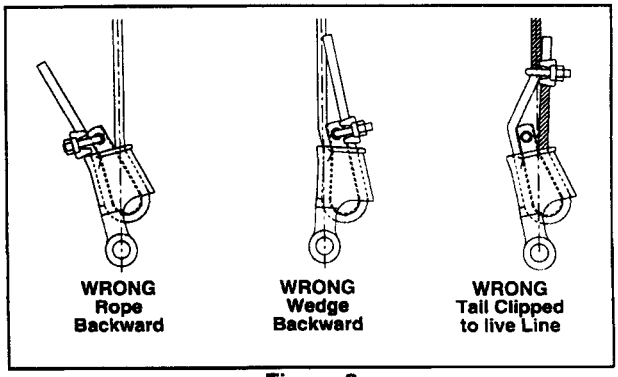


Figure 2

Operating Safety

- Apply first load to fully seat the Wedge and Wire Rope in the socket. This load should be of equal or greater weight than loads expected in use.
- Efficiency rating of the Wedge Socket termination is based upon the catalog breaking strength of Wire Rope. The efficiency of a properly assembled Wedge Socket is 80%.
- During use, do not strike the dead end section with any other elements of the rigging (Called two blocking).

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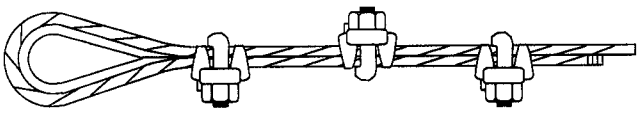
WIRE ROPE CLIP INSTALLATION PROCEDURE

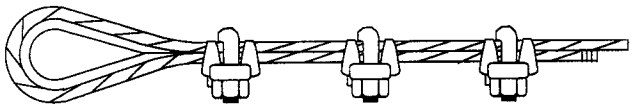
⚠ WARNING

CORRECT INSTALLATION OF ROPE CLIPS IS EXTREMELY IMPORTANT. FAILURE TO INSTALL CLIPS CORRECTLY CAN CAUSE DAMAGE TO THE CRANE AND THE LOAD AND ENDANGER PERSONNEL. TO GET MAXIMUM CLIP HOLDING POWER, CAREFULLY FOLLOW THE INSTALLATION PROCEDURE DESCRIBED BELOW. USE DROP FORGED STEEL TYPE CLIPS ONLY.

WRONG WAYS to clip wire rope

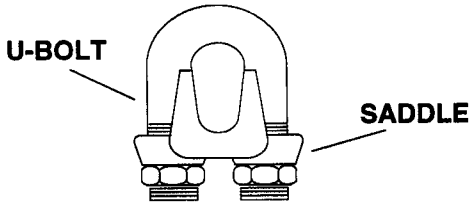


INCORRECT
Do not stagger clips.

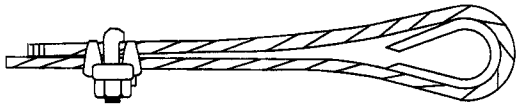


INCORRECT
Do not place U-bolt on live end of rope.

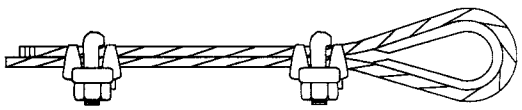
RIGHT WAY to clip wire rope



1. Turn back the specified amount of rope from the thimble. Apply the first clip one base width from the dead end of the wire rope (U-bolt over dead end; live end rests in clip saddle). Tighten nuts evenly to recommended torque.



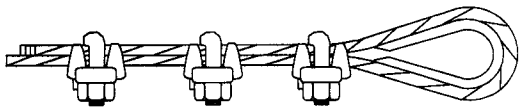
2. Apply the next clip as near the loop as possible. Turn on nuts firmly but do not tighten.



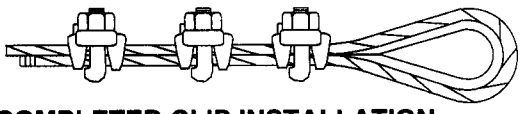
⚠ WARNING

ALL CLIPS MUST BE INSTALLED WITH THE CLIP SADDLE ON THE LIVE END OF THE WIRE ROPE. CUTTING OR KINKING OF THE ROPE MAY OCCUR IF THE "U" OF A CLIP BEARS ON THE LIVE END OF THE ROPE.

3. Space additional clips if required equally between the first two, placing them one base width apart. Turn on nuts - take up rope slack tighten all nuts evenly on all clips to recommended torque.



4. Apply the initial load and retighten nuts to the recommended torque.



COMPLETED CLIP INSTALLATION
U-BOLT OF ALL CLIPS ON DEAD END OF ROPE

NOTE: Rope will stretch and shrink in diameter when loads are applied. Inspect clips periodically and again evenly tighten all nuts on all clips to recommended torque.

A termination made in accordance with the above instructions and using the number of clips shown in the table on the right has an efficiency rating of approximately 80% for 1/8" - 7/8" rope and 90% for 1" - 3" rope.

This rating is based upon the calculated breaking strength of wire rope. If a pulley is used in place of a thimble for turning back the rope, add one additional clip.

The number of clips required is based upon using right regular of Lang lay wire rope, 6 x 19 class or 6 x 37 class, fibre core or IWRC, IPS or XIPS.

If Seale construction or similar large outer wire type construction in the 6 x 19 class is to be used for sizes 1 inch and larger, add one additional clip.

The number of clips shown also applies to right regular lay wire rope, 8 x 19 class, fibre core, IPS sizes 1 1/2 inch and smaller; and right regular lay wire rope, 18 x 7 class, fibre core, IPS or XIPS, sizes 1 3/4 and smaller.

For other classes of wire rope not mentioned above, it may be necessary to add additional clips to the number shown.

If a greater number of clips are used than shown in the table, the amount of rope turnback should be increased proportionately. **Above based on use of Genuine Crosby Clips on new rope.**

Clip Size Inches	Minimum No. of Clips	Amt. of Rope to Turn Back in Inches	Torque in Ft. Lbs.
1/8	2	3 1/4	4.5
3/16	2	3 3/4	7.5
1/4	2	4 3/4	15
5/16	2	5 1/4	30
3/8	2	6 1/2	45
7/16	2	7	65
1/2	3	11 1/2	65
9/16	3	12	95
5/8	3	12	95
3/4	4	18	130
7/8	4	19	225
1	5	26	225
1 1/8	6	34	225
1 1/4	7	44	360
1 3/8	7	44	360
1 1/2	8	54	360
1 5/8	8	58	430
1 3/4	8	61	590
2	8	71	750
2 1/4	8	73	750
2 1/2	9	84	750
2 3/4	10	100	750
3	10	106	1200

CAUTION

FAILURE TO MAKE A TERMINATION IN ACCORDANCE WITH THE INSTRUCTIONS DETAILED HERE AND ON THE PRECEDING PAGE OR FAILURE TO PERIODICALLY CHECK AND RETIGHTEN CLIPS TO THE RECOMMENDED TORQUE WILL CAUSE A REDUCTION IN THE EFFICIENCY RATING.

BOOM COMPOSITION CHART
47HI (1.19m) BOOM, 4 SHEAVE TIP WITH EXTENDED AXLE

Boom Length (Feet)	Boom Sections				
	20' 47HI Inner	10' 47H Center	20' 47H Center	30' 47H Center	20' 47HI Outer
40	1	0	0	0	1
50	1	1	0	0	1
60	1	0	1	0	1
70	1	0	0	1	1
80	1	1	0	1	1
90	1	0	1	1	1
100	1	0	0	2	1
110	1	1	0	2	1
120	1	0	1	2	1
130	1	0	0	3	1
140	1	1	0	3	1
150	1	0	1	3	1
160	1	0	0	4	1
170	1	1	0	4	1
180	1	0	1	4	1
190	1	0	0	5	1
200	1	1	0	5	1

MAXIMUM BOOM AND JIB SELF-ERECTION DATA

	Over the End and Over the Side	
	Boom Length (Feet)	Jib Length (Feet)
#7HL Jib	200 170	0 60
#9HL Jib	200 170	0 60

Note: Erection is with the A-Frame fully raised. Erection "OVER THE END" is with the boom over the idler end. Erection "OVER THE SIDE" is with the boom 90° to the sideframes and with the sideframes extended. Blocks, slings and other load carrying devices must be on the ground during erection.

LOAD HOISTING INFORMATION - 7/8" EIPS ROPE
47HI (1.19m) BOOM, 4 SHEAVE TIP WITH EXTENDED AXLE

Maximum Lifting Capacity - Lbs.	Minimum Parts of Line	Maximum Hoisting Distance - Feet	
		Main - (Right)	Auxiliary - (Left)
160,000	8	73	73
159,180	7	84	84
136,440	6	98	98
113,700	5	117	117
90,960	4	147	147
68,220	3	196	196
45,480	2	294	294
22,740	1	588	588

BOOM COMPOSITION CHART
46HI ANGULAR BOOM, 4 SHEAVE TIP

Boom Length Ft. (m)	Boom Sections				
	20' (6.10m) 46HI (1.17m) Inner	10' (3.05m) 46HR (1.17m) Center	20' (6.10m) 46HR (1.17m) Center	40' (12.19m) 46HR (1.17m) Center	20' (6.10m) 46HI (1.17m) Outer
40' (12.19m)	1	0	0	0	1
50' (15.24m)	1	1	0	0	1
60' (18.29m)	1	0	1	0	1
70' (22.86m)	1	1	1	0	1
80' (24.38m)	1	0	0	1	1
90' (27.43m)	1	1	0	1	1
100' (30.48m)	1	0	1	1	1
110' (33.52m)	1	1	1	1	1
120' (36.58m)	1	0	0	2	1
130' (39.62m)	1	1	0	2	1
140' (42.67m)	1	0	1	2	1
150' (45.72m)	1	1	1	2	1
160' (48.77m)	1	0	0	3	1

AMERICAN CRANE BOOM COMPOSITION

⚠ WARNING

IF ANY OF THE FOLLOWING SUBSTITUTIONS ARE GOING TO BE USED, THE INSTRUCTIONS MUST BE FOLLOWED EXACTLY. NEVER USE MORE THAN ONE SUBSTITUTION IN A SPECIFIC BOOM COMBINATION. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN AN ACCIDENT WITH PERSONAL INJURY, DEATH, OR SEVERE PROPERTY DAMAGE.

Each Rating Chart issued by American Crane has a Boom Composition Chart at the back of the Rating Chart. A Boom Composition tabulation on the back pages of the rating chart lists the type and location of each boom section for all legitimate boom lengths from minimum to maximum boom. In most cases the shortest center boom sections are placed closest to the bottom of the boom and the longest center sections are placed closest to the tip.

Individual boom sections are labeled "L", "S" or "H" to designate "light", "standard" or "heavy" sections. The substitution of a boom section heavier than one specified will reduce the crane's stability for both erection and operating conditions. The substitution of a boom section lighter than one specified reduces the strength of the boom and is never allowed.

⚠ WARNING

THE SUBSTITUTION OF BOOM SECTIONS OTHER THAN THOSE SPECIFIED OR THE USE OF ANY SECTIONS AT LOCATIONS OTHER THAN THOSE SPECIFIED, MAY RESULT IN AN ACCIDENT WITH SEVERE PROPERTY DAMAGE, PERSONNEL INJURY, OR DEATH.

Limited deviation from the boom composition sequence specified on the crane's assigned rating chart is allowable provided the following rules are strictly enforced.

1) No boom section can ever be replaced by a lighter section of the same length, e.g. a 40 ft. "H" section CANNOT be replaced by a 40 ft. "S" section.
2) A maximum of one center section can be replaced by a combination of shorter center sections of the same designation, e.g. a 40 ft. "S" section can be replaced by two 20 ft. "S" sections.
3) No more than three shorter sections can be used to replace a longer section of the same designation, e.g. a 40 ft. "S" section CANNOT be replaced by four 10 ft. "S" sections.
4) A maximum of one lighter center section can be replaced by a heavier section of the same length e.g. a 40 ft. "S" section can be replaced by a 40 ft. "H" section.
5) No more than three shorter sections of any designation can be used to replace a longer, lighter section, e.g. one 10 ft. "S" plus two 20 ft. "H" sections can be used to replace one 50 ft. "S" section. The same three sections CANNOT be used to replace one 50 ft. "H" section.
6) Absolutely no substitutions are allowed for boom or boom plus jib combinations within 50 ft. of maximum self-erectable length combinations.
7) Any time a substitution is used 2,000 pounds must be subtracted from each load chart rating.
8) No more than one of the above substitutions can be made in any given boom length.

If any of the allowed substitutions are to be made, the following rules must be followed in determining the new boom assembly sequence.

A) Heavier sections must always be placed below lighter sections.
B) Subject to Rule A), shorter sections must always be placed below longer sections.

If there are any questions concerning whether or not a particular substitution can be made, contact American Crane Service Department before proceeding.

NOTE: You cannot substitute an Angle Boom Section into a Tubular Boom, or a Tubular Boom Section into an Angular Boom even if they pin together.

47HI BOOM AND 9HL JIB
MAIN & JIB HOIST ROPE REQUIREMENTS

TOTAL OF BOOM & JIB LENGTH	ROPE LENGTHS AND CORRESPONDING PARTS OF LINE (FEET)							
	1	2	3	4	5	6	7	8
40	125	170	215	260	305	350	395	440
50	145	200	255	310	365	420	475	530
60	165	230	295	360	425	490	555	
70	185	260	335	410	480	555		
80	205	290	375	460	540			
90	225	320	415	510				
100	245	350	455	560				
110	265	380	495	610				
120	285	410	535					
130	305	440	575					
140	325	470						
150	345	500						
160	365	530						
170	385	560						
180	405	590						
190	425							
200	445							
210	465							
220	485							
230	505							

Main & Auxiliary Drum Spooling Capacity
588' Drum Working Capacity - 6 Layers
860' Drum Storage Capacity - 8 Layers

MAIN LOAD LINE (8 PARTS MAX.)

7/8" EIPS, RRL, IWRC, 79,600 LBS. Min. Brk. Str.

JIB WHIP LINE (1 PART MAX.)

7/8" EIPS, RRL, IWRC, 79,600 LBS. Min. Brk. Str.

The rope lengths calculated for load lines allow working at ground level with the boom at its minimum radius. For rope length adjustments when working at a different level, multiply the parts of line used times the difference in level from the ground. [8 parts of line x 10' (3.05m) below ground level = 80' (24.38m) extra added.] Add this adjustment for below ground level work, or subtract it for above ground level work.

NOTE: The load line lengths in the above table cover the various combinations of booms and jibs used on the HC 80 machine. Use your ratings chart to determine the minimum necessary parts of line for a particular lift. Then use the length of rope corresponding to the boom length or boom and jib used. See the reeving diagrams for reeving instructions.

46HI BOOM
MAIN & AUX. HOIST ROPE REQUIREMENTS

TOTAL OF BOOM & JIB LENGTH	ROPE LENGTHS AND CORRESPONDING PARTS OF LINE (FEET)							
	1	2	3	4	5	6	7	8
40'	93'	137'	184'	227'	273'	317'	362'	402'
45'	105'	152'	204'	252'	303'	353'	402'	447'
50'	115'	167'	224'	277'	333'	387'	442'	492'
55'	125'	182'	244'	302'	363'	422'	482'	538'
60'	135'	197'	264'	327'	393'	457'	522'	582'
65'	145'	212'	284'	352'	423'	492'	562'	627'
70'	155'	227'	304'	377'	453'	527'	602'	672'
75'	165'	242'	324'	402'	483'	562'	642'	717'
80'	174'	257'	344'	427'	514'	597'	682'	762'
85'	184'	272'	364'	452'	544'	632'	722'	807'
90'	194'	286'	383'	476'	572'	666'	762'	852'
95'	204'	301'	403'	501'	602'	701'	802'	
100'	214'	315'	422'	525'	630'	735'		
110'	234'	345'	462'	574'	690'	803'		
120'	253'	374'	501'	623'	749'			
130'	273'	404'	540'	672'	807'			
140'	293'	434'	580'	721'				
150'	313'	463'	619'					
160'	333'	492'	658'					

Main & Auxiliary Drum Spooling Capacity
588' Drum Working Capacity - 6 Layers
860' Drum Storage Capacity - 8 Layers

MAIN LOAD LINE (8 PARTS MAX.)

7/8" EIPS, RRL, IWRC, 79,600 LBS. Min. Brk. Str.

JIB WHIP LINE (1 PART MAX.)

7/8" EIPS, RRL, IWRC, 79,600 LBS. Min. Brk. Str.

The rope lengths calculated for load lines allow working at ground level with the boom at its minimum radius. For rope length adjustments when working at a different level, multiply the parts of line used times the difference in level from the ground. [8 parts of line x 10' (3.05m) below ground level = 80' (24.38m) extra added.] Add this adjustment for below ground level work, or subtract it for above ground level work.

NOTE: The load line lengths in the above table cover the various combinations of booms and jibs used on the HC 80 machine. Use your ratings chart to determine the minimum necessary parts of line for a particular lift. Then use the length of rope corresponding to the boom length or boom and jib used. See the reeving diagrams for reeving instructions.

46HI BOOM
MAIN & AUX. HOIST ROPE REQUIREMENTS

TOTAL OF BOOM & JIB LENGTH	ROPE LENGTHS AND CORRESPONDING PARTS OF LINE (METERS)							
	1	2	3	4	5	6	7	8
12.19m	28.96m	41.76m	56.08m	69.19m	83.21m	96.62m	110.34m	122.53m
13.72m	32.00m	46.33m	62.18m	76.81m	92.35m	107.59m	122.53m	136.25m
15.24m	35.05m	50.90m	68.28m	84.43m	101.50m	117.96m	134.72m	149.96m
16.76m	38.10m	55.47m	74.37m	92.05m	110.64m	128.63m	146.91m	163.98m
18.29m	41.15m	60.05m	80.47m	99.67m	119.79m	139.29m	159.11m	177.39m
19.81m	44.20m	64.62m	86.56m	107.29m	128.93m	149.96m	171.30m	191.11m
21.34m	47.24m	69.19m	92.66m	114.91m	138.07m	160.63m	183.49m	204.83m
22.86m	50.29m	73.76m	98.76m	122.53m	147.22m	171.30m	195.68m	218.54m
24.38m	53.04m	78.33m	104.85m	130.15m	156.67m	181.97m	207.87m	232.26m
25.91m	56.08m	82.91m	110.95m	137.77m	165.81m	192.63m	220.07m	245.97m
27.43m	59.13m	87.17m	116.74m	145.08m	174.35m	203.00m	232.26m	259.69m
28.96m	62.18m	91.74m	122.83m	152.70m	183.49m	213.66m	244.45m	
30.48m	65.23m	96.01m	128.63m	160.02m	192.02m	224.03m		
33.53m	71.32m	105.16m	140.82m	174.96m	210.31m	244.75m		
36.58m	77.11m	114.00m	152.70m	189.89m	228.30m			
39.62m	83.21m	123.14m	164.59m	204.83m	245.97m			
42.67m	89.31m	132.28m	176.78m	219.76m				
45.72m	95.40m	141.12m	188.67m					
48.77m	101.50m	149.96m	200.56m					

Main & Auxiliary Drum Spooling Capacity
588' Drum Working Capacity - 6 Layers
860' Drum Storage Capacity - 8 Layers

MAIN LOAD LINE (8 PARTS MAX.)

7/8" EIPS, RRL, IWRC, 79,600 LBS. Min. Brk. Str.

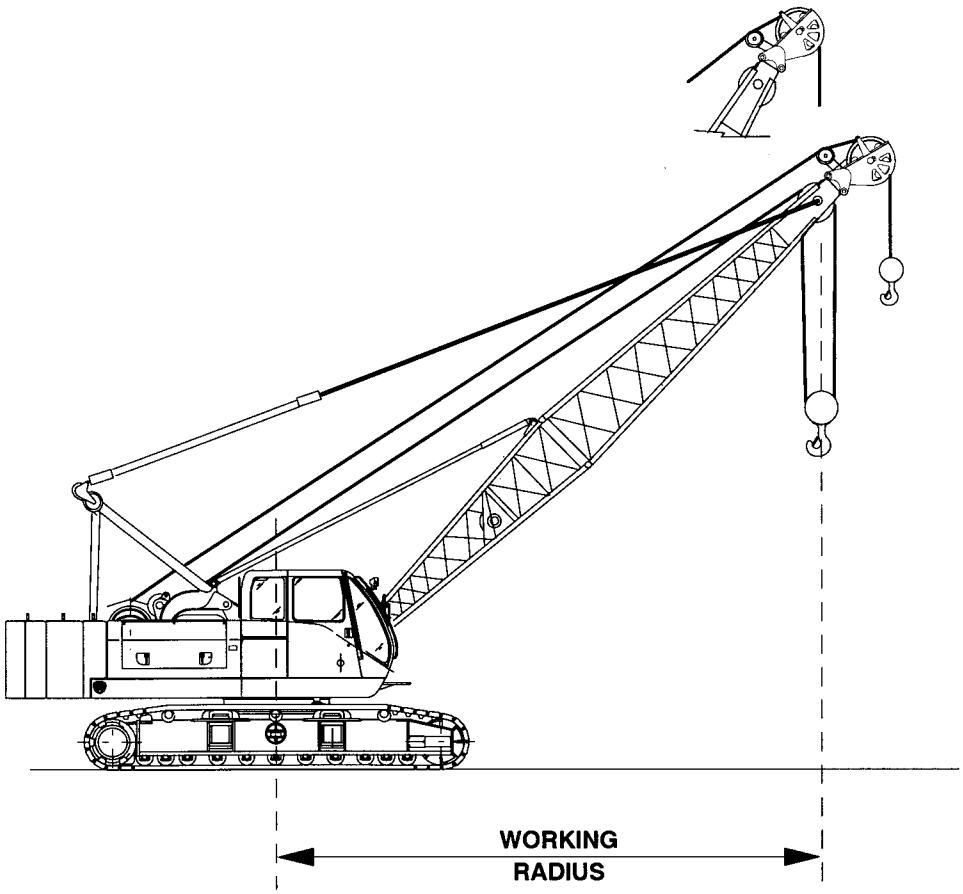
JIB WHIP LINE (1 PART MAX.)

7/8" EIPS, RRL, IWRC, 79,600 LBS. Min. Brk. Str.

The rope lengths calculated for load lines allow working at ground level with the boom at its minimum radius. For rope length adjustments when working at a different level, multiply the parts of line used times the difference in level from the ground. [8 parts of line x 10' (3.05m) below ground level = 80' (24.38m) extra added.] Add this adjustment for below ground level work, or subtract it for above ground level work.

NOTE: The load line lengths in the above table cover the various combinations of booms and jibs used on the HC 80 machine. Use your ratings chart to determine the minimum necessary parts of line for a particular lift. Then use the length of rope corresponding to the boom length or boom and jib used. See the reeving diagrams for reeving instructions.

BOOM TIP EXTENSION RATED CAPACITY



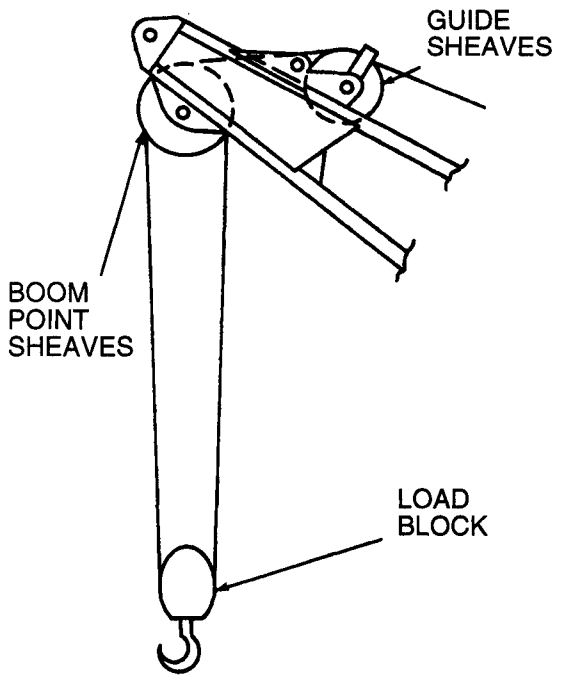
The Boom Tip Extension Capacity is the lesser of:

1. The maximum rated capacity of the Boom Tip Extension (22,740 pounds)
2. The hoisting drum's maximum rated single line pull multiplied by the allowable parts of line used
3. The allowable rope load multiplied by the allowable parts of line used
4. The mainfall capacity at the same working radius less the weight of the main fall tackle.

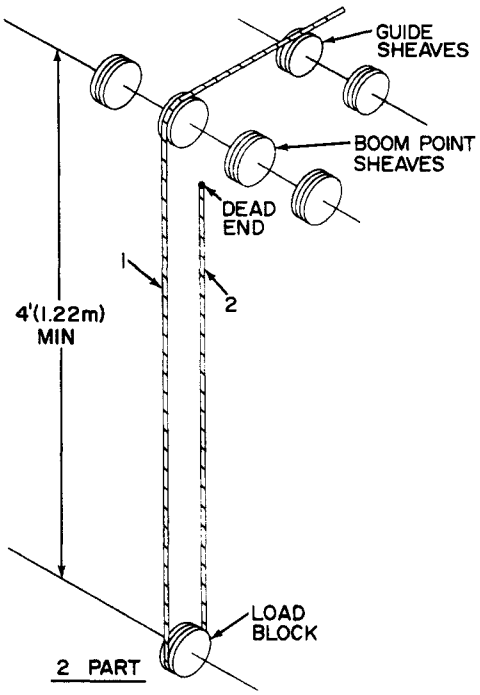
Please note the following:

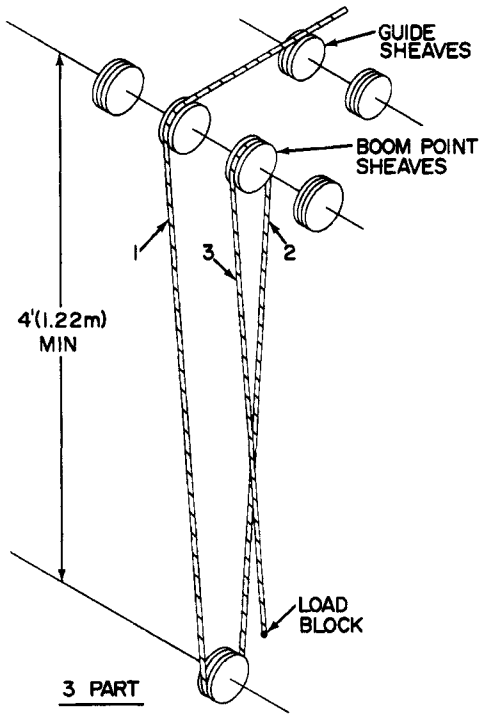
- Simultaneous lifting from both falls is not permitted. Panel tilt-up applications are an exception to this rule. Contact American Crane Service Department for additional information.
- When lifting from the main boom, with this boom tip extension in place, the LMI will automatically account for the weight of the boom tip extension.
- When lifting from the main boom, with this boom tip extension in place without the LMI, deduct 400 pounds from all ratings on the Load Chart.

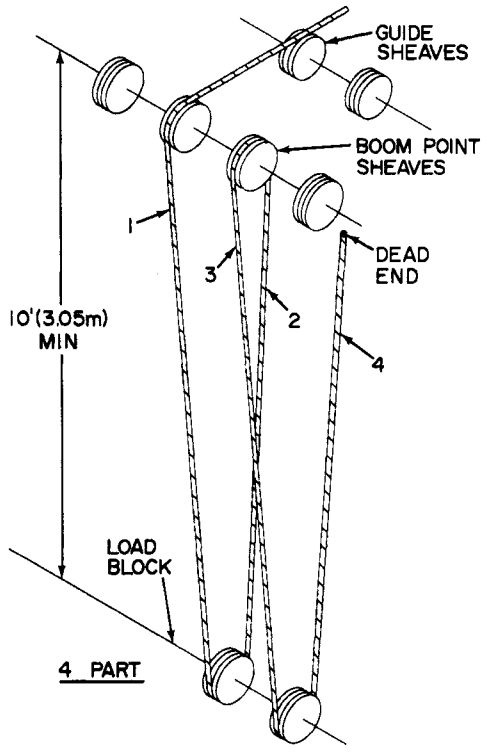
REEVING DIAGRAMS, 47" HI (1.19m) BOOMS WITH 4 SHEAVE OFFSET TIP



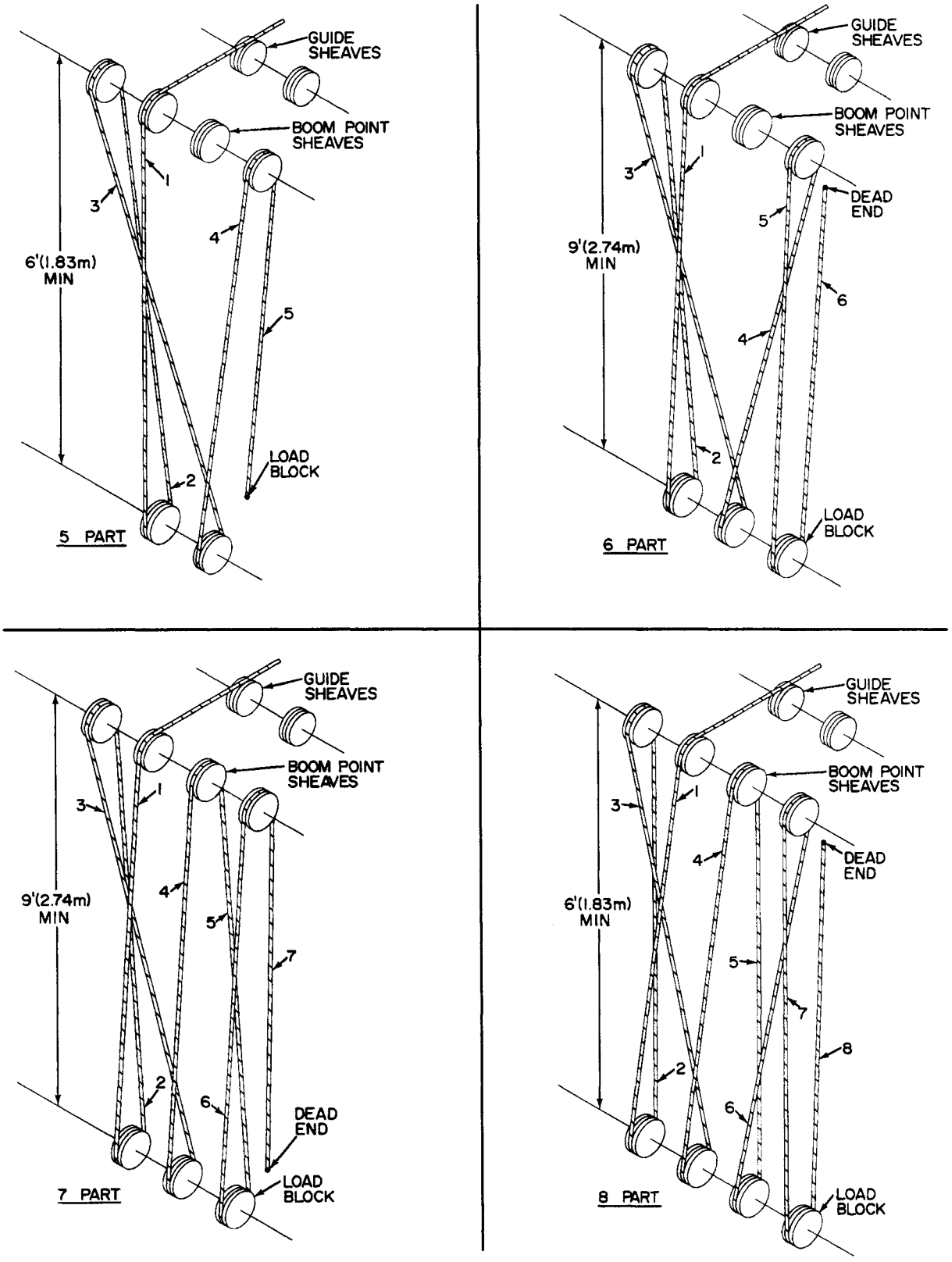
OFFSET TIP
GENERAL BOOM AND
BLOCK ARRANGEMENT
SIDE VIEW



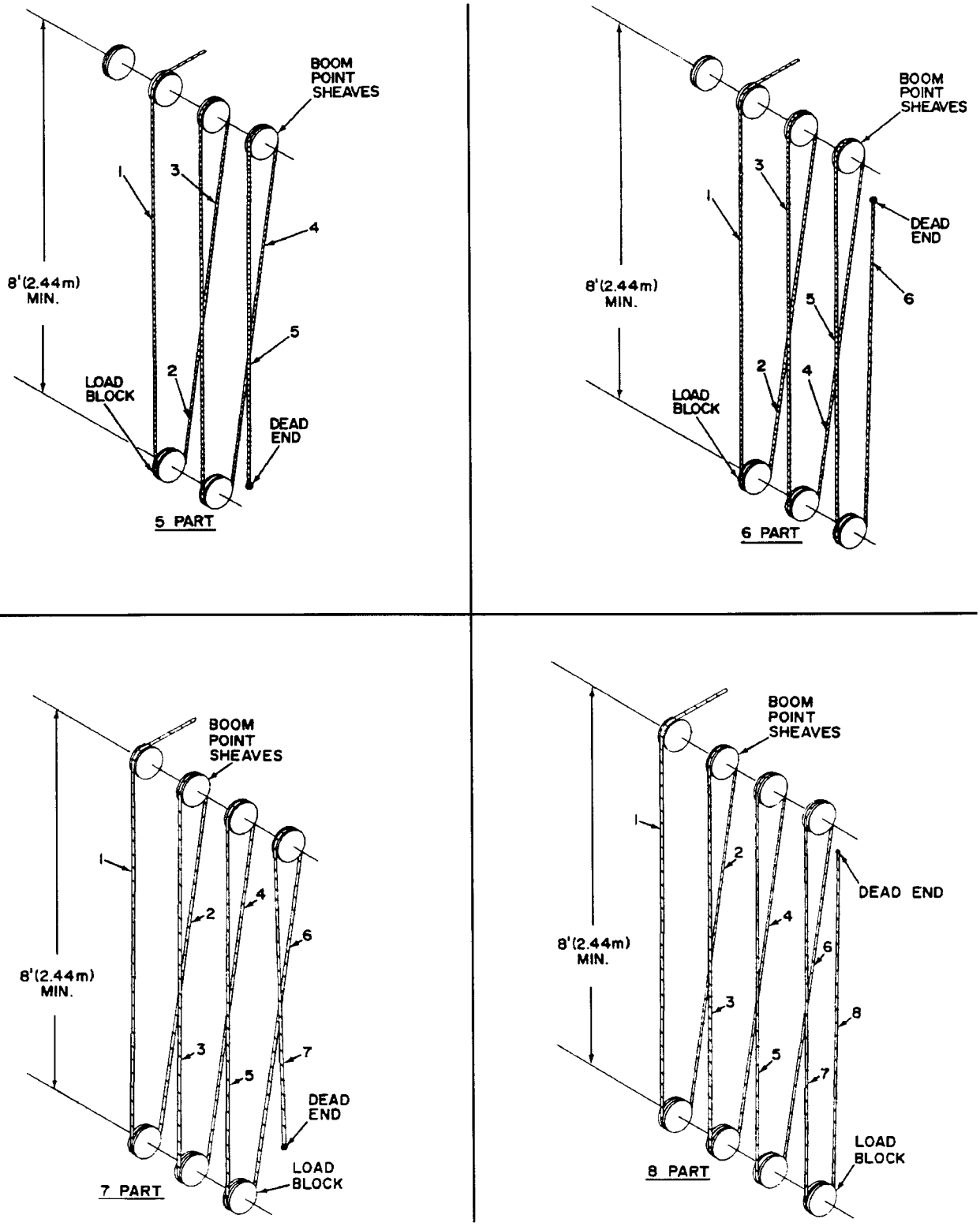




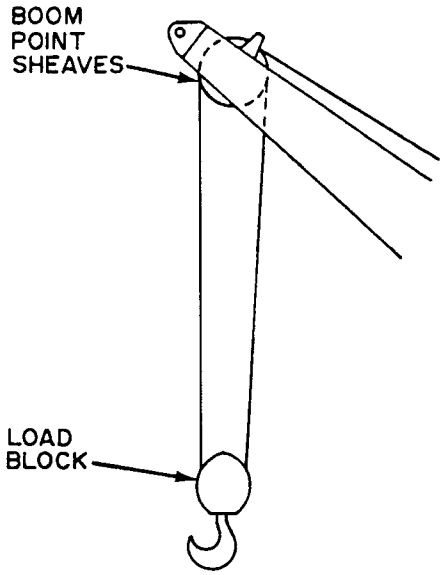
REEVING DIAGRAMS, 47" HI (1.19m) BOOMS WITH 4 SHEAVE OFFSET TIP



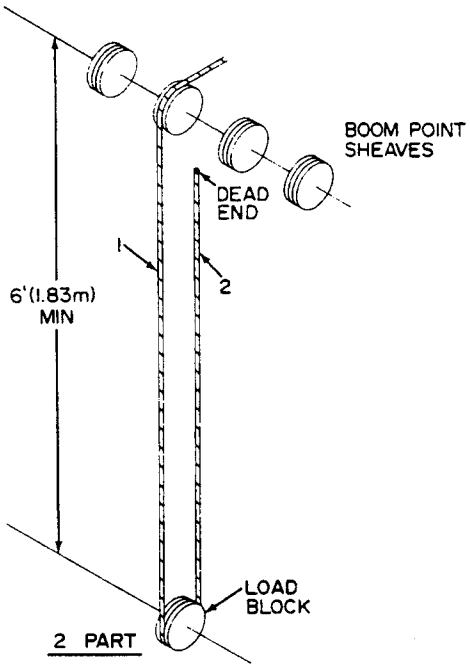
REEVING DIAGRAMS - 46HI HEAVY DUTY ANGLE BOOM



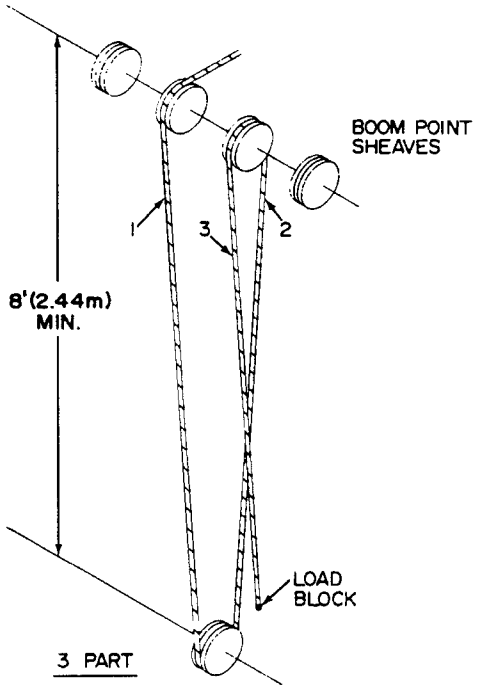
REEVING DIAGRAMS - 46HI HEAVY DUTY ANGLE BOOM



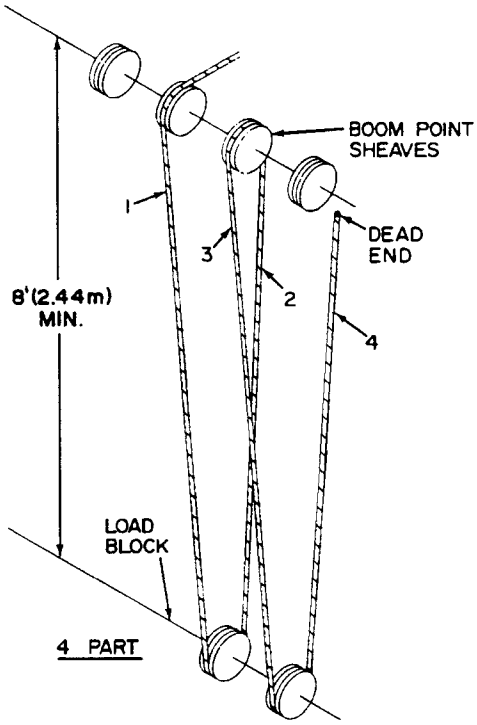
GENERAL BOOM & BLOCK ARRANGEMENT
SIDE VIEW



2 PART



3 PART



4 PART

BOOM RIGGING AND JIB - HC80 DRUM PERFORMANCE
46HI BOOM

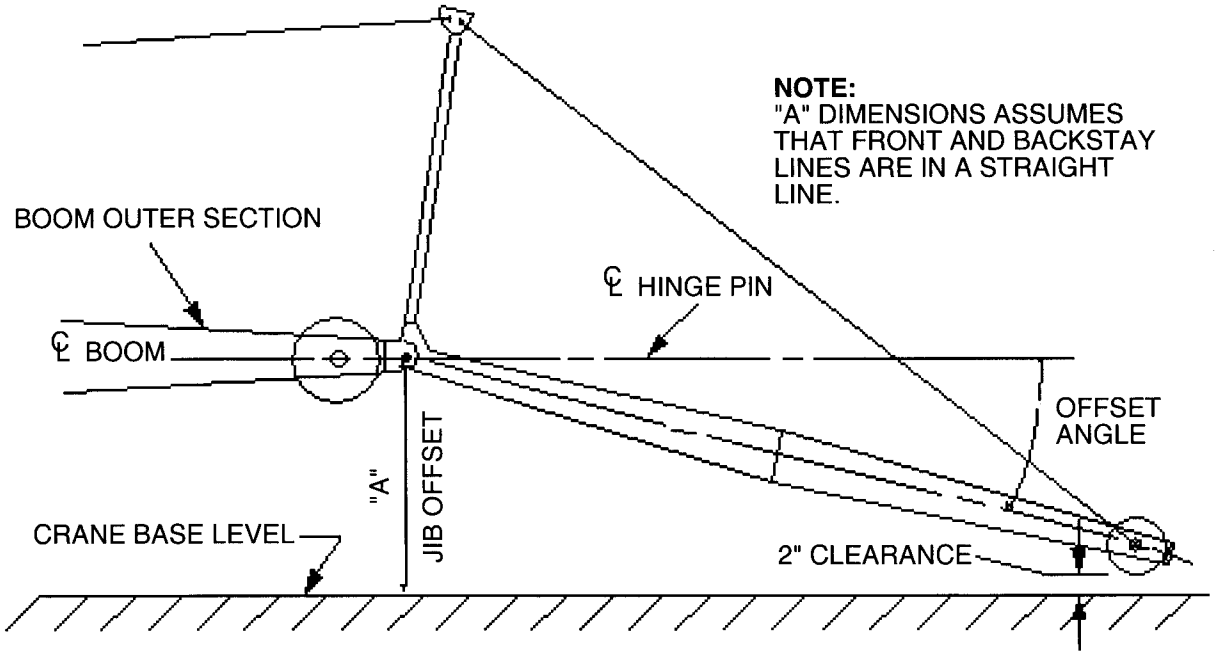
Main & Auxiliary Hoist 7/8" Diameter Rope					
Rope Layer	Low Range		High Range		Total Rope Length Feet
	Line Speed Feet per Minute	Single Line Pull Pounds	Line Speed Feet per Minute	Single Line Pull Pounds	
1	223	36,800	291	28,100	78
2	242	33,900	316	25,900	177
3	261	31,500	341	24,100	259
4	279	29,300	365	22,500	362
5	298	27,500	390	21,000	467
6	317	25,900	415	19,800	584
7	336	25,800	439	18,700	702
8*	355	- - -	464	- - -	833
9*	374	- - -	489	- - -	965
10*	393	- - -	513	- - -	1110
*8th, 9th and 10th Layer are for *storage only*.					
7/8" 6x25, FW, PREF, EIPS, RRL, IWRC, 79,600 LBS. MBS					

3rd Drum Type"A" with Free Fall 5/8" Diameter Rope				
	Low Range		No Load	
1	181	18,600	219	59
2	195	17,300	235	118
3	209	16,200	252	185
4	222	15,200	269	253
5	236	14,300	285	329
6	250	13,500	302	405
7	263	12,800	318	490
8	277	12,200	335	575
9	291	11,600	352	669
10	305	11,100	368	761
11*	317	- - -	384	835
*11th Layer is recommended for *storage only*.				
5/8" x 760 FT. MAX, 35,000 LBS. MBS, 6X25 FW, PREF, IWRC, RRL, IPS, BRIGHT				

#9 JIB COMPOSITION

#9 JIB COMPOSITION CHART							
JIB LENGTH (FEET)	10' INNER	10' CENTER	10' OUTER	EFF. JIB WEIGHT (POUNDS)	JIB OFFSET "A" IN FEET		
					5°	15°	25°
20	1	0	1	1,550	3.75	6.00	8.50
30	1	1	1	2.100	3.50	7.83	11.58
40	1	2	1	2,800	5.08	9.67	14.50

NOTE: The #9 jib mounted on a 46HI outer requires the use of a 46HI/ #9 jib adaptor.



JIB COMBINATIONS AVAILABLE

JIB DESCRIPTION		JIB LENGTH DESIRED	BASIC FRONTSTAY PENDANT (1 REQ'D)	JIB INSERT(S) NEEDED	FRONTSTAY INSERT PENDANT(S) NEEDED
SIZE	BOOM USED ON				
#9	46"	20'	46'-6"	None	None
#9	46"	30'	46'-6"	1-10'	1-18'-10-1/2"
#9	46"	40'	46'-6"	2-10'	2-18'-10-1/2"

JIB COMBINATIONS AVAILABLE (METRIC)

JIB DESCRIPTION		JIB LENGTH DESIRED	BASIC FRONTSTAY PENDANT (1 REQ'D)	JIB INSERT(S) NEEDED	FRONTSTAY INSERT PENDANT(S) NEEDED
SIZE	BOOM USED ON				
#9	1.17m	6.10m	14.17m	None	None
#9	1.17m	9.14m	14.17m	1-3.05m	1-5.75m
#9	1.17m	12.19m	14.17m	2-3.05m	2-5.75m

46HI BOOM WITH #9 JIB

7/8" (22.23mm) 6 x 25, F, RRL, IPS, IWRC (Used on #9 Jib)

⚠ CAUTION **IF NON-SPIN ROPES WITH 18 X 7, 19 X 7, OR 8 X 19 CONSTRUCTION ARE USED WITH SWIVEL ATTACHED TO ONE END, A REDUCTION IN THE BREAKING STRENGTH LISTED IN THE MANUFACTURERS CATALOG WILL RESULT.**

SINGLE PART WHIPLINE LENGTH

BOOM LENGTH FT (m)	20' (6.10m) JIB FT (m)	30' (9.14m) JIB FT (m)	40' (12.19m) JIB FT (m)
80 (24.38m)	218 (66.45m)	238 (72.54m)	258 (78.64m)
85 (25.91m)	228 (69.49m)	248 (75.59m)	268 (81.69m)
90 (27.43m)	238 (72.54m)	258 (78.64m)	278 (84.73m)
95 (28.96m)	248 (75.59m)	268 (81.69m)	288 (87.78m)
100 (30.48m)	258 (78.64m)	278 (84.73m)	298 (90.83m)
110 (33.53m)	278 (84.73m)	298 (90.83m)	318 (96.93m)
120 (36.58m)	298 (90.83m)	318 (96.93m)	338 (103.02m)
130 (39.62m)	318 (96.93m)	338 (103.02m)	358 (109.12m)
140 (42.67m)	338 (103.02m)	358 (109.12m)	378 (115.21m)
150 (45.72m)	358 (109.12m)	378 (115.21m)	398 (121.31m)
160 (48.77m)	378 (115.21m)	398 (121.31m)	418 (127.41m)
170 (51.82m)	398 (121.31m)	418 (127.41m)	438 (133.50m)

For two part whipline, use the single part load line length from above and add length of the boom and jib being used.

BOOM RIGGING AND JIB

HC 80 BOOM & JIB CONVERSION TABLE

1 m = 3.28084 Ft.	1 m = 39.37008 In.	1 mm = .03937 In.
1 Ft. = .3048 m	1 in. = .0254 m	1 In. = 25.4 mm
	1/10 Ft. = 1.20 In. = 1 13/64 In.	

The following metric lengfths are found throughout the Boom Rigging Section of the Operator's Manual. They have already been converted here for quick reference.

Meters	Feet
1.0	3.28
1.6	5.25
2.5	8.20
3.0	9.84
4.5	14.76
5.5	18.04
6.0	19.68
9.0	29.53

Meters	Feet
12.0	39.37
15.0	49.21
16.0	52.49
18.0	59.05
19.0	62.33
21.0	68.89
22.0	72.18

Meters	Feet
24.0	78.74
25.0	82.02
27.0	88.58
28.0	91.86
30.0	98.43
31.0	101.71
33.0	108.27

Meters	Feet
36.0	118.11
39.0	127.95
42.0	137.79
45.0	147.63
48.0	157.48
51.0	167.32
54.0	177.16

FORMULA: meters x 3.28084 = feet

#9 HL JIB COMPOSITION CHART

Jib Length (Feet)	20' Inner	10' Center	20' Center	20' Outer	Eff. Jib Weight (Pounds)
40	1	0	0	1	1,850
50	1	1	0	1	2,350
60	1	0	1	1	2,750

MAXIMUM BOOM & JIB SELF-ERECTION DATA

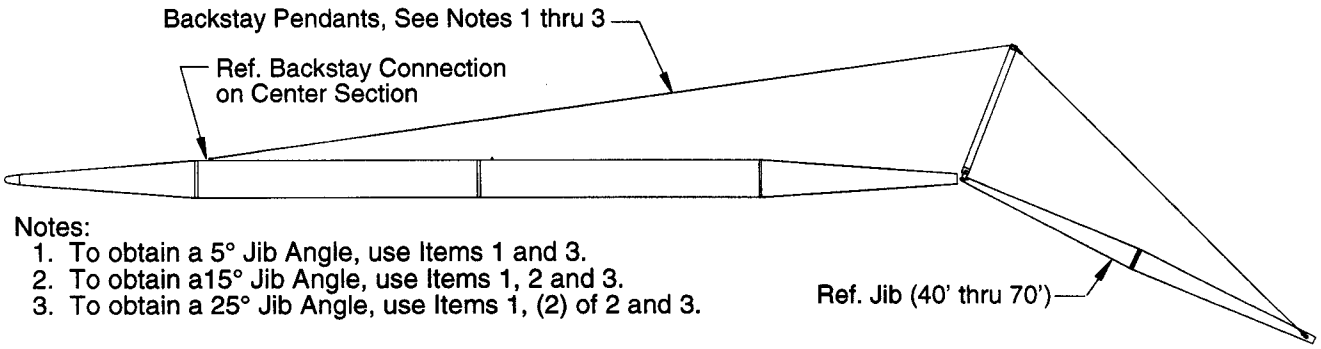
	Over the End		Over the Side	
	Boom Length (Feet)	Jib Length (Feet)	Boom Length (Feet)	Jib Length (Feet)
#9 HL Jib	200 170	0 60	200 170	0 60

LOAD HOISTING INFORMATION

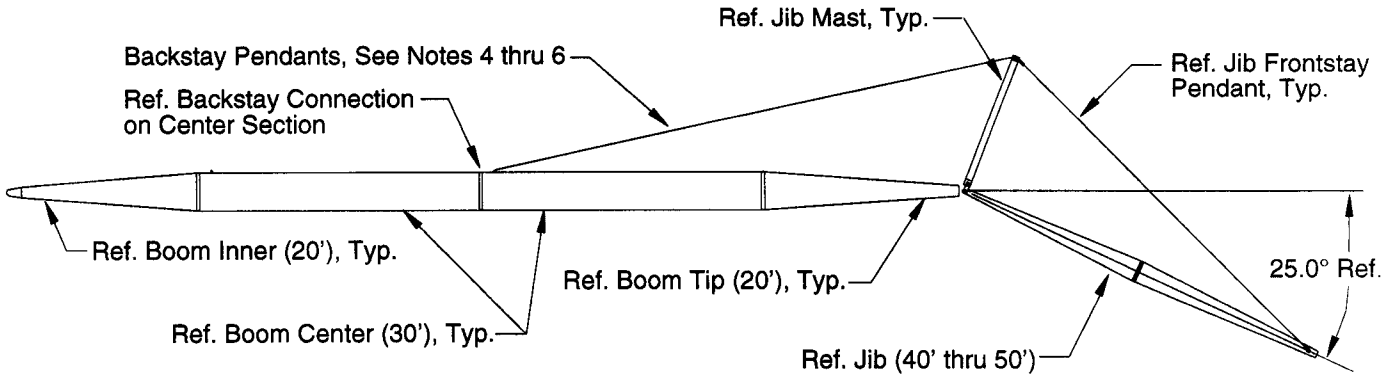
Maximum Lifting Capacity - Lbs.	Mimimum Parts of Line	Maximum Hoisting Distance - (Feet)	
		Main - (Right)	Aux. - (Left)
22,550	1	588	588

BOOM RIGGING AND JIB

BACKSTAY PENDANT INSTALLATION, #9HL JIB - 47HI BOOM



Notes:
1. To obtain a 5° Jib Angle, use Items 1 and 3.
2. To obtain a15° Jib Angle, use Items 1, 2 and 3.
3. To obtain a 25° Jib Angle, use Items 1, (2) of 2 and 3.



Notes:
4. To obtain a 5° Jib Angle, use Item 1.
5. To obtain a15° Jib Angle, use Items 1 and 2.
6. To obtain a 25° Jib Angle, use Items 1 and (2) of 2.

Note: When using Boom and Jib combinations, you must adhere to the following rules:
1. The Boom must be 2-1/2 times longer than the Jib.
2. The distance to the Jib Backstay connection must be equal to or greater than the length of the Jib.

REF. NO.	PART NO.	NO. REQ'D.	NAME OF PART
1	1179910	1	Pendant .875 Dia. 103'-3", Both Open
2	1179911	2	Pendant .875 Dia. 4'-9", Open/Closed
3	1179912	1	Pendant .875 Dia. 58'-5", Open/Closed

BOOM RIGGING AND JIB

#7 HL JIB COMPOSITION CHART

Jib Length (Feet)	10' Inner	10' Center	20' Center	20' Outer	Eff. Jib Weight (Pounds)	JIB OFFSET "A" IN FEET		
						5°	15°	25°
30	1	0	0	1	1,400	3.84'	7.67'	11.33'
40	1	1	0	1	1,950	4.50'	9.50'	14.33'
50	1	0	1	1	2,630	5.17'	11.50'	17.58'
60	1	1	1	1	2,950	5.75'	13.25'	20.58'

MAXIMUM BOOM & JIB SELF-ERECTION DATA

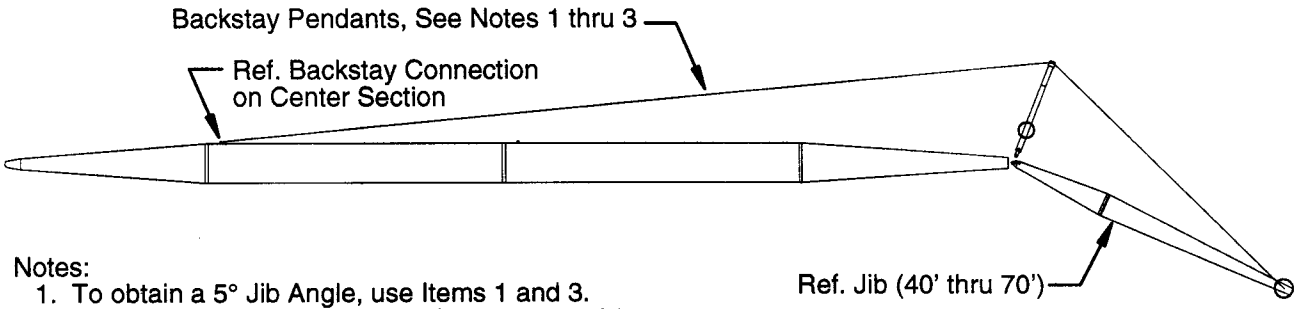
	Over the End		Over the Side	
	Boom Length (Feet)	Jib Length (Feet)	Boom Length (Feet)	Jib Length (Feet)
#7 HL Jib	200 170	0 60	200 170	0 60

LOAD HOISTING INFORMATION - 7/8" EIPS ROPE

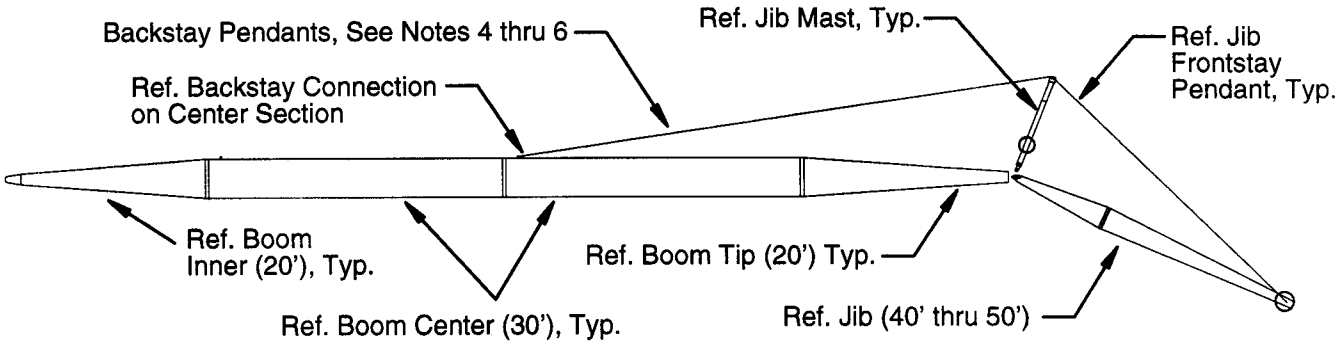
Maximum Lifting Capacity - Lbs.	Mimimum Parts of Line	Maximum Hoisting Distance - (Feet)	
		Main - (Right)	Aux. - (Left)
16,000	1	588	588

BOOM RIGGING AND JIB

BACKSTAY PENDANT INSTALLATION, #7HL JIB - 47HI BOOM



Notes:
1. To obtain a 5° Jib Angle, use Items 1 and 3.
2. To obtain a 15° Jib Angle, use Items 1, 2 and 3.
3. To obtain a 25° Jib Angle, use Items 1, (2) of 2 and 3.

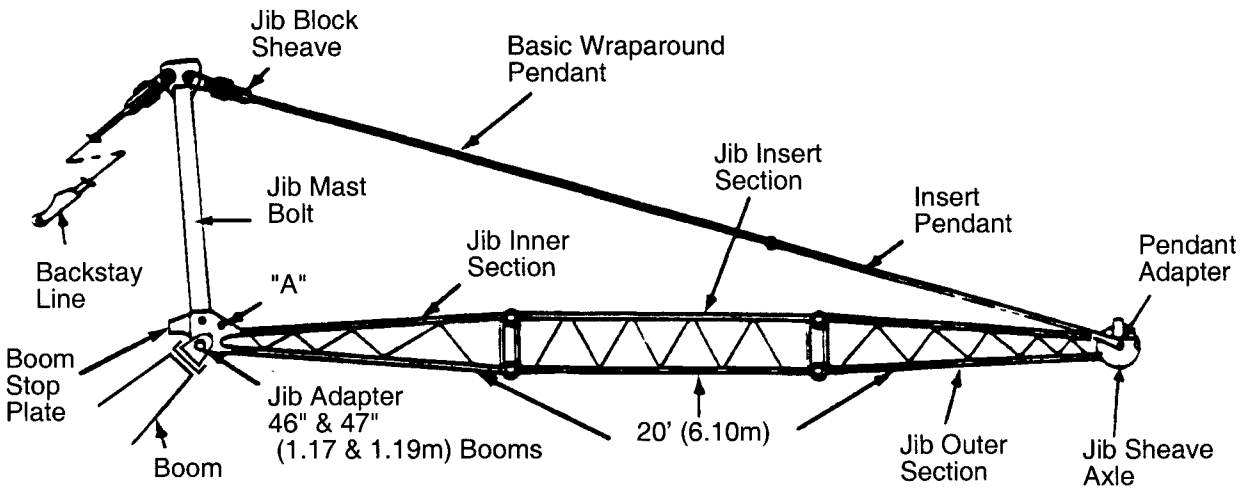


Notes:
4. To obtain a 5° Jib Angle, use Item 1.
5. To obtain a 15° Jib Angle, use Items 1 and 2.
6. To obtain a 25° Jib Angle, use Items 1 and (2) of 2.

Note: When using Boom and Jib combinations, you must adhere to the following rules:
1. The Boom must be 2-1/2 times longer than the Jib.
2. The distance to the Jib Backstay connection must be equal to or greater than the length of the Jib.

REF. NO.	PART NO.	NO. REQ'D.	NAME OF PART
1	1179914	1	Pendant .875 Dia. 101'-3", Both Open
2	1179915	2	Pendant .875 Dia. 3'-6", Open/Closed
3	1179916	1	Pendant .875 Dia. 59'-5", Open/Closed

JIB GENERAL ASSEMBLY AND INSTALLATION



Before assembling the jib on 46" or 47" (1.17 or 1.19m) booms, pin the jib adapter to the boom tip.

Assemble the jib sections on the ground and pin them together. Pin the jib mast to the jib inner section and lay it on blocking on the jib.

Next, assemble a wraparound pendant by running it through the jib block sheave and connecting it on each side of the jib point to the pendant adapter. When adding more sections, add pendants to the outer section of the jib to make up the length. Be sure the pendant connection never touches the jib block sheave.

Pin the jib to the boom tip.

Attach the backstay line to the jib mast and raise the mast. The backstay line may be attached to various places on the boom, with the following reservation:

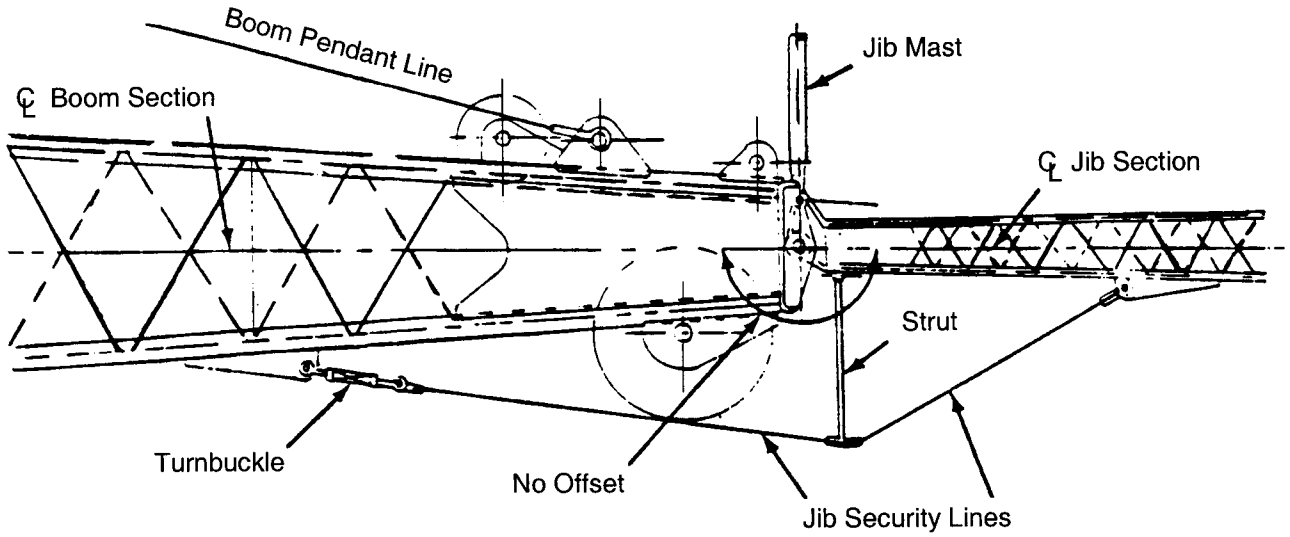
Note: The distance to the jib backstay line connection from the boom point must be equal to or greater than the length of the jib.

The backstay line is usually attached to the boom inner section ears, but may also be attached to the ears welded to the center sections if so equipped.

The maximum jib offset allowable is 25 degrees from the centerline of the boom. Before cutting the backstay line, leave enough so you may obtain the maximum offset if necessary. Coil the extra rope and lash it to the boom carefully.

Attach the backstay line to the boom and raise the boom and jib slightly to check your offset angle. Set down and readjust if required.

JIB SECURITY DEVICE
#9, #9HL



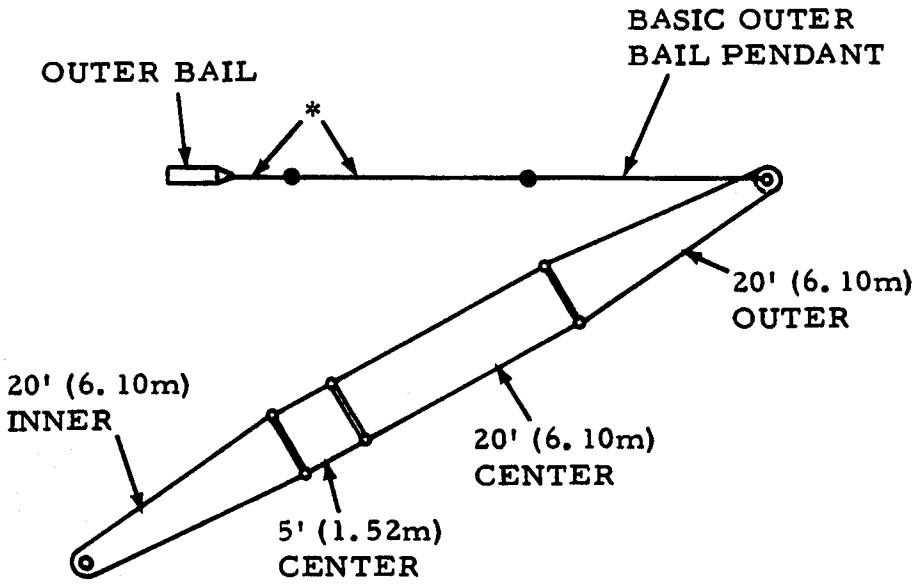
The jib security device is designed to limit upward travel of the jib so it may not overtop the boom in the event of hoisting tackle failure.

The security device should not be assembled until the boom is high enough off the ground so the strut has adequate ground clearance. The turnbuckle provides a slight adjustment. Tighten the turnbuckles so that the security lines are taut with the jib at 0 degrees (no offset). If an offset is to be used, the security device adjustment should be altered. With offset, the security lines should have as little slack in them as possible.

Note:

When laying the boom and jib on the ground, always disconnect the jib security lines before they become loaded with the weight of the jib and/or boom.

BOOM SUSPENSION RIGGING



46HI (1.17m), 65' (19.81m) Boom Shown

Please refer to your parts book for the proper length of basic outer bail pendant you have on your machine, as length will vary with type of boom used.

*Use pendants of the same length as the corresponding boom sections. Two pendants are used for each section as the pendant part of the boom suspension is 2 part.

IK 1400 BOOM - IK 700 JIB

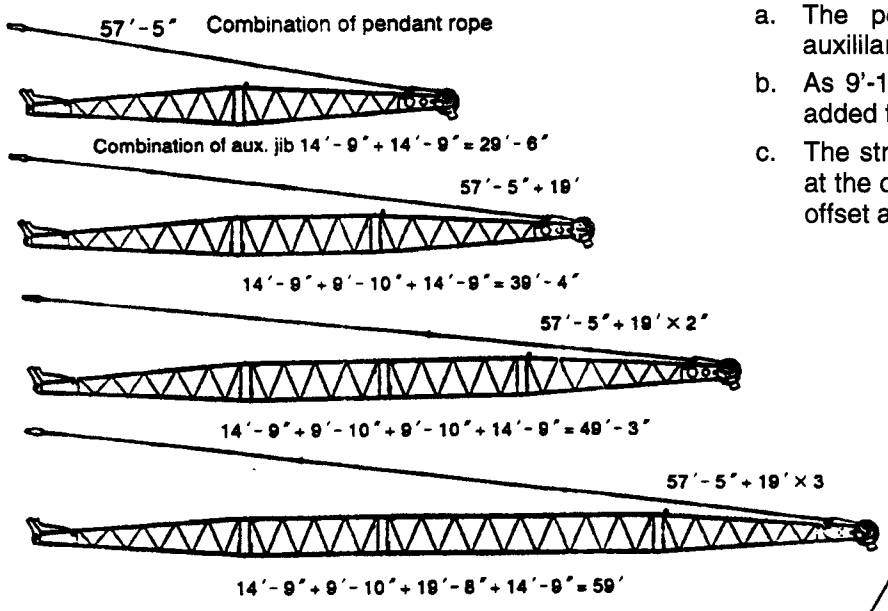
Mounting of auxiliary jib (for reference)

Composition of auxiliary jib length and pendant rope

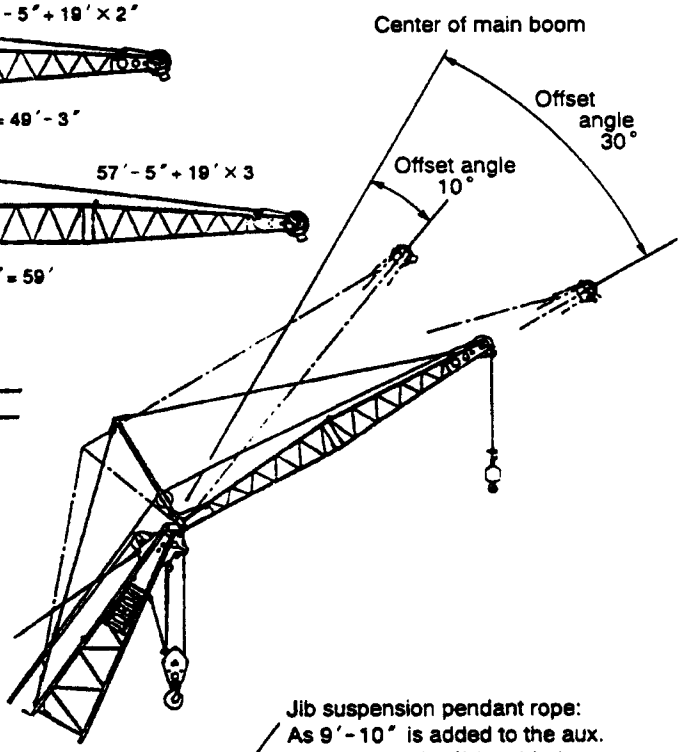
a. The pendant rope for the 29'-6" basic auxililary jib is 57'-5".

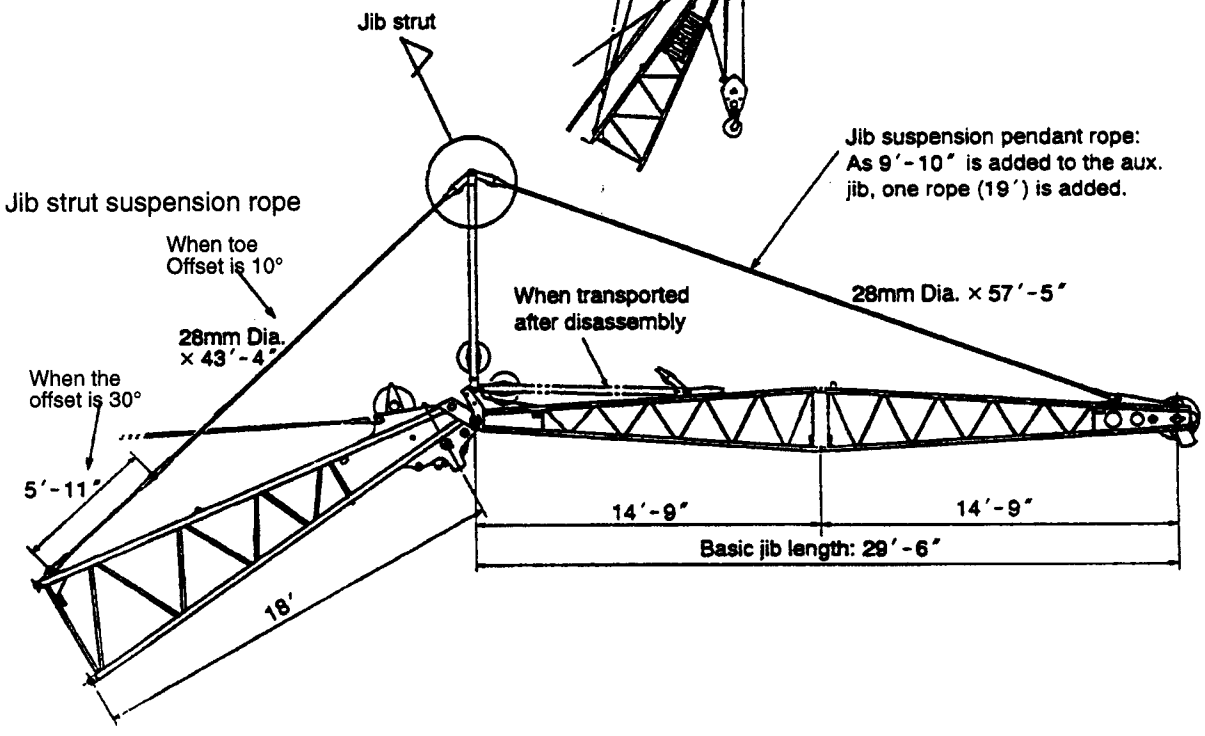
b. As 9'-10" is added to the auxiliary jib, 19' is added to the rope.

c. The strut suspension pendant rope is 43'-4" at the offset angle 10°. 5'-11" is added at the offset angle 30°.

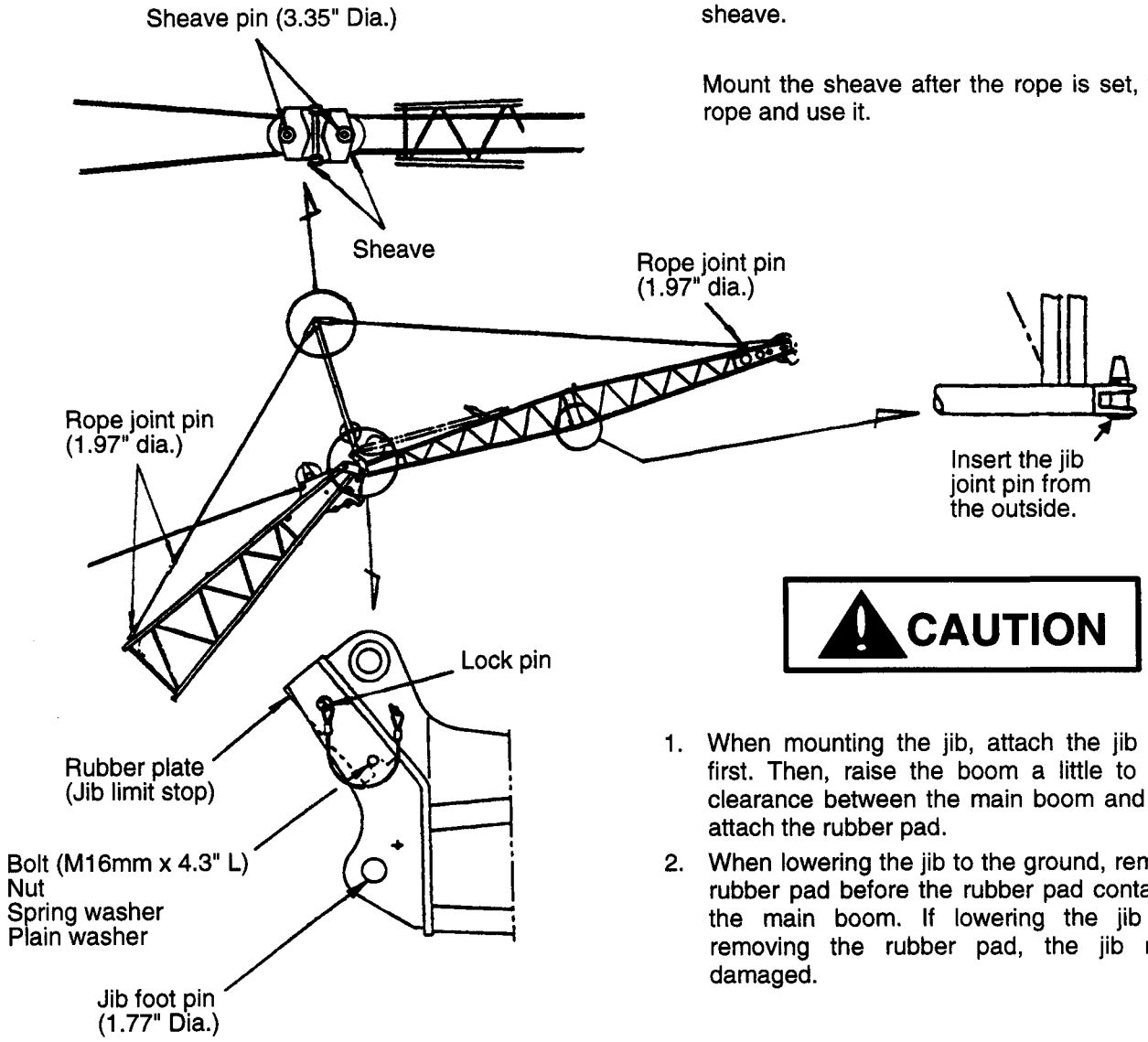


Fold the suspension rope with the sheave.





IK 1400 BOOM - IK 700 JIB



Remove the sheave pins and set the rope on the sheave.

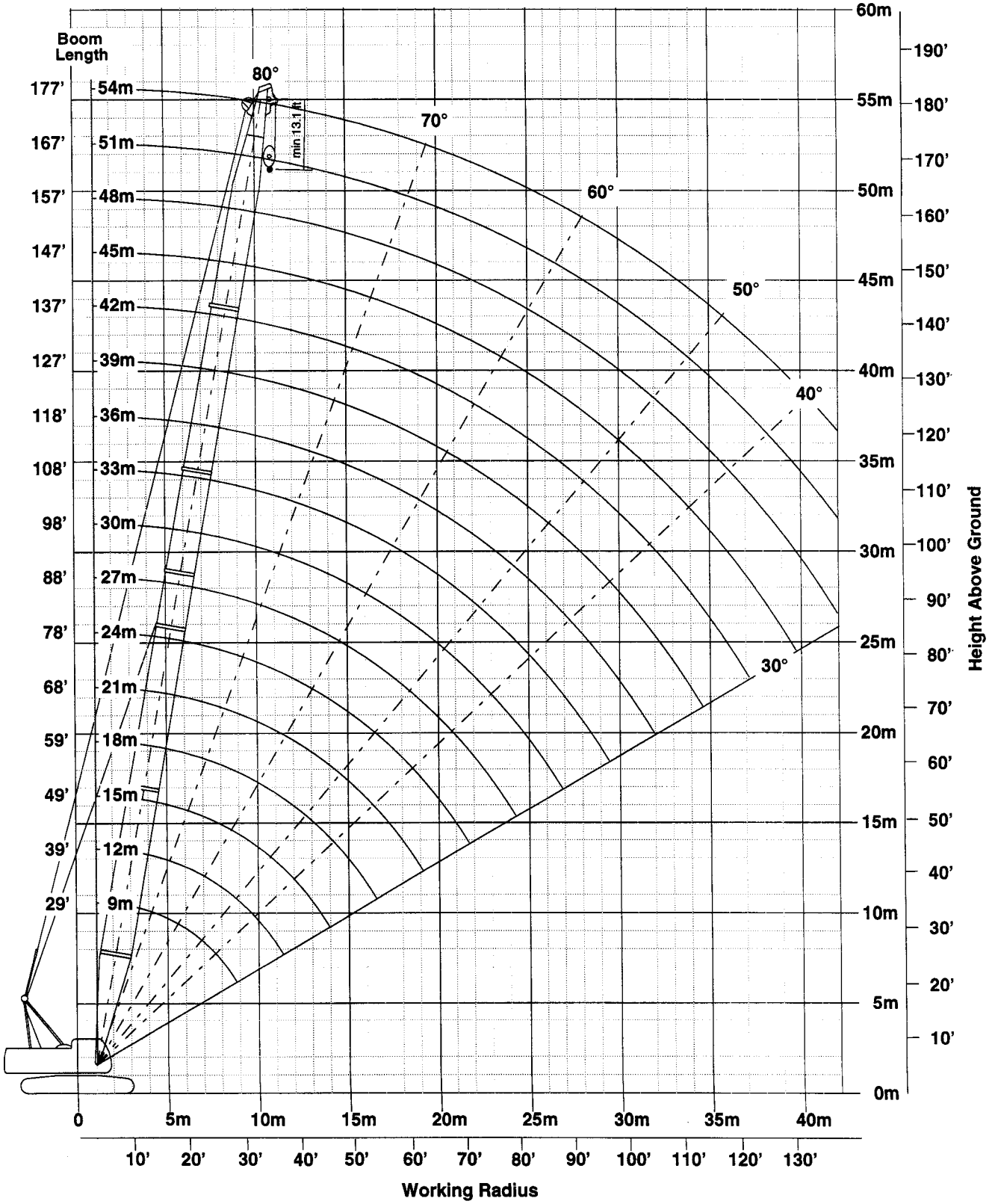
Mount the sheave after the rope is set, fold the rope and use it.

CAUTION

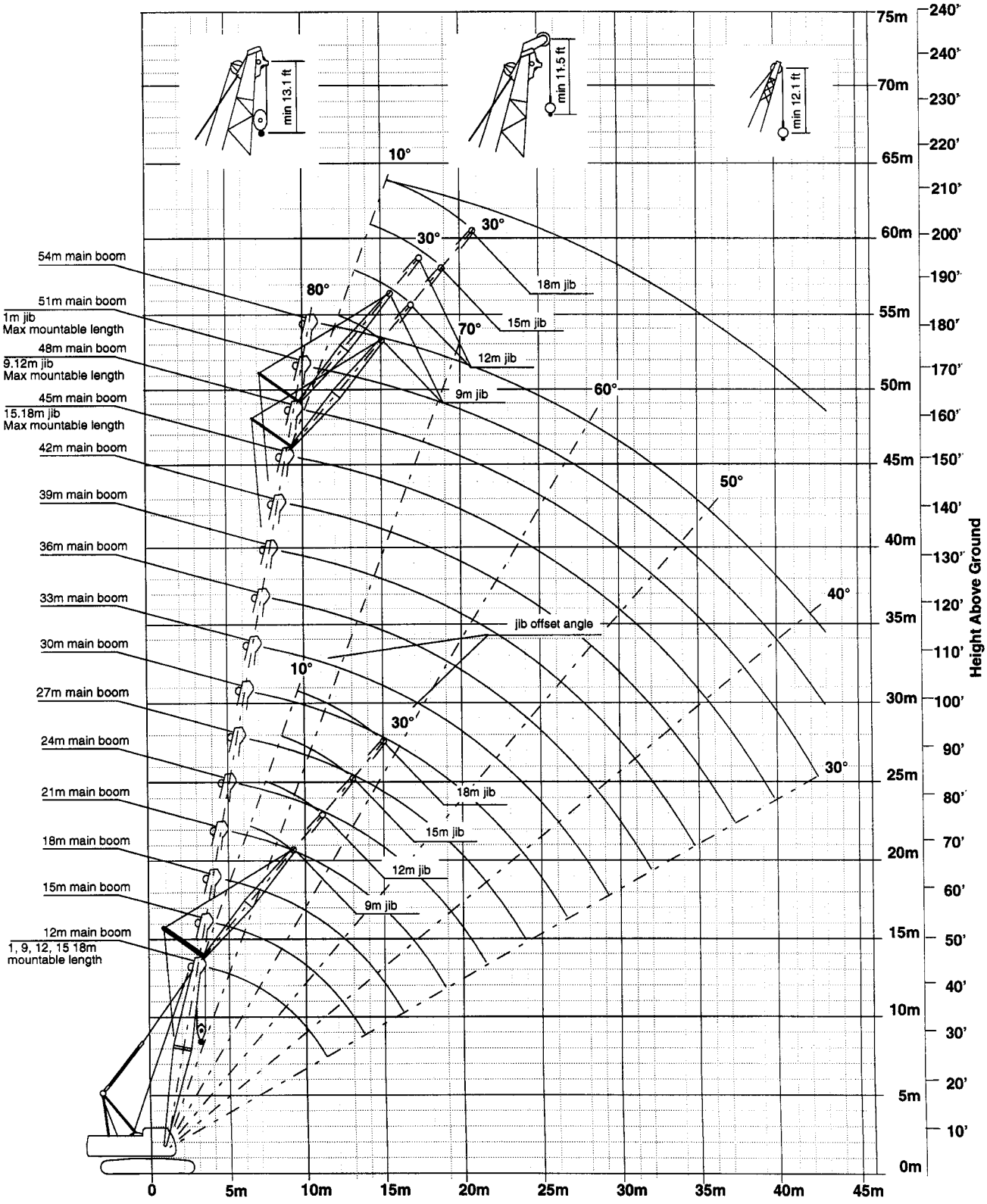
1. When mounting the jib, attach the jib foot pin first. Then, raise the boom a little to make a clearance between the main boom and jib, and attach the rubber pad.
2. When lowering the jib to the ground, remove the rubber pad before the rubber pad contacts with the main boom. If lowering the jib without removing the rubber pad, the jib may be damaged.

IK 1400 OFFSET TIP BOOM

The actual lifting height is the value obtained by subtracting 13.1 ft. (4m) of hook clearance.



IK 1400 OFFSET TIP BOOM - IK 700 FIXED JIB

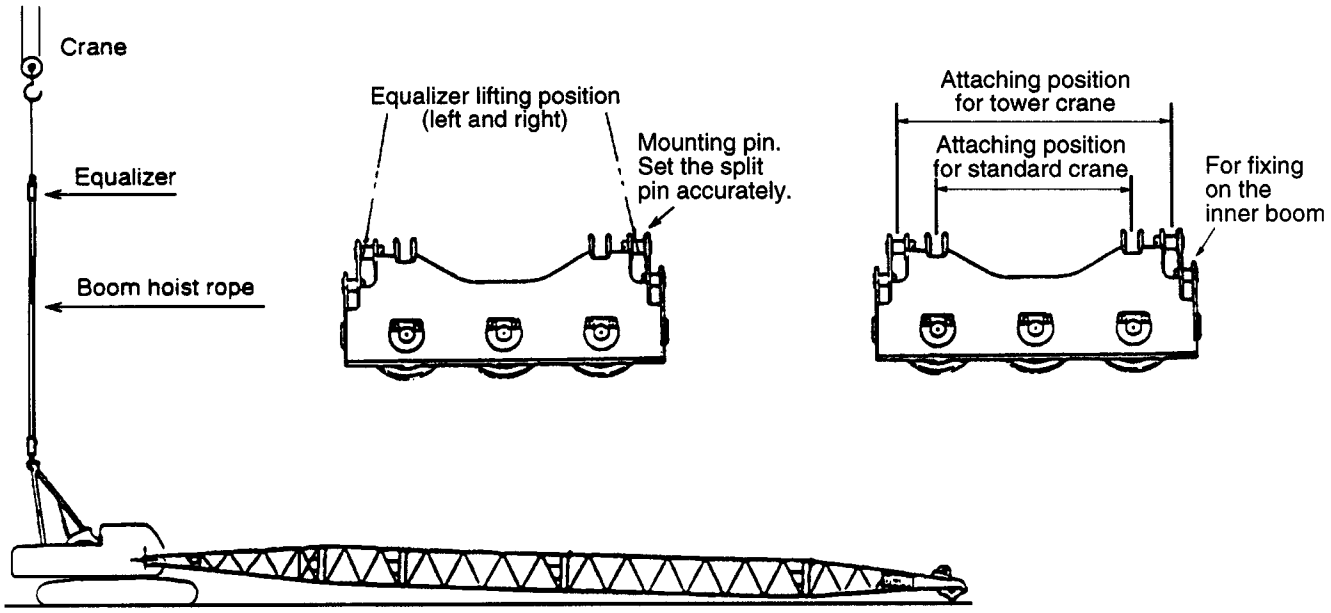


How to apply pre-tension to the boom hoist wire rope

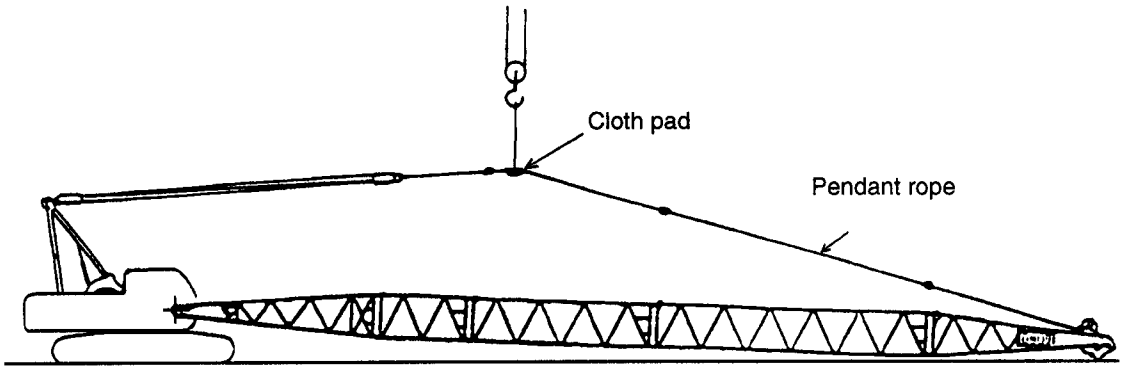
CAUTION

When replacing the boom hoist wire rope or when loosening the first layer of rope on the drum for repair, wind the first layer tightly while applying pretension and then wind the rope correctly while applying force to prevent the wire rope from not spooling. If not, the life of the wire rope will be shortened by the wire rope not spooling.

1. When replacing the boom hoist wire or when loosening the first layer of the rope on the drum:



a. Mount the pendant connecting pin to the equalizer, lift the equalizer with a crane and apply tension to the boom hoist rope. While applying tension, wind the boom hoist rope. Keep the proper length of the rope to be able to connect with the pendant rope.
b. Connect the equalizer with the pendant rope.
c. Lift the pendant rope with a crane and wind the boom hoist rope around the drum while applying the boom weight.



Use a pad for the lifted section of the pendant rope so as not to make an extreme bend in the rope. Gradually lift the next pendant rope in addition to the first one. For the tower crane, carry out the above procedure if necessary.

7. ASSEMBLY OF CRANE ATTACHMENT

7-1 Precautions for disassembly, assembly

1. Directions of operation:

⚠ DANGER

The Regulations on Safety of Cranes provides that a director should be selected for disassembly/assembly of attachment (boom and jib). Observe the regulations. Moreover, be careful about the following points.

1. **Don't enter under the boom during working process. Insert or remove the boom joint pin from the side.**
2. **If the joint pin is removed from the boom bottom while the pendant rope is tensed, the boom will drop. Put the boom point on the ground, mount the equalizer to the inner boom, stretch the boom hoist rope, remove the lower pin of the inner boom and then lower the boom to the ground.**
3. **When the equalizer is separated from the pendant rope, the equalizer is sometimes pulled toward the base machine. Be careful of the body position.**
4. **Use the double taper pin on bottom of crane for an inner boom lower pin. If this is done, the lower pin can be inserted or removed without entering under the boom.**
5. **Don't put your finger or hand into the pin hole when aligning the pin holes.**

2. Precautions for operation in a high place:

⚠ WARNING

When operating in a high place, the worker must use a safety belt to prevent an accidental fall. When working on the boom, use a footing plate.

3. Precautions for assembly order:

⚠ CAUTION

Be careful not to make a mistake with the crane assembly order and the usage of parts. Otherwise, the attachment may be damaged or fall down.

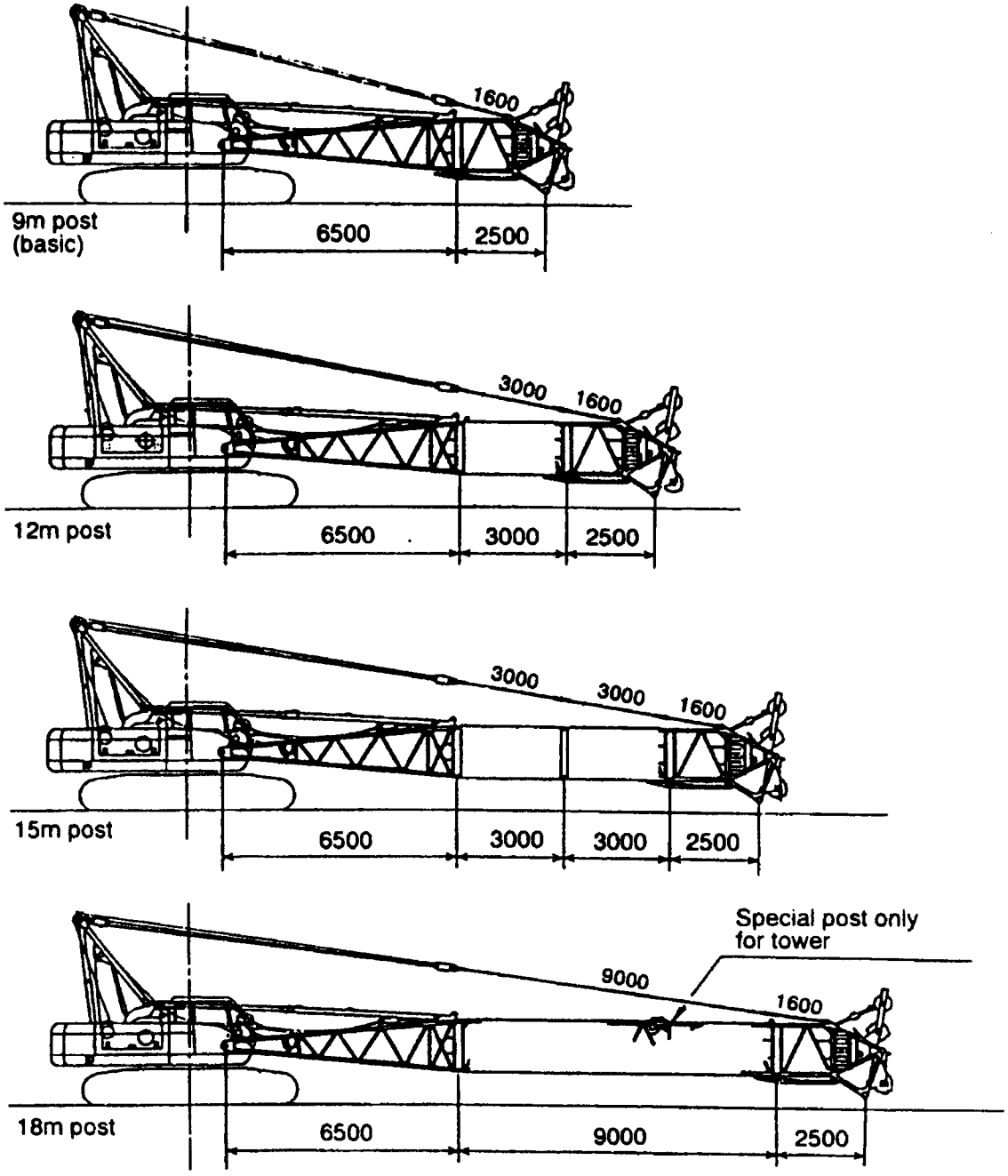
4. Precautions for handling electrical wires:

⚠ CAUTION

Be careful about the following points for handling the power supply and connectors when connecting or disconnecting the electrical wires of attachment. If the wires are damaged or splashed with water, the moment limiter and other safety devices will not operate correctly.

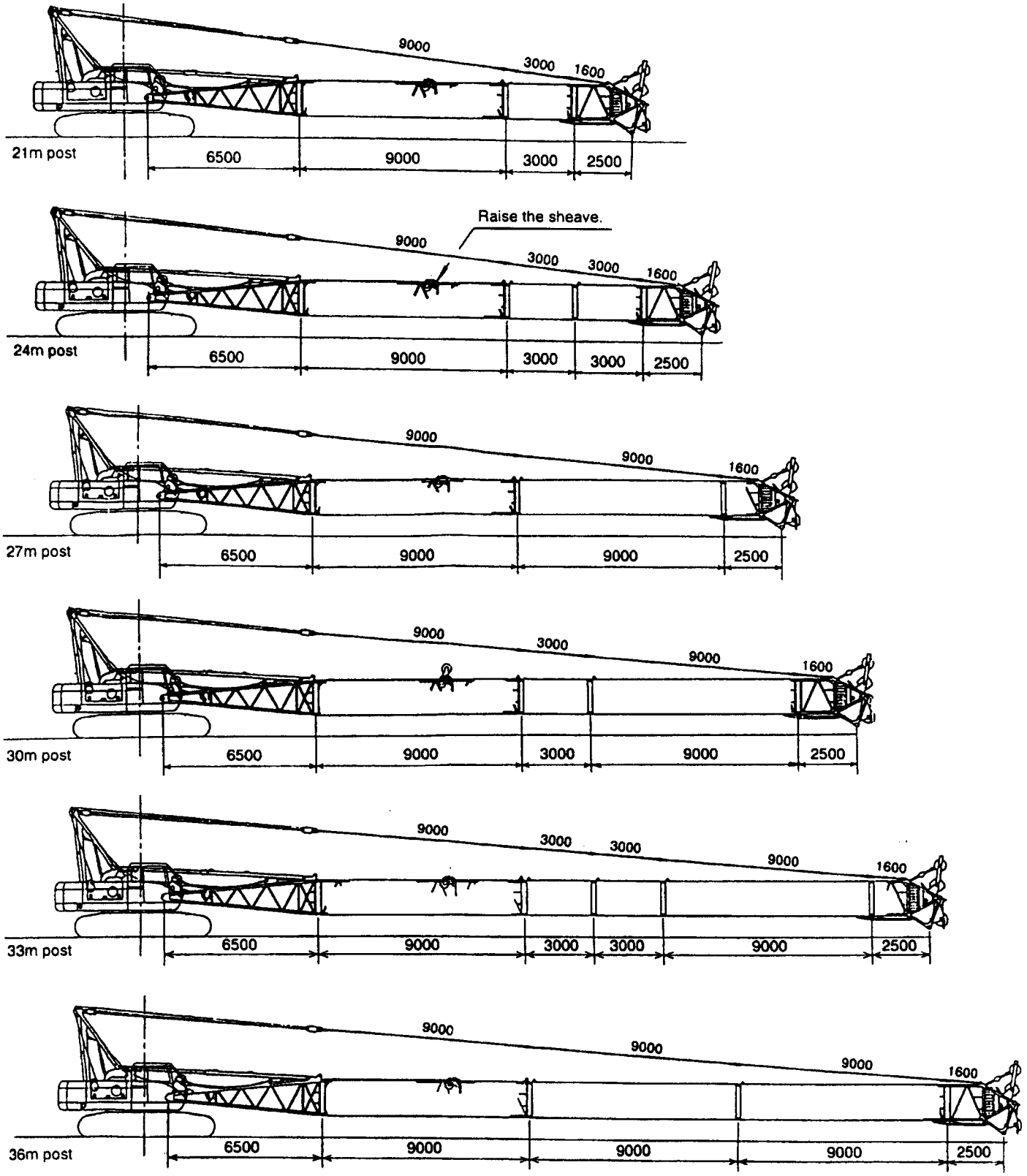
1. **Turn off the power before joining or separating the connector. If not, the devices may be burned or may malfunction.**
2. **Don't let water or mud adhere to the connector joints.**
3. **When the connector is separated, attach a cap to prevent water from entering.**
4. **Don't nip, step on or pull forcibly on the connectors and electric wires.**

8. TOWER BOOM AND BOOM SUSPENSION PENDANT ROPE COMPOSITION



Precautions for boom composition:

1. 18m boom ~ 42m boom can be used for the luffing jib crane and luffing tower crane. The boom length is 18m, 21m, 24m, 27m, 30m, 33m, 36m, 39m and 42m. Refer to Page 2-39 for the combination of the boom and tower jib.
2. 9m ~ 54m boom can be used by 3m intervals for the tower boom crane. If the 42m tower boom is used as a boom crane of 45m or more, add one of the intermediate booms - 3m, 6m or 9m.
3. When the boom length is 18m or more for the luffing jib crane, luffing tower crane or tower boom crane, use a 9m special boom with rail and hoist rope guide sheave at the lower end of the intermediate boom. House the guide sheave when an 18m or 21m boom is used. Raise the guide sheave and set the rope on it when a boom of 24m or more is used.


9000
3000
1600
21m post
6500
9000
3000
2500
Raise the sheave.
9000
3000
3000
1600
24m post
6500
9000
3000
3000
2500
9000
9000
1600
27m post
6500
9000
9000
2500
9000
3000
9000
1600
30m post
6500
9000
3000
9000
2500
9000
3000
3000
9000
1600
33m post
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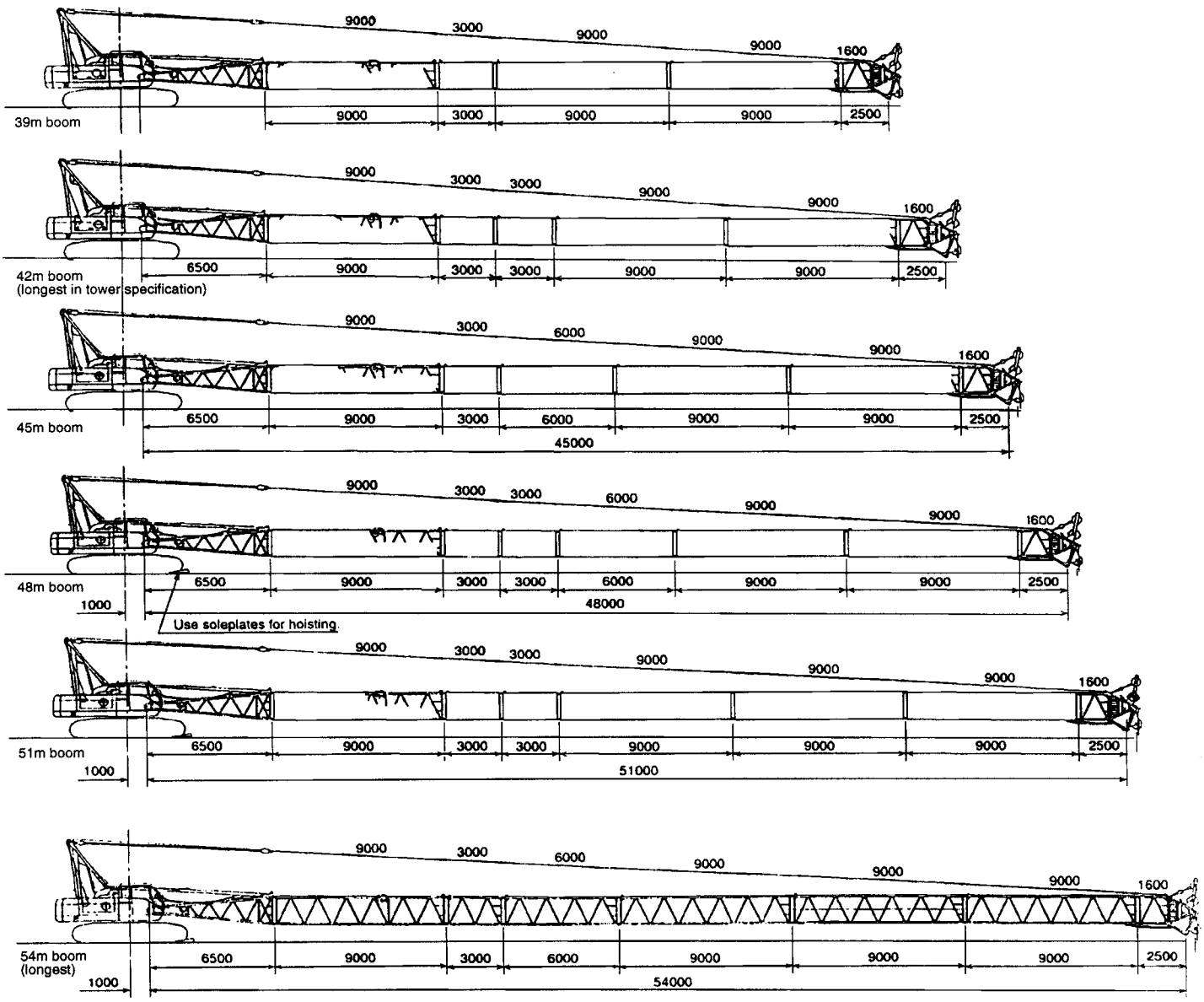
9000
9000
9000
2500

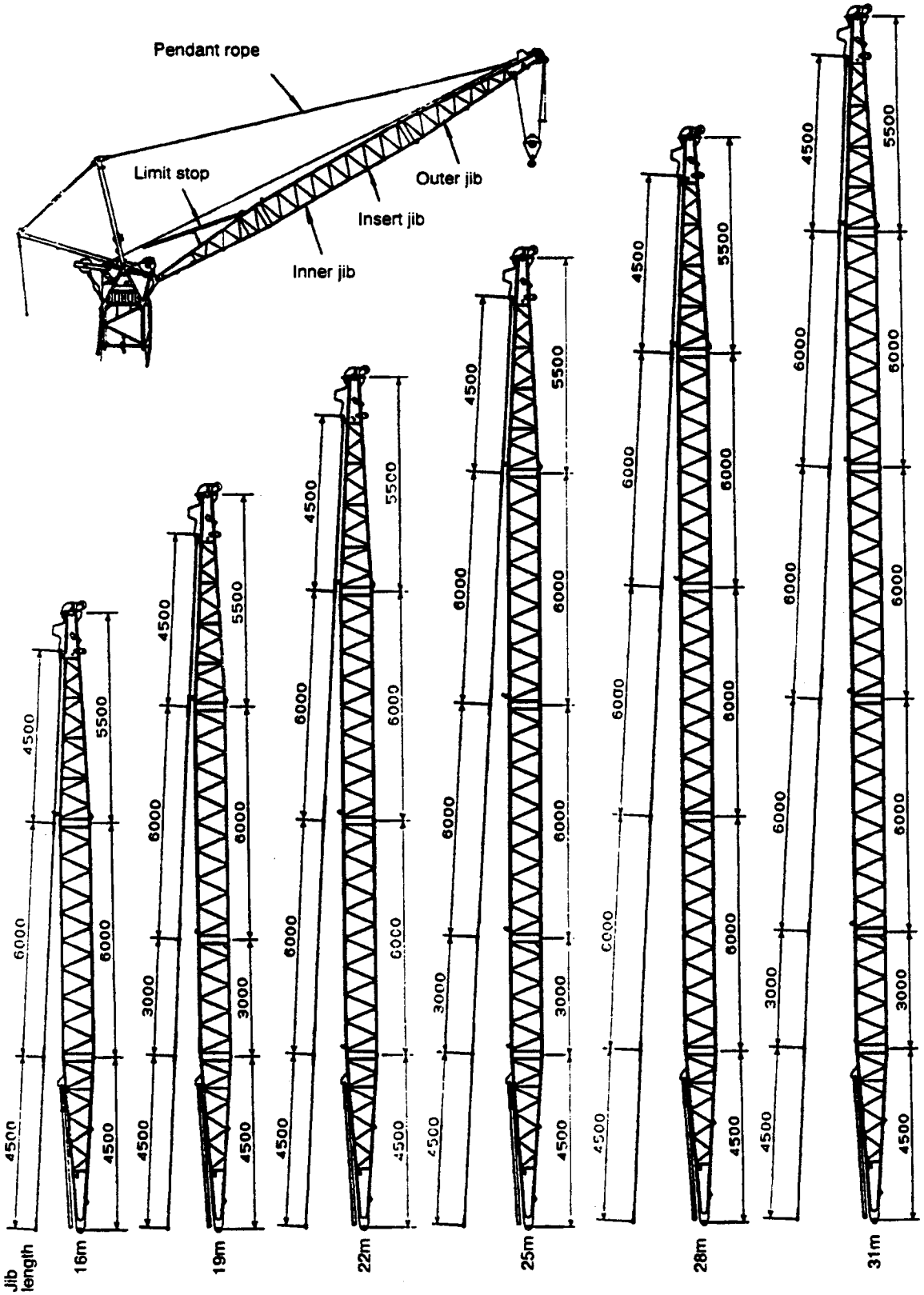


CAUTION

WHEN ERECTING 48m (157.48 FT.) OR MORE OF 1400IK BOOM, THE MACHINE MUST HAVE THE CRAWLERS "BLOCKED". THE LOWEST FRONT TRACK PAD MUST BE SUPPORTED BY THE SOLEPLATES SUPPLIED WITH THE MACHINE.

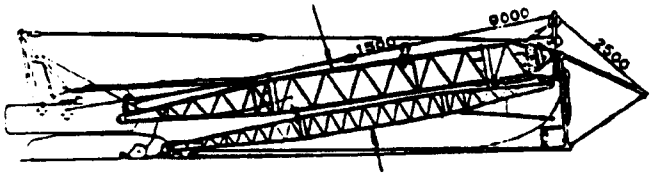
4. Use the 1.6m pendant rope for the 2.5m outer boom. Use the 3m, 6m or 9m pendant rope meeting the length of the added intermediate boom for other cases.

9. TOWER JIB AND JIB SUSPENSION PENDANT ROPE COMPOSITION



10. BOOM, TOWER JIB AND STRUT SUSPENSION PENDANT COMPOSITION

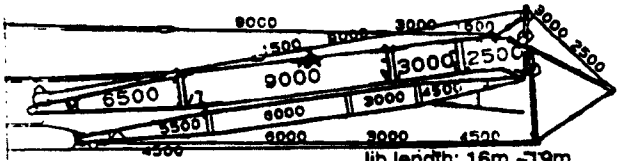
Basic post (6.5+9.0+2.5=18m)



Post length (m)

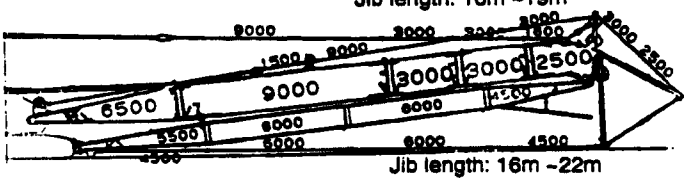
Basic jib (4.5+6.0+5.5=16m)

21



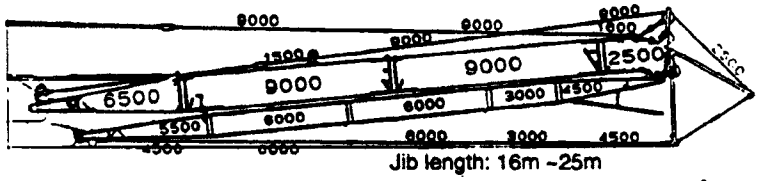
Jib length: 16m ~19m

24



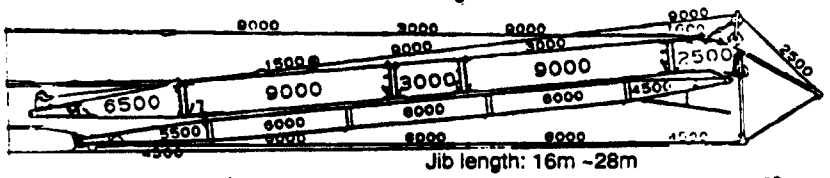
Jib length: 16m ~22m

27



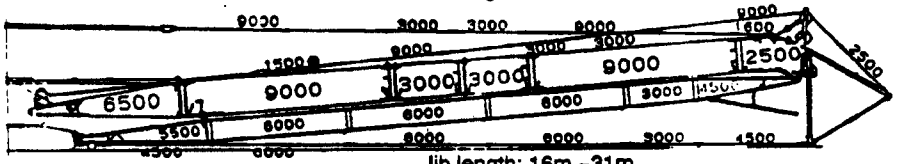
Jib length: 16m ~25m

30



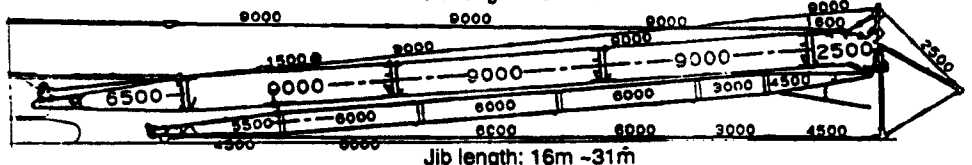
Jib length: 16m ~28m

33



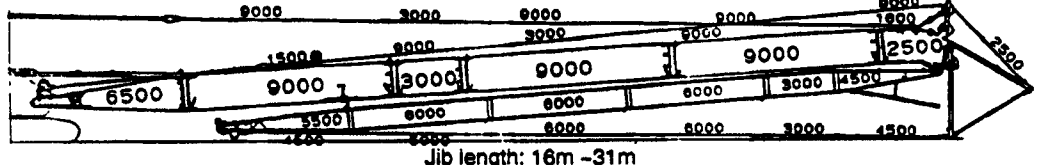
Jib length: 16m ~31m

36



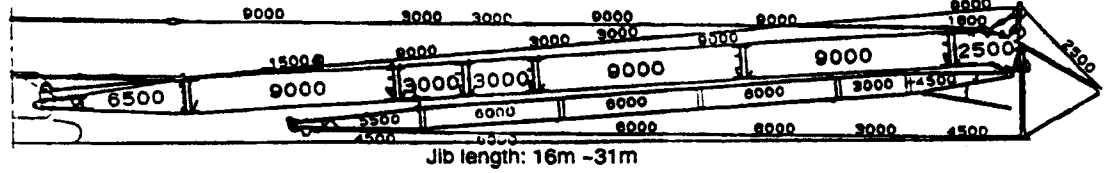
Jib length: 16m ~31m

39



Jib length: 16m ~31m

42



Jib length: 16m ~31m

Use the strut suspension pendant of the same length as the boom composition.

Attach the 1.5m pendant to the equalizer side.

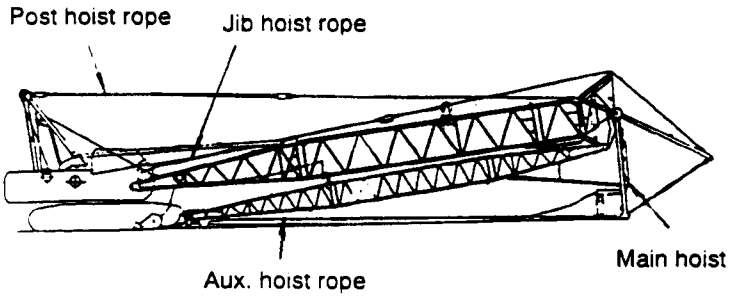
The rope guide roller must be attached to the bottom of the 3m, 6m or 9m boom. It should not be attached to the 9m special insert.

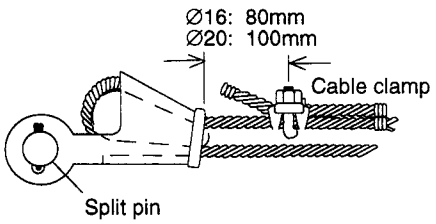
CAUTION

WHEN ERECTING ANY COMBINATIN OF TOWER/LUFFING JIB, THE CRAWLERS MUST BE "BLOCKED". THE LOWEST FRONT TRACK PAD MUST BE SUPPORTED BY THE SOLEPLATES SUPPLIED WITH THE MACHINE.

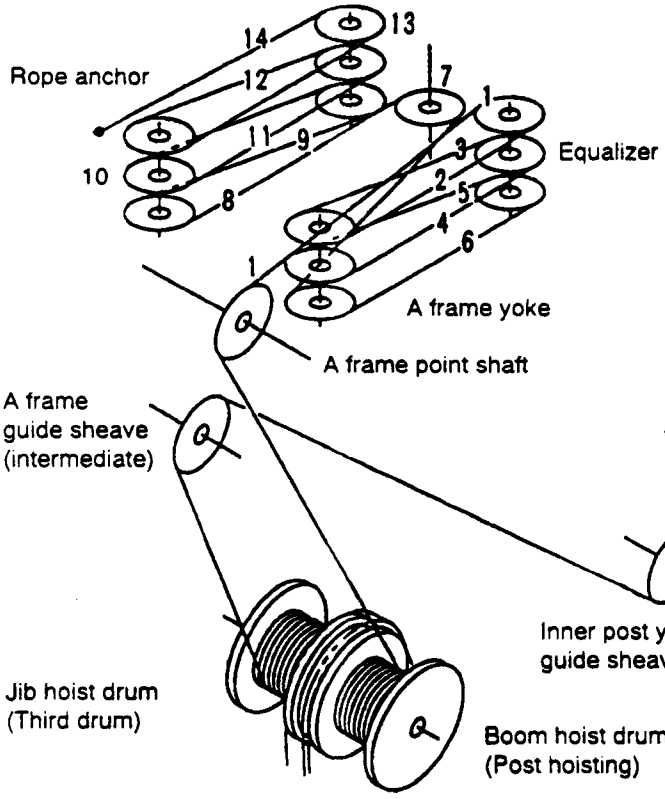
11. REEVING OF WIRE ROPE (LUFFING JIB/LUFFING TOWER)

11-1 Boom and jib hoist rope for luffing jib crane





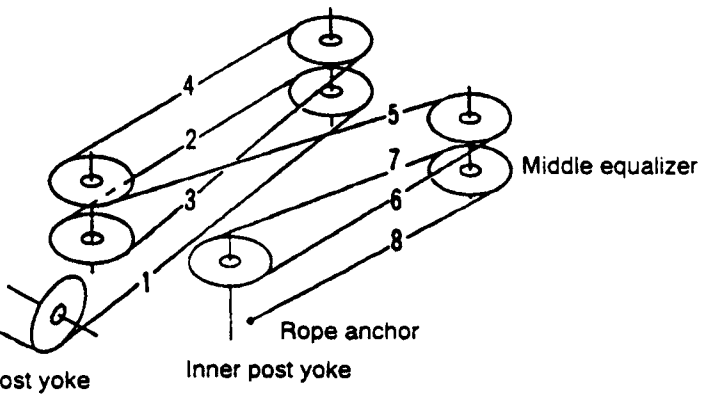
How to reeve the post hoist rope
(ϕ 16 × 168m, 14 – part of line)



CAUTION

Attach the rope anchor correctly as illustrated above. Open the split pin for the anchor pin correctly.

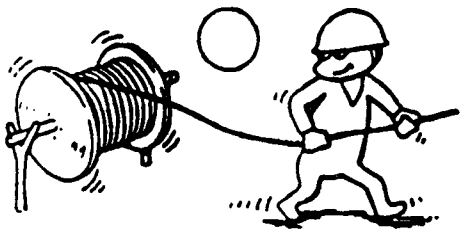
How to reeve the jib hoist rope
(ϕ 20 × 100m, 8 – part of line)



WARNING

Set the specified wire rope of correct parts of lines for the boom hoisting/jib hoisting ropes. If the rope is set erroneously or the parts of line number is changed, the wire rope may be damaged or broken.

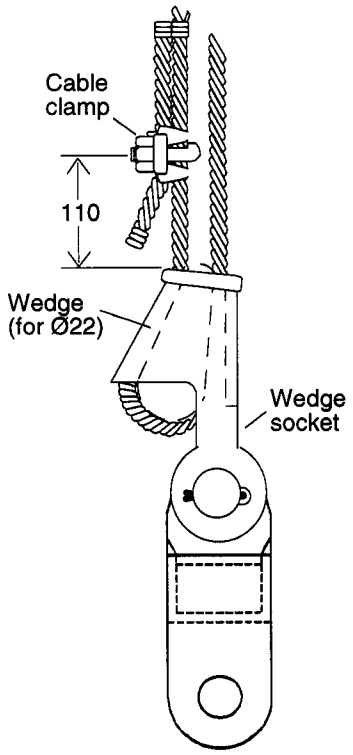
Pay away the wire rope while turning the reel so as not to cause twisting. Set the wire rope on the sheave so as not to cross it.



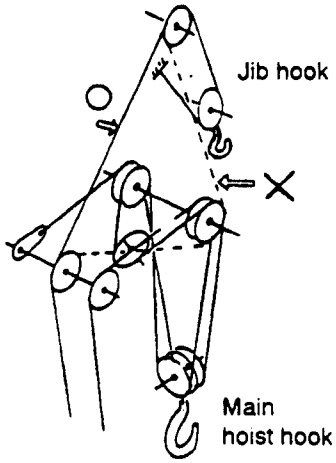
11-2 How to reeve the main/auxiliary rope for the luffing jib crane

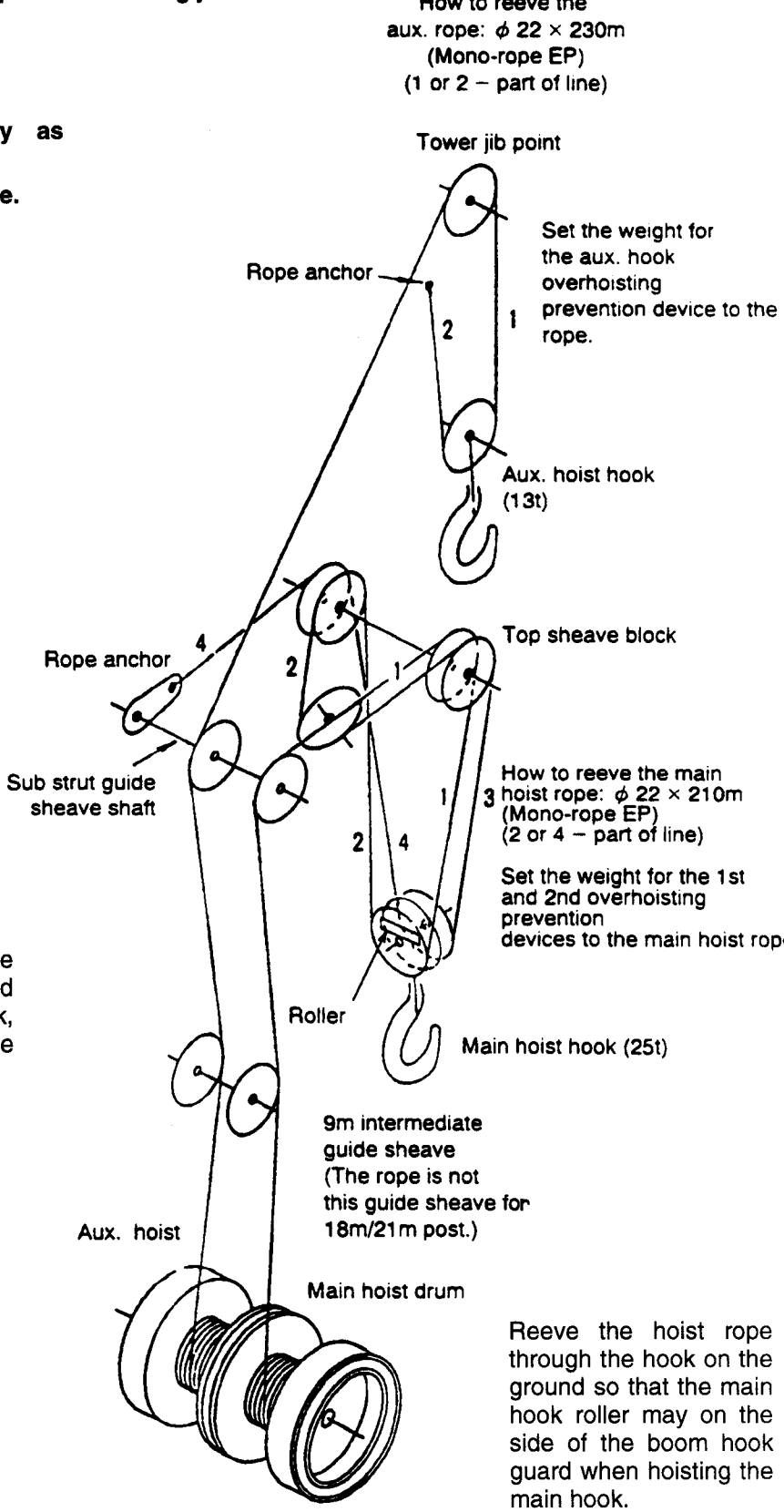
CAUTION

1. **Mount the rope anchor correctly as illustrated.**
2. **The allowable load is 6.5t for one rope.**



Pass the jib hook rope through the outside of the main hoist hook. If the rope is passed through the inside of the main hoist hook, the jib hook is mounted through the same inside when hoisting the jib.





Reeve the hoist rope through the hook on the ground so that the main hook roller may on the side of the boom hook guard when hoisting the main hook.

BOOM RIGGING AND JIB - HC80 DRUM PERFORMANCE

Main & Auxiliary Hoist 7/8" Diameter Rope					
Rope Layer	Low Range		High Range		Total Rope Length Feet
	Line Speed Feet per Minute	Single Line Pull Pounds	Line Speed Feet per Minute	Single Line Pull Pounds	
1	258	32,400	337	24,400	81
2	279	29,900	365	22,500	174
3	300	27,900	392	21,000	268
4	321	26,000	420	19,600	375
5	336	24,500	447	18,400	482
6	363	23,000	474	17,300	603
7*	379		495		722
*7th Layer is recommended for *storage only*.					
7/8" 6x25, FW, PREF, EIPS, RRL, IWRC, 79,600 LBS. MBS					

3rd Drum Type"A" with Free Fall 5/8" Diameter Rope				
ROPE LAYER	Low Range		No Load	TOTAL ROPE LENGTH FT.
	LINE SPEED/FPM	SINGLE LINE PULL/LBS.	LINE SPEED/FEET PER MINUTE	
1	181	18,600	219	59
2	195	17,300	235	118
3	209	16,200	252	185
4	222	15,200	269	253
5	236	14,300	285	329
6	250	13,500	302	405
7	263	12,800	318	490
8	277	12,200	335	575
9	291	11,600	352	669
10	305	11,100	368	761
11*	317		384	835
*11th Layer is recommended for *storage only*.				
5/8" x 760 FT. MAX, 35,000 LBS. MBS, 6X25 FW, PREF, IWRC, RRL, IPS, BRIGHT				

Boom Hoist Drum with 5/8" Diameter Rope				
ROPE LAYER	Low Range		No Load	TOTAL ROPE LENGTH FT.
	LINE SPEED/FPM	SINGLE LINE PULL/LBS.	LINE SPEED/FEET PER MINUTE	
1	168	19,900	209	56
2	181	18,400	226	113
3	195	17,200	242	172
4	208	16,100	259	243
5	221	15,100	275	317
6	234	14,200	291	390
7	247	13,500	308	472
8	260	12,800	324	553
9	274	12,200	341	648
5/8" x 560 FT., 41,200 LBS. MBS, 6X26 PREF, RAL, EIPS, BRIGHT, WS, IWRC				

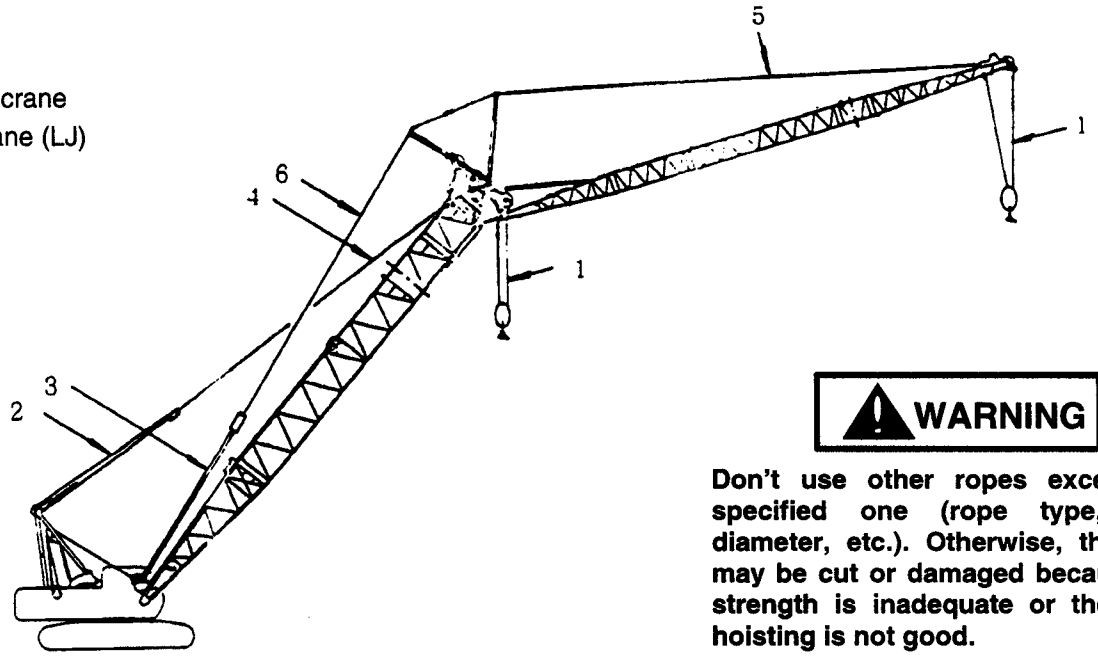
BOOM RIGGING AND JIB - HC80 DRUM PERFORMANCE

3rd Drum Type "A" with Free Fall 3/4" Diameter Rope				
Rope Layer	Low Range		No Load	Total Rope Length Feet
	Line Speed Feet per Minute	Single Line Pull Pounds	Line Speed Feet per Minute	
1	183	18,500	221	52
2	199	16,900	241	104
3	216	15,600	261	165
4	233	14,500	281	226
5	250	13,500	302	297
6	267	12,700	322	367
7	283	11,900	343	448
8	300	11,200	363	526
9*	317		383	616
*9th Layer is recommended for *storage only*.				
3/4" x 620 FT., 51,200 LBS. MBS, 6X25 FW, PREF, RR., IWRC, IPS, BRIGHT				

Luffing Jib Drum with 20mm Diameter Rope				
Rope Layer	Low Range		No Load	Total Rope Length Feet
	Line Speed Feet per Minute	Single Line Pull Pounds	Line Speed Feet per Minute	
1	178	18,700	221	45
2	195	17,200	242	89
3	211	15,900	263	142
4	228	14,600	284	194
5	245	13,700	304	256
6	261	12,800	325	316
7	278	11,900	346	385
8*	295		367	453
*8th Layer is recommended for *storage only*.				
20mm X 328 FT., 6X19 IWRC, WS, RAL, 66,100 LBS. MBS				

12. SPECIFICATIONS OF WIRE ROPE (LUFFING JIB/LUFFING TOWER)

Tower boom crane
Luffing jib crane (LJ)



WARNING

Don't use other ropes except the specified one (rope type, rope diameter, etc.). Otherwise, the rope may be cut or damaged because the strength is inadequate or the drum hoisting is not good.

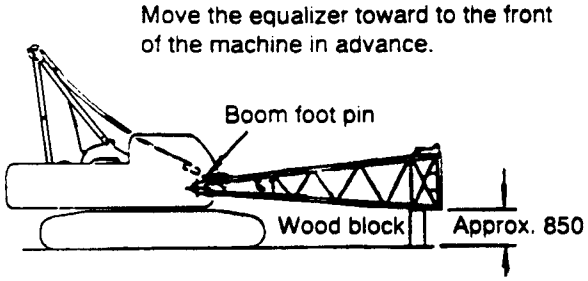
Ref. No.	Wire Rope	Type	Diameter (mm)	Length (m)	Breaking Strengh (t)		Remarks	
1	Load Hoisting	3 x F (40) IWRC 6 x Fi (29) IWRC 6XP • Fi (29) IWRC 6XP • WS (31) P• S (19) + 39XP • 7	22.4		43.8 36.4			
				210	42.9 42.9		Luffing Jib Main Hoisting	
				230	44.9		Luffing Jib Aux. Hoisting	
2	Boom Hoisting	IWRC 6 x Fi (29) IWRC 6XP • Fi (29) IWRC 6XP • WS (31)	16	168	(Ø 16) 19.2 21.8 21.9	(Ø 20) 30.0 34.1 34.1		14 - Parts of line
3	Jib Hoisting		20 (LJ)	100				8 - Parts of line
4	Boom Suspension Pendant	6 x Fi (29) IWRC Regular Z lay	34	1.6 3.0 6.0 9.0	86.7		Out Boom 3m Boom 6m Boom 9m Boom	
5	Jib Suspension Pendant		28	4.5 3.0 6.0 4.5	59.7		Jib Inner 3m Insert 6m Insert Jib Outer	
6	Jib Strut Suspension Pendant		31.5	2.5 3.0 6.0 9.0	74.9		For the leading end (tower top) 3m Insert 6m Insert 9m Insert	

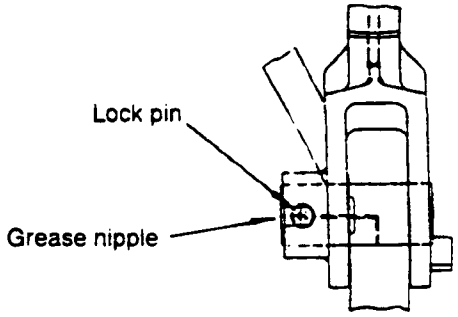
Note: For machine Serial No. HY67 & up, the length of tower jib hoist wire is 105m

13. ASSEMBLY OF TOWER BOOM (BOOM CRANE/LUFFING JIB CRANE)

13-1 Assembly of tower boom crane

1. Assembly of inner boom



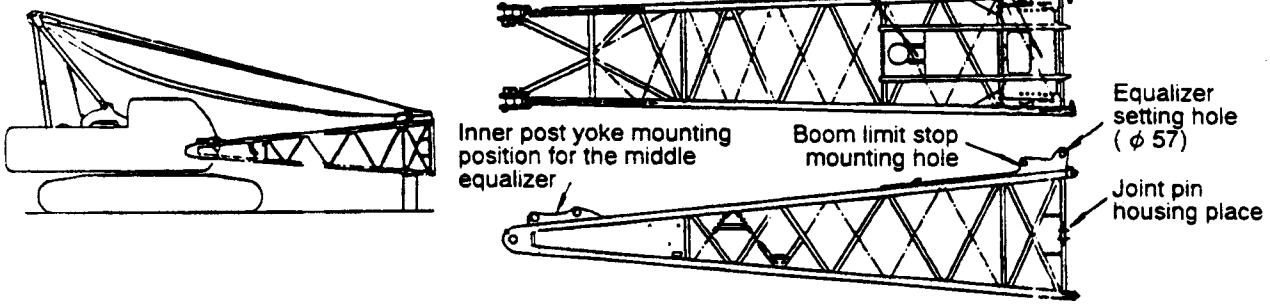


With the inner boom lifted with a crane, align the foot pin setting hole of the turntable with the pin hole of the boom, and insert the left and right boom foot pins. Fix the foot pins with the lock pins. Support the leading end of the boom with a wood block and remove the crane.

NOTICE

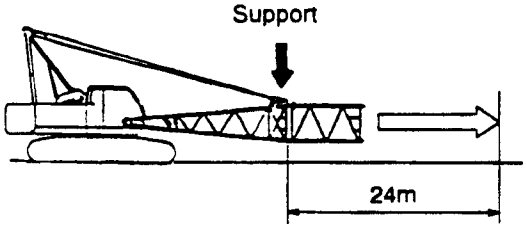
The foot pin must be mounted so that the grease nipple is on the rear side.

2. Shifting of equalizer (supporting of inner boom)



Suspend the equalizer with the crane. While paying out the boom hoist rope, move the equalizer from the temporary position to the leading end of the inner boom.

In case the machine must be moved to the position of the intermediate boom or outer boom to be mounted next, the inner boom must be supported with the equalizer fastened to the bracket at the leading end of the inner boom.



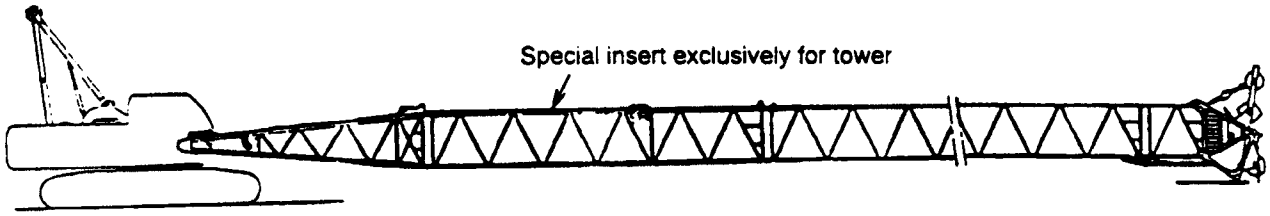
When the inner boom is supported by the equalizer,

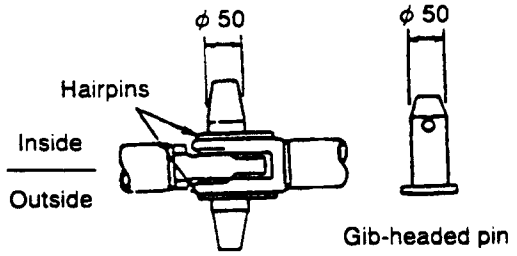
the boom length to be left above the ground is 24m as connected to the leading end. Don't mount the outer boom. If so, the boom may be damaged. Let the machine travel at a slow speed when the boom is joined at the front of the inner boom.

3. Connection of intermediate boom and outer boom

CAUTION

Set a wood block only at the leading end to support the boom. If supporting near the inner boom, the boom will be bent because of its weight.





Double taper pin

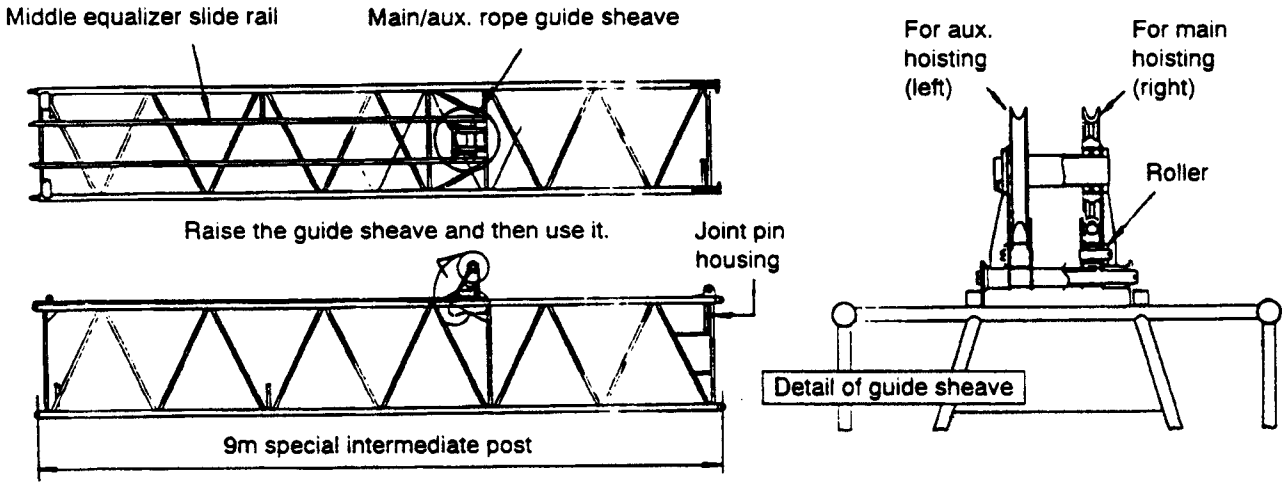
CAUTION

For the boom joint pin, use the double taper pin only on the bottom side of the inner boom. Use gib-headed pins for other points.

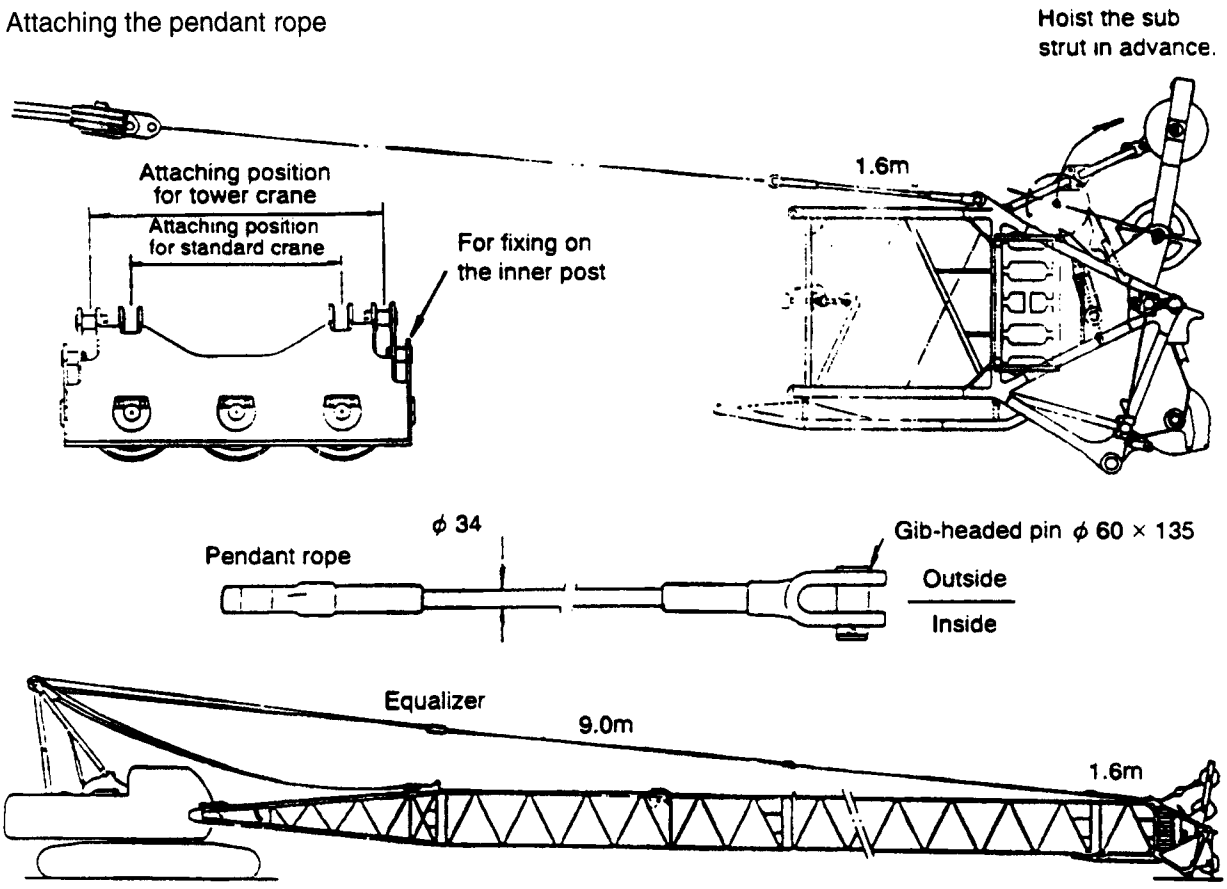
The pin can be removed or inserted without entering the area under the boom by using the double taper pin on bottom of crane.

Add the intermediate boom and finally join the outer boom to make the composition as specified. Refer to Page 2-14 for the standard boom configuration.

If the boom length is 18m or more, join the 9m special boom exclusively for tower. In other cases, join the standard boom.



4. Attaching the pendant rope



For the outer boom, attach a pendant rope of 1.6m. For the intermediate booms, attach a pendant rope of 3m or 9m meeting the length of each boom. (The 6m is prepared for 45m or longer.)

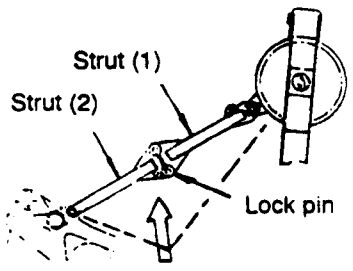
Insert the rope joint pin from the outside. Insert and open the split pin correctly.

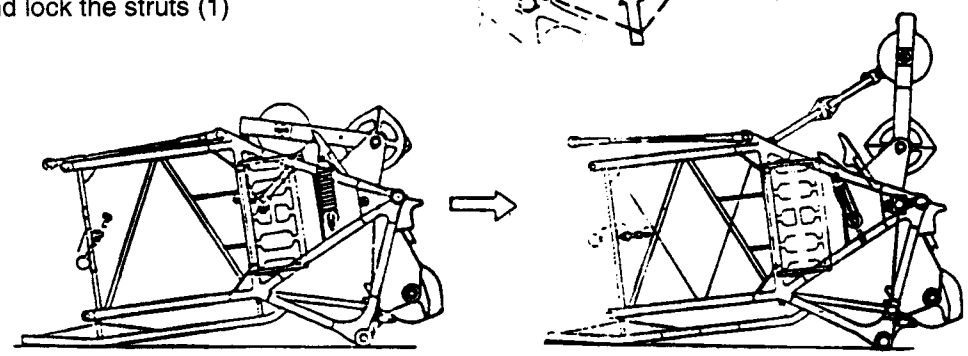
NOTICE

The attaching position of the equalizer and pendant rope is different between the standard crane and tower crane. Attach them correctly as illustrated.

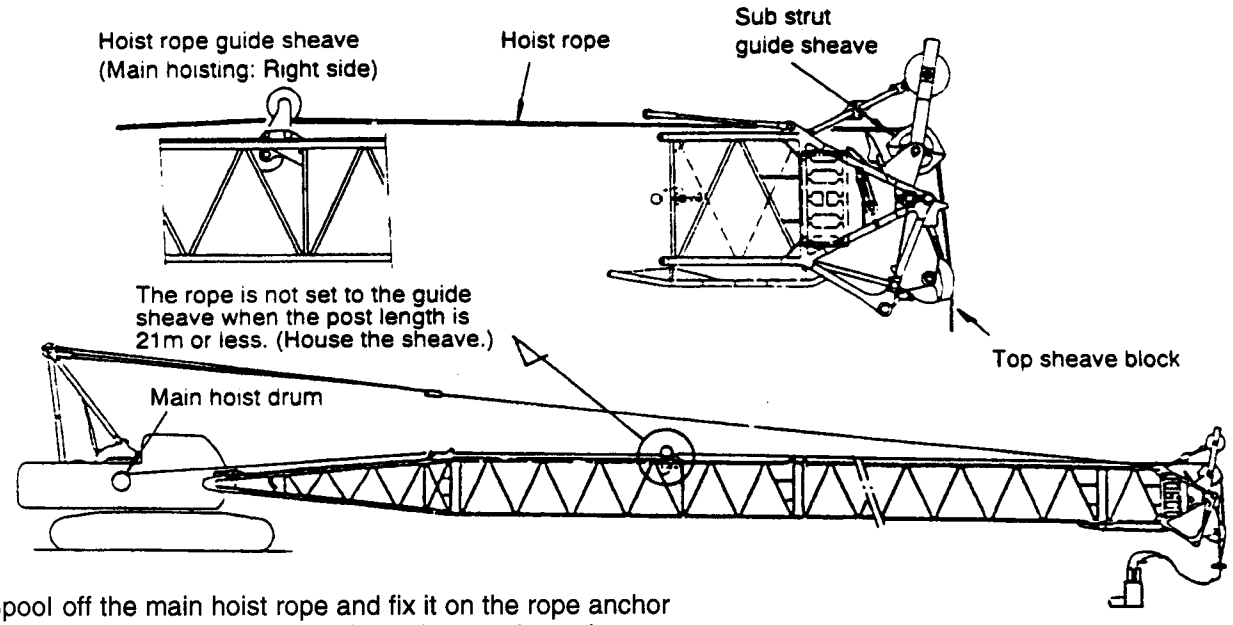
Hoist the sub strut and lock the struts (1) and (2) correctly.

Hoisting the strut

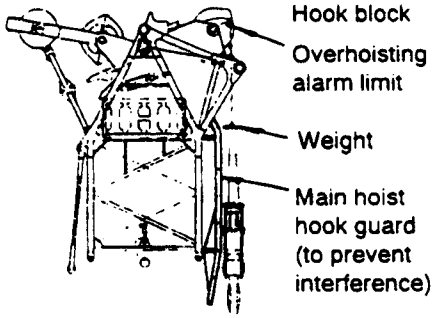




5. Attaching the main hoist rope

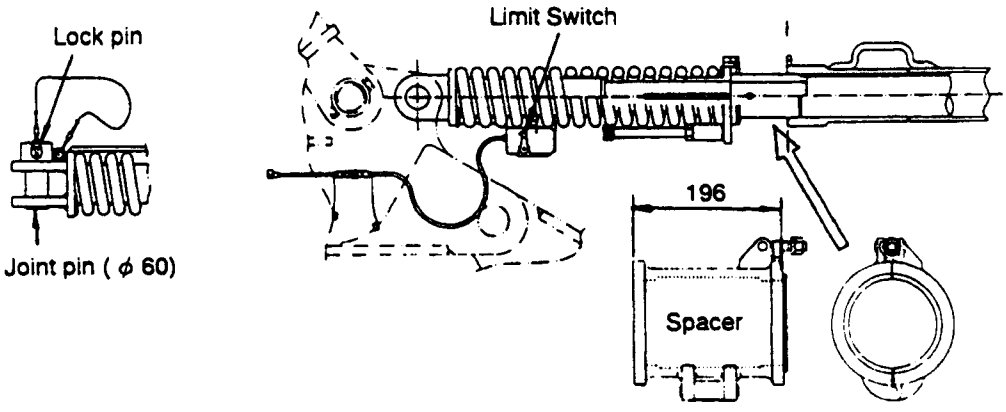


Spool off the main hoist rope and fix it on the rope anchor via the rope guide sheave of 9m boom, the sub strut sheave, the top sheave block and hook block. Set the weight for the overhoisting prevention device between the sheave block and hook. (Refer to Page 2-18 for the reeving of rope.) Put the hook to be right under the boom point when hoisting the boom by 50° and then attach the hoist wire rope. For the 39m boom, it must be 50° when the working radius is approximately 26m.



6. Mounting the stabilizer (rear stopper)

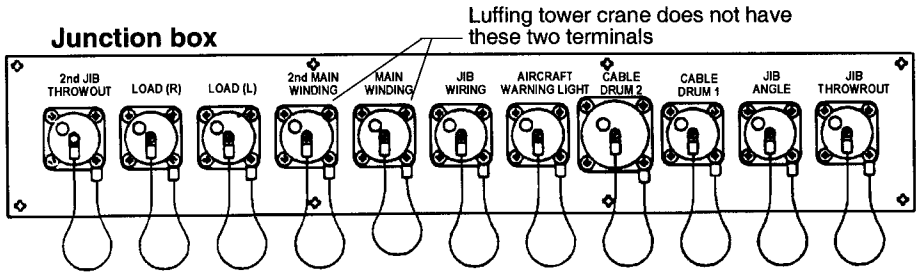
Pull out the inner member of the stabilizer, which is housed in the inner boom, and attach it to the low gantry frame.

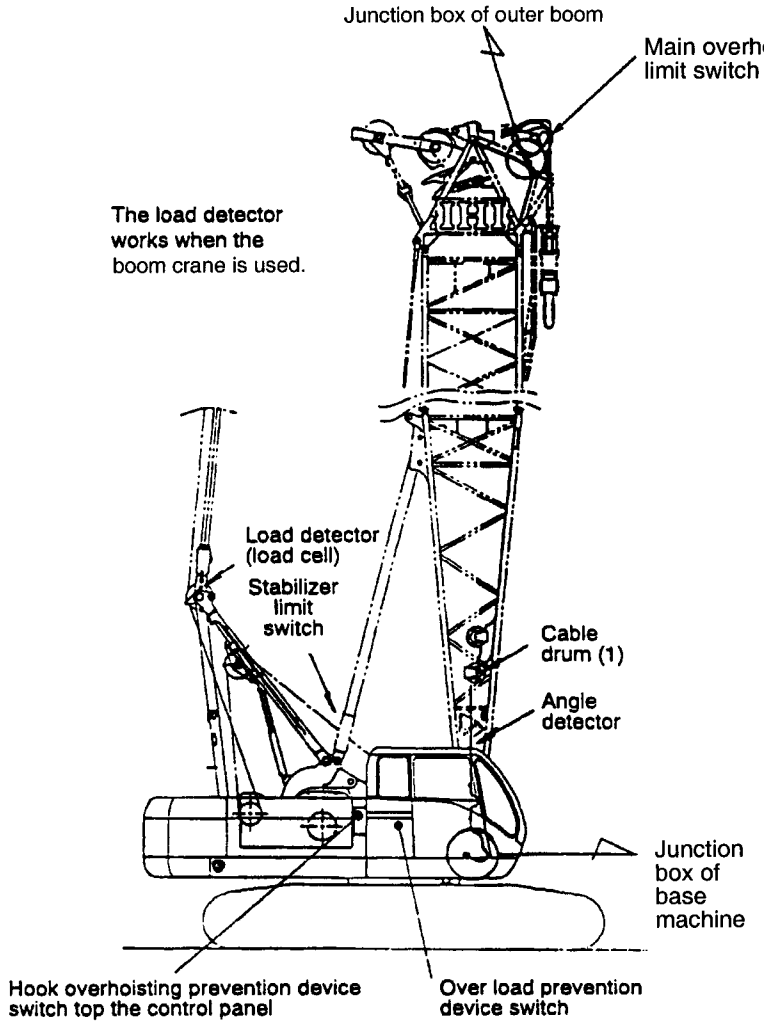


NOTICE

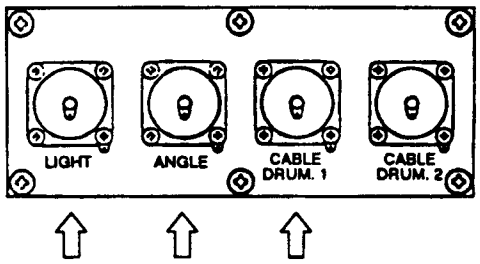
1. **Attach the spacer to the inner member of the stabilizer as illustrated above when using the boom crane or when using the luffing jib crane without the tower jib.**
2. **Perform adjustment so that the boom throw-out may operate in 80° and the second throwout in 82°.**
3. **Set the crane/tower selector switch to the crane side.**
4. **When a tower crane is used, remove the above-mentioned spacer and set the crane/tower selector switch to the tower side. Adjust the boom throw-out so that the alarm may be actuated for 85°.**

13-2 Connection of external electric cables





Connect the cable to the safety devices such as the overload prevention device and hook overhoisting prevention device. The arrow marks show the cables for the boom. Refer to Page 2-37 for the tower jib. Before hoisting the boom, turn the overload prevention device switch to erection side and set the hook overhoisting prevention device switch to the release side on the rear control panel. When the boom is hoisted up and the crane is set to the working status, turn the overload prevention device switch to operation position and set the hook overhoisting prevention device switch to the active side. If a winch is used, set its hook overhoisting prevention device switch to the active side on the control panel top. (See Page 1-13 for detail).



⚠ CAUTION

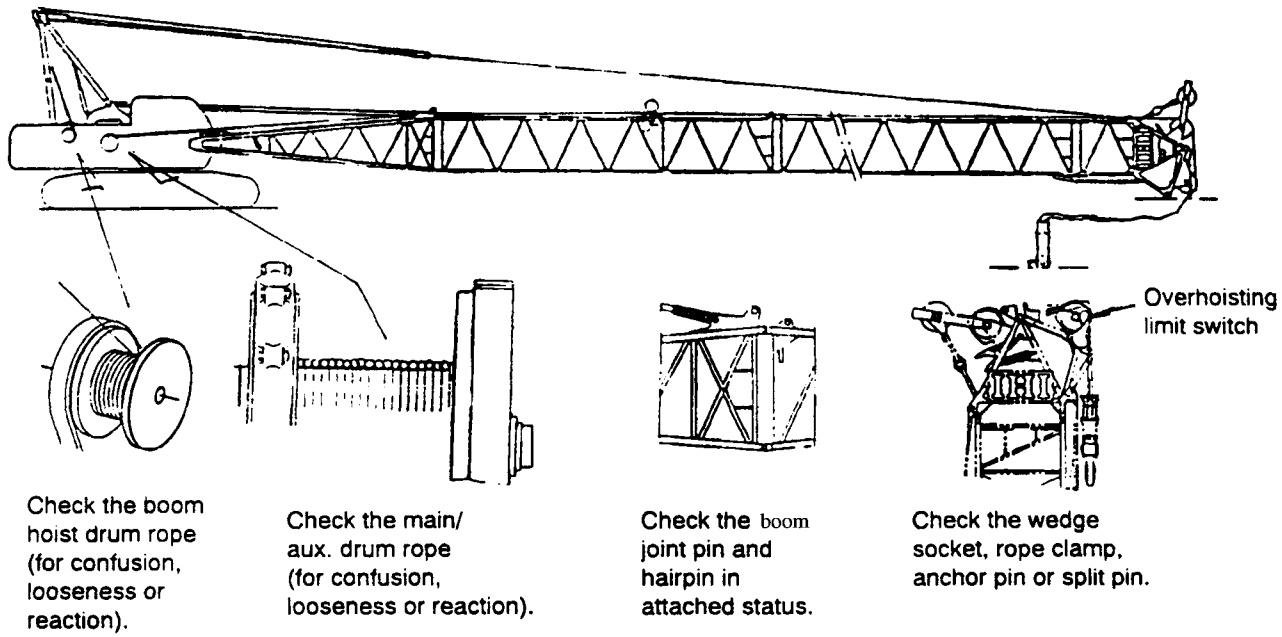
1. **If a cable is disconnected or reconnected in the electrified status, the electrical equipment may burn out or malfunction. Turn off the power before cable connection or reconnection.**
2. **Make sure that the safety devices operate correctly after hoisting the boom. If not, an accident may occur.**

13-3 Hoisting the boom

The assembly of the boom has been ended by the above mentioned procedure for the luffing jib crane main hoisting operation [boom length: 59.05'-137.80' (18m~42m)] and for the tower boom crane [boom length: 29.53'-177.17' (9m~54m)].

Check the following points and apply grease before hoisting the boom. Refer to the subsequent pages for the assembly of the luffing jib crane and tower crane jib.

When winding the boom hoist wire rope around the drum, give pre-stress to the wire rope and then wind it around the boom drum. Refer to Page 2-32 for giving pre-stress.



Check the boom hoist drum rope (for confusion, looseness or reaction).

Check the main/ aux. drum rope (for confusion, looseness or reaction).

Check the boom joint pin and hairpin in attached status.

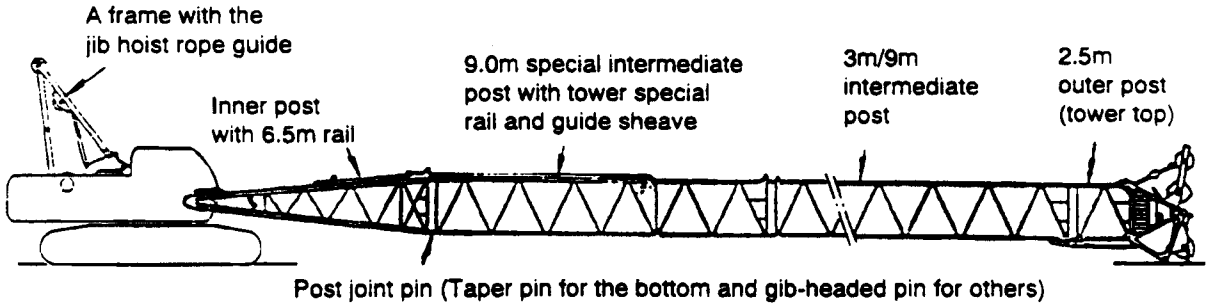
Check the wedge socket, rope clamp, anchor pin or split pin.

⚠ CAUTION

1. **Apply grease before hoisting the boom. If the initial greasing is neglected, the machine life will be affected.**
2. **Check the boom mounting pins, pendant connecting pins, split pins, hair pins and electric cables. If a pin falls off, a serious accident may occur.**
3. **Don't keep a tool or part on the boom. If it drops when setting up the boom, an accident resulting in injury or death may occur.**
4. **When winding the boom hoist wire rope around the drum, wind the wire rope from the drum's first layer on the drum correctly while giving pre-stress to the rope. If not, the wire rope will not spool on the drum and will shorten the rope's life.**

14. ASSEMBLY OF LUFFING JIB CRANE

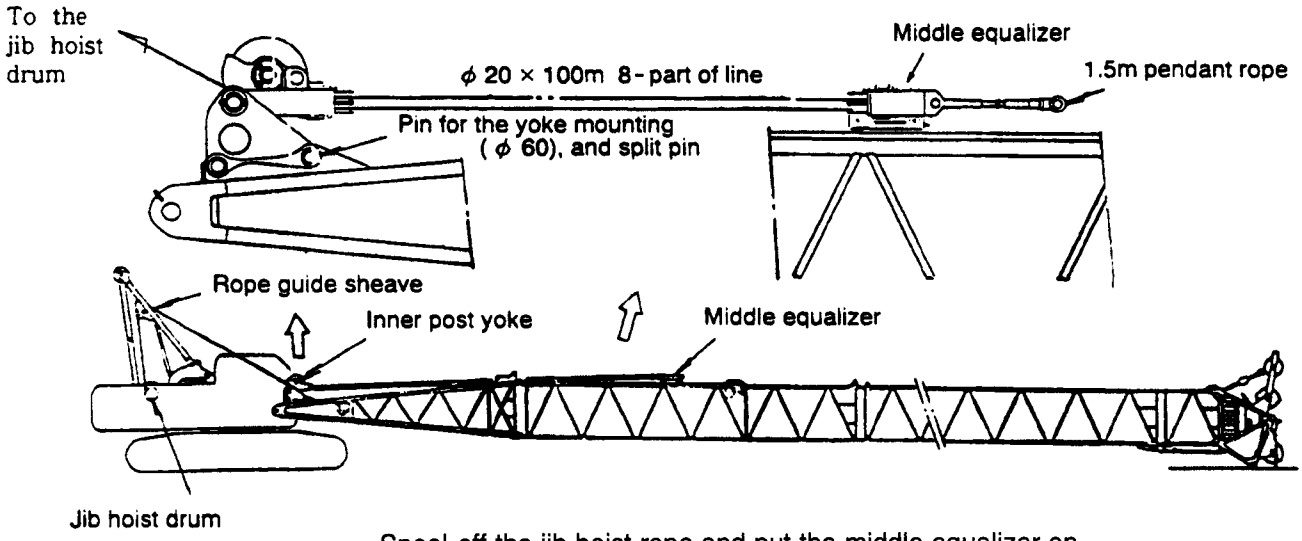
The "16. ASSEMBLY OF TOWER BOOM" shows the procedure when lifting a load by only the boom of the tower boom crane/luffing jib crane. If a tower jib is mounted on the assembled boom to use it as a luffing jib crane or luffing tower crane, the tower jib, strut, pendant rope, middle equalizer, jib hoist rope and jib fixing device must be mounted. At the same time the spacer of stabilizer must be removed.



14-1 Mounting of middle equalizer (luffing jib or luffing tower crane)

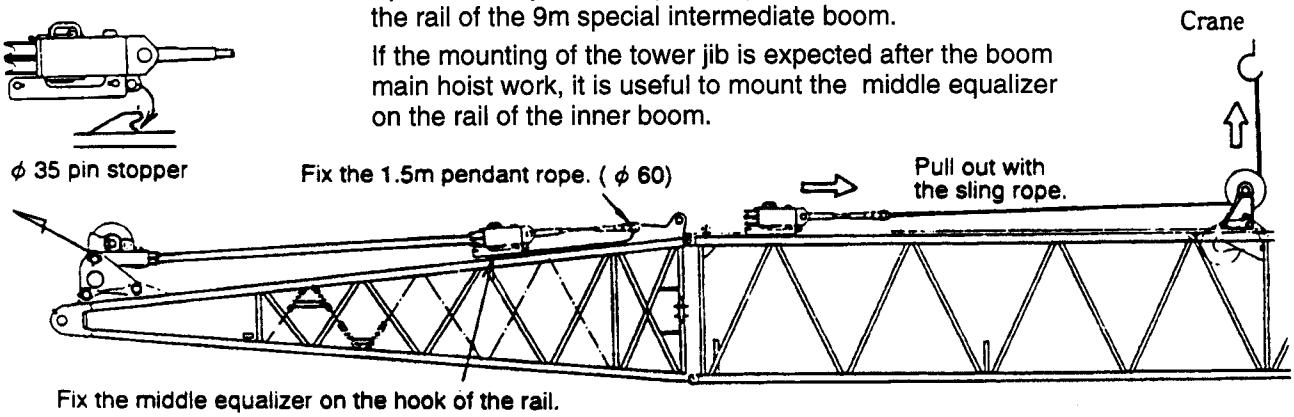
1. Mounting the jib hoist middle equalizer

   Attach the inner boom yoke to the inner boom and set the jib hoist rope between the yoke and middle equalizer.

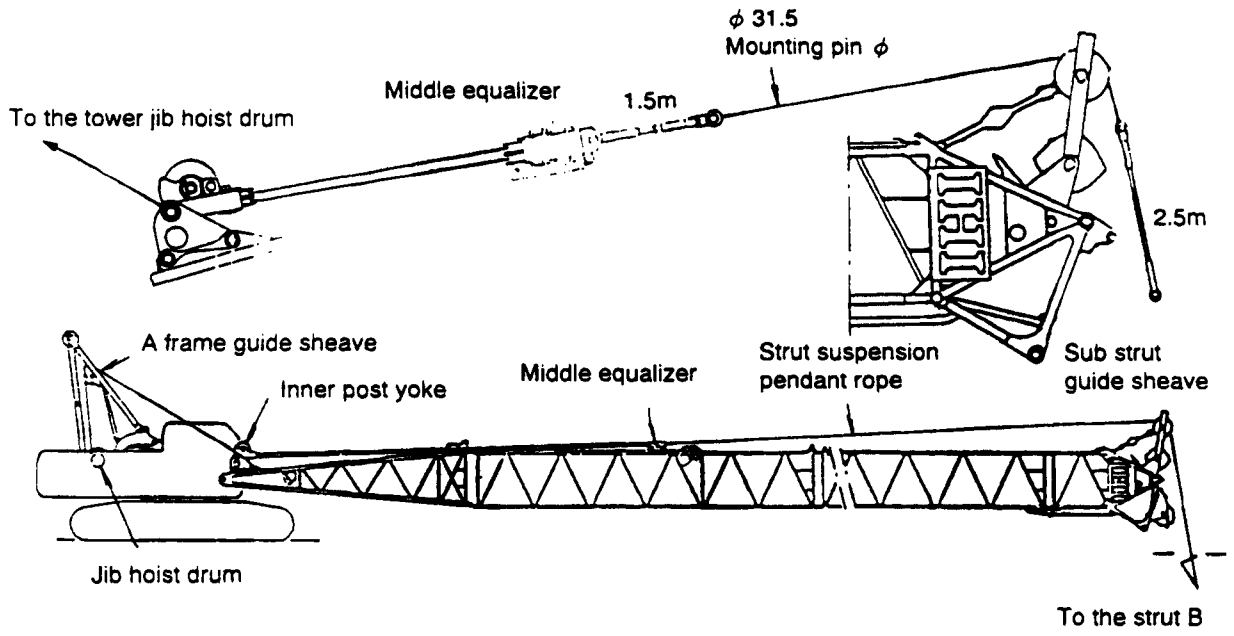


Spool off the jib hoist rope and put the middle equalizer on the rail of the 9m special intermediate boom.

If the mounting of the tower jib is expected after the boom main hoist work, it is useful to mount the middle equalizer on the rail of the inner boom.



2. Setting the strut hoist rope



Set the strut suspension pendant rope between the middle equalizer and strut B.

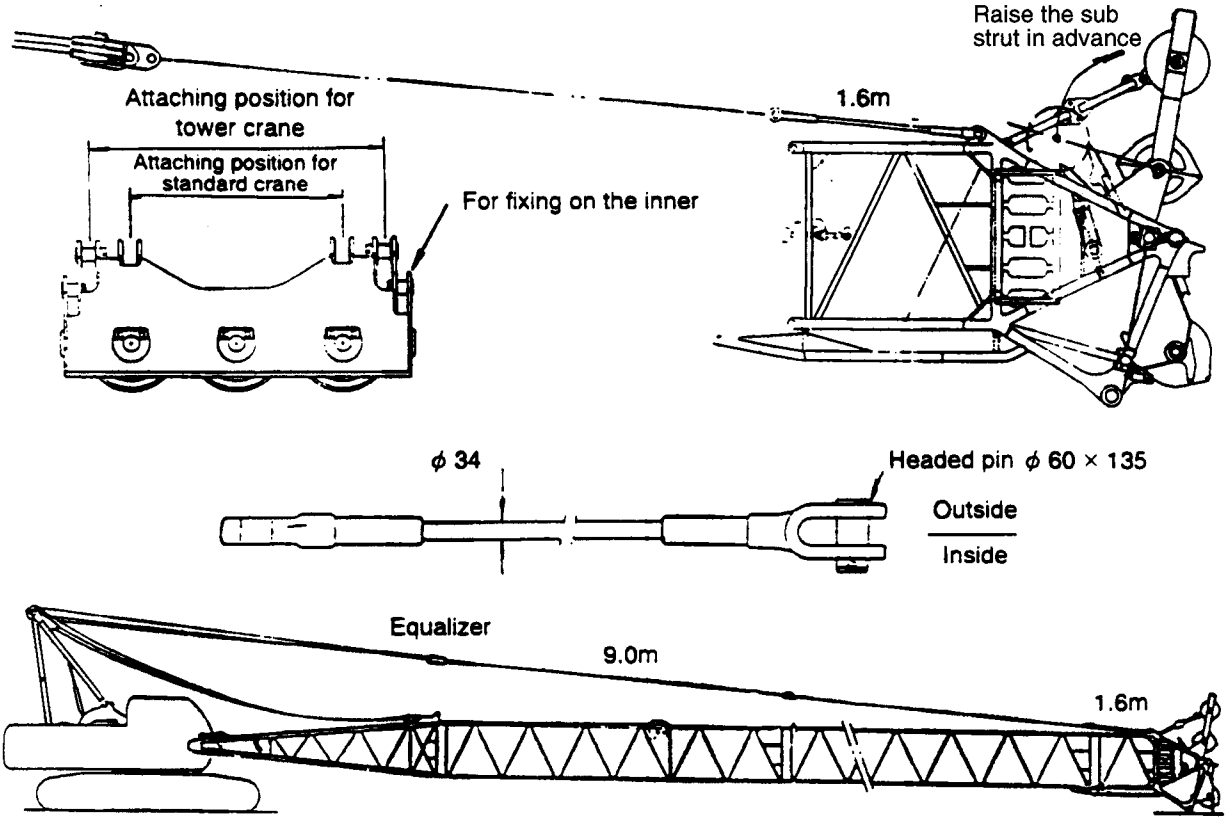
a. Connect the pendant rope whose lower end is 1.5m to the middle equalizer. Use the same parts as the boom composition for others and connect the 1.5m pendant rope to the strut B.
b. Refer to Page 2-17 for the composition of the boom, tower jib and strut suspension pendant rope. Put the middle equalizer connected with the pendant rope on the rail behind the 9m special boom guide sheave. Let the end of the pendant rope hang down through the sub strut guide sheave. It will be connected with the strut B later. On the luffing jib crane, the third drum is the jib hoist drum. On the luffing tower crane, the auxiliary drum is the jib hoist drum.

⚠ CAUTION

1. **When the boom crane work is done with the middle equalizer housed in the inner boom, the wire rope for the middle equalizer is tensed as lowering the boom. The equalizer mounting bracket or boom may be damaged. Make sure that the wire rope for the equalizer is not tensed when putting the boom on the ground.**
2. **Straighten every rope without lay or twist and then connect it correctly. Don't twist the rope forcedly in the straightened direction.**
3. **Insert the headed pin from the outside.**
4. **Insert and open the split pin accurately. If the pin is removed or falls off, a serious accident may occur.**

14-2 Attaching the boom suspension pendant

This procedure is not necessary if the boom suspension pendant is already mounted.

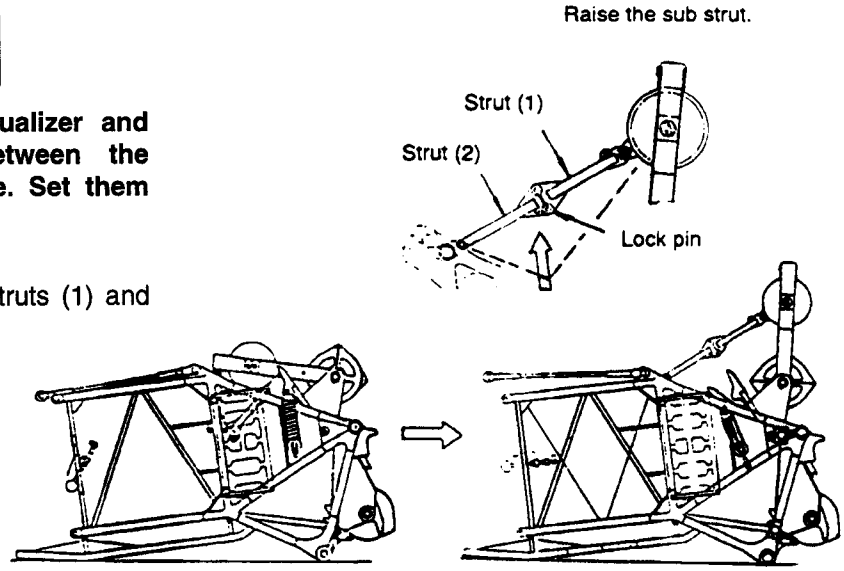


For the outer boom, connect the 1.6m pendant and for the intermediate posts, connect the 3m or 9m pendant meeting the boom length. (The 6m pendant is prepared for 45m or longer boom.)

NOTICE

The setting position of the equalizer and pendant rope is different between the standard crane and tower crane. Set them correctly as illustrated.

Raise the sub strut and lock the struts (1) and (2) accurately.

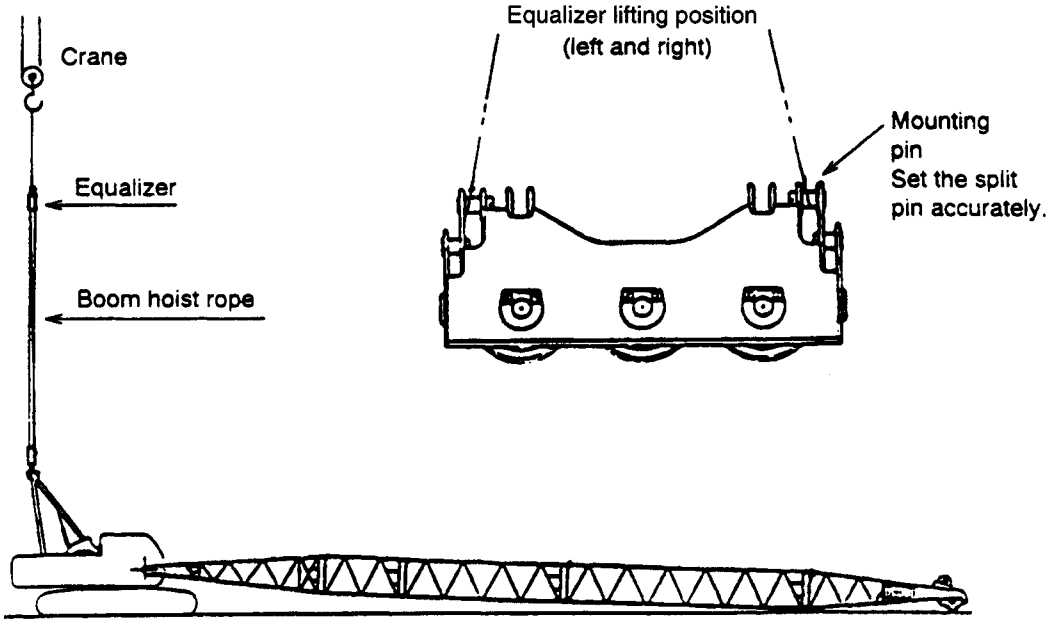


How to apply pre-tension to the boom hoist wire rope

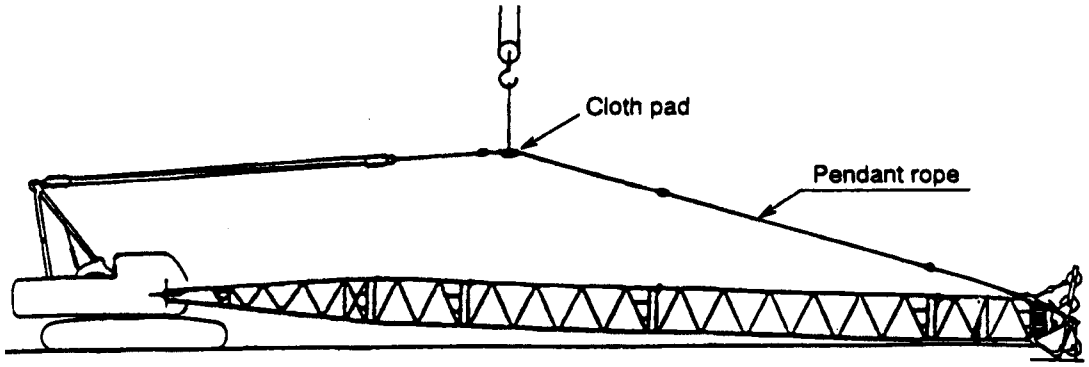
⚠ CAUTION

When replacing the boom hoist wire rope or when loosening the first layer of rope on the drum for repair, wind the first layer tightly as applying pretension and then wind the rope correctly while applying force to prevent the wire rope from not spooling. If not, the life of the wire rope will be shortened by the wire rope not spooling.

1. When replacing the boom hoist wire or when loosening the first layer of the rope on the drum:



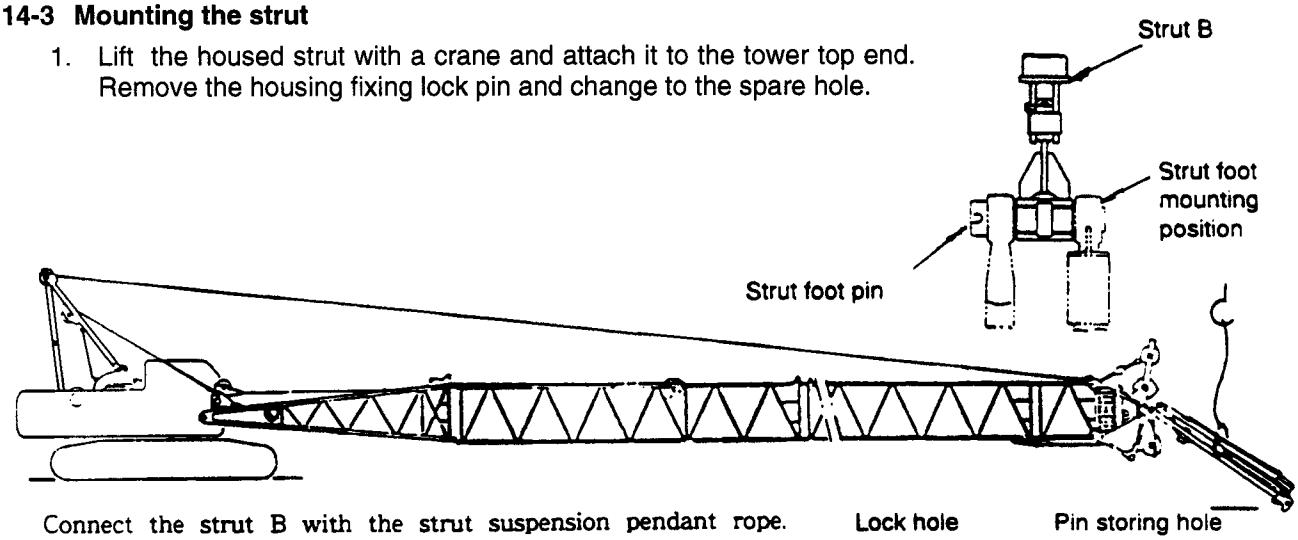
   a. Mount the pendant connecting pin to the equalizer, lift the equalizer with a crane and apply tension to the boom hoist rope. While applying tension, wind the boom hoist rope. Keep the proper length of the rope to be able to connect with the pendant rope.
   b. Connect the equalizer with the pendant rope.
   c. LIft the pendant rope with a crane and wind the boom hoist rope around the drum while applying the boom weight.



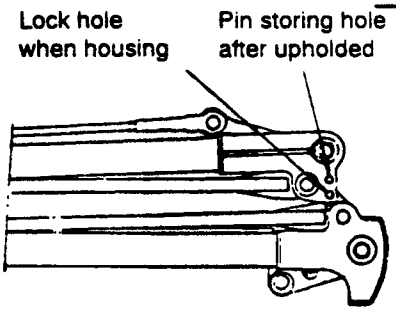
   Use a pad for the lifted section of the pendant rope so as not to make an extreme bend in the rope. Gradually lift the next pendant rope in addition to the first one. For the tower crane, carry out the above procedure if necessary.

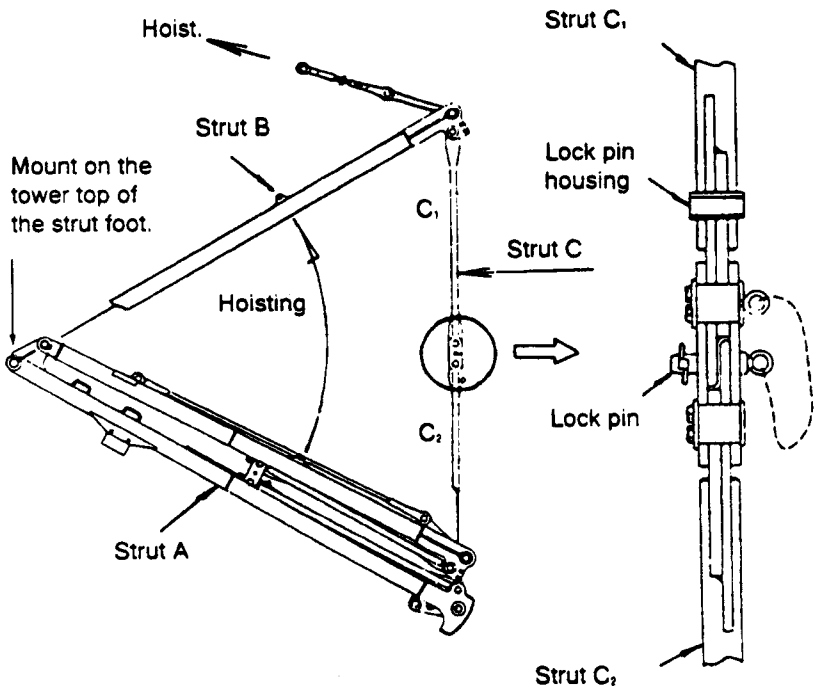
14-3 Mounting the strut

1. Lift the housed strut with a crane and attach it to the tower top end. Remove the housing fixing lock pin and change to the spare hole.

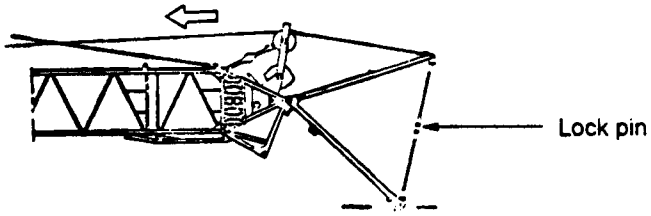


Connect the strut B with the strut suspension pendant rope.



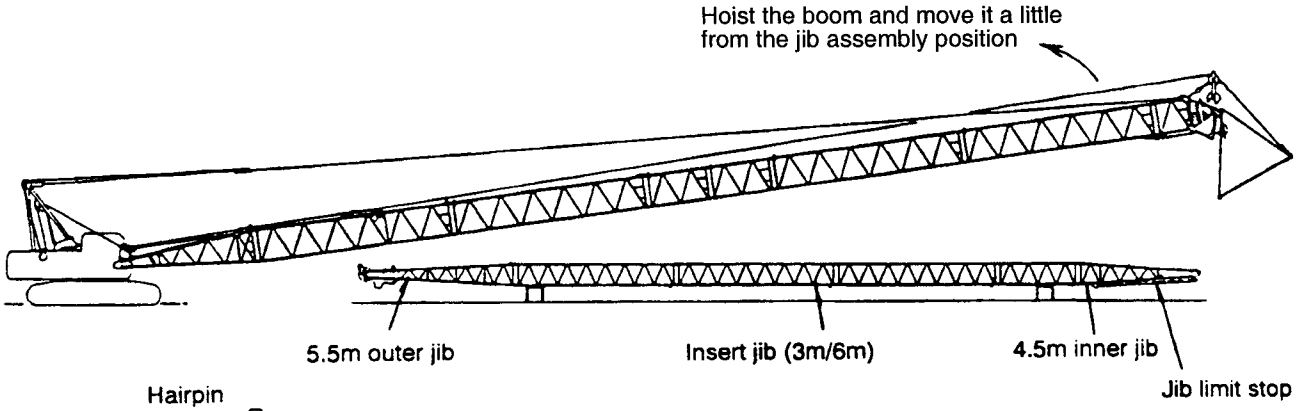


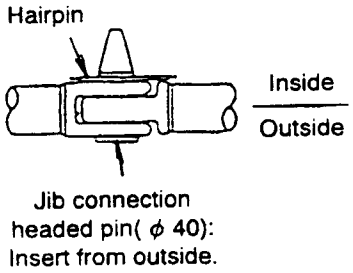
2. Upholding the struts
   Wind the jib hoist rope carefully and hoist strut "B". When the struts are expanded completely, insert the lock pin and fix them where struts "C" are straight.



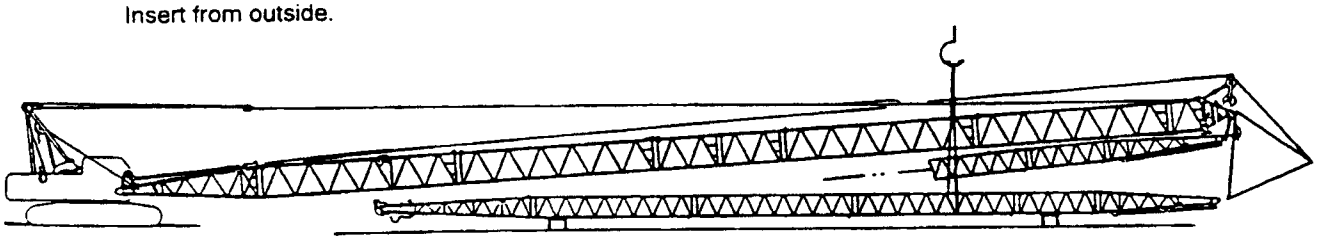
14-4 Assembly of tower jib

1. Hoist the boom, swing it a little and move it from the jib assembly position to assemble the jib. Assemble the jib on the machine center line.



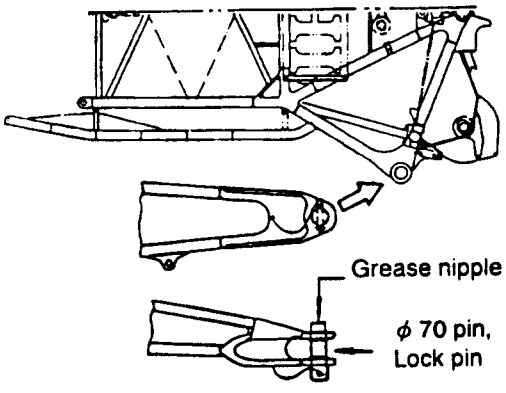


2. Put a stand in the jib assembly position. Assemble a jib with specified length so that the jib bottom may be upside down. Refer to Page 2-17 for the jib composition.



3. Swing the boom and lower it onto the assembled jib.

4. Lift the jib foot with a crane and mount it on the tower top with pins. Attach the foot pin so that the grease nipple may be inside.

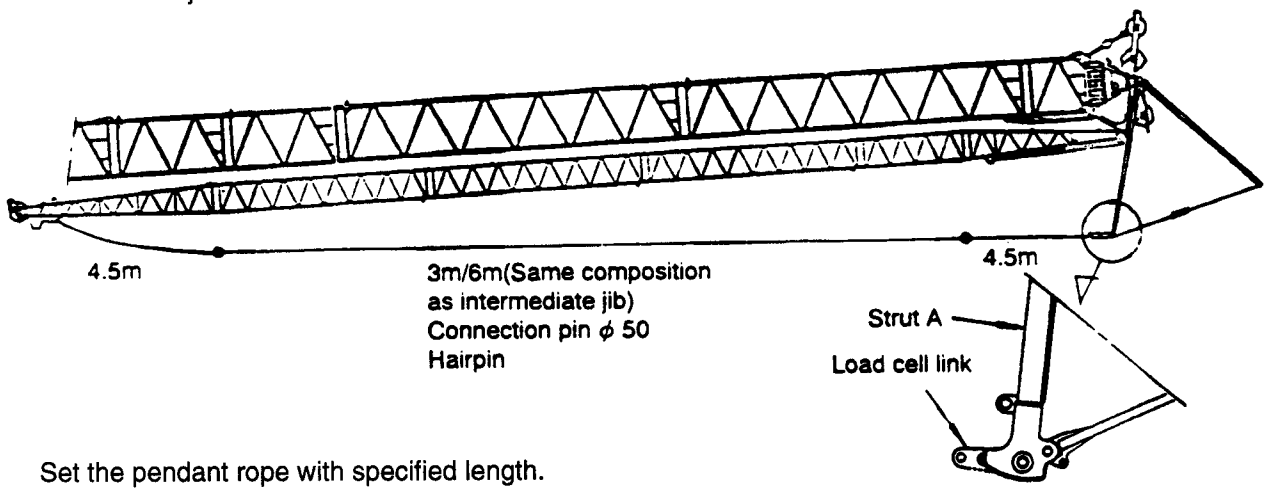


Jib foot pin section

NOTICE

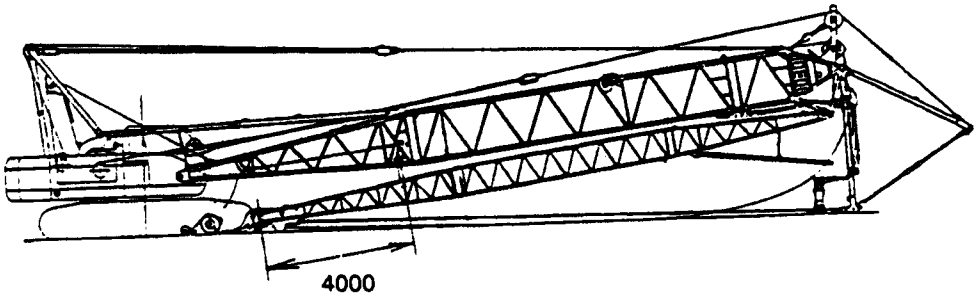
1. **Change the attaching position of the boom 85° alarm device (boom throw-out) when changing the crane to the tower crane. Refer to Chapter 5 "OPERATOR AIDS".**
2. **Make allowance for setting the electric wire from the tower boom to the jib in consideration of the jib hoisting. Don't loosen the wire too much. It may interfere with other parts.**

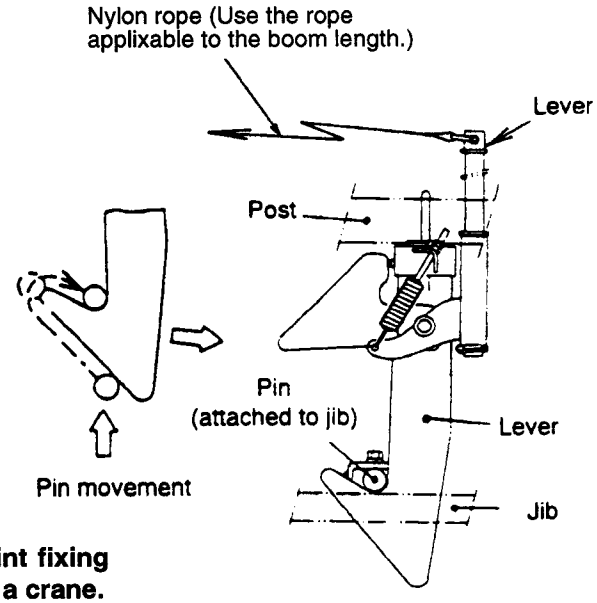
5. Attaching the jib suspension pendant rope
   Set the pendant rope with the same composition as the jib between strut "A" and outer jib. The pendant rope for the outer jib should be 4.5m.



   Set the pendant rope with specified length.
   Refer to Page 2-16 for the composition of pendant and jib.

6. Mounting the jib point fixing device
   The mounting position is changed by the combination of the boom length and jib length.
   Determine the position of the fixing device according to the jib length.





When the tower jib is fixed:
The jib approaches the boom. The pin touches the lever, the lever is moved in the arrow direction and is set at the hook.

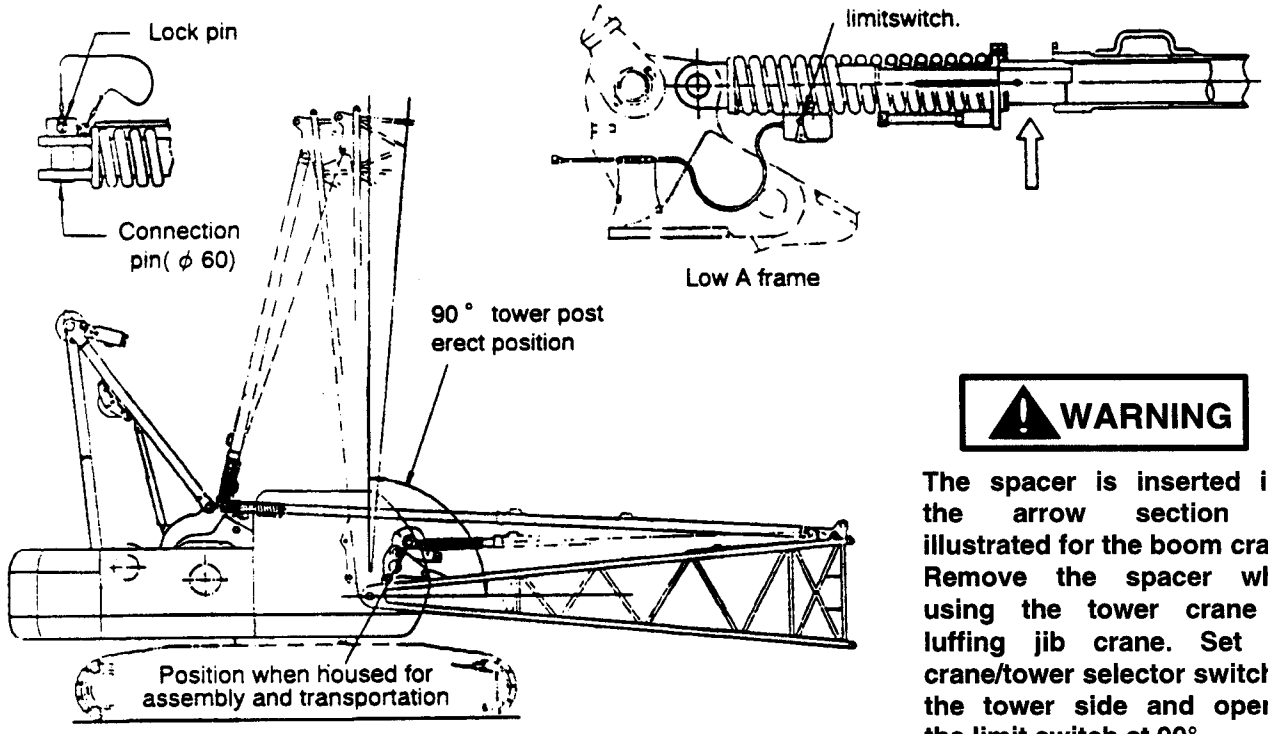
When the tower jib is released:
If pulling the nylon rope in the operator's cab, the lever is moved and the pin is separated from the hook.

⚠ CAUTION

Make sure by testing twice or more that the jib point fixing device is fixed or released while the jib is lifted with a crane.

14-5 Mounting the stabilizer (rear stopper)

Pull out the inner member of the stabilizer housed in the inner boom and attach it to the low A-frame. Be careful not to damage the limit switch for stopping the hoist of boom.

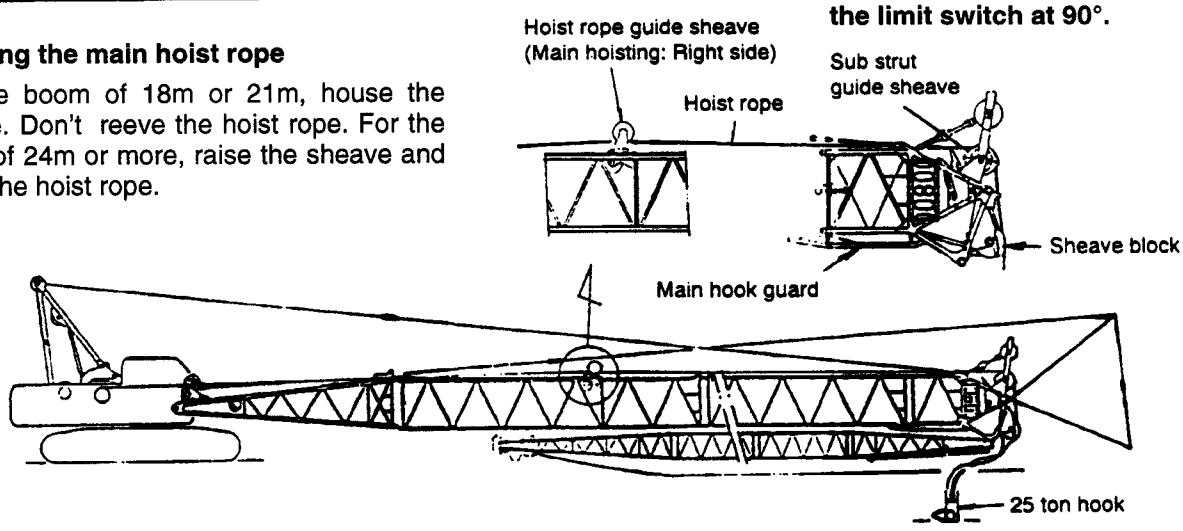


⚠ WARNING

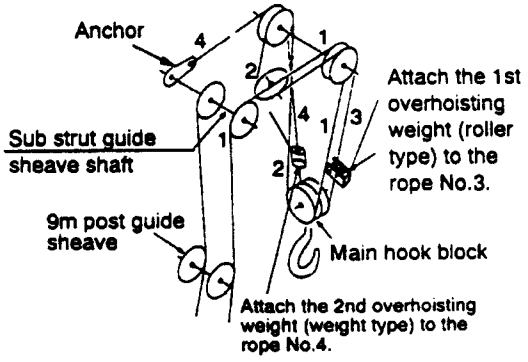
The spacer is inserted into the arrow section as illustrated for the boom crane. Remove the spacer when using the tower crane or luffing jib crane. Set the crane/tower selector switch to the tower side and operate the limit switch at 90°.

14-6 Setting the main hoist rope

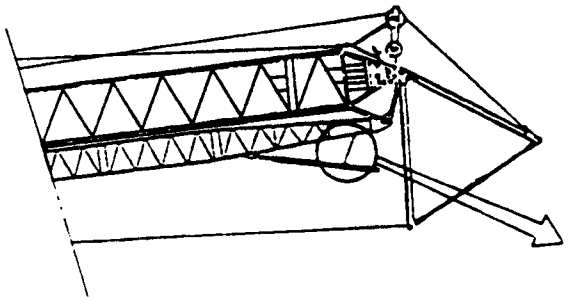
For the boom of 18m or 21m, house the sheave. Don't reeve the hoist rope. For the boom of 24m or more, raise the sheave and reeve the hoist rope.

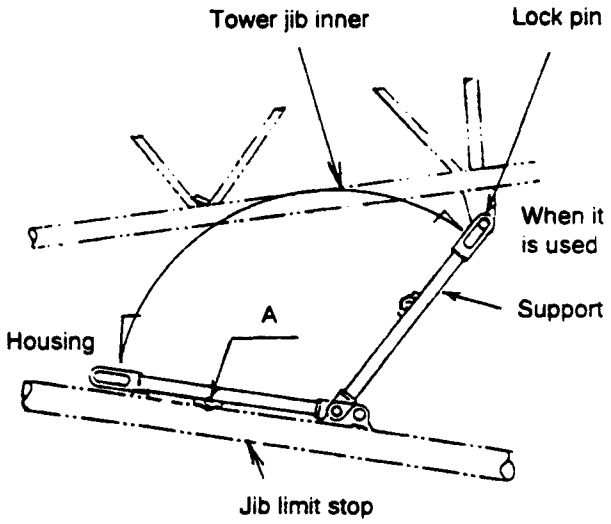


Spool off the main hoist rope and fix it on the rope anchor via the rope guide of the 9m boom, the sub strut guide sheave, the sheave block and hook block. Set the weight for the overhoisting prevention device between the sheave block and hook. Refer to Page 2-19 for reeving the main hoist rope. If the main hook is already attached as shown in Page 2-19, this procedure on this page is not necessary.



14-7 Handling the jib limit stop (rear stopper)



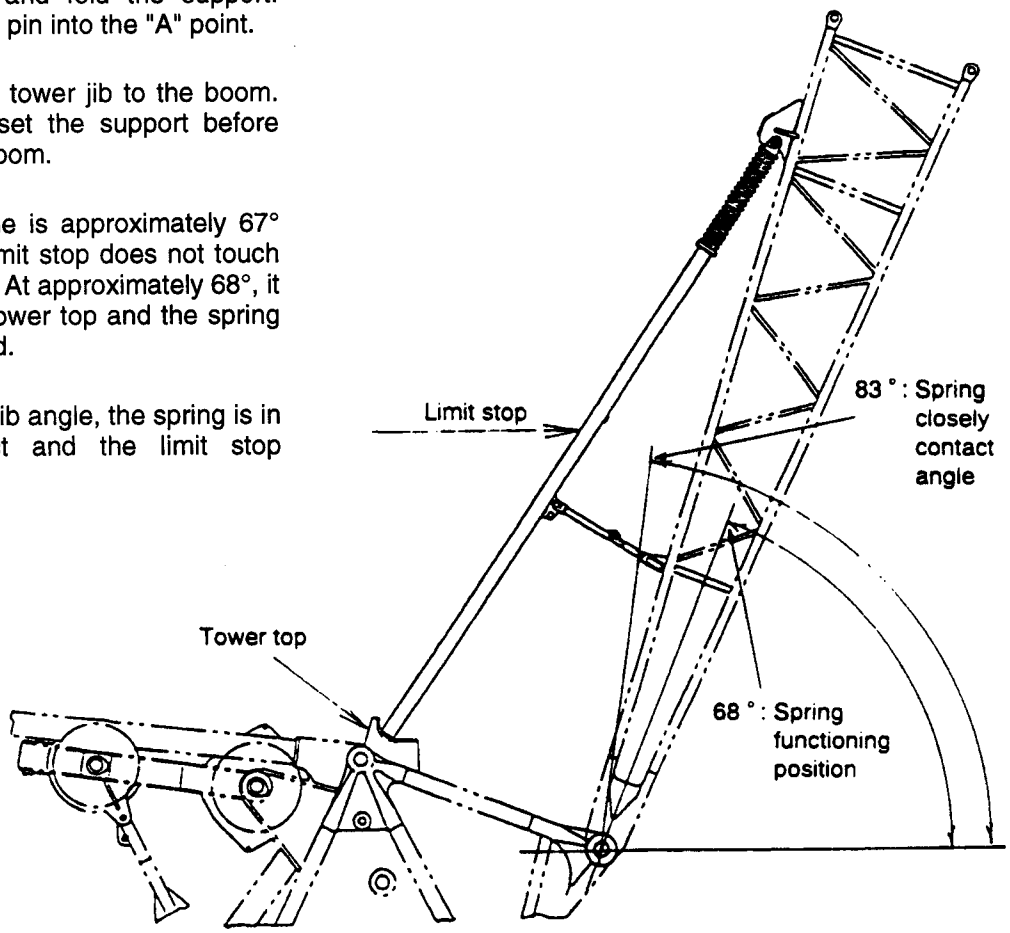


1. When disassembling the jib, remove the lock pin and fold the support. Insert the lock pin into the "A" point.

2. Assemble the tower jib to the boom. Pull up and set the support before hoisting the boom.

3. If the jib angle is approximately 67° or less, the limit stop does not touch the tower top. At approximately 68°, it touches the tower top and the spring is compressed.

4. At 83° of the jib angle, the spring is in close contact and the limit stop functions.

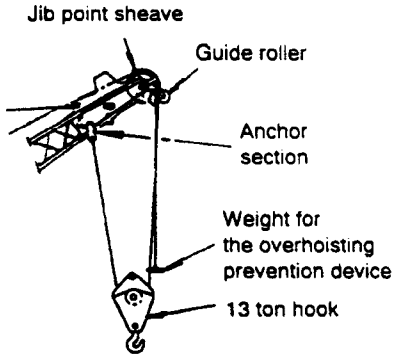


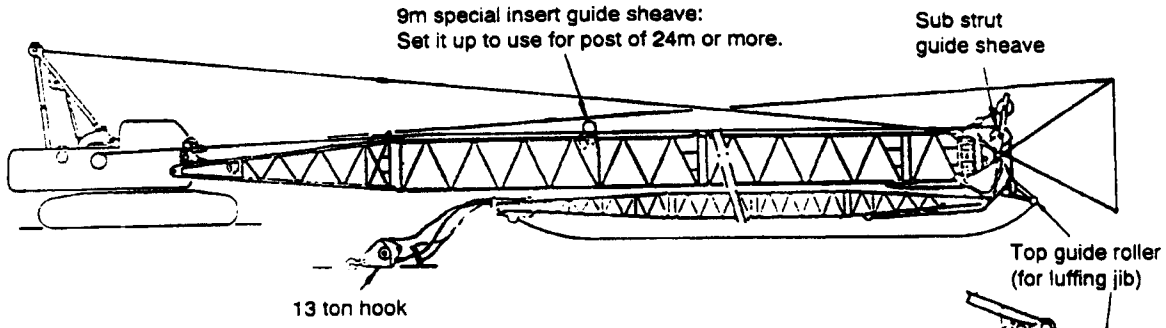
14-8 Setting the hoist rope for tower jib

1. Spool off the auxiliary rope and set it to the hook block via the guide sheave and sub strut guide sheave on the boom or the top guide roller if the luffing jib is used. The setting status is shown below. The wire is set while jib is being held.

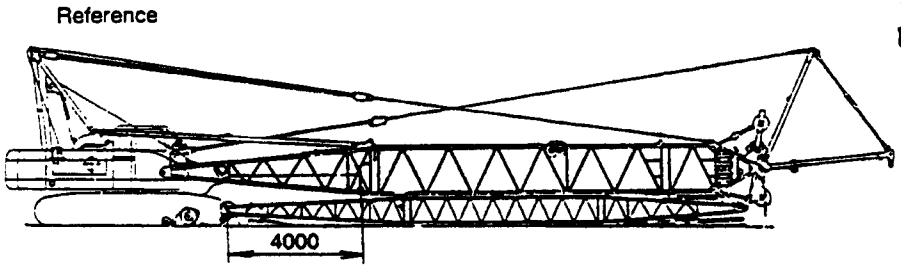
   Be careful not to set the wire erroneously. Attach the top guide roller so that the main hook may not interfere with the auxiliary wire when hoisting the main hook.

2. Fix the rope end on the link through the weight for the hook overhoisting prevention device. Refer to Page 2-35 and 2-36 for mounting the anchor.





3. Refer to Page 2-33 for mounting the jib fixing device.



Setting of the boom hoist rope

If the boom can be hoisted or lowered first, it will be useful to assemble others except mounting of the middle equalizer.

Adjustment of height for assembly

If the joint pin is removed from the bottom side of the outer jib, the boom position is lowered and the assembly or disassembly can be done more safely. It is useful to set the jib limit stop in the last procedure (Page 2-52).

Attaching of the jib suspension pendant

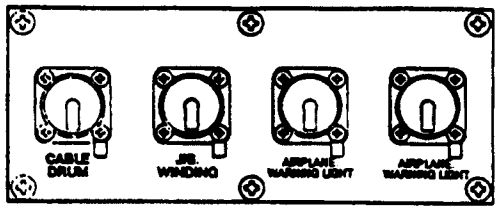
If the connection pin for the pendant rope and strut "A" is removed and only the strut is hoisted or lowered, it is easier to assemble the jib or to set the hoist rope.

⚠ WARNING

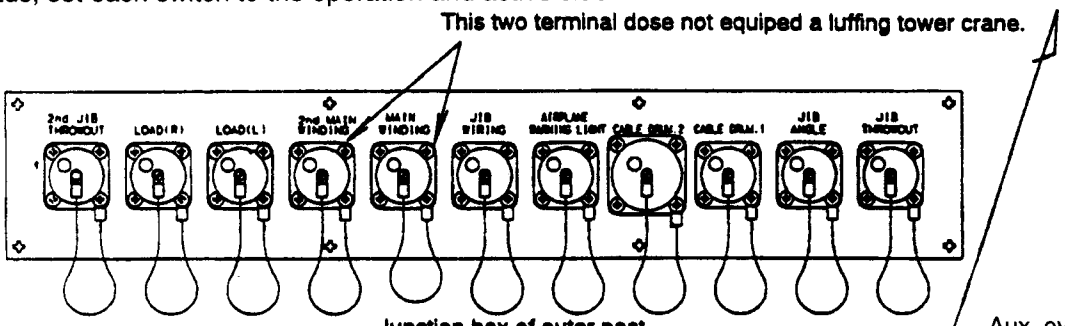
1. **When the auxiliary drum is used for hoisting the jib in a tower crane, attach the pin for fixing the wire drum and clutch spider to prevent the jib from lowering freely.**
2. **Select the auto. mode for the winch mode.**

14-9 Connection of external electrical cables

Connect cables to the overload prevention device and overhoisting prevention device. Turn the overload prevention device switch to erection position and the hook overhoisting prevention device switch to release side when hoisting the boom. When the boom is set up to the working status, set each switch to the operation and active side.

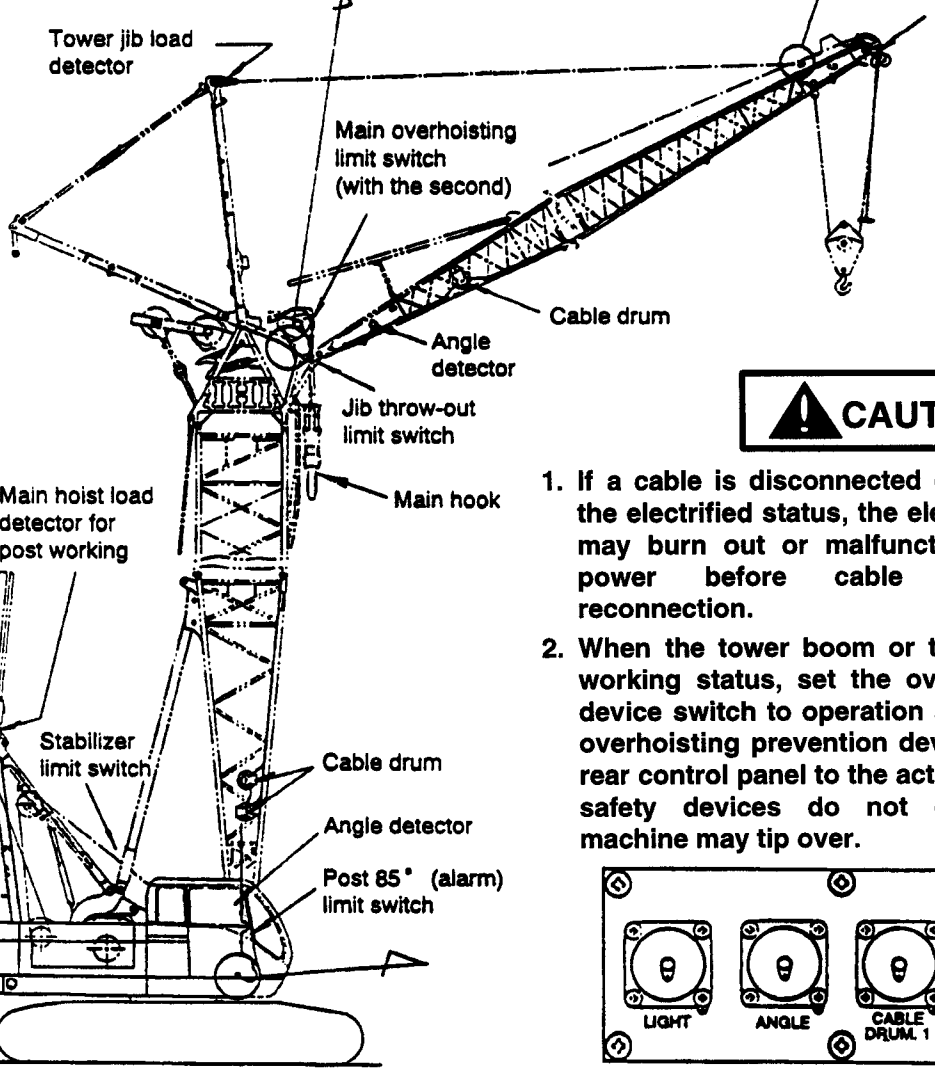


Junction box of tower jib



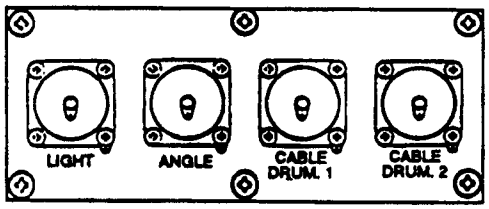
This two terminal dose not equiped a luffing tower crane.

Junction box of outer post



⚠ CAUTION

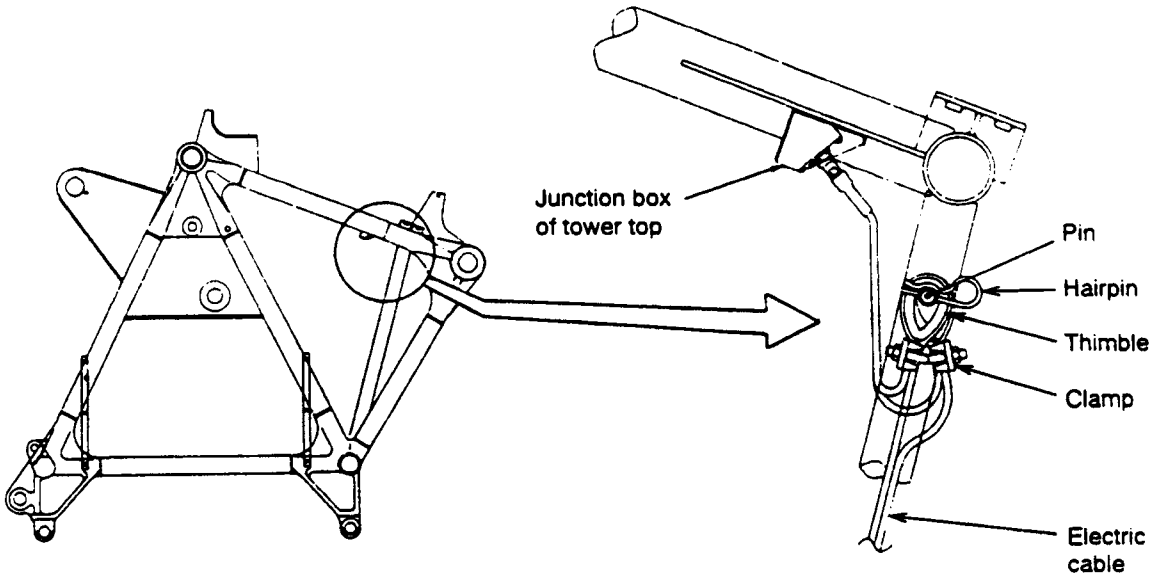
1. **If a cable is disconnected or reconnected in the electrified status, the electrical equipment may burn out or malfunction. Turn off the power before cable connection or reconnection.**
2. **When the tower boom or tower jib is in the working status, set the overload prevention device switch to operation side and the hook overhoisting prevention device switch on the rear control panel to the active side. If not, the safety devices do not operate and the machine may tip over.**



Junction box of base machine

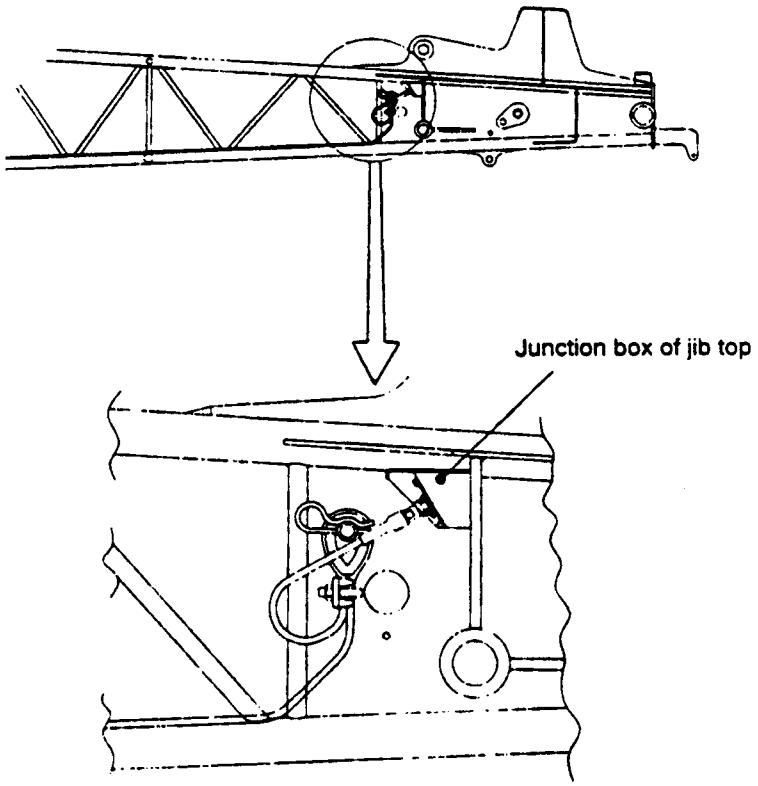
Intermediate support for the electric cables

There is a supporting pin near the junction box. Support the electric cables with the thimble, clamp and hairpin.



Tower top

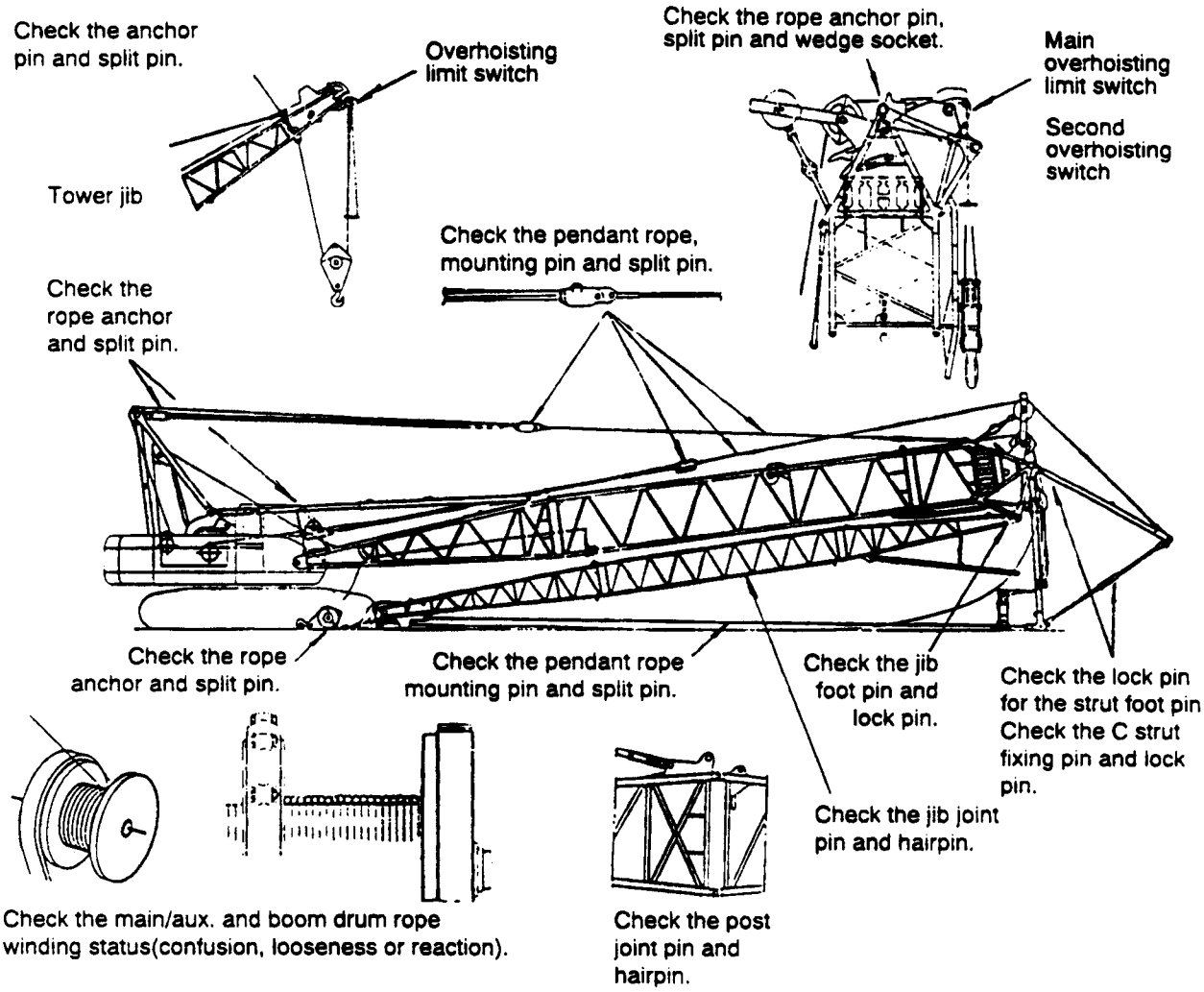
Cable intermediate support illustration



Jib top

14-10 Check and greasing before hoisting boom

1. Check the following points.



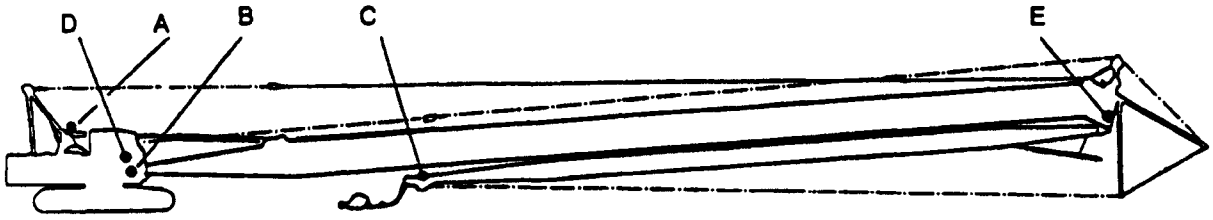
2. Apply grease before hoisting the boom. Refer to the greasing points of attachments in Chapter 3 "MAINTENANCE".
3. Wind the boom hoist rope lightly and make sure that the rope is set to the drum and is reeved correctly. Refer to Page 2-47 for how to apply pre-tension to the drum wire.
4. Make sure that the jib hoist rope, main hoist rope and auxiliary hoist rope are wound to the drum and are reeved correctly.

⚠ CAUTION

1. **Apply grease before hoisting the boom. If the initial greasing is neglected, the machine life will be affected.**
2. **Check the boom mounting pins, pendant mounting pins, split pins, hair pins and electric cables. If a pin falls off, a serious accident may occur.**
3. **Don't keep a tool or part on the boom. If it drops when hoisting the boom, an accident resulting in injury or death may occur.**

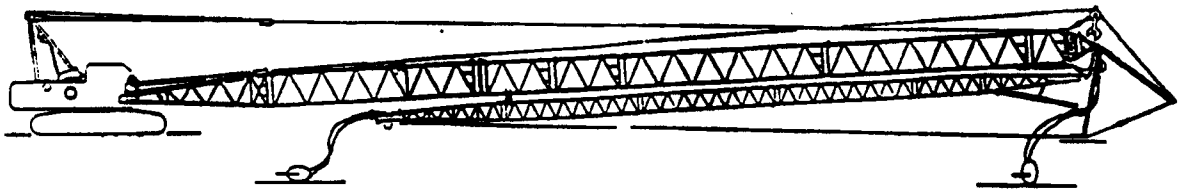
14-11 Check before hoisting

1. Check of safety devices (check the operation manually twice or more.)



	Name	Normal Condition		Manual Check
		Function	Operation	
A	Boom excessive setting up preventive Stabilizer Limit-switch 2P	· Prevents the boom from being set up excessively. · The No. 1 limit switch operates at the boom angle 90° and No. 2 limit switch operates at 90.12°.	· When the boom drum stops, the alarm buzzer sounds. · Operates when the boom angle is 90°. · When the No. 2 limit switch operates, all the winch hoisting stops.	When pressing the limit switch by hand, check if the alarm occurs and boom stops.
B	Boom 85° alarm Post 85° alarm 85° 2P Limit Switch	· Warns that the boom setting up angle is too high. · The working angle is over 85°.	· The forecast sounds (peep). · The alarm keeps sounding when the boom angle is 85° or more.	When operating the limit switch by hand, check if the forecast occurs. · Set the crane/tower selector switch to "Tower" in advance.
C	Hook overhoisting preventive Jib hook Boom hook Tower jib Weight	· Prevents the hook from overhoisting. · When the 2nd main overhoisting prevention device of the luffing jib crane operates, boom hoisting, main hoisting and aux. hoisting stop.	· When the main hoist drum stops, the alarm buzzer sounds. When the aux. hoist drum stops, the alarm buzzer sounds.	When lifting the weight by hand and operating the limit switch, check if the alarm occurs and the hook hoist stops.
D	Overload Prevention Device (Moment limiter) While the crane is disassembled or assembled, set the overload prevention device switch to "ERECTION". When the crane is in the working posture by hoisting the attachment, set the overload prevention device to "OPERATION".	· Prevents overload · Prevents the work outside the working range (Max. working radius stop.)	· Difference between the allowable load and actual load: Less than 90~100% - - forecast (peep) 100% or more - - Alarm (beep) occurs and the machine stops. · The jib or boom lowering stops when the working radius is maximum.	· Lower the jib or boom without load and make sure that lowering stops automatically at the maximum radius.
E	Jib hoist throw-out Limitswitch 80°	· Prevents the tower jib from overhoisting.	· When the jib (aux. hoist) drum stops, the alarm buzzer sounds (peep).	When operating the limit switch by hand, check if the alarm occurs and the jib drum stops. (Boom lowering main hoist aux. hoist.)
		· The 1st limit switch operates at the offset angle 10°, and 2nd limit switch operates at 9°.		

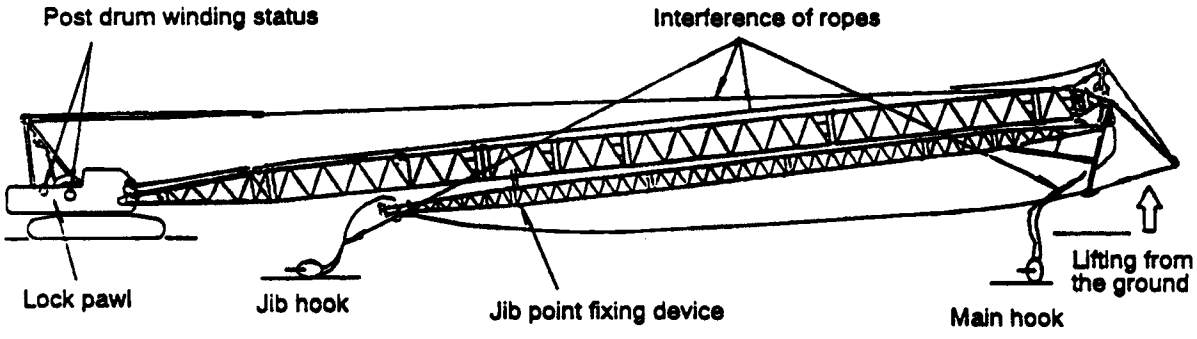
2. Preparation and check before hoisting



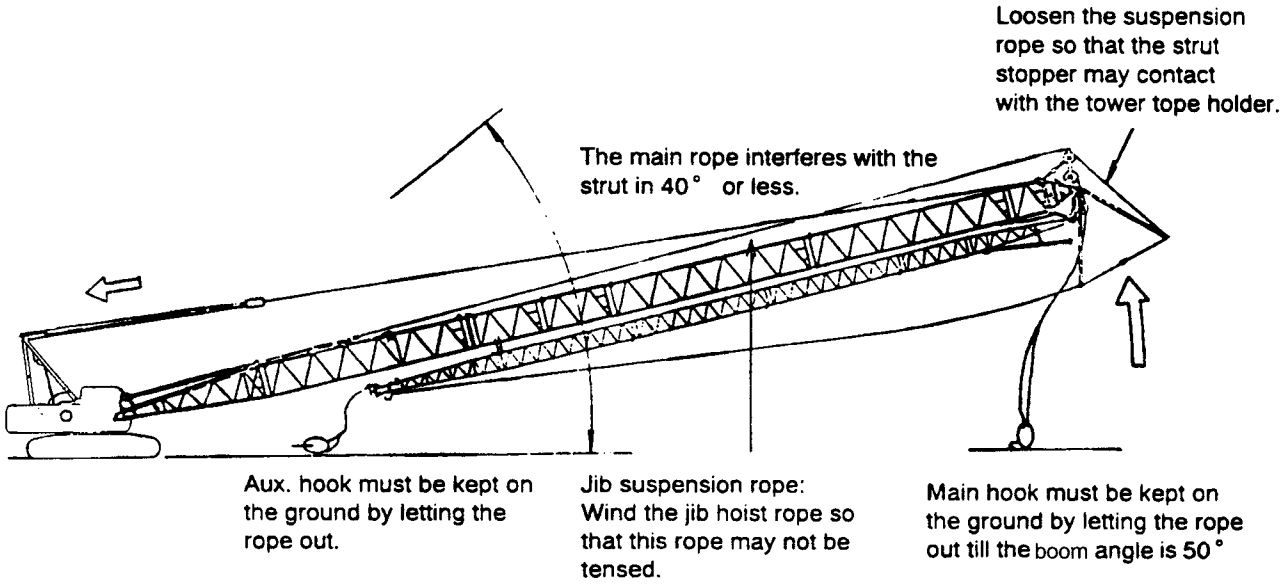
a. Check the composition of boom and jib and the attached status of connection pins.
b. Check the composition of pendant ropes and the attached status of connection pins.
c. Check if the ropes are reeved properly.
d. Check if the drum ropes are spooled correctly.
e. Check if the ropes interfere with each other.
f. Check if there is any problem in the clutches, brake and drum lock.
g. Check if the sole plates are set.
h. Check if the tower/crane selector switch is set at the tower side.
i. Set the engine revolution at 1000 rpm.
j. Check if the overload prevention device switch to "ERECTION" position and hook overwind prevention device switch in the machine room are at the "RELEASE" positions.
k. Check if the jib point fixing device is fixing the jib accurately.

14-12 Hoisting the boom

1. Preparation
   a. Turn on the boom 85° alarm switch.
   b. Turn off the boom hoist lock switch.
   c. Turn on the boom hoist drum lock (boom lock) switch.
   d. Set the sole plates under the crawler and put the crawler on them carefully.
2. Check when the boom is just lifted from the ground.
   a. Wind the boom hoist rope slowly and stretch it a little. Check of the boom hoist rope is wound normally.
   b. Wind the boom hoist rope carefully, lift it from the ground and stop temporarily. Check the following items.



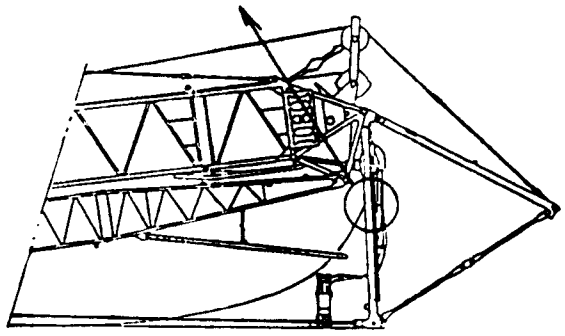
3. Link operation while hoisting the boom
   a. While hoisting the boom, the jib hoist rope is loosened a little. Don't wind it forcibly. If the boom is hoisted by winding the jib hoist rope, the rope will support the boom's total weight.
   b. Keep the main hook on the ground by loosening the brake pedal and letting the rope out until the boom angle is 50° because the intermediate brace pipe of the A strut and the ladder interfere with the rope.
   c. The auxiliary hook must be kept on the ground until the boom is erected and the tower jib is set up. Loosen the auxiliary brake and let the rope out so as not to raise the hook.



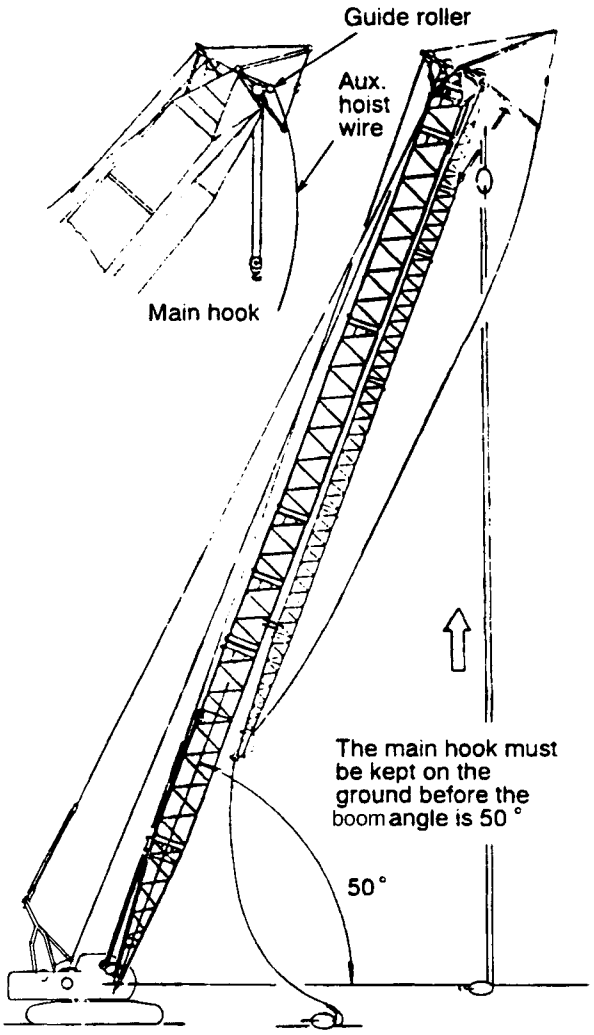
CAUTION

When hoisting the boom, the operator must perform the link operation being careful for the safety and stability of hoisting and simultaneously watching several operations such as loosening the tower jib hoist rope or letting out the wire rope for main/aux. hook. Hoist the boom while keeping the posture and speed to be able to watch all the operations.

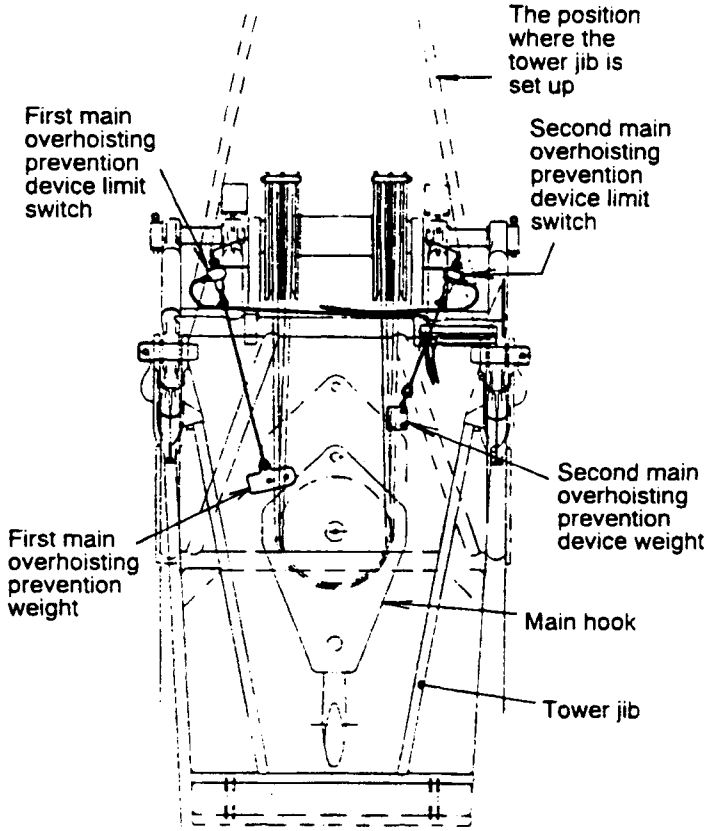
Don't apply the hook weight to the rope because the strut interferes with the hoist rope before the boom angle is 50°



4. Hoisting the boom and the main hook
   a. Carefully hoist the boom to approximately 50°,at a low speed. Don't stop or restart in the middle of hoisting if possible because such action gives the structure a shock and vibration. Hoist the boom slowly and continuously at a stable speed.
   b. Stop hoisting when the boom angle is 50°. Hoist the main hook to the position where the main hook avoids the jib foot when setting up the tower jib. Let out the auxiliary wire rope and loosen it fully beforehand so that the main hook may not interfere with the auxiliary wire rope when hoisting the main hook.

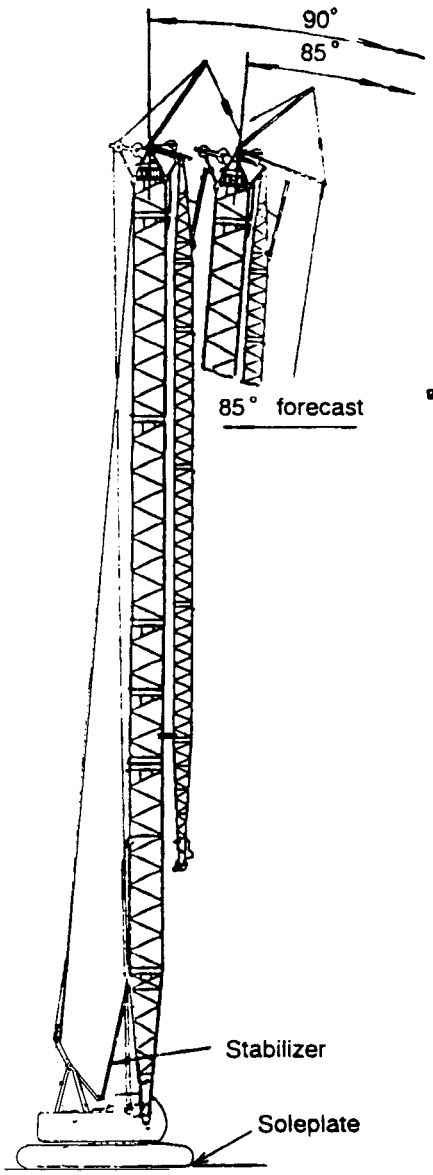


The aux. hook must be kept on

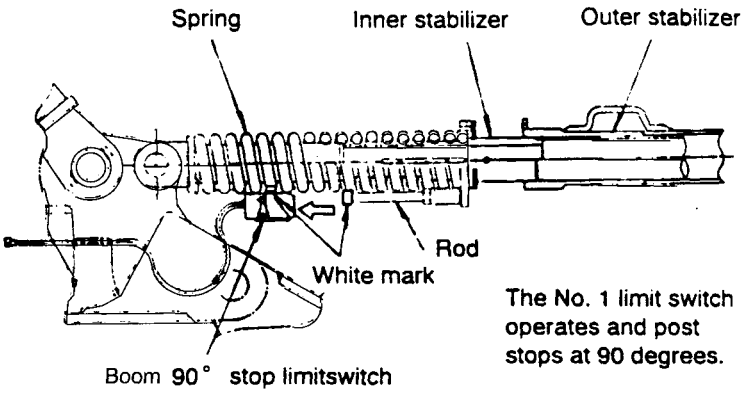


1). Set the overhoisting prevention device switches (on top of the control panel in the machine room) to the "ACTIVE" side.
2). Hoist the hook at a low speed near the weight for the main overhoisting prevention device.
3). While hoisting continually, hoist the hook until the first main overhoisting alarm sounds.
4). When the main overhoisting alarm works, hoist the hook a little while turning the safety device switch to the "RELEASE" side. When the second main overhoisting alarm sounds, all the winches stop. Lower the hook a little to release the second overhoisting alarm. When the boom angle is 80°, remove the sole plates.
5). When the boom angle is changed from 50° to 90°, the hook lowers approximately 400mm. Repeat the above steps (3) and (4) while hoisting the boom by 90° so that the hook may not interfere with the jib. When the boom angle is changed from 90° to 50°, the hook rises approximately 400mm. If the hook rises, the first and second main overhoisting alarms work and the boom cannot be lowered. In such a case, lower the boom while lowering the hook.

14-13 Setting the boom erect position



Set up the boom to 85°, carefully, at a low speed.



1. When the boom angle is 85° or more, an intermittent sound (peep) occurs by the boom foot forecast device. This shows that the boom hoisting angle is high. If this forecast sound occurs, stop hoisting temporarily. Hoist the boom to be erected more carefully.

   *The 85° forecast device has only the forecast sound without the stop function. Turn off the 85° alarm buzzer switch to stop the sound. As soon as you hear the forecast sound of 85°, you may turn off the switch.

2. Hoist the boom while watching the boom indicator.

   *The correct boom erect position is where the white mark is fit in the stabilizer unit. When the boom angle is 90°, the limit switch operates and hoisting of boom is stopped.

   *The right angle mentioned above shows that the boom makes a right angle with the base machine.

3. Make sure that the lock pawl is accurately applied to the boom hoist drum for an emergency.

⚠ WARNING

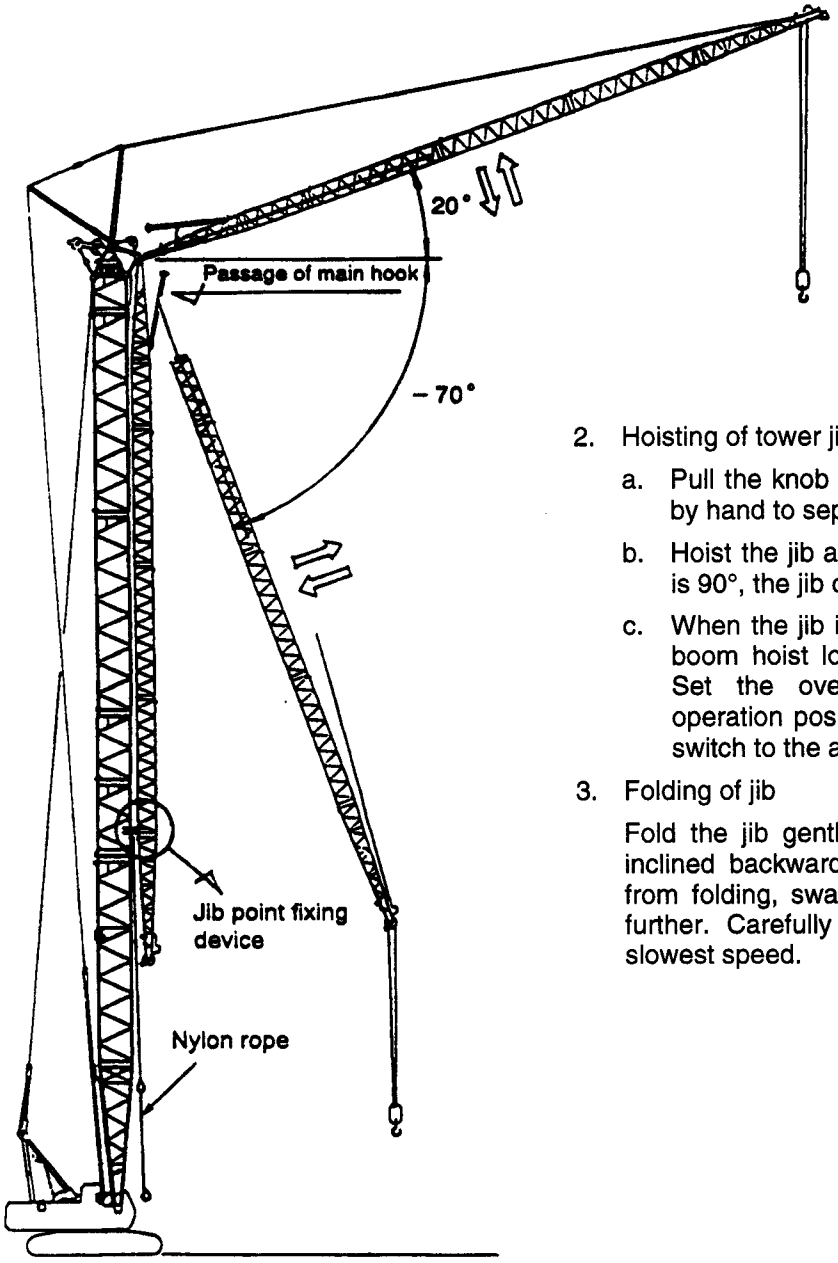
1. **Lower the boom the opposite way of the boom hoisting procedure. When the boom is lowered, the jib hoist rope is tense. Let the jib hoist rope out according to the boom lowering speed to loosen it. If the jib hoist rope is tense, this rope will support the total weight of boom.**
2. **If hoisting the boom by 90° while the sole plates are being set, the boom may be inclined backward and tip over. When the boom angle is 80°, remove the sole plates.**

14-14 Hoisting and folding of tower jib

1. Preparation
   a. Make sure that the tower/crane selector switch is at the tower side.
   b. Turn on the jib hoist drum lock (third drum) switch.
   c. Set the boom hoist lock switch to the active "ON" side.

⚠ CAUTION

Hoist or lower the tower jib while the boom is erected (90°). Carefully hoist or lower the jib while checking that the main hook does not interfere with the jib foot.



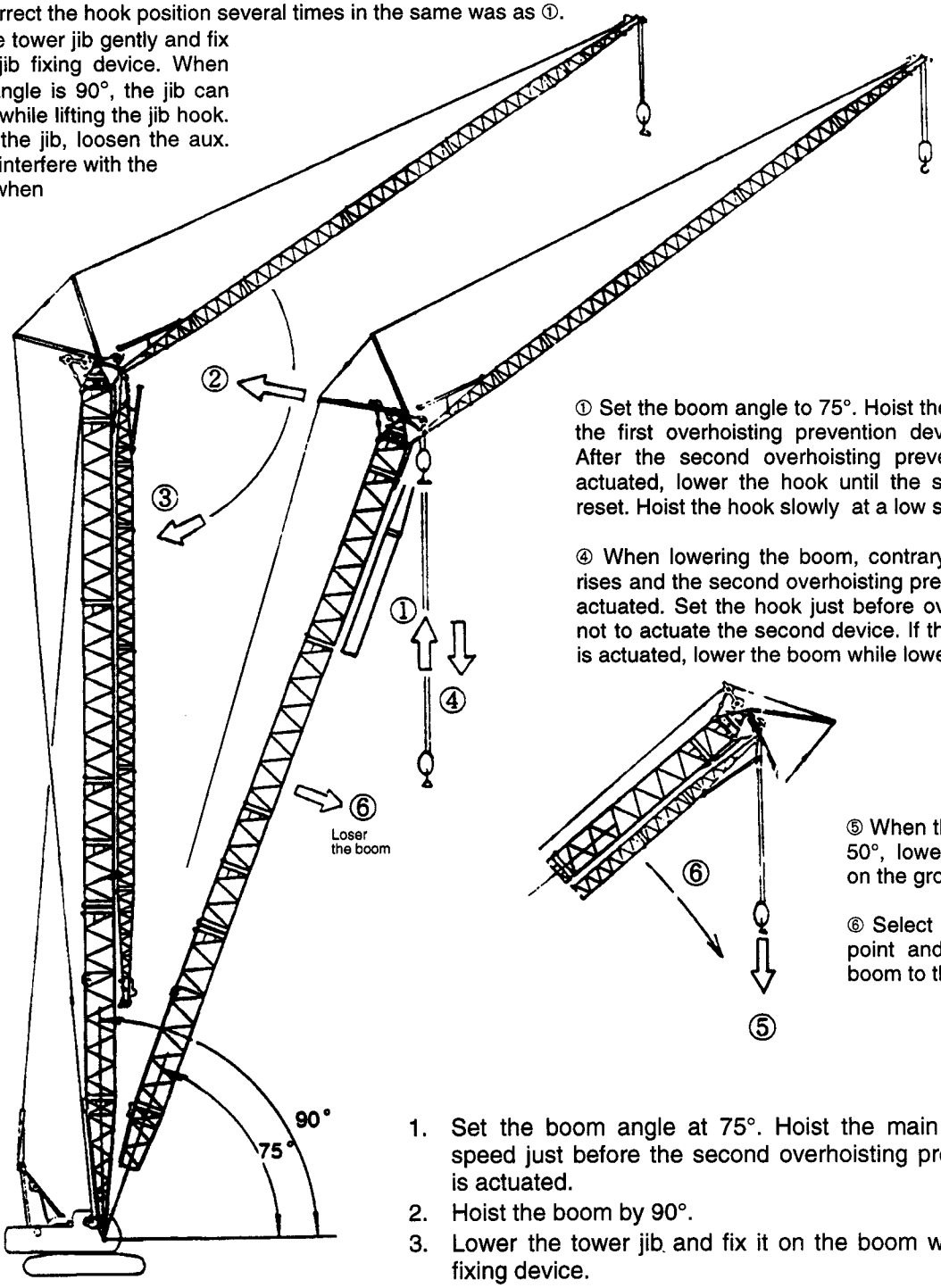
2. Hoisting of tower jib
   a. Pull the knob for releasing the jib point fixing device by hand to separate the boom from the jib.
   b. Hoist the jib at a slow speed. When the boom angle is 90°, the jib can be hoisted while lifting the jib hook.
   c. When the jib is set up to the working status, set the boom hoist lock switch to the release "OFF" side. Set the overload prevention device switch to operation position, hook overwind prevention device switch to the active side.
3. Folding of jib

   Fold the jib gently. While folding the jib, the boom is inclined backward a little. If you suddenly stop the jib from folding, swaying occurs and the boom is inclined further. Carefully fold the jib from 20° to -70° at the slowest speed.

14-15 Hoisting of tower jib and lowering of boom

② Hoist the boom by 90°. the hook will be lowered by 400mm. Correct the hook position several times in the same was as ①.

③ Lower the tower jib gently and fix it with the jib fixing device. When the boom angle is 90°, the jib can be lowered while lifting the jib hook. After fixing the jib, loosen the aux. wire, not to interfere with the main hook when lowering.



① Set the boom angle to 75°. Hoist the main hook until the first overhoisting prevention device is actuated. After the second overhoisting preventing device is actuated, lower the hook until the second device is reset. Hoist the hook slowly at a low speed.

④ When lowering the boom, contrary to ②, the hook rises and the second overhoisting prevention device is actuated. Set the hook just before overhoisting so as not to actuate the second device. If the second device is actuated, lower the boom while lowering the hook.

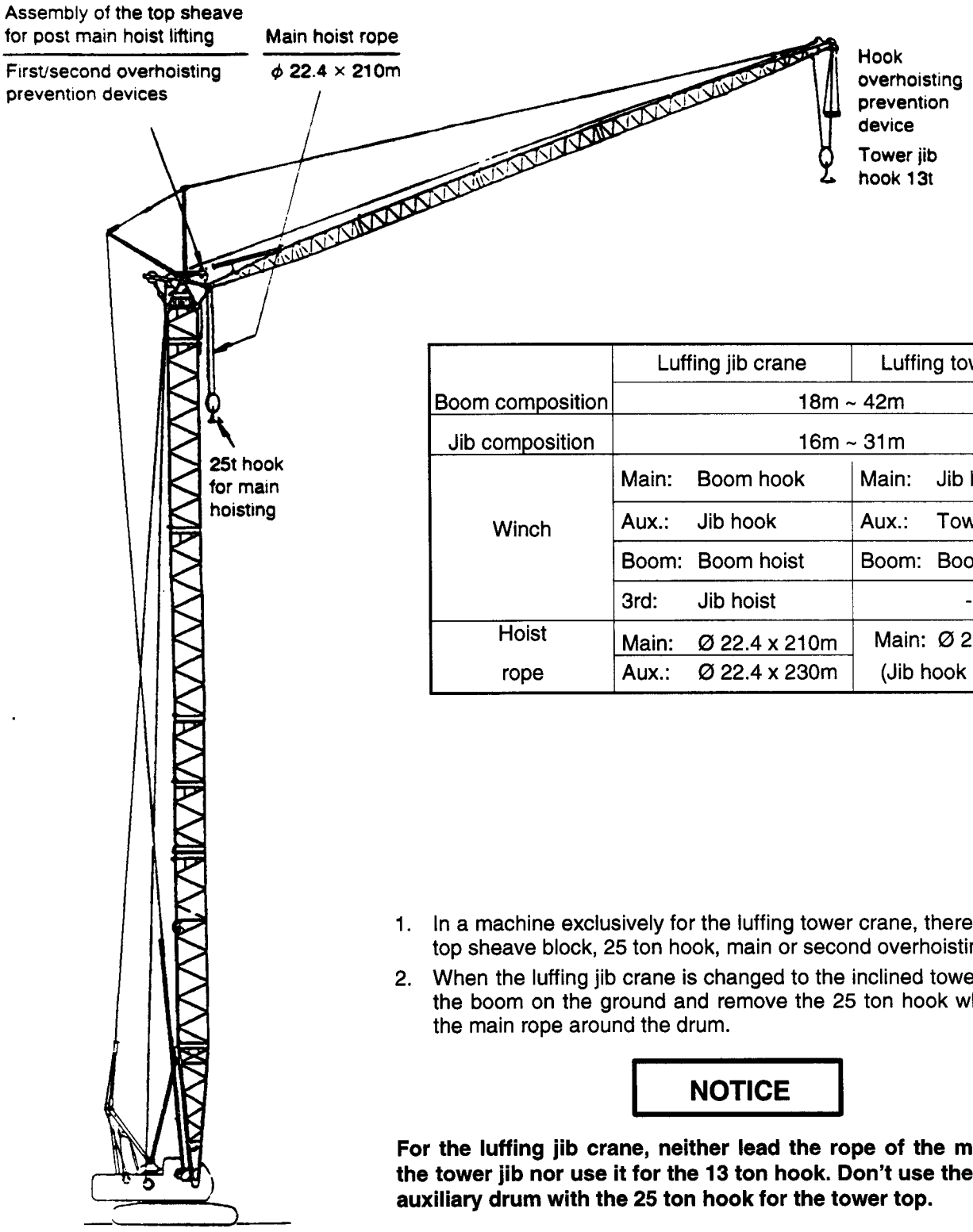
⑤ When the boom angle is 50°, lower the main hook on the ground.

⑥ Select the boom setting point and then lower the boom to the ground.

1. Set the boom angle at 75°. Hoist the main hook at a low speed just before the second overhoisting prevention device is actuated.
2. Hoist the boom by 90°.
3. Lower the tower jib and fix it on the boom with the jib point fixing device.
4. Lower the tower boom by 80° and then set the sole plates. Lower the tower boom by 50° and then lower the main hook. Refer to the above.
5. While lowering the boom, put the main hook on the ground when the boom angle is approximately 40°.
6. While letting out the jib hoist rope according to the boom lowering speed, determine the boom lowering position and put the boom on the ground. Take special care that the total boom weight is not applied to the jib hoist rope.

15. DISASSEMBLY/ASSEMBLY OF LUFFING TOWER CRANE

As compared with the luffing jib crane, the luffing tower crane does not have the boom main hoist device. In the assembly procedure, mounting of the boom lifting hook and mounting of the main hoist first/second overhoisting prevention devices are omitted. The main drum is the drum for the hook hoist rope.



	Luffing jib crane	Luffing tower crane
Boom composition	18m ~ 42m	
Jib composition	16m ~ 31m	
Winch	Main: Boom hook	Main: Jib hook
	Aux.: Jib hook	Aux.: Tower jib
	Boom: Boom hoist	Boom: Boom hoist
	3rd: Jib hoist	---
Hoist rope	Main: Ø 22.4 x 210m	Main: Ø 22.4 x 230m
	Aux.: Ø 22.4 x 230m	(Jib hook hoist rope)

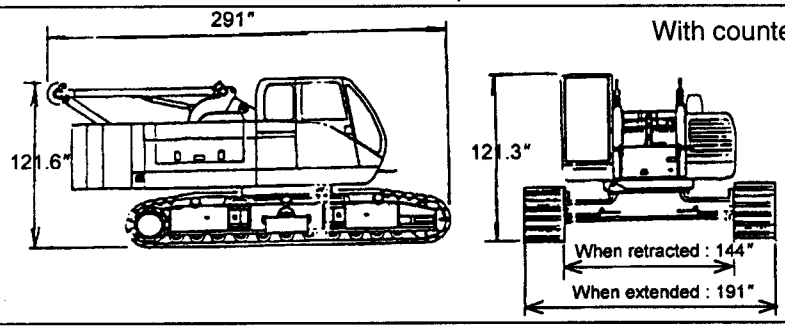
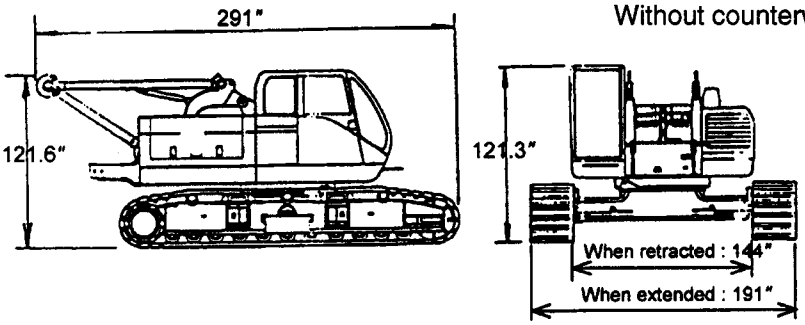
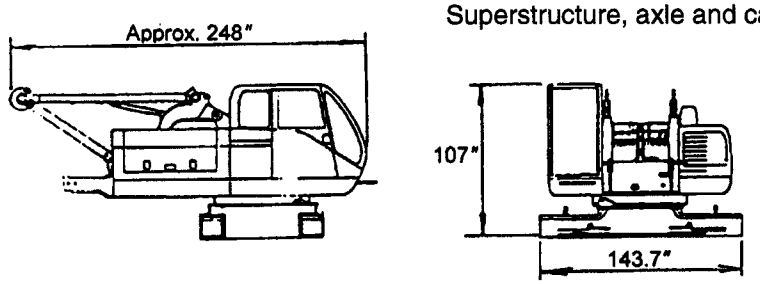
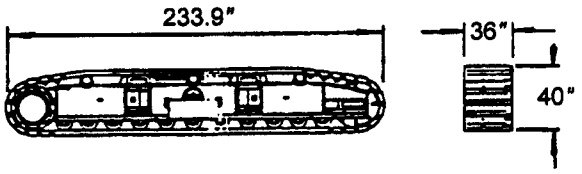
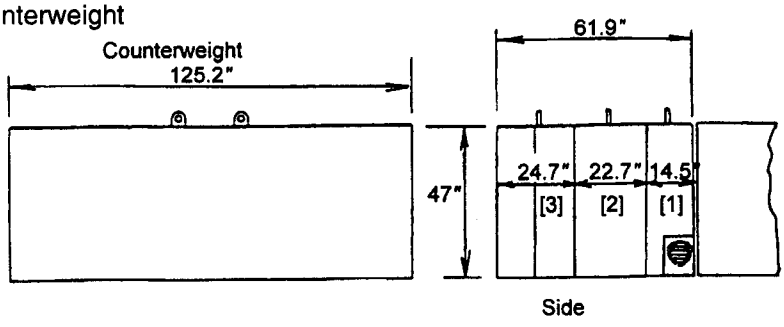
1. In a machine exclusively for the luffing tower crane, there is no tower top sheave block, 25 ton hook, main or second overhoisting devices.
2. When the luffing jib crane is changed to the inclined tower crane, put the boom on the ground and remove the 25 ton hook while winding the main rope around the drum.

NOTICE

For the luffing jib crane, neither lead the rope of the main drum to the tower jib nor use it for the 13 ton hook. Don't use the wire for the auxiliary drum with the 25 ton hook for the tower top.

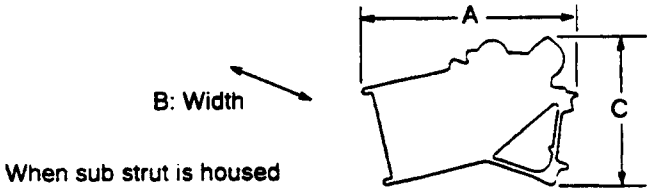
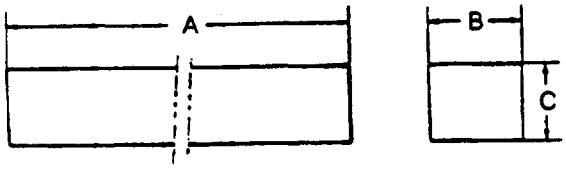
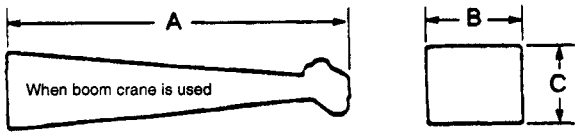
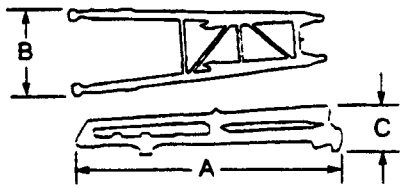
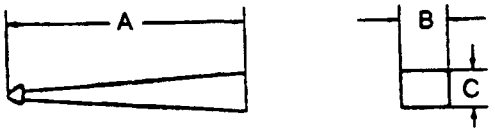
16. WEIGHT & DIMENSIONS AT THE TIME OF DISASSEMBLY (STANDARD CRANE)

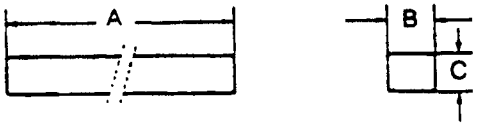
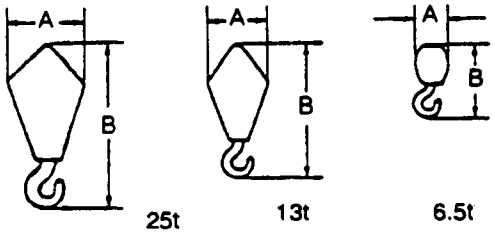
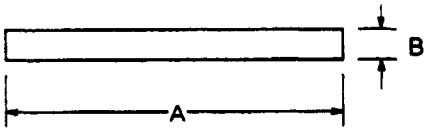
16-1 Base machine

Outline and posture	Weight, etc.
With counterweight 	Weight: Approx. 60.2 ton with A-frame and counterweight
Without counterweight 	Weight: Approx. 35.2 ton
Superstructure, axle and carbody 	Weight: Approx. 22.0 ton
Crawler frame assembly 	Weight: Approx. 6.8 ton x 2
Counterweight 	Unit: ton 1 Inner 5.0 2 Center 10.0 3 Outer 9.5 Total 24.5

16-2 Luffing jib and luffing tower

Each value is approximate

	Outline (dimension) drawing	Symbol	Dimension & Weight		
Inner Boom		A	6.8m		
		B	1.5m		
		C	1.7m		
		W	1.5t		
Tower Top	 When sub strut is housed	A	3.9m		
		B	1.5m		
		C	2.3m		
		W	1.5t		
Insert Boom			3m Insert	6m Insert	9m Insert
		A	3.1m	6.1m	9.1m
		B	1.5m	1.5m	1.5m
		C	1.5m	1.5m	1.5m
		W	0.26t	0.45t	0.65t
Outer Boom		A	6.0m		
		B	1.5m		
		C	1.5m		
		W	1.1t		
Strut	 When ABC struts are housed	A	4.2m		
		B	1.4m		
		C	0.8m		
		W	0.63t		
Tower Inner Jib		A	4.6m		
		B	1.1m		
		C	0.9m		
		W	0.32t		
Tower Outer Jib		A	5.8m		
		B	1.1m		
		C	0.9m		
		W	0.4t		

	Outline (dimension) drawing	Symbol	Dimension & Weight		
Tower Insert Jib			3m Insert	6m Insert	
		A	3.1m	6.1m	
		B	1.1m	1.1m	
		C	0.9m	0.9m	
		W	0.15t	0.25t	
Hook			25 ton hook	13 ton hook	6.5 ton hook
		A	0.62m	0.64m	0.28m
		B	1.40m	1.3m	0.58m
		C	0.25m	0.3m	0.28m
		W	0.50t	0.45t	0.25t
Stabilizer		A	5.2m		
		B	0.3m		
		W	0.66tf (2 lines)		

16-3 Weight of wire rope

Name	Dimension	Weight (kgf)	Remarks
Load hoist rope	Ø 22.4 x 230m	485	Mono-rope EP
Boom hoist rope	Ø 16 x 168m	190	
Jib hoist rope	Ø 20 x 100m	186	
Boom suspension rope (Ø 34.0)	1.6m	24.0	For boom end
	3.0m	32.0	For insert boom
	6m	47.0	
	9m	63.0	
Strut suspension rope (Ø 31.5)	2.5m	25.0	For boom end
	1.5m	19.0	Equalizer side
	3m, 6m, 9m	26.0, 39.0, 52.0	For insert boom
Jib suspension rope (Ø 28)	3m	17.0	For inner and outer
	4.5m	23.0	
	6m	28.0	

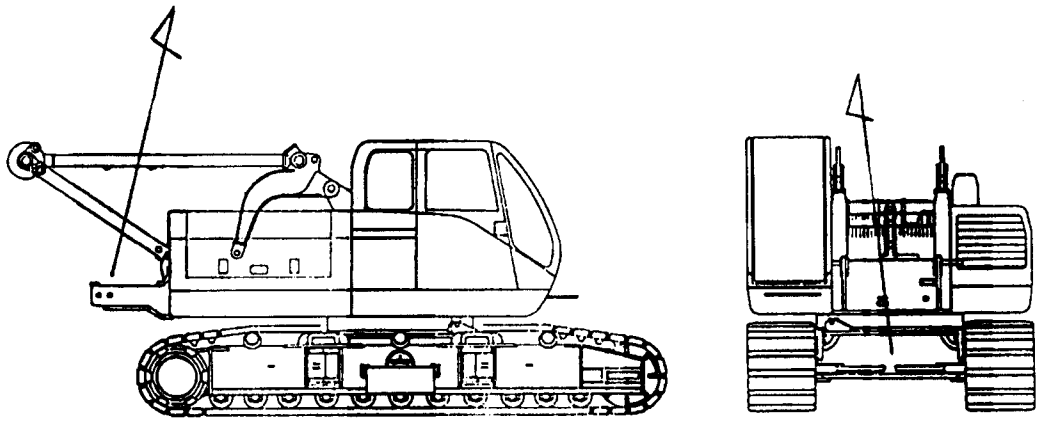
17. PRECAUTIONS FOR TRAILER TRANSPORTATION

17-1 Precautions and posture before loading on a trailer

1. Remove the front attachment.
2. Remove the counterweight.
3. Lower the high A-frame. Wind the boom hoist rope around the drum to some extent and set the equalizer on the gantry.
4. Wind the tower jib hoist rope around the jib hoist drum or remove it toward the middle equalizer side to bundle on the inner boom beforehand
5. Retract the crawler to set the proper posture for loading on a trailer.
6. Prepare a trailer with more capacity than the machine weight.

⚠ WARNING

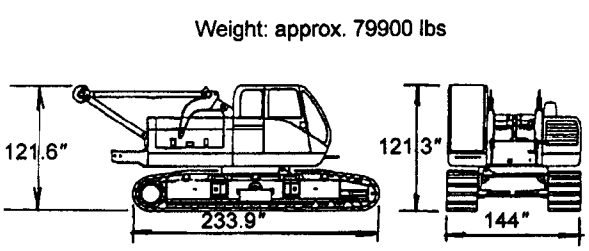
1. **Remove the counterweight when loading on a trailer. If equipped with a counterweight, the machine may tip over on a ramp board because the center of gravity is on the rear.**
2. **If the trailer with the machine exceeds the allowable loading weight, it cannot drive on public ways.**
3. **Change the crawler width (by extension or retraction) without counterweight.**
4. **After retracting the crawler, perform swinging or traveling carefully, at a low speed.**



Weight without counterweight: Approx. 34.7 tons

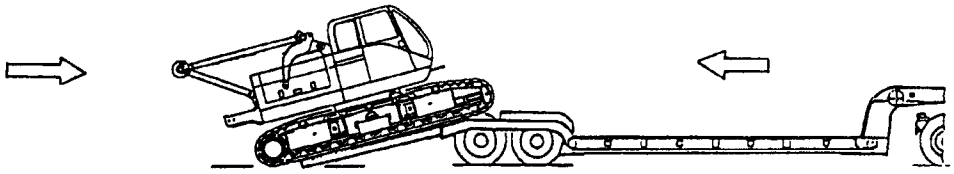
17-2 Trailer operations for going up or down on ramp board

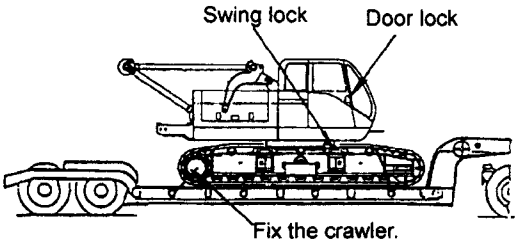
Set the trailer on level ground, apply the parking brake and set the stopper for the tires. The ramp board angle should be approximately 15°. If the angle is too low, the ramp board length is too long. If the angle is too large, it is dangerous when the center of gravity for the crane is moved.



Set the machine in the forward direction and apply the swing lock accurately. The traveling speed should be low, but not enough to hinder the machine from going up or down.

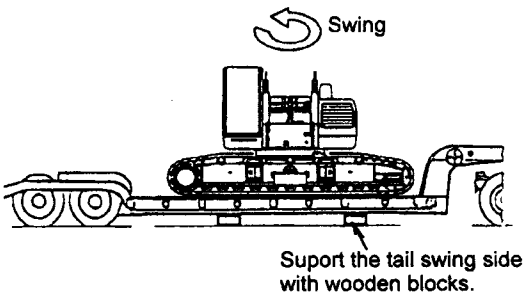
Don't steer the machine while on the trailer or the ramp board. Center the machine and trailer on the ground before going on the ramp board.





When steering while going up on the ramp board, get off the board, change the direction on the ground and get on the board again. Fix the machine on the trailer with a wire rope or chain to prevent its shift during transportation. Make sure that the swing lock is applied.

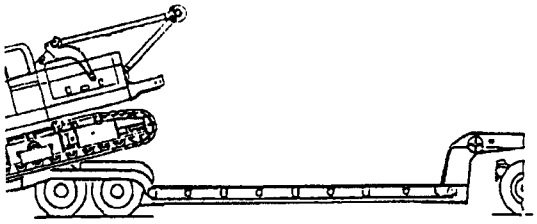
Check the lock condition so that the operator's cab, rear door or side door may not open. When swinging the machine on the trailer, set the wood plates between the trailer frame and road to prevent the trailer from being inclined.



⚠ WARNING

Don't change the direction of or swing the machine while going up or down on the ramp board. The machine may tip over or drop.

When unloading from the trailer, set the superstructure to the front side. If the rear side is unloaded first, the machine may tip over when going to the inclined surface.



Section 3

MAINTENANCE

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1. GENERAL CAUTION ON MAINTENANCE

1. **Precautions for handling battery**

⚠ WARNING

The battery electrolyte is diluted sulfuric acid. If it is adhered to the skin, it will cause a burn. If the eye is splashed with it, eyesight may be lost. Moreover, nitrogen gas is generated during or right after the engine revolution. If fire is near the electrolyte, an explosion may occur. Be careful about the following items:

1. **Attach the battery cable or booster cable from the positive terminal and remove it from the negative terminal to avoid sparking.**
2. **If your eye is splashed with the battery electrolyte, wash the eye at once and then see a doctor.**
3. **Don't set a fire near the electrolyte and don't perform charging or start with other power supply while the electrolyte is frozen. The generated gas cannot be discharged and an explosion is caused.**
4. **When handling the battery, wear protective glasses, protective gloves, etc. Don't put a tool or other item on the battery so as to prevent spark.**

2. **Check of wire ropes and sheaves**

⚠ WARNING

Inspect the boom hoist rope, load hoist rope and slings and replace them if any of the following deficiencies are found. Inspect before starting and monthly. If the boom hoist rope is broken and the boom falls, a serious accident will occur. If the load hoist rope or sling rope is broken, a load falling accident will occur.

1. **Check if the connection is proper at the rope end, if the rope is spooled and if the rope is worn or damaged before starting.**
2. **Check the rope for specification, length and oil shortage in the monthly check. Check if the rope is in the following status:**
   a. **The diameter is reduced by 7% or more of the nominal diameter.**
   b. **More than 10% of the wires (except fillers) are broken within one lay of the rope.**
   c. **The rope has kinked.**
   d. **The rope has been significantly deformed or corroded.**

⚠ CAUTION

Check if the sheave and hook block are damaged or worn. If the sheave is broken, the wire rope will be cut. If the hook is broken a serious accident such as load dropping will occur.

1. **Sheave**

   Check if the sheave is damaged or cracked, if the groove and flange are excessively worn, if the bearing is normal when turning the sheave, if the suspension is good, if the protective metal is damaged, deformed or loosened.

   - **When the rope diameter is 25mm or more, the sheave groove must be within "standard bottom dia. - (rope dia. x 0.2)". When the rope diameter is less than 25mm, it must be within "standard bottom dia. - (rope dia. x 0.3)".**
   - **The sheave should not be cracked, worn or deformed excessively.**
   - **The wear of the bearing or pin should be within 0.15% of the original dimension, that of the bushing hole should be within 2.0% of the original diameter, and that of the bushing or pin should be within 0.6% of the original diameter.**
   - **The oil supply should be sufficient and done properly.**

2. **Hook block**

   - **Check if the hook block is damaged, if the rope stopper is deformed or damaged and if the contact section with rope is worn excessively.**
   - **Check if the bolts, nuts or pins are loosened or lost. The wear of the hook wire contact section should be within 3%. The hook opening should not be worn, deformed or damaged. The bearing should not be damaged, and oil should be supplied to the bearing sufficiently.**

3. **Engine stop for check**

⚠ WARNING

Stop the engine before checking the fan belt or fan to prevent your hand from being caught. Stop the engine before checking the rotary sections.

4. **Maintenance of safety devices**

⚠ CAUTION

The following shows the causes for the malfunction of the hook overhoisting prevention device, boom overhoisting prevention device and other safety devices.

1. **The electric current is not good due to the deterioration of electric cables. The cables are disconnected. The cables are imbued with water.**
2. **The electric equipment such as the limit switch is bad. Other components are deteriorated. The voltage drops.**
3. **Improper check or adjustment.**

When removing the electric cables, set the waterproof cap to prevent water through the terminals. Measure the electric current and insulation resistance periodically. Replace the cables if necessary. Overhaul the overhoisting prevention devices every 2 years. Replace them if necessary.

CAUTION

5. **Parts requiring periodic replacement**

   Replace the hydraulic hose for hoisting clutch and brake system periodically.

   1. **Clutch and hydraulic hose of the brake system ..... Replace every 2 years**
   2. **Rotary joint, clutch cylinder and master cylinder..... Replace every 2 years**
   3. **Sheave and pendant wire rope..... Replace if it reaches the allowable limit or every 4 years**
   4. **Limit switches of safety devices and electric cables ..... Replace every 2 years**

   The parts which may cause a serious accident when deteriorated, must be replaced periodically. Immediate replacement is necessary if any abnormality is found on these parts, even before the periodic replacement time.

6. **Prevention of falling and other precautions**

WARNING

Use a safety belt to prevent a fall accident when working in a high place. Use a footing plate when working on the boom.

CAUTION

1. **If grease or oil remains on the cab, crawler or boom after greasing, a slip or fall accident may occur. Wipe off the residual grease or oil.**
2. **When adjusting or repairing the brake and clutch, lower the load and hook block on the ground and stop the engine. Lower the boom if necessary.**

7. **Precautions for handling radiator and others**

CAUTION

1. **The coolant temperature is high and pressure is applied in the radiator during engine revolution or right after engine stop. If the radiator cap is removed carelessly in such status, hot water will spout out and cause a burn. Stop the engine and wait until the coolant temperature is lowered properly. Then, discharge the inner pressure by turning the radiator cap slowly and remove the cap. Check and supply the coolant in the reservoir tank.**
2. **Don't touch the muffler or engine main unit during engine revolution or right after engine stop. You will be scalded by the high temperature.**
3. **Stop the engine before supplying the fuel to prevent fire.**

⚠ CAUTION

8. **Management of hydraulic fluid**

   Keep the contamination of the hydraulic oil within the specified value, NAS Class 12, to operate the solenoid valve and other hydraulic devices smoothly and to prolong their lives. Replace the elements such as the line filter or return filter periodically.

   1. **For a new machine, replace the elements after first 50 hours operation. When they are used for 50 hours, all the contaminants adhere to them in the circuit.**
   2. **Replace the elements every 250 hours after the first replacement.**
   3. **Don't let dust enter the circuit when repairing the machine, supplying the oil or replacing the elements.**
   4. **Drain away from the bottom of the hydraulic oil tank.**

9. **Precautions for handling electric cables**

⚠ CAUTION

When installing or removing the electric cables for the attachment or others, be careful about the following points for handling the power supply and connectors. If the cables are damaged or imbued with water, the moment limiter and other safety devices do not operate correctly. It is dangerous.

1. **Before plugging or unplugging a connector, turn off the power switch. If not, the devices may burn out or malfunction.**
2. **Prevent the joining section of a connector from touching water or mud.**
3. **Attach a cap to prevent water from touching connector when unplugging.**
4. **Don't stamp, pull or catch forcibly a connector or cable.**

10. **Others**

⚠ CAUTION

Check the switches and the electric sections of the safety devices for corrosion, mounting status and operating status periodically. Replace them if necessary.

NOTICE

Use the genuine parts of American Crane Corporation when replacing parts or repairing a machine.

11. **Relationship between hour meter reading and calendar**

The hour meter reading should be related to the calendar time span with reference to the table below.

Hour meter reading (hour)	Calendar time span	Hour meter reading (hour)	Calendar time span
4	Half day	250	1 month
8	1 day	500	2 months
50	1 week	1000	4 months
100	2 weeks	1500~2000	6 to 12 months

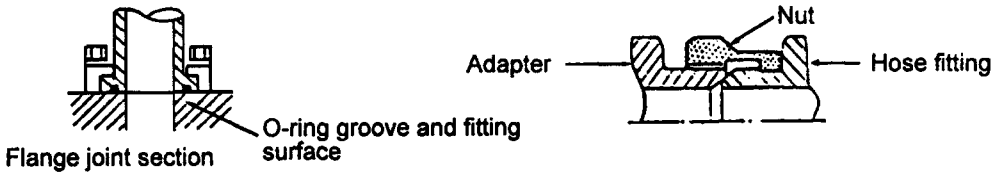
12. Handling of hydraulic equipment

⚠ WARNING

Before disassembling the hydraulic hoses or equipment, remove the residual pressure from the circuit. If not, you may be injured by the spouting oil or scattered part.

⚠ CAUTION

1. **Never disassemble the hydraulic pump, hydraulic motor, control valve, or relief valve. Do not tamper with the adjusting parts of hydraulic equipment.**
2. **Carefully handle the hydraulic equipment so that foreign materials such as dust will not enter inside.**
   a. **Clean the equipment and surrounding area.**
   b. **Do not remove the dust preventative plug of the joint section before assembly.**
   c. **Be sure to wash the tube and hose before connecting them.**
3. **Carefully handle the connections of hydraulic equipment parts so as not to damage them.**



4. **Do not fit the high-pressure hose in a twisted state. Otherwise, its service life will be shortened significantly.**
5. **If the union nut of the high-pressure hose is tightened beyond the specified torque, the caulking portion may be deformed and disabled for use. So, observe the specified torque.**
6. **Tighten the four split flange fastening bolts of hydraulic piping to the same torque for preventing oil leakage.**
7. **If you determine a repair to be too difficult, contact American Crane Service Department.**

13. Retightening

To prevent accidents due to loosened bolts, tighten the bolts of principal sections to the specified torque.

14. Lubrication

1. For lubrication, it is important to use clean oil and grease and take care not to allow the entrance of dust during injection.
2. When the machine is used under severe conditions, lubrication frequency should be increased.
3. Carry out lubrication on safe and level ground.
4. Use oil and grease of the same brands, avoiding mixture of different brand lubricants where possible.

2. PERIODIC MAINTENANCE TABLE

Periodic checking is most important to operate the machine safely and demonstrate its performance fully. Take special care when using the machine under severe conditions.

▲ = First time ❑ = Periodic time
✻ = See "Remarks" column

Maintenance Position		Maintenance/ Inspection	Daily	50h (1 week)	250 h (1 month)	1000h (4 months)	1500~ 2000h (6~12 months)	Remarks
Operation Device	Lamp, meter, moment	Indication	❑					
	Switch	Operation	❑					
	Lever, pedal	Operation	❑					
Clutch	Main hoist, auxiliary hoist Third drum (only in A-specification	Oil or water adhere check	❑					
		Operation	❑					
		Adjusting		▲	✻			Adjustment according to clutch force
		Lining				✻		Replacement according to wear condition
		Hydraulic cylinder					✻	Replacement as required
Brake	Main hoist, auxiliary hoist, Swing (disk) Third drum Traveling (disk)	Oil or water adhere check	❑					
		Operation	❑					
		Adjusting		▲	✻			• Adjustment according to brake force • Excluding the travel/swing brakes
		Lining				✻		Replacement according to wear condition
		Hydraulic cylinder				✻		Excluding swing brake
Lock	Main hoist drum	Operation	❑					
	Auxiliary hoist drum							
	Third drum, boom drum	Hydraulic cylinder					✻	Replacement as required
	Swing	Operation	❑					
Hydraulic Equipment	Hydraulic fluid tank	Oil quantity and cleanliness	❑					
		Tank water removal			❑			
		Oil replacement & tank cleaning					✻	Replace regardless of specified time when oil is contaminated
	Third drum	Oil quantity check	❑					
	Oil reservoir	Oil replacement				❑ 500h		
	Master cylinder	Inspection				❑		For third drum
	Return filter, line filter	Element replacement		▲	❑			
	Air breather	Filter cleaning		▲	❑			
	Accumulator	Gas pressure check				❑ 500h		
		Gas charging					✻	Replace or recharge as required
Reduction	Main drum (left & right) Third drum (Jib drum) Boom, Swing, Travel	Oil replacement			▲	❑		
Tightening Bolt		Tightening bolt check	❑					
		Retightening		▲	❑			
	✻Main tightening bolt	Retightening		▲	❑			See periodic tightening points in this chapter

Maintenance Position		Maintenance/ Inspection	Daily	50h (1 week)	250 h (1 month)	1000h (4 months)	1500~ 2000h (6~12 months)	Remarks
Safety devices	Over-loading	Operation	❑					
	prevention device	Actual load adjustment			❑			
	Boom or tower jib overwind prevention	Operation	❑					
	device (boom hoist	Operating angle adjustment			❑			
	throwout)	Microswitch					❋	Replace as required
	Boom (or tower jib) back fall stopper	Set condition check	❑					
	Hook overhoist	Operation	❑					
	prevention device	Microswitch					❋	Replace as required
	Boom (or tower jib) over-hoisting prevention device, Max. working radius stop device	Operation check			❑			
Engine	Fuel tank	Residual fuel check, supply	❑					
		Water drain			❋			Drain water as needed
	Oil pan	Oil quantity check, supply	❑					
		Oil replacement			❑			
	Battery	Liquid quantity check	❑					
		Liquid density check			❑			
		Terminal cleaning, oil supplying						
	Radiator	Cooling water quantity and dirt check	❑				❋	Replace as required
Travel unit	Crawler belt	Shoe pin pulling out check	❑					
		Belt adjustment		▲	❋			Adjust according to soil condition
	Upper/lower rollers, front idler	Oil leak check	❑				❋	Oil replacement as required
Hydraulic Equipment	Hydraulic equipment	Oil leak check	❑					
	Hydraulic	Oil leak check	❑					
	pipe	Hose crack & rubbing check	❑					
Grease supply point								See lubrication
Attachment	Boom, auxiliary jib, tower	Connection pin & lock pin check	❑					Report damage to Dealer/ Factory
	boom, tower jib	Lacing bending & crack check	❑					Report damage to Dealer/ Factory
	Hook, sheave, grab bucket	Deformation & crack check	❑					Sheave must not exceed wear limit given in inspection guideline
	Wire rope	Socket, wedge, clamp, joint pin check	❑					
	Pendant rope	Wear, corrosion & lub. check	❑					
		Wire rope replacement					❋	Replace as required
	Electric	Wiring damage check	❑					
	wiring	Checking connectors for water	❑					

1. Maintenance should be carried out with reference to the total operation time read on the hour meter in the cab.
2. Lubrication:

   Check frequency should be increased when the machine is used under difficult conditions. Shortening the maintenance interval may be required.
3. Handling of hydraulic equipment:

   Never disassemble the hydraulic pump, motor, control valve, or relief valve. When disconnecting and reconnecting a hydraulic pipe, clean the pipe and its surrounding area in order to prevent foreign materials from entering the joint and pipe.
4. Retightening:

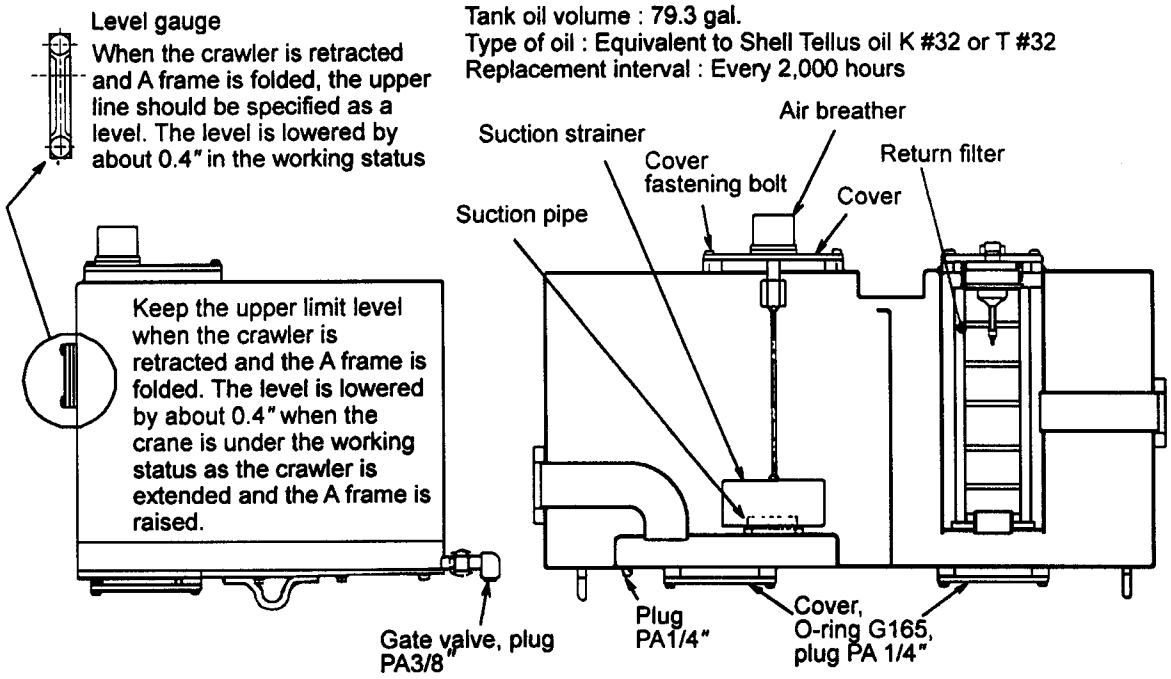
   To prevent an accident due to loose bolts in any principal section, the bolts should be retightened to the specified torque periodically.

⚠ CAUTION

1. **Set the machine on level ground, lower the attachments to the ground, stop the engine and then check or repair the machine in a safe manner.**
2. **When checking the safety devices, set the engine revolution at a low speed and keep a safe speed so as to be able to stop the machine as required.**

3. MAINTENANCE OF HYDRAULIC EQUIPMENT

3-1 Hydraulic oil tank



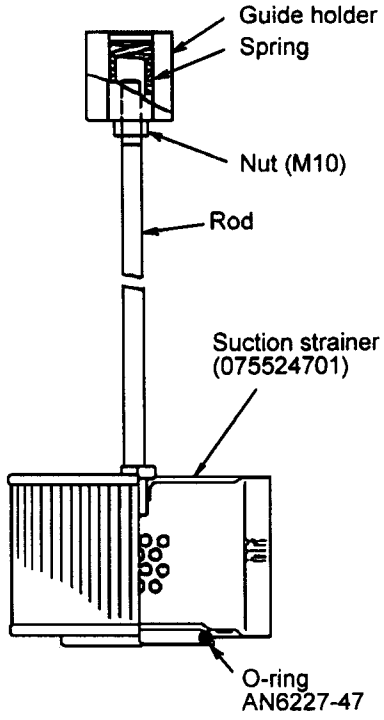
WARNING

A pressure of 60 to 85 kgf/cm^2 is built up in the control hydraulic circuit. After the engine has stopped, the circuit has a residual pressure for some time. If a hose, line filter or similar part is disconnected under a residual pressure, great danger may be caused. So, relieve the residual pressure, depress the brake pedal a few times. After the control circuit pressure gauge reads zero, disconnection is allowed.

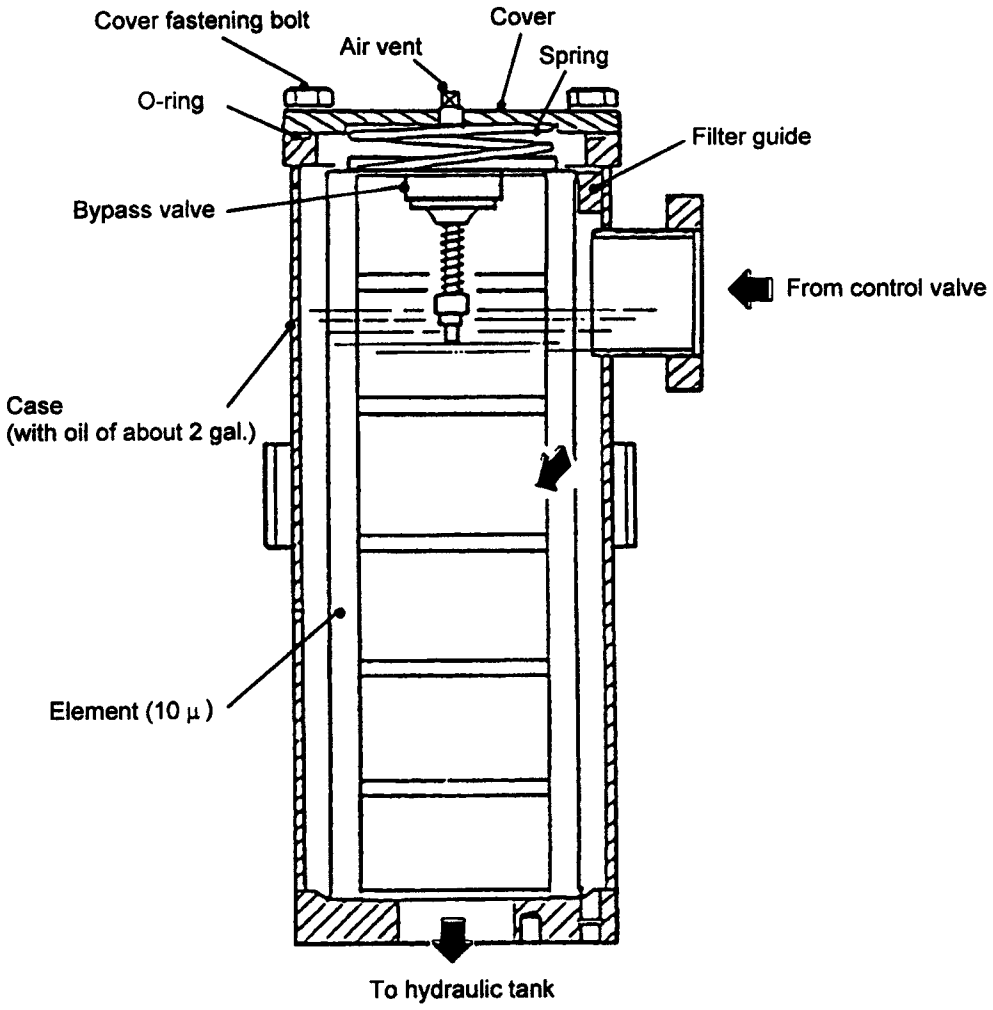
1. Water draining from the tank should be done before start of operation when water has settled down at the bottom. Loosen each plug of the lower cover and gate valve to discharge a little volume of water.

3-2 Suction strainer

1. Remove the cover fastening bolt at the top of tank and remove the cover.
2. Grip the guide holder and pull it out straight. Don't wash the O-ring with a volatile oil. Take care not to let the spring in the guide holder drop into the tank.
3. Mount the cleaned strainer in the tank. Fit the strainer to the suction pipe, paying attention to the O-ring.
4. Put the spring in the guide holder and fix the holder with the cover.



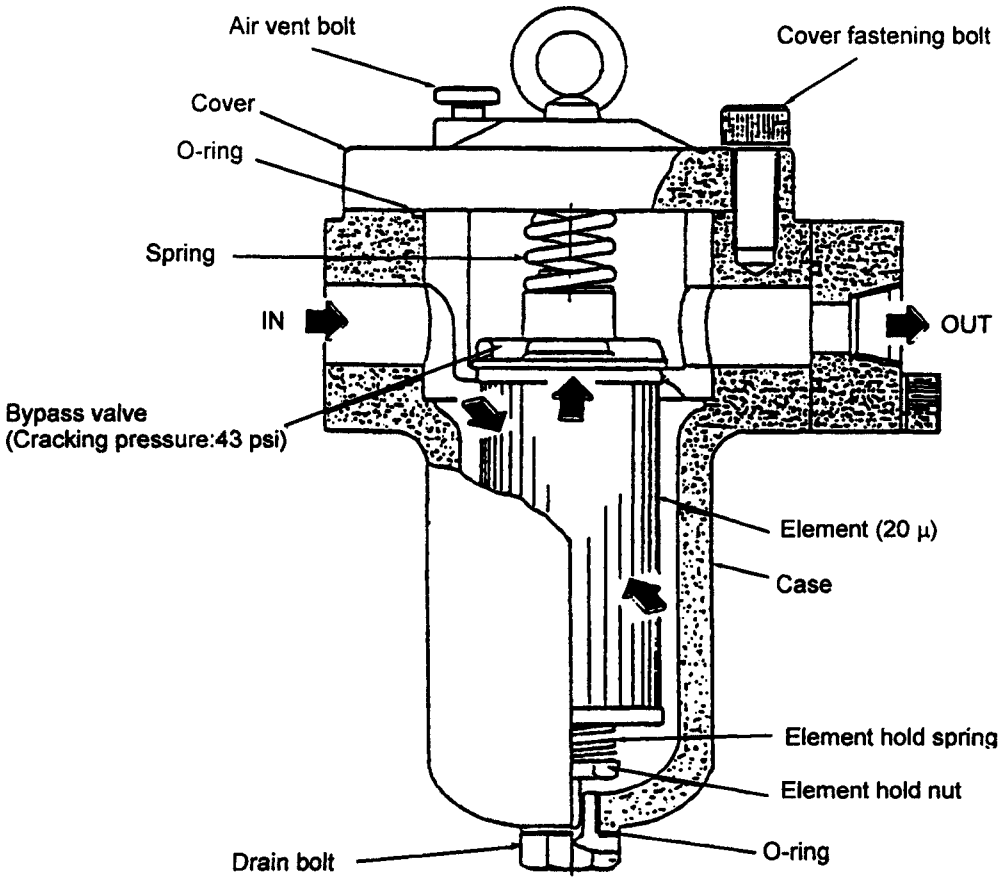
3-3 Return filter



How to replace filter element:

1. Stop the engine.
2. Loosen the air vent plug at the top. Then, tighten the plug.
3. Remove the cover fastening bolts and detach the cover.
4. Pull out the spring and bypass valve, and lift out the element. Remove dust from the case bottom.
5. Install a new element.
6. Mount the bypass valve and spring above the element.
7. Reattach the cover.
8. Start the engine and let the oil circulate at an idling speed.

3-4 Line filter (mounted beside the auxiliary winch reduction gear)



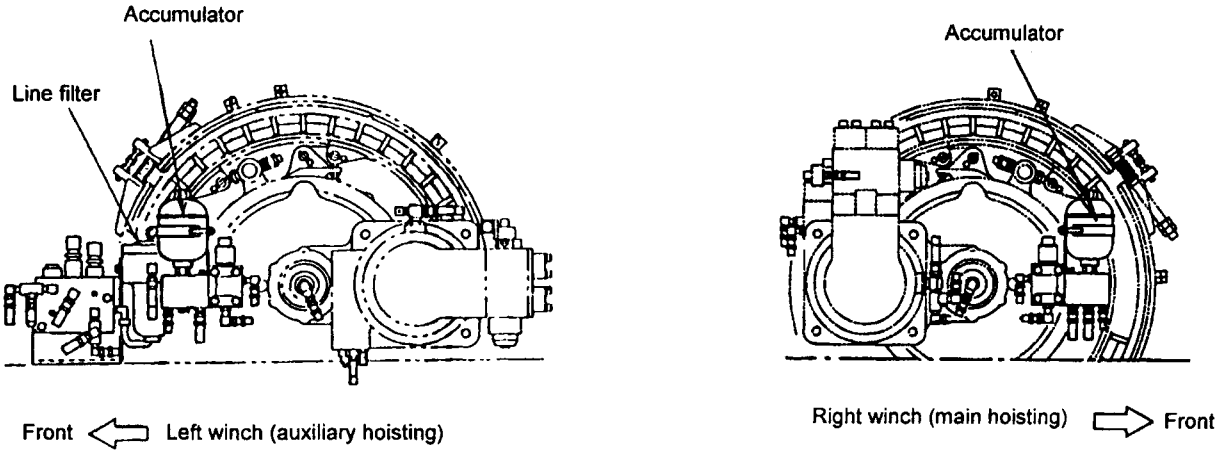
⚠ DANGER

After the engine has stopped, the pressure remains in the control (operation) circuit for a while. Operate the brake pedal or control levers until the pressure gauge of the control circuit shows "0" and then disassemble the machine. If the pressure remains, the oil will spout out to injure you during disassembly.

How to replace element:

1. Stop the engine and fully relieve the residual pressure from the circuit.
2. Clean the cover and case area.
3. Remove the cover fastening bolts and detach the cover.
4. Loosen the drain bolt at the bottom of case to discharge oil from the case.
5. Take out the spring, bypass valve, element, hold spring and nut in this order.
6. Clean the inside of case.
7. Replace the old element with a new one and reverse the above steps. The old O-ring should be replaced with a new one.
8. Start the engine and let the oil circulate at an idling speed.

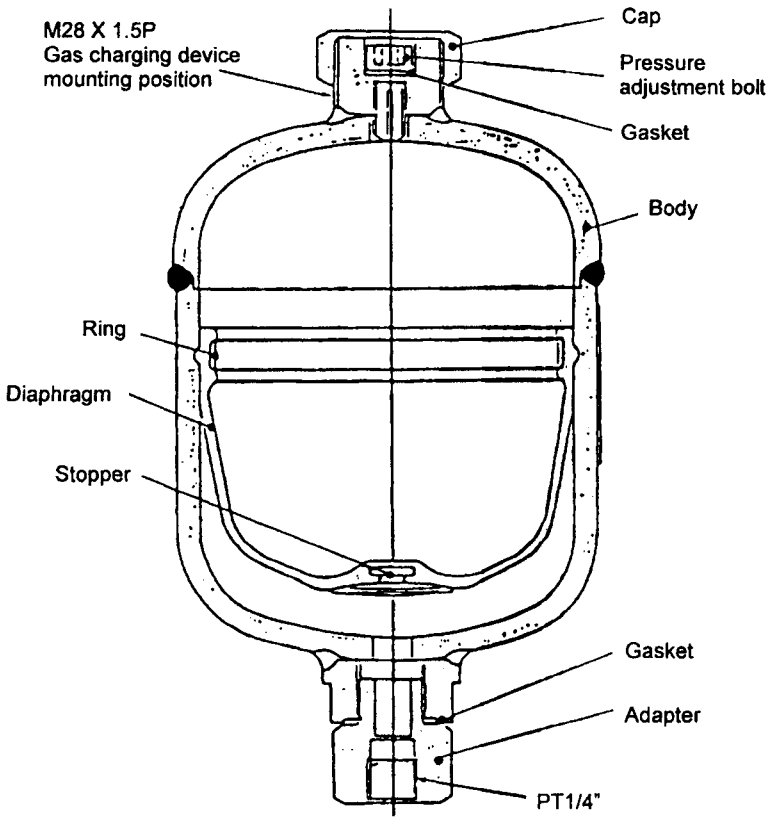
3-5 Accumulator



Line filter and accumulator mounting positions

Gas is charged in the accumulator at a pressure of 55 kgf/cm^2 (782 psi). When the gas pressure drops to about 45 kgf/cm^2, the nitrogen needs to be recharged. Ask your local service shop for gas pressure measurement and recharging.

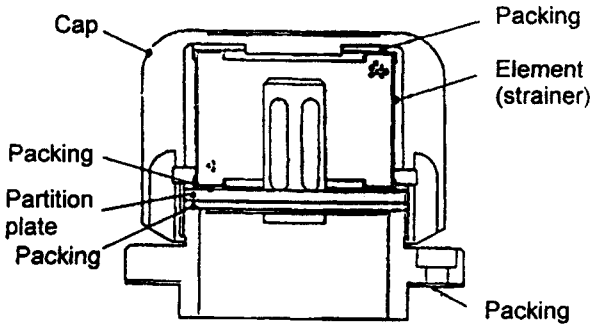
Nitrogen gas charging pressure	55 kg/cm^2 (782 psi)
Capacity	0.7 *l*



3-6 Air breather (mounted on the hydraulic oil tank)

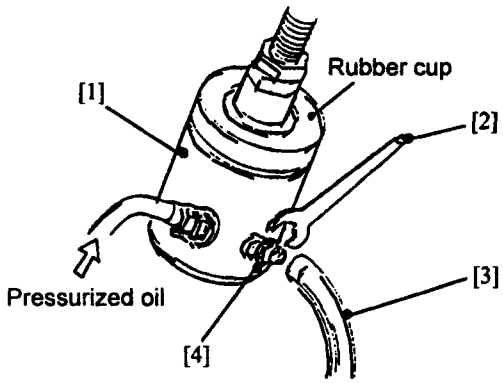
Air flows into and out of the tank through the strainer. When the strainer is clogged, a negative pressure is built up in the tank when the tank oil level falls. Once a negative pressure has built up in the tank, the suction performance of the hydraulic pump is degraded.

Clean the element every 500 hours.



Air breather

3-7 Clutch and brake cylinders



① Cylinder
② Wrench (size 10mm)
③ Vinyl hose (dia. 6mm x 1000mm)
④ Air bleeder

Air bleeding procedure:

1. Start the engine and set it at an idling speed.
2. Operate the clutch or brake to deliver oil to the selected cylinder ①.
3. Insert the transparent vinyl hose ③ into the air bleeder ④ and loosen the air bleeder gradually with the wrench ②.

   Bleed air until white bubbles are no longer discharged.
4. After completion of air bleeding, tighten the air bleeder firmly with the wrench.

NOTICE

1. **If the bleeder ④ is loosened suddenly. The vinyl hose ③ will be ejected, causing oil to be splashed. To prevent this, the bleeder should be loosened gradually while holding the inserted vinyl hose with the hand. In particular, exercise maximum care when bleeding air from clutches.**
2. **If oil leaks and sticks to the clutch lining, the clutch will slip. Therefore, if oil leakage is detected cylinder replacement or a similar measure is required.**

Oil leak check (monthly)

1. Locate the clutch spider so that the cylinder rod faces upward.
2. Remove the rubber cup shown above and check if hydraulic oil is collected.

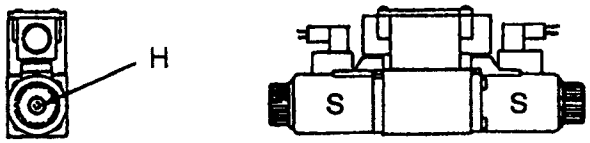
3-8 Manual operation of solenoid valve

Measure to be taken when the solenoid valve fails to operate normally due to an electric problem, etc.

Resetting method:

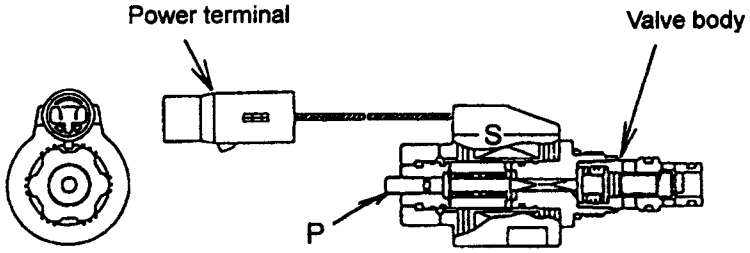
1. Push the manual operation pin if there is one.
2. If there is a pin hole for manual operation, push the pin inside the hole with a thin rod.
3. Turn the manual adjustment screw if there is one.

- Direction selecting solenoid valve

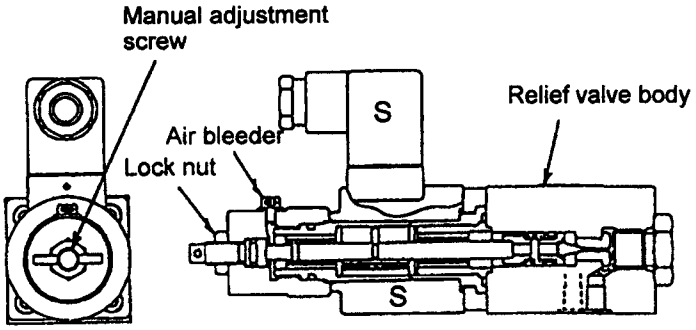


Note:
S = Solenoid valve
P = Manual operation pin
H = Manual operation pin hole

- Cartridge solenoid valve controlling hydraulic pump (flow regulation)

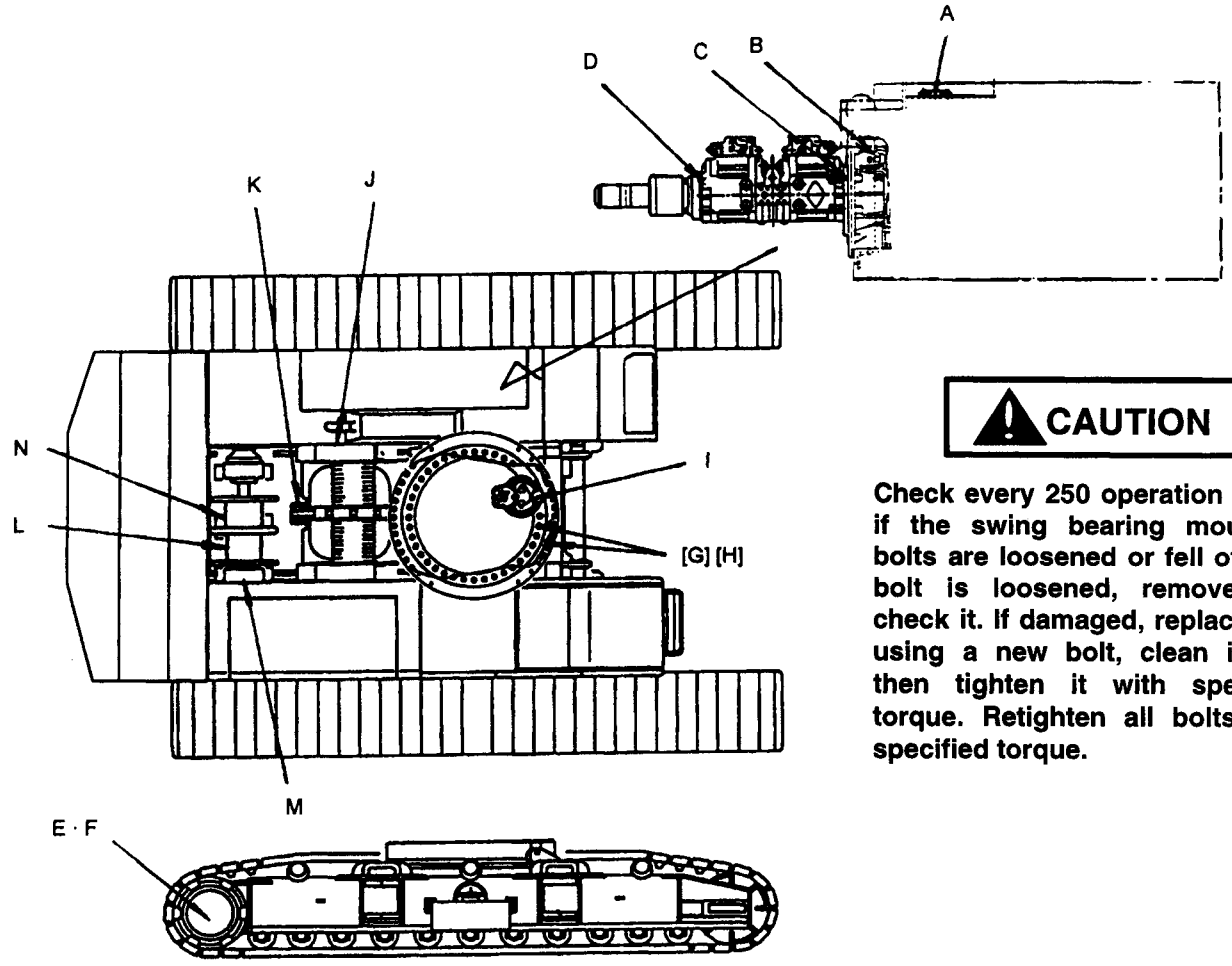


- Electromagnetic proportional relief valve controlling hydraulic pump



Pressure is set by turning the adjustment screw with the lock nut loosened. Normally, return the screw completely and be sure to tighten the lock nut.

4. PERIODIC RETIGHTENING POSITIONS AND TORQUES



CAUTION

Check every 250 operation hours if the swing bearing mounting bolts are loosened or fell off. If a bolt is loosened, remove and check it. If damaged, replace it. If using a new bolt, clean it and then tighten it with specified torque. Retighten all bolts with specified torque.

4-1 Tightening positions and torques

Symbol	Position	Bolt Size	Wrench Size	Q'ty.	Tightening Torque kgf/m	Ft/lb
A	Engine bed and frame	M20	30	8	46	330
B	PTO and flywheel housing	M	Bar	4	46	330
C	PTO coupling & hydraulic pump	M	30	4	46	330
D	Gear pump mounting	M	19	4	9.3	67
E	Travel reduction gear & drive tumbler	M	Bar	30	46	330
F	Travel reduction gear & crawler frame	M	36	22	73	530
(G)	Swing bearing	M	46	66	186	1350
(H)	Swing bearing mounting (tap)	M	46	8	148	1230
I	Swing reduction gear & turntable	M	24	18	21	150
J	Winch drum shaft & frame (left/right)	M	36	8	73	530
K	Winch drum shaft & frame (center)	M	46	8	OK	OK
L	Boom drum & frame	M	36	7	73	530
M	Boom motor & reduction gear	M	24	18	21	152
N	Jib hoist drum & frame	M	36	4	73	530

1. At the positions shown above, retightening is first required when 50 hours is on the hour meter after the new machine is delivered (or overhauled).

   Subsequently, retightening is required every 250 hours.
2. Check the circled positions routinely. If loose, retightening is required to the specified torque.
3. For the bolts and nuts other than in this figure, refer to the "Tightening Torque Table".

4-2 General tightening torque value (10T bolt)

Bolt Size	Spanner Size (mm)	Tightening Torque (kgf•m)	
		Metric, coarse-thread, heat treated bolt	Metric, fine-thread, heat treated bolt
M8	13	2.3	46
M10	17	4.8	73
M12	19	8.5	186
M16	24	21.0	148
M20	30	42.0	21
M24	36	73.0	73
M30	46	148.0	OK
M36	55	259.0	73
M48	71	628.0	21
M64	95	1505.0	73

High-pressure hose union nut	
Hose size (inch)	Tightening torque (kgf•m)
1/4"	2.5
3/8"	5.0
1/2"	6.0
3/4"	12.0
1"	14.0
1 1/4"	17.0

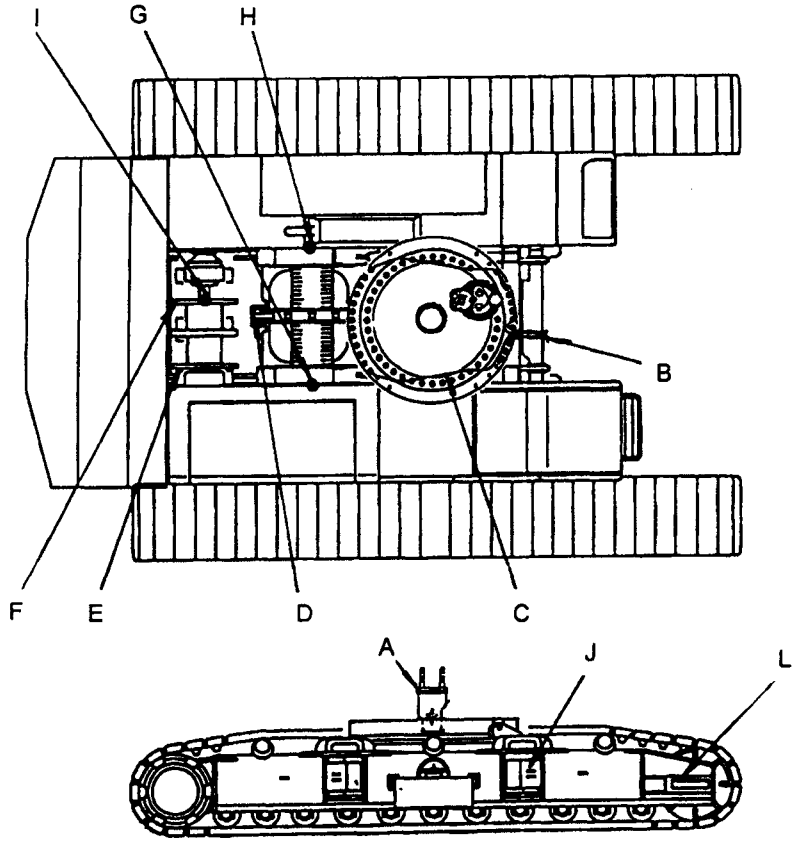
Pay attention not to damage the tapered area of the union nut.

In case any heat-treated bolt does not have torque specification, refer to the above table. For the bolt of SS400, about 30% of the above torque for the coarse-thread bolt should be a reference.

The tightening torque of bolts is specified to maintain the clamping force (bolt tension) for connecting two or more substances. Clean bolts and nuts and then tighten them. If the threaded part or washer is damaged, corroded or soiled, the torque will be decreased. When there are such problems, the necessary torque is not demonstrated even if tightening as specified, resulting in the bolt looseness.

5. GREASING POINTS

5-1 Base machine greasing points, etc.

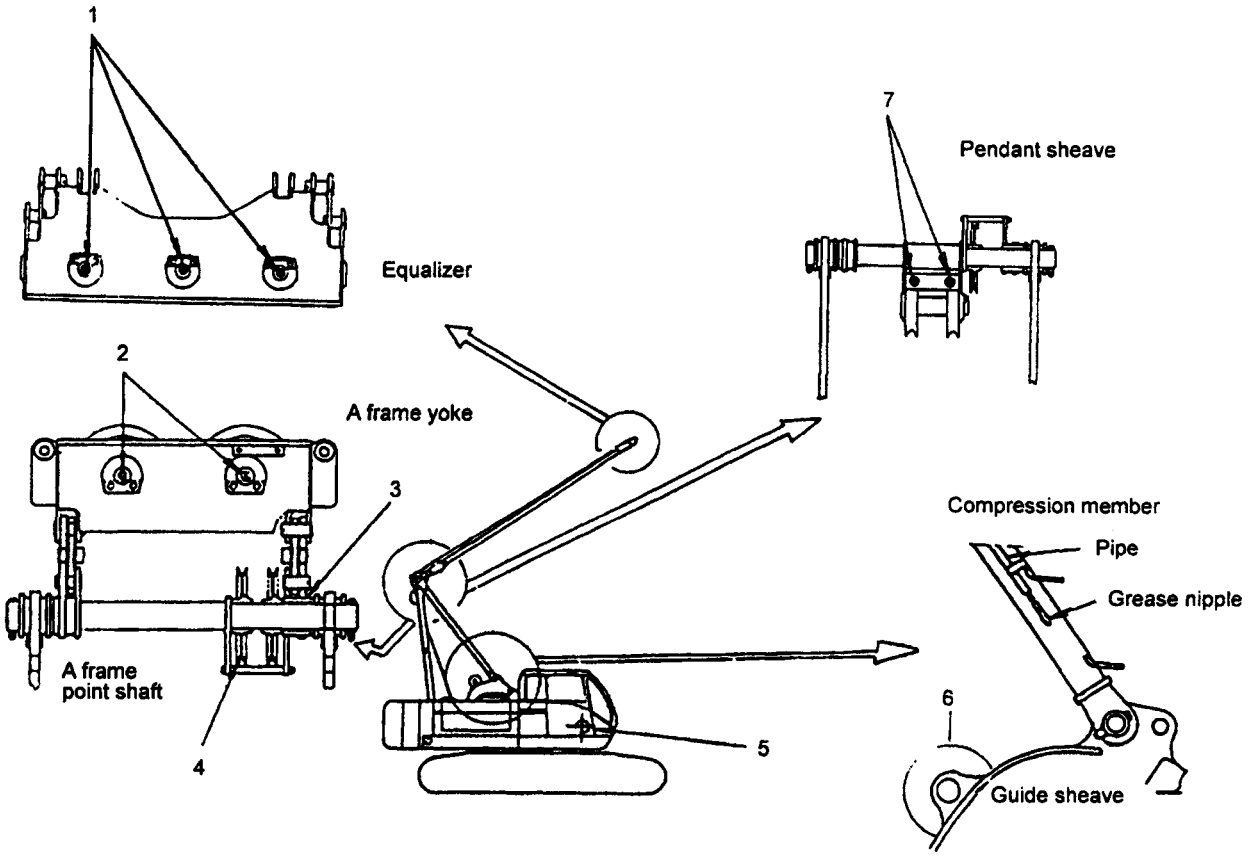


NOTICE

Carry out greasing until the old grease is pushed out. Wipe off the spilled grease. Grease or oil on clutch or brake pads can cause slippage.

Symbol	Position	Q'ty.	Interval	Remarks
A	Rotary joint	1	1000 hours	Small amount of grease
B	Swing bearing	4	250 hours or 1 month	Collective lubrication
C	Swing ring gear (grease bath)	1	1000 hours	About 9.2 gallons (35 *l*)
D	Main and auxiliary drum locks	1 ea.	1000 hours	Small amount of grease
E	Boom drum lock	1		
F	Jib hoist drum lock (third drum)	1		
G	Main drum clutch rotor	1		
H	Auxiliary drum clutch rotor	1		
I	Third drum clutch rotor (opt.)	1		
J	Extension axle pin	8	500 hours or 3 months	Grease
L	Idler shaft slide (left/right)	4	250 hours or 1 month	Coating with grease

5-2 Crane attachment



Symbol	Name	Greasing Point	Interval
1	Equalizer sheave	3	Lubrication type:
2	High A-frame yoke sheave	2	Greasing every 500 hours
			Non-lubrication type: Grease replacement through disassembly every 2000 hours
3	Yoke link bushing	2	8 hours or
4	Boom hoist slide sheave	1	1 day at
5	Boom foot pin	2	maximum
6	Guide sheave	1	250 hours or
7	Pendant sheave	2	1 month

The yoke shaft and connection link should be greased through the above grease pipe.

NOTICE

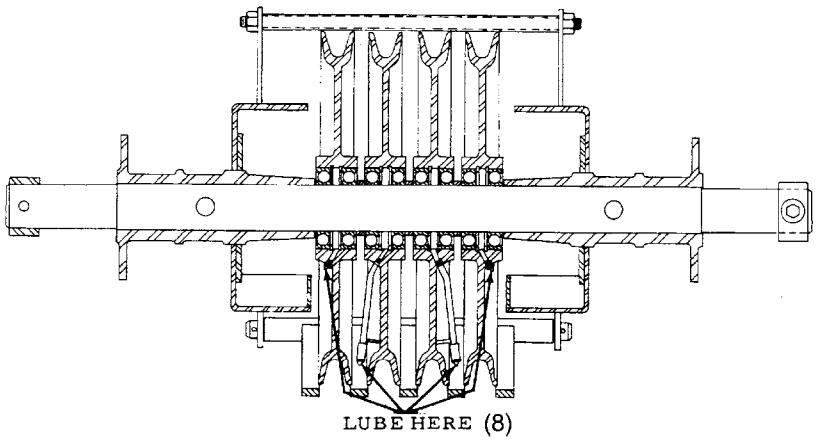
Sheaves are of either lubrication type or non-lubrication type. The lubrication type sheave requires greasing every 500 hours.

The non-lubrication type sheave requires replacement of the grease in the bearing every 2000 hours through sheave disassembly.

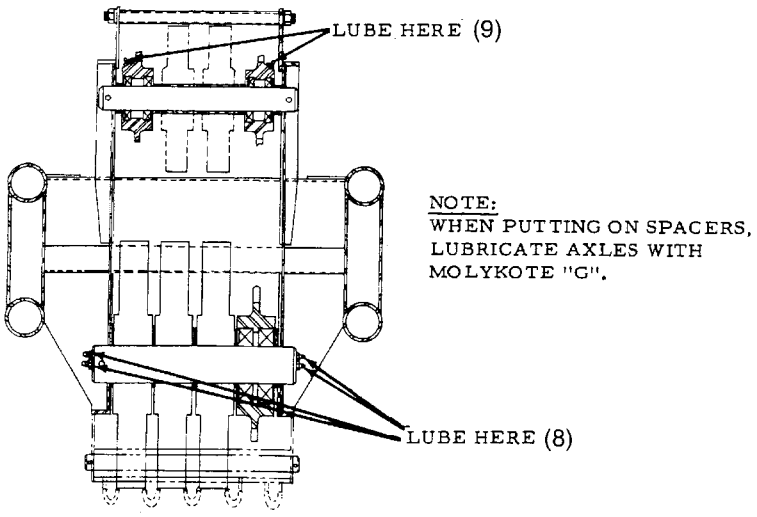
Grease used: EP #2

5-2 Crane attachment (continued)

46HI BOOM TIP



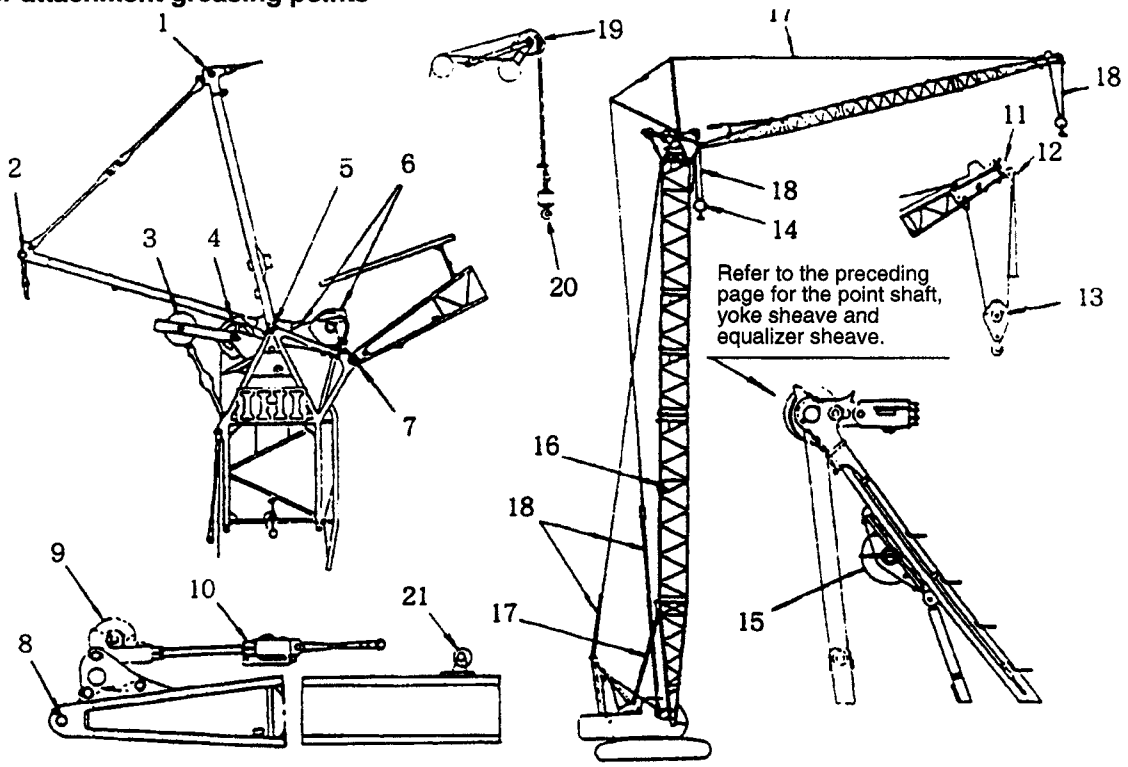
47HI BOOM TIP



Symbol	Name	Greasing Point	Interval
8	Boom tip main sheaves	As shown	Weekly
9	Boom guide sheaves	As shown	Weekly

Grease used: EP #2

5-3 Tower attachment greasing points



Symbol	Position	Q'ty.	Interval	Remarks
1	Strut A and load cell link pin	2		
2	Strut B and link pin	2	Every 100 hours or 2 weeks	
3	Strut suspension rope guide sheave	2	Every 500 hours	Apply grease
4	Hoist rope guide sheave	2	Every 500 hours	
5	Strut foot pin	2	Every 8 hours or every day	
6	Main hoist rope top sheave	5	Every 500 hours	
7	Jib foot pin	2	Every 8 hours or every day	Lubrication type:
8	Boom foot pin	2	Every 8 hours or every day	Apply grease every
9	Inner boom yoke sheave	4	Disassemble and apply	500 hours
10	Middle equalizer yoke sheave	4	grease every 2000 hours	
11	Jib point sheave	1	Every 500 hours	
12	Jib point guide roller	1	Every 500 hours	Non-lubrication type:
13	13 ton auxiliary hook	2		Disassemble and apply
14	25 ton main hook	2	Every 8 hours or every day	grease every 2000 hours
15	Jib hoist rope guide sheave	1	Every 500 hours	
16	Hoist rope guide sheave	2	Disassemble and apply grease every 2000 hours	
17	Stabilizer member	2	Every 250 hours or 1 month	Apply grease
18	Wire rope		Every 250 hours or 1 month	Apply grease
19	Tower boom jib point sheave	1	Every 500 hours	Lubrication type
20	Jib 6.5 ton hook	1	Every 8 hours or every day	
21	Insert boom guide sheave	2	Every 500 hours	

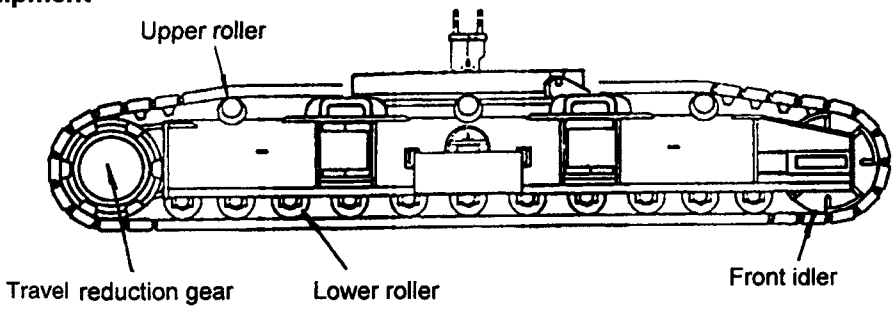
NOTICE

1. **Sheaves are either lubrication type or non-lubrication type. The lubrication type sheave requires greasing every 500 hours.**
2. **The non-lubrication type sheave requires replacement of the grease in the bearing every 2000 hours through sheave disassembly. Grease used: EP #2.**
3. **Apply grease to all the points when the attachment is disassembled and then reassembled.**

6. REPLACEMENT OF REDUCTION GEAR OIL, ETC.

Before oil replacement, move the machine onto level ground so that the exact quantity of oil can be known.

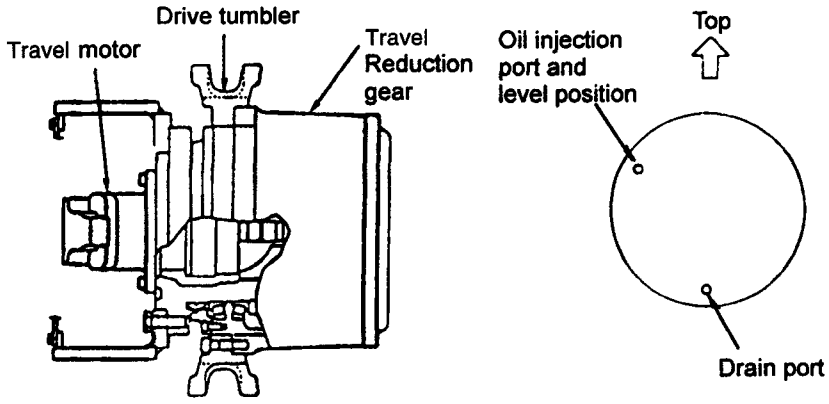
6-1 Travel equipment



Description	Type of oil	Capacity (*l*)	Replacement interval	
			First time	Thereafter
Travel reduction gear	Gear oil SAE #90 API GL-5	23 (one side)	250 hours	1000 hours
Front idler bearing	Engine oil SAE #30 API CD	0.37 (one side)		3000 ~ 4000
Lower roller		0.29 (per roller)		
Upper roller		0.11 (per roller)		

6-1-1 Travel reduction gear

Oil can be discharged easily when it is still hot, shortly after operation.



Park the machine on level ground so that each port is positioned as shown at left, and then discharge the old oil and fill new oil.

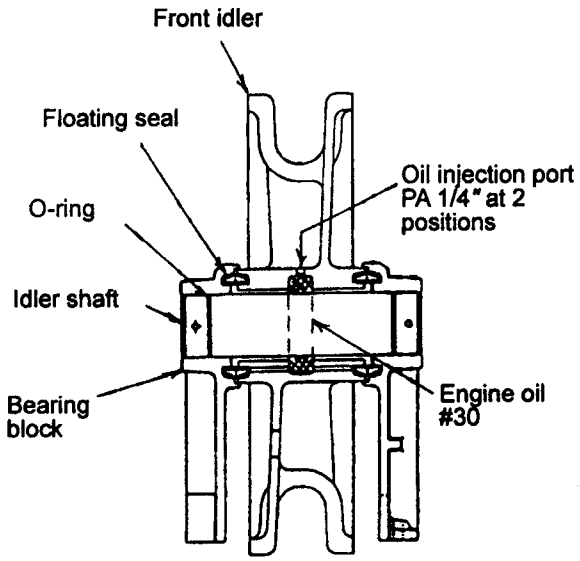
1. Move the machine onto level ground so that the oil filler and drain ports are positioned as shown above.
2. Remove the oil filler, level port and drain ports to discharge the old oil.
3. After fitting the drain port plug, fill gear oil through the oil filler port. When the oil overflows the level port, filler should be stopped.
4. Fit the oil filling port plug.

NOTICE

When the inside of the reduction gear needs to be cleaned, fill hydraulic oil or the like and turn the gear a few minutes under no load. After cleaning, fill gear oil. Never fill volatile oil. The volatile oil damages the seals and shortens the lives of other parts.

6-1-2 Front idler (left/right)

1. Position the two plugs of the idler vertically.

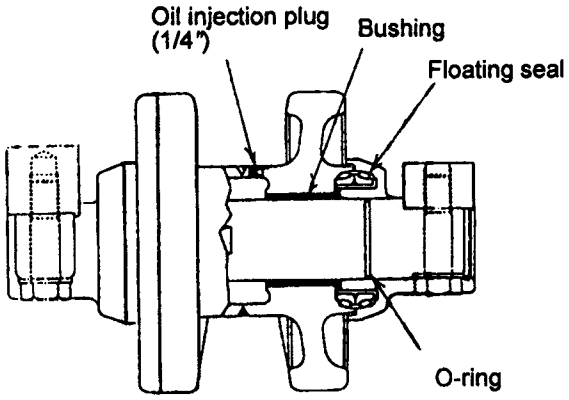


2. Remove the two plugs and discharge the old oil.
3. After discharging the oil, position the two plugs horizontally and inject new oil. Stop injection when oil flows out through the opposite plug hole.
4. Fit the two plugs securely.

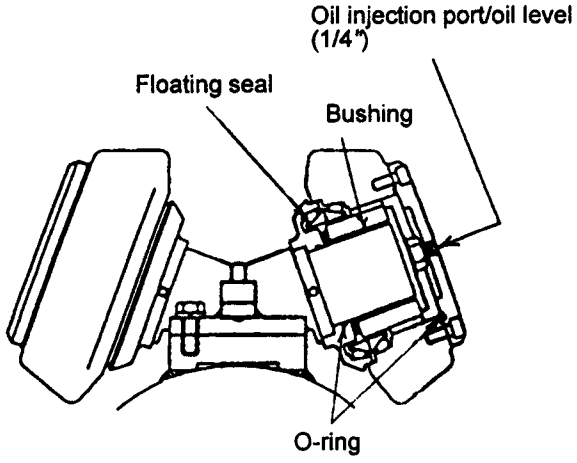
NOTICE

After oil injection, revolve the front idler by 5 turns and confirm the absence of oil leakage. If oil leaks, the floating seal must be replaced.

6-1-3 Upper roller and lower roller (upper x 12, lower x 22)



Lower roller



Upper roller

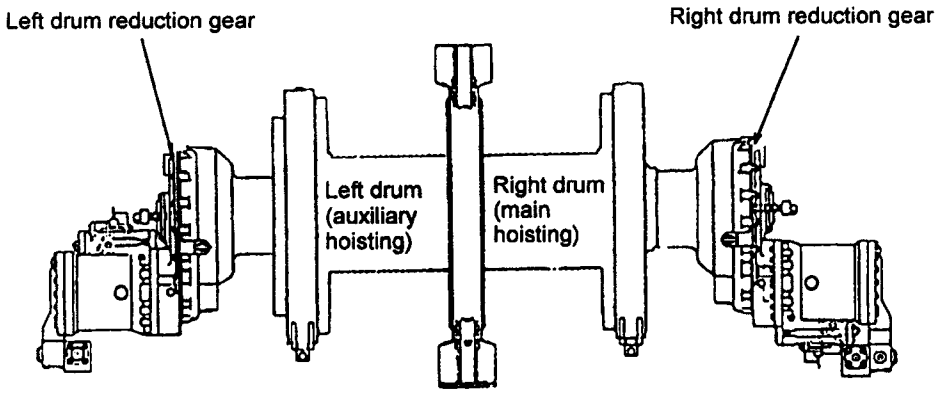
1. Remove the roller from the crawler frame.
2. Inject oil through the oil injection plug hole. (If oil cannot be injected smoothly, disassemble the roller, then inject oil again.)
3. Inject 290cc of new oil.
4. Fit the plug.

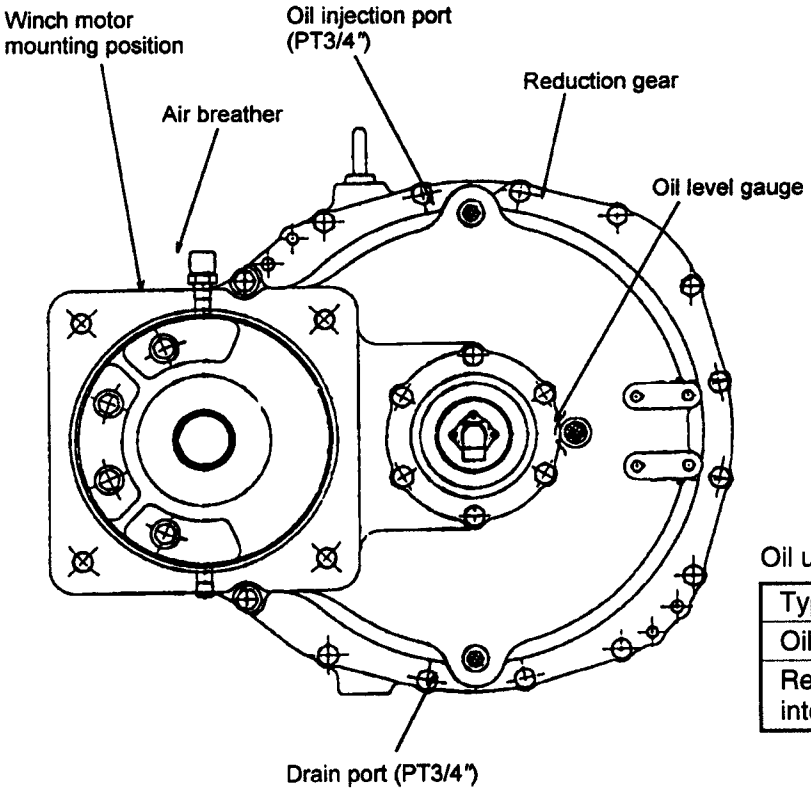
1. Remove the plug from the oil injection port.
2. Inject oil. Stop injection when oil overflows.
3. Fit the plug.

NOTICE

After oil injection, revolve the front idler by 5 turns and confirm the absence of oil leakage. If oil leaks, the floating seal must be replaced.

6-2 Winch reduction gear (left/right)





Oil used, etc.

Type of oil	SAE #90, API GL - 5
Oil volume	7 *l*
Replacement interval	Initially at 250 hours, subsequently every 1000 hours

Oil replacement

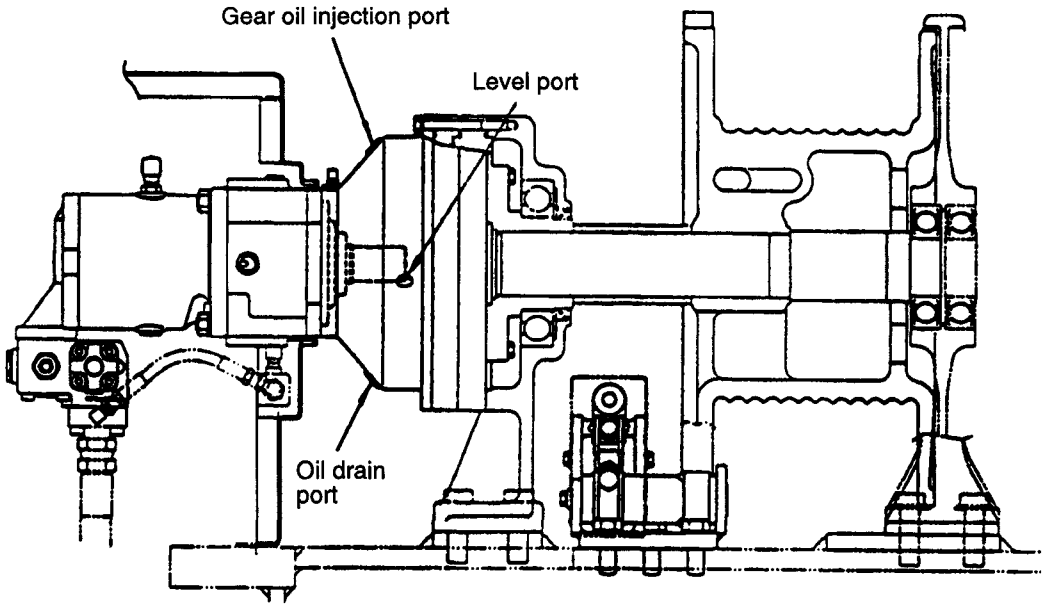
1. Remove each plug from the oil drain port and oil injection port and allow the old oil to flow out.
2. Fit the oil drain port plug.
3. Inject oil through the injection port. When the oil level has risen up to the center of the oil level gauge, injection should be stopped.
4. Fit the oil injection port plug.

- Make sure the air flow through the air breather is satisfactory.

6-3 Third drum

B-specification (Tower jib hoist drum)

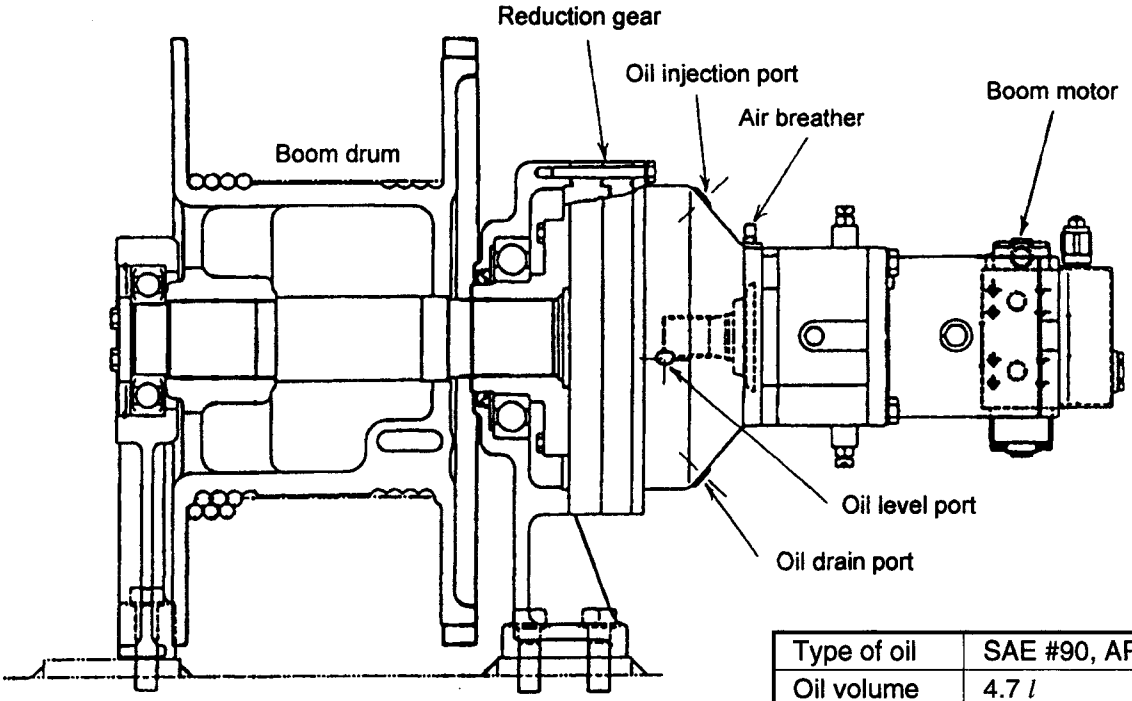
Type of oil	SAE #90, API GL - 5
Oil volume	4.7 *l*
Replacement interval	Initially at 250 hours, subsequently every 1000 hours



Oil replacement

1. Remove each plug from the oil injection port, oil drain port, and oil level port to discharge the old oil.
2. Fit the oil drain port plug and inject oil.
3. When the oil flows out through the level port, stop injection and fit the oil level and injection port plug.

6-4 Boom reduction gear



Type of oil	SAE #90, API GL - 5
Oil volume	4.7 *l*
Replacement interval	Initially at 250 hours, subsequently every 1000 hours

Oil replacement

1. Remove each plug from the oil injection port, oil drain port, and level port to discharge the old oil.
2. Fit the oil drain port plug.
3. Inject oil through the oil injection port. When the oil flows out through the level port, stop injection.
4. Fit the oil injection and level port plugs.

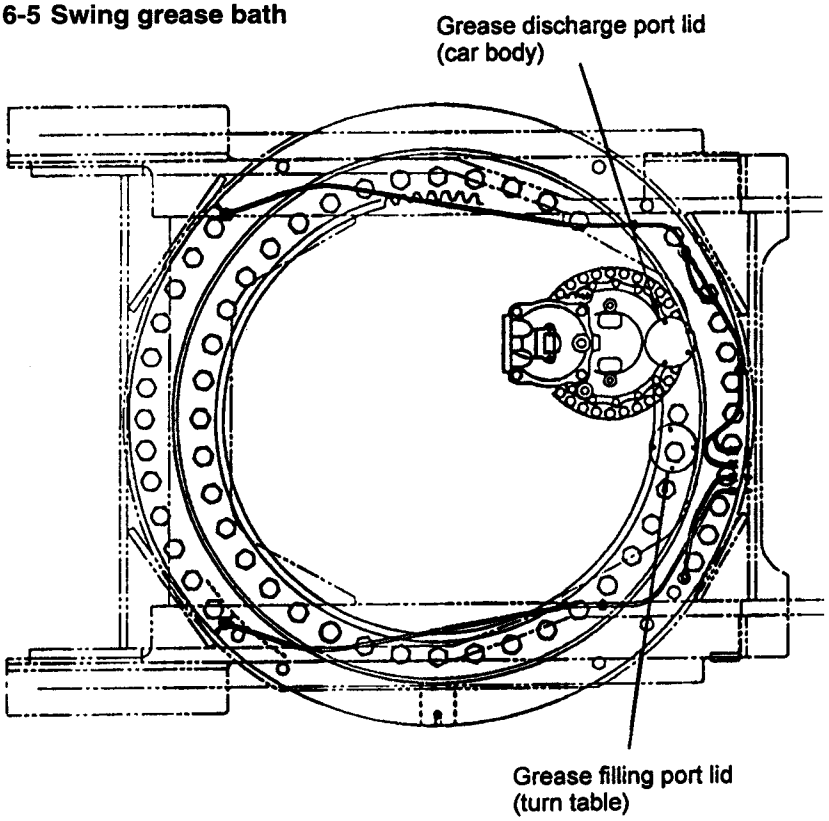
⚠ CAUTION

1. **When replacing the oil or performing other repairs, put the load on the ground, and lower the attachment to the ground if necessary. Then, stop the engine and show a label of "REPAIR" on the operator's cab.**
2. **Be careful not to spill the old oil when discharging it from the reduction gear. Wipe off the spilled oil to maintain the safety on footing and to prevent fire.**

NOTICE

1. **Use the specified oil when replacing at specified interval. If the drained oil has metallic powder which is different from the normal worn powder, the reduction gear must be checked.**
2. **Ask the industrial waste disposal expert to manage the drained oil.**

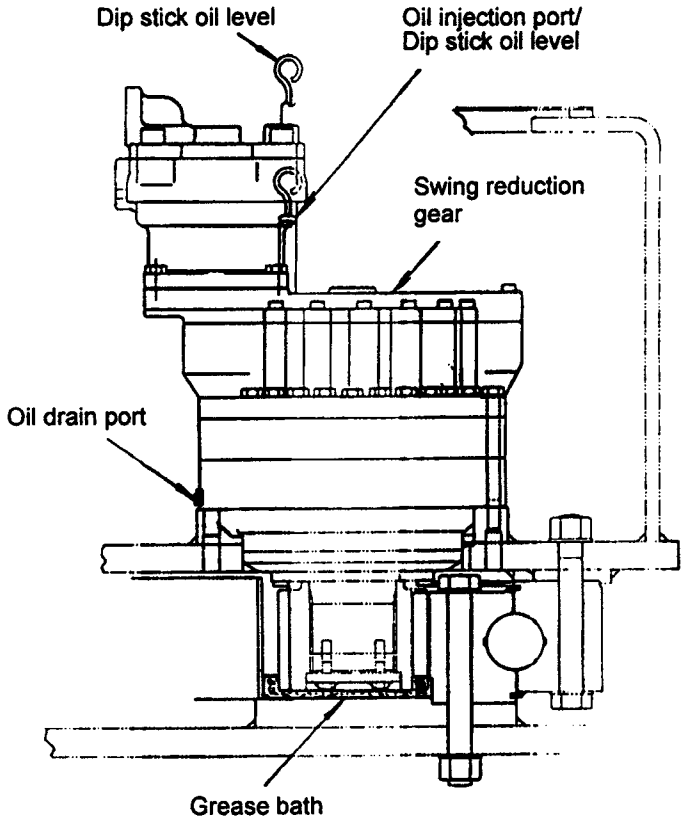
6-5 Swing grease bath



Grease	EP #2
Volume	36 *l*

1. Remove the grease discharge port lid to discharge the old grease. If the grease is not discharged smoothly, insert a rod or the like into the hole of the turntable and manipulate it so as to facilitate discharge.
2. Attach the discharge port lid and inject grease through the hole at the top of the turntable.
3. Inject grease in the determined quantity. Be careful not to inject excessively.
4. Perform a swing operation to make sure the grease is distributed to the ring gear and pinion.
5. Attach the injection port lid.

6-6 Swing reduction gear



Type of oil	SAE #90, API GL - 5
Oil volume	8 *l*
Replacement interval	Initially at 250 hours, subsequently every 1000 hours

1. Remove the oil drain port plug and oil level gauge to discharge the old oil.
2. Fit the oil drain port plug and inject oil through the oil injection port. Although an oil injection of 8 liters is needed, oil will overflow before reaching 8 liters of the old oil is not discharged completely. Inject oil up to the specified level with the aid of the level gauge.

7. LUBRICATION OIL TABLE

	Lubricating point	Required Volume	Replacing & Supplying time	Application	Designation	Shell	Esso Std. Oil	Mobil Oil
	Engine (Hino H07CT)	28 *l*	250 hours (Inspection every day)	For severe cold, less than -10°C	API-CD SAE-10W	Rimula Z oil 10W	Exxon D-3 10W	Delbac 1310
				For general -10°~40°C	API-CD SAE-30	Rimula Z oil 30	Exxon D-3 30	Delbac 1330
	Hydraulic oil (tank only: 300 *l*)	Total oil Volume 430 *l*	1500 hours ~ 2000 hours	Ambient temperature more than -5°C	ISO VG32, 46 Wear resistance	Tellus oil K32 Tellus oil ✶K46	Nuto HP 32 ✶HP 46	Mobil DTE oil 24 ✶DTE oil 25
Reduction Gear	Boom	4.7 *l*	1000 hours or every 6 months	For winter	API GL-5 SAE-80	Gelco oil 5080	Esso gear oil GX-80W 90	Mobilube HD 80W 90
	Main hoist	7 *l*						
	Travel	23 *l*		In general	API GL-5 SAE-90	Gelco oil 5090	Standard super gear oil 90	
	Swing	8 *l*						
	Third drum	4.7 *l*						
			100 hours ~ 150 hours	For winter	Gear Compound	Cardium Compound A	Surett fluid	Mobiltac MM.QQ.4
	Wire rope	--		In general		Cardium Compound D	N5K	
	Swing grease bath	36 *l*	1000 hours	--	EP-2 Lithium	Alvania EP grease 2	Lithtan EP2	Mobilux EP2
	Greasing point	--	--					

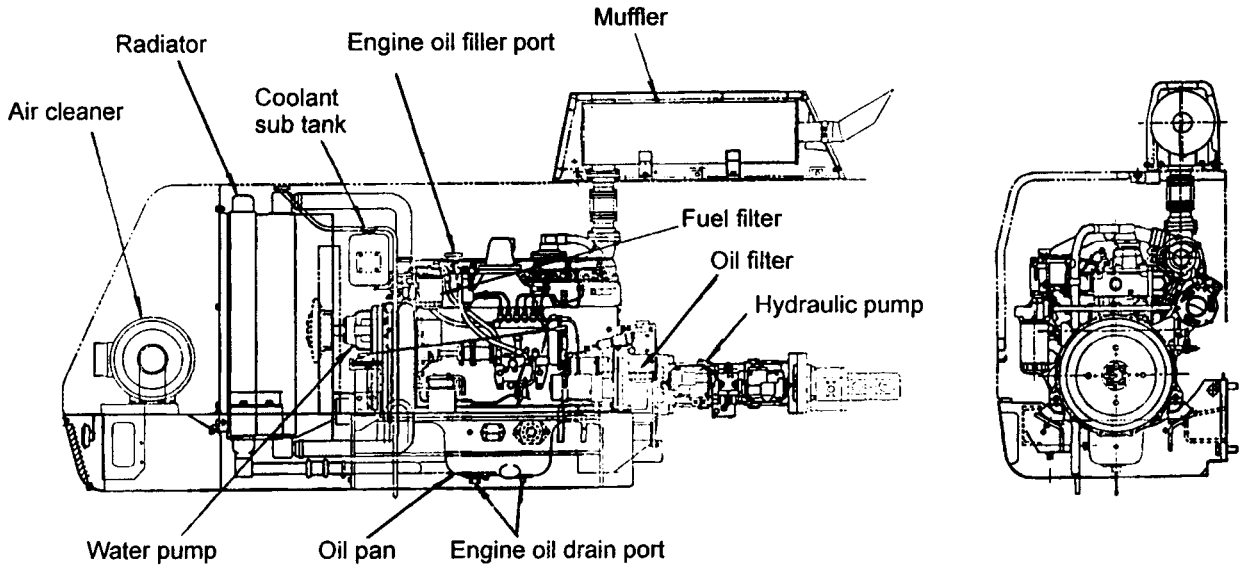
Inject 370cc, 290cc and 110cc of No. 30 engine oil into the front idler, lower roller and upper roller, respectively.

Note:

1. For the oil marked ✶ in the Hydraulic Oil section of chart should be used above 0°C.
2. If oil is contaminated or degraded excessively, it should be replaced even before the regular replacement time point.
3. The lubricants listed inside the ☐ are the ones used at the time of shipment from the factory.
4. Use of oil and grease of the same brands ... avoid mixing lubricants of different brands.
5. We recommend Shell Tellus oil K46 for tropical countries such as Taiwan, the Philippines, Hong Kong, Singapore, Malaysia, Indonesia, Thailand and China (south of Shanghai).

8. CHECK AND MAINTENANCE OF ENGINE

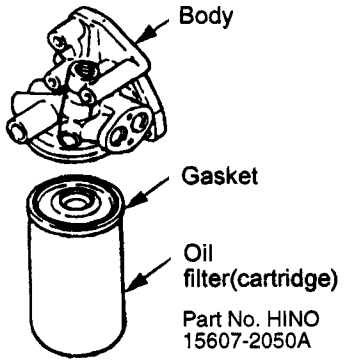
For details of engine handling, refer to the instruction manual of the engine.



8-1 Maintenance table

Name	Capacity (*l*)	Check and Replacement Interval (hours)						Remarks
		Daily	30	120	250	500	1000	
Engine oil	H level: 24 L level: 16 Total volume: 28	☐						Oil level check & replenishment
			☐					Initial oil replacement
				☐				Fuel & water mix - in check
					☐			Oil & water filter element replacement
Fuel line (light oil)	Tank Capacity: 240			☐				Water & dust mix - in check
						☐		Filter element replacement
Air cleaner					☐			Element check & cleaning
							☐	Element replacement
		Monthly operation condition check						Operation of dust indicator
Coolant	Engine alone: 13 Total volume: 28	Yearly cleaning and replacement						The interval of replacement can be lengthened by using a long-life coolant
		Mixing ratio of antifreeze						
		Min. temperature		- 10°C	- 15°C	- 25°C	- 35°C	
		Mixing ratio		20%	30%	40%	50%	
		Antifreeze volume		5.6 *l*	8.4 *l*	11.2 *l*	14.0 *l*	
		Coolant volume		22.4 *l*	19.6 *l*	16.8 *l*	14.0 *l*	
Water pump	Small amt. grease	Monthly (Not easily seen, take care not to omit greasing.)						

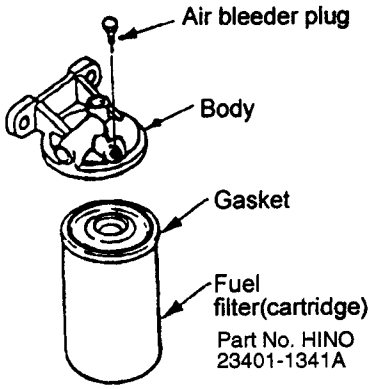
8-2 Replacement of oil filter element



1. Clean the bottom face of the body adequately.
2. Dismount the filter by using the wrench.
3. Coat the gasket of the new oil filter with engine oil and mount it on the body.

   From the position where the gasket comes in contact with the bottom face of the body, further turn the gasket by 3/4 to 1 revolution in the tightening direction.
4. Check engine oil level.

8-3 Replacement of fuel filter element

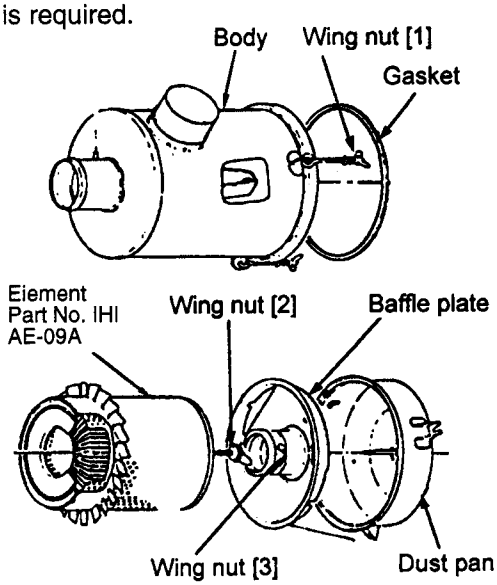


1. Clean the body and piping area.
2. Dismount the filter by using the filter wrench. Pay attention not to spill the fuel which remains in the filter.
3. Apply a thin film of light oil to the gasket face and mount the gasket on the body.

   From the position where the gasket comes into contact with the bottom face of the body, further tighten the gasket by about 2/3 turn.

8-4 Cleaning of air cleaner and replacement of element

When the clogging indicator lamp flickers on the OK monitor, the element is clogged. Cleaning or replacement is required.



1. Loosen wing nut ① and remove the dust pan.
2. Loosen wing nut ③ and remove the baffle plate and eliminate dust from inside the dust pan.
3. Loosen wing nut ② and remove the element.
4. Clean the element. If the element is dry, blow compressed air, or wash it with a neutral detergent if stained with oil.
5. Replace with the new element and assemble the air cleaner. Carry out assembly by reversing the disassembling procedure.

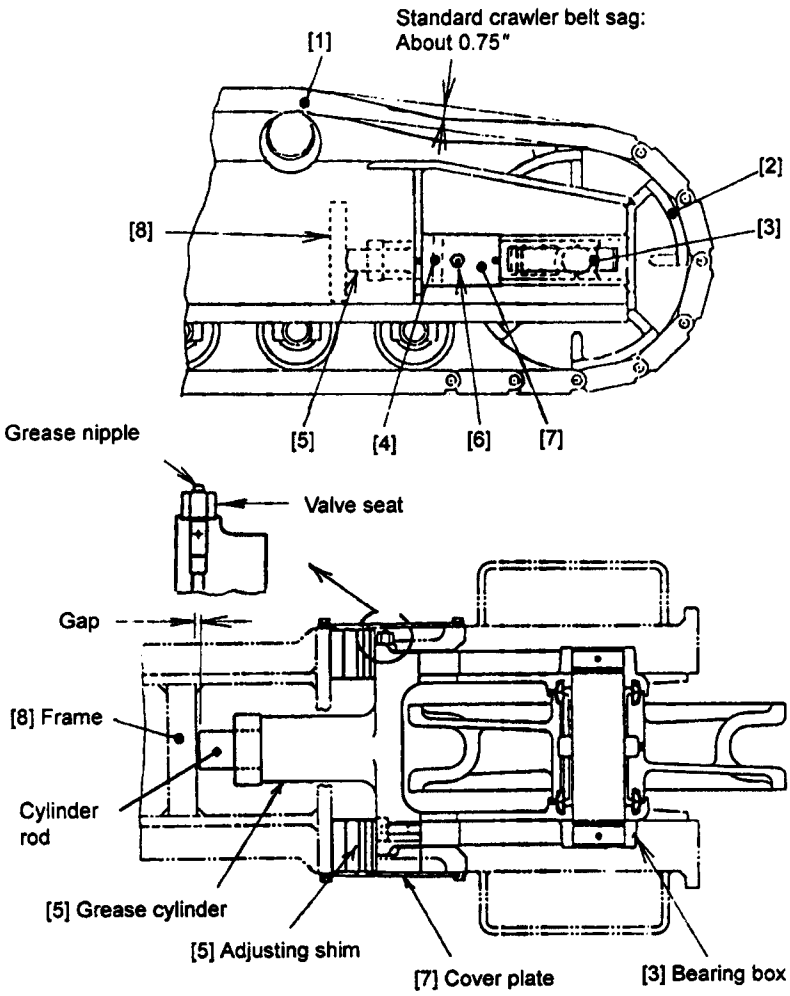
   *Clean the pre-cleaner dust, together with air cleaner.

9. ADJUSTMENT OF CRAWLER BELT

9-1 Part name and structure

WARNING

IF CRAWLER BELT SAG IS MORE THAN 1.50", DAMAGE CAN OCCUR TO THE IDLER AND DRIVE TUMBLERS.



① Crawler belt
② Idler tumbler
③ Bearing box
④ Adjusting shim (*)
⑤ Grease cylinder
⑥ Valve seat, grease fitting
⑦ Cover plate
⑧ Frame

(*) Types of shim: 3.2-, 6-, 12-, and 25- mm. Shims are kept in the tool box.

9-2 Adjustment procedure

Adjustment is to be performed by moving the bearing box ③ of the idler tumbler section on level ground.

1. Drive the machine forward by a distance equal to the length of crawler belt ① to bring the sagging of the belt to the top.
2. Remove the two covers ⑦ at the adjusting shim section.
3. With the valve seat tightened, inject grease into grease cylinder ⑤ through grease nipple ⑥. When the belt sag shown above becomes 20mm, grease injection should be stopped. Place spare shims ④ so that the force of idler can be supported by the frame. (The quantity of shim should be the same between both sides.)
4. After adjustment, loosen the valve seat ⑥ until grease comes out in order to separate the frame ⑧ and cylinder rod. (This is for receiving the force of the idler not by the grease cylinder but by the shims.)
5. Attach the cover ⑦. Adjust the opposite crawler in the same way.

NOTICE

After adjustment of the crawler belt tension, loosen the valve seat until grease comes out. The cylinder rod and frame will be separated from each other. This measure is required for supporting the force of the idler not by the cylinder, but by the shims.

If this measure is neglected, the cylinder will be broken.

NOTICE

1. **For adjustment, the quantity of shim should be the same between the inside and outside. If the tumbler shaft is not perpendicular to the crawler belt, the adjustment bearing seal, shaft, tumbler, etc. may be damaged.**
2. **Once the machine has been adjusted, drive it back and forth a few times and make sure belt sag is even between the two crawlers. This is essential for distributing the load uniformly on both sides and for ensuring exact straight traveling.**
3. **When traveling in deep sand or on other soft ground, increase the belt sag. This prevents sand and dirt from being trapped.**

9-3 How to loosen crawler belt

After removing the adjusting shims ④, loosen the crawler belt.

1. Supply the grease through the grease nipple ⑥, extend the grease cylinder a little, and remove the force applied to the shims ④.
2. Remove the adjusting shims ④ meeting the looseness of the crawler belt.
3. Loosen the valve seat ⑥ a little and discharge the grease in the grease cylinder ⑤. If the valve seat is loosened excessively, it may be blown by the grease pressure. Be careful not to loosen the valve seat too much.

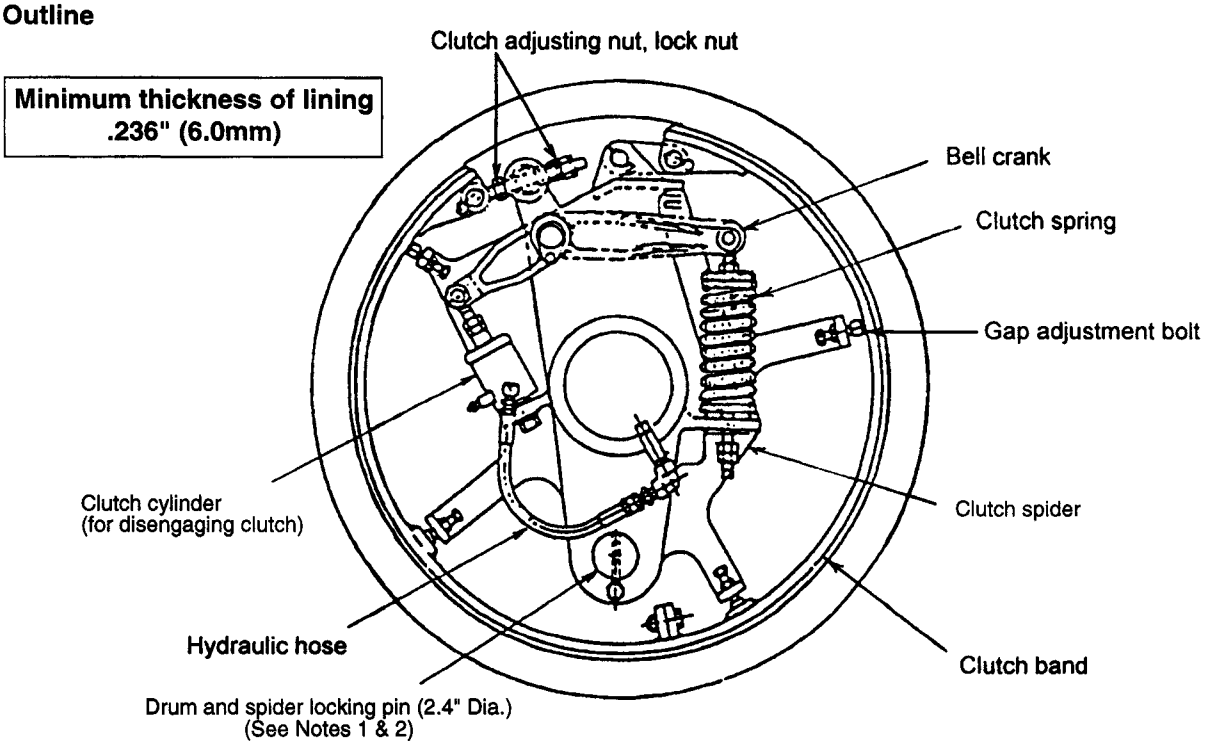
   If it is difficult to discharge the grease, let the machine travel by 1~2m while the valve seat is loosened to apply force to the cylinder.
4. When the crawler is loosened, make sure that the cylinder rod is separated from the frame ⑧ and then tighten the valve seat ⑥. For other parts, follow the crawler adjustment procedure.

⚠ CAUTION

When the valve seat is loosened, the grease is discharged from the bottom of the valve seat. If the valve seat is loosened excessively while the cylinder ⑤ has inner pressure, it may be blown by the pressure. Don't place your face or body in front of the valve seat when loosening it.

10. ADJUSTMENT OF HOIST CLUTCH (MAIN AND AUXILIARY HOISTS)

10-1 Outline



⚠ CAUTION

NOTES:

1. **This pin is used to lock the clutch spider and hoist drum. For standard crane operation, the pin should be removed. Operation is allowed with the pin in place if free fall of the hook and load is unnecessary.**
2. **For the tower crane, the left drum (for tower jib hoisting) must be locked with this pin to secure the clutch spider to the wire drum.**
3. **Before adjusting or repairing the brake or clutch, the hook block and suspension load must be lowered to the ground. Lower the boom if necessary for safety.**

NOTICE

Clutch slippage affects the crane work. Check the following points to prevent the clutch from slipping. Replace, repair, or clean the lining if necessary.

1. **Is the thickness of the clutch lining over the allowable limit?**
2. **Is the spring tension of the clutch adjusted properly?**
3. **Is water or oil adhered to the clutch lining?**
4. **Does oil leak from the clutch cylinder? Is the piston of the clutch cylinder in contact with the cylinder bottom?**

1. In the case of this clutch, the band is always expanded by the tension of the clutch spring (clutch is engaged). The clutch cylinder serves to disengage the clutch. When setting the winch lever to neutral with the winch set in manual mode, oil is supplied to the clutch cylinder and the clutch is disengaged. As a result, the drum and spider are disengaged to allow free fall of the load.
2. To rotate the clutch spider independently for adjustment, etc., depress the brake pedal, then set the winch mode selector switch to the manual mode. Next, turn the clutch switch to the "OFF" position. The clutch spider can now be rotated to the desired position by the winch lever.

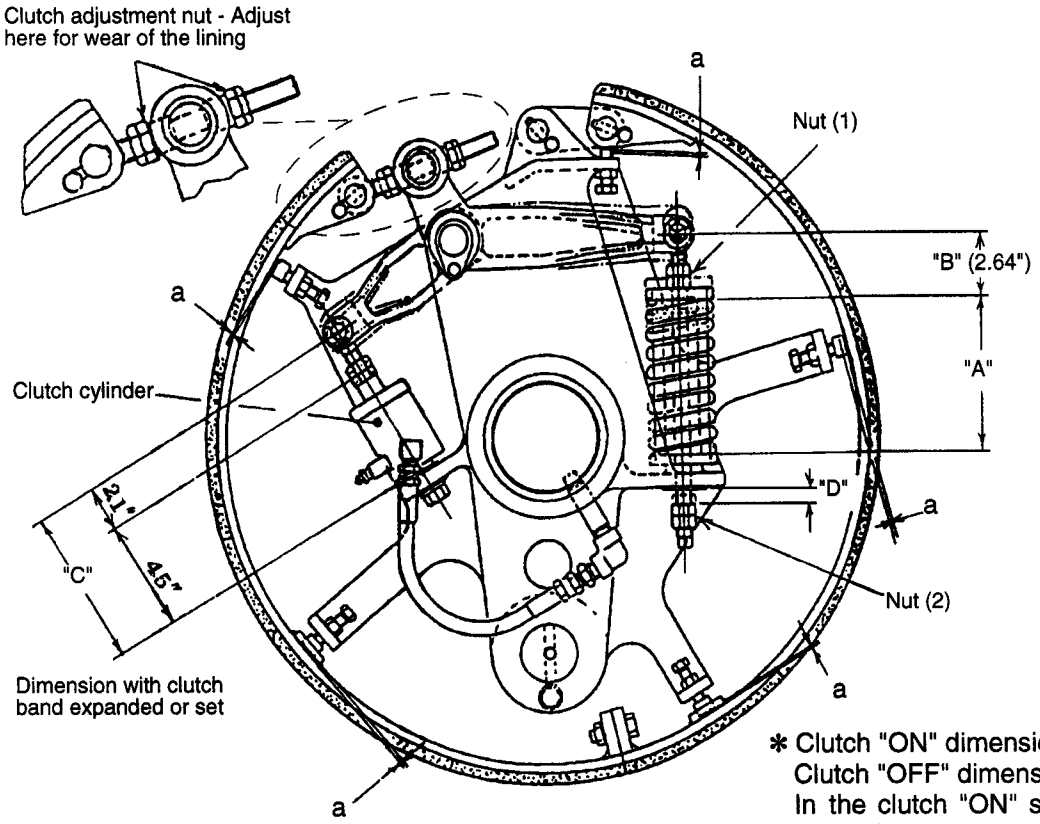
10-2 Adjustment

Dimensions for initial adjustment

For adjustment due to normal wear of the lining, adjust the clutch adjustment nut to obtain spring dimension of 5.96 in. (151.5mm). Then adjust gap "a" at 5 places and the clutch cylinder dimensions*. Verify all other dimensions.

(With clutch engaged)

A	Set length of spring	5.96 in.	151.5mm
B	Distance between spring & pin	2.64 in.	67mm
C	Set length of cylinder	6.57 in.	167mm
a	Band gap	.024 in.	0.6mm



* Clutch "ON" dimension: 4.5 in. (114mm)
Clutch "OFF" dimension: 4.72 in. (120mm)
In the clutch "ON" status, a gap of .43 in. (11mm) is obtained between the clutch cylinder bottom and piston.

Usually, the clutch is adjusted for wear of the lining. If the clutch has been disassembled for repair, etc., the above dimensions for initial adjustment should be obtained. Follow the procedure given below.

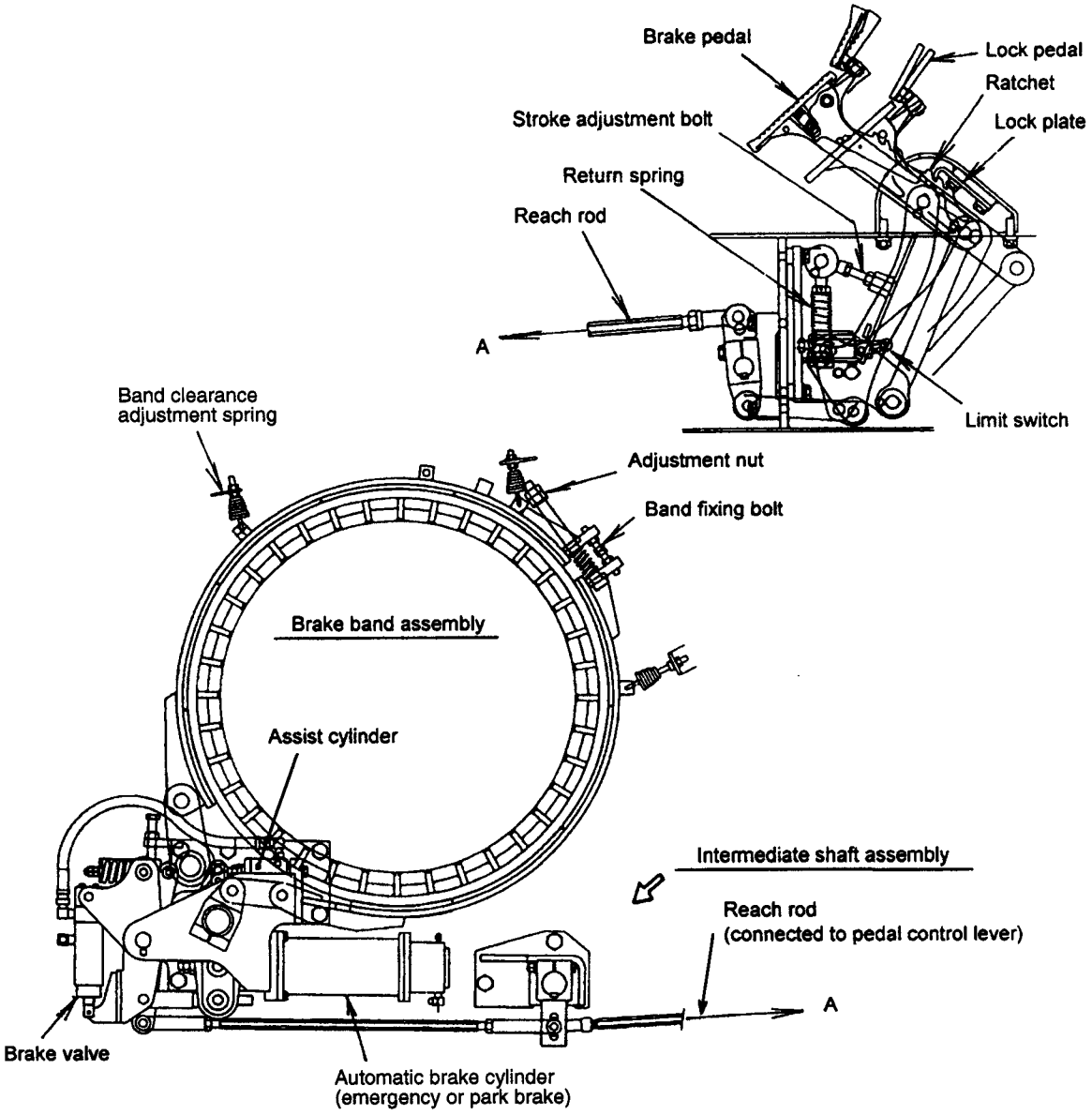
1. Tighten nut (1) so that the set length of spring becomes 5.96 in. (151.5mm).
2. Adjust the tension of the clutch band by turning the clutch band adjustment nut.
3. Adjust gap "D" to .59 in. (15mm) by turning nut (2).
4. Set length "C" of the clutch cylinder and clutch "ON", "OFF" dimensions*.
5. Adjust a gap between each stop "a" and cutch band to .024 in. (0.6mm) (at 5 points).
6. Break in the clutch by operating, hoisting a light load in "manual" mode.
7. Lift a load at maximum single line pull to make sure that the clutch is holding properly.

⚠ CAUTION

If dimension "D" is reduced to .47 in. (12mm) or less due to wear of the lining, be sure to return it to .59 in. (15mm) by readjusting the band. If the lining is used despite significant wear, the bottom of the clutch cylinder will contact with the piston, disabling expansion of the clutch. As a result, the clutch fails to hold and the load may fall.

11. ADJUSTMENT OF HOIST BRAKE (MAIN & AUXILIARY HOISTS)

11-1 Outline of brake



Brake assist device assembly

This brake mechanism consists of two systems: Manual mode, dependent on pedal operation, and one for Automatic mode, in which the brake is controlled with the automatic brake cylinder.

Manual mode: Although this mode is basically the same as a mechanical brake, in which the brake band is controlled by the pedal force, a hydraulic assist mechanism is designed to boost the pedal force.

Automatic mode: Returning the winch control lever to neutral, the automatic brake cylinder activates to engage the brake band, thereby applying the brake.

The automatic brake cylinder functions as an emergency brake to keep the brake engaged in an emergency such as a drop in control hydraulic pressure. The brake is spring applied hydraulic release.

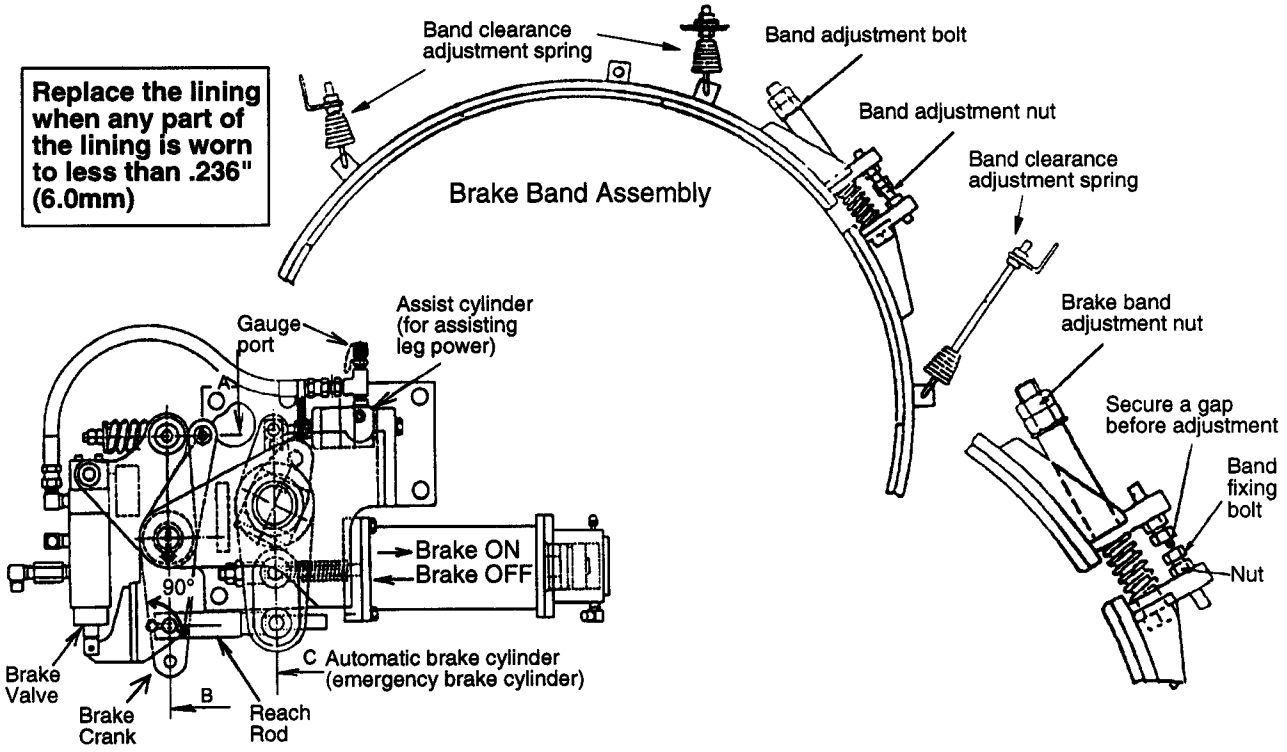
11-2 Adjustment of brake band

CAUTION

Adjust the brake to hold a maximum single line pull of 32,000 lbs. on 1st layer. If the brake is not operating properly, the load may be dropped. Check the following when the brake is not holding maximum single line pull.

1. **Is the brake lining worn to less than the minimum thickness?**
2. **Is the brake lining contaminated with water, oil, grease or some other contaminate?**
3. **Is the brake band and mechanism adjusted properly?**
4. **Is the brake band clearance maintained over the entire drum circumference? When the brake is applied, the lining must have contact over the entire lining area.**
5. **Is the brake pedal force proper? Is the brake power assist working?**
6. **Is the brake rod or linkage in good operating condition? Make sure that all linkage is free to move and in good operating condition.**

Replace the lining when any part of the lining is worn to less than .236" (6.0mm)



CAUTION

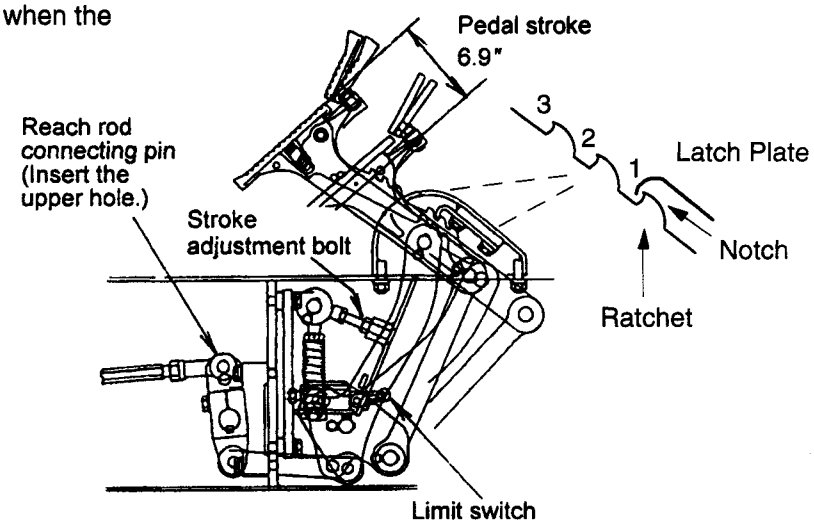
As the lining is wearing, the effect of the brake pedal weakens and the pedal comes closer to the floor so that the braking force is reduced. To compensate for lining wear, adjust the brake band in the following procedure.

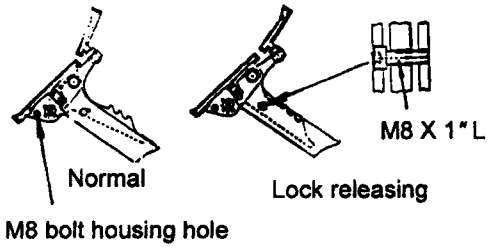
1. Lower the load and the hook to the ground.
2. Unlatch the brake pedal to release the brake.
3. Loosen the nut of the band adjusting bolt and back out the bolts to provide a gap between the heads of the two bolts.
4. Tighten the band adjustment nut so that the brake crank is 90° to the reach rod. Test the brake with single line pull by lifting a load.
5. When brake is engaged, move the band fixing bolts until their heads come in contact with each other to stabilize the band.
6. Adjust the tension of the band clearance adjustment springs to provide clearance. Adjustment is satisfactory when the lining and brake drum are separated over the entire circumference when the brake is released.

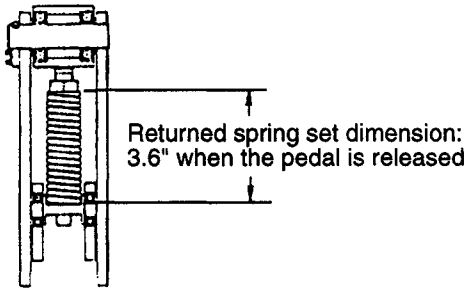
11-3 Adjustment of pedal stroke

If an adequate pedal stroke in not ensured, the hydraulic assist device will not operate satisfactorily, which may cause dragging of the band. Make sure that the pedal moves 6.9 in. (175mm) with the rod connecting pin pulled out. Insert the connecting pin.

1. Depress the pedal down to first notch as a reference. If the drum is hot, the pedal should be depressed down to the second notch.
2. Allow the pedal to rise by 6.9 in. (175mm). At this position, bring the stroke adjust bolt into contact with the stop.
3. Adjust the reach rod, so that the brake will hold while depressed to the 1st notch holding maximum single line pull.
4. Confirm that the limit switch is activated when the pedal is depressed.





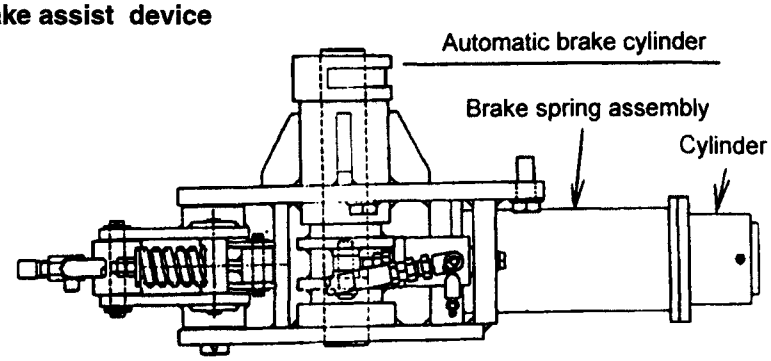


Releasing pedal lock

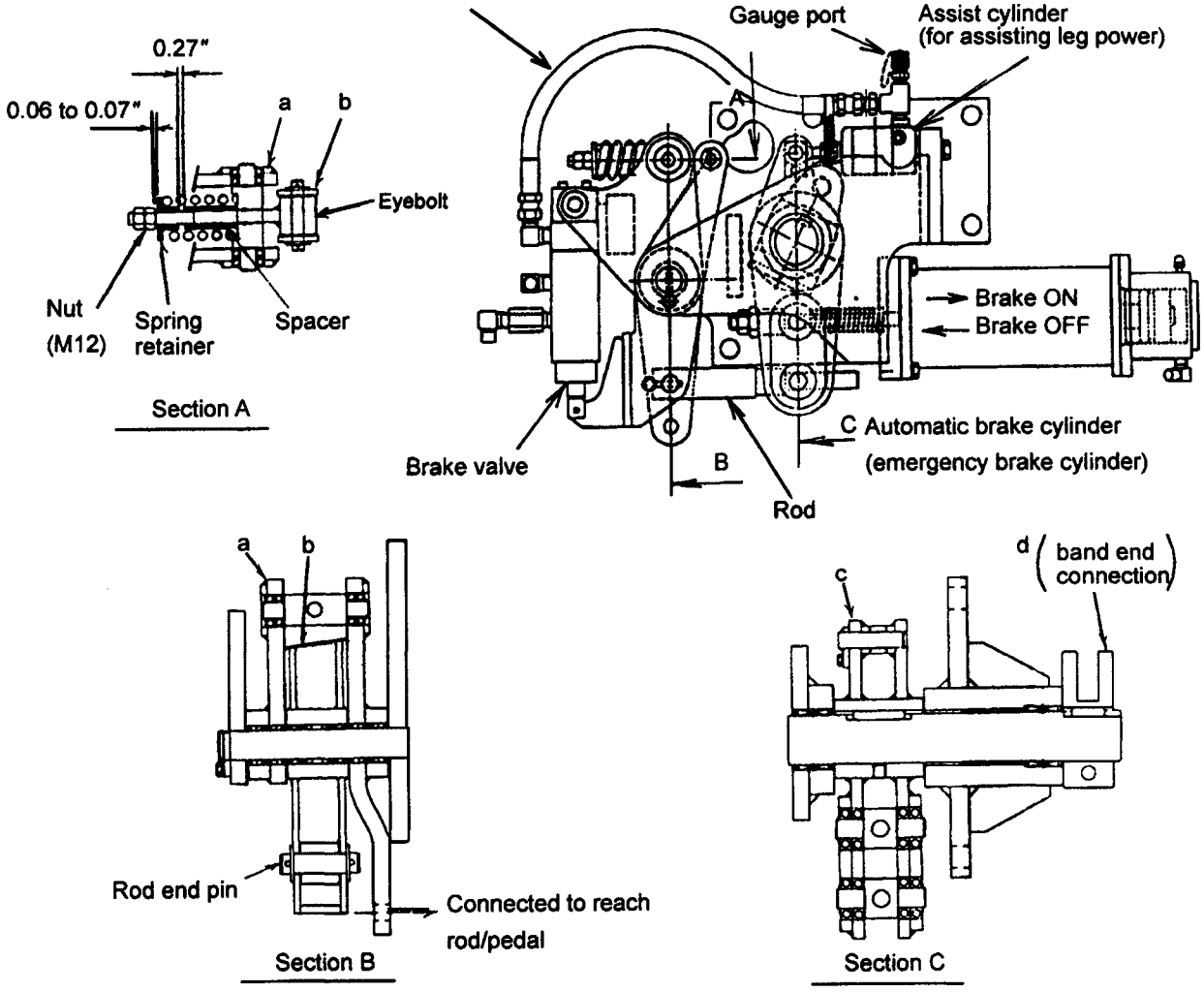
If the pedal lock function is not required with clamshell operation, etc., the ratchet can be locked by tightening the bolt (shown above) so that the pedal lock cannot be engaged. (For normal operation, the bolt should be in the housing hole.)

11-4 Composition and operation of the brake assist device

Levers "a" and "b" (Section A below) are connected with the eyebolt. The gap between the nut and retainer is the free play during operation. The gap between the retainer and spacer equals the control stroke of the brake valve. When the brake valve is fully stroked, maximum hydraulic pressure is delivered to the assist cylinder.



NOTE: Replace this hose every 2 years (P/N 407000120)

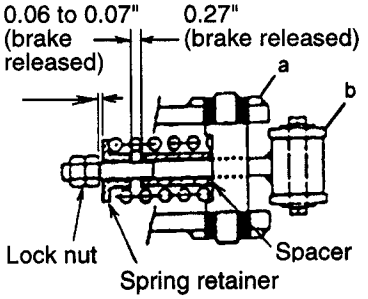


The brake valve mounted between levers "a" and "b" opens as the brake pedal force is increased. The valve has a stroke from 0 to 7mm. In proportion to this stroke, pressurized oil of 0 to 1140 psi (80 kgf/cm$^{2)}$ is delivered to the assist cylinder. The assist cylinder moves in the brake applying direction to increase the brake pedal force. (The assist cylinder assists the movement of lever "C").

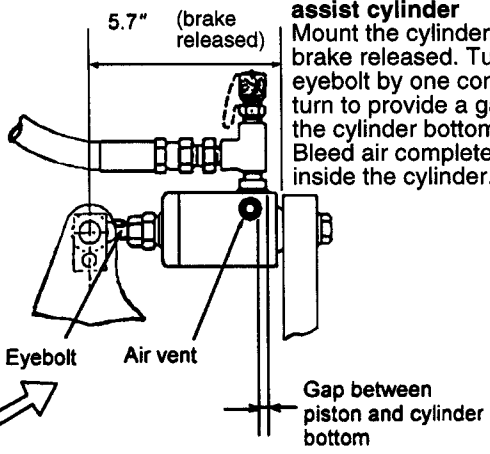
11-5 Assist and automatic brake adjustment

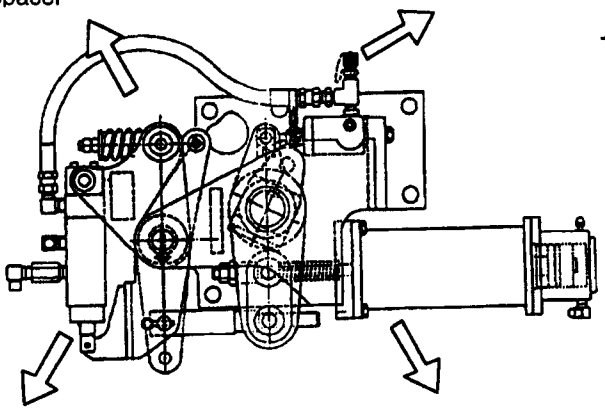
Normally, the band is adjusted to compensate for wear of the brake lining. After disassembly of the brake block, adjustment should be made in the following way. Verify dimensions during inspection.

Adjustment of lever a/b connection
The spring has a free length of 2.91 in. (74mm). The lock nut should be fixed after providing a gap of .060 to .070 in. (1.5 to 1.8mm) between the spring retainer and the lock nut.

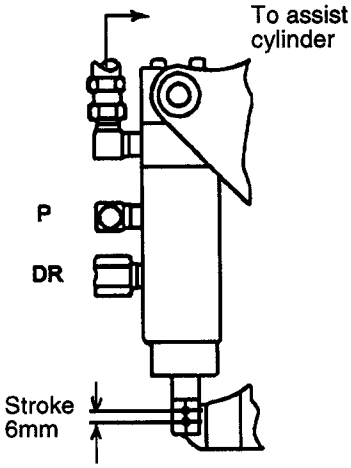


Setting of brake assist cylinder
Mount the cylinder with the brake released. Turn the eyebolt by one complete turn to provide a gap between the cylinder bottom and piston. Bleed air completely from inside the cylinder.

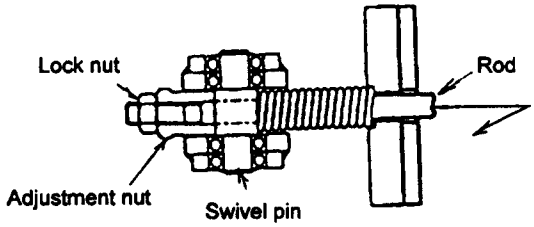


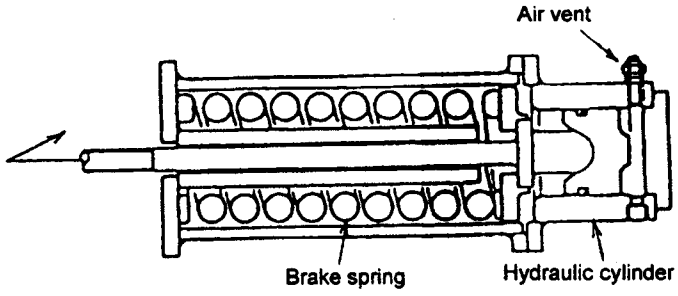


Brake valve
The brake valve opens as foot pedal force is increased.



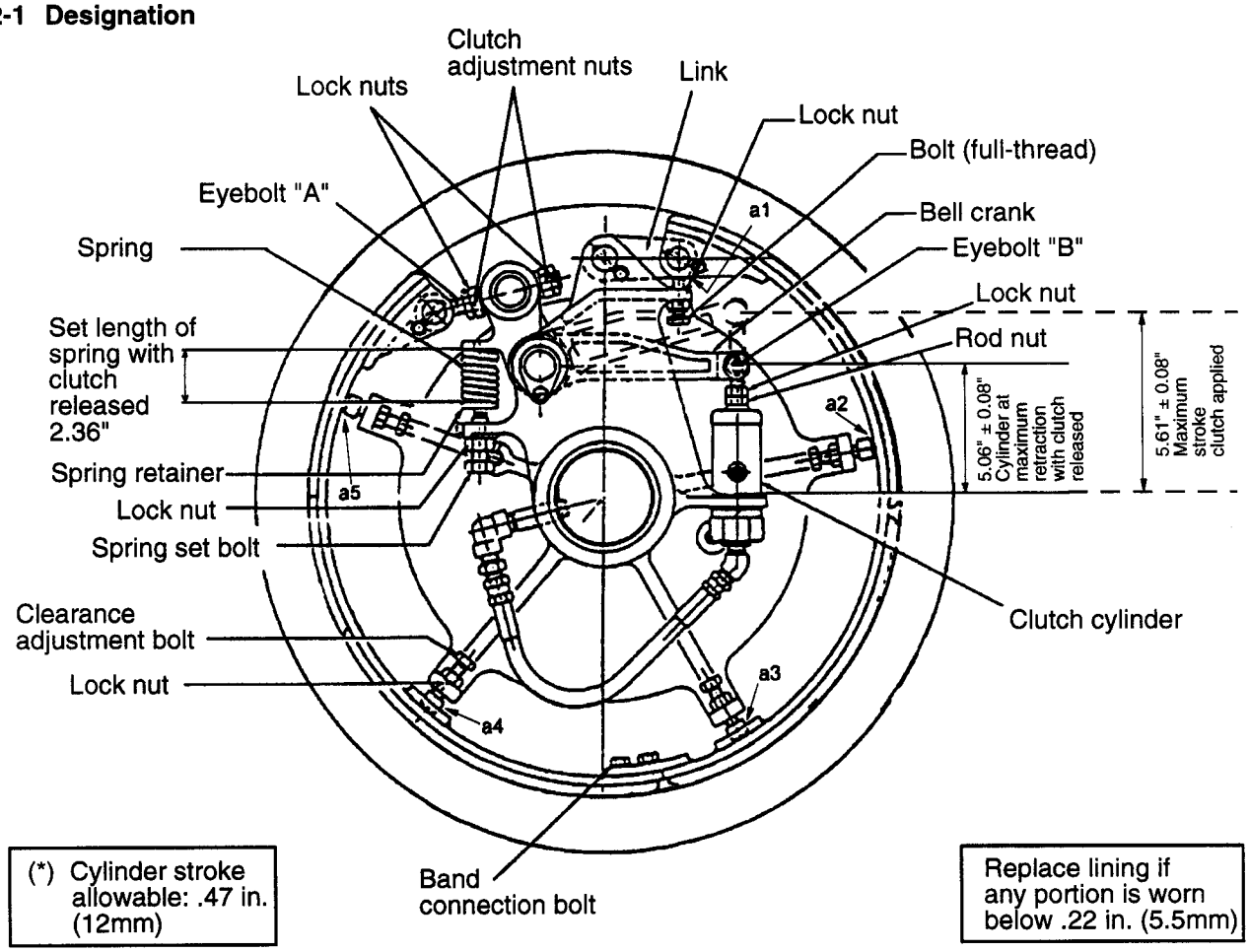
Adjustment of automatic brake cylinder
With the load & hook on the ground, select the "Manual" mode so the brake cylinder releases. The hoist is now in free fall. Release the brake by raising the pedal. Adjust by loosening the adjustment nut half a revolution from where the swivel pin is in contact with the adjust nut and tighten the lock nut.





12. ADJUSTMENT OF THIRD DRUM CLUTCH

12-1 Designation



Note: Spring released, hydraulic set.

Setting dimension

Symbol	Operation	
	With clutch engaged	With clutch released
Band clearances a1 to a5	.012 in. (0.3mm)	- -
Cylinder to bell crank	- -	5.060 ± .080 in. 128.5 ± 2mm
Spring length	- -	2.36 in. 60mm

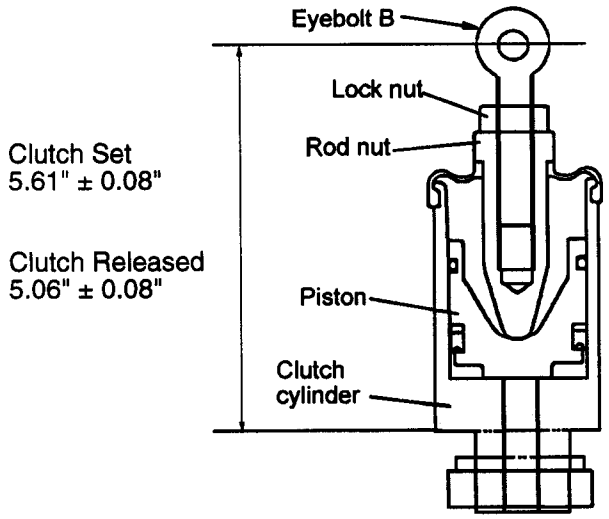
12-2 Adjustment

1. Preparation for check and adjustment
   Before check and adjustment, take the following steps to ensure safety.
   a. Lower the hook to the ground
   b. Locate the band end of the clutch at the top (as shown above).
   c. Stop the engine
   d. Never rotate clutch, apply or release clutch if hands or body parts are near the clutch.

2. Inspection and adjustment of clutch assembly - due to wear or lining replacement

Note: Adjustment is necessary if the clearance between the lining and the drum is .031 in. (0.8mm) or greater with the clutch disengaged or if the stroke of the cylinder is .47 in. (12mm) or greater.

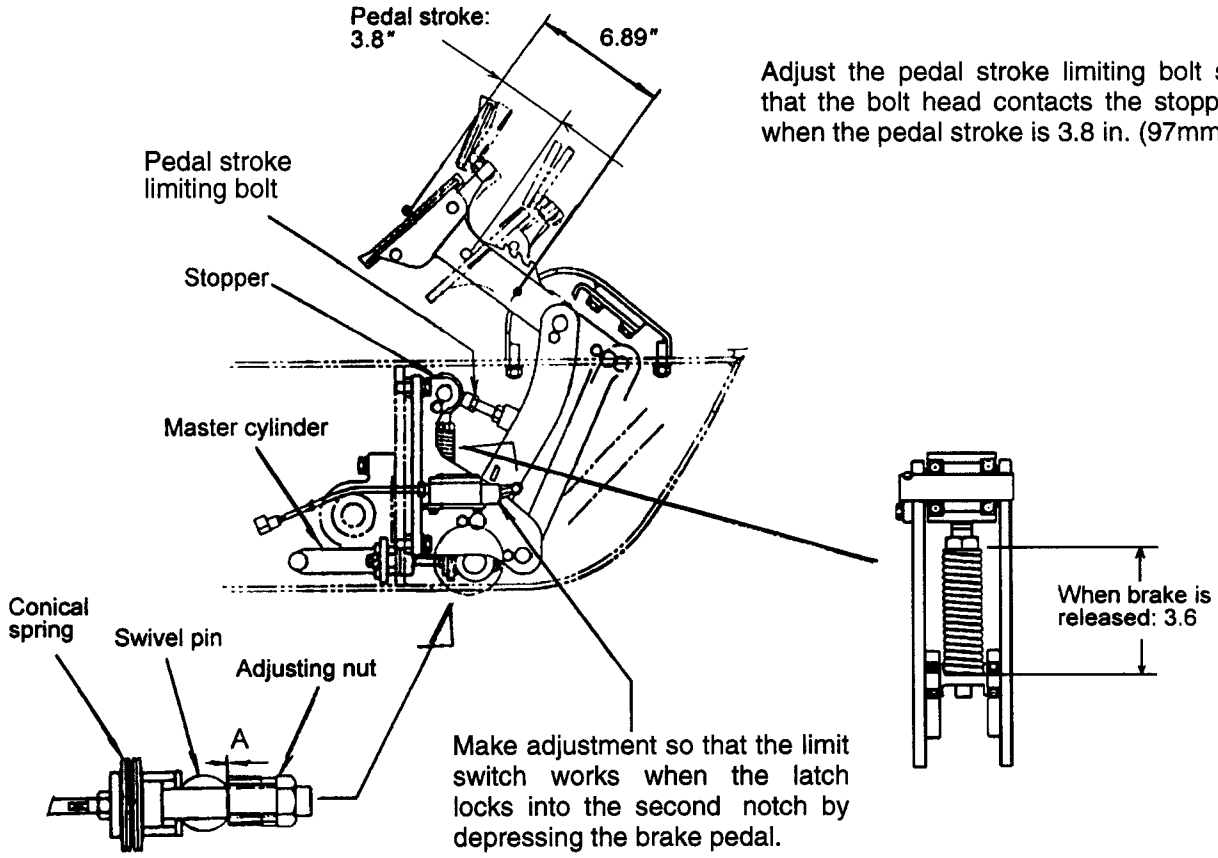
a. With clutch disengaged, loosen both adjustment nuts and lock nuts.
b. Adjust at 5 places a1 thru a5, the clearance adjustment bolts, to obtain .012 in. clearance between the lining and the drum clutch surface. Lock the 5 stop lock nuts.
c. Adjust the cylinder eye bolt "B" C/L to base of cylinder 5.06 ± .08 in. (128.5 ± 2mm) by turning the clutch adjusting nuts so the cylinder rod goes back into the cylinder to maintain the 5.06 ± .08 in. (128.5 ± 2mm).
d. Loosen the lock nut on the eye bolt "B" and turn the rod nut until the piston bottoms out (just contacts) to the clutch cylinder. Then, turn the rod nut the opposite direction one revolution to pull the piston slightly off the bottom of the cylinder.
e. Tighten the lock nut to the rod nut.



CAUTION

1. **The clutch cylinder stroke should not exceed .47 in. (12mm). If the stroke is excessive, the oil may leak from the cylinder.**
2. **After adjusting the clutch, test maximum single line pull to make sure that the clutch is working properly.**

13. ADJUSTMENT OF THIRD DRUM BRAKE



Adjust the pedal stroke limiting bolt so that the bolt head contacts the stopper when the pedal stroke is 3.8 in. (97mm).

Make adjustment so that the limit switch works when the latch locks into the second notch by depressing the brake pedal.

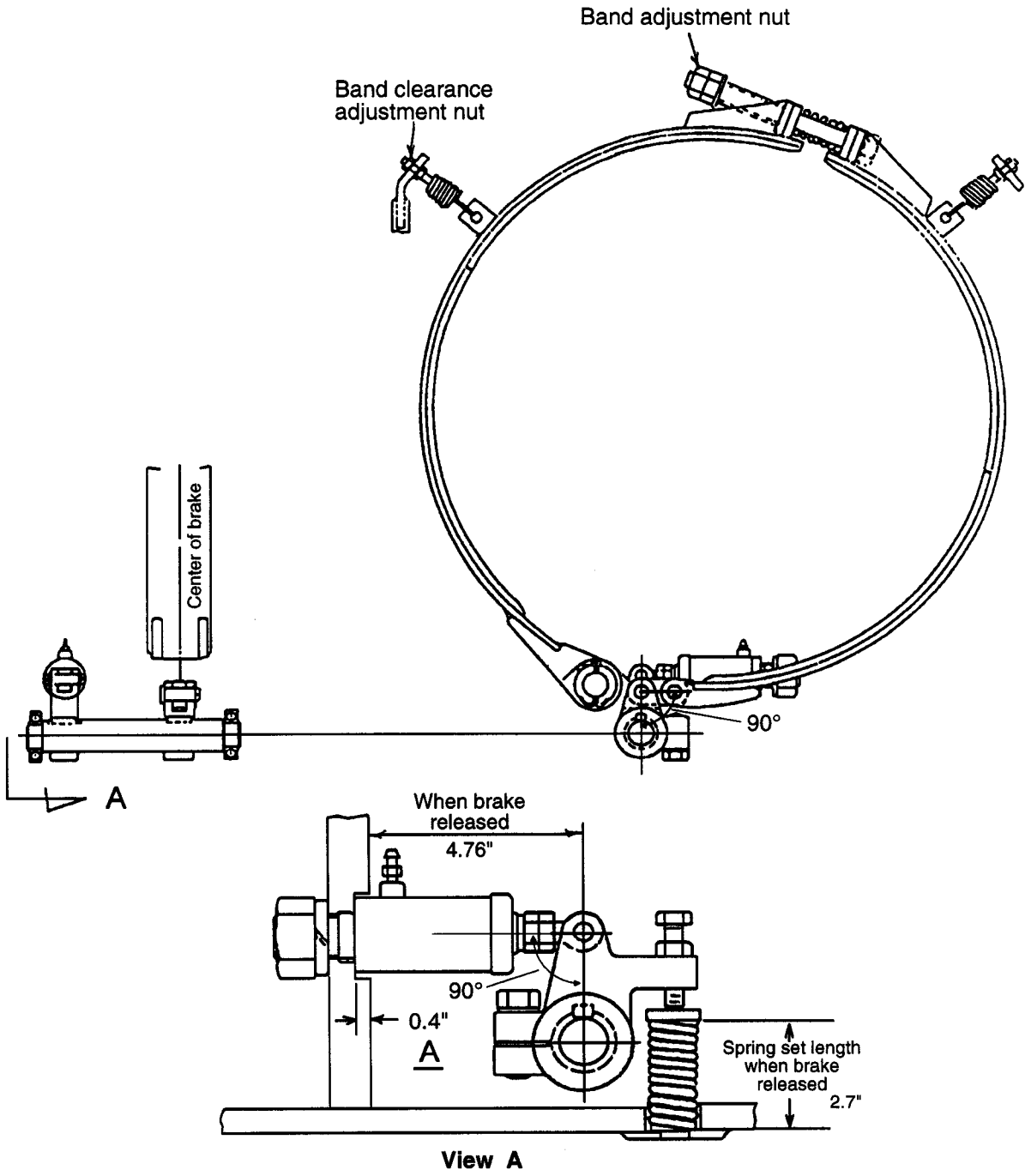
Adjust the nut so that a clearance of .039" (1mm) may be generated in the "A" area while depressing the pedal.

The brake pedal and lever of the third drum have the same structure as those of the main and auxiliary drums.
Adjusting method:

1. The limit switch works when the second pawl of the pedal latch lever is applied to the lock lever. Adjust the brake force to keep the rated load at the above position.
2. Now, the stroke of the master cylinder must be about 18mm. Normally, adjust the brake band so that the stroke of the master cylinder becomes 18mm.
3. The brake is locked when the pedal third pawl is locked by depressing the pedal. If the brake drum is hot, lock the second pawl.
4. Adjust so that the rod of the master cylinder reaches the neutral position completely (a play must be provided without receiving a force) when the brake is released by raising the pedal.

⚠ CAUTION

1. **Before adjusting the brake, be sure to lower the load to the ground and stop the engine.**
2. **Make sure the oil reservoir for the master cylinder contains hydraulic oil up to the level mark. If inadequate, replenish the hydraulic oil.**



View A

The set dimension of the brake cylinder must be 4.76 in. (121mm) when the brake is released.

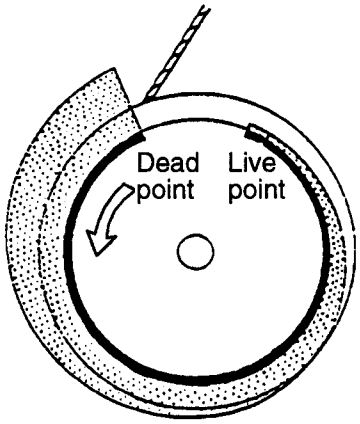
The brake spring must have a length of 2.72 in. (69mm) when it is released.

To adjust the brake band, tighten the band adjustment nut gradually until the brake crank C/L is at 90° to the brake band link and cylinder. As the lining of the brake band wears, the stroke of the brake cylinder becomes longer than the initial value. Adjust the band clearance adjustment nut so that the band and drum have clearance over the entire circumference when the brake is released.

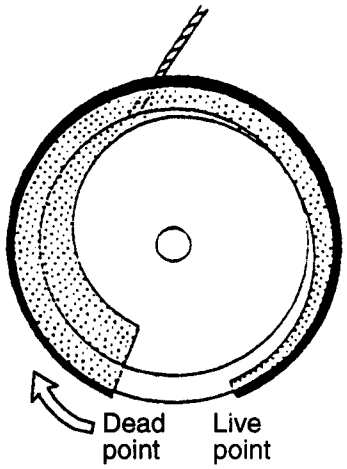
14. SERVICE LIFE OF LINING AND SHEAVE

The band type lining usually begins wearing from the dead point side (clutch/brake band fixed end). However, it may wear at different places, depending on how the lining contacts. Measure the most worn point of the lining and replace it if worn beyond the minimum thickness.

14-1 Figures for one-way characteristic (band type)



Clutch transmission force



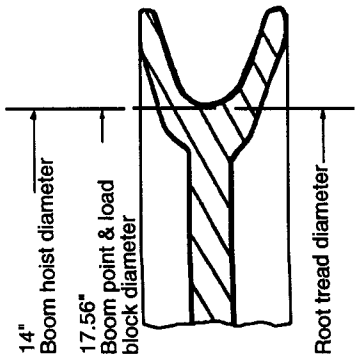
Braking force

14-2 Lining service life

Position		Thickness of New Lining	Minimum Thickness
Clutch	Main and aux. hoist	.393 in. (10.0mm)	.236 in. (6.0mm)
	Third drum	.374 in. (9.5mm)	.217 in. (5.5mm)
Brake	Main and aux. hoist	.393 in. (10.0mm)	.236 in. (6.0mm)
	Third drum	.374 in. (9.5mm)	.217 in. (5.5mm)

Replace linings if any portion of lining is worn below the minimum thickness.

14-3 Service limit of sheave

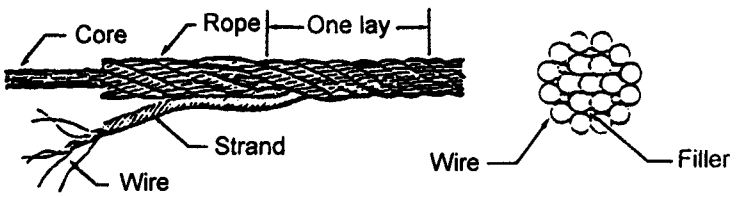


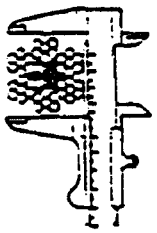
1. Wear of the sheave groove must not be worn below the following minimum limit:
   a. Boom hoist sheave
      14" - .1875" = 13.8125" minimum root tread diameter
   b. Load hoist or load block sheave
      17.56" - .2625" = 17.2975" minimum root tread diameter
2. Check for excessive wear or deformation. Wear or deformation into the groove or groove sides must not be worn or deformed so that it does not uniformly support the rope or it has sharp edges which would damage the rope. If this type of wear or deformation is present - replace the sheave.
3. If bearing or shaft is worn less than 15% of the original dimension, replace the worn part.

14-4 Service limit of wire rope

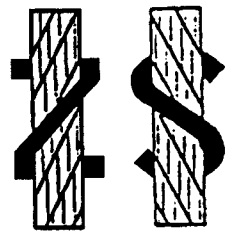
Wire rope should be inspected regularly and with particular care regarding the parts where wear and corrosion are apt to occur, and should be replaced before reaching the service limit.

The following standards are based on the general regulations for operational safety of cranes, etc. The pendant rope should also be inspected carefully.

<table>
<tr><th>Service Limit</th><th>Remarks</th></tr>
<tr><td>When more than 10% of the wires (except fillers) are broken within one lay of the rope</td><td> 

Example: Wire rope of 6 x Fi (29) has 22 wires per strand. Thus, we obtain:
$6 \times 22 \times \frac{10}{100} = 13.2$ Therefore, if 14 wires are broken within 1 lay, it can no longer be used.</td></tr>
<tr><td>When the rope diameter has been reduced by more than 7% of its nominal diameter</td><td> 
The diameter should be measured in three different directions without a load to work out an average for comparison within the nominal diameter.
Example: In the case of wire rope having a nominal diameter of 20mm
$20 \times (1 - \frac{7}{100}) = 18.6$ Therefore, this wire rope must be replaced when the average diameter has been reduced to less than 18.6mm.</td></tr>
<tr><td>When the rope has kinked</td><td> 
The remaining breaking strength of kinked wire rope differs depending on how the rope was kinked. However, once the rope is kinked, loss of its strength is inevitable. So, immediate replacement is essential.
Decrease in breaking strength due to kinking
<table>
<tr><th>Rope condition</th><th>Remaining strength</th></tr>
<tr><td>Original rope</td><td>100%</td></tr>
<tr><td>Kinked but corrected</td><td>83 to 80%</td></tr>
<tr><td>Kinked in twisting direction</td><td>60 to 55%</td></tr>
<tr><td>Kinked in untwisting direction</td><td>45 to 40%</td></tr>
</table></td></tr>
<tr><td>When the rope has been significantly deformed or corroded</td><td>Significant deformation: Dents in the strands, exposed core or more than one loose strand
Significant corrosion: Pits on wire surfaces or corrosion reaching the inside of the rope</td></tr>
</table>

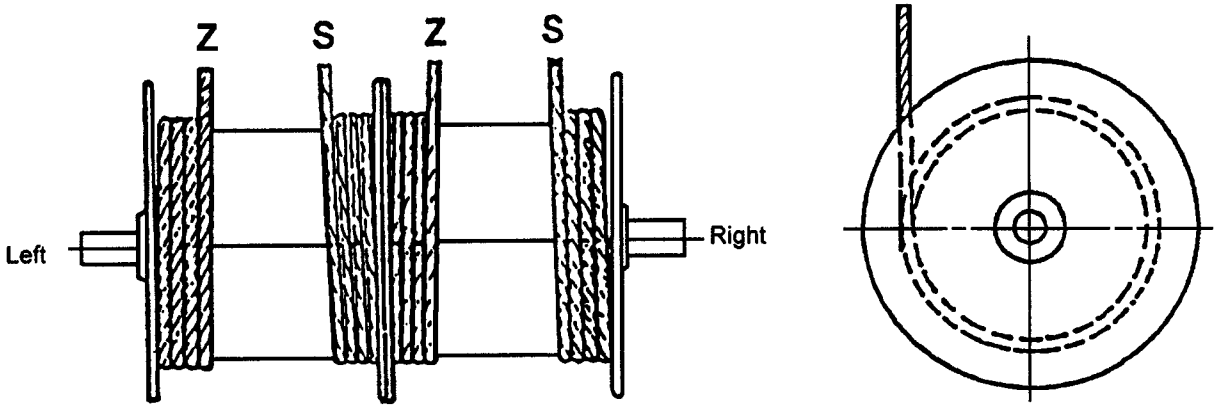
Rope twisting direction and winding onto drum (reference)



For "Z" lay, rope is wound from left to right.

For "S" lay, rope is wound from right to left.

Therefore, when winding the rope from the inside of each drum, use the "Z" lay for the right drum, and the "S" lay for the left drum. When winding the rope from the outside of each drum, use the "Z" lay for the left drum, and the "S" lay for the right drum.



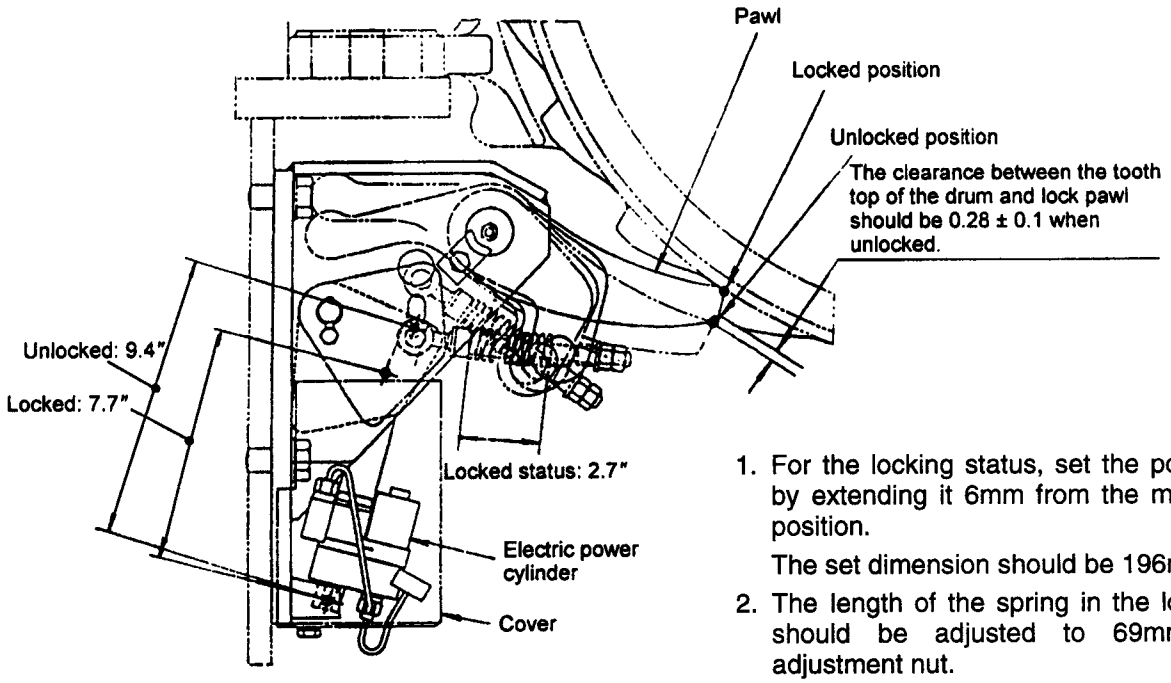
The wire rope tends to turn in the untwisting direction when it is tensed. When winding the first layer of rope evenly by pulling strongly as shown above, it serves as a basis for subsequent correct winding. If the rope is wound roughly on the first layer, it is overlaid one-sidedly or bitten between adjacent ropes, causing excessive wear or crushing. As a result, the rope will reach the end of its service life earlier.

The standards for the structure of the crane, etc., stipulate that at least 2 rope windings should always be left on each drum.

15. ADJUSTMENT OF DRUM LOCK

The power cylinder for lock operation is the same for the main and auxiliary hoist drums and the boom drum.

15-1 Main/auxiliary hoist drums

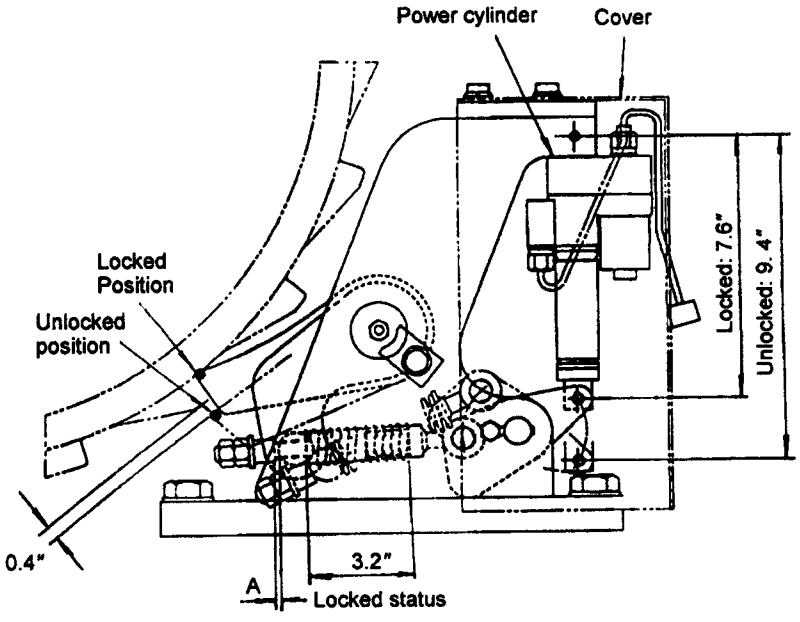


1. For the locking status, set the power cylinder by extending it 6mm from the most retracted position.

   The set dimension should be 196mm.
2. The length of the spring in the locking status should be adjusted to 69mm with the adjustment nut.
3. Make sure the distance between the tooth top of the drum and lock pawl is 7 ± 3mm in the unlocking status.

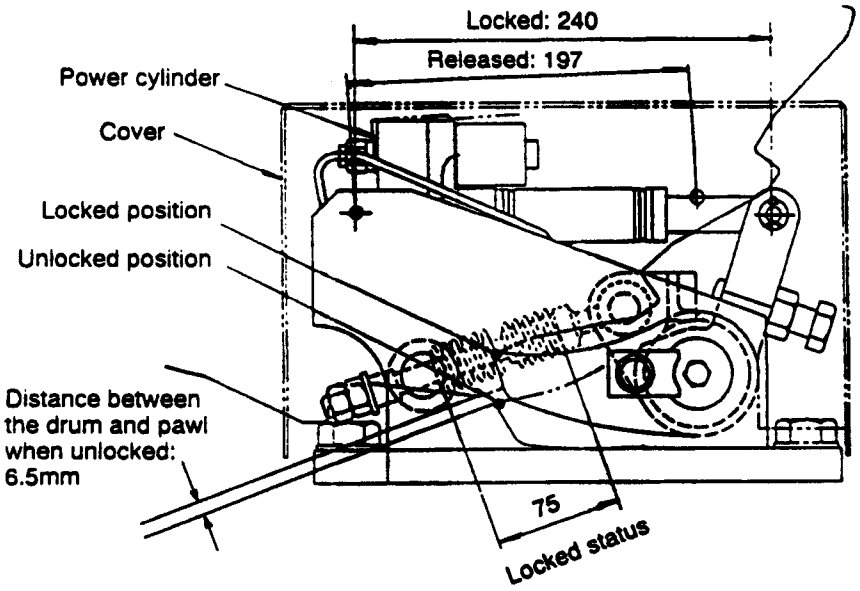
15-2 Boom drum lock

1. Remove the cover.
2. Adjust the set dimension of the power cylinder to 193mm in the locking status.
3. In the locking status, adjust the length of the spring to 81mm to secure a gap of 3mm at position "A".
4. Make sure the clearance between the tooth top of the drum and the lock pawl is 10mm in the unlocking status.
5. Reattach the cover.

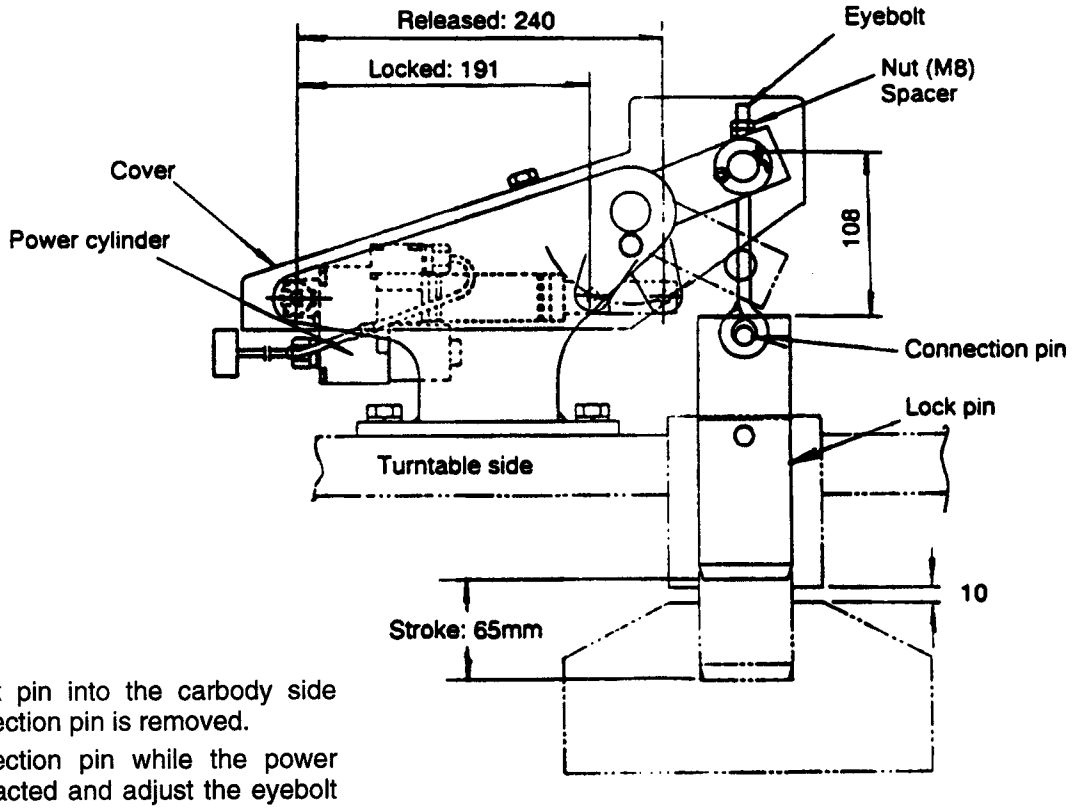


15-3 Tower jib hoist drum lock (Third drum in "B" specifications)

The principle is the same as that of the main/auxiliary hoist drum lock. Check the adjustment dimensions as illustrated below.



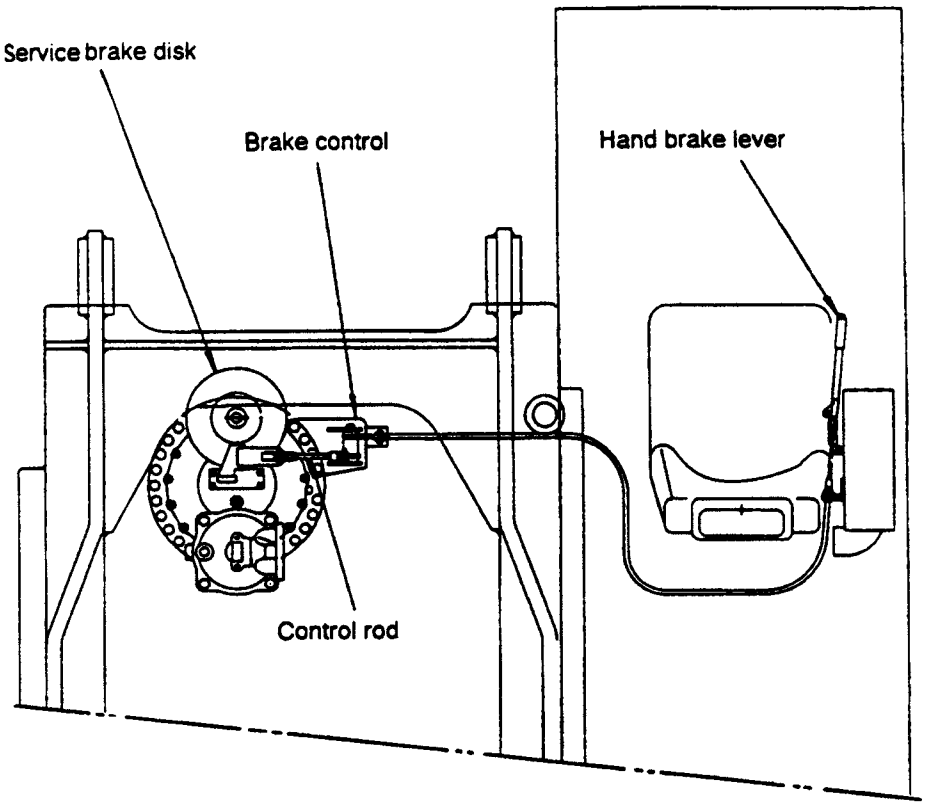
15-4 Swing lock

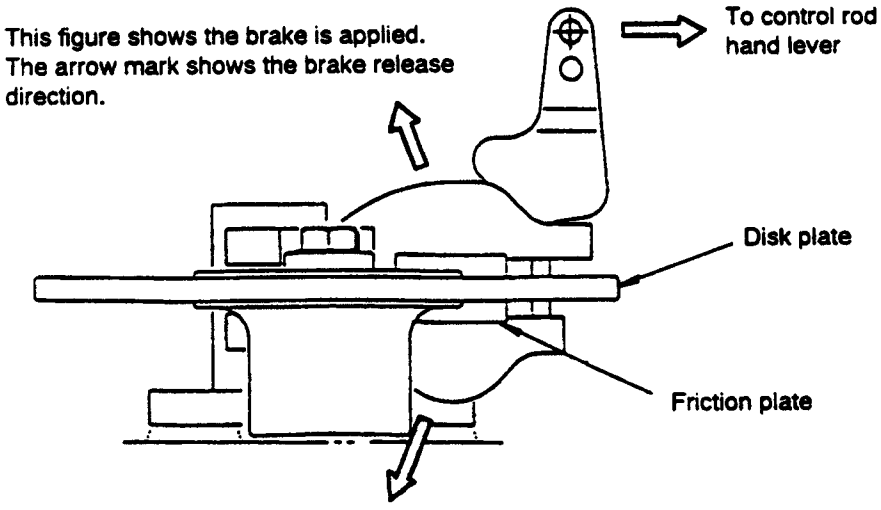


1. Insert the lock pin into the carbody side while the connection pin is removed.
2. Set the connection pin while the power cylinder is retracted and adjust the eyebolt to 108mm.
3. Extend the power cylinder fully and make sure that the stroke of the lock pin is 65mm.

Pin holder on the car body side

16. ADJUSTMENT OF SWING SERVICE BRAKE





Adjustment

1. Adjust the control rod so that the disk plate can be stopped by contacting with the friction plate lightly when the hand brake lever is raised by 1 notch from its free status.
2. Carry out swinging while the engine rotates idly. Make sure that swing stops when raising the hand lever by 6~7 notches.

17. MAINTENANCE UNDER SPECIAL CONDITIONS

17-1 Operation in water

(Maximum depth of water should be one half the crawler height for operation in water)

- Before operation:
  1. Adjust the tension of the crawler belts according to the condition of the river bed, etc.
  2. Confirm that the crawler shoe pins, lock bolts and pins are firmly tightened.
  3. Confirm that the plugs of the travel reduction gear, front idler, etc., are properly clamped. Retighten reduction gear clamp bolts.
- After operation:
  1. Wash undercarriage with fresh water.
  2. Apply grease to the slides of the idler tumbler adjustment bearings, and waste oil on shoe pins.
  3. Discharge a slight amount of the oil by loosening the plug of travel reduction gear and check if water is mixed in.
     a. For operation in water, the depth must not exceed 1/2 the crawler height.
     b. Do not steer the machine in water without checking the bed condition.
     c. The place for refuge in the event of flooding or some other emergency should be determined before operation and a passage to the place should be secured. After operation, the machine should be moved to this place for refuge.

Note: The instructions on operation in water are also applicable to operation on muddy ground.

17-2 Operation on a beach

- Before operation:
  1. Moving parts, even if not provided with a grease fitting, should always be coated with adequate oil or grease.
  2. Be sure to use soft water for the cooling system.
  3. Apply grease to the necessary positions of electrical parts as a corrosion prevention measure, since problems with these parts are often caused by rust and moisture.
- After operation:
  1. Wash the machine thoroughly to eliminate salty substances and wipe with a cloth soaked in oil when necessary.
  2. Retouch the areas where paint has peeled off.

17-3 Operation in a dusty or windy place

1. Clean the air cleaner element earlier than usual.
2. Earlier maintenance is required for the oil cooler and radiator core in order to prevent clogging.

17-4 Operation at a rocky site

1. Carefully check that the crawlers are free from cracks, wear, damage, etc.

17-5 Operation in cold weather

1. Check the level and specific gravity of the battery electrolyte, and recharge the battery earlier than in mild weather.
2. Use the lubricating oil and hydraulic oil recommended for cold weather.
3. Be sure to discharge the engine coolant if antifreeze is not used.
4. Drain water completely from the fuel tank. Replenish fuel after operation and drain precipitated water from the tank before operation.
5. When stowing away the machine, place planks under the crawlers to prevent freezing. In addition, avoid a location exposed to strong wind and cover the machine with canvas or the like.

18. STOWAGE OF MACHINE

Take the following measures when stowing away the machine for a long time.

18-1 Preparation for stowage

1. Select a place where no damage can be caused by wind or water and park the machine on level ground.
2. When the machine is not intended to be used for 10 days or longer, lower the front attachment to the ground regardless of its type, length, etc. This measure should also be taken before stowage for less than 10 days if strong winds, an earthquake or the like is anticipated.
3. All parts required to be greased as stated on the lubrication chart should be greased. All reduction gears, the hydraulic oil tank, and engine oil pan should be supplied with the determined oil up to the specified level.
4. All control levers should be set in neutral. All brakes and locks should be applied and engaged.
5. All control switches should be turned off. Any disconnected electric terminal of the front attachment should be completely sealed with vinyl tape.
6. When the ambient temperature is expected to fall below 0°C, drain the radiator coolant completely unless antifreeze is added. Attach a tag saying that water has been drained. Water for the cab heater should also be drained.
7. Disconnect battery terminals and cover the battery, or dismount and stow it away.
8. Close every machine door completely and engage the lock key when provided.
9. When stowing the machine for over a month, clean each section and cover the base machine with canvas or the like.

18-2 Maintenance during stowage

1. Run the engine under no load for 30 to 60 minutes once a month. When the tower crane is lowered on the ground, hoist the boom every other month up to the working position and perform no-load operation for about one hour.
2. During no-load operation, check to see if each device (particularly safety devices in the case of the crane configuration) operates normally. If any device does not operate normally, it must be repaired immediately.
3. Recharge the battery every month.

18-3 Preparation for operation after stowage

1. Before starting the engine, carry out the general appearance check.
   a. Confirm that oil is not leaking from the engine, hydraulic equipment, piping, etc.
   b. Confirm that the front attachment does not have an ejected joint pin or loose bolt.
   c. Confirm that wire ropes are in normal condition and they are not caught by the joint pin, etc.

18-3 Preparation for operation after stowage (continued)

2. Drain water from:
   a. Engine oil pan
   b. Hydraulic oil tank
   c. All reduction gear cases
   d. Fuel tank
      - Confirm that oil is contained up to the specified level
   e. Check that radiator coolant is contained up to the specified level
3. Grease all points specified in the lubrication chart
4. After starting the engine, run it at idling speed for about 5 minutes. During idling, perform the following confirmations:
   a. Confirm that oil is not leaking
   b. Confirm that no abnormal sound is emitted
   c. Confirm that the clutch and brake of the main drum function satisfactorily
   d. Confirm that drum locks and brakes function normally. In particular, normal functioning of the auxiliary (jib hoisting) drum in the tower crane configuration must be confirmed with utmost care.
5. After setting the machine in the working position, avoid starting crane work immediately. Instead, carry out the following:
   a. Perform no-load operation for about 10 minutes in order to confirm that each device (particularly safety devices) operate normally.
   b. Confirm that the same operability as before stowage is available.

19. BOOM GUIDELINES & REPAIR PROCEDURES

WARNING

THE STRUCTURAL AND MECHANICAL PARTS OF AMERICAN CRANES ARE BUILT FROM A VARIETY OF STEELS, MANY OF WHICH ARE HEAT TREATED OR CONTAIN SPECIAL ALLOYS. BECAUSE OF THIS, WELDING IN MOST CASES IS EXTREMELY CRITICAL AND MUST BE PERFORMED WITH THE CORRECT PROCEDURE, OR DAMAGE WILL RESULT. THIS DAMAGE IS NOT ALWAYS READILY VISIBLE BUT NONE THE LESS CAN BE QUITE SERIOUS.

Therefore, for all welding procedures not specifically covered in your service parts manual, it is imperative that you contact the Customer Service Department at American Crane for detailed welding instructions.

Failure to use the proper welding procedures will result in weakened and/or damaged portions of the crane.

Do not weld on any structural element of the crane without first consulting the Service Manual or American Crane Customer Service Department.

When welding, attach the ground cable directly to the piece or area you are welding. This will prevent arc and current from traveling through bearings, bushings, and spacers.

American Crane Corporation does not authorize any type of repair in the field or shop on tubular high lift jibs. If it becomes necessary to replace lacings, the replacement must be performed by a welder supplied by American Crane Corporation.

TUBULAR CHORD BOOM GUIDELINES FOR FIELD EVALUATION

⚠ WARNING

DO NOT USE any Boom Sections that do not meet ALL of the following conditions. Any conditions which are not met must be corrected prior to use.

TUBULAR CHORD BOOM SECTIONS

1.0 SCOPE

This procedure provides the guidelines and essential requirements in the determination, feasibility, methods and limitations of field repair of tubular boom sections, excluding tubular chord high lift jibs. The replacement of specific boom section components shall be governed by procedures that identify that particular repair.

2.0 POLICY

2.1 The evaluation and/or subsequent repairs to any tubular boom section shall be performed by qualified personnel. The materials used in American boom construction include quenched and tempered carbon and alloy steels that require conformance to the applicable procedure to avoid any irreversible damage. **American assumes no liability for repairs performed by personnel not employed by American Crane.**

2.2 Damage to the lacing or to the chords (four [4] corner members) may render that boom section unfit for use in its damaged condition. A complete examination of the entire section is required to determine the type and extent of the damage incurred. Visual and magnetic particle (yoke) method examinations must be utilized in the determination of repair feasibility.

2.3 This procedure applies to all tubular boom sections wherein the boom section size is forty-seven inches (47") or larger. Boom sections used in jib applications shall be included in this procedure providing the section size is equal to or greater than forty-seven inches (47")

2.4 Definitions

2.4.1 To provide a common understanding and consistent interpretation of the terms used within this procedure, the following definitions will apply:

2.4.1.1 "Unrestrained Chord"

Area of chord in which connecting lacings have been cut free of the chord.

2.4.1.2 "Gouge"

A condition of the chord surface wherein material has been removed or displaced resulting in reduced chord wall thickness. The reduced wall thickness may have been caused by being struck by a sharp instrument or object, or wear due to an abrasive action, and it is generally fairly sharp and/or severe.

2.4.1.3 "Dent"

A condition wherein the chord surface has been deformed from its normal rounded shape, and is without any noticeable removal of the material itself. The dent shall be considered as having no effect on the overall straightness of the chord. A dent may be the result of being struck by or striking a flat or rounded object.

2.4.1.4 "Bend"/"Bow"

A condition of a chord wherein deformation of the chord results in a permanent change of direction to the centerline straightness of that chord. A bent chord may be the result of hitting or being hit by another object severely enough to cause the directional change of the chord centerline straightness, within a relatively short distance, and is usually noticeable on both sides of the chord.

Bent or buckled chords shall not be repaired and that boom section shall be rendered unfit for further use.

3.0 REFERENCES

This procedure provides the guidelines and essential requirements in the determination, feasibility, methods and limitations of field repair of tubular boom sections, excluding tubular chord high lift jibs. The replacement of specific boom section components shall be governed by procedures that identify that particular repair.

3.1 American Welding Standard WEL-2000 (Reference: Pages 715.1 thru 715.3, American Operating and Maintenance Manual) - Welding Procedure for Lacing Replacement in High Strength Tubular Booms.

4.0 CLASSIFICATION OF BOOM REPAIR

4.1 Lacing Replacement: American Welding Standard WEL-2000 designates the procedure to successfully remove and replace lacing in a boom section. Acceptability of any given boom section for lacing replacement shall be contingent on the chord condition defined in this procedure

4.2 Boom Splice Replacement: Contact American Customer Service Department for boom splice replacement.

SEE TABLE VI FOR BOOM SPLICE JOINT INSPECTION CRITERIA

4.3 Chord Examination

4.3.1 Chord Straightness

4.3.1.1 The method used to determine chord straigtness shall be by positioning two

(2) blocks of equal dimensions, one at each end of the chord, drawing a wire or line taut over the two blocks, and measuring the variations to the chord surface.

4.3.1.2 Chord straightness measurements must be taken to determine the maximum out of straight condition, both planes (horizontal and vertical) prior to lacing removal. Assessment of the length and location of an out of straight condition of the chord shall be included in this examination.

4.3.1.3 Damaged lacing may affect the chord straightness in any segment of the total length of that boom section. Damaged lacings in these areas must be cut free from the chord to determine their effect on that one particular cord. Re-examine chord for straightness when free of lacings in the location of the acceptable out of straight condition. In the event the lacings removed may affect the end plane squareness, a squaring fixture or boom section must be used to hold the affected end.

4.3.1.4 The maximum variation from straight in an unrestrained chord (reference 2.4.1.1) that will permit a straightness repair may not exceed the values in Table I. Specific restrictions on the minimum length allowing a straightening repair, and the number of chords affected in a given boom section are stated in Table II (see next page).

TABLE I

CHORD VARIATIONS FROM STRAIGHT (UNRESTRAINED) ALLOWING REPAIR

CHORD DIAMETER (INCHES)	Length of Section (Feet)				
	10	20	30	40	50
3	1/4"	1/4"	5/16"	3/8"	-
3½	1/4	1/4	5/16	3/8	-
4	1/4	1/4	5/16	3/8	-
4½	1/4	1/4	5/16	3/8	7/16
5	1/4	5/16	3/8	7/16	1/2
5½	1/4	5/16	3/8	7/16	1/2
6	1/4	5/16	3/8	7/16	1/2

See 4.3.1.5 for Straightness Requirement after repairs

4.3.1.5 With the boom section ends secured to other boom sections, or squaring fixtures, and with all restraining lacings removed, straighten the chord to within 1/8" (one eighth inch) of absolute straight. This may be accomplished by pulling or pushing the chord straight by applying a load at the location of bow. The load applied may be by use of a come-along, load binder, or other device. **Do not use heat** to straighten the chord. Care must be exercised to avoid additional damage to chord surface when applying load to straighten. Protect surfaces by using belting, partial sleeves, etc.

Position and tack weld the lacings in place and complete the welding in accordance with American WEL-2000. Weld discontinuities or nonconformances shall be removed and repaired, and the welds re-examined in the same manner as specified for the original welding.

Remove the reworked boom section from the fixtures used and re-examine for chord straightness, lacing to chord welds for soundness, and the total section for possible twist within that section.

4.3.2 Chord Surface

4.3.2.1 Boom section chords (four [4] corner members) that receive damage by whatever the cause, must receive a thorough examination to determine the acceptability of that boom section for possible future use. the four (4) chords are the main load carrying members of a boom section, and, depending on the type and severity of the damage, may render that section unfit for use.

4.3.2.2 To determine the type of damage incurred, refer to Section 2.4, "Definitions", of this procedure to identify the type of damage. Two types of chord damage (gouge and dent) may allow a repair, while a bent chord will not allow a repair.

4.3.2.3 Gouged Chord Surface

4.3.2.3.1 Chords wherein a "gouge" type damage condition exists must meet the requirements in Table III. The minimum wall thickness shall control the maximum depth limit of any gouge. Chord wall thicknesses vary, even somewhat within the same chord, making it critical that the actual chord wall thickness be known. An ultrasonic thickness measuring instrument is required to determine the actual wall thickness at the location of the gouge and the areas adjacent to the gouge. **The minimum wall thickness requirement is absolute and a chord with wall thickness below that value shown in Table III will not be repaired or used**. Chords with wall thicknesses greater than nominal shall be allowed up to the maximum depth shown in Table III, but never reducing wall thickness below the minimum value shown.

TABLE II

CHORD STRAIGHTNESS RESTRICTIONS ALLOWING REPAIR

MINIMUM LENGTH FOR MAXIMUM VARIATION FROM STRAIGHT (TABLE I) - 8 FEET NUMBER OF CHORDS REQUIRING STRAIGHTENING MAY NOT EXCEED - 2

TABLE III

CHORD SURFACE - GOUGE TYPE CONDITION

Nominal Wall Thickness (Inches)	Minimum Wall Thickness (Inches)	Maximum Depth of Gouge (Inches)
.188	.174	.025
.250	.230	.035
.375	.345	.050
.500	.462	.060
.625	.587	.070
1.000	.940	.125

4.3.2.3.2 The maximum length and width of a gouge is also a consideration affecting the feasibility of repair. The maximum length shall not exceed one (1) times the chord diameter. The maximum width shall not exceed twenty five percent (25%) of the chord diameter. The **length** of gouge should run with length of chord and not across chord.

4.3.2.3.3 Repair of a gouge shall only be accomplished by the tapering of the surface adjacent to the gouge by grinding, filing, etc., to avoid any abrupt change on the surface contour. Care must be exercised to control heat created in blending; the temperature shall not exceed 200° F. The tapered length and width of the gouge shall be equal to or greater than twenty (20) times the actual depth of the depression.

4.3.4.3.4 Surface damage identified as dents, but which are smaller in length and width than the material thickness shall be regarded as gouges.

4.3.2.4 Dented Chord Surfaces

4.3.2.4.1 Chord wherein a "dent" type damage condition exists must meet the requirement specified in Table IV. There shall be no abrupt (sharp) change in chord surface at the edges of a dent. Abrupt changes will require minimum wall thickness determination and must be judged at that point or points the same as a gouge. An ultrasonic thickness measuring instrument is required to insure the minimum wall thickness (Table III) is maintained.

TABLE IV

CHORD SURFACE - DENT TYPE CONDITION

Nominal Wall Thickness (Inches)	Depth (Inches)	Maximum Allowable Length (Inches)	Width (Inches)
.188	.030	3.0	.500
.250	.050	4.0	1.00
.375	.065	4.5	1.00
.500	.080	5.0	1.00
.625	.100	6.0	1.50
1.000	.125	10.0	2.00

4.3.2.5 Other Limitations

4.3.2.5.2 The minimum distance between dents, gouges, or dent and gouges shall be three (3) times the chord tube diameter. Example: A four (4) inch diameter chord tube will require a minimum distance of twelve (12) inches between these types of surface damage.

4.3.2.5.3 Surface deterioration by corrosion shall be governed by the minimum wall thickness specified in Table III.

The chord must be sand blasted to remove all corrosion and an ultrasonic thickness measuring instrument is required to measure the minimum wall thickness that remains.

When inspecting booms for corrosion, particular attention should be paid to areas of the chords or lacings that are wrapped or clamped. Corrosion can occur under the boom timber clamps, rope rub wraps, and other places that could conceal moisture.

Before placing boom section back into service, it should be re-primered and finish painted to protect against future corrosion.

4.4 Repaired Boom Section Examination

4.4.1 Each repaired boom section shall be examined for chord straightness, chord surface condition, lacing to chord weld conformance, and boom section twist after the removal from other boom sections or fixtures. These examinations shall be in conformance with the table and/or the instructions included within this procedure, or their own governing procedure.

4.4.2 Twist is the measured difference of one end of the boom section to the other end of that section on the same plane. Twist shall not exceed the dimensional tolerance specified in Table V.

TABLE V

BOOM SECTION TWIST TOLERANCE

	Boom Section Length (Feet)				
	10	20	30	40	50
Maximum Tolerance (Inches)	.065	.080	.120	.160	.200

TABLE VI

AMERICAN CRANE
BOOM SPLICE JOINT INSPECTION CRITERIA

Boom Size	Boom Connecting Pin Minimum	Boom Connecting Bore Maximum*	Maximum Difference Pin to Bore
47"	1.8636	1.879	.012
59"	1.8636	1.879	.012
77"	2.3626	2.380	.015
92"	2.3626	2.380	.015
94"	2.9886	3.006	.015

***Elongation of bore is a maximum of .002 difference at 90 degree readings**

AMERICAN CRANE
ANGLE CHORD BOOM SPLICE JOINT INSPECTION CRITERIA

Boom Size	Boom Connecting Pin Minimum	Boom Connecting Bore Maximum*	Maximum Difference Pin to Bore
37"	1.3636	1.379	.012
46"	1.8636	1.879	.012
58"	2.3626	2.380	.015

Angle chord boom splice joint inspection criteria supplied for your reference

⚠ CAUTION

FOR ANY INSPECTIONS THAT ARE NOT WITHIN THESE GUIDELINES, CONSULT AMERICAN CRANE SERVICE DEPARTMENT. DO NOT ATTEMPT ANY REPAIRS WITHOUT APPROVAL OF AMERICAN CRANE.

ANGLE CHORD BOOM GUIDELINES FOR FIELD EVALUATION

⚠ WARNING

DO NOT USE any Boom Sections that do not meet ALL of the following conditions. Any conditions which are not met must be corrected prior to use.

ANGLE CHORD BOOM SECTIONS

1.0 SCOPE

This procedure provides the guidelines and essential requirements in the determination, feasibility, methods and limitations for field repair of angle chord boom sections, including angle chord jibs. The replacement of specific boom section components shall be governed by procedures that identify that particular repair.

2.0 POLICY

2.1 The evaluation and/or subsequent repairs to any angle boom section shall be performed by qualified personnel. The materials used in American boom construction include quenched and tempered carbon and alloy steels that require conformance to the applicable procedure to avoid any irreversible damage. **American assumes no liability for repairs performed by personnel not employed by American Crane.**

2.2 Damage to the lacing or to the chords (four [4] corner members) may render that boom section unfit for use in its damaged condition. A complete examination of the entire section is required to determine the type and extent of the damage incurred. Visual and magnetic particle (yoke) method examinations must be utilized in the determination of repair feasibility.

2.3 This procedure applies to all angle chord boom and jib sections

2.4 Definitions

2.4.1 To provide a common understanding and consistent interpretation of the terms used within this procedure, the following definitions will apply:

2.4.1.1 "Unrestrained Chord"

Area of chord in which connecting lacings have been cut free of the chord.

2.4.1.2 "Gouge"

A condition of the chord surface wherein material has been removed or displaced resulting in reduced chord thickness. The reduced thickness may have been caused by being struck by a sharp instrument or object, or wear due to an abrasive action, and it is generally fairly sharp and/or severe.

2.4.1.3 "Dent"

A condition wherein the chord surface has been deformed from its normal shape, and is without any noticeable removal of the material itself. The dent shall be considered as having no effect on the overall straightness of the chord. A dent may be the result of being struck by or striking a flat or rounded object.

2.4.1.4 "Bend"

A condition of a chord wherein deformation of the chord results in a permanent change of direction to the centerline straightness of that chord. A bent chord may be the result of hitting or being hit by another object severely enough to cause the directional change of the chord centerline straightness, within a relatively short distance, and is usually noticeable on both legs of the chord.

Bent or buckled chords shall not be repaired and that boom section shall be rendered unfit for further use.

3.0 REFERENCES

3.1 American Welding Standard WEL-2013 or 2012 (Reference: Pages 715.6 thru 715.9 or 715.12 thru 715.14 and 716-717, American Operating and Maintenance Manual) - Welding Procedure for Lacing Replacement in Angle Chord Tubular Booms.

4.0 CLASSIFICATION OF BOOM REPAIR

4.1 Lacing Replacement: American Welding Standard WEL-2013 or 2012 disignates the procedure to successfully remove and replace lacing in a boom section. Acceptability of any given boom section for lacing replacement shall be contingent on the chord condition defined in this procedure.

4.2 Boom Splice Replacement: **Contact American Customer Service Department for boom splice replacement.**

SEE TABLE VI FOR BOOM SPLICE JOINT INSPECTION CRITERIA

4.3 Chord Examination

4.3.1 Chord Straightness

4.3.1.1 The method used to determine chord straightness shall be by positioning two (2) blocks of equal dimensions, one at each end of the chord, drawing a wire or line taut over the two blocks, and measuring the variations to the chord surface.

4.3.1.2 Chord straightness measurements must be taken to determine the maximum out of straight condition, both planes (horizontal and vertical) prior to lacing removal. Assessment of the length and location of an out of straight condition of the chord shall be included in this examination.

4.3.1.3 Damaged lacing may affect the chord straightness in any segment of the total length of that boom section. Damaged lacings in these areas must be cut free from the chord to determine their effect on that one particular cord. Re-examine chord for straightness when free of lacings in the location of the unacceptable out of straight condition. In the event the lacings removed may affect the end plane squareness, a squaring fixture or boom section must be used to hold the affected end.

4.3.1.4 The maximum variation from straight in an unrestrained chord (reference 2.4.1.1) that will permit a straightness repair may not exceed the values in Table I. Specific restrictions on the minimum length allowing a straightening repair, and the number of chords affected in a given boom section are stated in Table II (see next page).

TABLE I

CHORD VARIATIONS FROM STRAIGHT (UNRESTRAINED) ALLOWING REPAIR

CHORD ANGLE (Inches)	LENGTH OF SECTION (Feet) 10	20	30	40
2"	1/4"	-	-	-
2 1/2"	1/4"	1/4"	-	-
3"	1/4"	1/4"	-	-
3 1/2"	1/4"	1/4"	5/16"	3/8"
4"	1/4"	1/4"	5/16"	3/8"
5"	1/4"	5/16"	3/8"	7/16"
6"	1/4"	5/16"	3/8"	7/16"

See 4.3.1.5 for Straightness Requirement after repairs.

4.3.1.5 With the boom section ends secured to other boom sections, or squaring fixtures, and with all restraining lacings removed, straighten the chord to within **1/8"** (one eighth inch) of absolute straight. This may be accomplished by pulling or pushing the chord straight by applying a load at the location of bow. The load applied may be by use of a come-along, load binder, or other device. **Do not use heat** to straighten the chord. Care must be exercised to avoid additional damage to chord surface when applying load to straighten. Protect surfaces by using belting, wood blocking, etc.

Position and tack weld the lacings in place and complete the welding in accordance with American WEL-2013 or 2012. Weld discontinuities or nonconformances shall be removed and repaired, and the welds re-examined in the same manner as specified for the original welding.

Remove the reworked boom section from the fixtures used and re-examine for chord straightness, lacing to chord welds for soundness, and the total section for possible twist within that section.

4.3.2 Chord Surface

4.3.2.1 Boom section chords (four [4] corner members) that receive damage by whatever the cause, must receive a thorough examination to determine the acceptability of that boom section for possible future use. The four (4) chords are the main load carrying members of a boom section, and, depending on the type and severity of the damage, may render that section unfit for use.

4.3.2.2 To determine the type of damage incurred, refer to Section 2.4, "Definitions", of this procedure to identify the type of damage.

4.3.2.3 Gouged Chord Surface

4.3.2.3.1 Chords wherein a "gouge" type damage condition exists must meet the requirements in Table III. The minimum thickness shall control the maximum depth limit of any gouge. Chord wall thicknesses vary, even somewhat within the same chord, making it critical that the actual chord thickness be known. **The minimum thickness requirement is absolute and a chord with thickness below that value shown in Table III will not be repaired or used**. Chords with thicknesses greater than nominal shall be allowed up to the maximum depth shown in Table III, but never reducing thickness below the minimum value shown.

TABLE II

CHORD STRAIGHTNESS RESTRICTIONS ALLOWING REPAIR

MINIMUM LENGTH FOR MAXIMUM VARIATION FROM STRAIGHT (TABLE I) - 8 FEET NUMBER OF CHORDS REQUIRING STRAIGHTENING MAY NOT EXCEED - 2

TABLE III

CHORD SURFACE - GOUGE TYPE CONDITION

Nominal Angle Thickness (Inches)	Minimum Angle Thickness (Inches)	Maximum Depth of Gouge (Inches)
.188	.176	.025
.312	.300	.040
.375	.360	.050
.500	.485	.065
.562	.547	.075

4.3.2.3.2 The maximum length and width of a gouge is also a consideration affecting the feasibility of repair. The maximum length shall not exceed one **(1) times** the chord width. The maximum width shall not exceed twenty five percent (25%) of the chord width. The **length** of gouge should run with length of chord and not across chord.

4.3.2.3.3 Repair of a gouge shall only be accomplished by the tapering of the surface adjacent to the gouge by grinding, filing, etc., to avoid any abrupt change on the surface contour. Care must be exercised to control heat created in blending; the temperature shall not exceed 200° F. The tapered length and width of the gouge shall be equal to or greater than twenty (20) times the actual depth of the depression.

4.3.4.3.4 Surface damage identified as dents, but which are smaller in length and width than the material thickness shall be regarded as gouges.

4.3.2.4 Dented Chord Surfaces

4.3.2.4.1 Chord wherein a "dent" type damage condition exists must meet the requirement specified in Table IV. There shall be no abrupt (sharp) change in chord surface at the edges of a dent. Abrupt changes will require minimum thickness determination and must be judged at that point or points the same as a gouge. A micrometer or vernier is required to insure the minimum thickness (Table III) is maintained.

The "square" of the angle must also be maintained. Maximum allowable out of square is .025 x (times) length of angle leg.

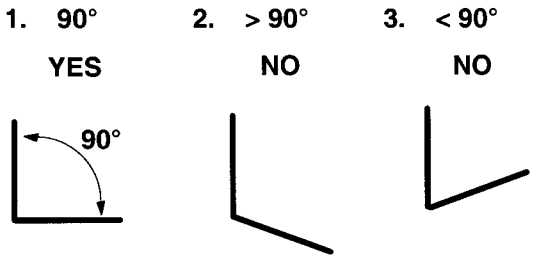


TABLE IV

CHORD SURFACE - DENT TYPE CONDITION

Nominal Thickness (Inches)	Depth (Inches)	Maximum Allowable Length (Inches)	Width (Inches)
.188 = 3/16	.030	3.0	0.50
.312 = 5/16	.050	4.0	1.00
.375 = 3/8	.065	4.5	1.00
.500 = 1/2	.080	5.0	1.00
.562 = 9/16	.100	6.0	1.50

4.3.2.5 Other Limitations

4.3.2.5.2 The minimum distance between dents, gouges, or dent and gouges shall be three (3) times the chord width. Example: A four (4) inch chord will require a minimum distance of twelve (12) inches between these types of surface damage.

4.3.2.5.3 Surface deterioration by corrosion shall be governed by the minimum thickness specified in Table III.

The chord must be sand blasted to remove all corrosion and using a caliper measure the minimum thickness that remains.

When inspecting booms for corrosion, particular attention should be paid to areas of the chords or lacings that are wrapped or clamped. Corrosion can occur under the boom timber clamps, rope rub wraps, and other places that could conceal moisture.

Before placing boom section back into service, it should be re-primered and finish painted to protect against future corrosion.

4.4 Repaired Boom Section Examination

4.4.1 Each repaired boom section shall be examined for chord straightness, chord surface condition, lacing to chord weld conformance, and boom section twist after the removal from other boom sections or fixtures. These examinations shall be in conformance with the table and/or the instructions included within this procedure, or their own governing procedure.

4.4.2 Twist is the measured difference of one end of the boom section to the other end of that section on the same plane. Twist shall not exceed the dimensional tolerance specified in Table V.

TABLE V

BOOM SECTION TWIST TOLERANCE

	Boom Section Length (Feet)			
	10	20	30	40
Maximum Tolerance (Inches)	.065	.080	.120	.160

TABLE VI

AMERICAN CRANE
ANGLE BOOM SPLICE JOINT INSPECTION CRITERIA

Boom Size	Boom Connecting Pin Minimum	Boom Connecting Bore Maximum*	Maximum Difference Pin to Bore
26"	1.3636	1.379	.012
30"	1.3636	1.379	.012
37"	1.3636	1.379	.012
46"	1.8636	1.879	.012
58"	2.3626	2.380	.015

***Elongation of bore is a maximum of .002 difference at 90 degree readings**

AMERICAN CRANE
ANGLE JIB SPLICE JOINT INSPECTION CRITERIA

Jib Size	Jib Connecting Pin Minimum	Jib Connecting Bore Maximum*	Maximum Difference Pin to Bore
# 6	1.116	1.128	.010
# 9	1.116	1.128	.010
# 15	1.116	1.128	.010

***Elongation of bore is a maximum of .002 difference at 90 degree readings**

⚠ CAUTION

FOR ANY INSPECTIONS THAT ARE NOT WITHIN THESE GUIDELINES, CONSULT AMERICAN CRANE SERVICE DEPARTMENT. DO NOT ATTEMPT ANY REPAIRS WITHOUT APPROVAL OF AMERICAN CRANE.

LACING REPAIR
(Sleeve Method)

TUBULAR BOOMS ONLY

1. Read Welding Instructions found in this tab before welding.
2. Saw off the entire damaged portion of the lacing. The absolute minimum length of undamaged lacing is 2-1/2" (6.35cm): the maximum length is 6" (15.24cm) (See Figure 1, B1 and B2). You must contact the Customer Service Department if welding is to be performed closer than 2" (5.08cm) to the chords.
3. Determine distance "C" between the stubs and measure the outside diameter of the stubs.
4. Select the required size repair tube from Table A. The repair tube length must be 1" (2.54cm) longer than dimension "C" giving a 1/2" (12.70mm) overlap on each stub. (See Figure 1).

Note: All welds to be unequal leg fillets. To eliminate notches for leg sizes, see Table "A".

5. Thoroughly clean the repair tube and stubs using degreasing solvents. Remove the paint from the welding area.
6. Mark the stubs so that when you slip the repair tube on, you can be sure it overlaps both stubs evenly.
7. When welding, use a fillet weld all around both ends. Use an E-7018 (ACC 826840) electrode. (See Figure 1).

   Electrodes are sold in 10 lb. (4.54kg) hermetically sealed cans.

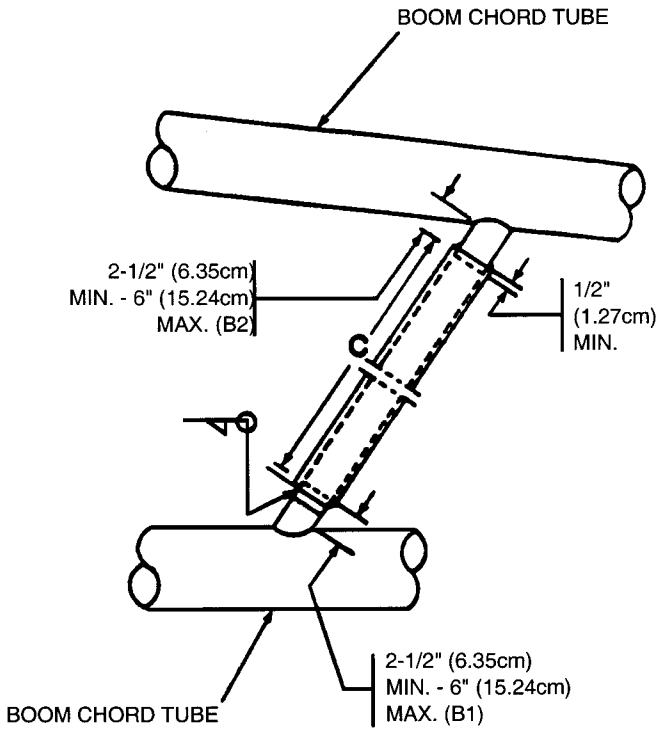


FIGURE 1

MAXIMUM NUMBER OF SLEEVE REPAIRS ALLOWED	LENGTH OF BOOM SECTION		
	10'	20' + 30'	40' + 50'
PER PANEL	3	4	5
PER SECTION	6	10	14

LOW CARBON STEEL 0.25% MAXIMUM TUBING MATERIAL (FOR SLEEVE REPAIR ONLY)

Table "A"

BOOM SIZE INCHES	SIZE OF ORIGINAL LACING	RECOMMENDED TUBE FOR REPAIRS	
		SIZE	PART NO.
47"	1-1/4" OD	1-1/2" OD x 0.095" Wall x 6'-6"	815986
59" 76" 77" 92"	1-5/8" OD	1-7/8" OD x 0.095" Wall x 6'-6"	815987
77"	1-7/8" OD	2-1/8" OD x 0.095" Wall x 6'-8"	826568
76" 77" 92"	2" OD	2-1/4" OD x 0.095" Wall x 6'-0" 2-1/4" OD x 0.095" Wall x 8'-0"	815988 815988-2
92" 94"	2-1/4" OD	2-1/2" OD x 0.095" Wall x 8'-0"	840300
92" 94"	2-1/2" OD	2-3/4" OD x 0.095" Wall x 6'-0" 2-3/4" OD x 0.095" Wall x 8'-0"	826712 826712-2
94"	2-3/4" OD	3-1/4" OD x 0.188" Wall x 8'-0"	840301
94"	3" OD	3-1/2" OD x 0.188" Wall x 8'-0"	840302
94"	3-1/2" OD	4-1/8" OD x 0.250" Wall x 8'-0"	840303
94"	4" OD	4-5/8" OD x 0.250" Wall x 8'-0"	840304

Table "A" (Metric)

BOOM SIZE METERS	SIZE OF ORIGINAL LACING	RECOMMENDED TUBE FOR REPAIRS	
		SIZE	PART NO.
1.19	3.18cm OD	3.8cm OD x 241cm Wall x 1.98m	815986
1.50. 1.93. 1.96. 2.34	4.13cm OD	4.8cm OD x 241cm Wall x 1.98m	815987
1.96	4.76cm OD	5.4cm OD x 241cm Wall x 2.03m	826568
1.93. 1.96. 2.34	5.08cm OD	5.7cm OD x 241cm Wall x 1.83m 5.7cm OD x 241cm Wall x 2.44m	815988 815988-2
2.34. 2.39	5.72cm OD	6.4cm OD x 241cm Wall x 2.44m	840300
2.34. 2.39	6.35cm OD	7.0cm OD x 241cm Wall x 1.83m 7.0cm OD x 241cm Wall x 2.44m	826712 826712-2
2.39	6.99cm OD	8.3cm OD x 478cm Wall x 2.44m	840301
2.39	7.62cm OD	9.0cm OD x 478cm Wall x 2.44m	840302
2.39	8.89cm OD	10.5cm OD x 635cm Wall x 2.44m	840303
2.39	10.16cm OD	11.8cm OD x 635cm Wall x 2.44m	840304

Note: Do not use the above listed sleeve material for complete lacing replacement. The material specifications for sleeve lacing material are different than the material specifications of original lacings used in all tubular booms.

WELDING PROCEDURES FOR LACING REPLACEMENT IN HIGH STRENGTH TUBULAR BOOMS

WELDING PROCEDURES

1.0 SCOPE

1.1 The following welding procedure shall be used when replacing lacing on high strength tubular booms of the following sizes: 47", 59", 77", 92", standard and heavy duty.

1.1.1 This procedure shall be used only when the lacing repair method stated on Pages 3-93 & 3-94 of the Operating and Maintenance Manual **cannot** be used.

1.1.2 This procedure obsoletes previously issued welding standards WEL-2000 through WEL-2011 (last issue dated October, 1977) and combines the welding procedure requirements into a common welding standard.

1.2 This procedure does not apply to the repair of tubular high lift jibs, since these types of repairs are **not** authorized by American Crane. If jib damage has occurred, contact the American Crane Service Department.

2.0 RESPONSIBILITY

2.1 The Structural components of American products are manufactured from a variety of heat treated carbon and alloy steels. Because of this, welding is extremely critical and must be performed in accordance with the proper welding procedure (which will be supplied by American), or **permanent damage will result**.

Satisfactory repairs can be achieved if the welding procedures are followed by a qualified welder. However, due to the unique requirements of performing these repairs, it is understood that American assumes no liability for any repairs performed by any personnel other than certified welders employed by American Crane. American Crane will provide, at your request, certified welders anywhere in the world for a nominal charge.

2.2 American Crane Corporation strongly recommends that welders performing lacing replacement welding be qualified in accordance with the A.W.S. Structural Welding Code - D1.1, A.W.S. Specifications for Welding Earthmoving and Construction Equipment - D14.3 (Method A), A.S.M.E. Pressure Vessel Code - Section IX, A.P.I. Standard for Welding Pipelines and Related Facilities - Standard 1104, or an equivalent industry accepted code or standard.

3.0 FOR INFORMATION AND MATERIAL

3.1 If any doubt arises on the feasibility of repairing a boom or additional information is required contact:

American Crane Corporation
Service Department
202 Raleigh Street
Wilmington, NC USA 28412

Telephone: (910) 395-8500
FAX: (910) 395-8538

3.2 Through the use of the "Tubular Boom Lacing Request Form" OE-153, secure replacement lacing from American Crane Corporation **ONLY**. Lacings are a special material and have critical dimensions.

4.0 INSPECTION OF BOOM SECTION PRIOR TO REPAIR

4.1 Visually examine the entire boom section to determine the extent of damage to lacing, chord tubes, boom splice (pin end) castings, and other parts.

4.2 The chord tube must not be damaged in any way. Bends, cracks, arc strikes, or gouges are not permissible. If chord tube damage is found, contact American Crane Service Department.

4.3 Inspect the boom section for corrosion damage to the lacing or chord tube, impact dents to the lacing or chord tube and cracks in the boom splice connections. If this type of damage is found, contact American Crane Service Department.

4.4 If four (4) or more damaged lacing in a row are found, contact American Crane Service Department.

4.5 If the framing lacing (the lacing that hold the boom square) or numerous lacing on one panel are damaged to the extent of possibly affecting the squareness of the boom section, the boom section must be placed in a squaring fixture or pinned to a mating boom section of known accuracy to insure squareness is maintained during lacing replacement.

4.6 If the damaged lacing have not been broken or bent at the chord tube or near the weld (within 2-1/2", 6.35cm) they should be repaired by following the lacing repair procedure detailed in the Operating and Maintenance Manual, Pages 714 and 715.

5.0 REMOVAL OF LACING

5.1 Damaged lacing are to be removed and replaced in a sequence such that chord straightness and boom section squareness are maintained.

5.2 Using a hacksaw or grinder, cut the lacing as close as possible to the chord tube. Air carbon arc cutting equipment may also be used, but, **DO NOT** cut the lacing closer than 1/2" (12.7mm) from chord tube. Grind lacing stub flush. Extreme caution must be taken during lacing removal not to gouge or remove any chord material.

5.3 Grind and blend excess lacing and weld material to the contour of the chord tube. **DO NOT** grind into the chord tube.

5.4 Clean all dirt, grease, paint, rust or other foreign matter from the weld area.

5.5 Perform Magnetic Particle or Liquid Penetrant Examination of the chord tube surface in the ground area to assure absence of cracks.

6.0 LOCATING & WELDING OF NEW LACING

6.1 When performing welding on boom sections, extreme care must be taken when attaching welding ground connection. Attach ground connection directly to the part being welded. **DO NOT** ground through bearings, bushings, etc.

6.2 Protect chords, lacing and wire rope from arc strikes and weld spatter by wrapping with insulating type blankets or use other shielding materials, i.e., steel plate, wood, etc.

6.3 Determine the position of the replacement lacing by measuring the existing good lacing junctions (see Figure 1) and locate the replacement lacing accordingly. Maximum allowable gap 1/16" (1.6mm) per end. Weld size must be increased equal to gap.

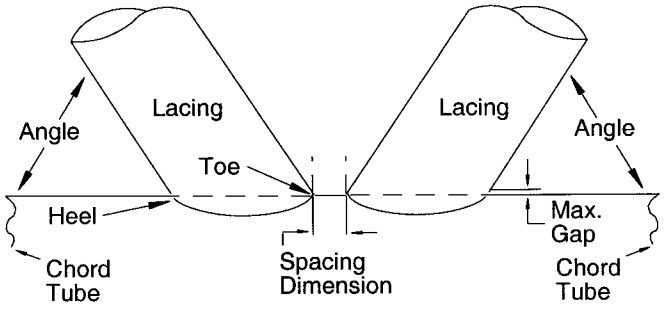


Figure 1

6.4 Locate and tack weld the replacement lacing. Place the tack weld at the toe and heel on each end. Tack weld using 3/32" (2.4mm) diameter or 1/8" (3.2mm) diameter E-9018M welding electrode.

6.5 Position the boom section so that the lacing are welded in a flat position, within the limits shown in the following figure (see Figure 2).

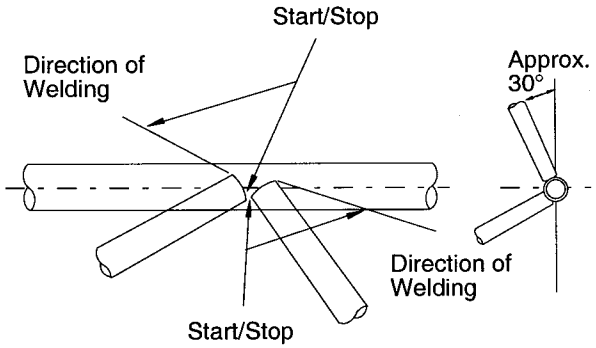


Figure 2

Note: Weld 1st side Toe to Heel and 2nd side Heel to Toe.

6.6 Select electrode type, size, amperage, voltage, weld travel speed (inches or mm per minute), preheat temperature, and interpass temperature valves from Table 1 below, based on the chord diameter or circumference.

Note: On certain boom sections the top chord tubes are different size (diameter) than the bottom chord tubes. It is of utmost importance that both the top and bottom chord tubes are measured and the proper procedure selected and used.

(1) See Section 8.0 for approved electrodes. Electrodes must meet the requirements of A.W.S. A5.5, latest revision.

6.7 Lacing shall be welded from toe to heel for one-half of the lacing and from heel to toe on the second one-half of the lacing (see Figure 2).

6.8 Chip and wire brush all slag and weld spatter between passes and at the completion of the weld. Grind out any defects and reweld.

8.0 AMERICAN CRANE APPROVED ELECTRODES

8.1 The following electrodes have been tested and are approved for use:

(A) Chemtron ATOM Arc E-9018
(B) Hobart LH 918M
(C) Airco Code Arc 9018M
(D) McKay 9018M
(E) B.O.C. Fortrex E-9018M
(F) AFROX E-9018M

Note: Electrodes MUST be obtained in hermetically sealed cans only.

9.0 ELECTRODES STORAGE & CONTROL

9.1 The welding electrodes (E-9018M) required to successfully perform the lacing replacements are a low hydrogen type. They **must** be obtained in moisture-free hermetically sealed cans, free from physical damage that would result in exposure of the electrodes to the atmosphere. It is essential that these electrodes remain moisture-free for acceptable welding application.

9.2 **Maximum** exposure time for E-9018M, once the container seal has been broken is **one (1) hour.**

9.3 Storage of these electrodes (E9018M) after the can has been opened shall be in an electrode storage oven at a temperature of at least 250°F (120°C).

9.4 Electrodes which have been exposed to the atmosphere longer than one (1) hour shall be either destroyed or baked in a oven at 750-800°F (399-427°C) for one (1) hour. The electrodes must then be cooled at a controlled rate of 250°F (120°C) over a two (2) hour span. Electrodes shall not be rebaked more than one (1) time.

TABLE 1

	Inches	3	3.5	4	4.5	5.0	6.0
Chord O. D.	mm	76.2	88.9	101.6	114.3	127.0	152.4
Chord	Inches	9.42	10.99	12.56	14.13	15.70	18.84
Circumference	mm	239.3	279.1	319.0	358.9	398.8	478.5
(1)			E-9018M		E-9018M	E-9018M	E-9018M
Electrode Type	Inches		1/8		1/8	5/32	5/32
Electrode Dia. (Max)	mm		3.2		3.2	4.0	4.0
Amperage (Max)			130		140	170	170
Voltage (Max)			22		22	22	22
Travel Speed	Inches		9		9	8	8
Per Minute (Min.)	mm		228.6		228.6	203.2	203.2
Preheat Temp.	°F		70-100		70-100	200	200
(Min)	°C		21-38		21-38	93	93
Interpass Temp.	°F		200		300	300	400
(Max)	°C		93		150	150	204

7.0 INSPECTION OF THE COMPLETED LACING REPLACEMENT

7.1 Visually inspect the finished lacing replacements completely.

7.2 The chord tube and lacing must be free of undercutting and arc strikes. If arc striking does occur, they shall be buffed out completely.

7.3 The welds must be of equal leg length on the chord tube and lacing, and equal in size to the welds on adjacent lacing. The weld must be smooth and uniform.

7.4 The start/stop areas must be relatively smooth. Craters shall be filled to at least 90% of the full weld cross section and large humps shall be blended.

7.5 Prime and finish paint all new lacing and weld areas immediately after the weld area has cooled to 100°F (38°C) or below.

WELDING PROCEDURES TO REPLACE A036 ANGLE OR TEE LACING TO A030 ANGLE CHORD

WELDING PROCEDURES

1.0 SCOPE

1.1 The following welding procedure shall be used to replace A036 Angle or Tee Lacing to A030 Angle Chord.

2.0 RESPONSIBILITY

2.1 The structural components of American Crane products are manufactured from a variety of heat treated carbon and alloy steel. Because of this, welding is extremely critical and must be performed in accordance with the proper welding procedure (which will be supplied by American Crane), or **permanent damage will result.**

Satisfactory repairs can be achieved if the welding procedures are followed by a qualified welder. However, due to the unique requirements of performing these repairs, it is understood that American assumes no liability for any repairs performed by any personnel other than certified welders employed by American Crane. American Crane will provide, at your request, certified welders anywhere in the world for a nominal charge.

2.2 American Crane Corporation strongly recommends that welders performing lacing replacement welding be qualified in accordance with the A.W.S. Structural Welding Code - D1.1, A.W.S. Specifications for Welding Earthmoving and Construction Equipment - D14.3 (Method A), A.S.M.E. Pressure Vessel Code - Section IX, A.P.I. Standard for Welding Pipelines and Related Facilities - Standard 1104, or an equivalent industry accepted code or standard.

3.0 FOR INFORMATION AND MATERIALS:

3.1 If any doubt arises on the feasibility of repairing a boom or additional information is required contact:

American Crane Corporation
Service Department
202 Raleigh Street
Wilmington, NC USA 28412

Telephone: (910) 395-8500
FAX: (910) 395-8538

3.2 Secure replacement lacing from American Crane Corporation **ONLY**. Lacings are a special material and have critical dimensions. Any substitutions **MUST** br approved by American Crane Service Department.

4.0 INSPECTION OF BOOM SECTION PRIOR TO REPAIR

4.1 Visually examine the entire boom section to determine the extent of damage.

4.2 The chord angles must not be damaged in any way. Bends, cracks, arc strikes, or gouges are not permissible. Examine chord angles for straightness. If angle chord damage is found, contact American Crane Service Department.

4.3 Inspect boom sections for corrosion damage to the lacing or to the angle chord, impact dents to the lacing or to the chord and cracks in the boom splice connections. If this type of damage is found, contact American Crane Service Department.

4.4 If four (4) or more damaged lacing in a row are found, contact American Crane Service Department.

4.5 If the framing lacing (the lacing that hold the boom square) or numerous lacing on one panel are damaged to the extent of possibly affecting the squareness of the boom section, the boom section must be placed in a squaring fixture or pinned to a mating boom section of known accuracy to insure squareness is maintained during lacing replacement.

5.0 REMOVAL OF LACING

5.1 Damaged lacing are to be removed and replaced in a sequence such that chord angle straightness and boom section squareness are maintained.

5.2 Prior to removing damaged lacing, measure and record Dimension A (Views I, II, III and IV). (See page 3-100 for illustration).

5.3 Use carbon/arc (air arc) or grinder, cut the lacing as close to the chord as possible being **careful** not to remove any chord material.

5.4 Grind and blend excess material to the contour of the chord. **Do not grind into the chord.**

5.5 Clean all dirt, grease, paint, rust or other foreign matter from the weld area.

5.6 Perform Magnetic Particle or Liquid Penetrant Examination of the chord in the ground area to assure absence of cracks.

6.0 LOCATING & WELDING OF NEW LACING

6.1 When performing welding on boom sections, extreme care must be taken when attaching welding ground connections. Attach ground connection directly to the part being welded. **DO NOT** ground through bearings, bushings, etc.

6.2 Protect **chords**, **lacing** and **wire rope** by wrapping with insulating type blankets or use other shielding materials, i.e., steel plate, wood, etc.

6.3 Secure the new lacing with a clamp to hold in position and eliminate any gaps. Position the new lacing as close as possible to the same position as the old lacing (refer to Dimension "A" which was taken per 5.2).

6.4 Locate and tack weld the replacement lacing into place. Use a 3/32" (2.4mm) diameter or 1/8" (3.2mm) diameter E7018 electrode.

6.5 Position the boom section so that the lacing may be welded in as flat a position as possible.

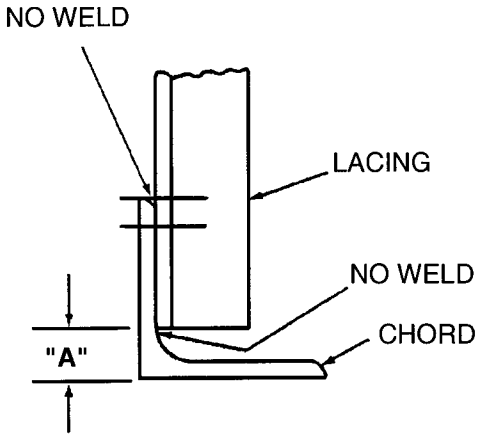
6.6 Do not weld across the top, bottom or around the corners of the lacing (refer to Views I, II, III and IV).

6.7 Weld using a 1/8" (3.2mm) E7018 electrode at 130 amperes, 22 volts. Weaving the electrode shall not exceed two (2) times the electrode diameter.

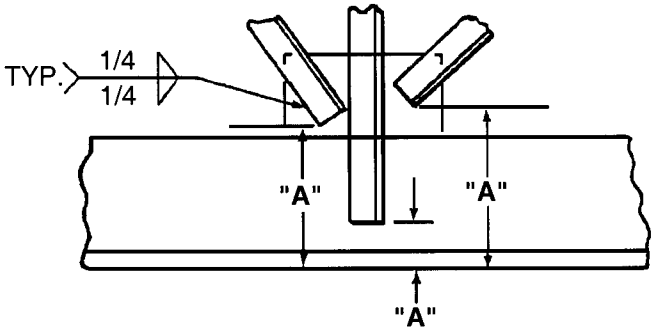
6.8 Prior to welding, the repair area within 3 inches (76.2mm) of the weld joint shall be preheated to 70-100° F (21-38° C).

6.9 A 300° F (149° C) maximum interpass temperature shall be maintained.

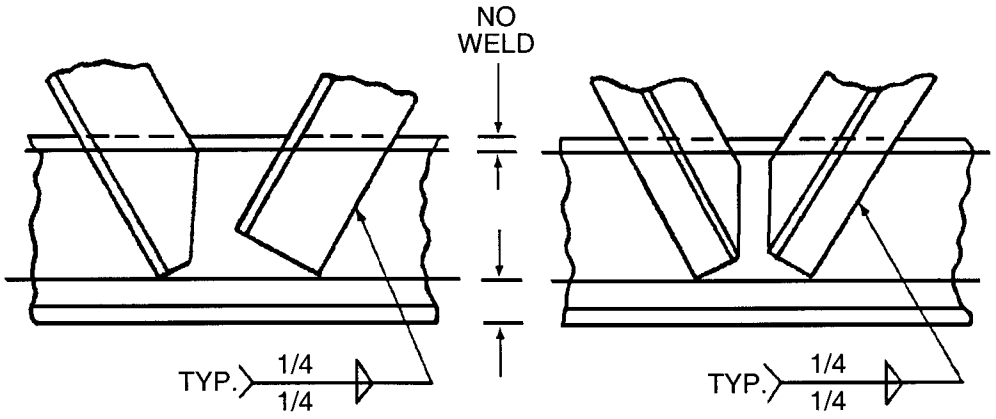
6.10 Chip, clean, and wire brush all slag and weld spatter between passes and after the final pass.



View I



View II



View III

View IV

7.0 INSPECTION OF COMPLETED LACING REPLACEMENT

7.1 Visually inspect the finished lacing replacements for weld quality and straightness of chord angles.

7.2 The welds must be of equal leg length on the angle chord and lacing. The weld must be smooth and uniform.

7.3 The start/stop areas must be smooth. Craters shall be filled to at least 90% of the full weld cross section and large humps shall be blended.

7.4 The chord and lacing shall be free from undercut. There shall be a smooth transition between the chord and the weld.

7.5 The weld and weld area must be free of arc strikes. If arc striking does occur, they shall be buffed out completely.

8.0 PAINTING

8.1 Prime and finish paint all repaired areas immediately following completion of the repairs, after the weld area has cooled to 100°F (38°C) or below.

9.0 AMERICAN CRANE APPROVED ELECTRODES

9.1 The following electrodes have been tested and are approved for use:

(A) Chemtron ATOM Arc E7018
(B) Hobart LH 718
(C) Murex Speedex HTS-M-MR
(D) Airco Code-Arc 7018MR
(E) Lincoln LH78 and LH70
(F) Esab 7018
(G) Westinghouse WIZ-18

Note: Electrodes **MUST** be obtained in **hermetically sealed cans only**.

10.0 ELECTRODE STORAGE & CONTROL

10.1 The welding electrodes (E7018) required to successfully perform the lacing replacements are a low hydrogen type. They **must** be obtained in moisture-free hermetically sealed cans, free from physical damage that would result in exposure of the electrodes to the atmosphere. It is essential that these electrodes remain moisture-free for acceptable welding application.

10.2 **Maximum** exposure time for E7018 electrodes, once the container seal has been broken, is **two (2) hours.**

10.3 Storage of these electrodes (E7018) after the can has been opened shall be in an electrode storage oven at a temperature of at least 250°F (120°C).

10.4 Electrodes which have been exposed to the atmosphere longer than **two (2) hours** shall be destroyed. Once the electrodes have been exposed to the atmosphere, even though the time limit of **two (2) hours** has not been exceeded, they shall **not** be returned to the electrode storage oven.

WELDING PROCEDURES TO REPLACE A061 CRIMPED TUBULAR LACING TO A030 ANGLE CHORD

WELDING PROCEDURES

1.0 SCOPE

1.1 The following welding procedure shall be used to replace A061 Crimped Tubular Lacing to A030 Angle Chord.

2.0 RESPONSIBILITY

2.1 The structural components of American Crane products are manufactured from a variety of heat treated carbon and alloy steel. Because of this, welding is extremely critical and must be performed in accordance with the proper welding procedure (which will be supplied by American Crane), or **permanent damage will result.**

Satisfactory repairs can be achieved if the welding procedures are followed by a qualified welder. However, due to the unique requirements of performing these repairs, it is understood that American assumes no liability for any repairs performed by any personnel other than certified welders employed by American Crane. American Crane will provide, at your request, certified welders anywhere in the world for a nominal charge.

2.2 American Crane Corporation strongly recommends that welders performing lacing replacement welding be qualified in accordance with the A.W.S. Structural Welding Code - D1.1, A.W.S. Specifications for Welding Earthmoving and Construction Equipment - D14.3 (Method A), A.S.M.E. Pressure Vessel Code - Section IX, A.P.I. Standard for Welding Pipelines and Related Facilities - Standard 1104, or an equivalent industry accepted code or standard.

3.0 FOR INFORMATION AND MATERIALS:

3.1 If any doubt arises on the feasibility of repairing a boom or additional information is required contact:

American Crane Corporation
Service Department
202 Raleigh Street
Wilmington, NC USA 28412

Telephone: (910) 395-8500
FAX: (910) 395-8538

3.2 Secure replacement lacing from American Crane Corporation **ONLY**. Lacings are a special material and have critical dimensions. Any substitutions **MUST** br approved by American Crane Service Department.

4.0 INSPECTION OF BOOM SECTION PRIOR TO REPAIR

4.1 Visually examine the entire boom section to determine the extent of damage.

4.2 The chord angles must not be damaged in any way. Bends, cracks, arc strikes, or gouges are not permissible. Examine chord angles for straightness. If angle chord damage is found, contact American Crane Service Department.

4.3 Inspect boom sections for corrosion damage to the lacing or to the angle chord, impact dents to the lacing or to the chord and cracks in the boom splice connections. If this type of damage is found, contact American Crane Service Department.

4.4 If four (4) or more damaged lacing in a row are found, contact American Crane Service Department.

4.5 If the framing lacing (the lacing that hold the boom square) or numerous lacing on one panel are damaged to the extent of possibly affecting the squareness of the boom section, the boom section must be placed in a squaring fixture or pinned to a mating boom section of known accuracy to insure squareness is maintained during lacing replacement.

5.0 REMOVAL OF LACING

5.1 Damaged lacing are to be removed and replaced in a sequence such that chord angle straightness and boom section squareness are maintained.

5.2 Using a hacksaw or oxy-fuel torch, cut the lacing as close to the chord as possible being **careful** not to remove any chord material.

5.3 Grind and blend excess material to the contour of the chord. **Do not grind into the chord.**

5.4 Clean all dirt, grease, paint, rust or other foreign matter from the weld area.

5.5 Perform Magnetic Particle or Liquid Penetrant Examination of the chord in the ground area to assure absence of cracks.

6.0 LOCATING & WELDING OF NEW LACING

6.1 When performing welding on boom sections, extreme care must be taken when attaching welding ground connections. Attach ground connection directly to the part being welded. **DO NOT** ground through bearings, bushings, etc.

6.2 Protect **chords**, **lacing** and **wire rope** by wrapping with insulating type blankets or use other shielding materials, i.e., steel plate, wood, etc.

6.3 Position the new lacing as close as possible to the same position as the old lacing. If a gap greater than 1/16 inch (1.5mm) exists at each end, remove and build up the chord by welding to reduce the gap to 1/16 inch (1.5mm) or less.

6.4 Inspect the build up area for slag, cracks or lack of fusion and repair as required.

6.5 Locate and tack weld the replacement lacing into place. Use a 3/32" (2.4mm) diameter or 1/8" (3.2mm) diameter E7018 electrode.

6.5 Position the boom section so that the lacing may be welded in as flat a position as possible.

6.7 Weld using a 1/8" (3.2mm) E7018 electrode at 130 amperes, 22 volts. Weaving the electrode shall not exceed two (2) times the electrode diameter.

6.8 Prior to welding, the repair area within 3 inches (76.2mm) of the weld joint shall be preheated to 70-100° F (21-38° C).

6.9 A 300° F (149° C) maximum interpass temperature shall be maintained to minimize burn through and uncercutting possibilities on the tubular A061 lacing.

6.10 Chip, clean, and wire brush all slag and weld spatter between passes and after the final pass.

7.0 INSPECTION OF COMPLETED LACING REPLACEMENT

7.1 Visually inspect the finished lacing replacements for weld quality and straightness of chord angles.

7.2 The welds must be of equal leg length on the angle chord and lacing. The weld must be smooth and uniform.

7.3 The start/stop areas must be smooth. Craters shall be filled to at least 90% of the full weld cross section and large humps shall be blended.

7.4 The chord and lacing shall be free from undercut. There shall be a smooth transition between the chord and the weld.

7.5 The weld and weld area must be free of arc strikes. If arc striking does occur, they shall be buffed out completely.

8.0 PAINTING

8.1 Prime and finish paint all repaired areas immediately following completion of the repairs, after the weld area has cooled to 100°F (38°C) or below.

9.0 AMERICAN CRANE APPROVED ELECTRODES

9.1 The following electrodes have been tested and are approved for use:

(A) Chemtron ATOM Arc E7018
(B) Hobart LH 718
(C) Murex Speedex HTS-M-MR
(D) Airco Code-Arc 7018MR
(E) Lincoln LH78 and LH70
(F) Esab 7018
(G) Westinghouse WIZ-18

Note: Electrodes **MUST** be obtained in **hermetically sealed cans only**.

10.0 ELECTRODE STORAGE & CONTROL

10.1 The welding electrodes (E7018) required to successfully perform the lacing replacements are a low hydrogen type. They **must** be obtained in moisture-free hermetically sealed cans, free from physical damage that would result in exposure of the electrodes to the atmosphere. It is essential that these electrodes remain moisture-free for acceptable welding application.

10.2 **Maximum** exposure time for E7018 electrodes, once the container seal has been broken, is **two (2) hours.**

10.3 Storage of these electrodes (E7018) after the can has been opened shall be in an electrode storage oven at a temperature of at least 250°F (120°C).

10.4 Electrodes which have been exposed to the atmosphere longer than **two (2) hours** shall be destroyed. Once the electrodes have been exposed to the atmosphere, even though the time limit of **two (2) hours** has not been exceeded, they shall **not** be returned to the electrode storage oven.

ALL BOOM AND JIB LACING - GUIDELINES FOR FIELD EVALUATION

WARNING

DO NOT USE any Boom and Jib Sections that do not meet ALL of the following conditions. Any conditions which are not met must be corrected prior to use.

ALL BOOM AND JIB LACING - TUBULAR AND ANGULAR

1.0 SCOPE

This procedure provides guidelines for determining whether a tubular, tubular crimped, angle or tee, lacing needs to be repaired or replaced because of damage not conforming to the following specifications.

2.0 POLICY

2.1 The evaluation and/or subsequent repairs to any boom lacing shall be performed by qualified personnel. Original American lacing will be used for replacement. **American assumes no liability for repairs performed by personnel not employed by American Crane.**

2.2 Definitions

2.2.1 To provide a common understanding and consistent interpretation of the terms used within this procedure, the following definitions will apply:

2.2.1.1 "Corrosion"

A condition of removed material or wall thickness reduction due to chemical action on steel.

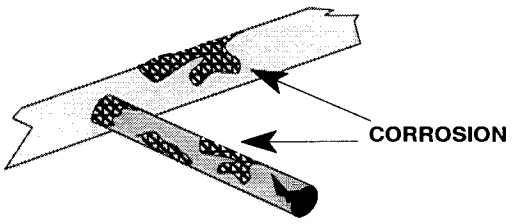


FIGURE 1

2.2.1.2 "Gouge"

A condition of removed material or wall thickness reduction that may have been caused by striking a sharp object or abrasive wear.

2.2.1.3 "Dent"

A condition where the lacing surface has been deformed from its normal shape without any noticeable removal of material. The dent may have no effect on the overall straightness of the lacing.

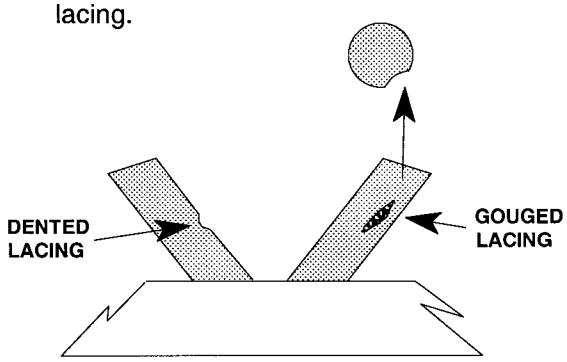


FIGURE 2

2.2.1.4 "Bend"/"Bow"

A condition where a permanent gradual change in the direction of center line of the lacing or variation in straightness.

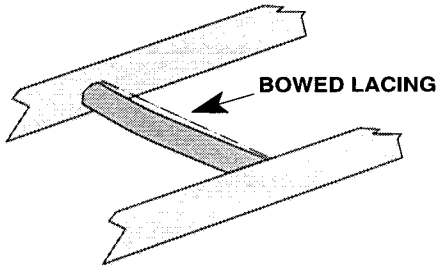


FIGURE 3

2.2.1.5 "Kink"

A condition where the lacing has been bent to a point where there is a crease formed across the diameter.

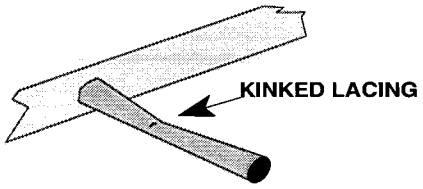


FIGURE 4

3.0 TUBULAR LACING ACCEPTANCE CRITERIA

3.1 The maximum reduction in wall thickness due to "corrosion" or a "gouge" cannot exceed 10% of the original wall thickness. The maximum length shall not exceed 100% of the lacing diameter and the maximum width shall not exceed 25% of the lacing diameter.

EXAMPLE: the "gouge" depth measures .011 in. (.3mm) and the original wall thickness is .095 in. (2.4mm), therefore the wall reduction is 12% which is unacceptable. The diameter of the lacing is 2.0 inches so the largest size can be 2.0 in. (50.8mm) long and .5 in. (12.7mm) wide.

3.1.1 One method of measuring is to use ultra sound and measure a good area of the lacing then measure the defective area to compare.

3.2.1 Another method is to use a micrometer to measure the diameter of the lacing in a good area. Then measure the defective area and compare. See Wall Thickness Table.

3.2 The maximum "dent" damage that is acceptable cannot exceed 2% of the original diameter. The maximum allowable length shall not exceed 100% of the diameter of the lacing. The maximum width shall not exceed 25% of the diameter of the lacing.

3.2.1 To measure the dent, use two scales or depth gauge.

3.3 The maximum "bend" or "bow" or variation from straight cannot exceed .002 in. (.05mm) per inch (25.4mm) of the length of the lacing up to 60 inches (15.24cm). Any lacing over 60 inches (15.24cm) long cannot exceed .120 in. (3.0mm).

EXAMPLE: A lacing 48 in. (12.19cm) long may be acceptable with a "bow" of .096 in. (24.4mm) maximum from the centerline.

3.3.1 To measure the "bow" or "bend" use two blocks of equal size positioned at each end of the lacing. Draw a wire or line taut over the blocks and measure the variation

⚠ CAUTION

ALL BROKEN, CRACKED AND KINKED LACING MUST BE REPLACED

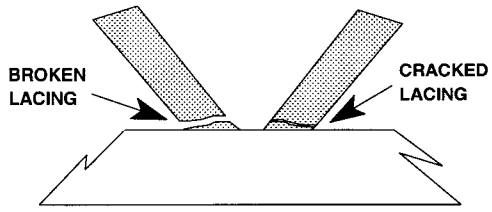


FIGURE 5

LACING WALL THICKNESS

OUTSIDE DIAMETER	WALL THICKNESS
.875" (22.2mm)	.072" (1.8mm)
1.00" (25.4mm)	.095" (2.4mm)
1.25" (31.8mm)	.095" (2.4mm)
1.50" (38.1mm)	.095" (2.4mm)
1.625" (41.3mm)	.095" (2.4mm)
1.625" (41.3mm)	.134" (3.4mm)
1.875" (47.6mm)	.095" (2.4mm)
2.00" (50.8mm)	.109" (2.8mm)
2.188" (55.6mm)	.120" (3.0mm)
2.25" (57.15mm)	.120" (3.0mm)
2.312" (58.7mm)	.120" (3.0mm)
2.500" (63.5mm)	.120" (3.0mm)
2.812" (71.4mm)	.120" (3.0mm)
3.00" (76.2mm)	.120" (3.0mm)
3.00" (76.2mm)	.156" (4.0mm)

These are current standard lacing sizes. Any lacings that are not listed, consult American Crane Service Dept.

4.0 REPAIR PROCEDURE FOR "BENT/BOWED" ANGULAR, TUBULAR OR TUBULAR CRIMPED LACING

4.1 Carefully "cold straighten" the lacing. **Do not use heat** to straighten the lacing. This may be accomplished by pulling or pushing the lacing straight, applying the forces at the center of the bow. The lacing surface must be protected by using belting, partial sleeves, hardwood, etc.

4.1.1 After the lacing has been straightened, carefully check to insure that no damage has occurred such as kinking or denting. Then magnetic particle (yoke method) examine or equivalent is required to insure that damage did not occur to the welds that attached "bent/bowed" lacing to the chord. Also chord straightness needs to be checked.

⚠ CAUTION

BEFORE PLACING BOOM OR JIB SECTIONS BACK INTO SERVICE, IT SHALL BE RE-PRIMERED AND FINISH PAINTED TO PROTECT AGAINST FUTURE CORROSION.

5.0 ANGULAR OR T LACING ACCEPTANCE CRITERIA

5.1 The maximum reduction of material thickness due to "corrosion" or a "gouge" cannot exceed 10% of the original material thickness. The maximum length shall not exceed 100% the width of the lacing leg and the maximim width cannot exceed 25% of the width of the lacing leg.

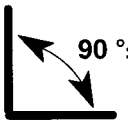
EXAMPLE: The angle lacing size is .25 x 2 x 2 in. (6.35 x 50.8 x 50.8mm), therefore, the maximum depth of gouge or corrosion cannot exceed .025 in. (.6mm). The maximum length cannot exceed 2.0 in. (50.8mm), the maximum width cannot exceed .5 in (12.7mm)

5.1.1One method of measuring is to use a micrometer to measure a damaged and undamaged area, then compare. See 6.0 for Corrosion or Gouge Repair.

5.2 Lacing with a "dent" type condition the maximum depth cannot exceed 15% of the thickness of the lacing. The maximum length is 100% the width of the lacing and the maximum width is 25% the width of the lacing.

EXAMPLE: The lacing is 2.0 in. (50.8mm) wide and .25 in. (6.35mm) thick, the maximum dent size is .037 in. (.9mm) deep, 2.0 in. (50.8mm) long and .50 in. (12.77) wide. Measure with a protractor.

The "square" of the angle must also be maintained.



See 6.0 for "dent" repair.

5.3 The maximum "bend" or "bow" or variation from straight cannot exceed .002 in. (.05mm) per inch (25.4mm) of the length of the lacing up to 60 inches (15.24cm). Any lacing over 60 inches (15.24cm) long cannot exceed .120 in. (3.0mm).

EXAMPLE: A lacing 48 in. (12.19cm) long may be acceptable with a "bow" of .096 (24.4mm) maximum from the centerline.

5.3.1 To measure the "bow" or "bend" use two blocks of equal size positioned at each end of the lacing. Draw a wire or line taut over the blocks and measure the variation

Any repair to bring the bowed angular lacing within specification can be performed as in section 4.0.

6.0 REPAIR PROCEDURE FOR ANGULAR OR T LACING WITH GOUGES, CORROSION, AND DENTS.

Note: All welding is to be performed by a qualified welder that is certified by an industry standard.

6.1 To repair the corrosion or gouge, clean the surface to be welded to remove paint scale, rust, moisture or other foreign material that will prevent proper welding.

a. Use 3/32 diameter E7018 electrode
b. Preheat required to 70° F (21°C) minumum
c. Maximum interpass temperature is 300°F (150° C)
d. Use Stringer Method only

After welding, grind to blend in smooth. Do not grind into base metal. Carefully inspect the area for cracks in the weld or material. If satisfactory, then prime and paint the repaired area.

6.2 If the lacing has a dent it can be repaired by heating the damaged area to 1000° F (378° C) and using a hammer to straighten the dent. Inspect the area for cracks in the material or welds. If satisfactory, prime and paint the repaired area. After repaired, the chord straightness must be inspected.

⚠ CAUTION

IF THE LACING CANNOT BE REPAIRED, IT MUST BE REPLACED USING PROCEDURES IN SECTION 7.0

7.0 REFERENCES

7.1 American Welding Standard WEL-2000 American Operating and Maintenance Manual - Welding Procedure for Lacing Replacement in High Strength Tubular Booms.

7.2 American Welding Standard WEL-2013 American Operating and Maintenance Manual - Welding Procedure for Lacing Replacement: A036 Angle or Tee Lacing to A030 Angle Chord.

7.3 American Welding Standard WEL-2012 American Operating and Maintenance Manual - Welding Procedure for Lacing Replacement: A061 Crimped Tubular Lacing to A030 angle Chord.

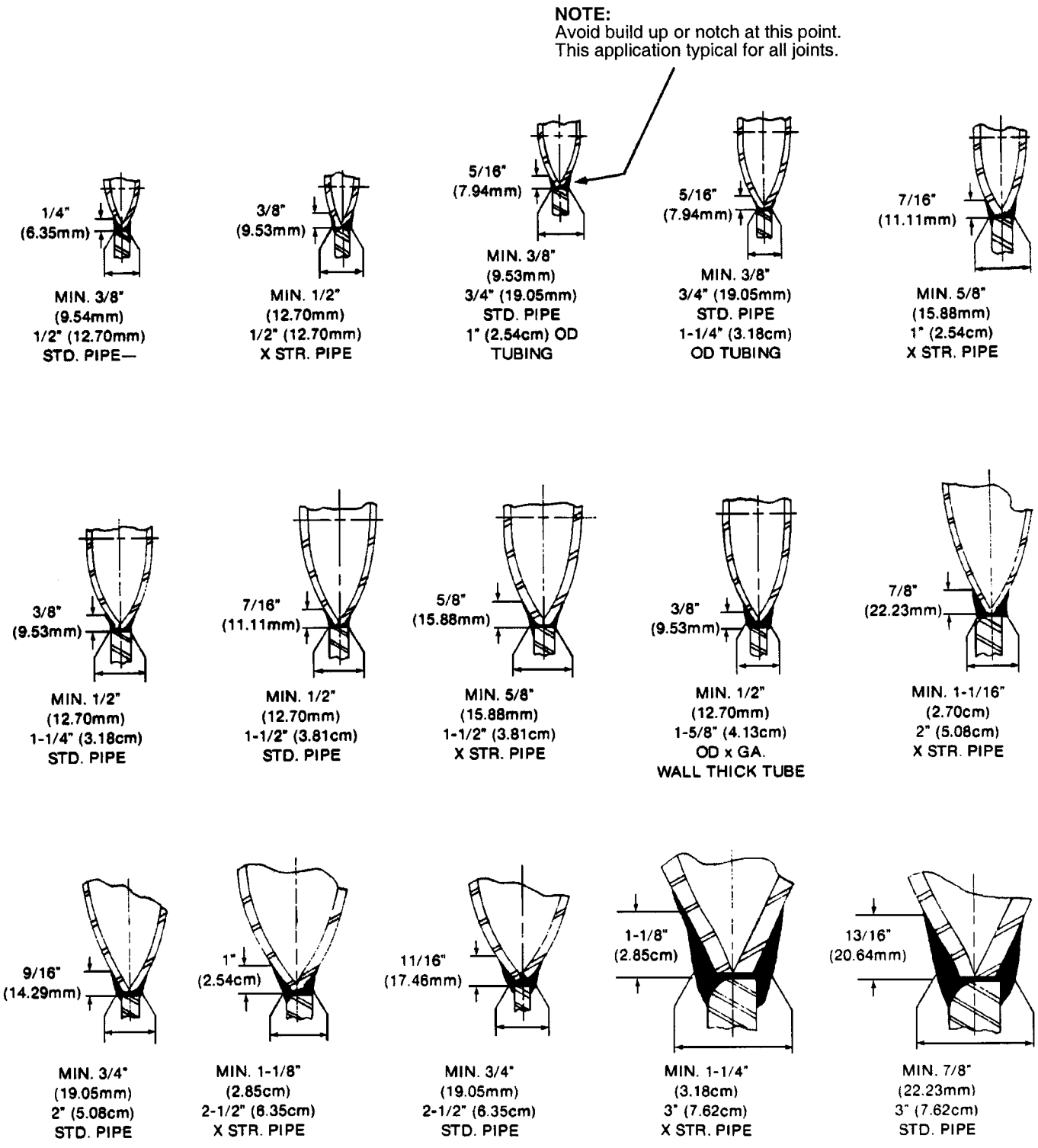
7.4 American Tubular Boom - Guidelines for Field Evaluation American Operating and Maintenance Manual.

7.5 American Angular Boom - Guidelines for Field Evaluation.

AMERICAN CRANE CORPORATION does not authorize any type of repair in the field or shop on tubular high lift jibs due to the technical weld process. If it becomes necessary to replace lacings, the replacement must be performed by a welder supplied by AMERICAN CRANE CORPORATION.

FOR ANY INSPECTION RESULTS OR QUESTIONS THAT ARE NOT WITHIN THESE GUIDELINES, CONSULT AMERICAN CRANE SERVICE DEPARTMENT

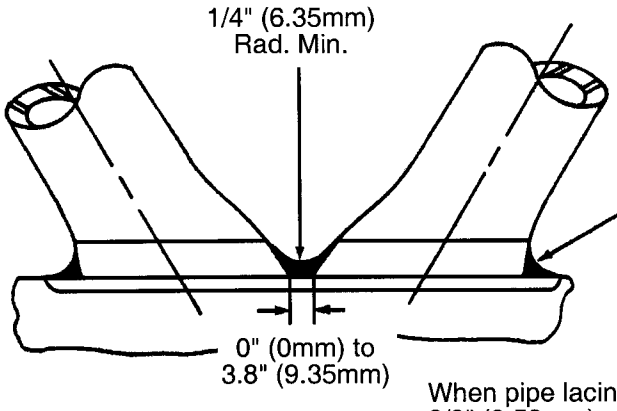
LACING REPAIRS - ANGLE CHORD BOOMS



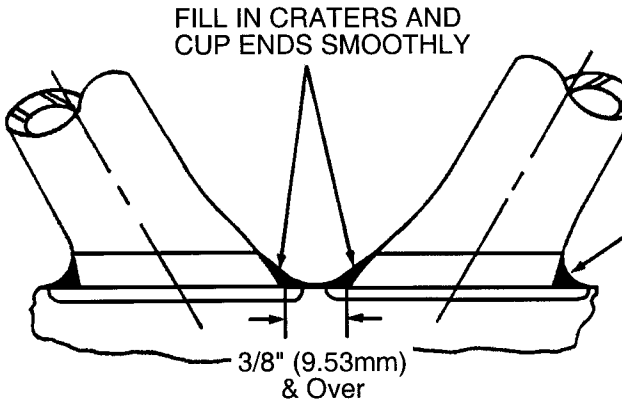
LACING REPAIRS

NOTE

These two welding applications shown are typical for pipe lacing, regardless of pipe size. Use E-7018 electrode for welding pipe lacing to chord angles.



When pipe lacing is spaced from 0" (0mm) to 3/8" (9.53mm) connect welds smoothly as shown, using a minimum of 1/4" (6.35mm) RAD.



When pipe lacing is spaced 3/8" (9.53mm) and greater, fill in craters and cup ends smoothly as shown.

Section 4

STRUCTURE

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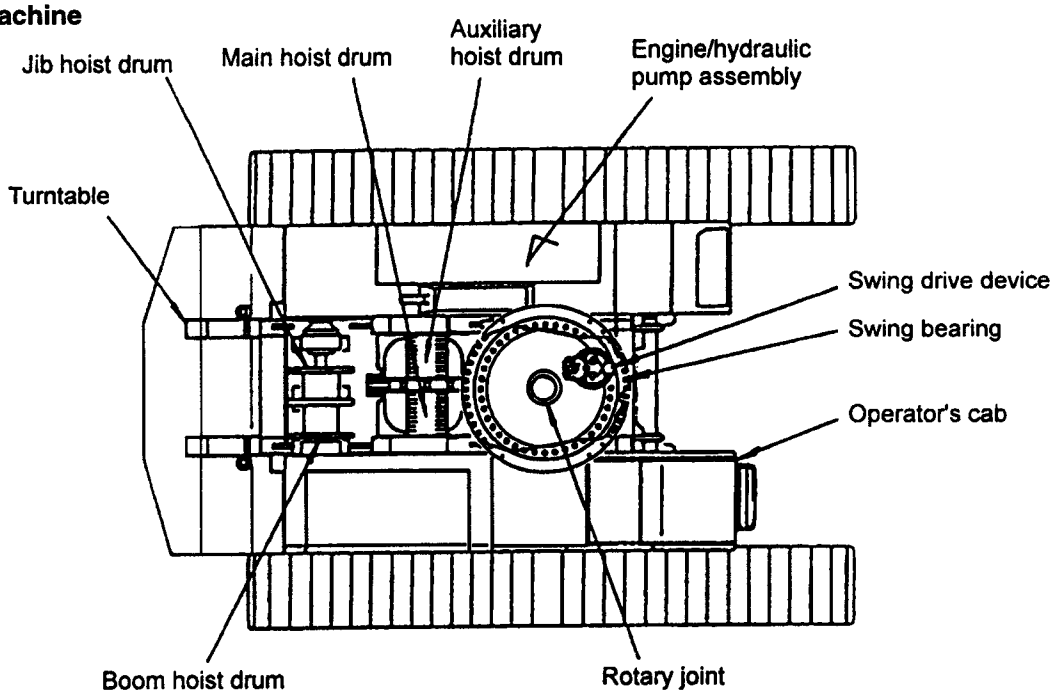
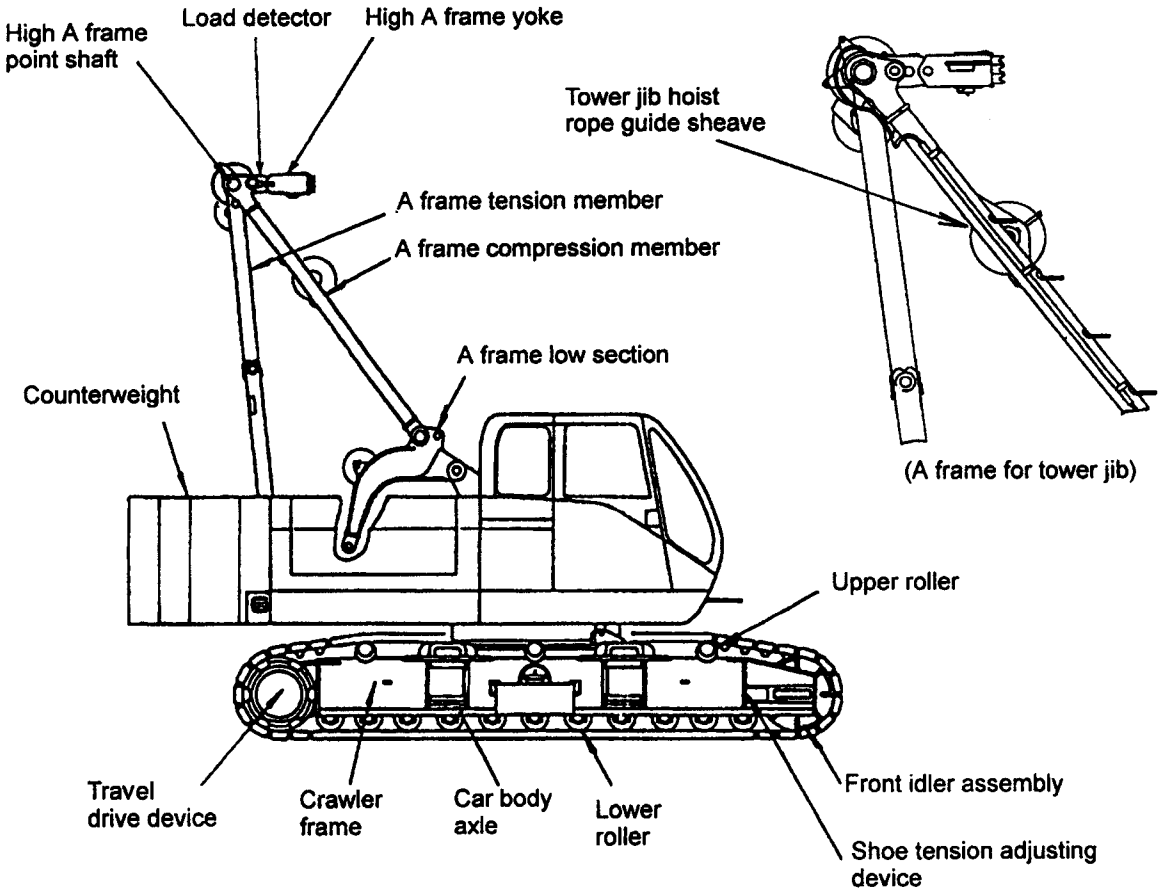
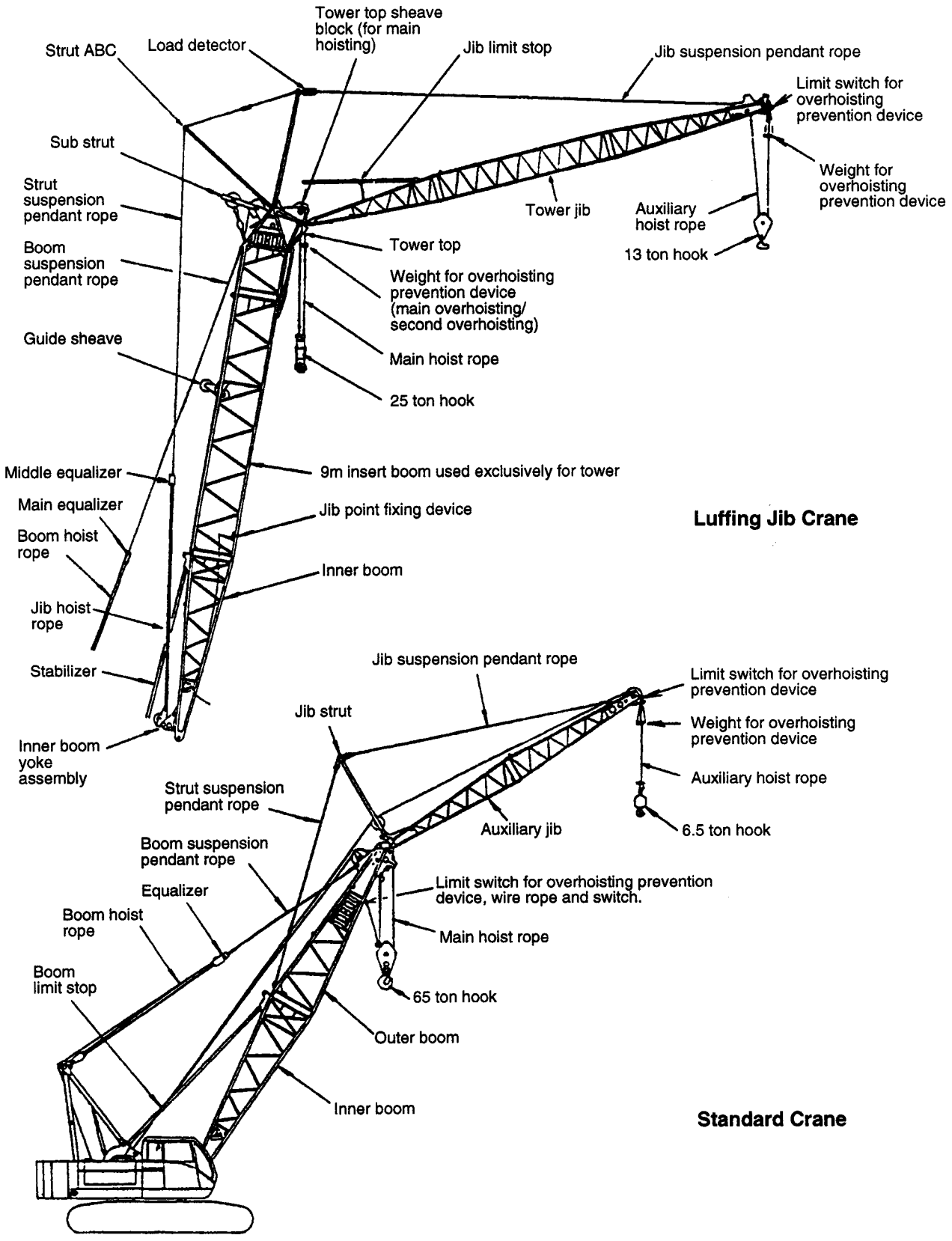
1. STRUCTURE AND NAME

1-1 Base machine





1-2 Attachment



Luffing Jib Crane

Standard Crane

2. EXPLANATION OF PRINCIPAL STRUCTURE

1. Power source

   The hydraulic pumps are driven by the diesel engine mounted on the left side of the superstructure. Two variable displacement pumps are used for winch hoisting, travel and boom hoisting, and two gear pumps are employed for swinging and control, respectively. Since a full-power control system is adopted between the two variable displacement pumps and the gear pump for swinging, engine output can be utilized efficiently. In addition, the variable displacement pumps are equipped with a very slow speed control unit which minimizes oil delivery from each pump when operation is not attempted, so that the pumps are automatically controlled as interlinked with the electronic engine throttle and each operation lever.

2. Load hoisting unit

   The main hoist and auxiliary hoist drums are arranged independently in an array and driven by different variable displacement hydraulic motors via respective reduction gears in order to hoist and lower a load. Since oil delivery from the pump varies in response to the stroke of the control lever, rope speed is variable. In addition, a very slow speed control unit interlinked with engine speed is provided for facilitating inching operation.

   Either foot brake or automatic brake mode is selected by the winch mode selector switch. In automatic brake mode, the brake is automatically applied with the lever at neutral, so the foot brake need not be operated. In foot brake mode, the automatic brake is released and the brake can be applied by depressing the pedal. With the foot brake, delicate half brake operation is easily allowed since the required depressing force is set at an appropriate level due to a hydraulic assist system. In automatic brake mode, the clutch is always engaged. In foot brake mode, the clutch is disengaged with the winch lever at neutral and automatically engaged/disengaged when operating the lever.

   On both the main and auxiliary hoisting sides, a clutch fixing pin, which directly couples the drum and clutch, and a ratchet drum lock are provided to prevent the load from dropping (see Page 3-31).

3. Boom hoisting unit

   This unit is driven by the hydraulic motor via the reduction gear. Boom hoisting is independent from other operations. Very slow hoisting and lowering can readily be carried out thanks to the very slow speed control unit of the pump. Rope speed is variable in response to the lever stroke. Safety is ensured by employing power fall for lowering, and automatic brake and ratchet drum lock for braking.

4. Swing unit

   This unit is driven by the hydraulic motor via the reduction gear. Swing operation is independent from other operations. The swing seat is provided on a ball bearing mechanism which allows smooth swinging free from load sway despite start/stop operation. A swing parking brake and swing lock are provided to ensure safety during machine stop, travel, etc. The swing parking brake has a shockless mechanism for minimizing boom sway, etc. if the brake is applied in error during swing operation.

5. Travel unit

   The travel unit is driven by the hydraulic motor mounted to the left and right crawlers through the reduction gear. Pivot turn and spin turn can easily be made. The travel brake employs a self-pressure control system (automatic brake). This means that brake is automatically applied when the travel lever is in neutral. Because the reduction gear and motor are of a shoe-in type, this crane is has an advantage for running on rough ground. The shoe tension adjuster uses a grease cylinder for easy adjustment. Furthermore, the travel frame has an inverse U-shaped frame design which excels in shedding soil.

6. Control lever

   The principal control levers are arranged on the left and right lever stands to ensure a better view below the operator. The winch, boom hoist, swing and travel control levers govern each main selector valve via a remote control valve. So, the levers can be operated by little force, moderating operator fatigue. Besides the horn, switches are mounted on the lever grips for engine throttle control, swing brake, winch mode selection and boom hoist pedal so that simultaneous operations can be performed easily.

7. Operator's cab

   The operator's cab is at the front right of the machine so that it is completely separated from the engine. As a result, the operator can operate the machine in quiet. The cab is as wide as 94cm, which conforms to the international standard (ISO), and the inside of the cab is provided with a lining, ensuring excellent riding comfort. The cab has glass windows at the front, rear, left, and right, and in the roof. The left, right, and rear windows can be slid open, and the front window can be opened and folded back under the roof. This design features wide visibility and good ventilation.

   The cab has an operation box designed with meticulous care, a molded plastic panel is utilized for the rear and roof dashboards, and a cassette player-equipped FM/AM radio set and an air conditioner are standard equipment, offering a comfortable operating environment. The door is a sliding one which can be opened and closed freely in a confined space.

8. Safety devices

   Both hydraulic and electrical systems are designed to operate on the safe side in the event of any unexpected problem. To further enhance this, an "entrance/exit lock unit" which responds to omission of lever return and misoperation upon entrance/exit is adopted in addition to the aforementioned safety device. When the operator leaves his seat, all operations are automatically locked.

   For protecting the boom from backward turn-over, the second throw-out (stop of all winch hoisting operations) is provided in addition to the conventional boom throw-out. Thus a triple safety measure is secured including the upper limit angle stop function of the moment limiter. The moment limiter can select various screens so that the load ratio of the machine and the date necessary for crane work can be known.

   The instrument box in the operator's cab is equipped with an OK monitor which traces the operational status of the machine.

9. Crane attachment

   The boom has a pipe structure using high-tension steel and it has a basic length of 12m (6.5m + 5.5m). Boom length can be extended up to 54m by adding insert booms of 3, 6 and 9m. Jibs of 1m and 9 to 18m can be mounted. Both boom and jib are pin-jointed. Since the pendant ropes are of a single lock type, they can be easily handled during assembly and disassembly.

3. WIRING DIAGRAM

3-1 Electrical system diagram

Notes:

1. Unless specified, wire size shall be 0.85mm^2.
2. For parenthesized symbol after each component name, refer to the explanatory note.
3. This diagram does not include a circuit which does not use the power supply of the base machine (DC24V battery).
4. Each component in a solid-line square is installed outside the control panel.
5. The component marked with ☆ is not installed to the machine without tower crane specification.
6. Use a red wire for the power supply and a black wire for ground.
7. The standard of other wires except the above is as follows:

Number	0~	100~	200~	300~	400~	500~	600~	700~
Color	White	Gray	Yellow	Blue	Green	Brown	Orange	Orange

8. In this circuit, the devices with oblique lines are not set.

Explanatory note:

(TW)... Used exclusively for tower crane and tower jib.

(LJ).... Used exclusively for luffing jib.

(OPT).. Shows the optional or selectable specification.

PB .... Push Button

PS .... Pressure Switch

KS .... Key Switch

(T.)..... Timer

(X)..... Relay

F..... Fuse

TS .... Toggle Switch

SN .... Sensor

(BZ).... Buzzer Alarm

(SL).... Solenoid

(L.).... Light

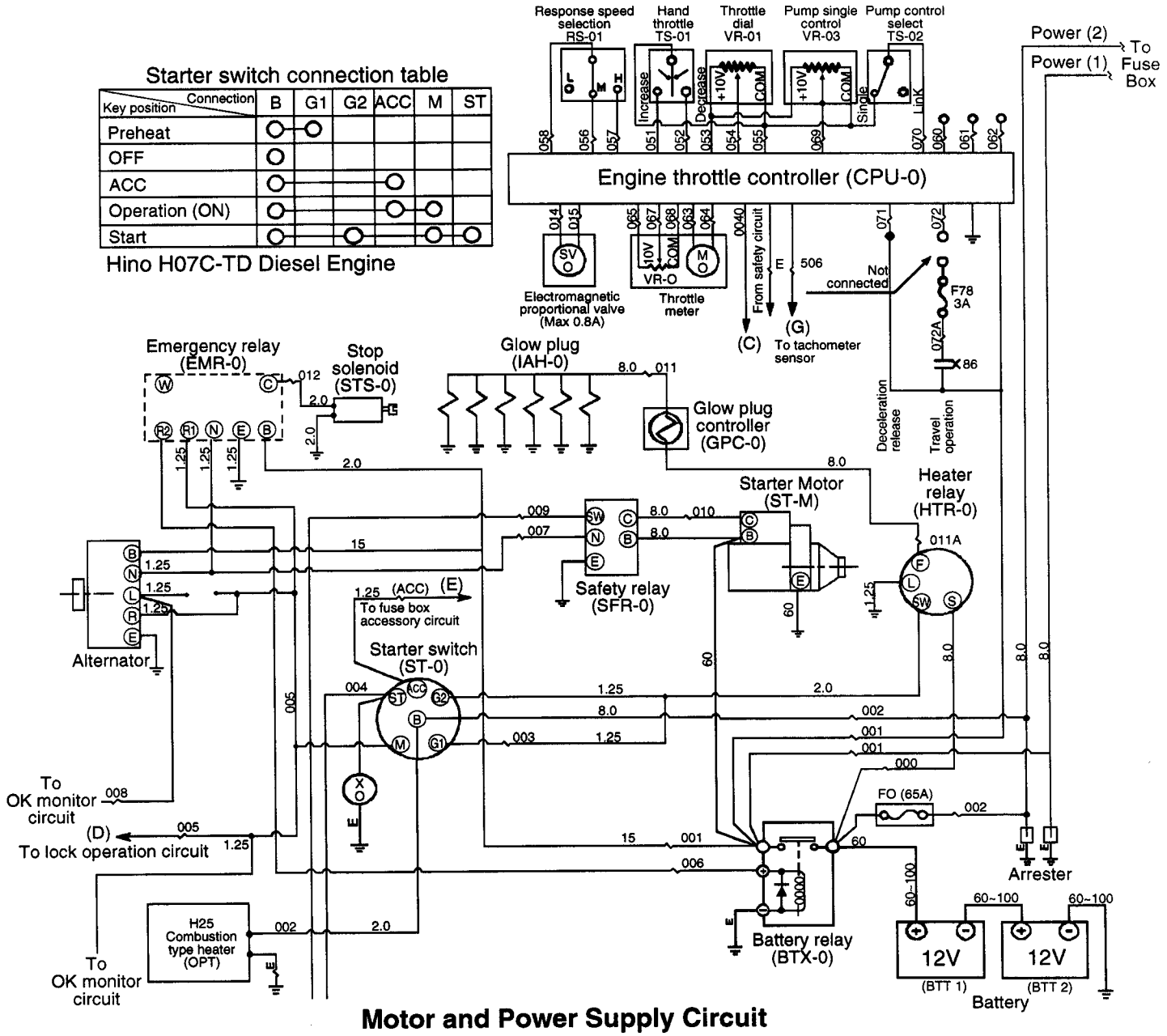
(M).... Motor

RL .... Red Light

M/L.... Moment Limiter

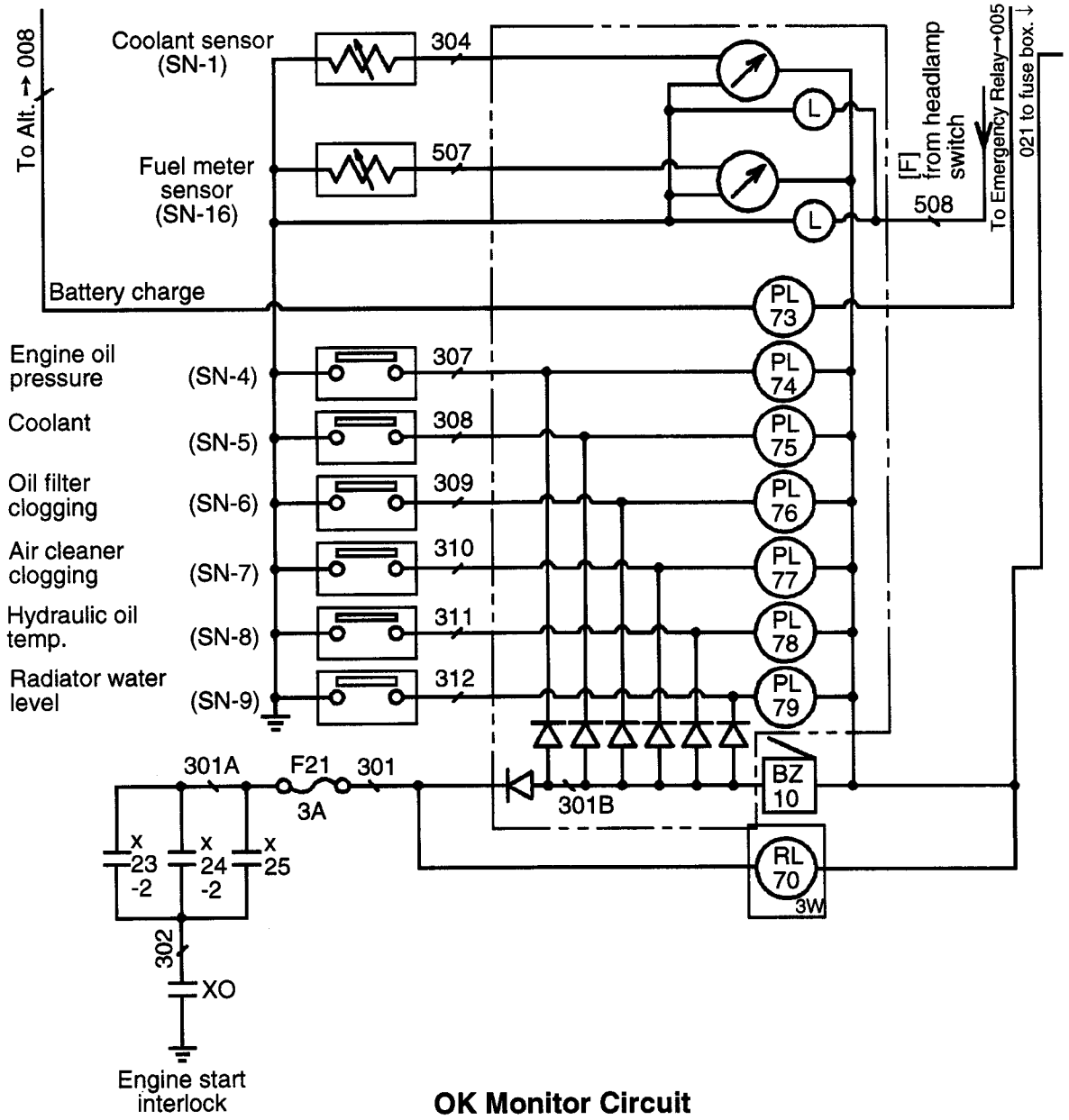
3. WIRING DIAGRAM

3-1 Electrical system diagram



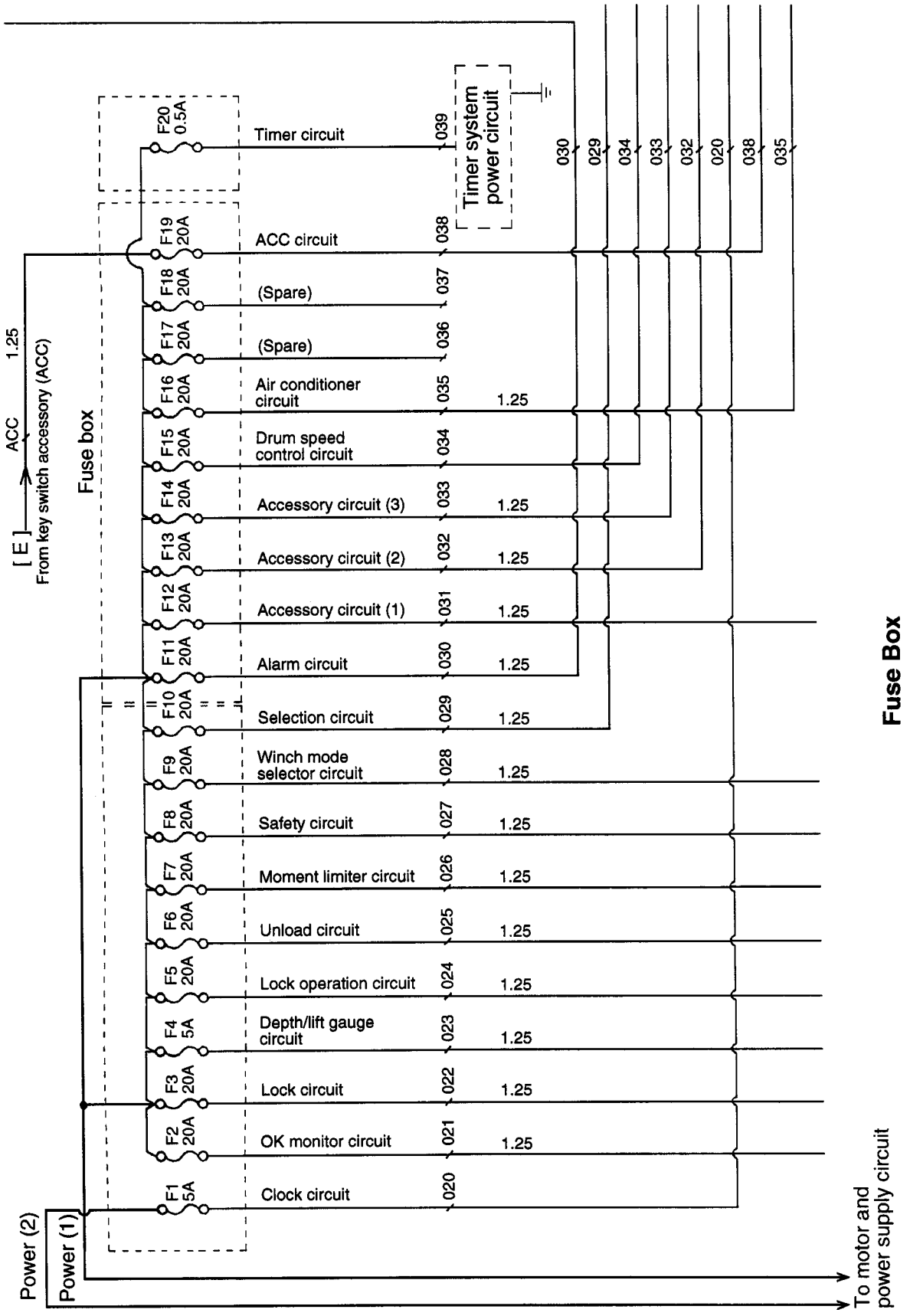
Motor and Power Supply Circuit

3-1 Electrical system diagram

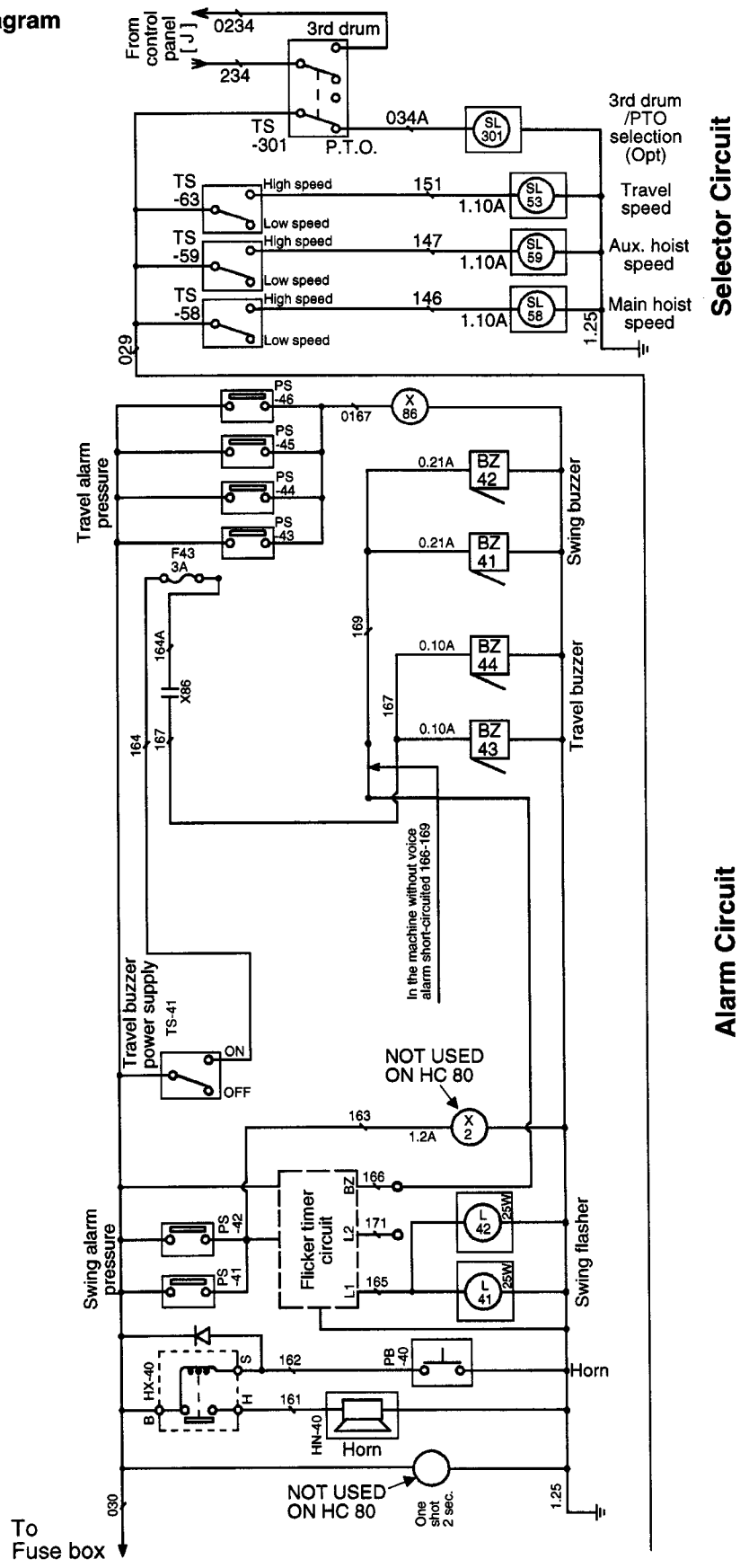


OK Monitor Circuit

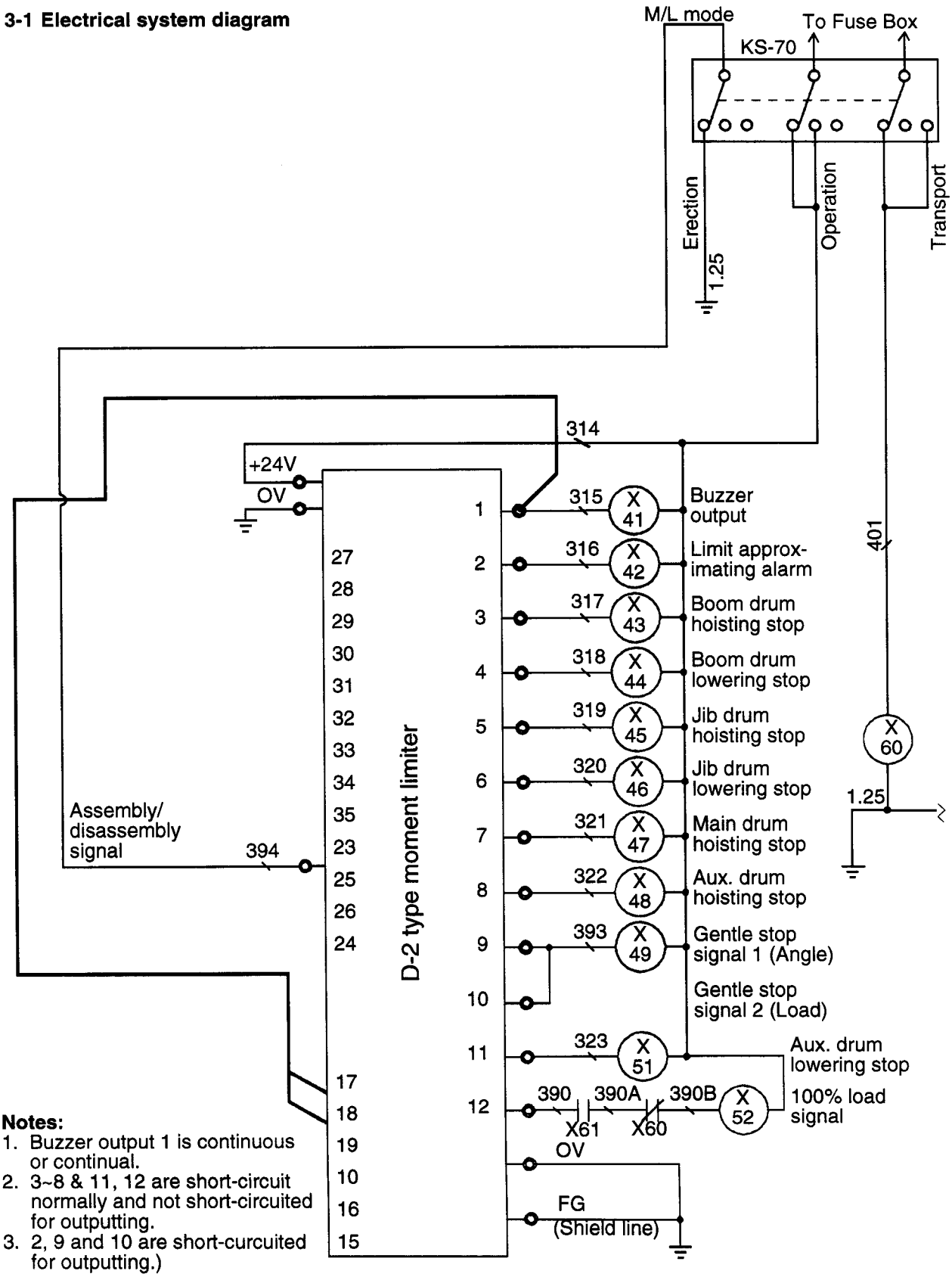
3-1 Electrical system diagram



3-1 Electrical system diagram



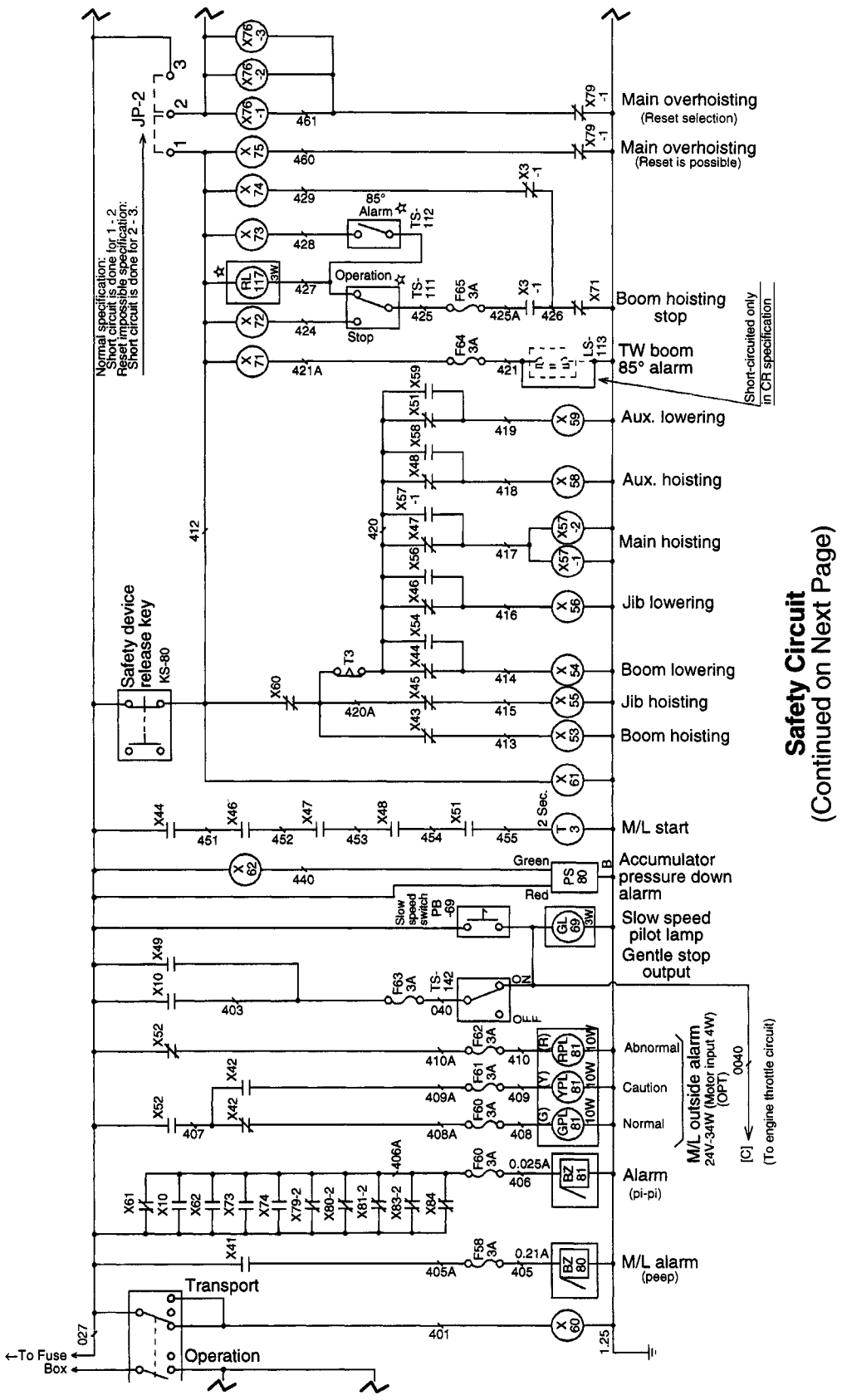
3-1 Electrical system diagram



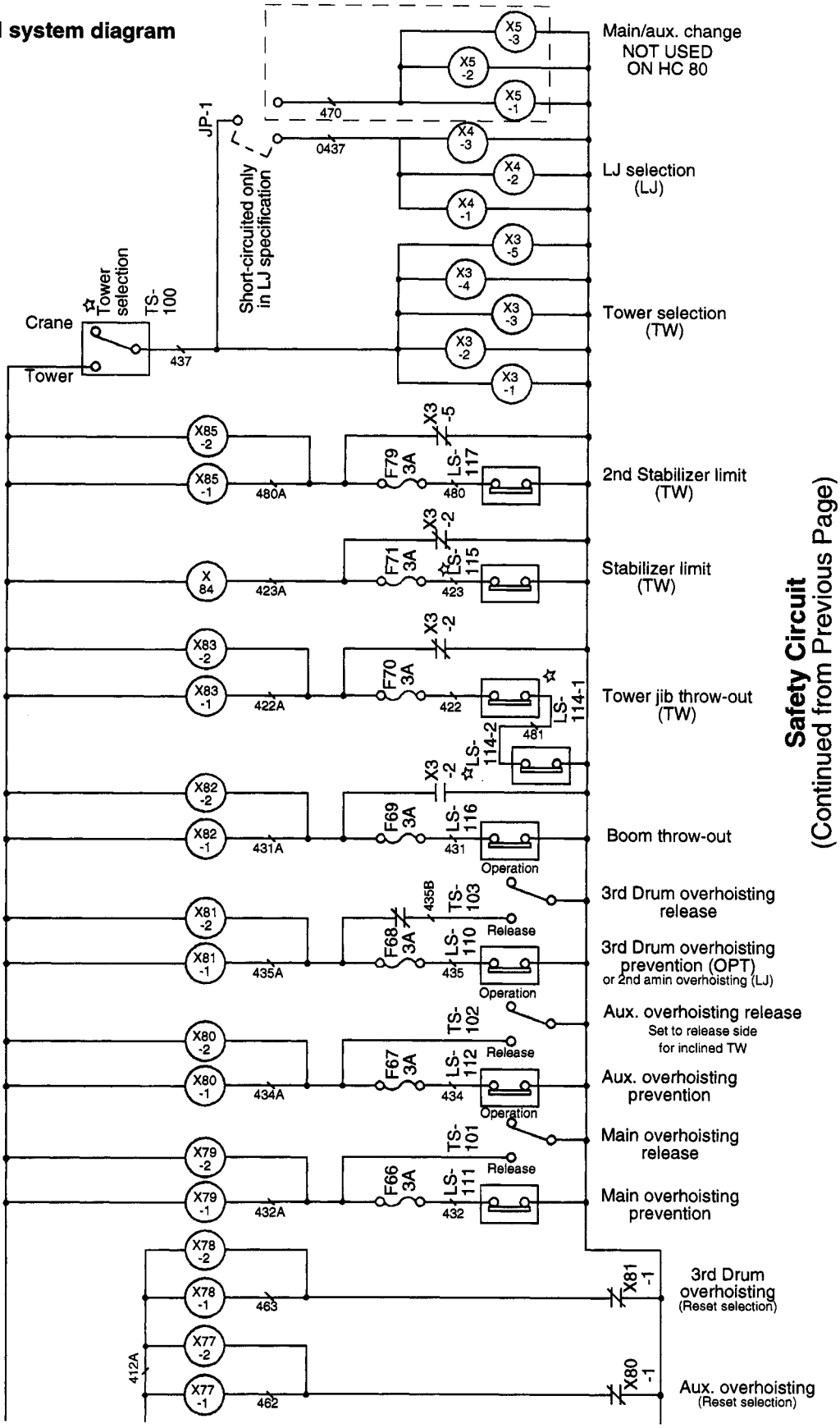
Notes:
1. Buzzer output 1 is continuous or continual.
2. 3~8 & 11, 12 are short-circuit normally and not short-circuited for outputting.
3. 2, 9 and 10 are short-curcuited for outputting.)

Moment Limiter Circuit

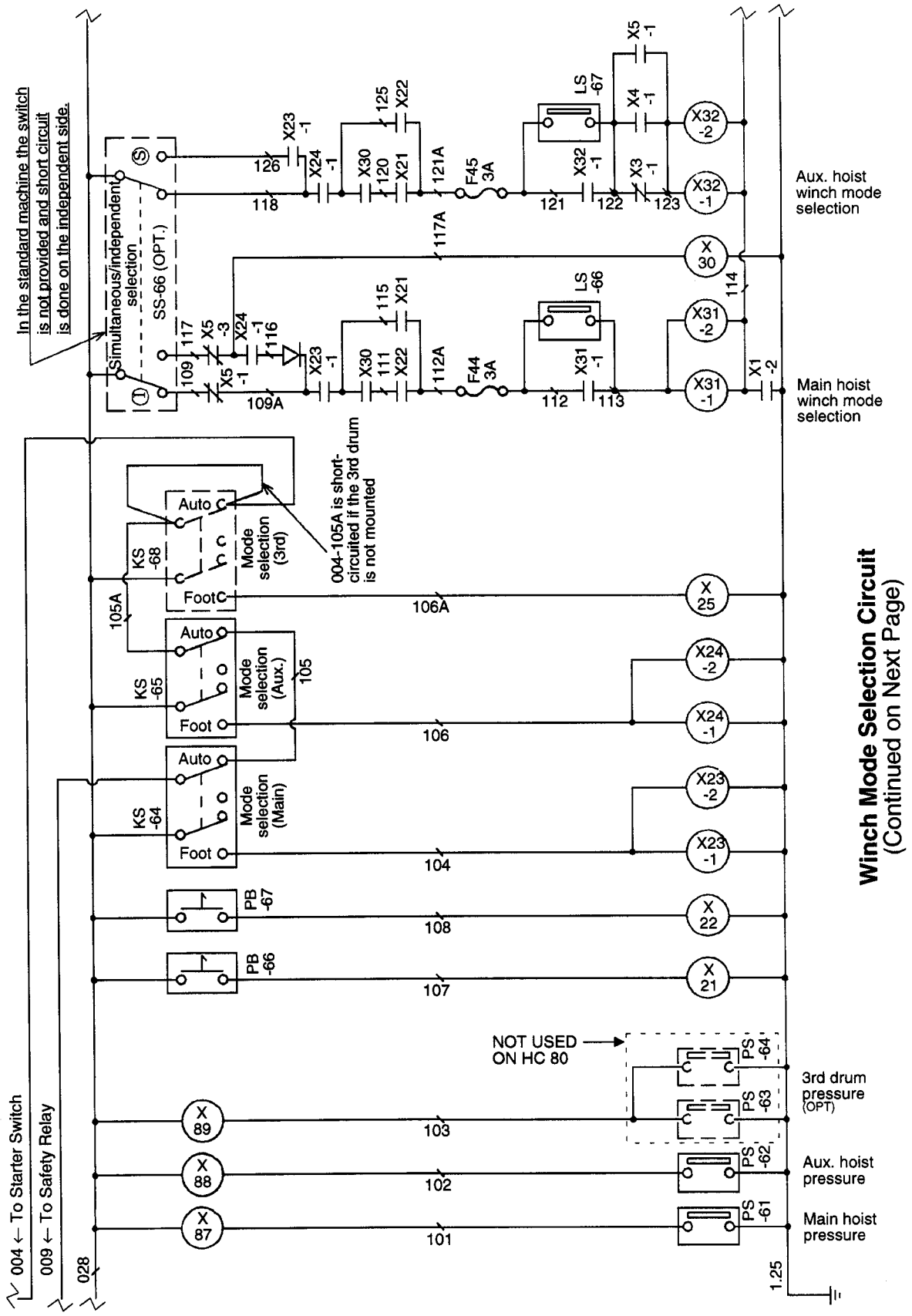
3-1 Electrical system diagram



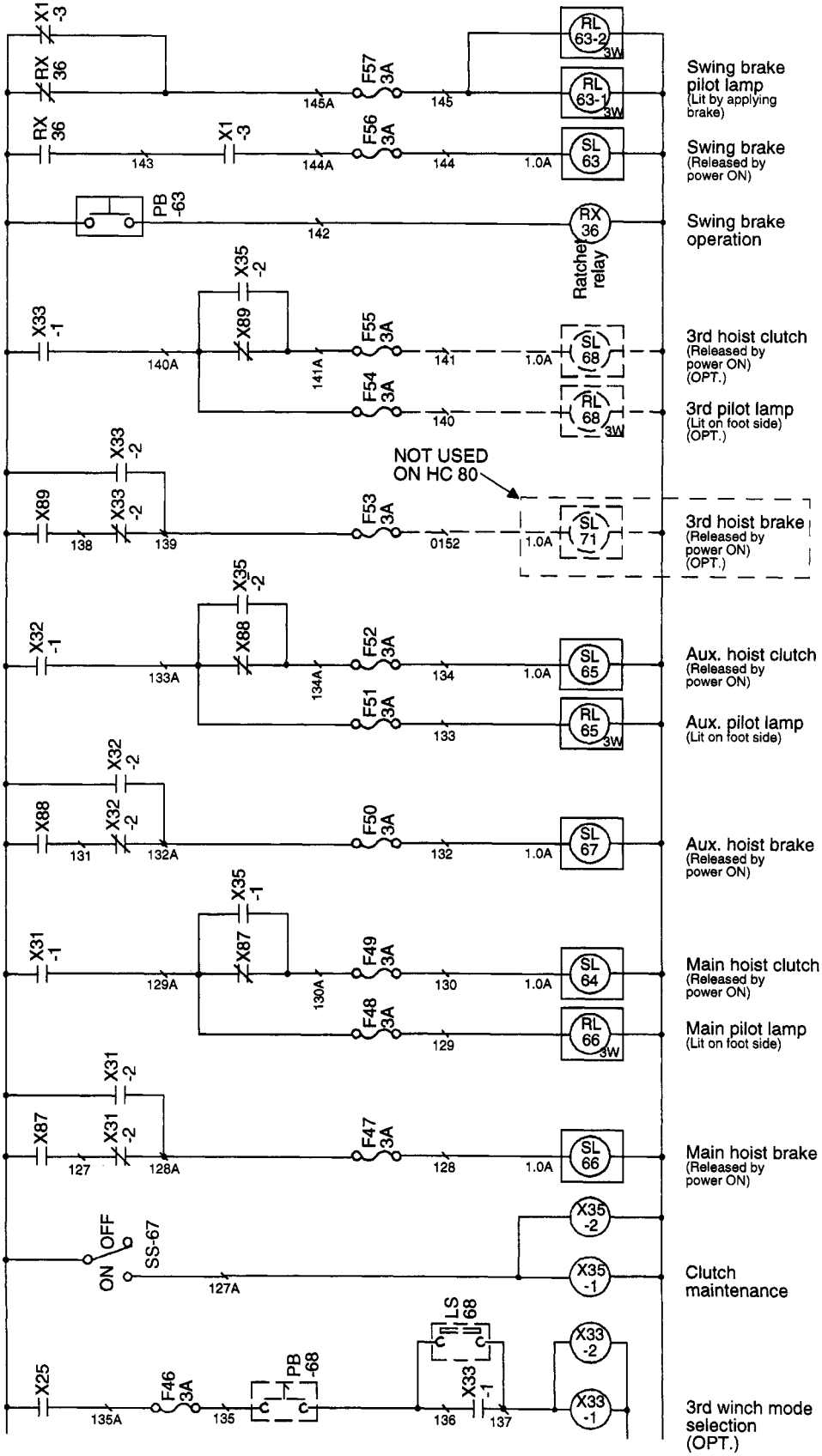
3-1 Electrical system diagram



3-1 Electrical system diagram

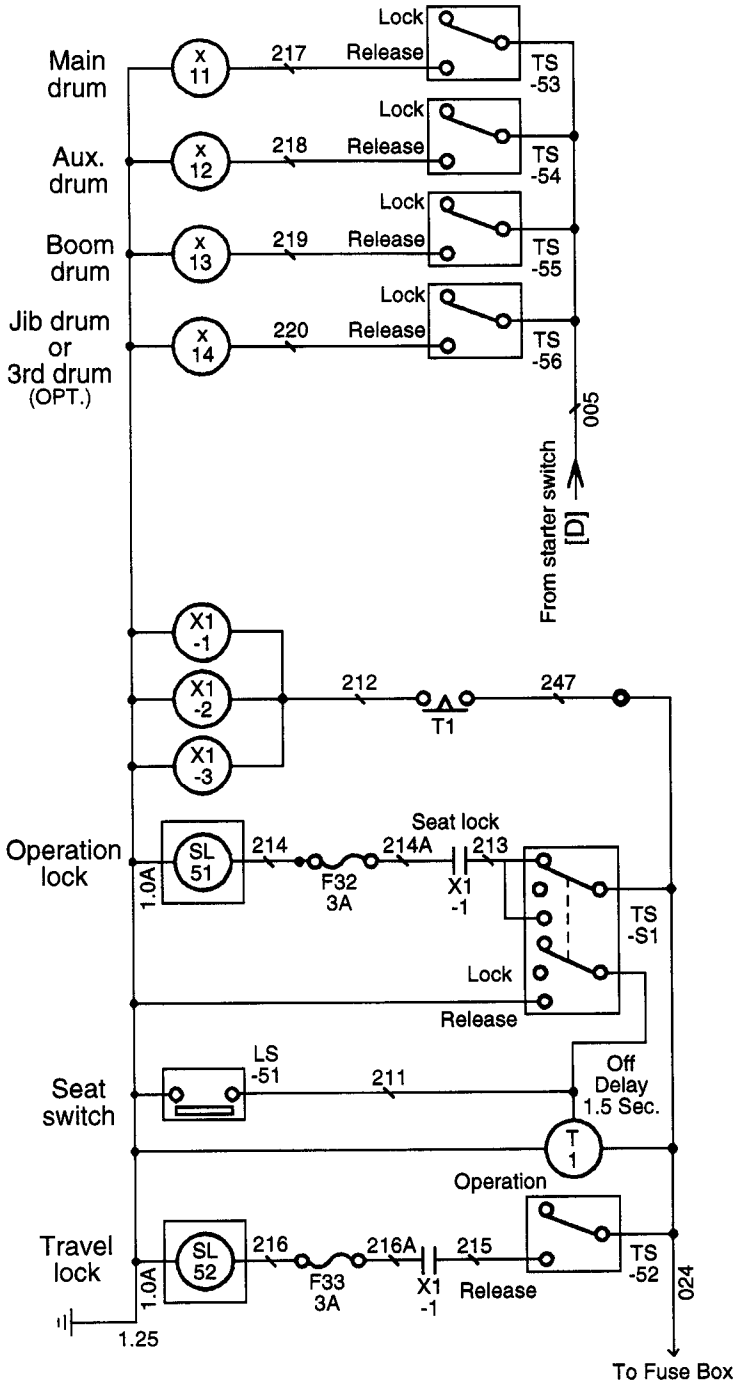


3-1 Electrical system diagram

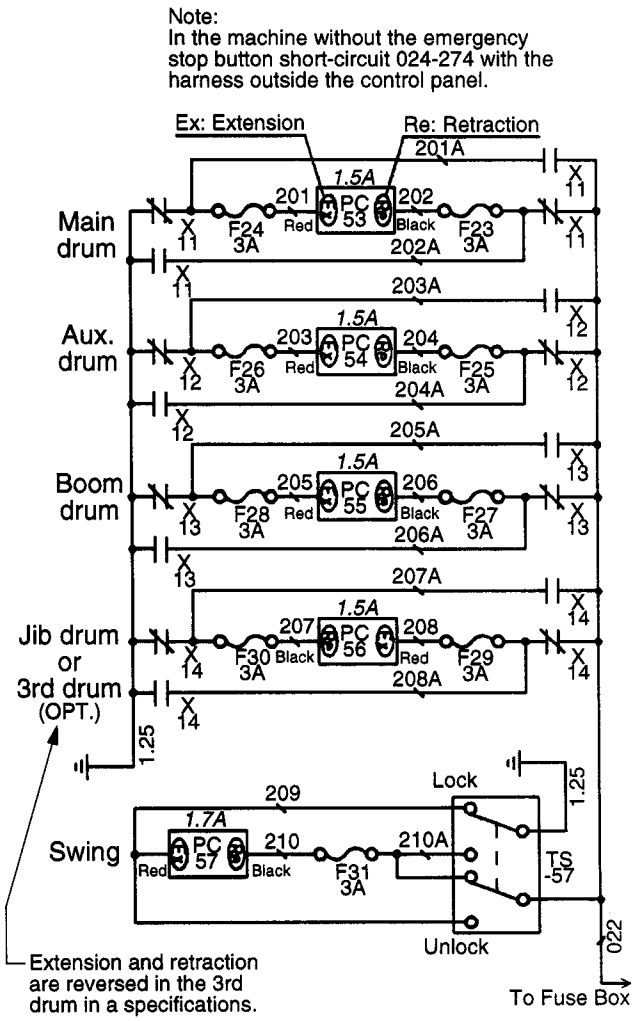


Winch Mode Selection Circuit
(Continued from Previous Page)

3-1 Electrical system diagram

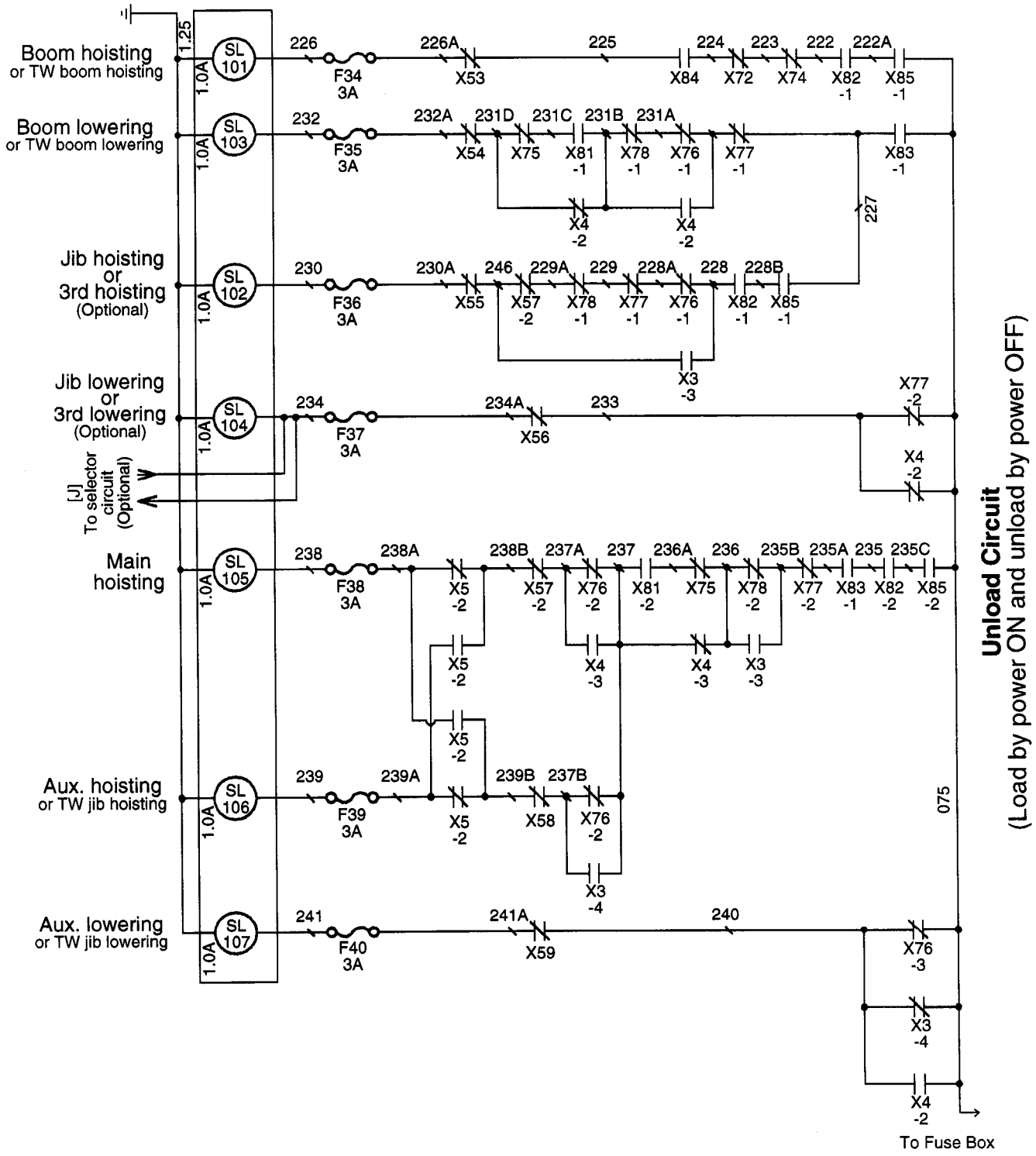


Lock Operation Circuit

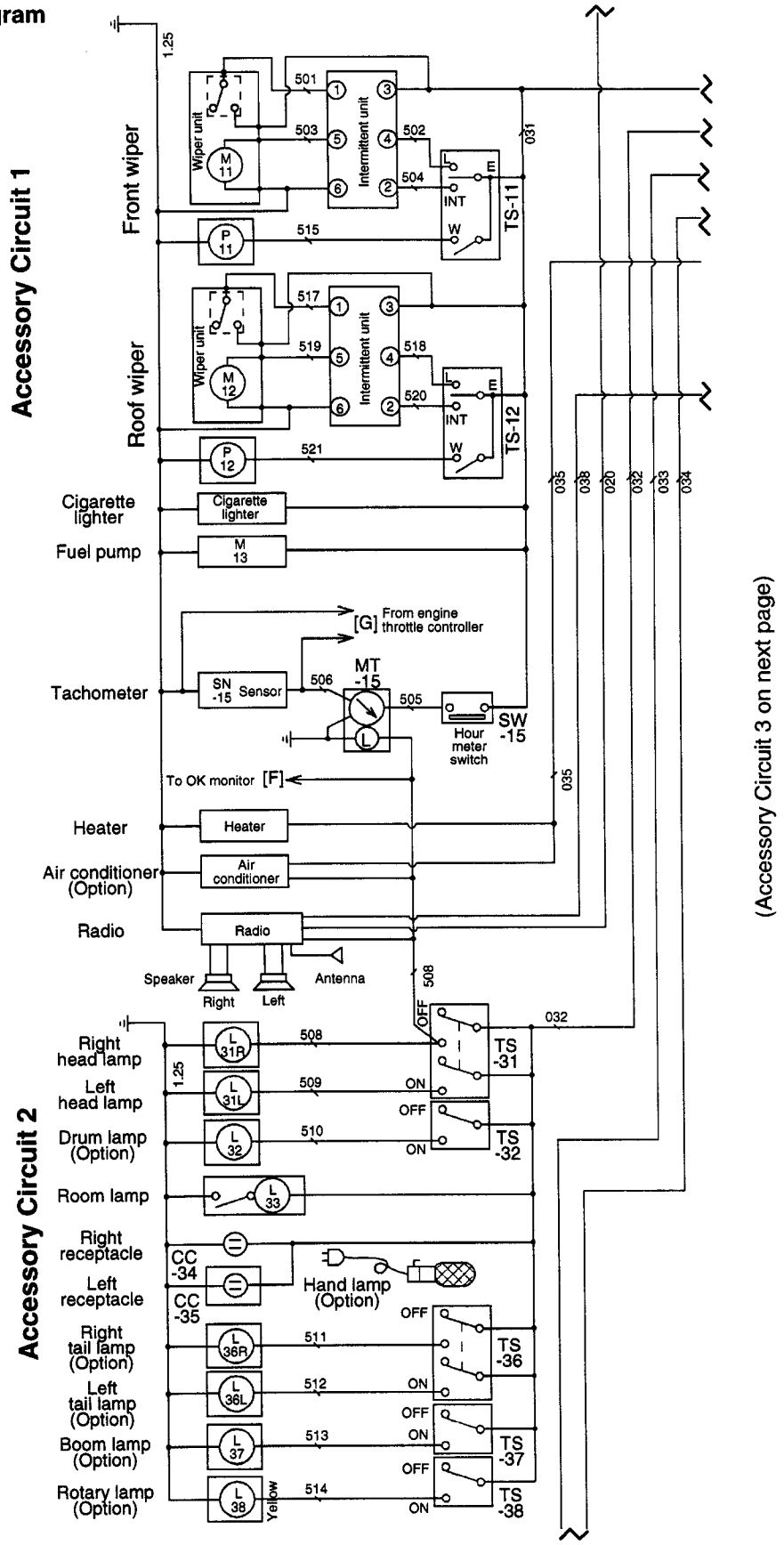


Lock Circuit (Power Cylinder)

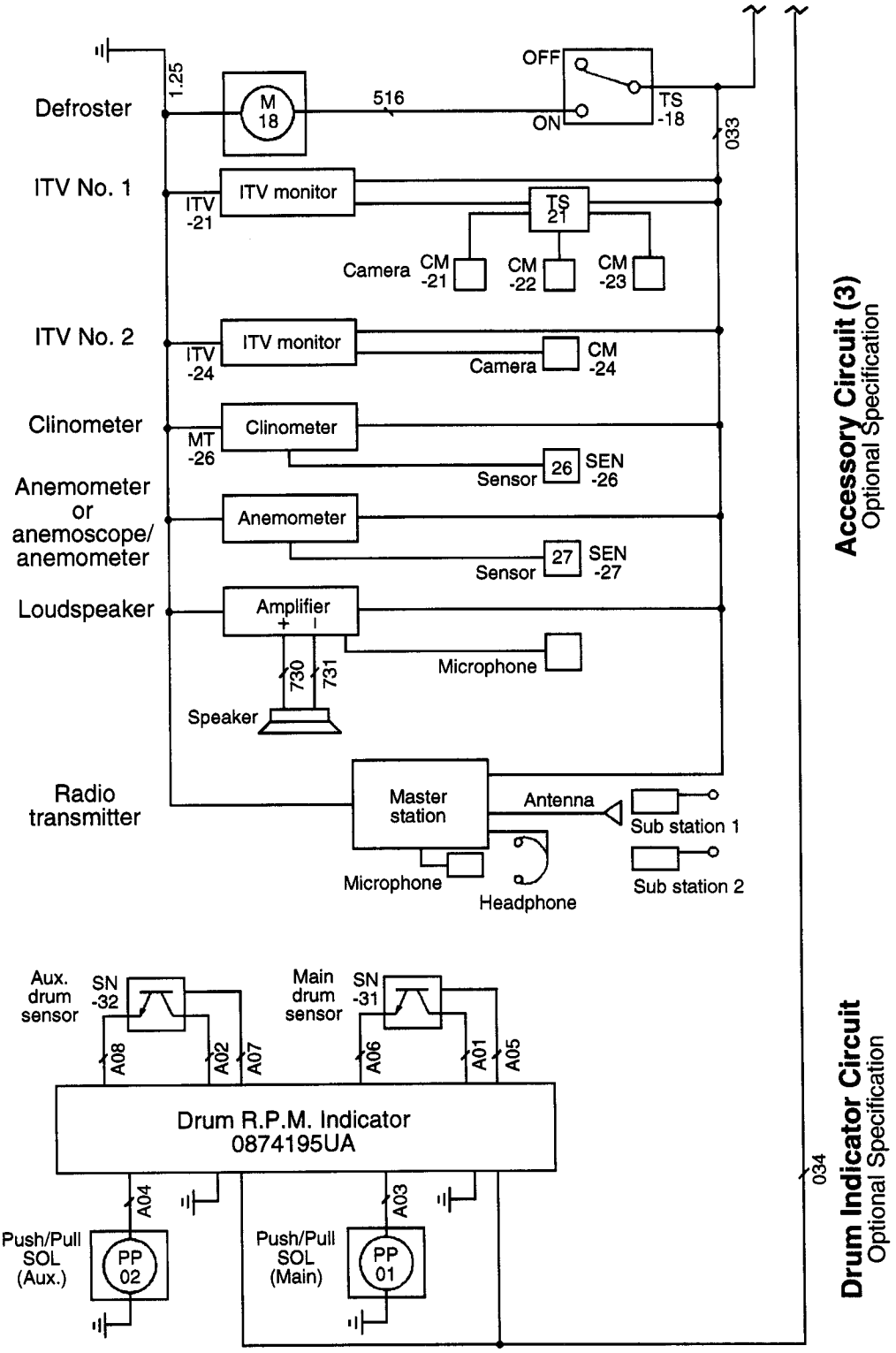
3-1 Electrical system diagram



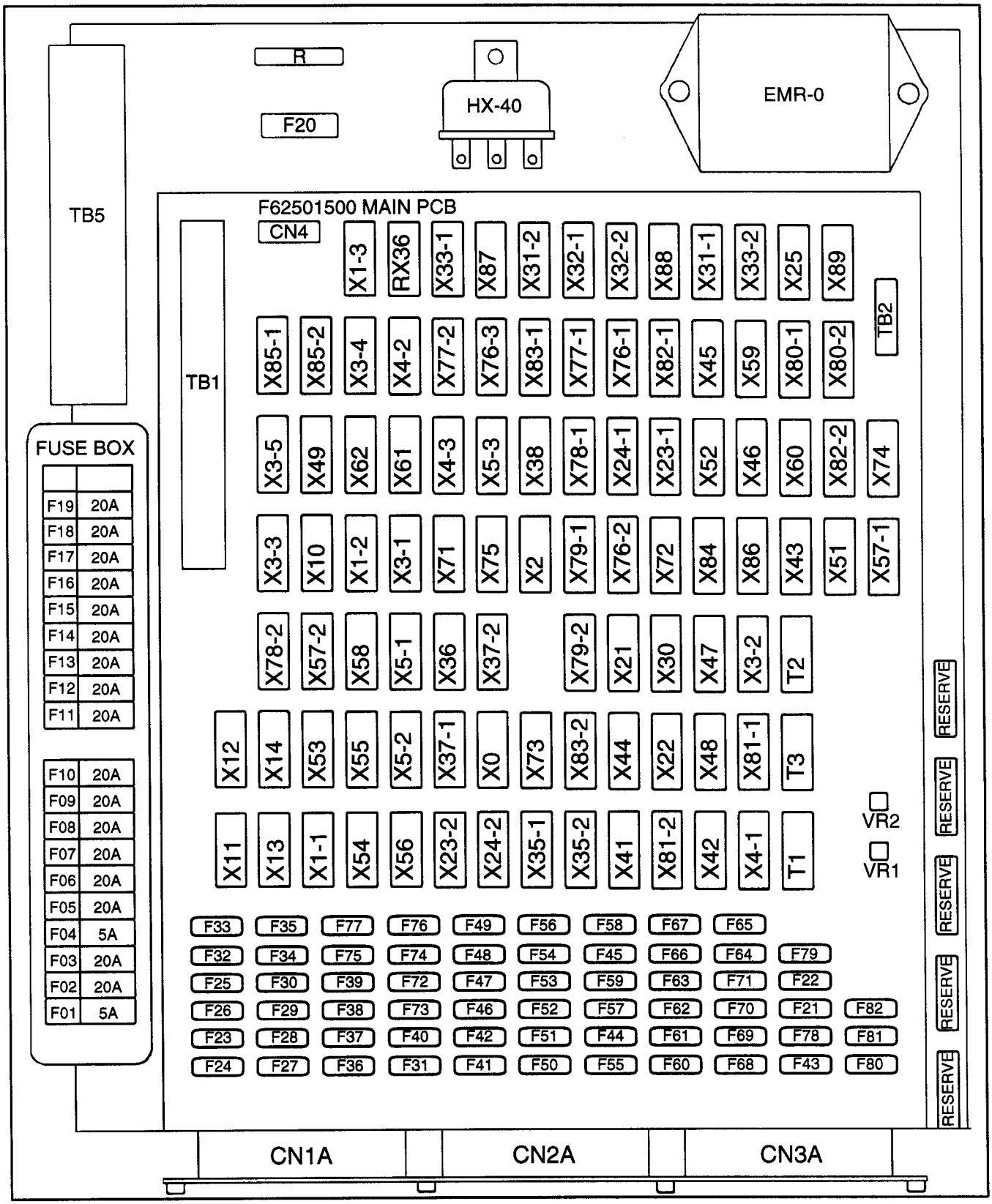
3-1 Electrical system diagram



3-1 Electrical system diagram



ELECTRICAL CONTROL PANEL



FUSE BOX

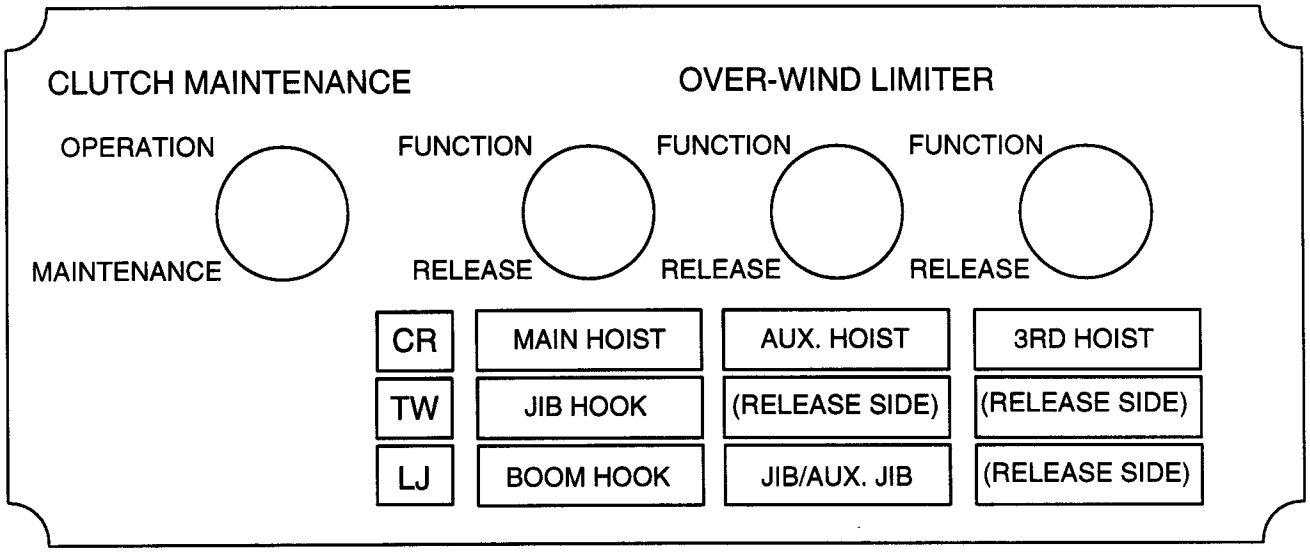
F01	5 A	CLOCK	F11	20 A	ALARM
F02	20 A	OK MONITOR	F12	20 A	ACCESSORY 1
F03	20 A	LOCK CIRCUIT	F13	20 A	ACCESSORY 2
F04	5 A	DEPTH GAUGE	F14	20 A	ACCESSORY 3
F05	20 A	LOCK CONTROL	F15	20 A	WINCH SPEED
F06	20 A	UNLOAD	F16	20 A	AIR CONDITIONER
F07	20 A	MOMENT LIMITER	F17	20 A	RESERVE
F08	20 A	SAFETY CIRCUIT	F18	20 A	RESERVE
F09	20 A	WINCH MODE	F19	20 A	ACC CIRCUIT
F10	20 A	CYLINDER SELECT			

FUSE ON PANEL

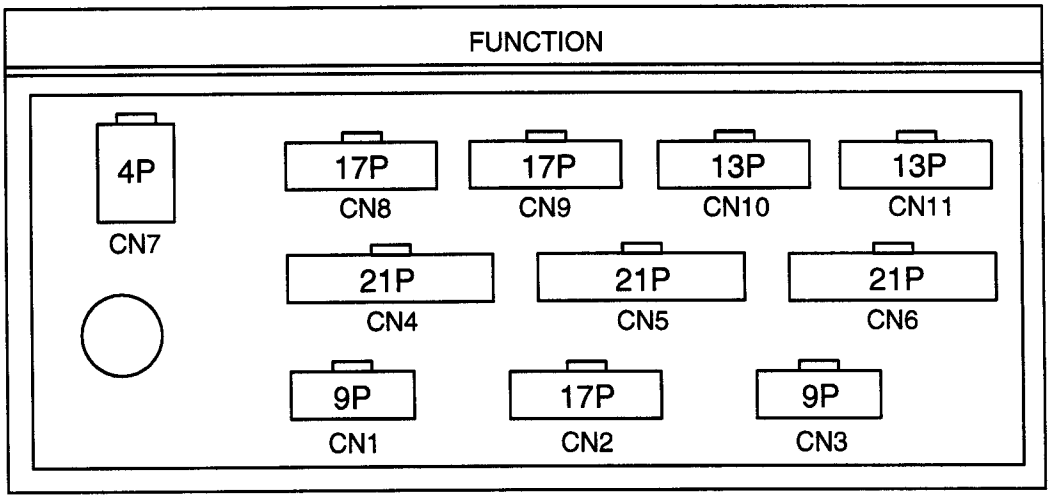
F20	0.5 A	TIMER

3 AMP FUSES ON PANEL

F21	ENGINE START INTERLOCK	F51	AUX. MODE LAMP
F22	SWING BRAKE LAMP	F52	AUX. HOIST CLUTCH
F23	MAIN DRUM LOCK	F53	3RD HOIST BRAKE
F24	MAIN DRUM LOCK	F54	3RD MODE LAMP
F25	AUX. DRUM LOCK	F55	3RD HOIST CLUTCH
F26	AUX. DRUM LOCK	F56	SWING BRAKE
F27	BOOM DRUM LOCK	F57	SWING BRAKE LAMP
F28	BOOM DRUM LOCK	F58	M/L ALARM
F29	3RD DRUM LOCK	F59	ALARM
F30	3RD DRUM LOCK	F60	GREEN SIGNAL
F31	SWING LOCK	F61	YELLOW SIGNAL
F32	LEVER LOCK	F62	RED SIGNAL
F33	TRACTION LOCK	F63	SLOW SPEED
F34	BOOM UNLOAD	F64	BOOM THROW-OUT
F35	BOOM UNLOAD	F65	POST LOCK
F36	3RD/JIB UNLOAD	F66	MAIN OVERWIND
F37	3RD/JIB UNLOAD	F67	AUX. OVERWIND
F38	MAIN DRUM UNLOAD	F68	2ND MAIN/3RD OVERWIND
F39	MAIN/AUX./JIB UNLOAD	F69	2ND THROW-OUT
F40	MAIN/AUX./JIB UNLOAD	F70	JIB THROW-OUT
F41	M/L VOICE ALARM	F71	STABILIZER LIMIT
F42	M/L VOICE ALARM	F72	CYLINDER SELECT
F43	VOICE ALARM	F73	TAGLINE
F44	MAIN HOIST MODE	F74	LOWER MACHINE CYLINDER
F45	AUX. HOIST MODE	F75	GANTRY FRAME CYLINDER
F46	3RD HOIST MODE	F76	LOWER MACHINE CYLINDER
F47	MAIN HOIST BRAKE	F77	GANTRY FRAME CYLINDER
F48	MAIN MODE LAMP	F78	TRACTION SIGNAL
F49	MAIN HOIST CLUTCH	F79	2ND STABILIZER
F50	AUX. HOIST BRAKE		



CLUTCH MAINTENANCE & OVER-WIND LIMITER



CONNECTOR LAYOUT

HC80 RELAY IDENTIFICATION

RELAY NO.	FUNCTION	COIL LOCATION	CONTACTS LOCATION
X11	Main Drum Lock	Lock Operation Circuit (Page 4-16)	Lock Operation Circuit (Page 4-16)
X12	Aux. Drum Lock	Lock Operation Circuit (Page 4-16)	Lock Operation Circuit (Page 4-16)
X13	Boom Drum Lock	Lock Operation Circuit (Page 4-16)	Lock Operation Circuit (Page 4-16)
X14	Jib Drum or 3rd Drum Lock (Option)	Lock Operation Circuit (Page 4-16)	Lock Operation Circuit (Page 4-16)
X1-1	Operation Lock/ Traction Lock Cut Control Pressure to Control Levers	Lock Operation Circuit (Page 4-16)	Lock Operation Circuit (Page 4-16)
X1-2	Simultaneous Selection of Winch Mode (Option)	Lock Operation Circuit (Page 4-16)	Winch Mode Selection Circuit (Page 4-14)
X1-3	Swing Brake (Seat switch activated) & Pilot Lamp	Lock Operation Circuit (Page 4-16)	Winch Mode Selection Circuit Activates swing brake solenoid (Page 4-15)
T1	Seat Switch Timer	Lock Operation Circuit (Page 4-16)	Lock Operation Circuit (Page 4-16)
X78-2	3rd Drum Overhoist Unload Main & Aux. Hoisting	Safety Circuit (Page 4-13)	Unload Circuit (Page 4-17)
X3-3	Tower Selection Cut Main, Aux., & Jib or 3rd Hoisting	Safety Circuit (Page 4-13)	Unload Circuit (Page 4-17)
X3-5	Tower Selection Activate 2nd Stabilizer Limit	Safety Circuit (Page 4-13)	Safety Circuit (Page 4-13)
X85-1	2nd Stabilizer Limit Tower Selection to Cut Boom & Jib or 3rd Hoisting	Safety Circuit (Page 4-13)	Unload Circuit (Page 4-17)
X53	Unload Boom Hoisting	Safety Circuit (Page 4-12)	Unload Circuit (Page 4-17)
X57-2	Unload Main Hoisting & Jib or 3rd Hoisting	Safety Circuit (Page 4-12)	Unload Circuit (Page 4-17)
X85-2	2nd Stabilizer Limit Unload Main & Aux. Hoisting	Safety Circuit (Page 4-13)	Unload Circuit (Page 4-17)
X54	Unload Boom Lowering (Holding Circuit)	Safety Circuit (Page 4-12)	Unload Circuit (Page 4-17)
X55	Unload Jib or 3rd Hoisting	Safety Circuit (Page 4-12)	Unload Circuit (Page 4-17)

HC80 RELAY IDENTIFICATION (Cont'd)

RELAY NO.	FUNCTION	COIL LOCATION	CONTACTS LOCATION
X58	Unload Aux. Holding (Holding Circuit)	Safety Circuit (Page 4-12)	Unload Circuit (Page 4-17)
X62	Low Control Pressure Alarm	Safety Circuit (Page 4-12)	Safety Circuit (Page 4-12)
X3-4	Tower Selection Aux. or TW Jib Hoisting	Safety Circuit (Page 4-12)	Unload Circuit (Page 4-17)
X56	Unload Jib or 3rd Lowering (Holding Circuit)	Safety Circuit (Page 4-12)	Unload Circuit (Page 4-17)
X 5-1 X5-2	**NOT USED ON HC 80**		
X3-1	Tower Selection Boom Hoisting Stop	Safety Circuit (Page 4-13)	Safety Circuit (Page 4-12)
X61	Alarm at LMI Off	Safety Circuit (Page 4-12)	Moment Limiter Circuit (Page 4-11)
X4-2	LJ Selection	Safety Circuit (Page 4-13)	Unload Circuit (Page 4-17)
X71	TW Boom 85° Alarm & Stop	Safety Circuit (Page 4-12)	Safety Circuit (Page 4-12)
X4-3	LJ Selection	Safety Circuit (Page 4-13)	Unload Circuit (Page 4-17)
X77-2	Aux. Overhoisting (Reset selection) Main & Aux. Overhoisting	Safety Circuit (Page 4-13)	Unload Circuit (Page 4-17)
X75	Main Overhoisting (Reset is possible)	Safety Circuit (Page 4-12)	Unload Circuit (Page 4-17)
X5-3	**NOT USED ON HC 80**		
X76-3	Main Overhhoisting (Reset selection) Unload Aux. or TW Jib Lowering	Safety Circuit (Page 4-12)	Unload Circuit (Page 4-17)
X73	TW 85° Alarm	Safety Circuit (Page 4-12)	Safety Circuit (Page 4-12)
X83-1	TW Jib Throw-out & LJ Main Overhoisting (TW Select) Unload TW Boom Lowering & Main Hoisting & TW Jib Hoisting	Safety Circuit (Page 4-13)	Unload Circuit (Page 4-17)
X83-2	Tower Jib Throw-out & LJ Main Overhoisting (TW Select) Alarm	Safety Circuit (Page 4-13)	Safety Circuit (Page 4-12)

HC80 RELAY IDENTIFICATION (Cont'd)

RELAY NO.	FUNCTION	COIL LOCATION	CONTACTS LOCATION
X79-2	Main Overhoisting Alarm	Safety Circuit (Page 4-13)	Safety Circuit (Page 4-12)
X79-1	Main Overhoisting Cut	Safety Circuit (Page 4-13)	Safety Circuit (Page 4-12)
X78-1	3rd Drum Overhoisting (Reset selection) Unload 3rd Drum & Boom Lowering	Safety Circuit (Page 4-13)	Unload Circuit (Page 4-17)
X77-1	Aux. Overhoisting (Reset selection) Jib Hoisting or 3rd Hoisting & Boom Lower Cut	Safety Circuit (Page 4-13)	Unload Circuit (Page 4-17)
X76-2	Main Overhoisting (Reset selection) Main & Aux. Hoist Cut	Safety Circuit (Page 4-12)	Unload Circuit (Page 4-17)
X76-1	Main Overhoisting (Reset selection) Boom Lower & Jib or 3rd Hoisting Cut	Safety Circuit (Page 4-12)	Unload Circuit (Page 4-17)
X81-2	3rd Drum Overhoist Alarm	Safety Circuit (Page 4-13)	Safety Circuit (Page 4-12)
X72	TW Boom Hoisting Lock	Safety Circuit (Page 4-12)	Unload Circuit (Page 4-17)
X82-1	Boom Hoisting Throw-out or Cut	Safety Circuit (Page 4-13)	Unload Circuit (Page 4-17)
X84	Tower Stabilizer Limit Boom Hoisting Cut	Safety Circuit (Page 4-13)	Unload Circuit (Page 4-17)
X4-1	LJ Selection No Release of Overhoisting for 3rd Drum Overhoisting	Safety Circuit (Page 4-13)	Safety Circuit (Page 4-13)
X81-1	3rd Drum Overhoisting Cut for Boom Lower 3rd Hoisting (Reset selection)	Safety Circuit (Page 4-13) & Unload Circuit (Page 4-17)	Unload Circuit (Page 4-17)
X3-2	Tower Selection Activated TW Jib Throw-out & Stabilizer Limit. Non-Activated Boom Throw-out	Safety Circuit (Page 4-13)	Safety Circuit (Page 4-13)
X59	Unload Aux. Lowering (Holding Circuit)	Safety Circuit (Page 4-12)	Safety Circuit (Page 4-12) & Unload Circuit (Page 4-17)
T3	M/L Start 2 Second Delay to Un-latch Safety Relays for Unload Circuit	Safety Circuit (Page 4-12)	Safety Circuit (Page 4-12)

HC80 RELAY IDENTIFICATION (Cont'd)

RELAY NO.	FUNCTION	COIL LOCATION	CONTACTS LOCATION
X60	Transport Mode Activates for Functions to Cut	Safety Circuit (Page 4-12)	Safety Circuit (Page 4-12)
X80-1	Unload Aux. Hoisting Activated Relay X77-1 & X77-2	Safety Circuit (Page 4-14)	Safety Circuit (Page 4-14)
X82-2	Boom Throw-out Main & Aux. Hoist Unolad	Safety Circuit (Page 4-13)	Safety Circuit (Page 4-13)
X80-2	Aux. Overhoisting Alarm	Safety Circuit (Page 4-13)	Safety Circuit (Page 4-13)
X57-1	Unload Main Hoisting (Holding Circuit)	Safety Circuit (Page 4-12)	Safety Circuit (Page 4-12)
X74	Boom Hoisting Stop Bypass when in Crane Mode	Safety Circuit (Page 4-12)	Safety Circuit (Page 4-12)
X49	Gentle Stop Signal 1 (Angle) Signal 2 (Load)	Moment Limiter Circuit (Page 4-11)	Safety Circuit (Page 4-12)
X41	Moment Limiter Buzzer Output	Moment Limiter Circuit (Page 4-11)	Safety Circuit (Page 4-12)
X44	Boom Lowering Stop Output from LMI	Moment Limiter Circuit (Page 4-11)	Safety Circuit (Page 4-12)
X42	Load Limit Approaching for Outside Alarm (Option)	Moment Limiter Circuit (Page 4-11)	Safety Circuit (Page 4-12)
X48	Aux. Drum Hoisting Stop Output from LMI	Moment Limiter Circuit (Page 4-11)	Safety Circuit (Page 4-12)
X47	Main Drum Hoisting Stop Output from LMI	Moment Limiter Circuit (Page 4-11)	Safety Circuit (Page 4-12)
X52	Overload 100% Signal for Outside Alarm (Option)	Moment Limiter Circuit (Page 4-11)	Safety Circuit (Page 4-12)
X45	TW Jib or 3rd Drum Hoisting Stop Output from LMI	Moment Limiter Circuit (Page 4-11)	Safety Circuit (Page 4-12)
X46	TW Jib or 3rd Drum Lowering Stop Output from LMI	Moment Limiter Circuit (Page 4-11)	Safety Circuit (Page 4-12)
X43	Boom Drum Hoisting Stop Output from LMI	Moment Limiter Circuit (Page 4-11)	Safety Circuit (Page 4-12)
X51	Aux. Drum Lowering Stop Output from LMI	Moment Limiter Circuit (Page 4-11)	Safety Circuit (Page 4-12)

HC80 RELAY IDENTIFICATION (Cont'd)

RELAY NO.	FUNCTION	COIL LOCATION	CONTACTS LOCATION
RX-36	Swing Brake	Winch Mode Selection Circuit (Page 4-15)	Winch Mode Selection Circuit (Page 4-15)
X23-2	Main Winch Mode Engine Start Interlock	Winch Mode Selection Circuit (Page 4-15)	OK Monitor circuit (Page 4-8)
X33-1	3rd Drum Mode Selection (Holding Circuit)	Winch Mode Selection Circuit (Page 4-15)	Winch Mode Selection Circuit (Page 4-15)
X24-2	Aux. Winch Mode Engine Start Interlock	Winch Mode Selection Circuit (Page 4-15)	OK Monitor circuit (Page 4-8)
X87	Main Hoist Auto Brake & Clutch Activated by Pressure Switch	Winch Mode Selection Circuit (Page 4-14)	Winch Mode Selection Circuit (Page 4-15)
X35-1	Main Clutch Release for Maintenance	Winch Mode Selection Circuit (Page 4-15)	Winch Mode Selection Circuit (Page 4-15)
X31-2	Main Hoist Winch Mode Selection for Main Hoist Brake Function	Winch Mode Selection Circuit (Page 4-14)	Winch Mode Selection Circuit (Page 4-15)
X35-2	Aux. Clutch Release for Maintenance	Winch Mode Selection Circuit (Page 4-15)	Winch Mode Selection Circuit (Page 4-15)
X32-1	Aux. Hoist Winch Mode Selection (Holding Circuit)	Winch Mode Selection Circuit (Page 4-14)	Winch Mode Selection Circuit (Page 4-15)
X21	Main Winch Mode Selection Activated by Lever Push Button	Winch Mode Selection Circuit (Page 4-14)	Winch Mode Selection Circuit (Page 4-14)
X24-1	Select Foot Brake Mode (Aux. Winch Drum)	Winch Mode Selection Circuit (Page 4-14)	Winch Mode Selection Circuit (Page 4-14)
X32-2	Aux. Hoist Winch Mode Selection for Aux. Hoist Brake	Winch Mode Selection Circuit (Page 4-14)	Winch Mode Selection Circuit (Page 4-15)
X22	Aux. Winch Mode Selection Activated by Lever Push Button	Winch Mode Selection Circuit (Page 4-14)	Winch Mode Selection Circuit (Page 4-14)
X30	Simultaneous Selection of Winch Mode Selection (Option)	Winch Mode Selection Circuit (Page 4-14)	Winch Mode Selection Circuit (Page 4-14)
X23-1	Select Foot Brake Mode (Main Winch Drum)	Winch Mode Selection Circuit (Page 4-14)	Winch Mode Selection Circuit (Page 4-14)
X88	Aux. Hoist Auto Brake Activated by the Pressure Switch	Winch Mode Selection Circuit (Page 4-14)	Winch Mode Selection Circuit (Page 4-15)

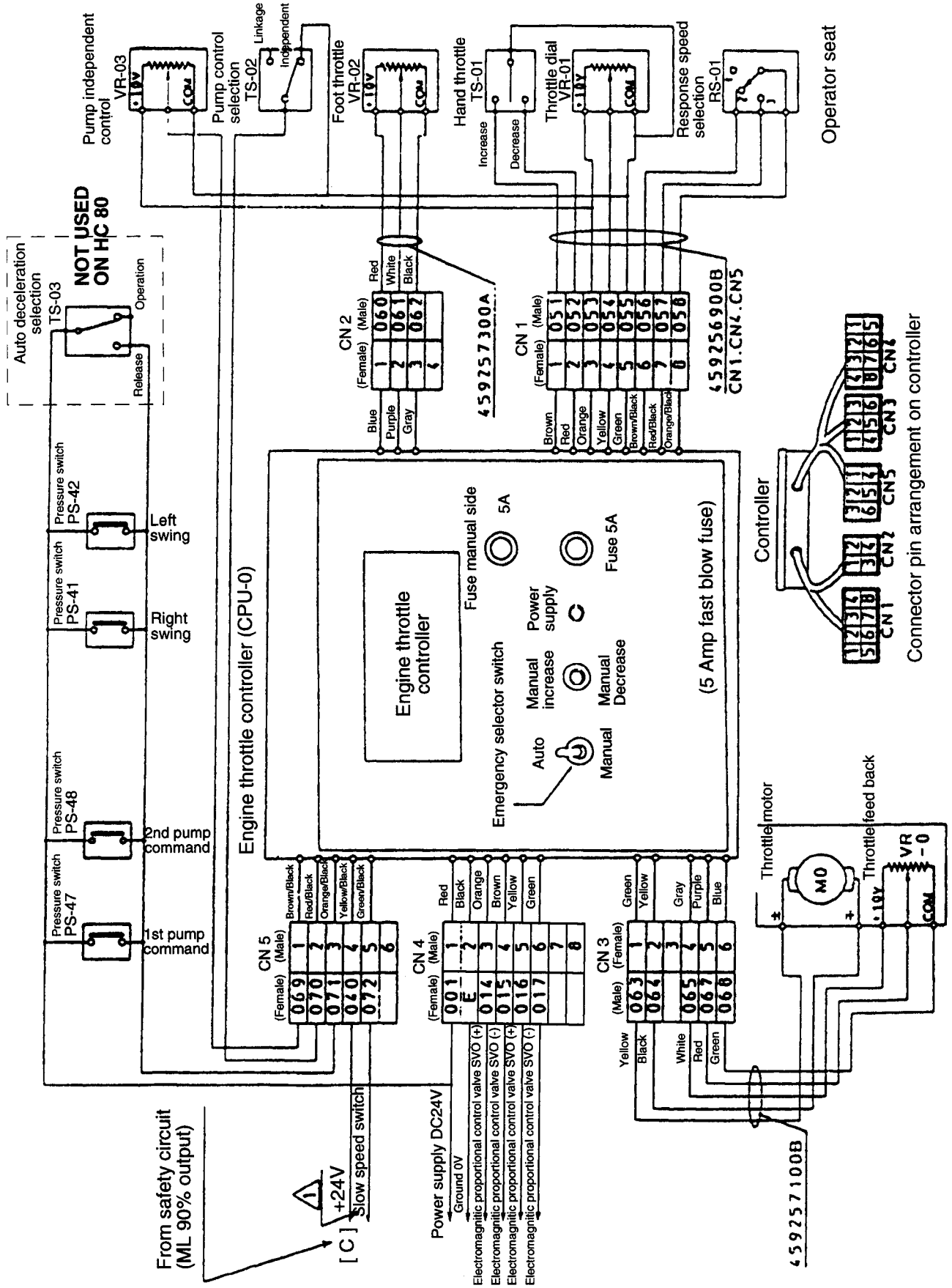
HC80 RELAY IDENTIFICATION

RELAY NO.	FUNCTION	COIL LOCATION	CONTACTS LOCATION
X31-1	Main Hoist Winch Mode Selection (Holding Circuit)	Winch Mode Selection Circuit (Page 4-14)	Winch Mode Selection Circuit (Page 4-15)
X33-2	3rd Winch Mode Selection (Option) Releases Brake for Freewheeling	Winch Mode Selection Circuit (Page 4-15)	Winch Mode Selection Circuit (Page 4-15)
X25	Mode Selection for 3rd Drum	Winch Mode Selection Circuit (Page 4-14)	Winch Mode Selection Circuit (Page 4-15)
X89	3rd Drum Auto Brake & Clutch Activated by Pressure Switch	Winch Mode Selection Circuit (Page 4-14)	Winch Mode Selection Circuit (Page 4-15)
X2	**NOT USED ON HC 80**		
X86	Travel Alarm	Alarm Circuit (Page 4-10)	Alarm Circuit (Page 4-10)
T2	**NOT USED ON HC 80**		
X0	Engine Start Interlock	Motor & Power Supply Circuit (Page 4-7)	OK Monitor Circuit (Page 4-8)
X10	Alarm Depth/Lift Meter (Option)	- - -	- - -
X36 X37-1 X37-2 X38	**NOT USED ON HC 80**		

HC80 SOLENOID IDENTIFICATION

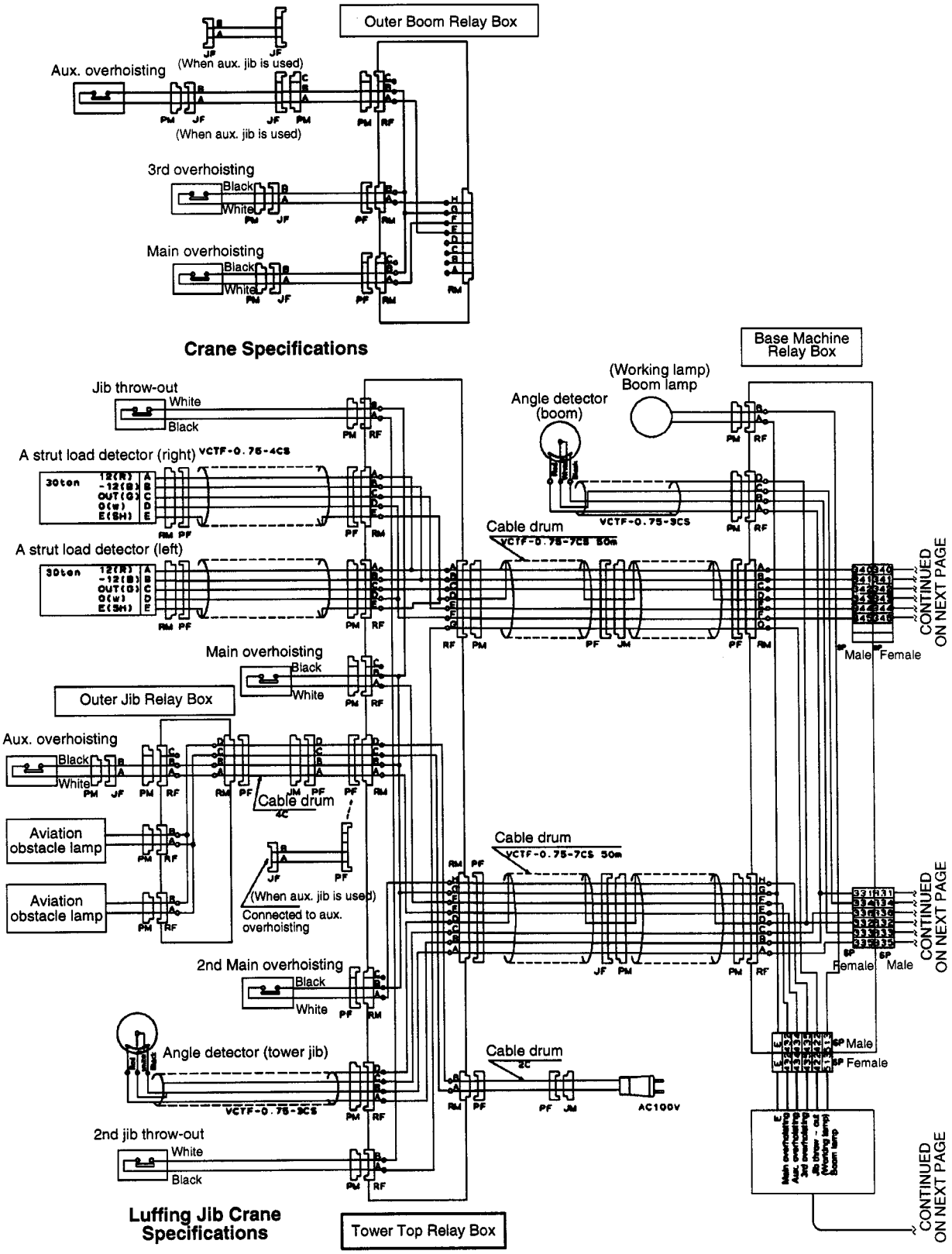
SOLENOID NO.	FUNCTION	SCHEMATIC PAGE #	LOCATION ON MACHINE
SV-0	(Proportional solenoid) Controls the main pump output by pump control switches & excessive HP draw. Receives signal through the throttle controller.	Page 4-7	Main Control Manifold
SL-51	Seat lock circuit for control pressure to HRCs (Swing, 3rd drum, main, aux. & boom)	Page 4-16	Main Control Manifold
SL-52	Travel lock for control pressure to travel HRCs	Page 4-16	Main Control Manifold
SL-53	Travel speed, sends control pressure to motor servo for high speed when energized	Page 4-10	Main Control Manifold
SL-58	Main hoist speed, sends control pressure to motor servo for high speed when energized	Page 4-10	Main Hoist Motor
SL-59	Aux. hoist speed, sends control pressure to motor servo for high speed when energized	Page 4-10	Aux. Hoist Motor
SL-63	Swing brake released by control pressure (570 psi) when energized	Page 4-15	Swing Brake Manifold
SL-64	Main hoist clutch released by control pressure (1100 psi) when energized	Page 4-15	Main Hoist Motor
SL-65	Aux. hoist clutch released by control pressure (1100 psi) when energized	Page 4-15	Aux. Hoist Motor
SL-66	Main hoist brake released by control pressure (1100 psi) when energized	Page 4-15	Main Hoist Motor
SL-101	Boom hoist cuts control pressure(570 psi) from HRC when de-energized	Page 4-17	Main Control Manifold
SL-102	Luffing jib or 3rd drum hoisting (Opt.), cuts control pressure (570 psi) from HRC when de-energized	Page 4-17	Main Control Manifold
SL-103	Boom lowering, cuts control pressure (570 psi) from HRC when de-energized	Page 4-17	Main Control Manifold
SL-104	Luffing jib or 3rd drum lowering (Opt.), cuts control pressure (570 psi) from HRC when de-energized	Page 4-17	Main Control Manifold
SL-105	Main hoist, cuts control pressure (570 psi) from HRC when de-energized	Page 4-17	Main Control Manifold
SL-106	Aux. hoist, cuts control pressure (570 psi) from HRC when de-energized	Page 4-17	Main Control Manifold
SL-107	Aux. drum or tower jib lowering, cuts control pressure (570 psi) from HRC when de-energized	Page 4-17	Main Control Manifold
SL-67	Aux. hoist brake released by control pressure (1100 psi) when energized	Page 4-15	Aux. Hoist Motor
SL-68	3rd drum (Opt.) clutch released by control pressure (1100 psi) when energized	Page 4-15	3rd Drum Motor
SL-71	3rd drum (Opt.) brake released by control pressure (1100 psi) when energized **NOT USED ON HC 80**	---	---
SL-301	P.T.O. or 3rd drum selection, control pressure (1100 psi) shifts a spool to direct pump flow to the P.T.O. when energized	Page 4-10	Behind 3rd Drum Motor

Engine Throttle Control Connecting Diagram

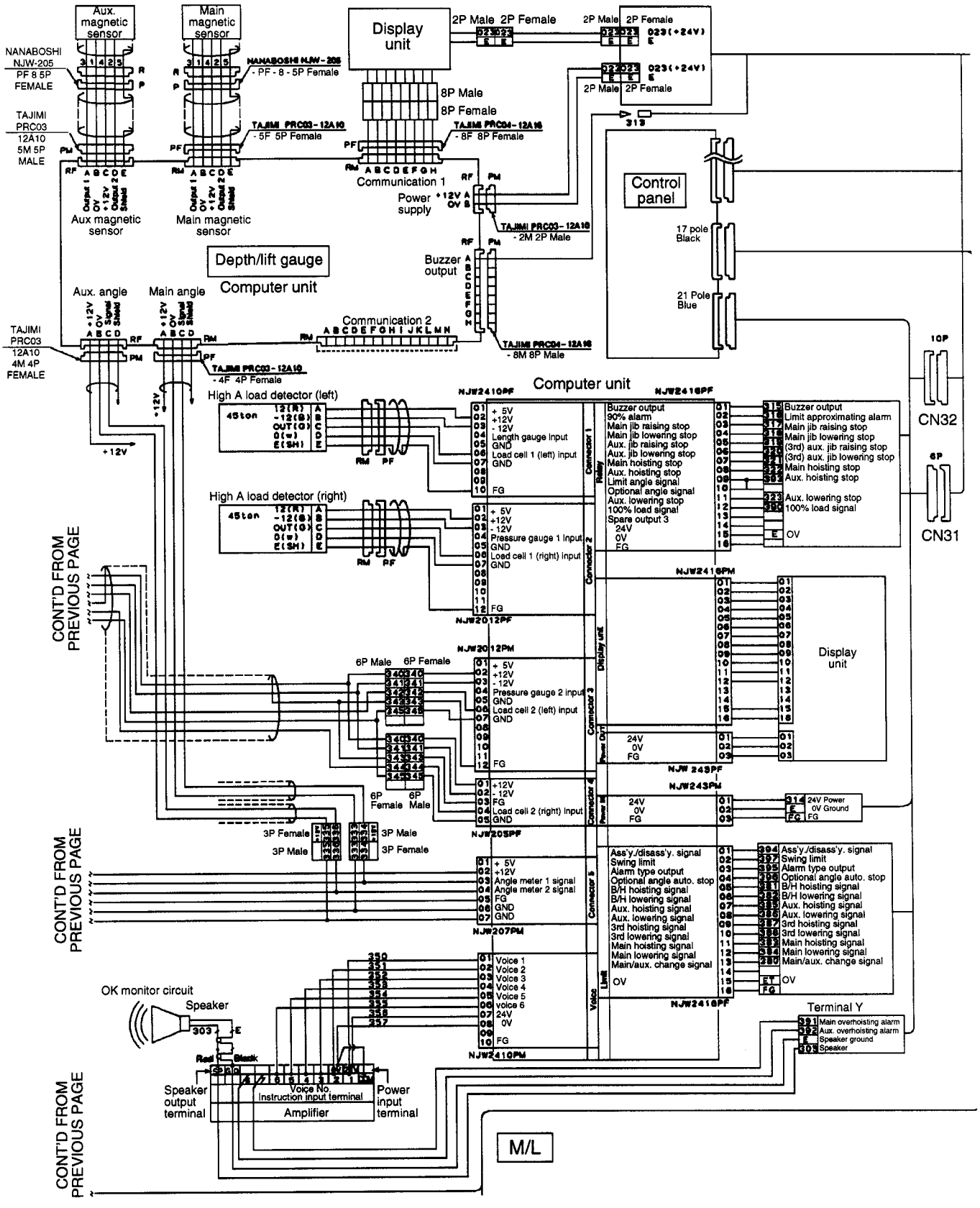


3-2 Moment limiter connecting diagram

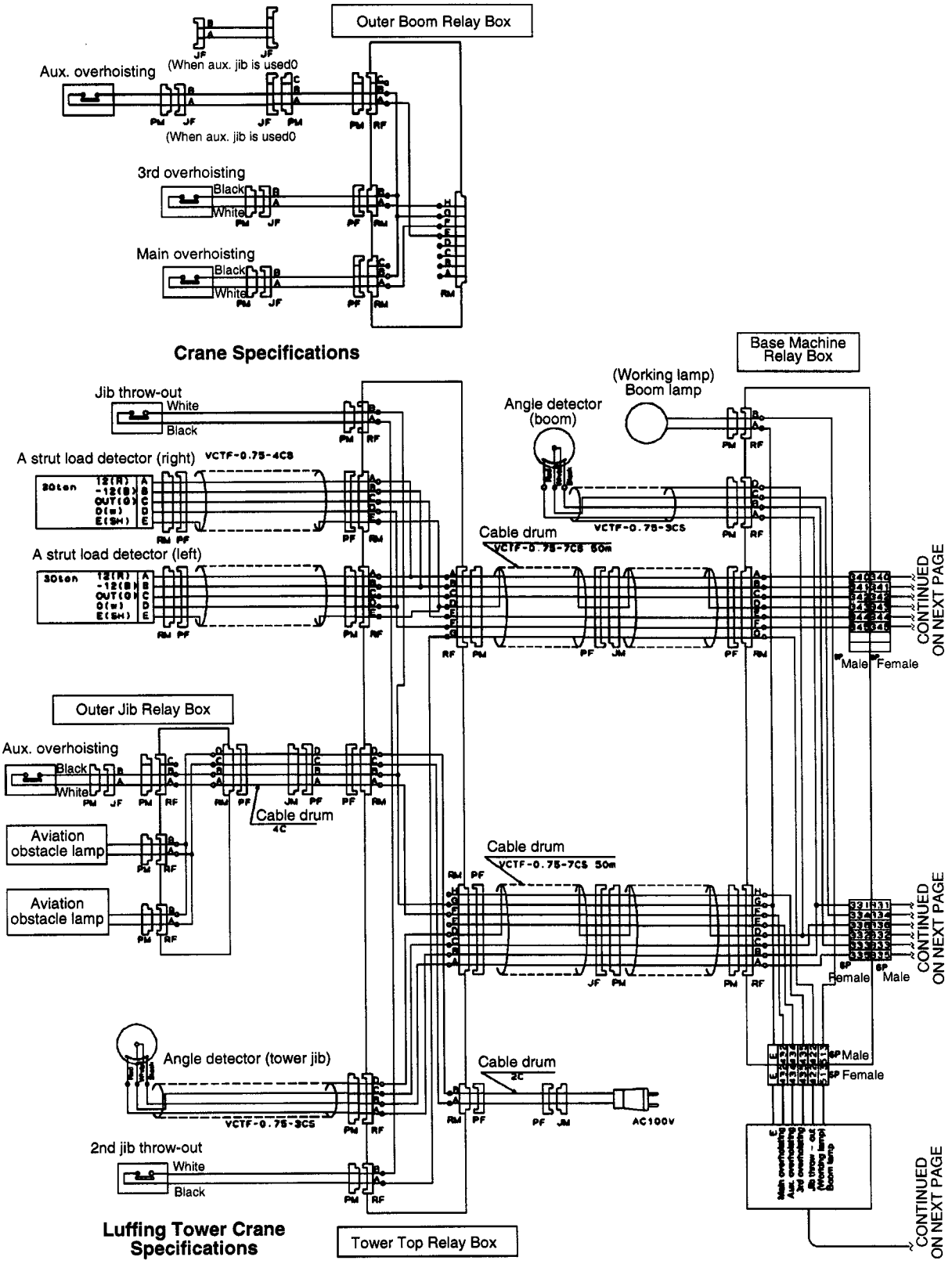
① Standard crane/luffing jib crane



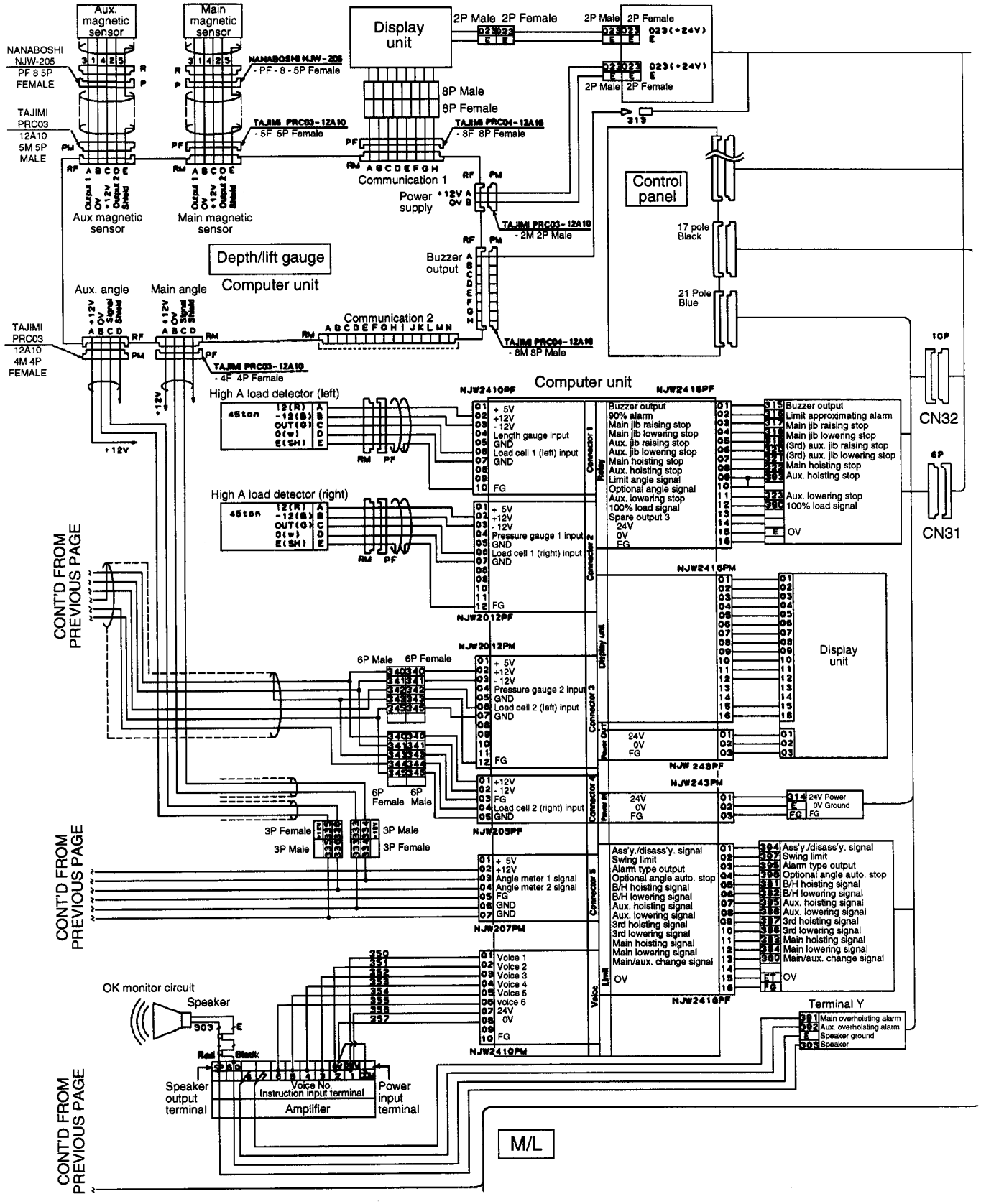
① Standard crane/luffing jib crane



② Standard crane/luffing tower crane

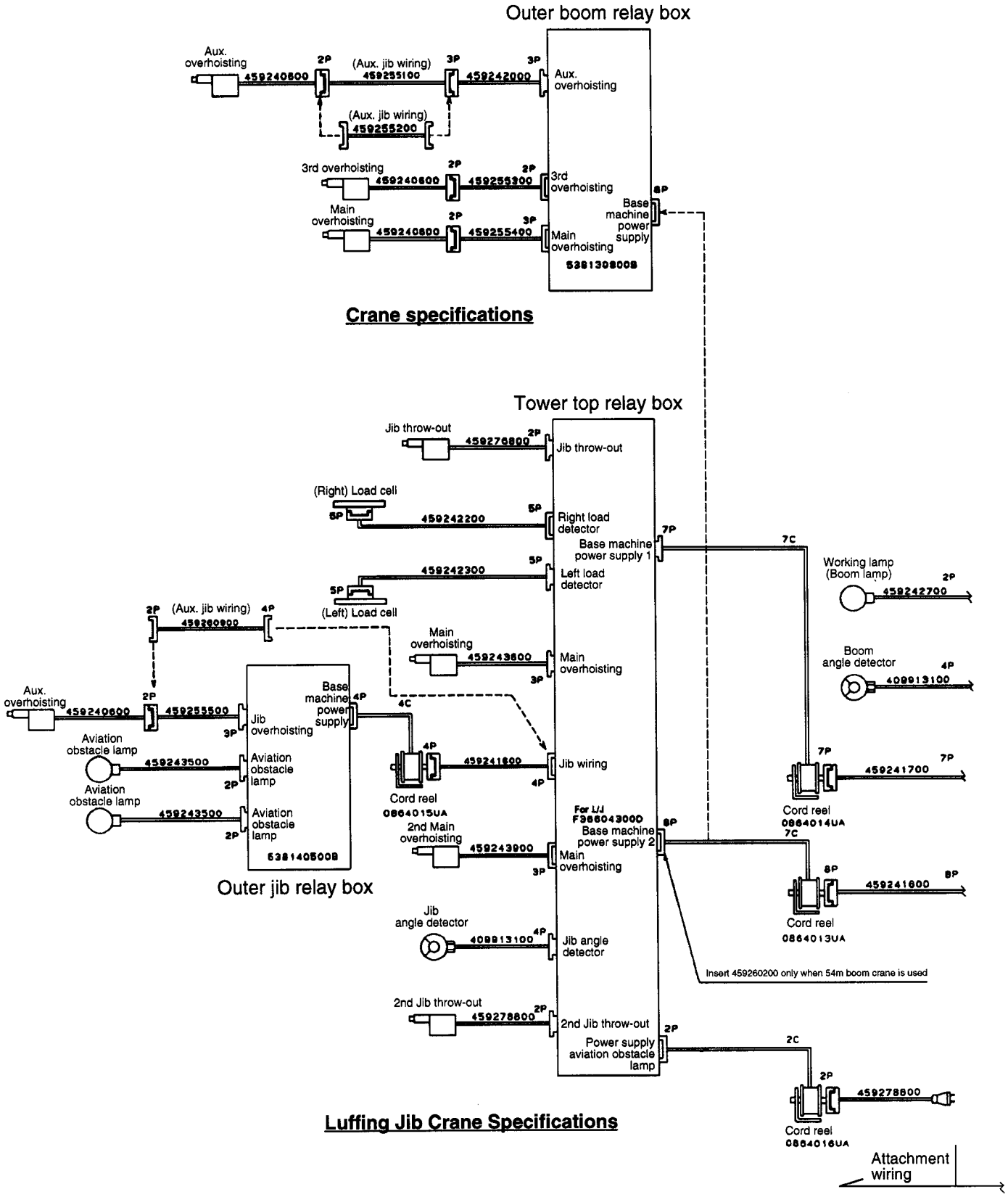


② Standard crane/luffing tower crane



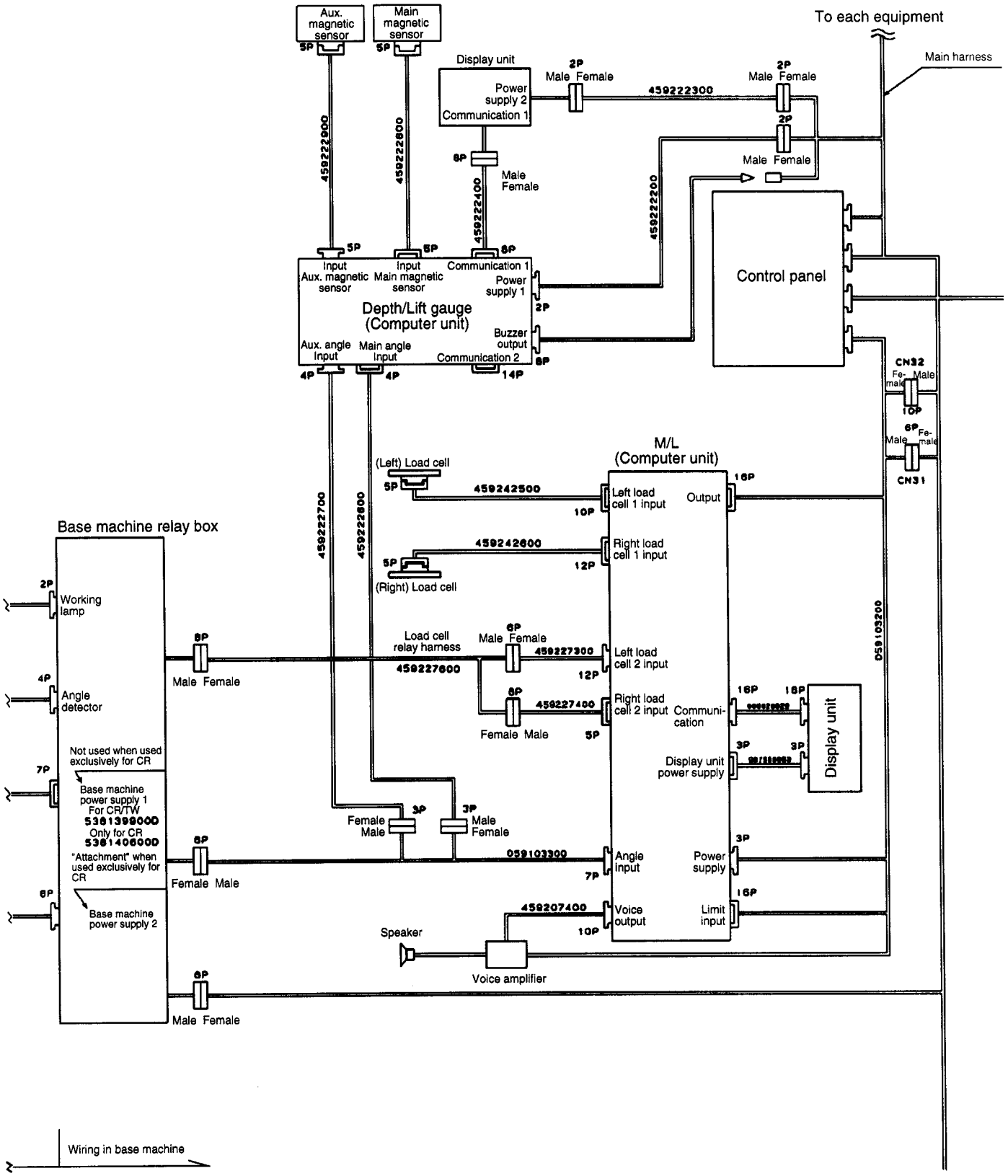
3-3 Cable diagram

① Standard crane/luffing jib crane

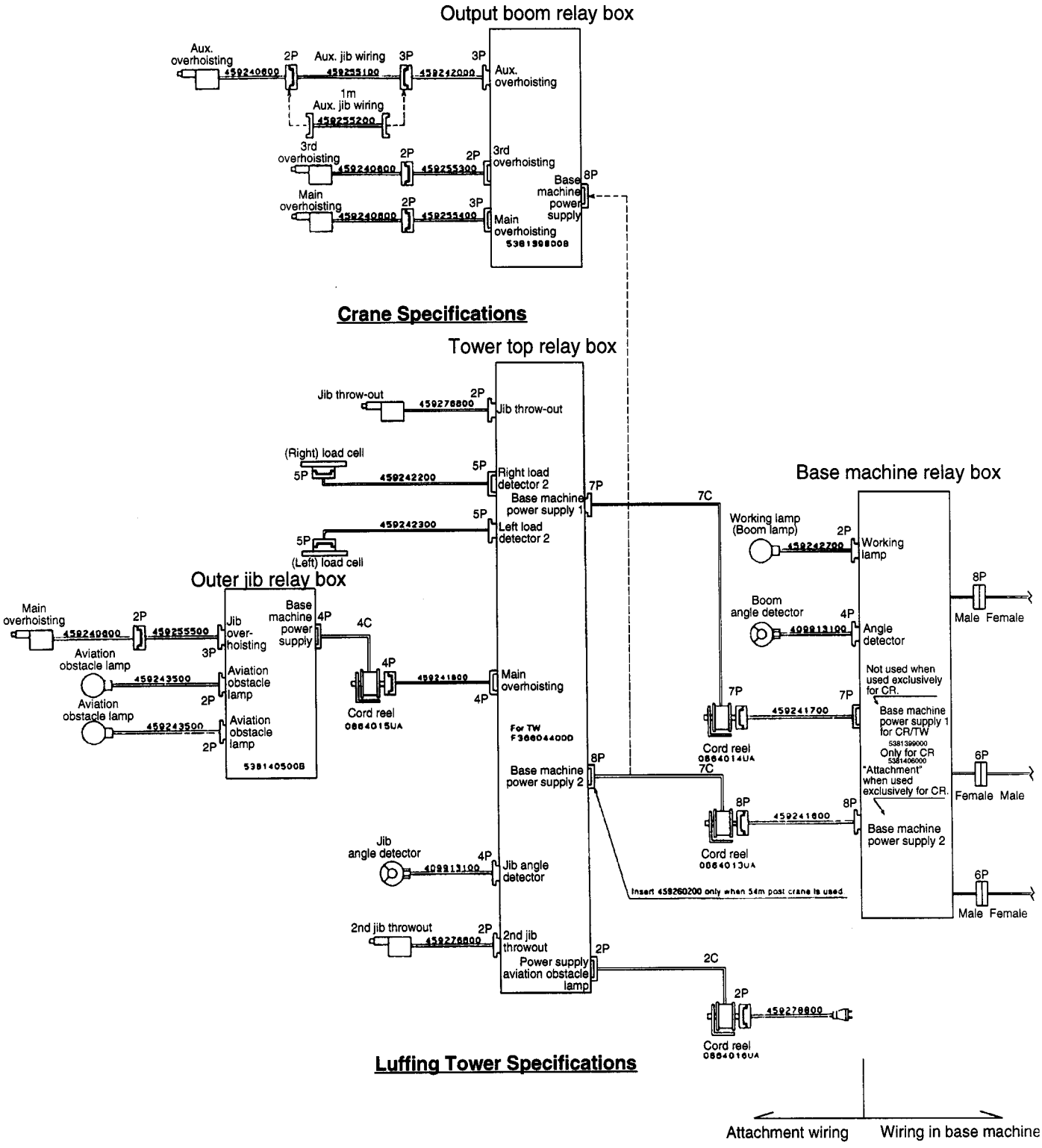


3-3 Cable diagram

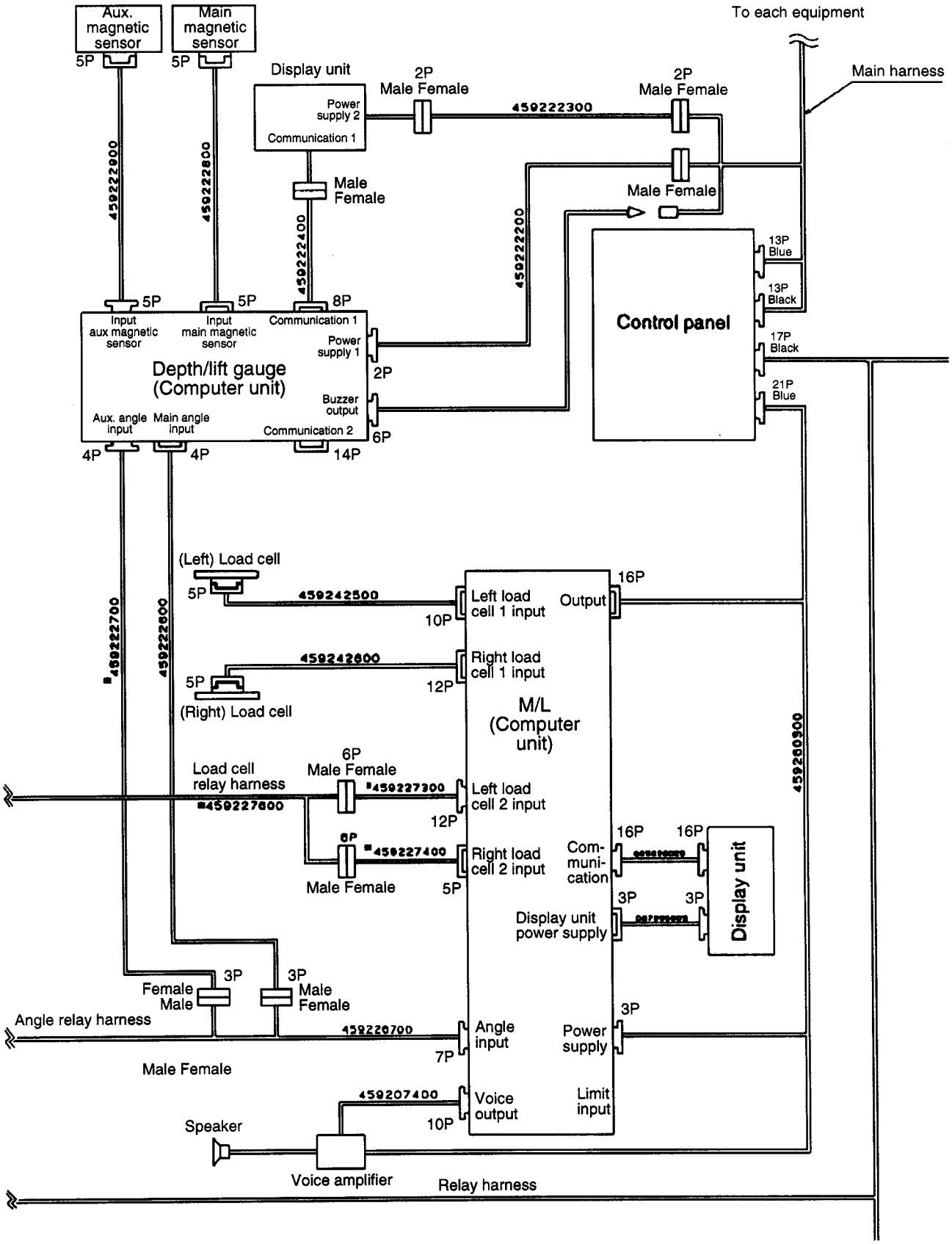
① Standard crane/luffing jib crane



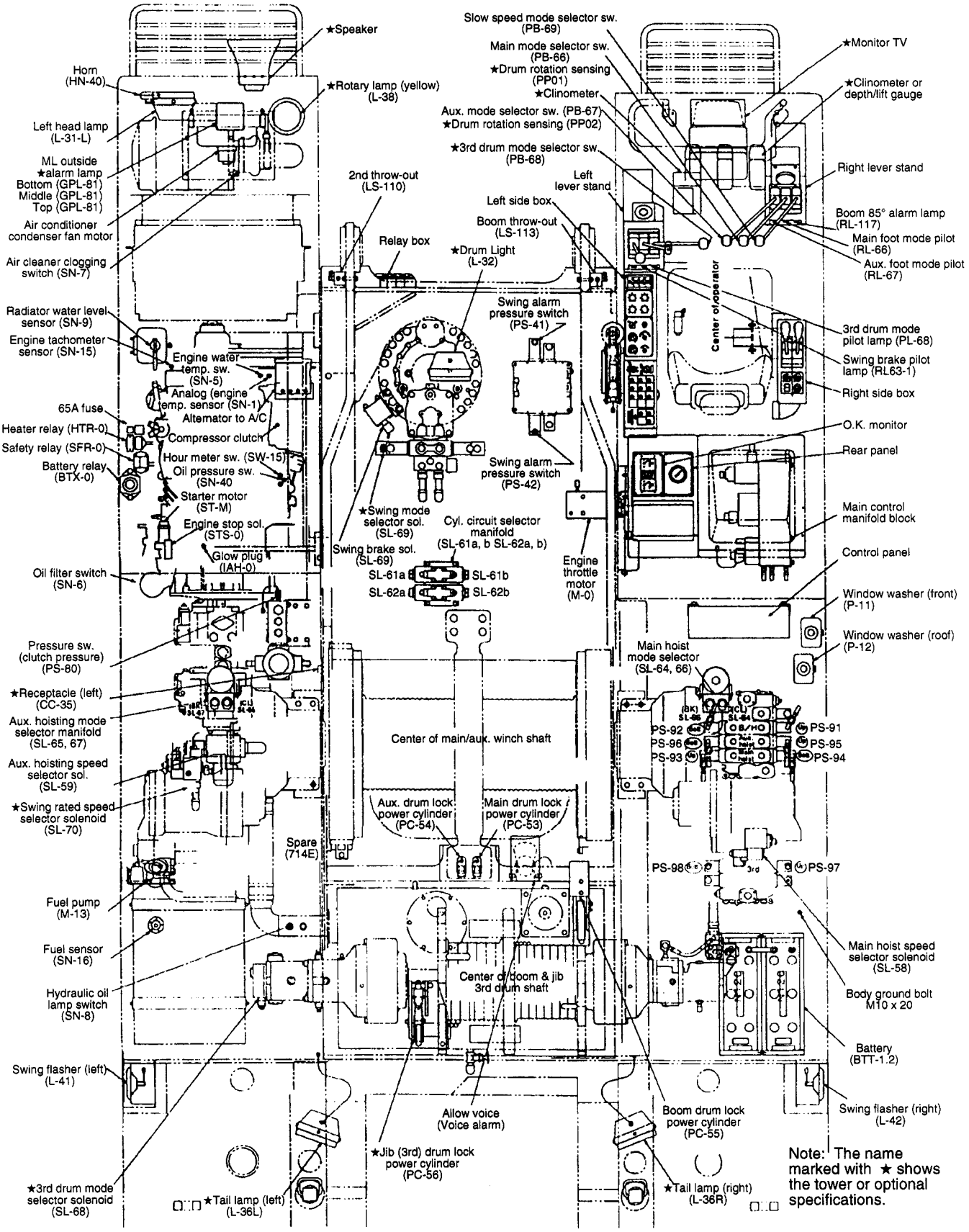
② Standard crane/luffing tower crane



② Standard crane/luffing tower crane

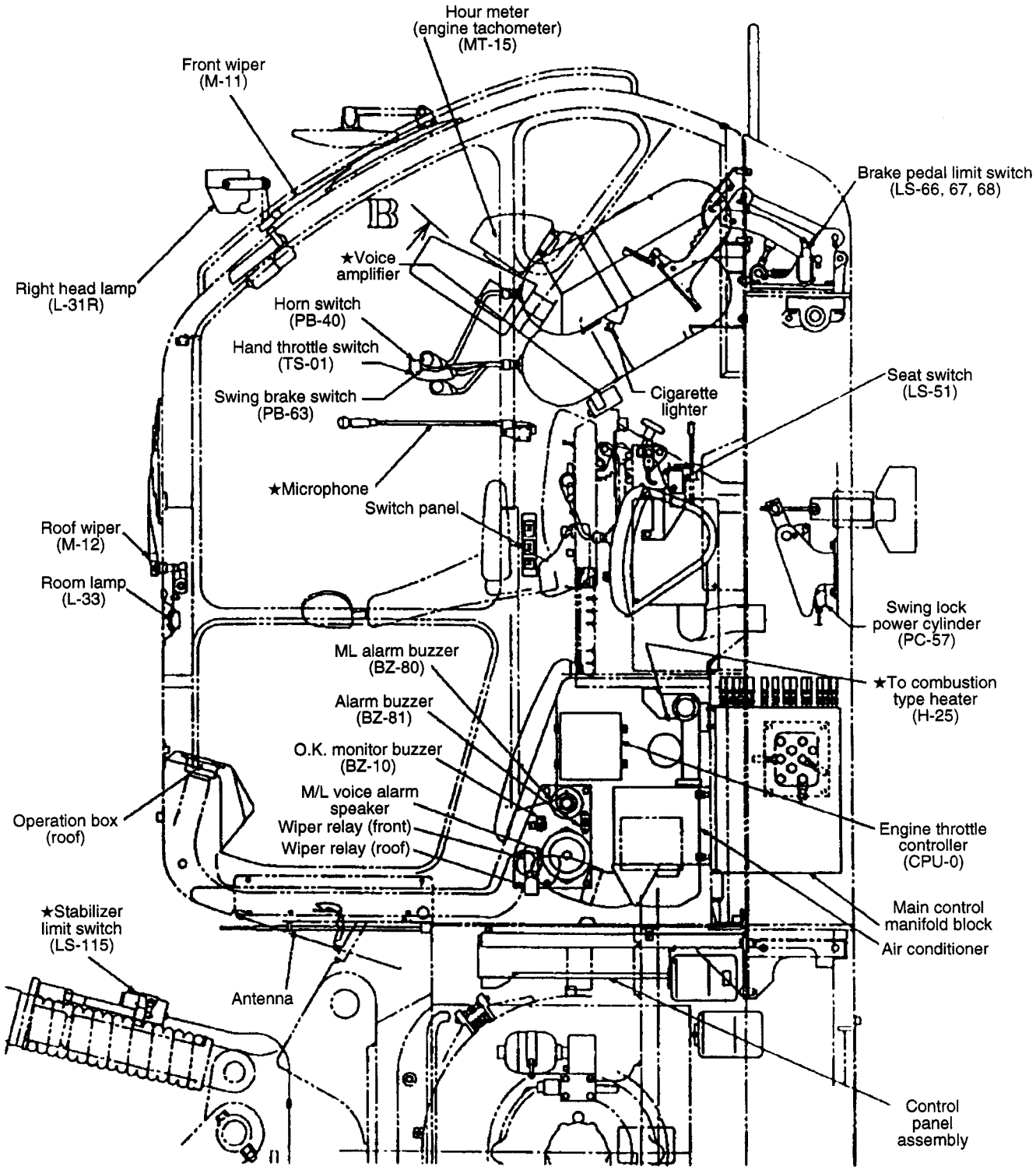


4. ARRANGEMENT OF ELECTRICAL EQUIPMENT



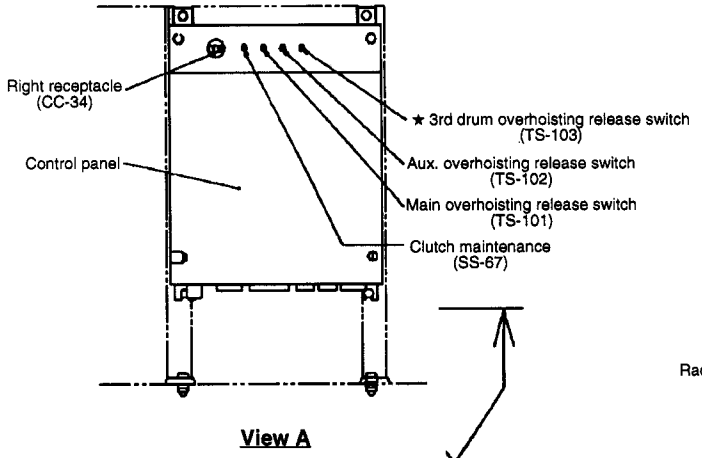
Note: The name marked with ★ shows the tower or optional specifications.

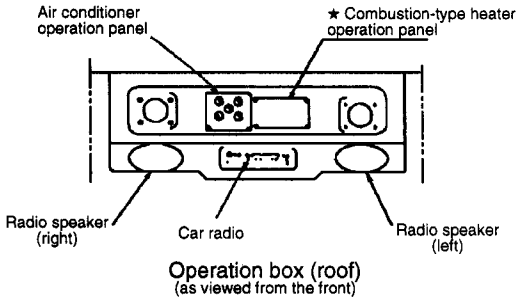
4. ARRANGEMENT OF ELECTRICAL EQUIPMENT



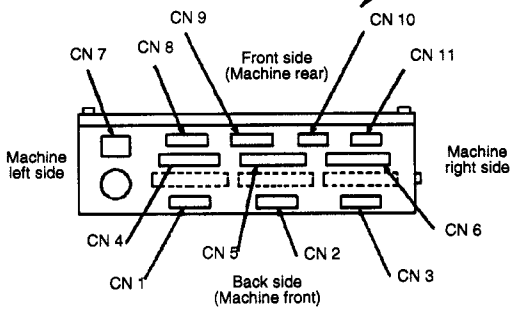
Note: The name marked with ★ shows the tower or optional specifications.

4. ARRANGEMENT OF ELECTRICAL EQUIPMENT

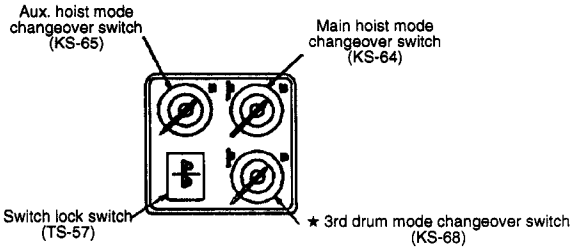




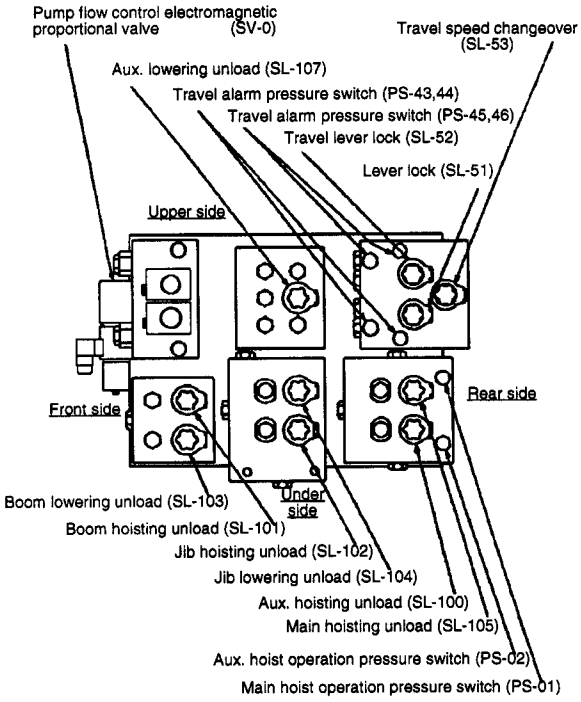
Operation box (roof)
(as viewed from the front)



Detail of control panel connectors arrangement
(as viewed from the bottom of the control panel)

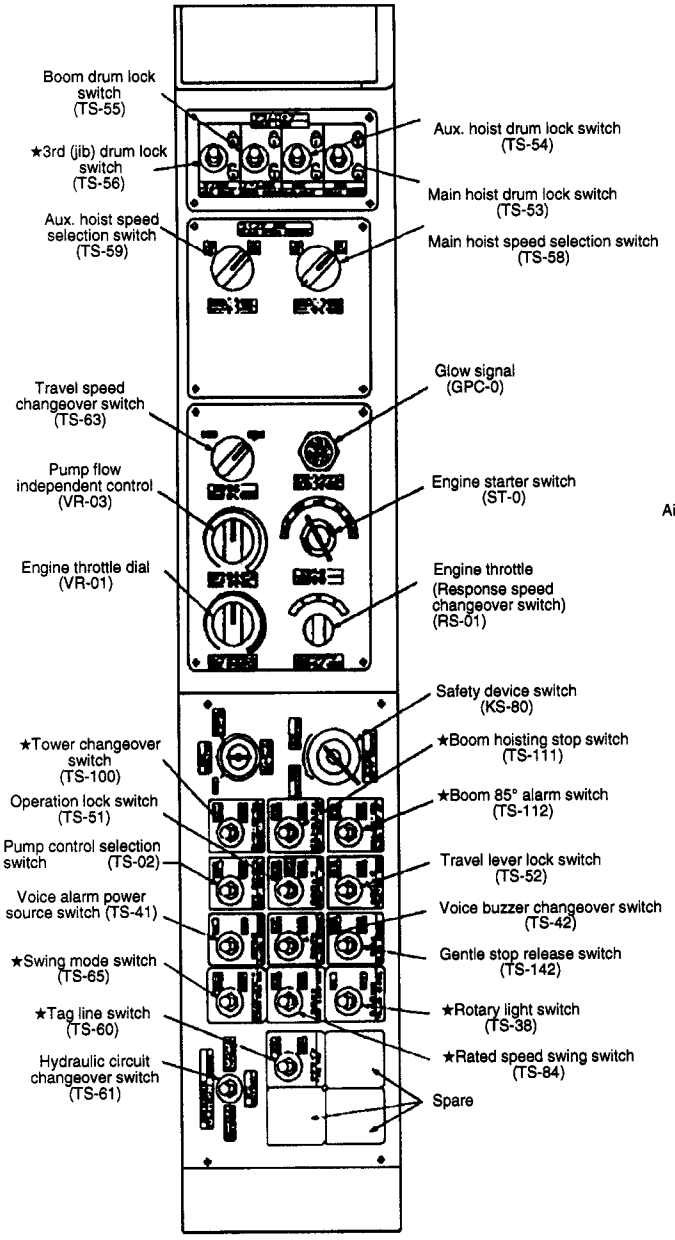


Right side box switch

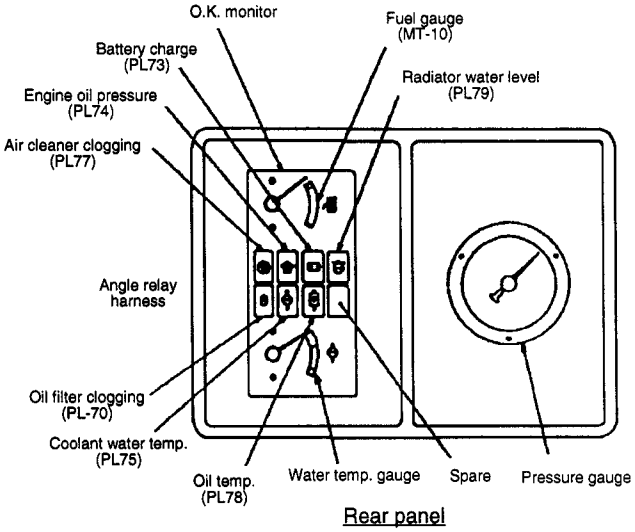


Main control manifold block
(as viewed from inside)

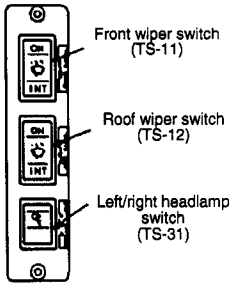
4. ARRANGEMENT OF ELECTRICAL EQUIPMENT



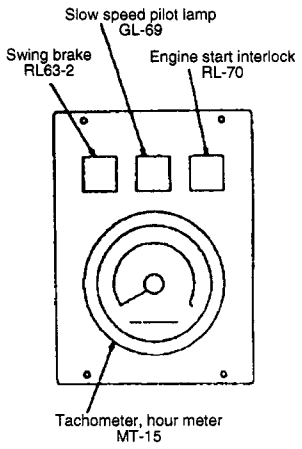
Left side box



Rear panel



Switch panel



View B

5. SAFETY DEVICE OPERATION SITUATION TABLE FOR STANDARD CRANE

NOTE: ■ Shows that the safety device can be released by the safety device release switch.
× Shows that the safety device cannot be released by the safety device release switch.

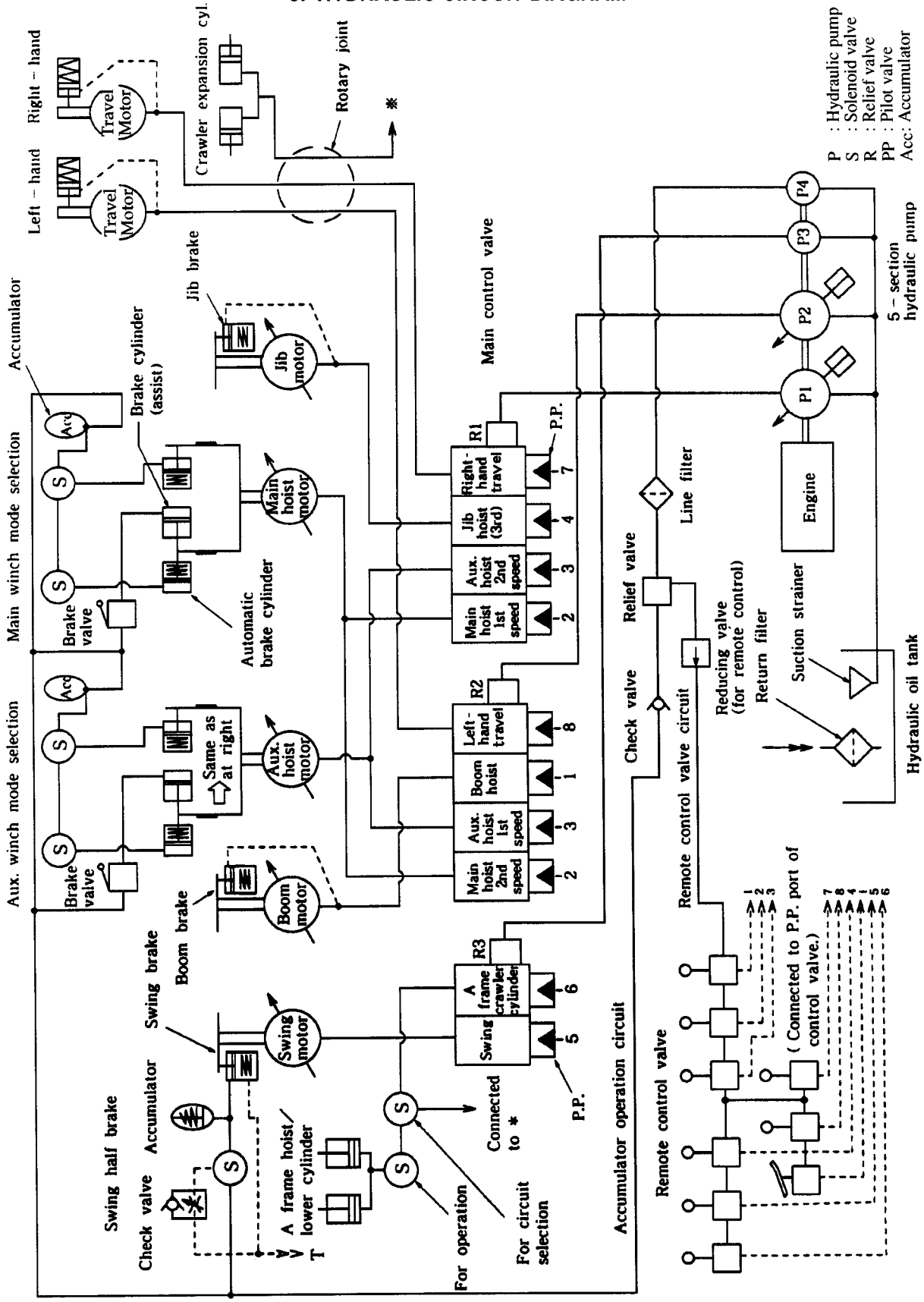
Work Mode		Crane (with jib) and boom crane								
Output / Safety device operation		Buzzer or voice output	Slow down activated	Boom drum hoisting stop	Boom drum lowering stop	3rd drum or jib drum hoisting stop	3rd drum or jib drum lowering stop	Main winch drum hoisting stop	Aux. winch drum hoisting stop	Aux. winch drum lowering stop
General safety devices	Boom kick-out (boom angle: 80°) with 1400 IK boom Boom kick-out (boom angle: 81°) with 46" or 47" HI boom Used as the boom 85° alarm in TW.	Beep, beep		■						
	2nd kick-out (boom angle: 82°)	Beep, beep		×		×		×	×	
	TW jib kick-out (1st offset angle: 10°, 2nd: 9°)									
	Stabilizer limit stop (TW boom angle: 90°)									
	2nd stabilizer limit stop									
	Main overhoisting prevention device	Beep, beep Main hook is over hoisted			■	■		■	■	
	Main 2nd overhoisting prevention device									
	Aux. overhoisting prevention device	Beep, beep Aux. hook is over hoisted			■	■		■	■	
	3rd overhoisting prevention device	Beep, beep			■	■		■	■	
Moment limiter	Load ratio: 100% or more	Beep overload			■	■		■	■	
	Load ratio: 90% ~ less than 100%	Beep, beep will stop soon automatically	×							
	Boom (TW boom): beyond the upper limit angle preset in computer	Boom is over hoisted	×	■		■		■	■	
	Boom (TW boom): below the lower limit angle preset in computer	None	×		■					
	Boom (TW boom): beyond the upper limit user set angle	None	×							
	Boom (TW boom): below the lower limit set angle user set angle	Boom is over lowered	×							
	Jib: Below the minimum offset angle	Jib is over hoisted								
	Jib: Below the lower limit angle	Jib is over lowered								
	Jib: Below the minimum offset set angle	Jib is over hoisted								
	Jib: Below the lower limit set angle	Jib is over lowered								

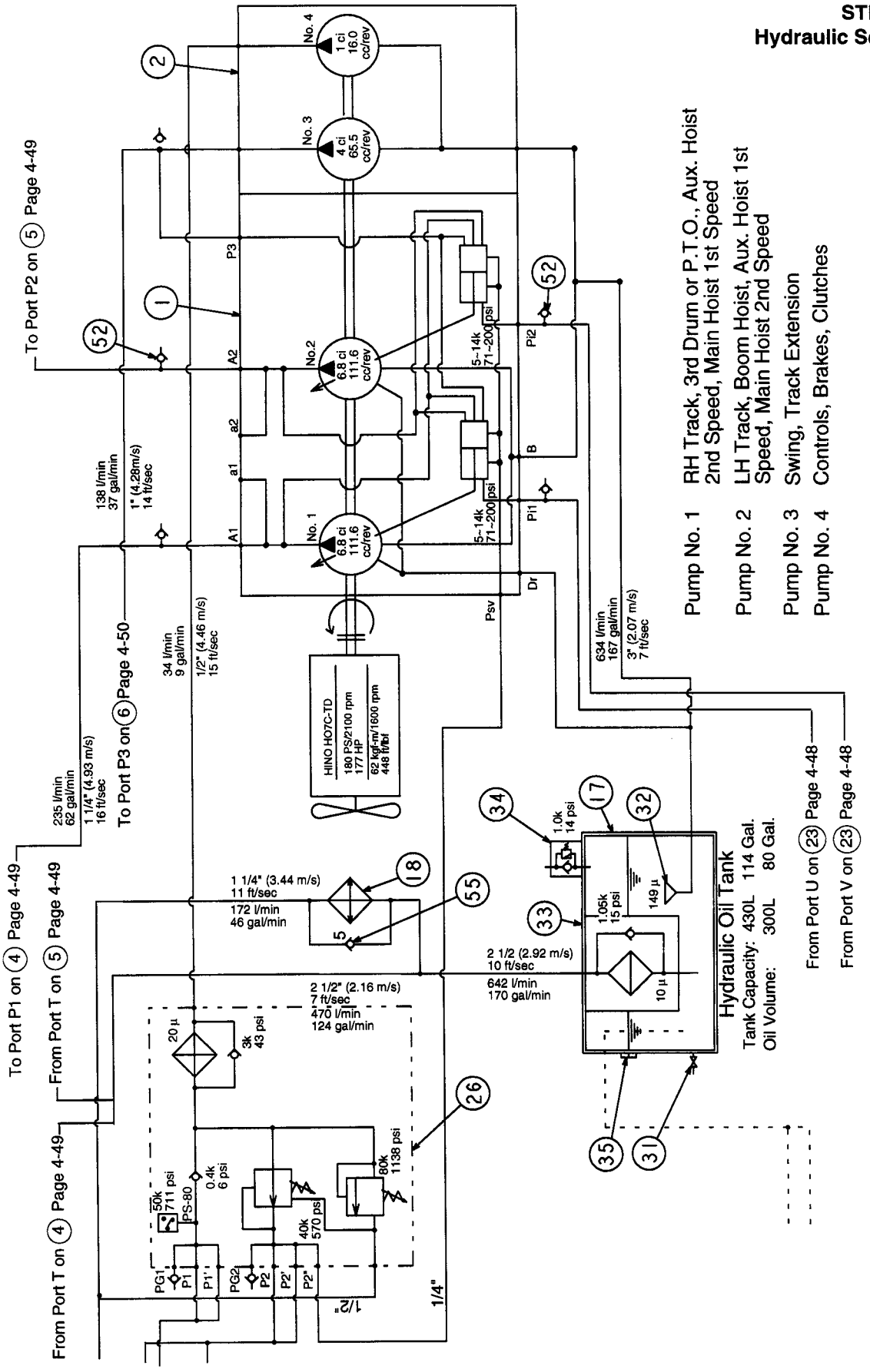
5. SAFETY DEVICE OPERATION SITUATION TABLE FOR LUFFING JIB CRANE

NOTE: ■ Shows that the safety device can be released by the safety device release switch.
× Shows that the safety device cannot be released by the safety device release switch.

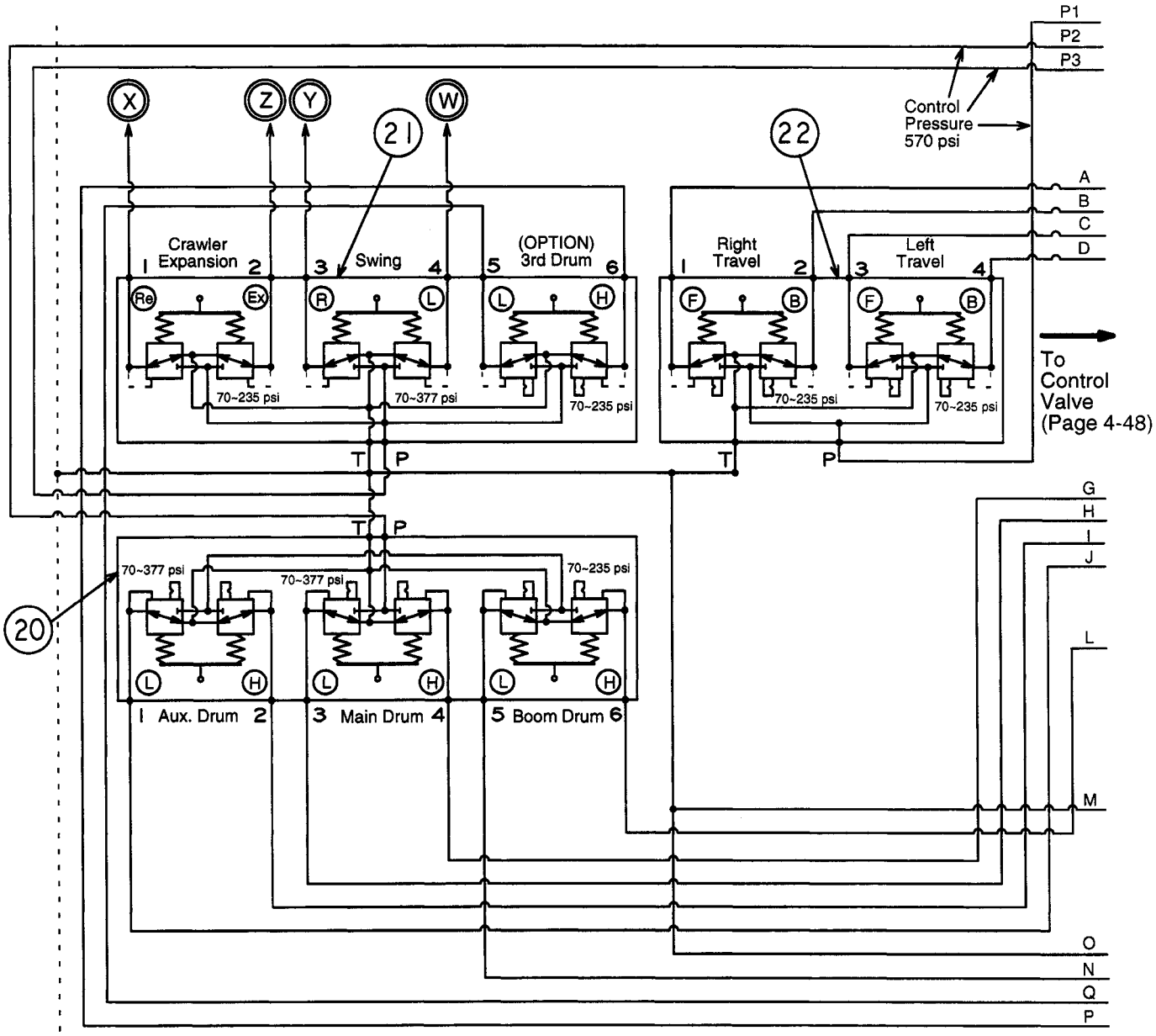
Work Mode			Luffing jib crane								
Output / Safety device operation			Buzzer or voice output	Gentle stop operation	Boom drum hoisting stop	Boom drum lowering stop	Jib drum or 3rd drum hoisting stop	Jib drum or 3rd drum lowering stop	Main winch drum hoisting stop	Aux. winch drum hoisting stop	Aux. winch drum lowering stop
General safety devices	Boom throw-out (boom angle: 80°) Used as the boom 85° alarm in TW.		Beep, beep Released at work.		■ Released at work.						
	2nd throw-out (boom angle: 82°)										
	TW jib throw-out (1st offset angle: 10°, 2nd: 9°)		Beep, beep			×	×		×	×	
	Stabilizer limit stop (TW boom angle: 90°)		Beep, beep		×						
	2nd stabilizer limit stop		Beep, beep		×		×		×	×	
	Main overhoisting prevention device		Beep, beep Main hook is over hoisted			■			■	■	
	Main 2nd overhoisting prevention device		Beep, beep			×			×	×	
	Aux. overhoisting prevention device		Beep, beep Aux. hook is over hoisted			■		■	■	■	
	3rd overhoisting prevention device				(Release this device before work)						
Moment limiter	Load ratio: 100% or more		Beep overload			■		■	■	■	
	Load ratio: 90% ~ less than 100%		Beep, beep will stop soon automatically	×							
	Boom (TW boom): beyond the upper limit angle		Boom is over hoisted		■		■		■	■	
	Boom (TW boom): below the lower limit angle		Boom is over lowered	×		■					
	Boom (TW boom): beyond the upper limit set angle		Boom is over hoisted	×							
	Boom (TW boom): below the lower limit set angle		Boom is over lowered	×							
	Jib: Below the minimum offset angle		Jib is over hoisted	×		■	■				
	Jib: Below the lower limit angle		Jib is over lowered	×		■		■			
	Jib: Below the minimum offset set angle		Jib is over hoisted	×							
	Jib: Below the lower limit set angle		Jib is over lowered	×							
Depth gauge	Main hook	Approximates to the upper limit.	Beep, beep	×							
		Approximates to the lower limit.									
	Aux. hook	Approximates to the upper limit.	Beep, beep	×							
		Approximates to the lower limit.									

6. HYDRAULIC CIRCUIT DIAGRAM



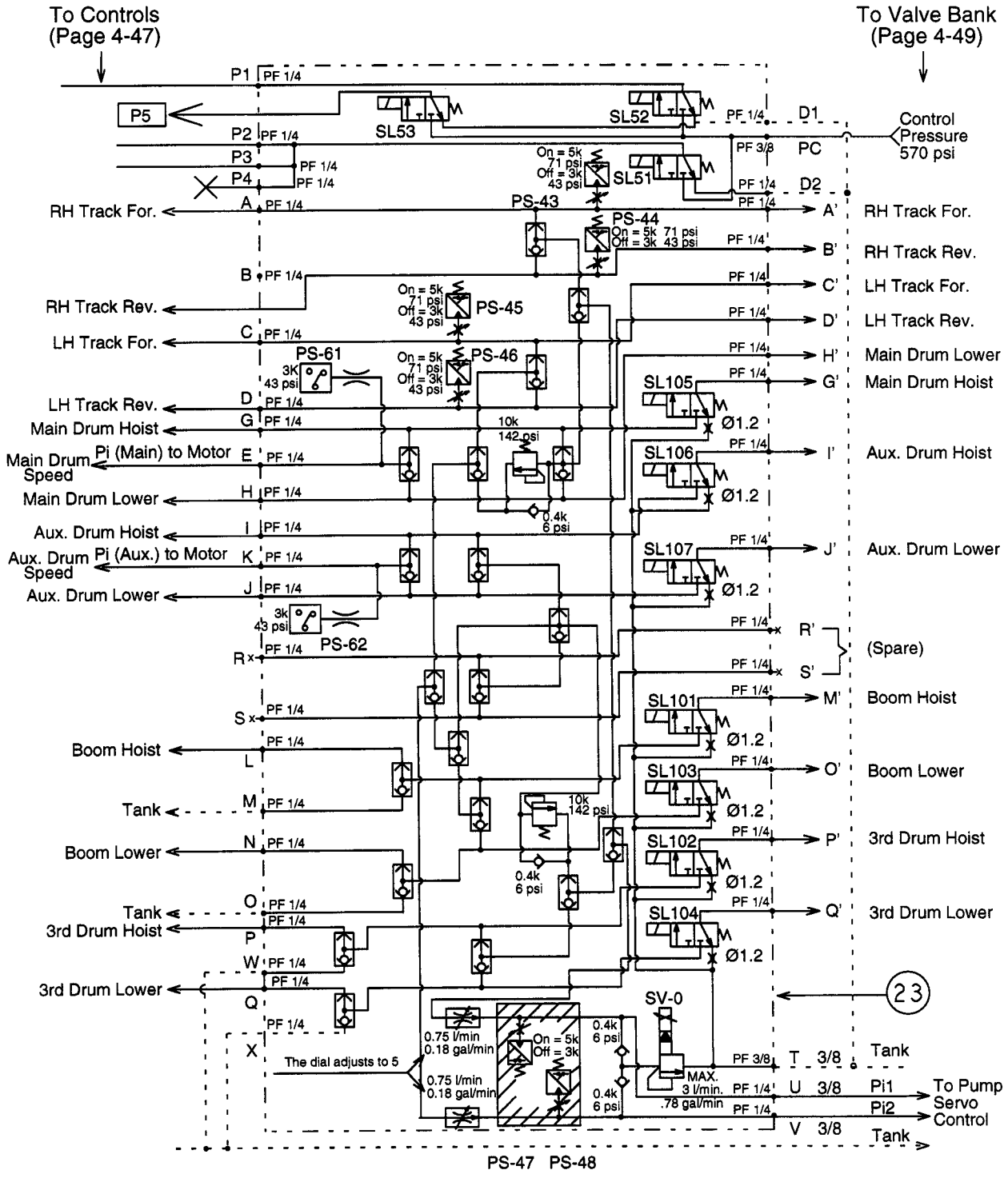


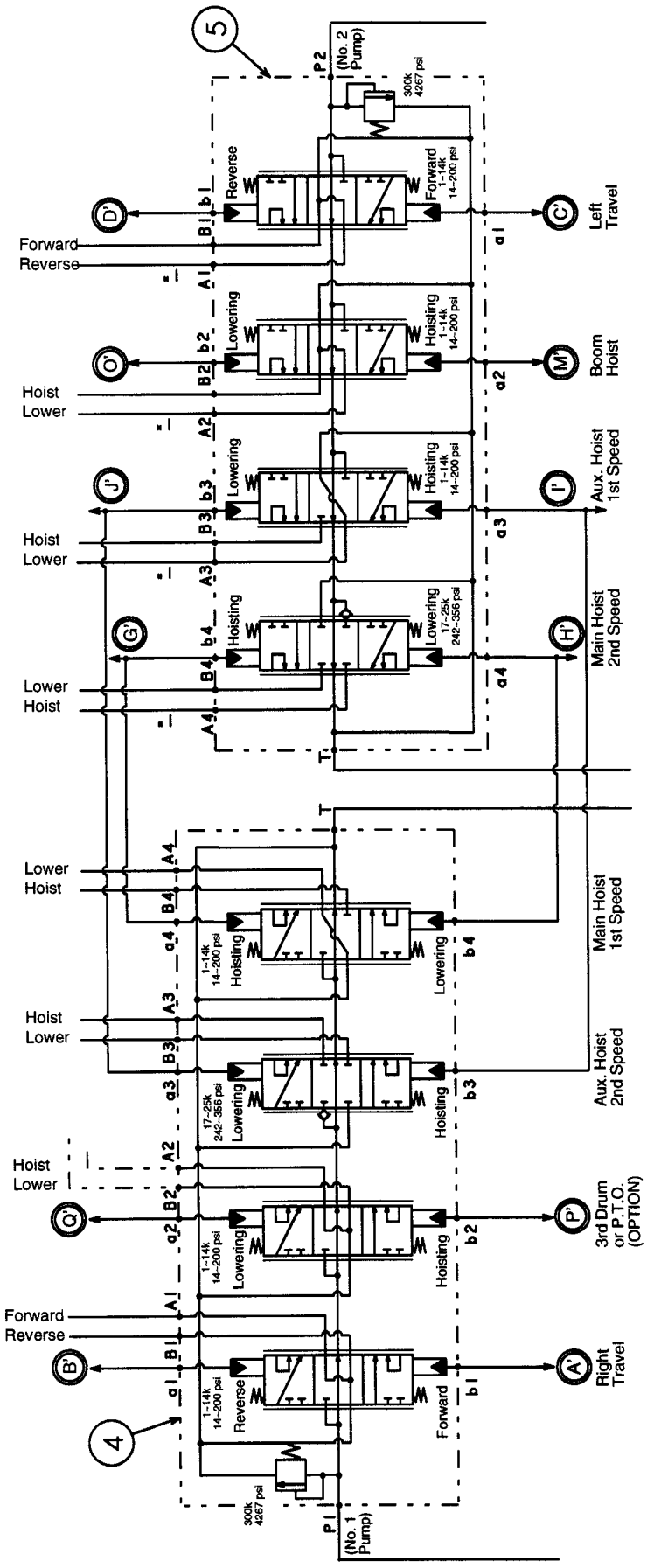
Pumps, Tank, Control Pressure



Cab Controls

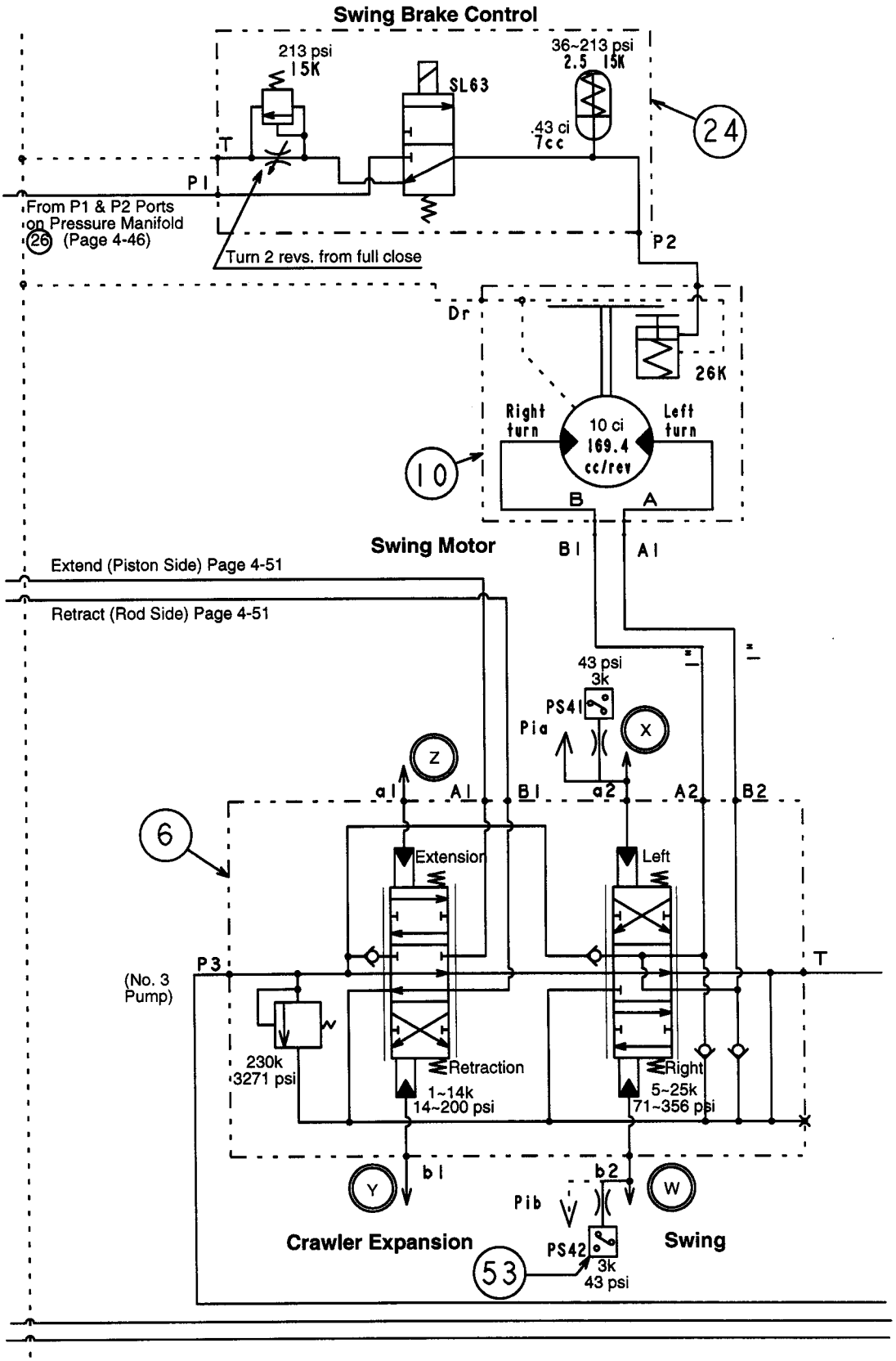
Control Valve Manifold

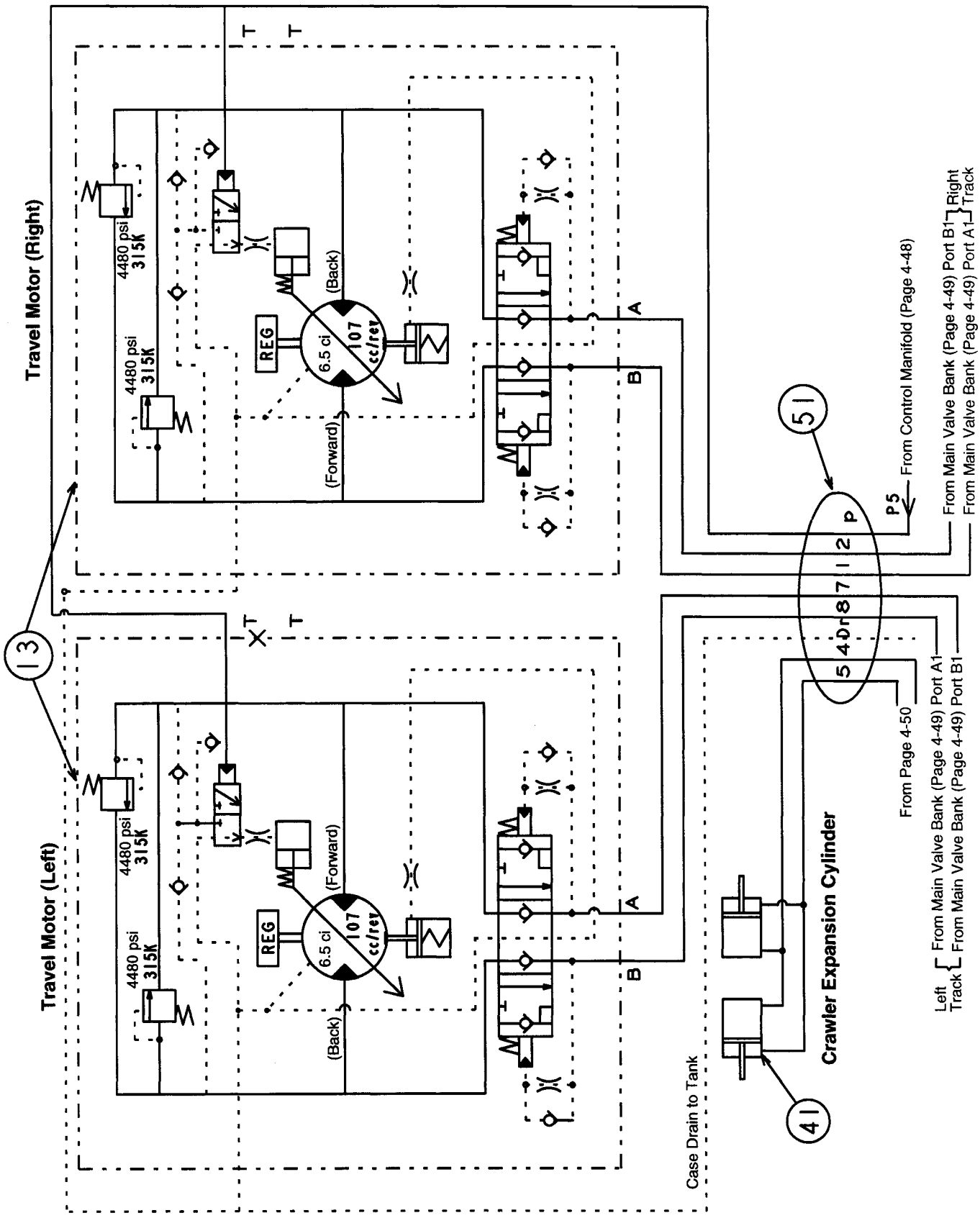


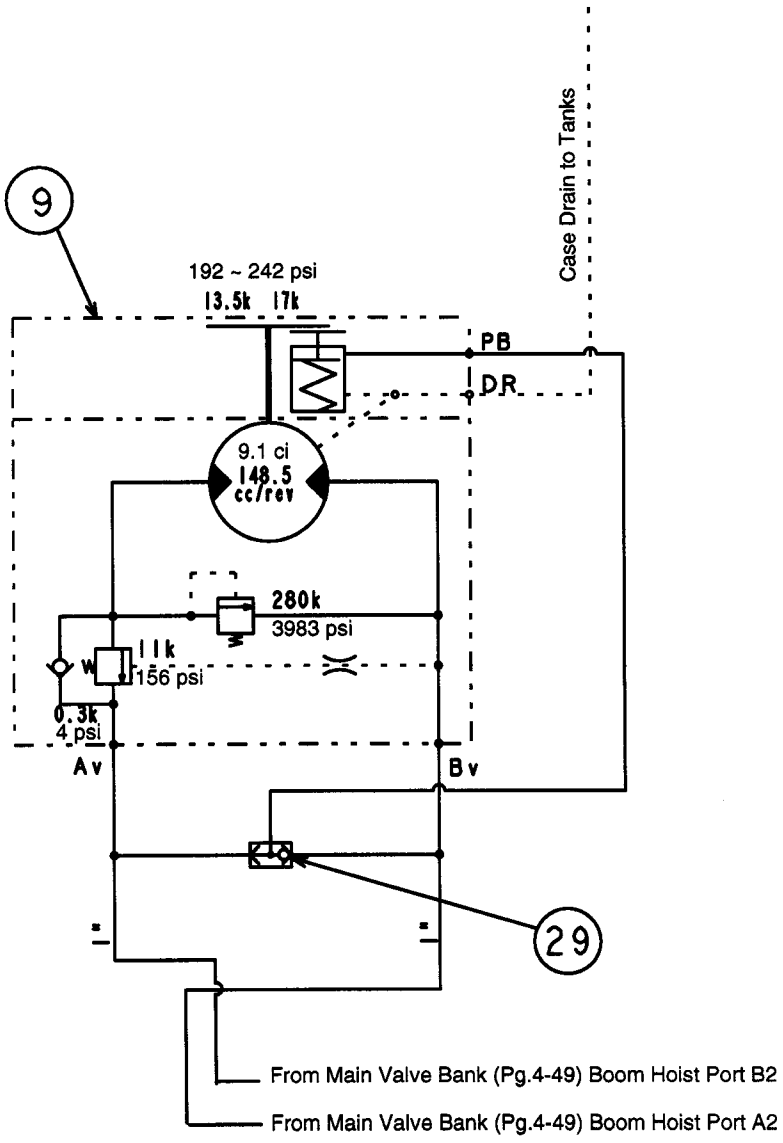


Main Valve Bank

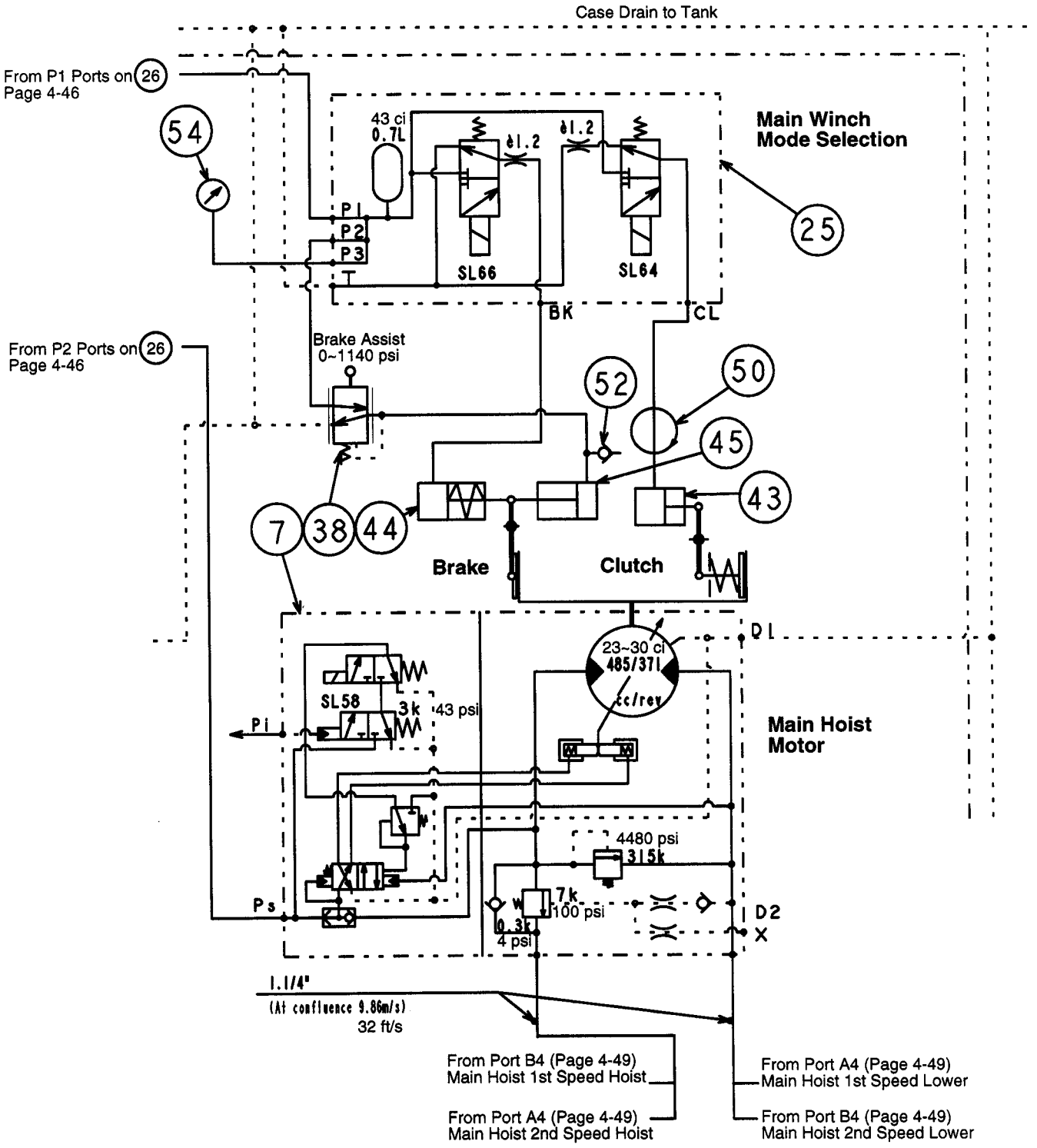
For letters in ◯ see Page 4-48

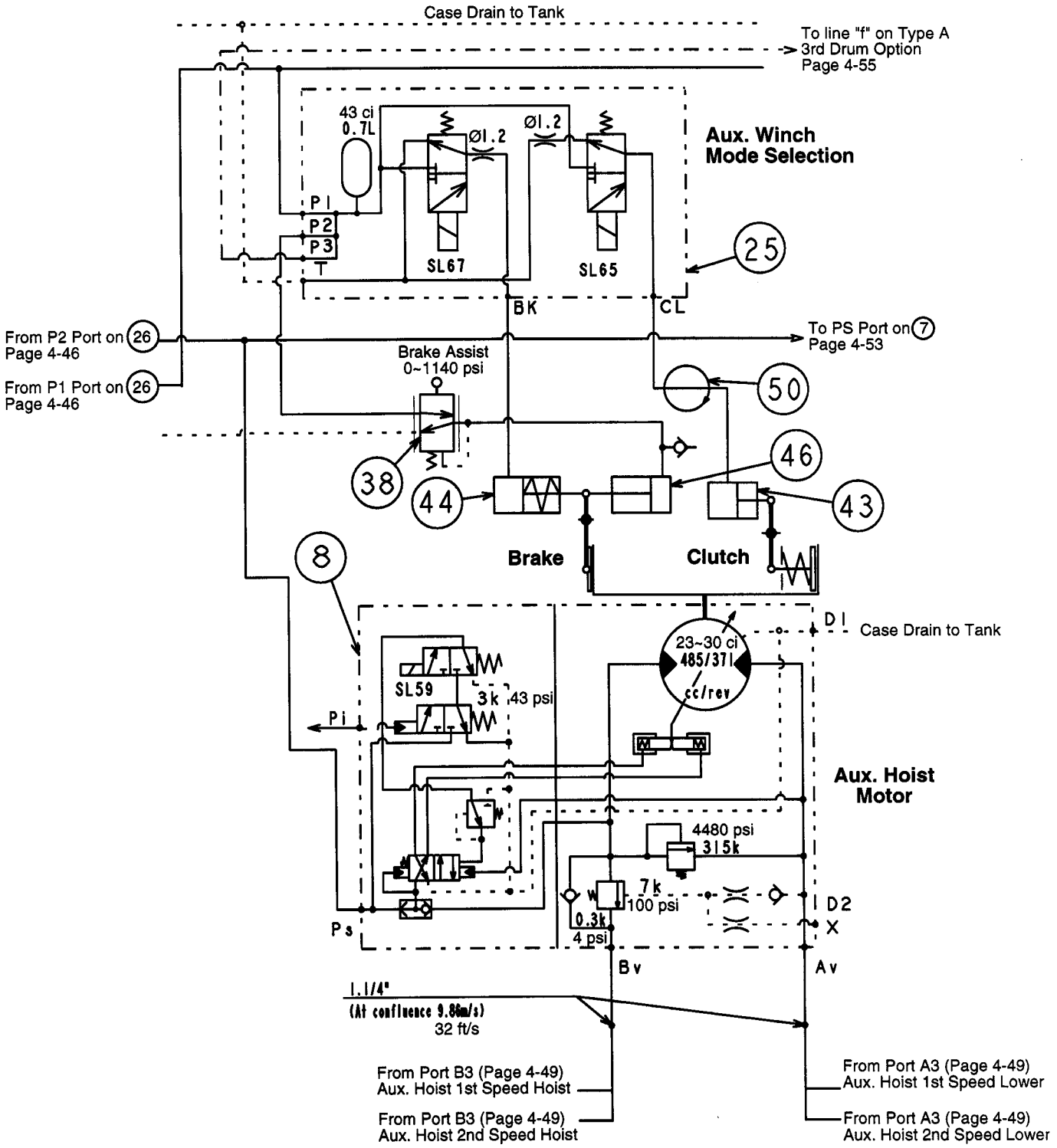

Swing Brake Control
213 psi
15K
SL63
36~213 psi
2.5 15K
.43 ci
7cc
24
T
P1
From P1 & P2 Ports
on Pressure Manifold
26 (Page 4-46)
Turn 2 revs. from full close
P2
Dr
26K
Right
turn
10 ci
169.4
cc/rev
Left
turn
10
B
A
Swing Motor
B1
A1
Extend (Piston Side) Page 4-51
Retract (Rod Side) Page 4-51
43 psi
3k
PS41
Pia
X
Z
a1
A1
B1
a2
A2
B2
6
Extension
Left
P3
T
(No. 3
Pump)
230k
3271 psi
Retraction
1~14k
14~200 psi
Right
5~25k
71~356 psi
b1
b2
Y
W
Pib
Crawler Expansion
PS42
Swing
53
3k
43 psi

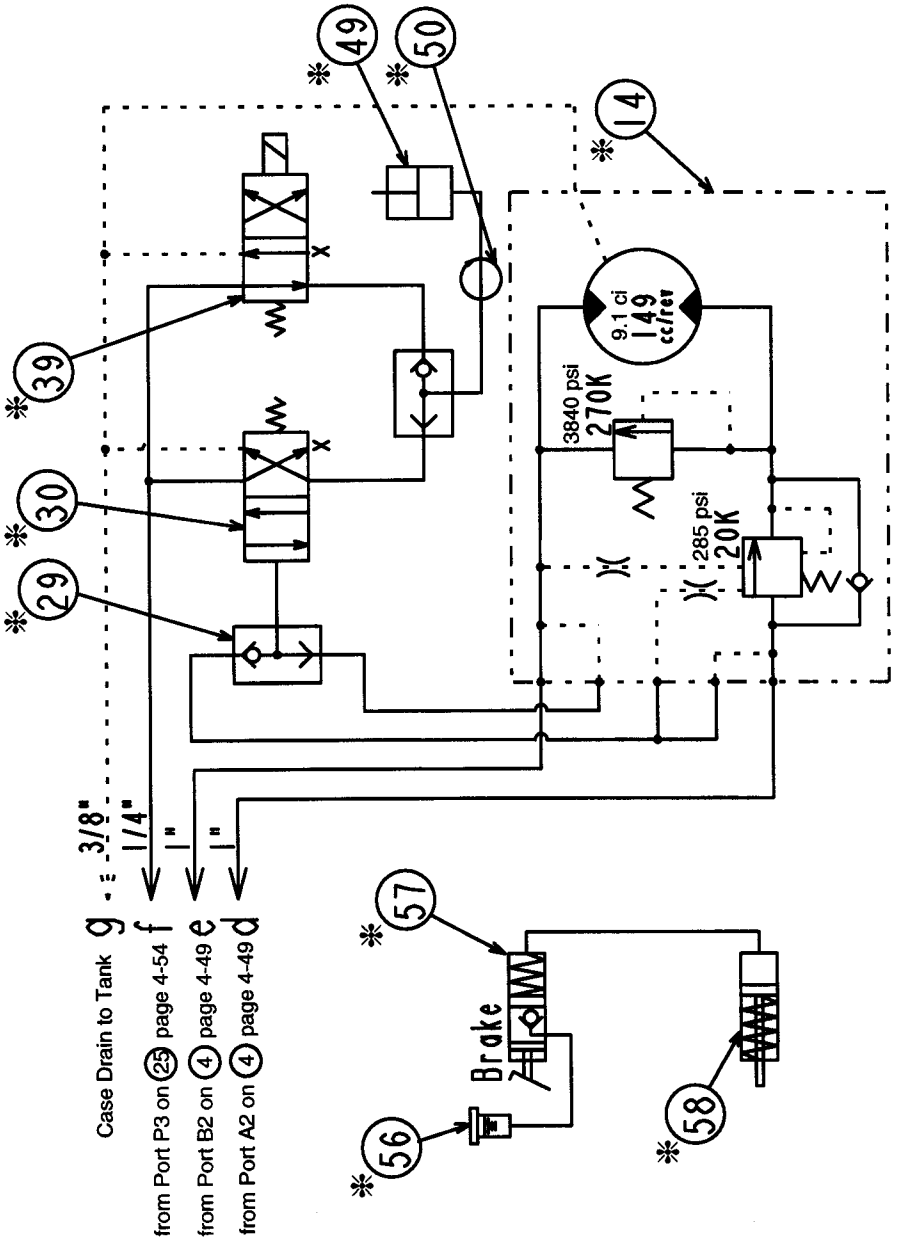

Travel Motor (Right)
Travel Motor (Left)
4480 psi
315K
REG
6.5 ci
107
cc/rev
(Back)
(Forward)
A
B
T
13
51
41
P5
P
2
1
7
8
Dr
4
5
From Control Manifold (Page 4-48)
From Main Valve Bank (Page 4-49) Port B1
From Main Valve Bank (Page 4-49) Port A1
Right Track
From Page 4-50
Crawler Expansion Cylinder
Case Drain to Tank
Left Track
From Main Valve Bank (Page 4-49) Port A1
From Main Valve Bank (Page 4-49) Port B1


9
192 ~ 242 psi
13.5k 17k
Case Drain to Tanks
PB
DR
9.1 ci
148.5
cc/rev
280k
3983 psi
11k
156 psi
0.3k
4 psi
Av
Bv
29
From Main Valve Bank (Pg.4-49) Boom Hoist Port B2
From Main Valve Bank (Pg.4-49) Boom Hoist Port A2

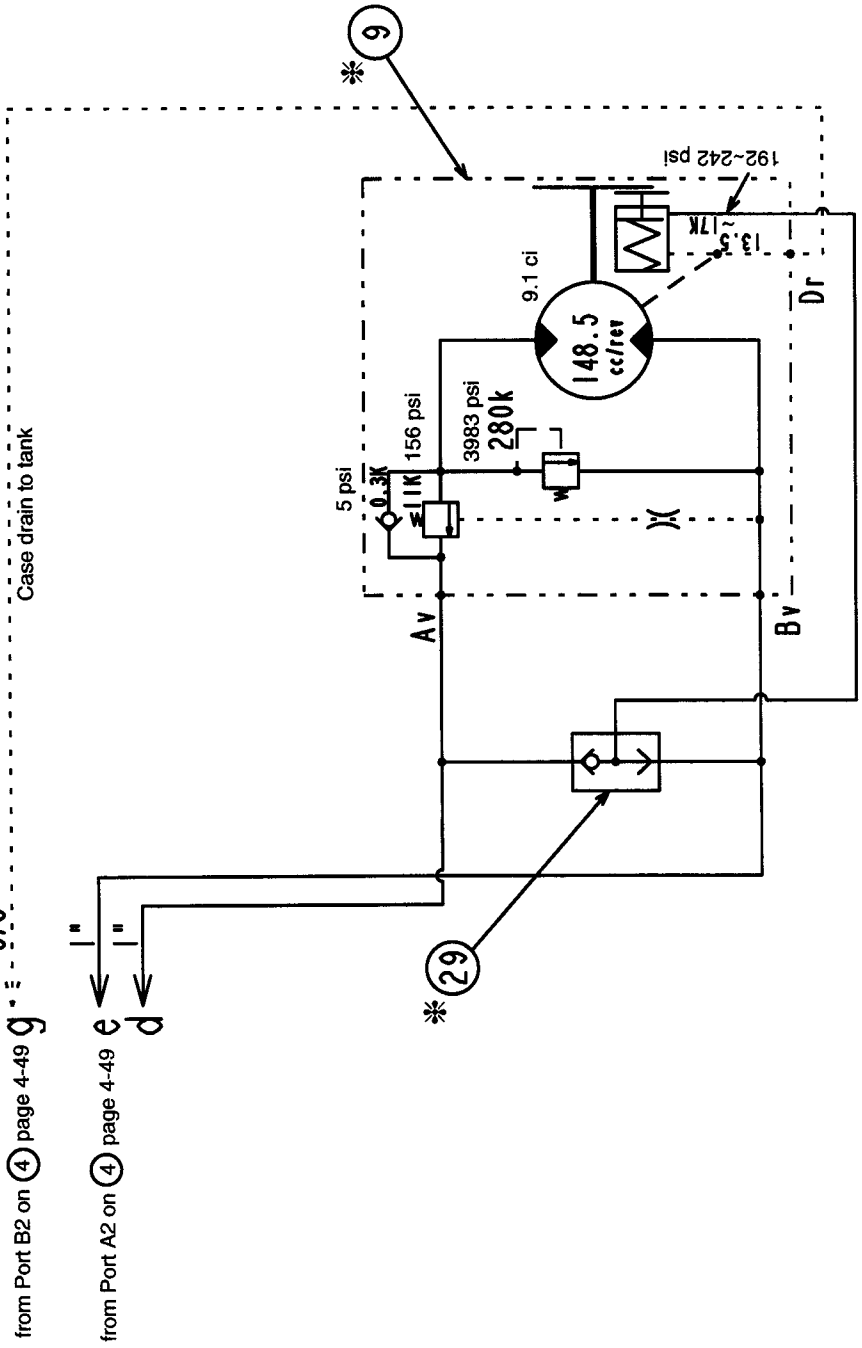
Boom Motor


Case Drain to Tank
From P1 Ports on 26 Page 4-46
54
43 ci 0.7L
ø1.2
ø1.2
Main Winch Mode Selection
25
P1
P2
P3
SL66
SL64
BK
CL
From P2 Ports on 26 Page 4-46
Brake Assist 0~1140 psi
52
50
45
43
7
38
44
Brake
Clutch
D1
23~30 ci 485/371 cc/rev
SL58
3k
43 psi
Pi
Main Hoist Motor
4480 psi
315k
7k
100 psi
0.3k
4 psi
Ps
D2
X
1.1/4"
(At confluence 9.86m/s)
32 ft/s
From Port B4 (Page 4-49) Main Hoist 1st Speed Hoist
From Port A4 (Page 4-49) Main Hoist 2nd Speed Hoist
From Port A4 (Page 4-49) Main Hoist 1st Speed Lower
From Port B4 (Page 4-49) Main Hoist 2nd Speed Lower

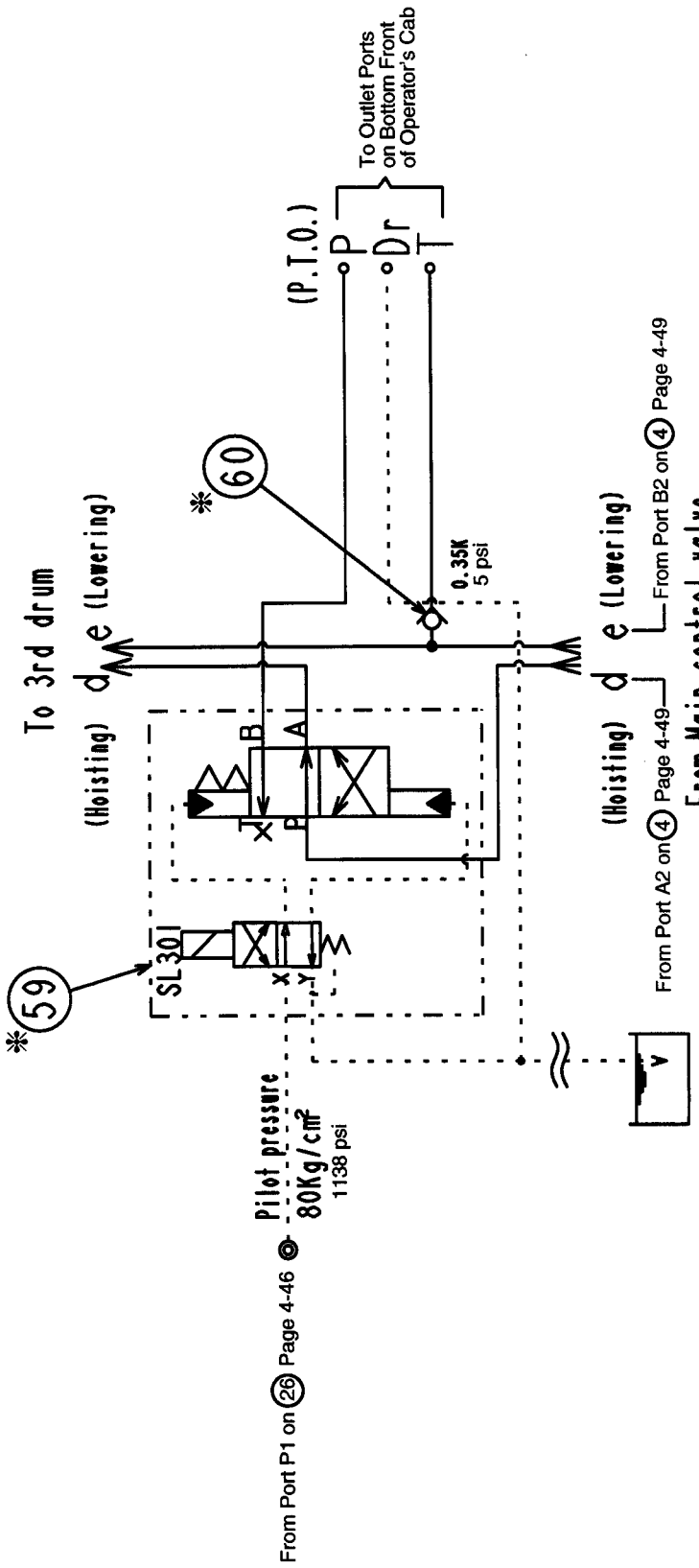

Case Drain to Tank
To line "f" on Type A
3rd Drum Option
Page 4-55
43 ci
0.7L
Ø1.2
Ø1.2
Aux. Winch
Mode Selection
P1
P2
P3
T
SL67
SL65
25
BK
CL
From P2 Port on 26
Page 4-46
From P1 Port on 26
Page 4-46
To PS Port on 7
Page 4-53
Brake Assist
0~1140 psi
50
38
44
46
43
Brake
Clutch
8
D1
Case Drain to Tank
23~30 ci
485/371
cc/rev
SL59
3k
43 psi
Pi
Aux. Hoist
Motor
4480 psi
315k
7k
100 psi
0.3k
4 psi
D2
X
Ps
Bv
Av
1.1/4"
(At confluence 9.8m/s)
32 ft/s
From Port B3 (Page 4-49)
Aux. Hoist 1st Speed Hoist
From Port B3 (Page 4-49)
Aux. Hoist 2nd Speed Hoist
From Port A3 (Page 4-49)
Aux. Hoist 1st Speed Lower
From Port A3 (Page 4-49)
Aux. Hoist 2nd Speed Lower



3rd Drum - Mode Selection Type A
Capable of Free Fall
(Optional)



J/H Drum - Automatic Brake Type Luffing Jib
No Free Fall Automatic Brake
(Optional)



P. T. O. (Auxiliary Hyd. Power) - 3rd Drum Selection Type B or J/H Drum (Luffing Jib)
No Free Fall Automatic Brake
(Optional)

HYDRAULIC SCHEMATICS
Parts List

No.	Description	Part No.
1	No. 1, No. 2 Piston Pump	0752062UA
2	No. 3, No. 4 Gear Pump	0752083UA
4	Main Control Valve	0756795UA
5	Main Control Valve	0756794UA
6	Swing Control Valve	0756796UA
7	Main Drum Motor	0757601UA
8	Auxiliary Drum Motor	0757602UA
9	Boom Drum Motor (3rd or J/H)	0757605UA
10	Swing Motor	0757682UA
13	Travel Motor	0669744UA
14❋	3rd Drum Motor	0753544UA
17	Hydraulic Oil Tank	535266300
18	Hydraulic Oil Cooler	0668152UA
20	B/H Main, Aux. Remote Control Valve	0756329UA
21	Swing, 3rd (J/H) Crawler Expansion Remo. Cont. Valve	0756330UA
22	Travel Remote Control Valve	0756954UA
23	Unload Solenoid Manifold	0754843UA
24	Swing Brake Control Solenoid Manifold	0754597UA
25	Winch Mode Selection Solenoid Manifold	0754595UA
26	Pressure Adjustment Manifold	0754596UA
29	B/H (3rd) Drum Control Shuttle Valve	0754541UA
30❋	3rd Drum Clutch Hydraulic Valve	0754111UA
31	Hyd. Oil Tank Gate Valve	072120706

No.	Description	Part No.
32	Hyd. Oil Tank Suction Strainer	0755251UA
33	Hyd. Oil Tank Return Filter	075514305
34	Hyd. Oil Tank Air Breather	0755012UA
35	Hyd. Oil Tank Oil Level Gauge	407900000
38	Brake Assist Valve	551090100
39❋	3rd Drum Clutch Solenoid Valve	0753852UA
41	Crawler Expansion Cylinder	0782133UA
43	Winch Clutch Cylinder	0752632UA
44	Winch Brake Cylinder	533511005
45	Winch Brake Assist Cylinder	0751696UA
46	Winch Brake Assist Cylinder	0751695UA
49❋	3rd Drum Clutch Cylinder	0751749UA
50	Main, Aux., 3rd Rotary Joint	0712202UA
51	Rotary Joint	0755856UA
52	Pressure Gauge Coupling	0754142UA
53	Swing Alarm Pressure Switch	085818010
54	Rear Panel Pressure Gauge	0755601UA
55	Oil Cooler Thermo. Valve Check	0753241UA
56❋	3rd Drum Brake Oil Reservoir	0755303UA
57❋	3rd Drum Brake Master Cylinder	0751610UA
58❋	3rd Drum Brake Clutch Cylinder	0751695UA
59❋	3rd/P.T.O. Selection Solenoid Valve	0756347UA
60❋	3rd/P.T.O Selection Check Valve	0753035UA

❋ Denotes Optional Equipment

HC 80 BOOM & JIB CONVERSION TABLE

1 m = 3.28084 Ft. | 1 m = 39.37008 In. | 1 mm = .03937 In.
1 Ft. = .3048 m | 1 in. = .0254 m | 1 In. = 25.4 mm
1/10 Ft. = 1.20 In. = 1 13/64 In.

The following metric lengfths are found throughout the Boom Rigging Section of the Operator's Manual. They have already been converted here for quick reference.

Meters	Feet
1.0	3.28
1.6	5.25
2.5	8.20
3.0	9.84
4.5	14.76
5.5	18.04
6.0	19.68
9.0	29.53

Meters	Feet
12.0	39.37
15.0	49.21
16.0	52.49
18.0	59.05
19.0	62.33
21.0	68.89
22.0	72.18

Meters	Feet
24.0	78.74
25.0	82.02
27.0	88.58
28.0	91.86
30.0	98.43
31.0	101.71
33.0	108.27

Meters	Feet
36.0	118.11
39.0	127.95
42.0	137.79
45.0	147.63
48.0	157.48
51.0	167.32
54.0	177.16

HC 80 HYDRAULIC SCHEMATIC CONVERSION TABLE

FORMULA: kilograms per centimeter squared x 14.22334 = pounds per square inch

kgf / cm^2 = psi
0.30 = 4
0.40 = 6
1.00 = 14
1.05 = 15
2.50 = 36
3.00 = 43
4.90 = 70

kgf / cm^2 = psi
5.00 = 71
7.00 = 100
10.0 = 142
11.0 = 156
13.5 = 192
14.0 = 200
15.0 = 213

kgf / cm^2 = psi
16.5 = 235
17.0 = 242
25.0 = 356
26.0 = 370
26.5 = 377
40.0 = 570

kgf / cm^2 = psi
50.0 = 711
80.0 = 1,138
230.0 = 3,271
280.0 = 3,983
300.0 = 4,267
315.0 = 4,480

FORMULA: liters x .264172 = gallons

liters / min = gals / min
0.75 = 0.20
3.00 = 0.80
34.00 = 9.00
138.00 = 36.00
172.00 = 45.00

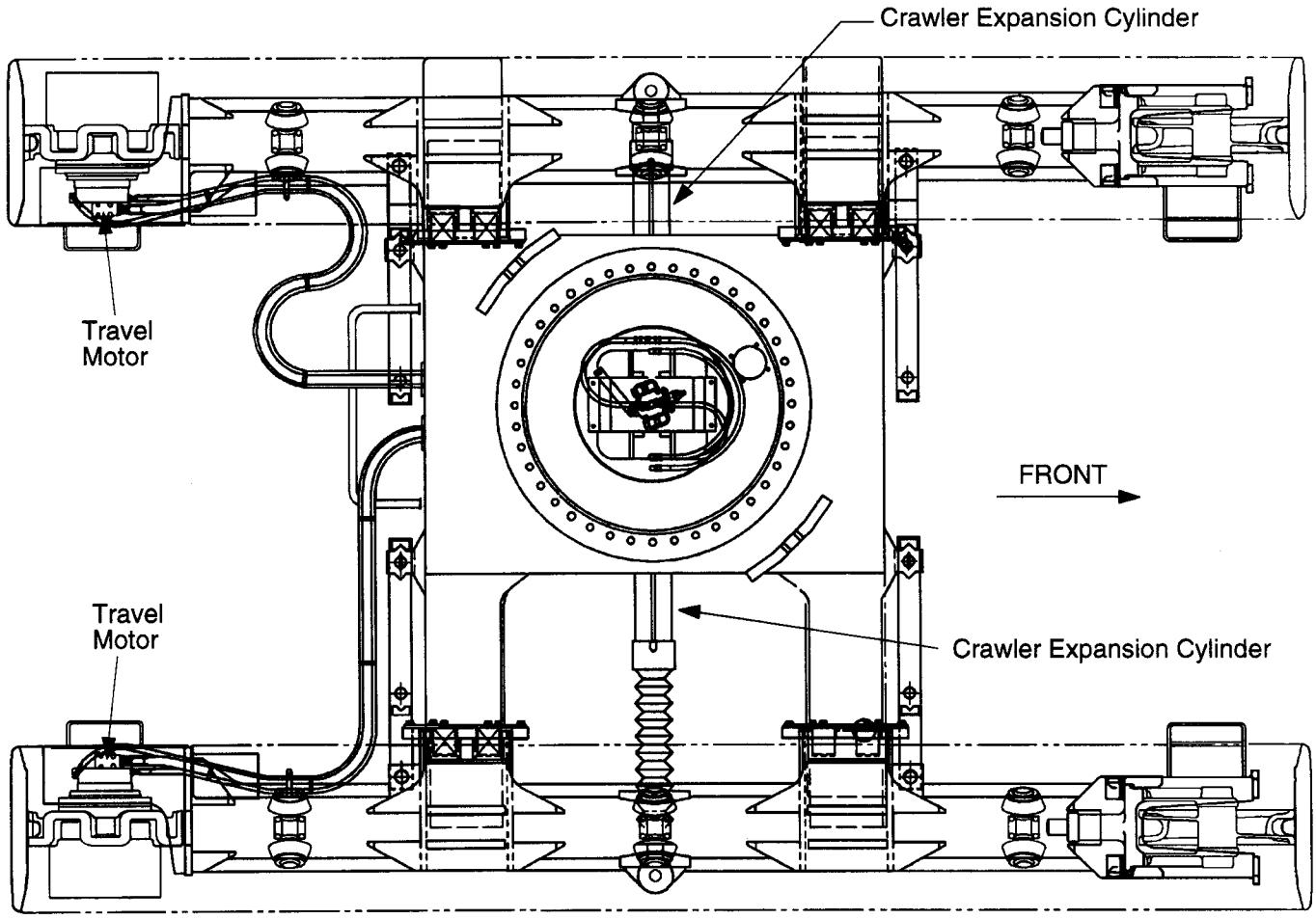
liters / min = gals / min
235.00 = 62.00
470.00 = 124.00
634.00 = 167.00
642.00 = 170.00

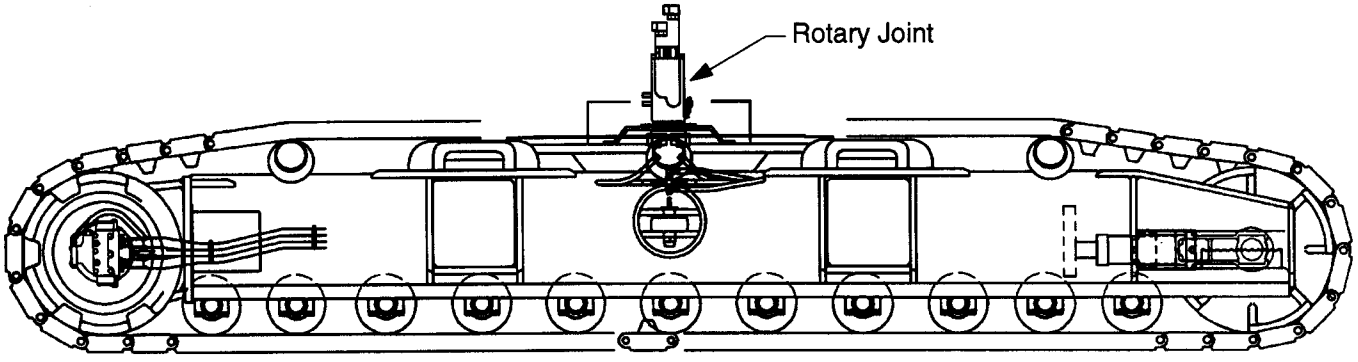
FORMULA: meters x 3.28084 = feet

meters / sec = feet / sec
2.07 = 7
2.16 = 7
2.92 = 10
3.44 = 11

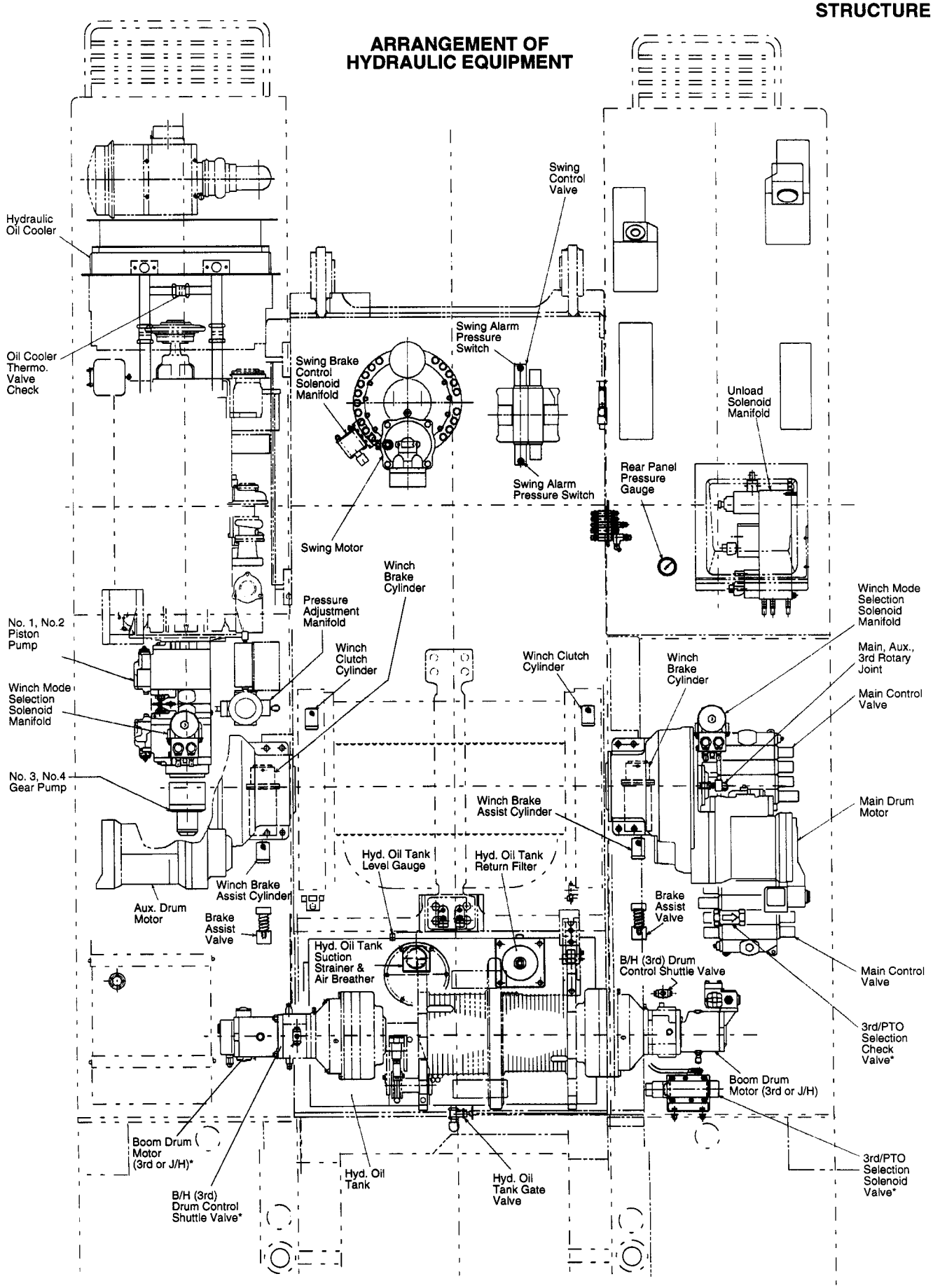
meters / sec = feet / sec
4.28 = 14
4.46 = 15
4.93 = 16
9.86 = 32

ARRANGEMENT OF HYDRAULIC EQUIPMENT

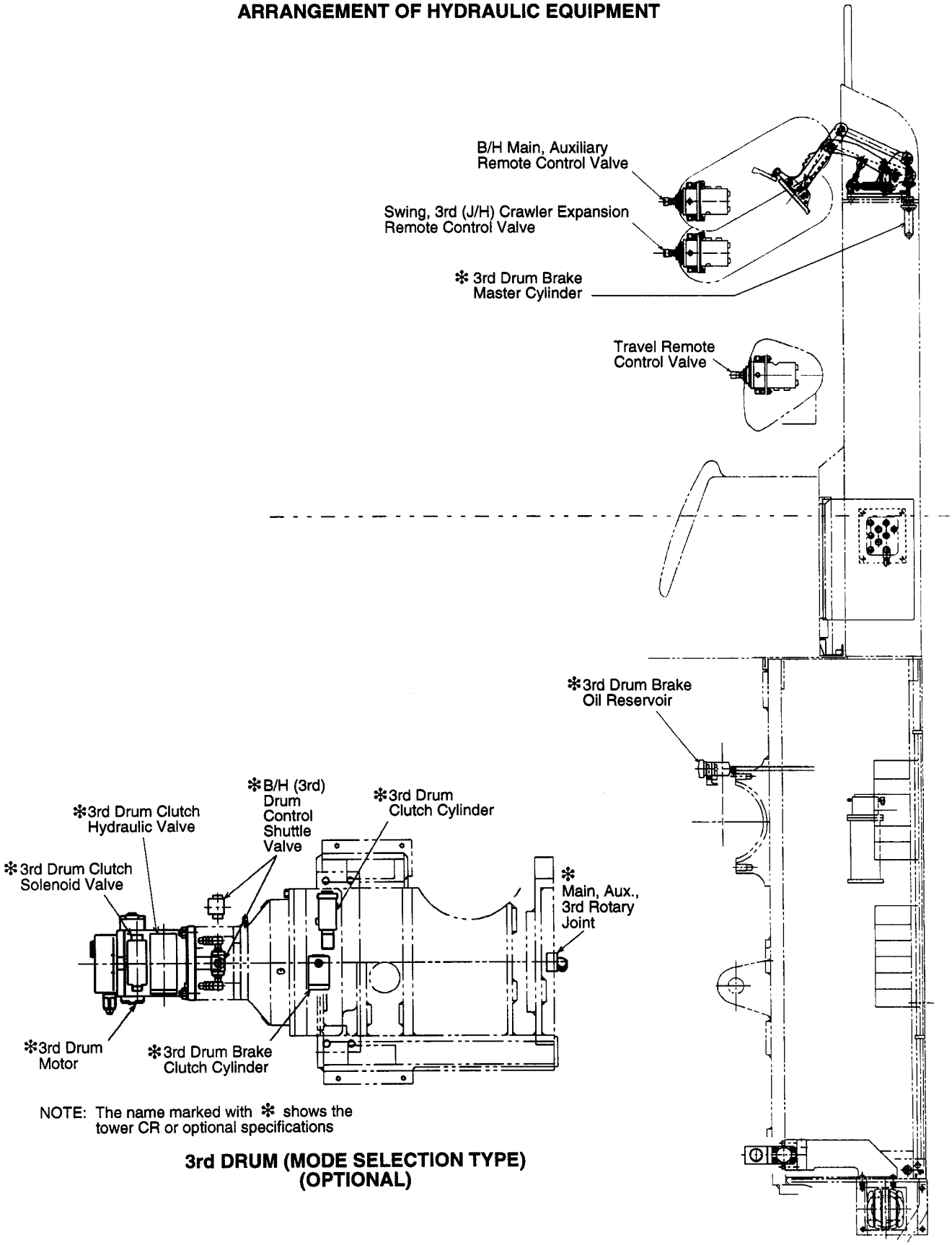




ARRANGEMENT OF HYDRAULIC EQUIPMENT



ARRANGEMENT OF HYDRAULIC EQUIPMENT



NOTE: The name marked with ✻ shows the tower CR or optional specifications

3rd DRUM (MODE SELECTION TYPE) (OPTIONAL)

Section 5

OPERATOR AIDS

Printed in U.S.A.
3/00 (R1-8/01)

1. KINDS OF OPERATOR AIDS

1-1 Overload prevention device (moment limiter)

When actual load reaches the permissible load limit, this safety device functions to automatically stop load lifting and boom lowering, and will sound buzzer in order to prevent a mobile crane from turning over. Even when the moment limiter is activated, operations toward the safer side, namely load lowering and boom hoisting are allowed. If the moment limiter operates, the machine should be returned to the safe area immediately. Automatic stop will be canceled in about 2 seconds. When the boom is hoisted excessively (beyond the rated upper limit angle) or the maximum working radius (rated lower limit angle) at the present boom length is reached, the moment limiter also issues the boom stop command and sounds the buzzer. In this case, lower or hoist the boom to the normal position and then release the stop status.

1-2 Hook overwind prevention device

This device prevents over-winding of the hook and thereby protects the machine from backward turn-over of boom and other dangers. Upon activation of this device, hook hoisting stops and the buzzer sounds continuously. On this occasion, lower the hook or load while paying adequate attention to safety. Once the hook is separated from the over-wind detection weight, the stop status is released. Even when the stopper is activated, the hook can be lowered.

Kinds of hook overhoisting prevention devices

Standard Crane	Luffing Jib Crane	Luffing Tower Crane
Main hook overhoisting prevention	Boom main hook overhoisting prevention	
1m jib hook overhoisting prevention	Boom main hook overhoisting prevention device (2nd overhoisting)	
9m~18m jib hook overhoisting prevention	Jib hook overhoisting (auxiliary hoisting) prevention	
3rd drum hook overhoisting prevention		

1-3 Boom overwind prevention device (boom throw-out)

(Standard crane)

When the boom is hoisted up to 80°, the limit switch at the boom foot is activated to stop the boom hoisting operation and sound the buzzer continuously. Lower the boom to release this prevention.

1-4 2nd Throw-out

The 2nd throw-out operates at a boom angle of 82.0°. On operation of the 2nd throw-out, boom hoisting and load hoisting are stopped. Even when both boom throw-out and moment limiter fail to stop boom hoisting it is stopped by the 2nd throw-out. The 3rd drum also stops.

(Tower boom crane)

The alarm buzzer works to tell the 80° position and boom hoisting stop by changing the limit switch installation position. Set the crane/tower selector switch to the crane side. Attach the spacer to the stabilizer. Lower the boom to the safe range, and the stop status will be released.

1-5 Tower jib overhoisting prevention device (jib throw-out)

For the luffing jib and luffing tower crane, the Number 1 limit switch, which is installed between the tower top and jib foot works and the tower jib stops automatically at the boom offset angle of 10°. Number 2 limit switch operates at the boom offset angle of 9°. Lower the jib to release the stop status.

1-6 Boom, tower boom and tower jib limit stop (rear stop)

Kinds of limit stops

Standard Crane	Luffing Jib and Luffing Tower Crane
Boom limit stop	Boom limit stop (stabilizer)
- -	Tower jib limit stop

1-7 Swing alarm

This tells the persons around the area of the crane that it will perform swinging. The lamp flickers and at the same time the voice or buzzer sounds in the link operation with the swing lever.

1-8 Travel alarm

This tells the persons around the area of the crane that it will travel. The voice or buzzer sounds in the link operation with the travel lever.

1-9 Moment limiter alarm lamp (optional specification)

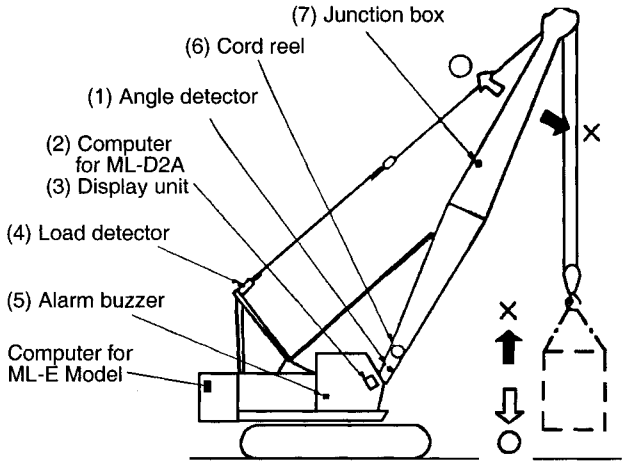
The yellow lamp comes on when the load ratio reaches 90%. When the load ratio equals 100%, the red lamp lights up and rotates to warn the nearby persons of danger.

1-10 Yellow flashing lamp (optional specification)

This yellow flashing lamp warns nearby persons of danger when transporting the crane on a trailer, etc.

2. MOMENT LIMITER

2-1 Outline of moment limiter (overload prevention unit)



O : Safe side

× : Dangerous side

This operator aid stops dangerous side operation (boom lowering and load hoisting) and sounds the alarm buzzer when an actual load beyond the rated load is applied to the hook. Note, however, operations can be performed on the safe side (boom hoisting and load lowering) even if this operator aid is activated.

Function of each unit:

1. Angle detector

   This detector sends a voltage, which varies with boom angle, to the computer unit.

2. Computer unit

   This unit comprises an electronic circuit. It calculates the permissible load in the present working position according to a voltage signal from the angle detector and the permissible load in the load detector. Moreover, it calculates the actual load through the reception of a voltage signal applicable to the weight of the lifted load. The load in the load detector is compared with the weight of the lifted load. When the value by comparison reaches 90%, the buzzer sounds intermittently. When the value by comparison reaches 100%, the buzzer sounds continuously and the machine stops automatically.

3. Display unit

   This unit displays working radius, main jib angle, actual load, permissible load and offset angle. In addition, this unit is capable of setting working conditions.

4. Load detector

   This is a strain gauge type detector mounted on the gantry yoke. This detector sends a voltage signal, which responds to the change of load, to the computer unit.

5. Alarm buzzer

   90% and 100% signal levels in the computer unit are informed by the intermittent and continuous sounds of a piezoelectric buzzer, respectively, as a warning to the operator.

6. Cord reel

   This is a wiring cord winding drum used to wind excess cord on it depending on boom length.

7. Junction box

   The junction box of outer boom houses cables for the jib hook and main hook overwind detector. The wiring of the boom hoisting throw-out is independent of the junction box.

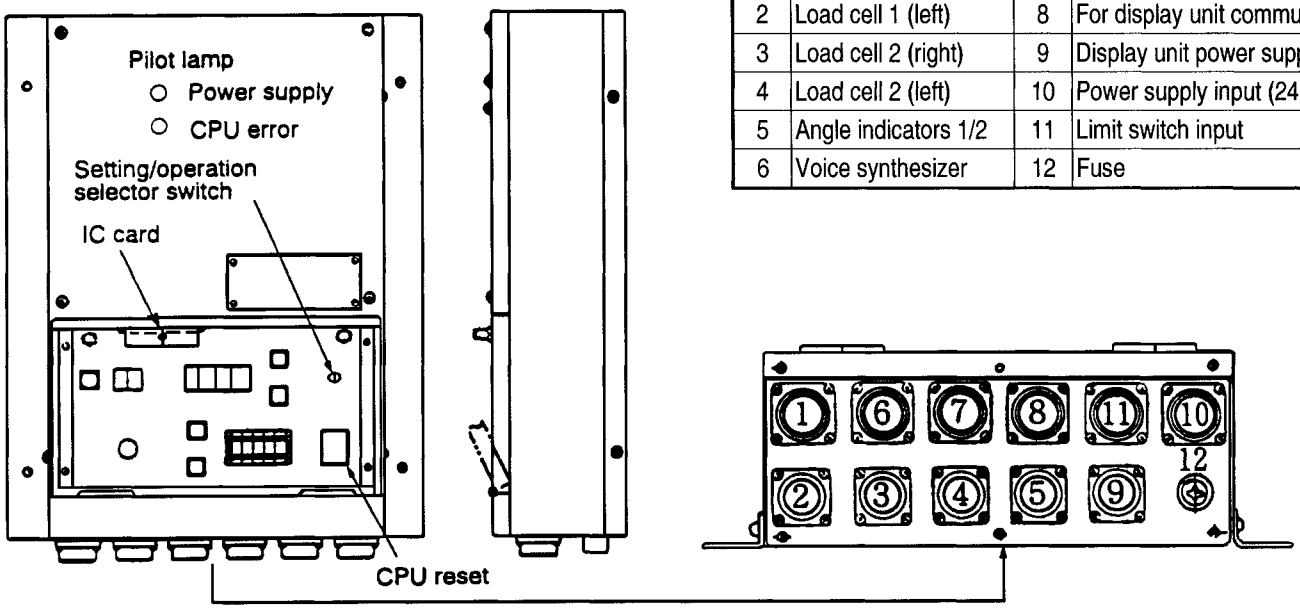
ML-E MODEL

2-2 Outline of computer unit

(Installed on the left side when you face the main hoisting drum clutch)

Connector layout

1	Load cell 1 (right)	7	Relay/buzzer output
2	Load cell 1 (left)	8	For display unit communic.
3	Load cell 2 (right)	9	Display unit power supply
4	Load cell 2 (left)	10	Power supply input (24 V)
5	Angle indicators 1/2	11	Limit switch input
6	Voice synthesizer	12	Fuse



Power supply:

24 V DC — Operable within a range of 18.5 to 35 V
Automatically reset below 18.5 V and within 35 to 36 V
Fuse blowout beyond 36 V

Principal configuration:

CPU (control and computation unit), 16 bits

Memory:
- ROM . . . . . For main software
- RAM . . . . . For computation
- EEP ROM . . . . . For writing set value, etc.
- Operation box: LED for monitor, various operation switches

Signal output circuit:

Relay output
- Signal OFF (power turned on at normal operation)
- Signal ON (power turned off at automatic stop)
- Signal ON (power turned off at computation error)

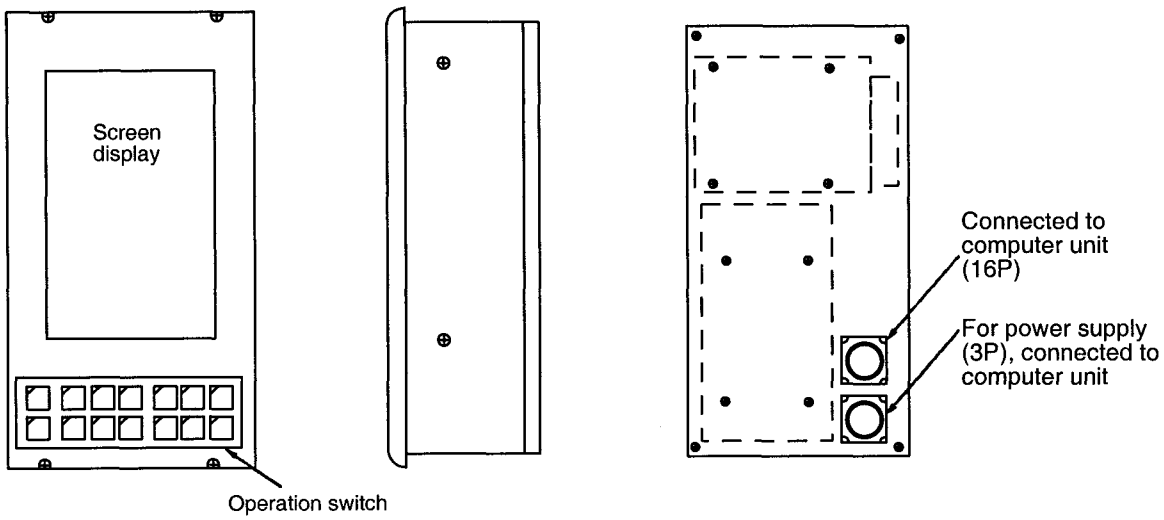
Buzzer output:
- Intermittent sound within 90 to 100%
- Continuous sound above 100%

NOTICE

1. **Before plugging in or unplugging the IC card, be sure to turn the overload prevention device switch to transportation position or engine starting switch "OFF" position. If the power supply remains turned on, there is a risk of the IC card being damaged.**
2. **The setting/operation selector switch should normally be set on the operation side.**

ML-E MODEL

2-3 Outline of display unit



Power supply:

24 V DC is supplied from the computer unit. When the setting/operation mode selector switch of the computer unit is set on the setting side, output from the computer unit to the display unit is stopped as a rule.

Configuration, etc.:

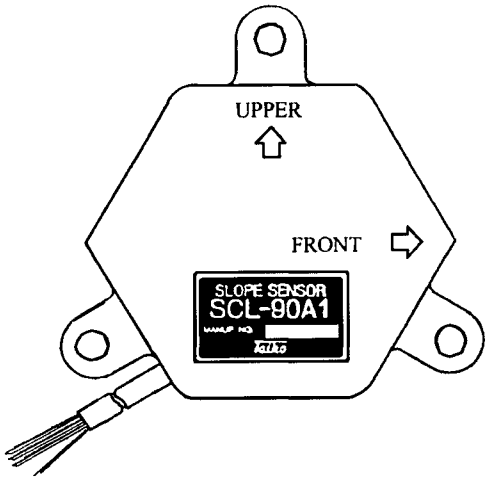
This unit consists of a display screen and 14 operation switches. With these switches, working conditions are settable and various display screens are selectable for monitoring.

Display:

Setting screen, standard screen, check screen, overall lifting load curve screen and overall lifting load table screen are displayed. Present working state and set working conditions can be checked.

2-4 Outline of sensor

1. Angle detector



Cord color
- Red: Power supply
- Black: Ground
- White: Output

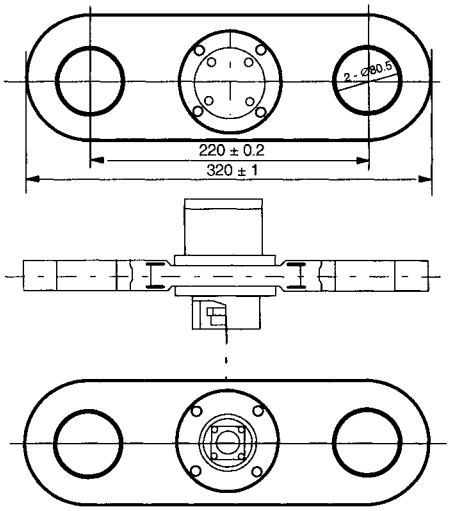
Rated voltage:	DC 12 V
Operating voltage:	DC 10.5~30 V
Detection angle:	0° ~ + 90°
Sensitivity:	35 mV/1° ± 5%

Angle	Output Voltage

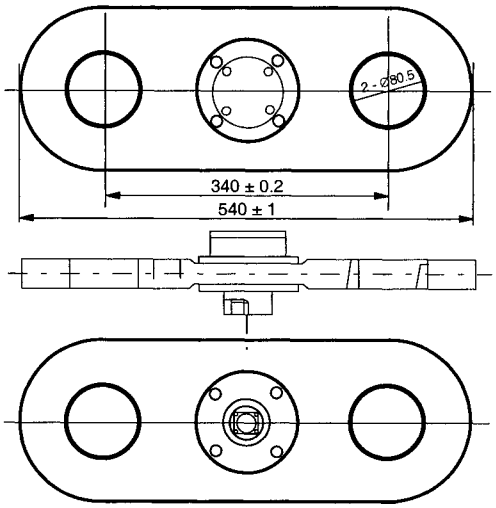
ML-E MODEL

2-4 Outline of sensor (Continued)

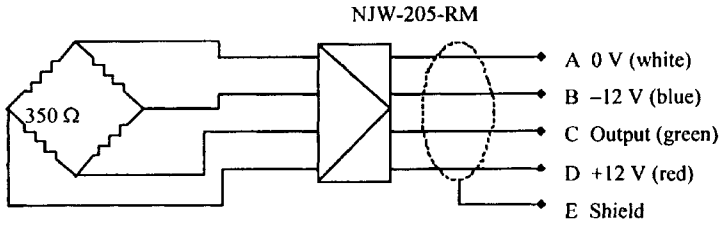
2. Load detector

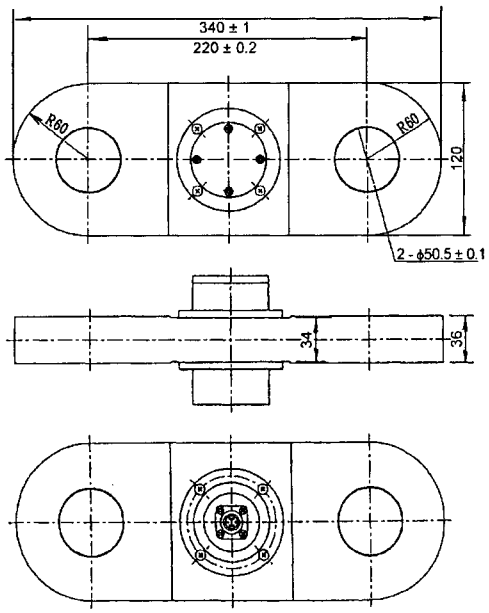


20-ton tension type load cell with built-in amplifier
Power supply ± 12 V DC

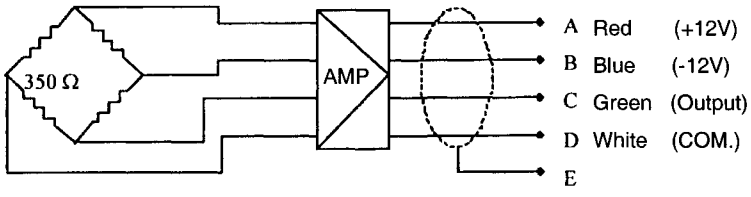


40-ton tension type load cell with built-in amplifier
Power supply ± 12 V DC



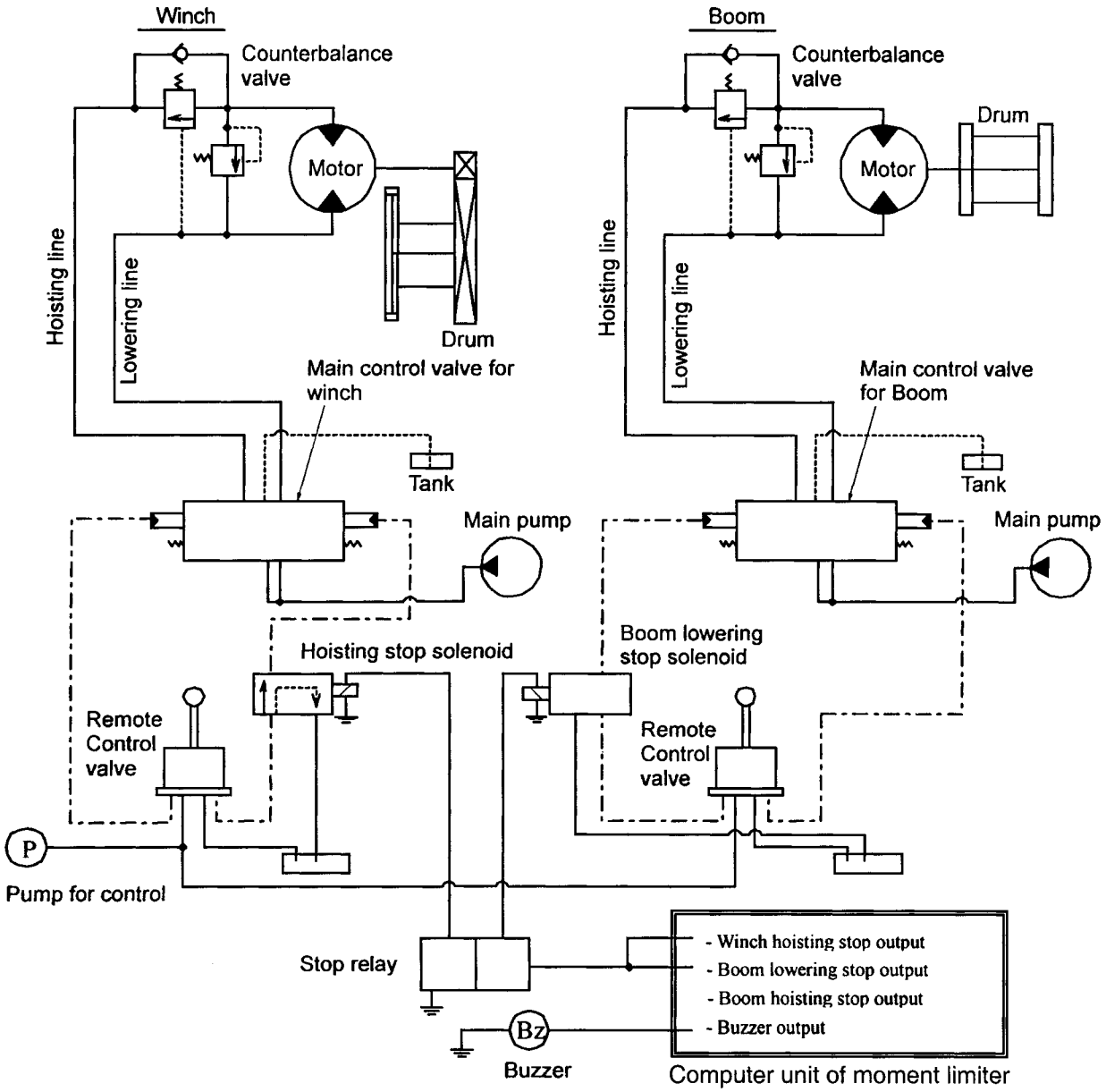


30-ton tension type load cell with built-in amplifier
Power supply ± 12 V DC



ML-E MODEL & ML-D2A MODEL

2-5 Stop mechanism



When the stop relay is activated in response to 100%-level stop output of the moment limiter, power supply to the winch hoisting stop solenoid and boom lowering stop solenoid is turned off. As a result, the solenoid valve is switched over. Pressurized fluid from the remote control valve normally passes through the solenoid valve and acts on the end of spool of the main control valve. When the stop solenoid is switched over, the pressurized fluid from the remote control valve returns from the solenoid valve to the tank. Consequently, the main control valve returns to the neutral position.

When the main control valve has returned to the neutral position, the pressurized fluid from the main pump is no longer supplied to the winch motor and boom motor. Therefore, winch hoisting and boom lowering are stopped by the counter balance valve and disc brake. With or without a load, boom lowering stop output and buzzer output are issued when the maximum working radius is reached. When the boom is hoisted at 80°, boom hoisting stop output and buzzer output are issued.

ML-E MODEL & ML-D2A MODEL

Automatic stop device

On activation of the automatic stop device, the relay is activated due to activation of the microswitch (for boom throw-out or hook overwind prevention) or stop command of the moment limiter. When the relay is activated, power supply to each solenoid valve in the load hoisting circuit and the boom hoisting/lowering circuit is turned off. When power supply to the solenoid valve is turned off, the valve is switched over.

Operating fluid via the remote control valve of operator's seat passes through the solenoid valve and flows into each main control valve. The fluid presses the end of spool of the main control valve until the valve is switched over.

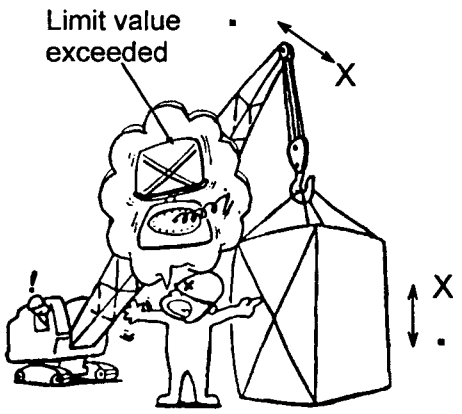
The pressurized fluid of the main pump passes through the control valve and flows into each motor. When the solenoid valve is switched over as mentioned above, the controlling fluid, which was led from the remote control valve to main control valve, returns to the tank. Therefore, the main control valve returns to the neutral position. When the main control valve has returned to the neutral position, the pressurized fluid of the main pump is no longer led to each hoisting motor. Consequently, the hoisting motor stops to disable load hoisting, boom hoisting or boom lowering.

Activation of overload prevention device and method of its release

When the actual value exceeds 90% of the limit value, the buzzer beeps intermittently. When the actual value exceeds 100%, the buzzer beeps continuously.

The machine automatically stops according to the stop signal from the moment limiter, and both load hoisting and boom lowering are disabled.

In case the machine is automatically stopped according to the stop command of the moment limiter, the working distance should be shortened by hoisting the boom or the load ratio should be reduced by lowering the load to the ground. Once the machine has returned to the safe area, the buzzer stops beeping. Return the crane to the safe area, an automatic stop is released in about 2 seconds and all the operation can be done.



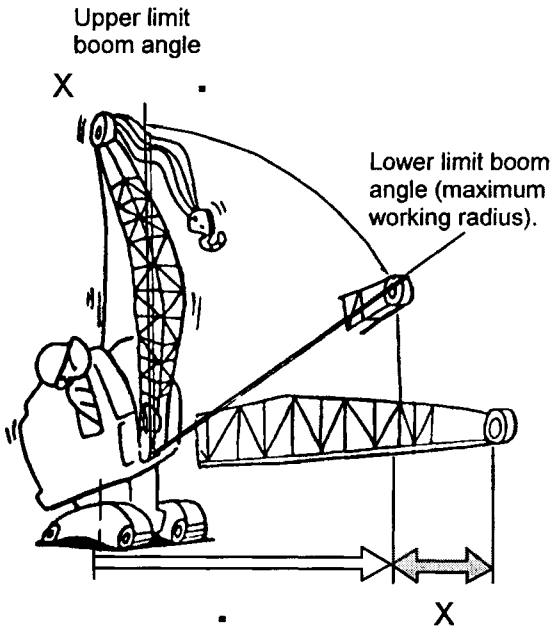
CAUTION

1. **Even if the machine is automatically stopped, boom lowering and load hoisting can be continued by turning the bypass switch to the released side. However, such an operation can cause a mobile crane to turn over. Never try such an operation.**
2. **If crane operation is carried out with the bypass switch kept released for any reason, there is a risk of machine tip-over, backward boom turn-over (boom hoist), etc. because the safety device does not function. To prevent this, never try such an operation.**
3. **During crane operation, never turn off the power supply of overload prevention device.**

Boom stop at rated upper limit or rated lower limit (at maximum working radius)

Regardless of whether or not a load is lifted, the boom automatically stops when it is hoisted at the upper limit angle or it is lowered so as to reach the maximum working radius at the present boom length. At the same time, the alarm buzzer sounds. The same action is taken in case of the tower jib.

The lower limit boom angle varies with the boom length. Refer to the rated overall lifting load table.



Release:

To release the automatic stop status, lower or hoist the boom.

When the buzzer stops, the stop status is released.

⚠ CAUTION

1. **When attempting to hoist the crane boom from the ground, hoisting operation is disabled because the boom stop command is issued as mentioned above. In this case, first turn overload prevention device switch to erection position or turn the bypass switch to released side, and then proceed to hoisting operation.**
2. **When the boom reaches the determined angle, be sure to turn to operation position of overload prevention device switch (moment limiter switch).**

⚠ CAUTION

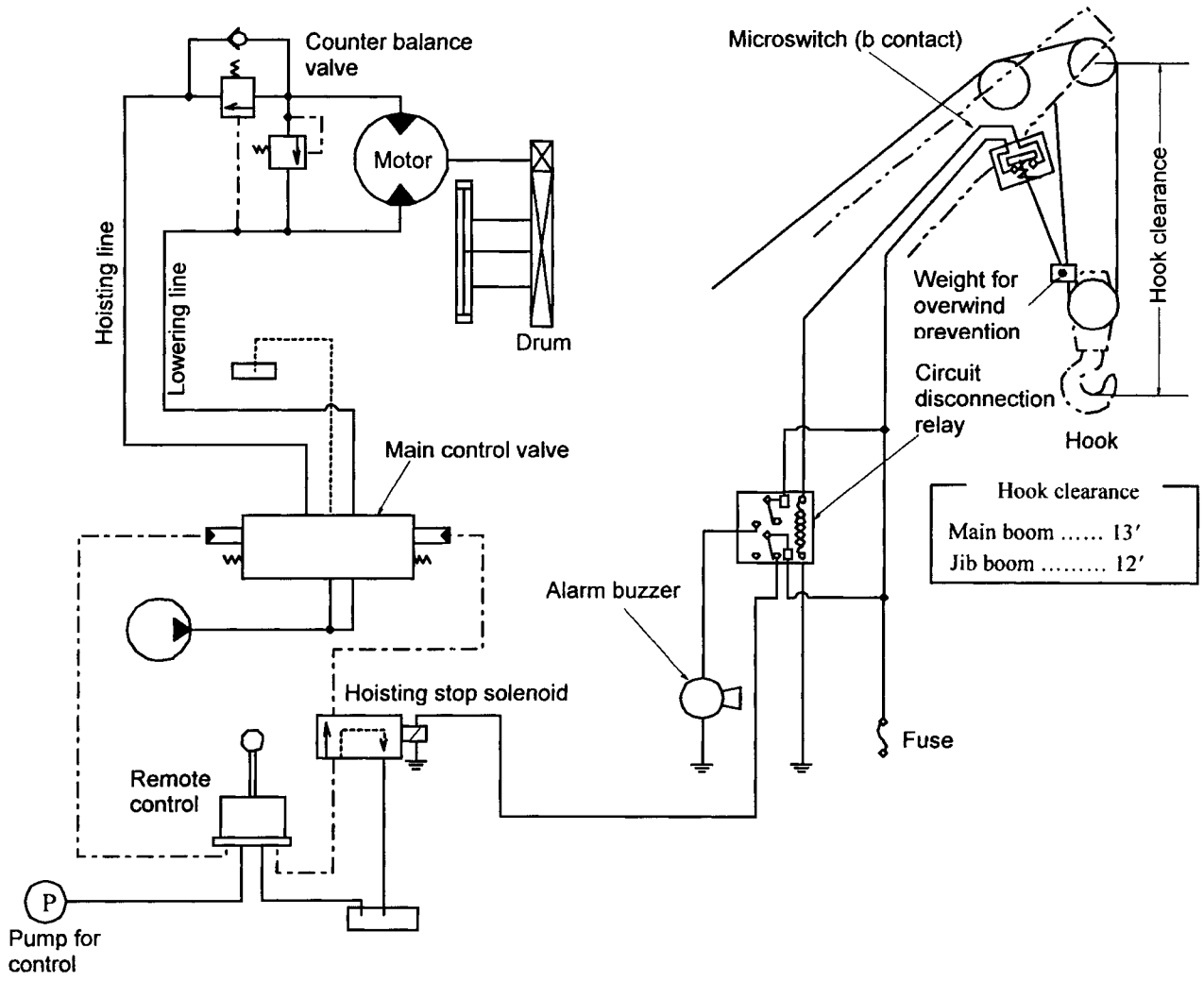
1. **Before the start of daily operation, the function of the overload prevention device must be checked. As a convenient method of functional check, the following procedure is usable:**

   Start lowering the boom without lifting a load. Confirm that when the lower limit boom angle is reached, the buzzer sounds continuously, the boom automatically stops, and the load ratio display becomes 100%. If confirmation is made, the function of the overload prevention device is normal.
2. **Never connect or disconnect cables without turning off the power switch, otherwise the computer unit may be damaged. Also, refrain from plugging in or unplugging the IC card without cutting off the power supply. Otherwise, the IC card may be damaged (ML-E Model).**

   After turning engine key to the "OFF" position or changing the overload prevention device switch to a transportation position, it carries out.

3. HOOK OVERWIND PREVENTION DEVICE

3-1 Outline of activation



When the hook pushes up the weight of overwind prevention device in hoisting, the contact of the microswitch opens so that excitation of the circuit disconnection relay is interrupted. The hoisting stop solenoid valve is switched over and the operating fluid from the remote control valve returns to the tank circuit through the overwind stop solenoid valve. Consequently, the force which has pushed the spool of the main control valve is lost. The spool of the main control valve returns to the neutral position and the hydraulic fluid in the main circuit is also returned to the tank circuit. This means that the route of fluid supply to the motor is cut off. Thus, the revolution of the motor is stopped with the counterbalance valve, thereby preventing the hook from being hoisted further. At the same time, the alarm buzzer is sounded.

To release this function, lower the hook until the alarm buzzer stops beeping. Make sure that the microswitch always functions normally.

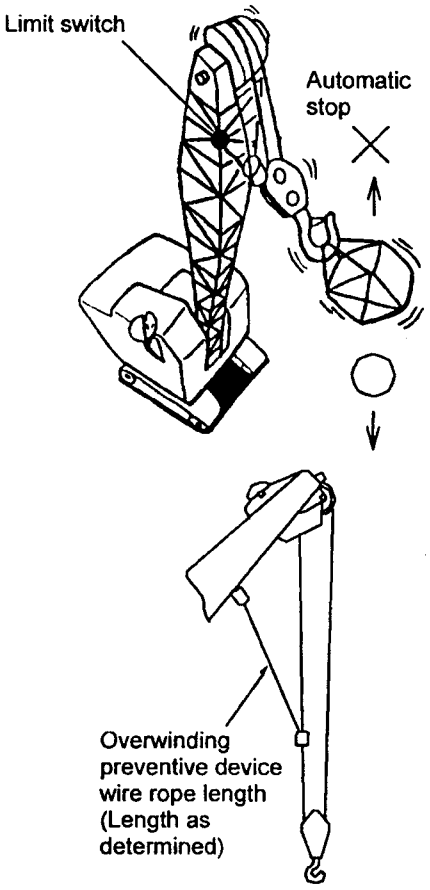
3-2 Activation check of limit switch and overwind prevention device

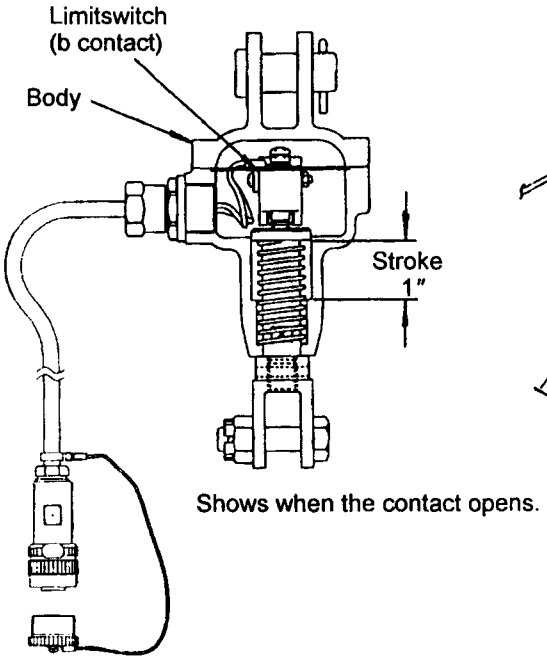
When the hook pushes up the weight for the overwind prevention device, the "b" contact of limit switch opens to activate the stop relay. On activation of the stop relay, hoisting of the hook stops and the alarm buzzer sounds.

To release the stop status, lower the hook until it is separated from the weight for overwind prevention device. Once the hook has been separated from the weight, the buzzer sound stops to indicate that the hoisting stop status is released.

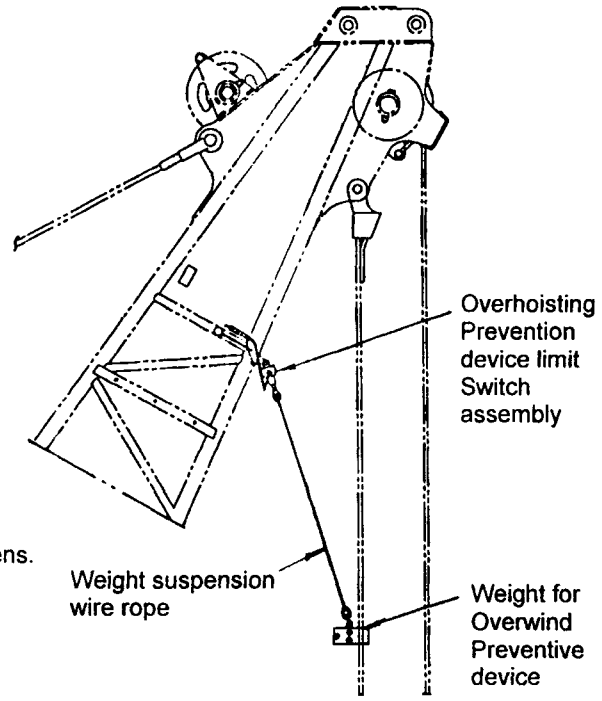
⚠ CAUTION

1. **The weight for overwind prevention device should be suspended by the wire rope of the determined length, without fail. If the rope length is not proper, the overhoisting prevention device may not work. This is dangerous.**
2. **Before crane work, confirm each activation of the limit switch and entire automatic stop mechanism. For confirmation, the hook should be hoisted at a very slow speed so that hook hoisting can be stopped immediately.**





Limit switch area



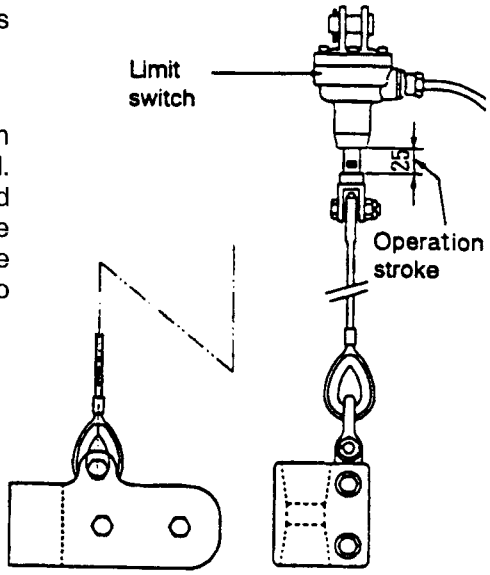
Hook overwind preventive device

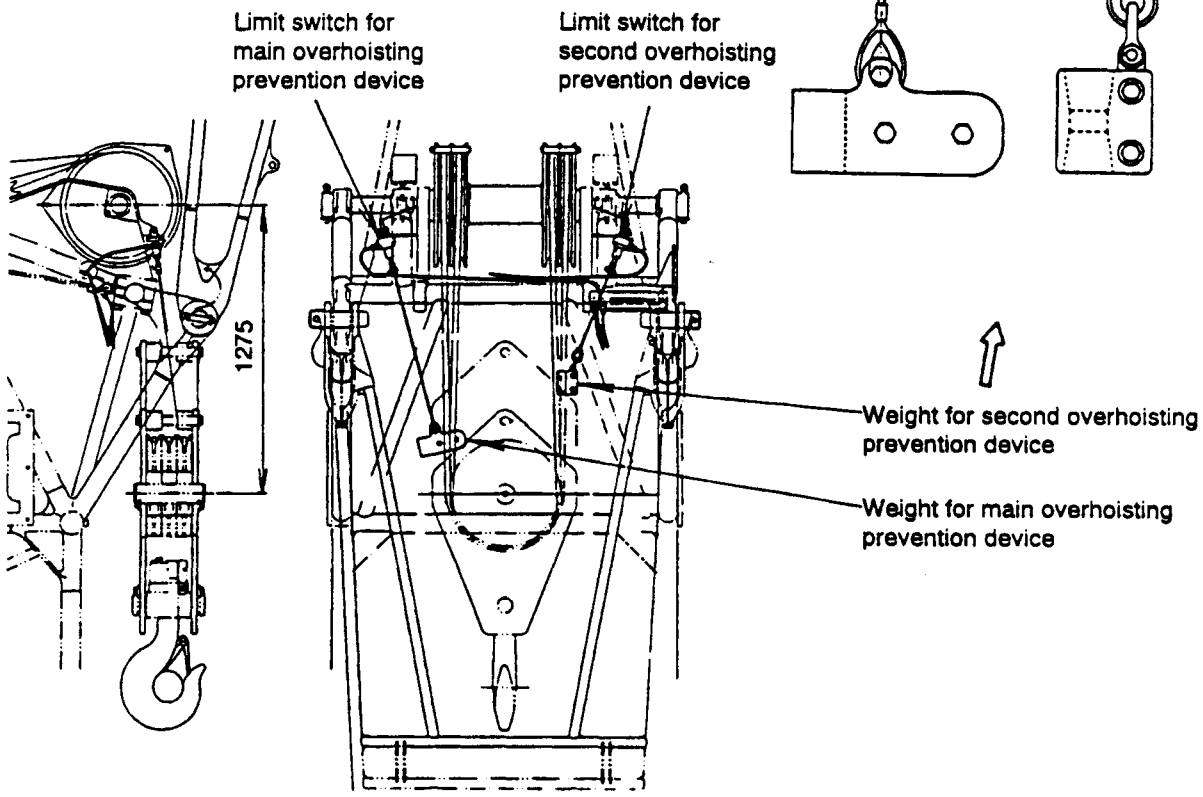
3-3 Boom main overhoisting prevention device

This overhoisting prevention device for the main hook is mounted on the leading end of the tower top.

1. Main overhoisting prevention device

   When the hook pushes up the weight for the main overhoisting prevention device, the limit switch is actuated. Consequently, the main winch, auxiliary winch hoist and boom winch lowering is stopped and at the same time, the alarm buzzer sounds. In such a case, the hook can be lowered and the boom can be hoisted. Lower the hook to release the stop status.





2. Second main hoisting prevention device

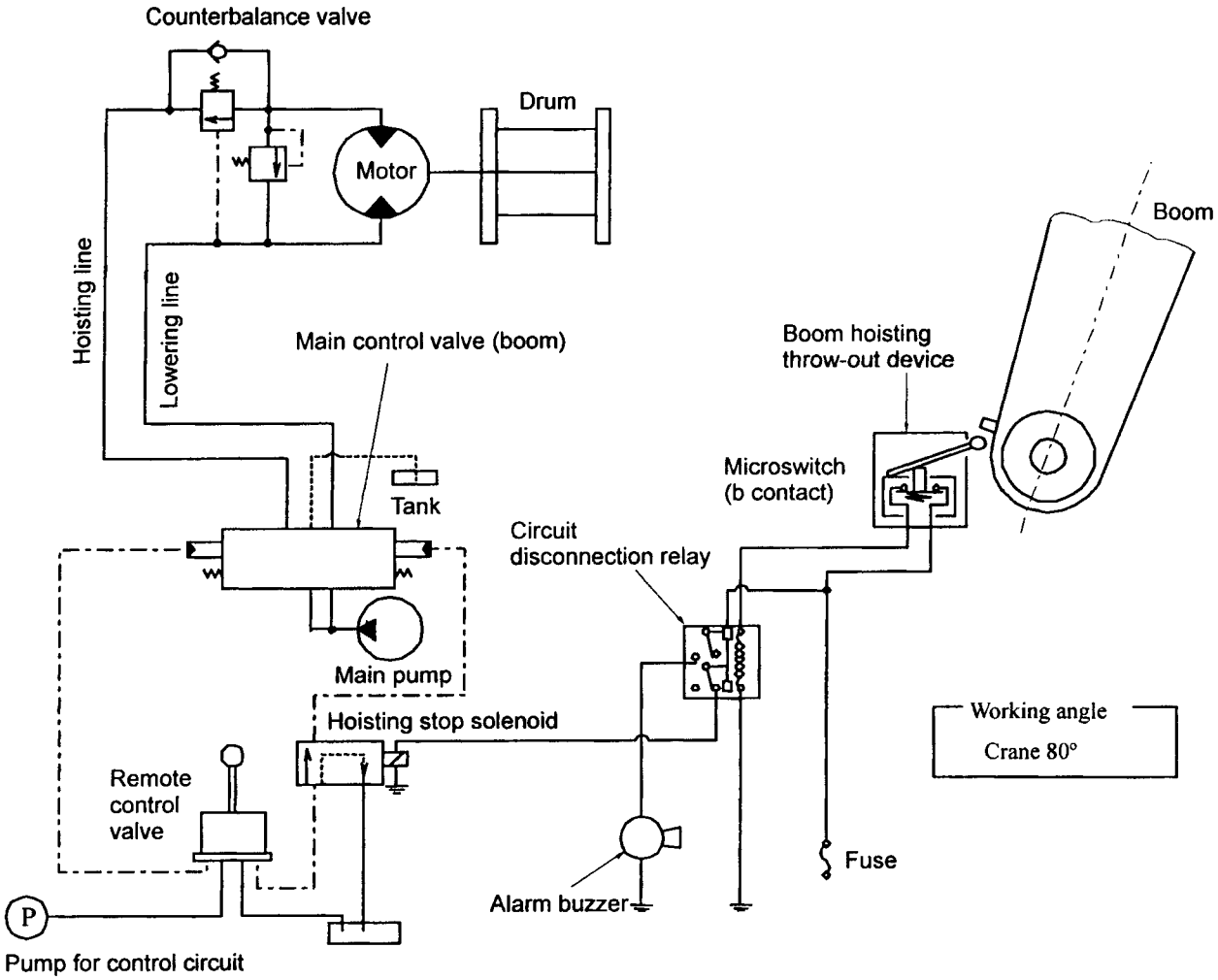
   When the main overhoisting prevention device operates, you can hoist the hook if turning the safety device switch to the release side. If the hook is hoisted as the safety device switch is turned to the released side and pushes up the weight for the second overhoisting prevention device, the second overhoisting limit switch operates to stop all winches. The second overhoisting prevention device cannot be released by the safety device switch. The hook can be lowered and the boom can be hoisted. Lower the hook and release the stop status.

NOTICE

Use a specified rope for lifting the weight of the overhoisting prevention device. If the rope length or the like is changed, the main hook is moved from the specified position at assembly or disassembly. Therefore, when hoisting or lowering the jib, the jib may interfere with the main hook to result in breakage.

4. BOOM OVERWIND PREVENTION DEVICE (BOOM THROW-OUT)

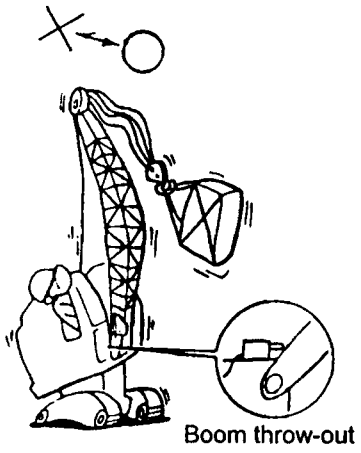
4-1 Outline of activation



When the contact of the limit switch opens due to activation of the boom hoisting throw-out in boom hoisting, the circuit disconnection relay operates. As a result, power supply to the hoisting stop solenoid valve is cut off and the solenoid valve is switched over. Since operating fluid from the remote control valve returns to the tank through the hoisting stop solenoid valve, the force which pressed the spool end of the main control valve is now unavailable. Therefore, the spool of the main control valve returns to the neutral position. This means that the fluid of the main pump also returns to the tank circuit. So, pressurized fluid is no longer supplied to the motor. Consequently, the motor is stopped with the counterbalance valve and multiple disc brake, thereby preventing the boom from being hoisted excessively. As soon as boom hoisting stops, the buzzer sounds an alarm. To release the stop status, lower the boom until the buzzer stops. The throw-out device must always be kept in the normally operable status.

4-2 Boom overhoist prevention device (boom throw-out)

When the boom is hoisted beyond the specified angle, the limit switch of boom throw-out is activated, so that the boom hoisting winch stops and the alarm buzzer sounds. To release the automatic stop status, lower the boom until the limit switch roller and boom foot are separated from each other. When the buzzer stops beeping, the stop status is released.

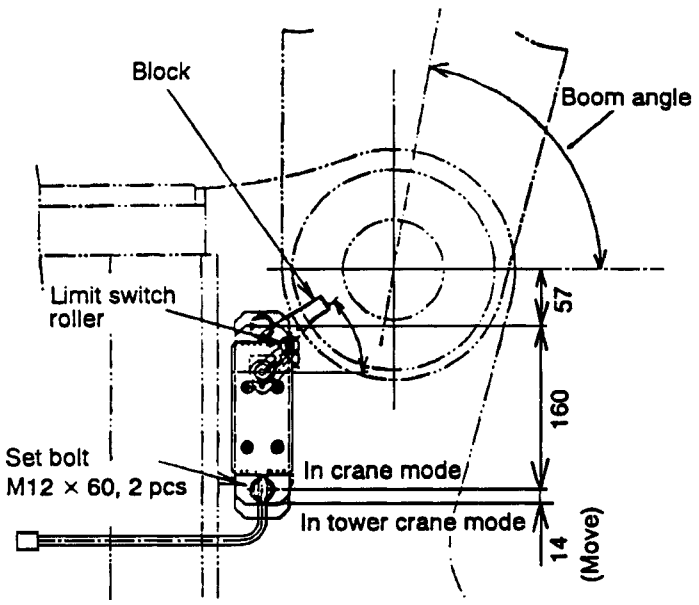


NOTICE

1. **It is recommended to avoid lifting a heavy load with the boom angle close to the maximum. When lifting a heavy load, it can be predicted that the boom moves backward after releasing the load and therefore the automatic stop device is activated.**
2. **In preoperational check, confirm that the boom throw-out functions normally.**

4-3 Boom throw-out adjustment

Adjust the boom throw-out so that it is activated at a boom angle of 80° in the standard crane. A boom angle of 85° or more emits an alarm when in luffing jib crane and luffing tower crane.



1. Move the machine onto the level ground.
2. Slow down engine rotation and hoist the boom at about boom angle of 80°.
3. Loosen the M12 set bolts and move the entire limit switch. Temporarily tighten the set bolts at a position where the roller of limit switch hits against the block to emit a sound.
4. Hoist and lower the boom a few times and confirm that the throw-out device operates at 79 to 80°. Finely adjust the position of the microswitch as required.
5. Tighten the two set bolts securely.

   In the tower crane mode, lower the limit switch by about 14mm so that the boom throw-out operates at about 85°.

4-4 Second throw-out

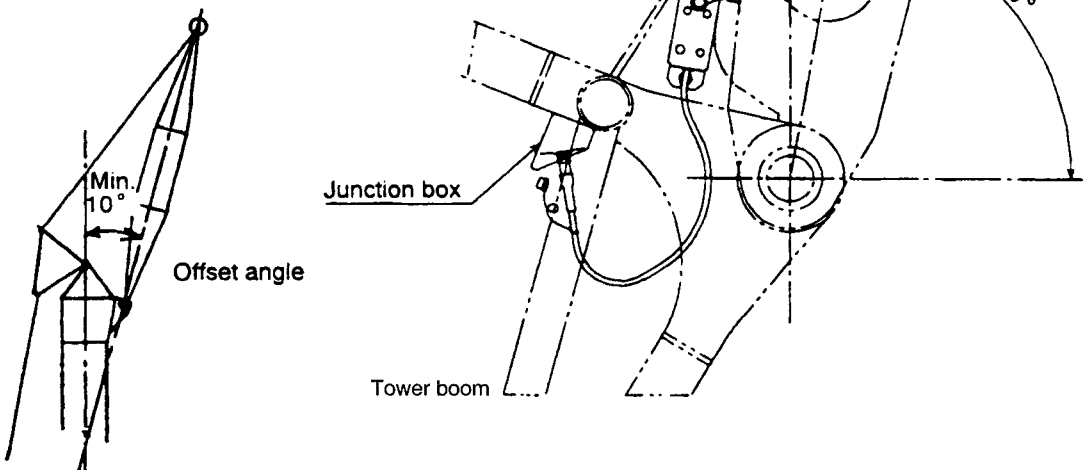
The 2nd throw-out is to be mounted at the boom foot on the left side. Activation angle should be set at 82°. On activation of the 2nd throw-out, hoisting of the boom, load and 3rd drum stops.

5. TOWER BOOM, JIB OVERHOISTING PREVENTION DEVICE AND LIMIT STOP

5-1 Tower jib throw-out

The minimum offset angle is 10° for the boom and tower jib. When hoisting the tower jib until the jib offset angle is 10°, the No. 1 limit switch on the boom is actuated to stop the jib hoist winch. The jib hoisting is stopped and the alarm buzzer sounds.

Lower the jib to release the stop status. When the offset angle is 9°, the No. 2 limit switch operates. When the limit switch operates, boom lowering, jib hoisting, main hoisting and auxiliary hoisting stop.



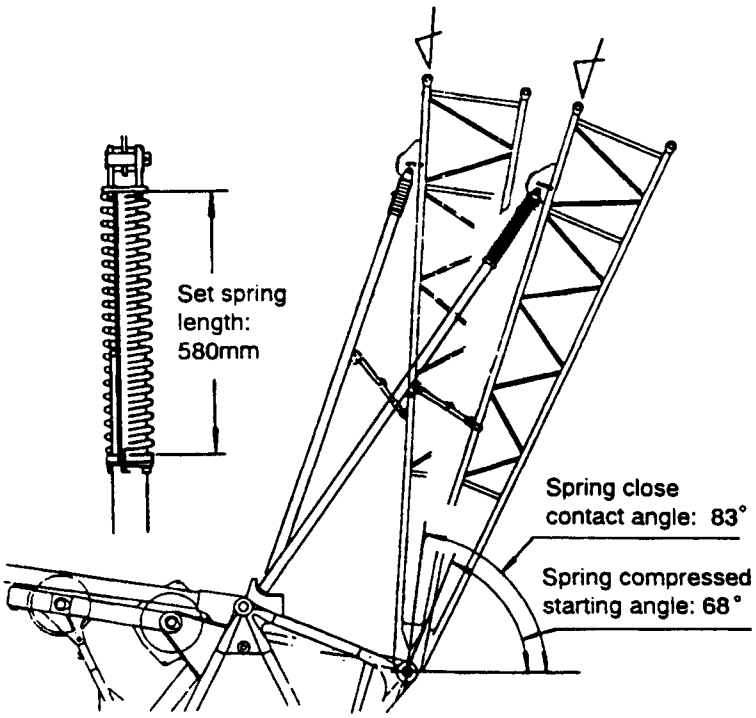
Offset angle: The angle formed by the boom center line and the tower jib center line.

Refer to Chapter 6 "SPECIFICATIONS" for the combination of boom length and jib length, and the working range of boom and jib.

5-2 Tower jib limit stop

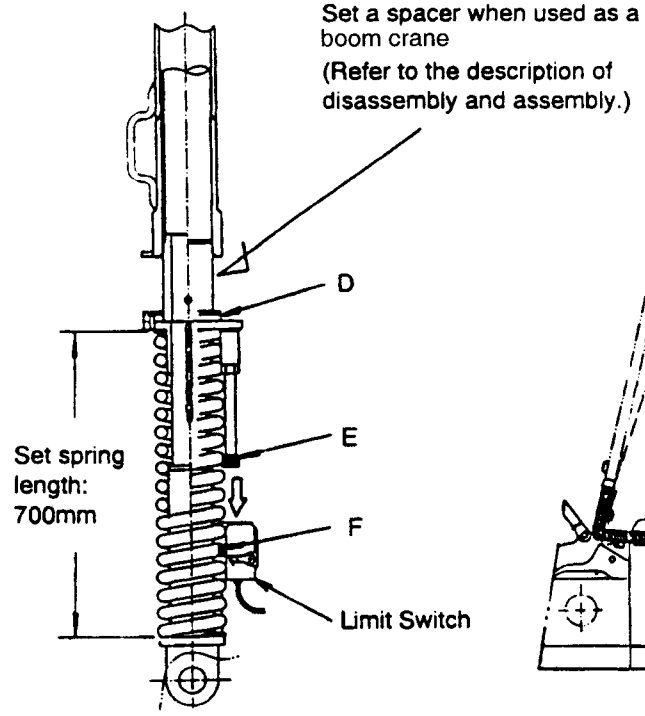
The bumper spring is set in the outer member beforehand. The set dimension is 580mm.

The figure at right shows that the spring starts to compress by the limit stop foot section touching the boom when the jib angle is 68°. The spring is in close contact when the jib angle is 83°.



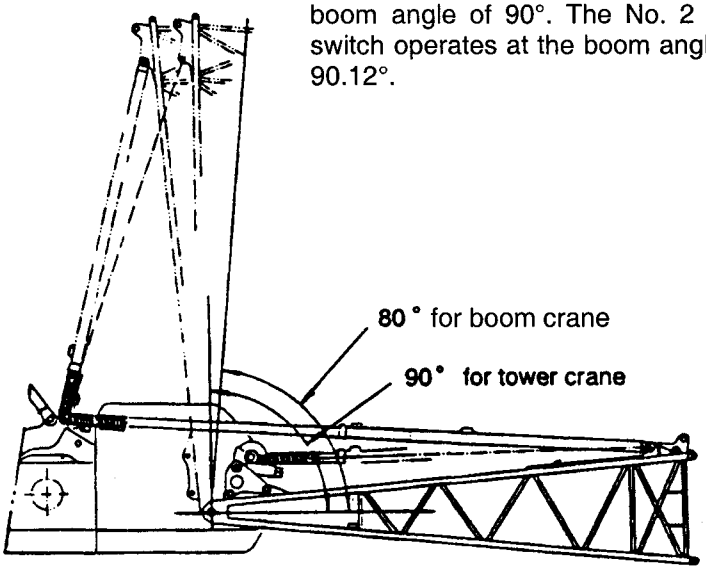
5-3 Tower boom stabilizer (used as limit stop for boom crane)

The spring is set in the inner member beforehand. The set dimension is 700mm. When the boom angle reaches 90°, the No. 1 limit switch operates and hoist up of boom is stopped. The fine adjustment is done by the "D" part shim as illustrated.



The "E" and "F" are matchmarks when the boom is erected. They are adjusted by the rod to be aligned when the boom is erected.

The No. 1 limit switch operates at the boom angle of 90°. The No. 2 limit switch operates at the boom angle of 90.12°.



6. OVERLOAD PREVENTION DEVICE ALARM LAMP (OPTIONAL SPECIFICATIONS)

Alarm lamp

This 3-lamp alarm is connected to the overload prevention device. The lamps show the load status as follows:

Green flashing lamp: Load is 90% or less

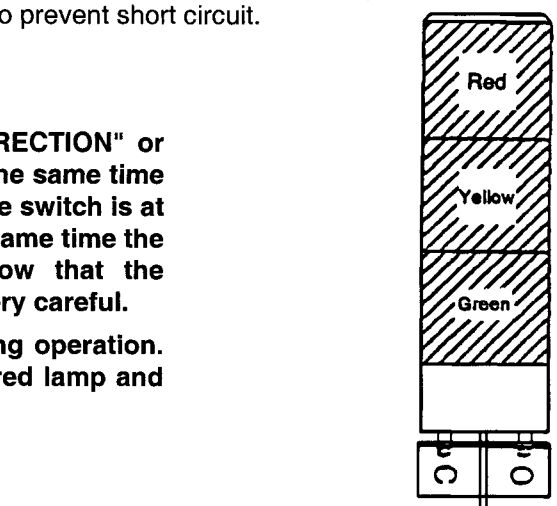
Yellow flashing lamp: Load is over 90%

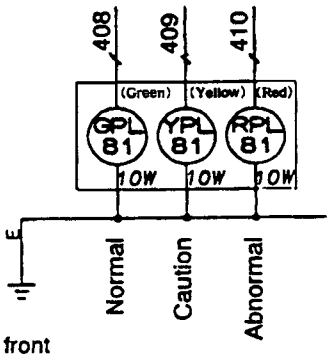
Red flashing lamp: Load is over 100%

This alarm is equipped with a buzzer. Connect the buzzer alarm to the desired lamp. There are four wires (gray) for buzzer. Apply insulation to the unused wires to prevent short circuit.

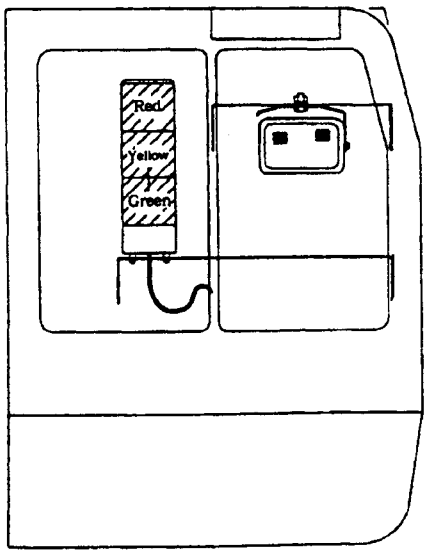
WARNING

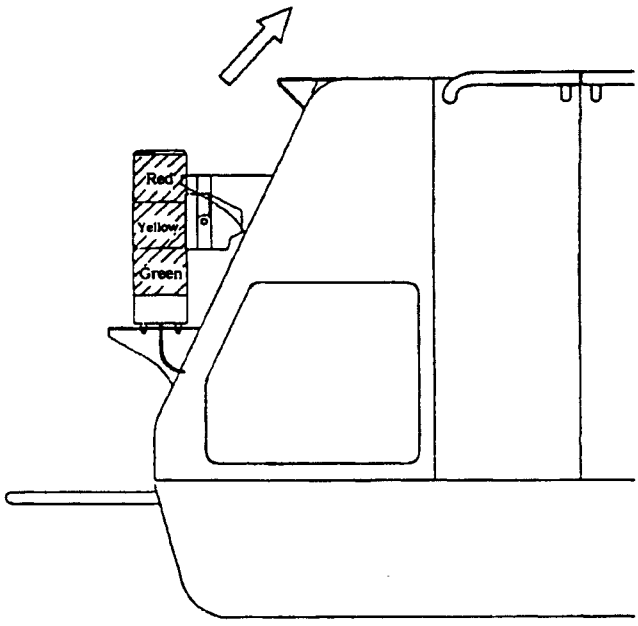
1. **If the overload prevention device switch is at "ERECTION" or "TRANSPORT", the red flashing lamp is lit and at the same time the buzzer sounds intermittently. If the safety device switch is at "RELEASE", the red flashing lamp is lit and at the same time the buzzer sounds intermittently. These alarms show that the overload prevention device does not operate. Be very careful.**
2. **Don't continue the work if the red lamp is lit during operation. Carry out the proper procedure to extinguish the red lamp and light the green lamp, and then start the work again.**



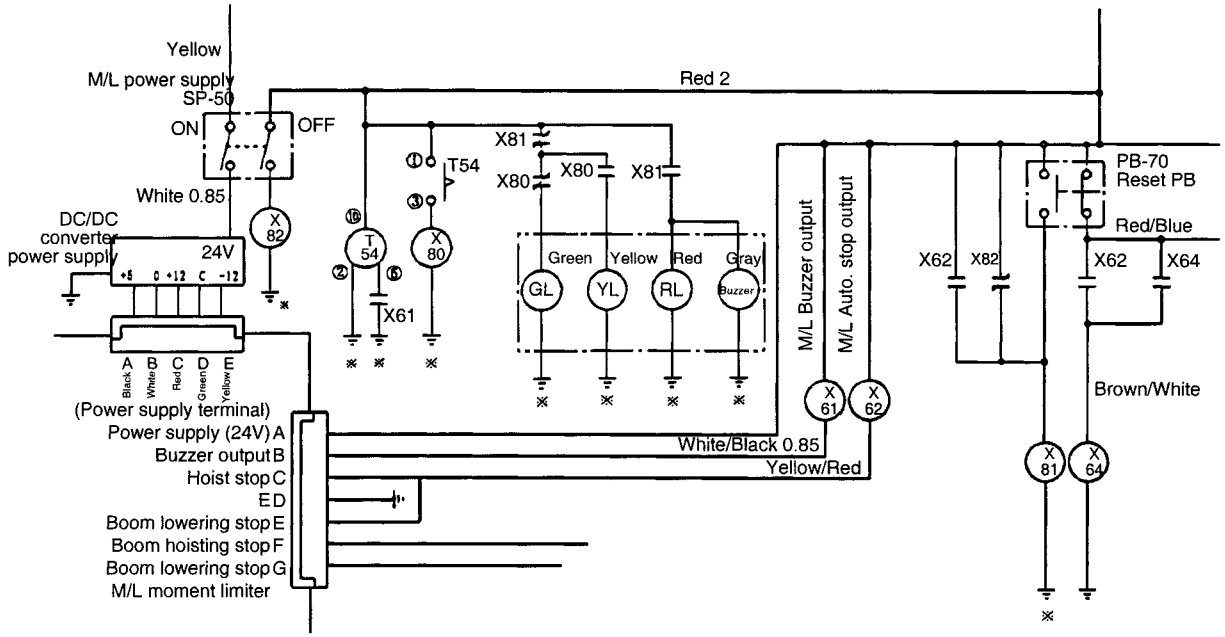


Mounted on the front left side of the machine.





Connection diagram (3-color M/L alarm lamp)



* Shows the additional circuit

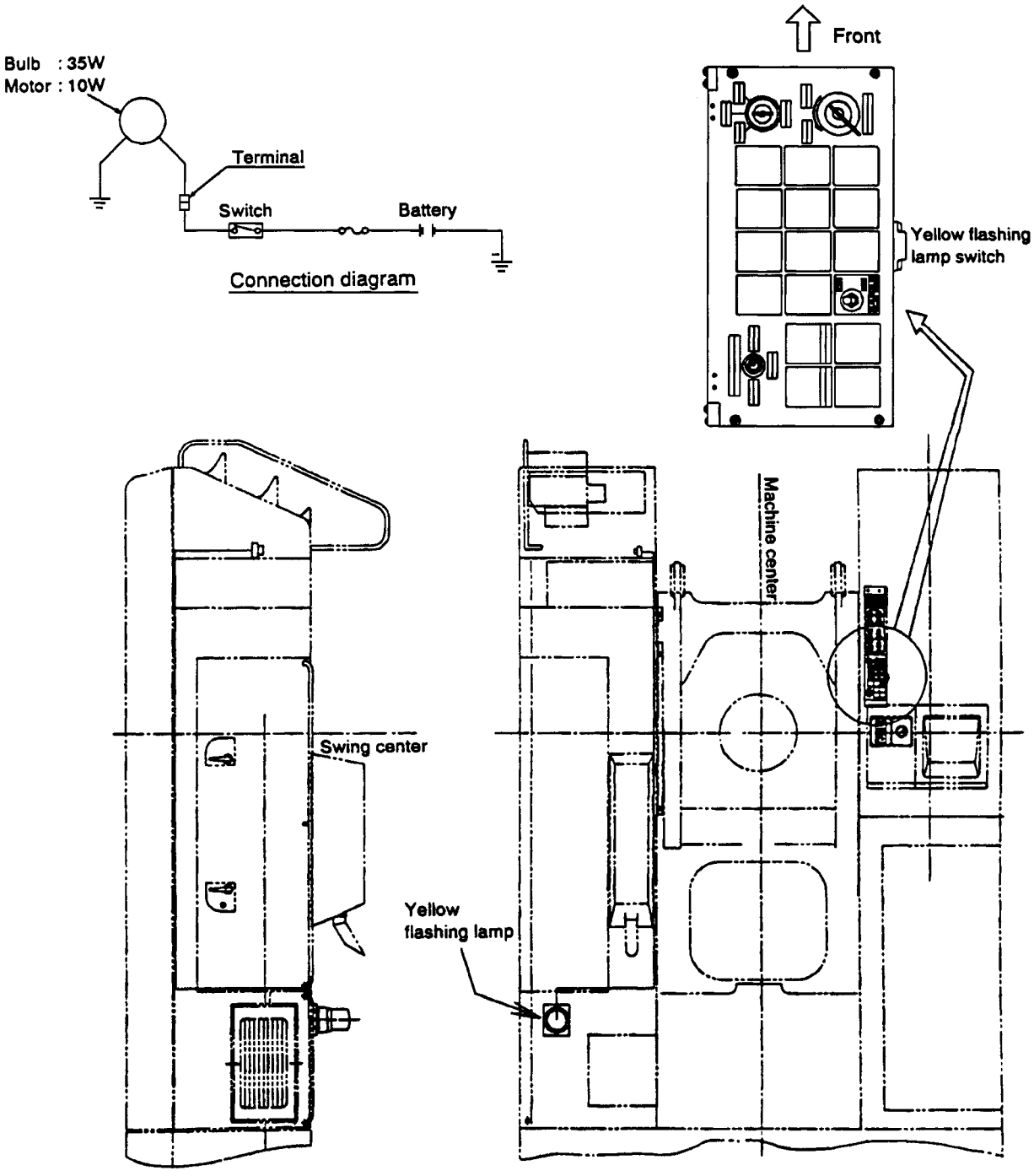
The flashing lamps of the moment limiter operate as follows:

Red lamp 1. The load ratio is 100% or more. 2. The overload prevention device switch is at "ERECTION". 3. The overload prevention device switch is at "TRANSPORT". 4. The safety device switch is at "RELEASE".
Yellow lamp The buzzer sounds and the red lamp is "OFF" when the crane approaches the limit value of the moment limiter.
Green lamp The red and yellow lamps are "OFF".

7. YELLOW FLASHING LAMP

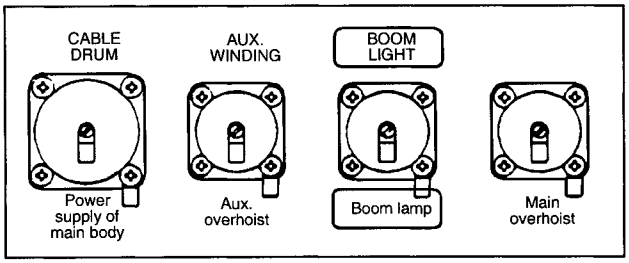
This is an alarm lamp for the people in the area when operating the machine or transporting the machine on a trailer.

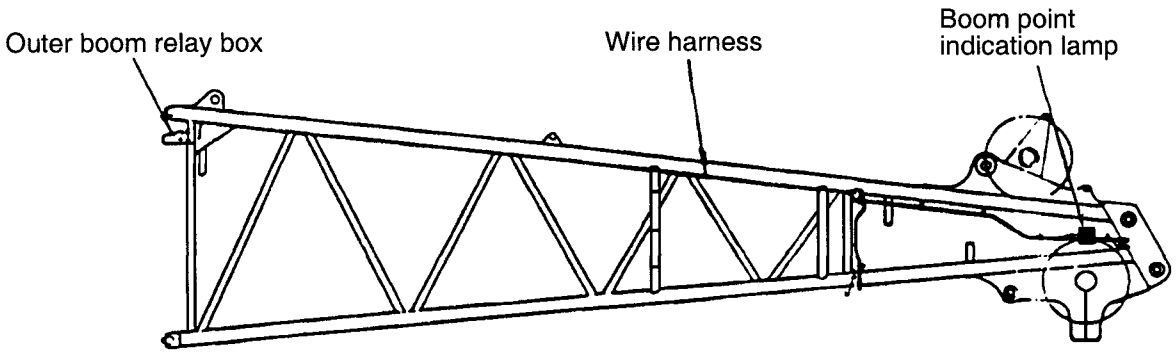
1. When transporting on a trailer, separate the terminal end and connect the power supply of the trailer to the terminal. Ground the trailer to the crane.
2. When transporting on a trailer, turn off the flashing lamp switch of the crane base machine.
3. The trailer power supply must be 24V.

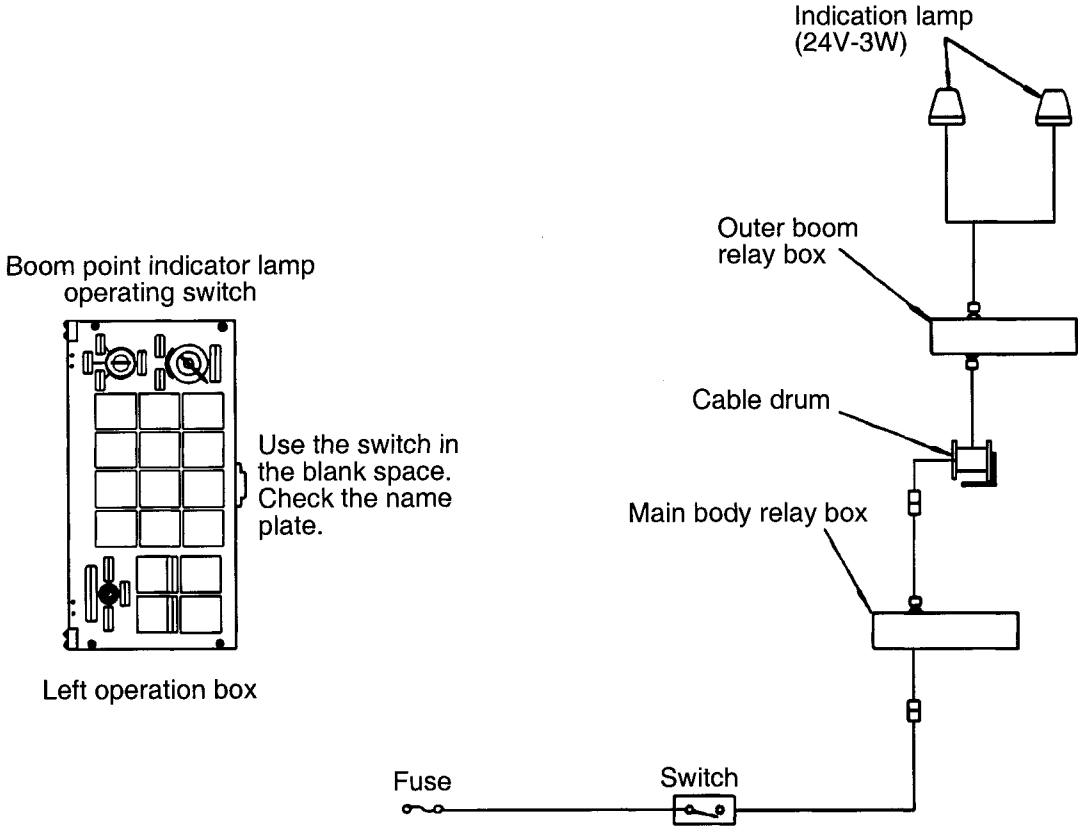


8. BOOM POINT INDICATION LAMP (OPTIONAL SPECIFICATION)

This is a light switch that indicates the boom point when parking the crane at night. Set the switch on the rear box to "ON" in the operator's cab if it is necessary to light this lamp.







Section 6

SPECIFICATIONS

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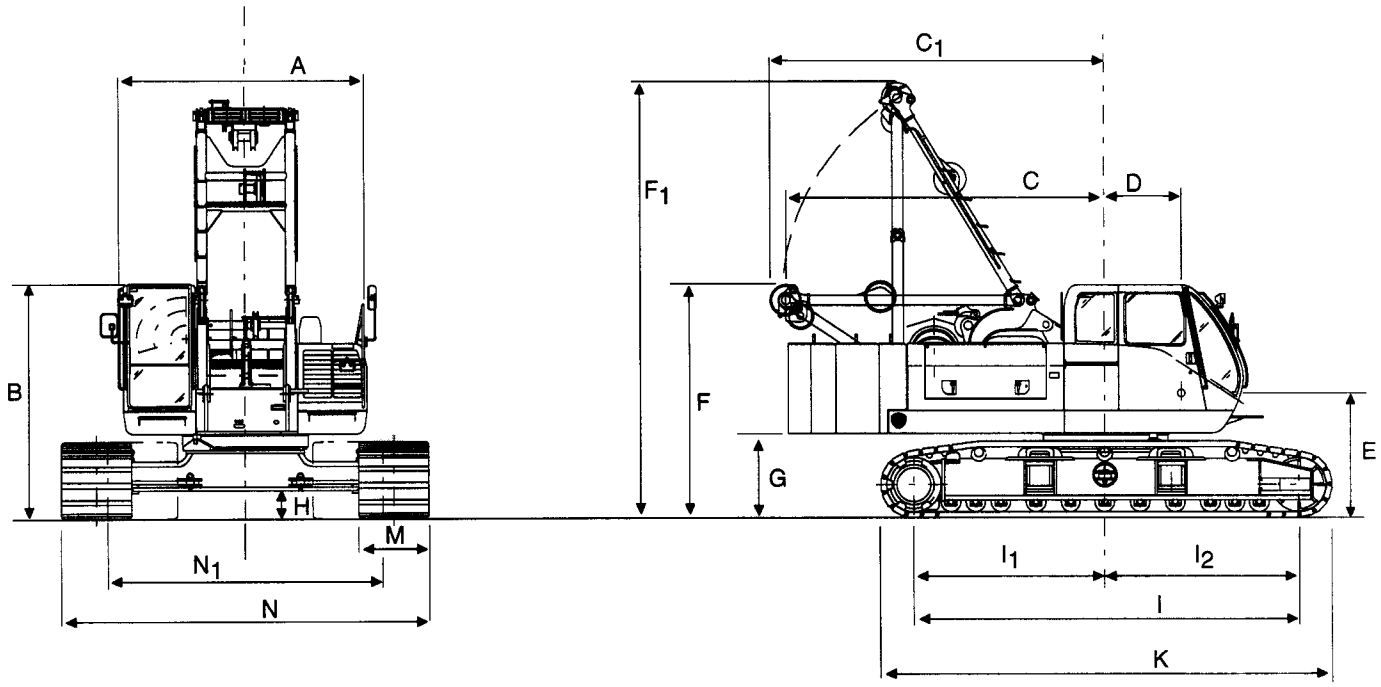
1. EXTERNAL DIMENSIONS OF STANDARD CRANE



Machine Weight:
63.3 tons when equipped with the
12m basic boom and 70 ton hook.

HC 80

GENERAL DIMENSIONS

		FT	MM
A	Width of machinery cab	10'-5 3/16"	3180
B	Height over operator's cab	10'-1 1/4"	3080
C	Tail swing	13'-8 3/8"	4175
C_1	Tail swing with A-Frame lowered	14'-5 1/4"	4400
D	Center rotation to boom foot	3'-3 3/8"	1000
E	Ground to center of boom foot	5'-5"	1650
F	Height over A-Frame lowered	10'-1 5/8"	3090
F_1	Height over A-Frame raised	18'-0 15/16"	5510

		FT	MM
G	Ground to bottom of counterweight	3'-7 7/8"	1115
H	Minimum ground clearance	1'-2 9/16"	370
I	Center to center of crawler tumblers	16'-7 1/4"	5060
I_1	Center of drive tumbler to center of rotation	8'-3 1/4"	2520
I_2	Center of idler tumbler to center of rotation	8'-4"	2540
K	Overall length of crawlers	19'-5 7/8"	5940
M	Width of tread shoe (standard)	36"	915
N	Overall width of crawlers Shoes Extended	15'-9"	4800
N_1	Shoes Retracted	11'-9 3/4"	3600

2. BASE MACHINE PERFORMANCE

1. Speed

Name	Speed		Remarks
	High Speed	Low Speed	
Swing	3.3 RPM		
Travel	✣ 2.0 km/hr	✣ 1.3 km/hr	
Main hoist	✣ 110/80 m/min	✣ 55/40 m/min	1st layer on drum
Auxiliary hoist	✣ 110/80 m/min	✣ 55/40 m/min	1st layer on drum
Boom	✣ 60 m/min		1st layer on drum
Tower jib (3rd drum)	✣ 60 m/min		1st layer on drum

The values marked with " ✣" vary with load value.

2. Gradeability

40% (22°)	In base machine configuration

3. Drum winding capacity

Name	Drum groove (rope dia.)	Capacity	Remarks
Main hoist	Lebus type (Ø 22.4)	260m	8th layer
Auxiliary hoist	Lebus type (Ø 22.4)	260m	8th layer
Boom	Lebus type (Ø 16.0)	168m	8th layer
Tower jib	(Ø 20.0)	138m	8th layer

The rope winding capacity does not represent the usable rope length.

4. Combination of jib and boom length

Jib length (m)	Boom Length (m)														
	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54
1	●	●	●	●	●	●	●	●	●	●	●	●	●	●	- -
9	●	●	●	●	●	●	●	●	●	●	●	●	●	- -	- -
12	●	●	●	●	●	●	●	●	●	●	●	●	●	- -	- -
15	●	●	●	●	●	●	●	●	●	●	●	●	- -	- -	- -
18	●	●	●	●	●	●	●	●	●	●	●	●	- -	- -	- -

5. Engine

Maker	Hino Motors, Ltd.
Model	H07C-T diesel engine
Type	4-stroke, water-cooled overhead valve, direct fuel injection
No. of cylinders - diameter x stroke	6-4.33" x 4.65" (6 - 110 x 118mm)
Engine displacement	410 cu. in. (6.728 *l*)
Compression ratio	17.5 : 1
Rated output	132.4 kW/2,100 rpm (180 ps/2100 rpm)
Maximum torque	485 ft lbs./1,600 rpm (67 kgfm/1600 rpm)
Fuel consumption ratio	Approx. 0.375 lbs/psh (2,100 rpm) (170 g/psh [2100 rpm])
Minimum rpm with no load	725 ± 25 rpm
Supercharger	Exhaust turbo-supercharger
Starter	24V - 5.5kW motor (Sawafuji Co., Ltd.)
Air cleaner	Dry filter paper type (Tokyo Filter Co., Ltd.)
Generator	24V AC 45A, IC regulator built in (Sawafuji Co., Ltd.)
Battery	24V - 120 AH x 2 units
Engine oil capacity	H - 6.3 gal., L - 4.2 gal. (total amount 7.4 gal.) H - 24 *l*, L - 16 *l* (total amount 28 *l*)
Fuel tank capacity	63 gal. (240 *l*)
Coolant capacity	7.4 gal. (engine alone: 3.4 gal.) (28 *l* [engine alone: 3.0 *l*])

6. Hydraulic oil capacity

Tank oil volume for reaching level mark	79 gal. (300 *l*)
Total oil volume for reaching level mark	114 gal. (in entire hydraulic system) 430 *l* (in entire hydraulic system)

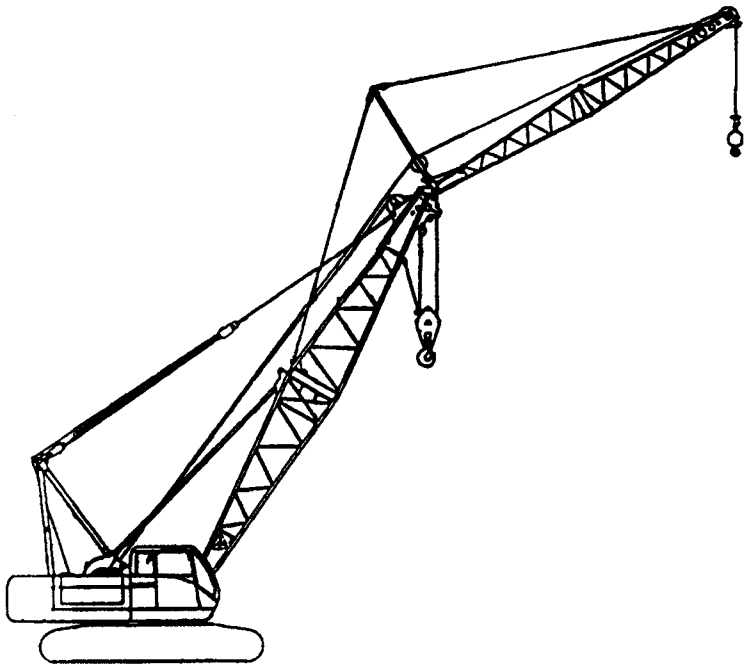
5. Engine

Maker	Cummins Engine Company, Inc.
Model	6BTA5.9
Type	4-stroke, water-cooled overhead valve, direct fuel injection
No. of cylinders - diameter x stroke	6-4.02" X 4.72"
Engine displacement	359 cu. in. (5.88 *l*)
Compression ratio	16.5:1
Rated output	147 kw/2,100 min-1 (198 PS/2100 rpm)
Maximum torque	814 N•m/1500 min-1 (600 ft-lbs/1500 rpm)
Fuel consumption ratio	Approx. 214 f/kW•h/2100 min-1 (0.352 lbs/BHP•h/2100 min-1)
Minimum rpm with no load	950 min-1
Supercharger	Exhaust turbo-supercharger
Starter	24V - 5.5kW motor (Nippondenso)
Air cleaner	Dry filter paper type (Tokyo Filter Co., Ltd.)
Generator	24V AC 50A, IC regulator built in (Delco Remy)
Battery	24V - 120 AH x 2 units
Engine oil capacity	High level: 5.3 gal. (20.1 *l*) Low Level: 4 gal. (15.1 *l*)
Fuel tank capacity	63 gal. (240 *l*)
Coolant capacity	6.8 gal. (25.7 *l*) [engine alone: 2.8 gal. (10.6 *l*)]

6. Hydraulic oil capacity

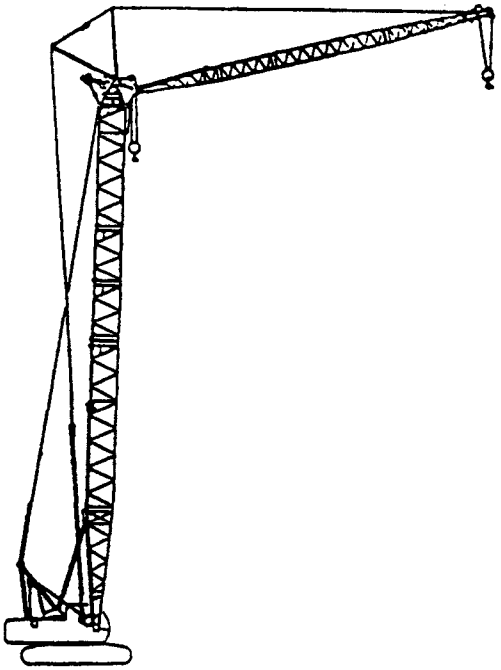
Tank oil volume for reaching level mark	79 gal. (300 *l*)
Total oil volume for reaching level mark	114 gal. (in entire hydraulic system) 430 *l* (in entire hydraulic system)

3. STANDARD CRANE PERFORMANCE



Lifting capacity	Main hoisting	Max. lifting load x working radius	72.5t x 3.7m
	Aux. hoisting	Max. lifting load x working radius	
Boom length	Main boom	Basic (inner + outer)	12m (6.5m + 5.5m)
		Maximum length	54m
	Jib	Minimum ~ Maximum	1m, 9m, 12m, 15m, 18m
	Maximum combination of main boom and jib		45m + 18m = 63m
Working range	Main boom	Working radius	4.1m ~ 42.0m
	Jib	Working radius	7.0m ~ 42m
	Main boom	Max. lifting height above ground (with 54m main boom)	Approx. 52m
	Jib	Max. lifting height above ground (with 45m + 18m)	Approx. 57m
	Main boom	Boom angle	30° ~ 80°
	Jib	Boom angle	58° ~ 80°
Number of rope parts	Main hoisting	72.5t hook	2 to 10 parts of line
	Aux. hoisting	7.2t hook	1 part of line
	Boom hoisting		14 parts of line
Counterweight	Inner + central + outer		24.5t (5.0t + 10.0t + 9.5t)
Working weight	With main boom 12m long		63.3t
Average grounding pressure	With main boom 12m long		0.72kgf/cm^2

4. LUFFING JIB CRANE PERFORMANCE



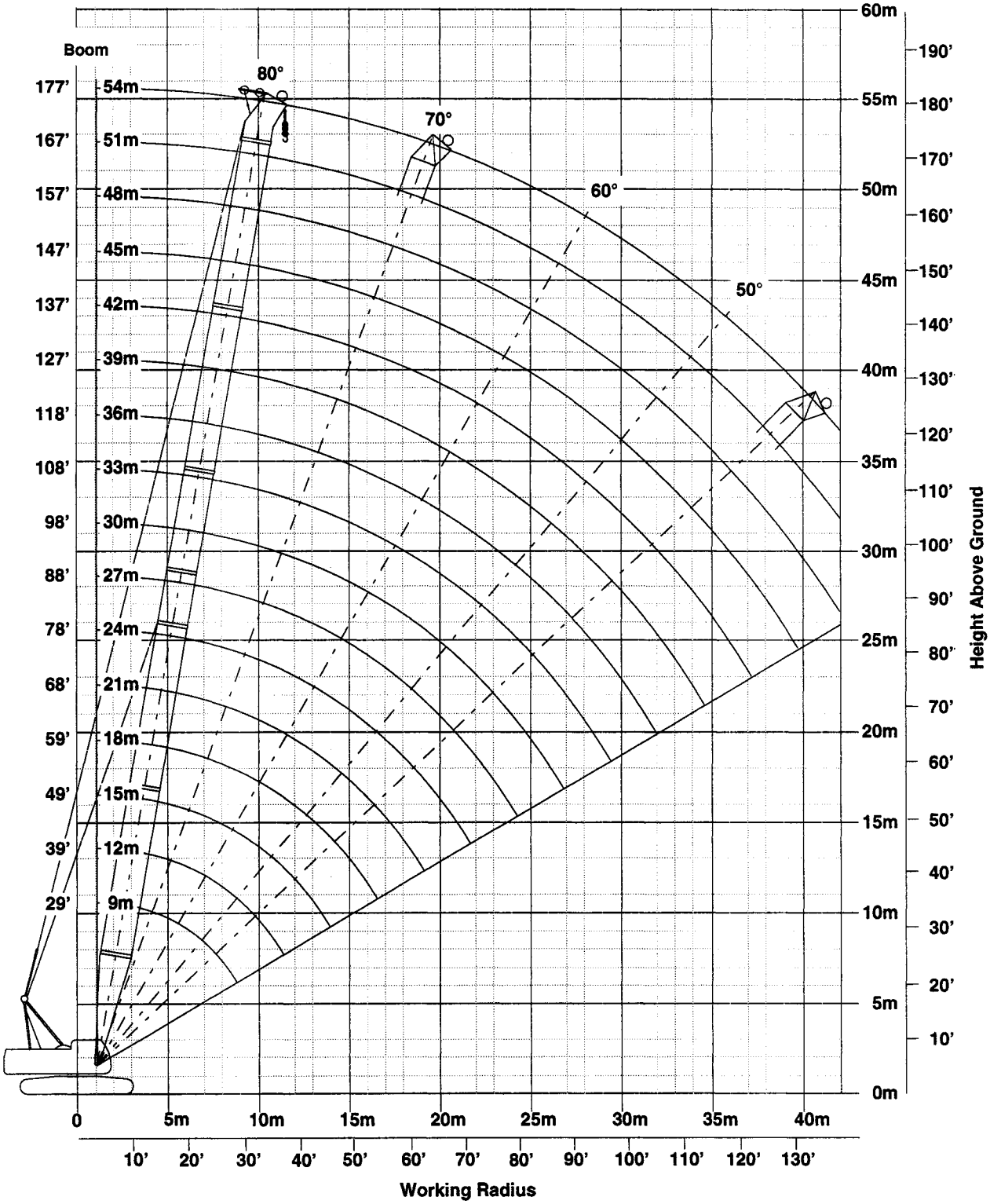
Note: 25 ton x 7.7m main hoist is only luffing jib crane

Lifting capacity	Main hoisting	Max. lifting load x working radius	25t x 7.7m (LJ)
	Aux. hoisting	Max. lifting load x working radius	13t x 12.0m (LJ, TW)
Boom length	Boom	Basic (inner + insert + outer)	18.0m (6.5 + 9.0 + 2.5m)
		Maximum length	42m
	Tower jib	Minimum ~ Maximum	16, 19, 23, 25, 28, 31m
	Maximum combination of boom and tower jib		42m + 31m
Working range	Boom	Working radius	3.8m ~ 42.0m
	Tower jib	Working radius	5.2m ~ 46.0m
	Boom	Max. lifting height above ground (with 42m boom)	Approx. 41m
	Tower jib	Max. lifting height above ground (with 42m + 31m)	Approx. 70m
	Boom	Boom angle	90° ~ 60°
	Tower jib	Tower jib angle	80° ~ 15°
Number of rope parts	Main hoisting	25t hook	2 to 4 parts of line
	Aux. hoisting	13t hook	1 to 2 parts of line
	Boom hoisting		14 parts of line
	Jib hoisting		8 parts of line
Counterweight	Upper + central + lower		25t (8.1t + 8.0t + 8.9t)
Working weight	With 42m boom + 31m jib		Approx. 73t
Average grounding pressure	With 42m boom + 31m jib		0.89kgf/cm^2

5. WORKING RANGE DIAGRAM

5-1 Luffing jib crane boom lifting (without tower jib)

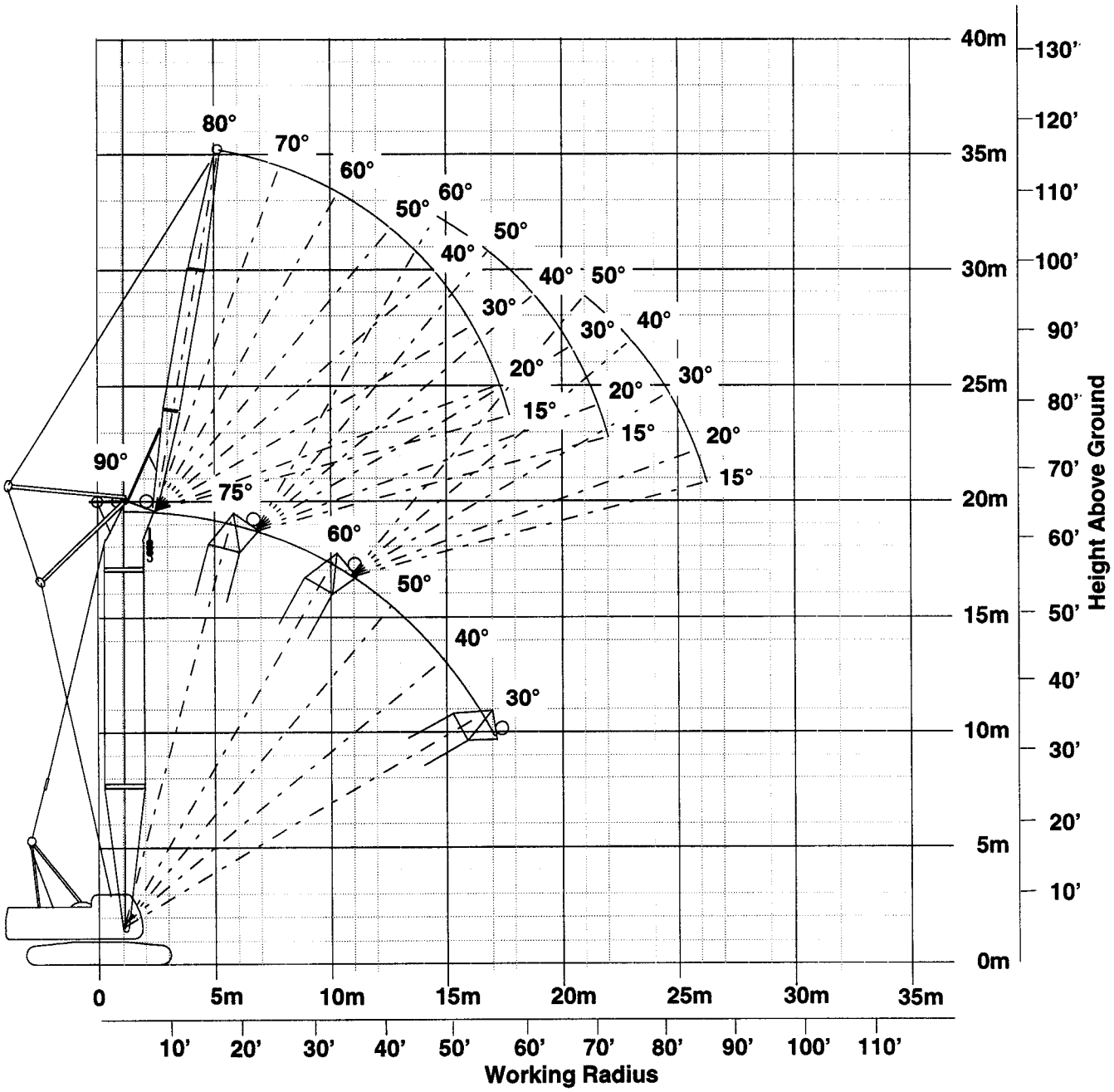
1. The curve is the locus of the tower jib mounting section (jib foot)
2. The center of top sheave is 500m above the curve.
3. The minimum hook clearance is 2.8m.



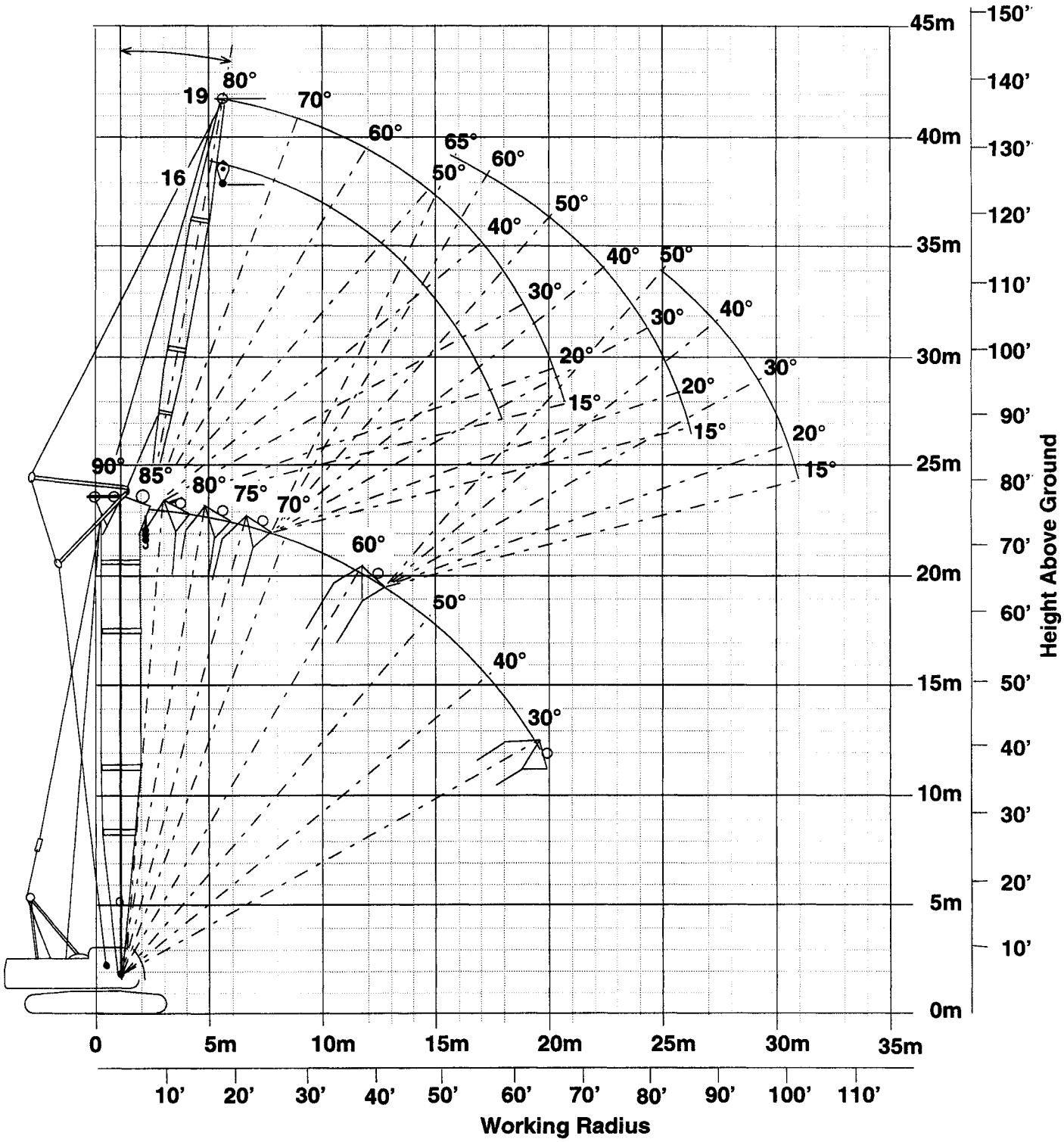
5-2 Luffing jib crane/luffing tower crane boom lifting and jib lifting

1. This is the working range diagram for every boom length and every jib.
2. The numeral beside the jib point is the length (m) of mountable tower jib.
3. This diagram shows the three kinds of the jib working range in the boom hoisting range.

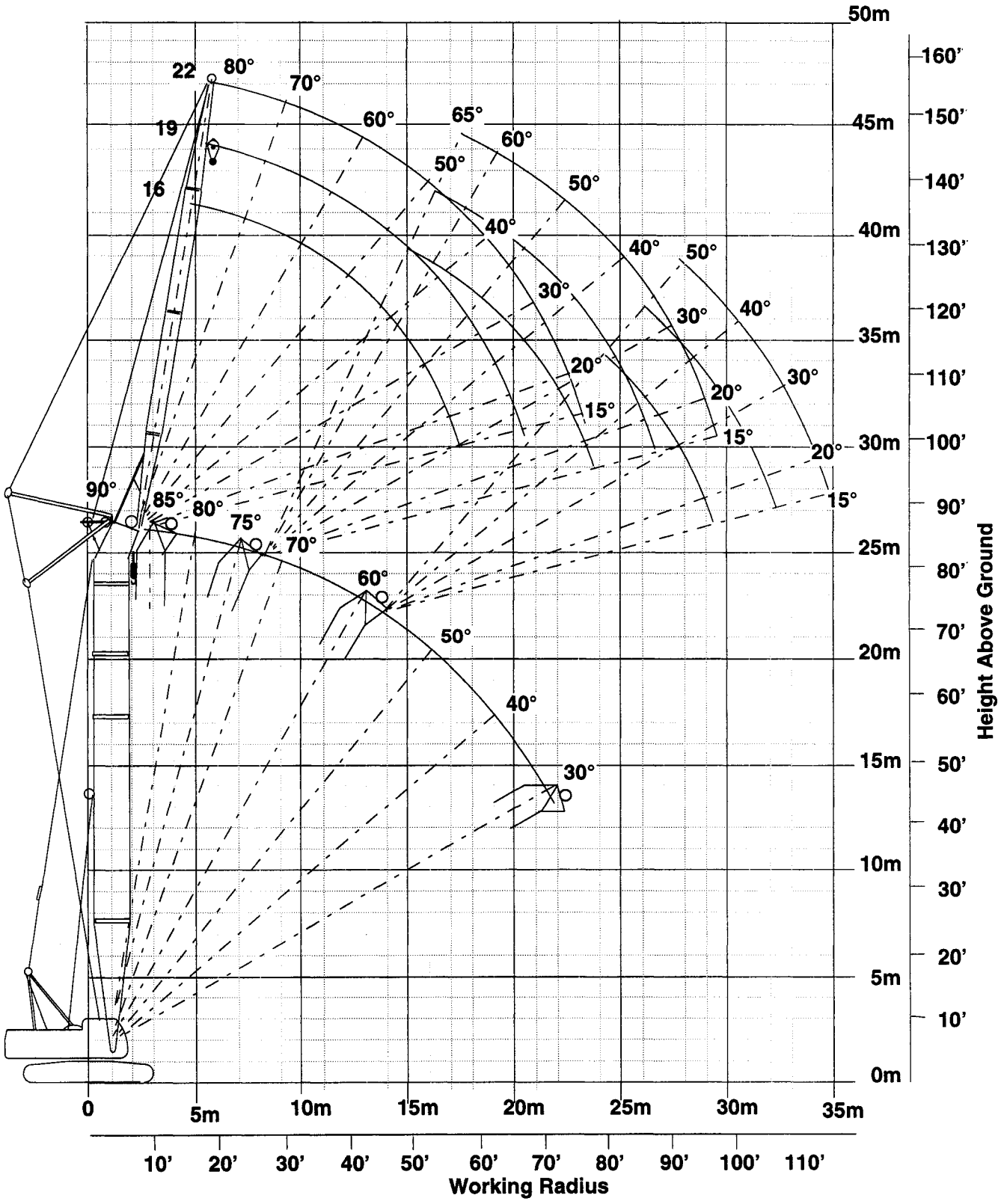
18m boom (mountable on up to 16m jib)



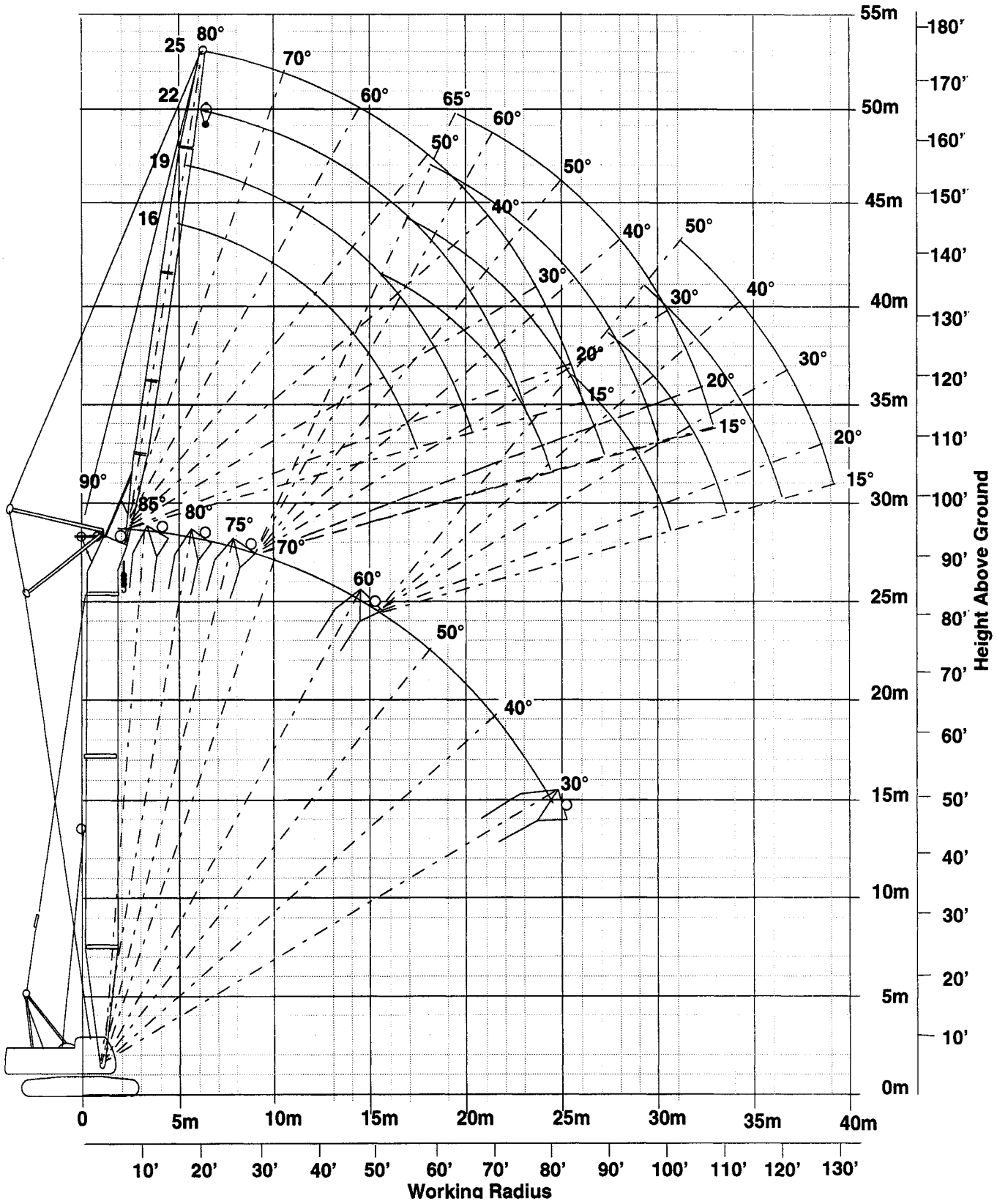
21m boom (mountable on up to 19m jib)



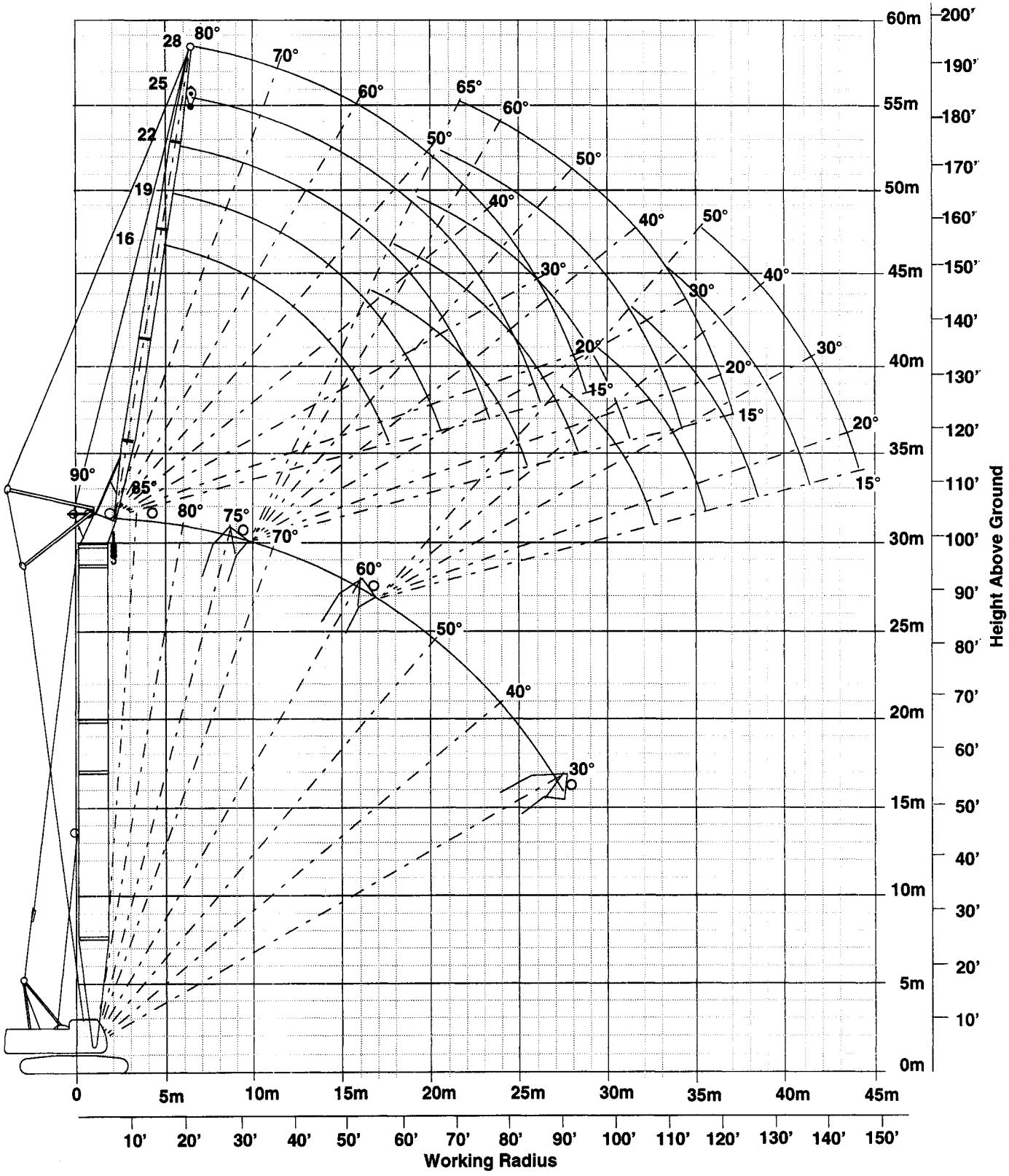
24m boom (mountable on up to 22m jib)



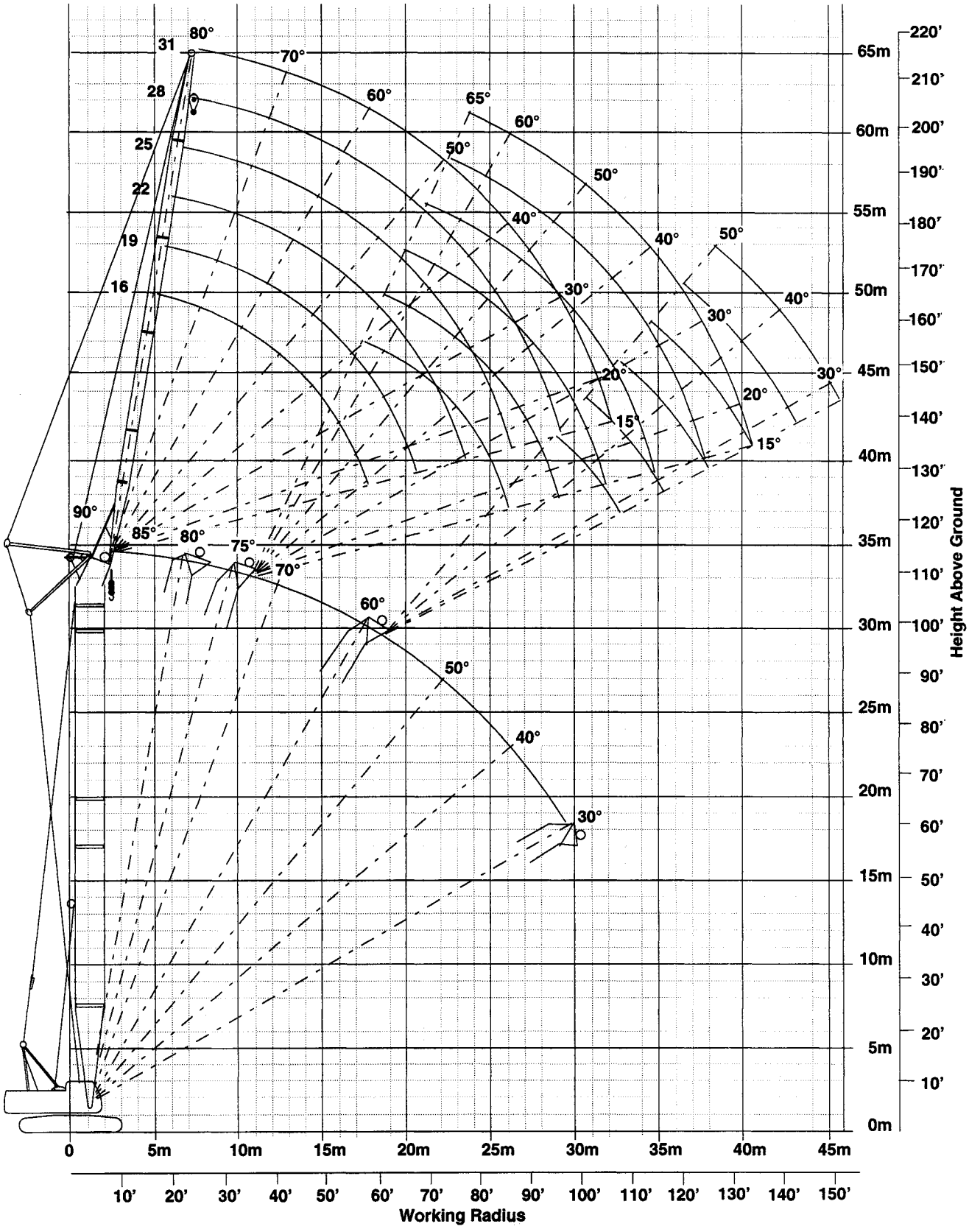
27m boom (mountable on up to 25m jib)



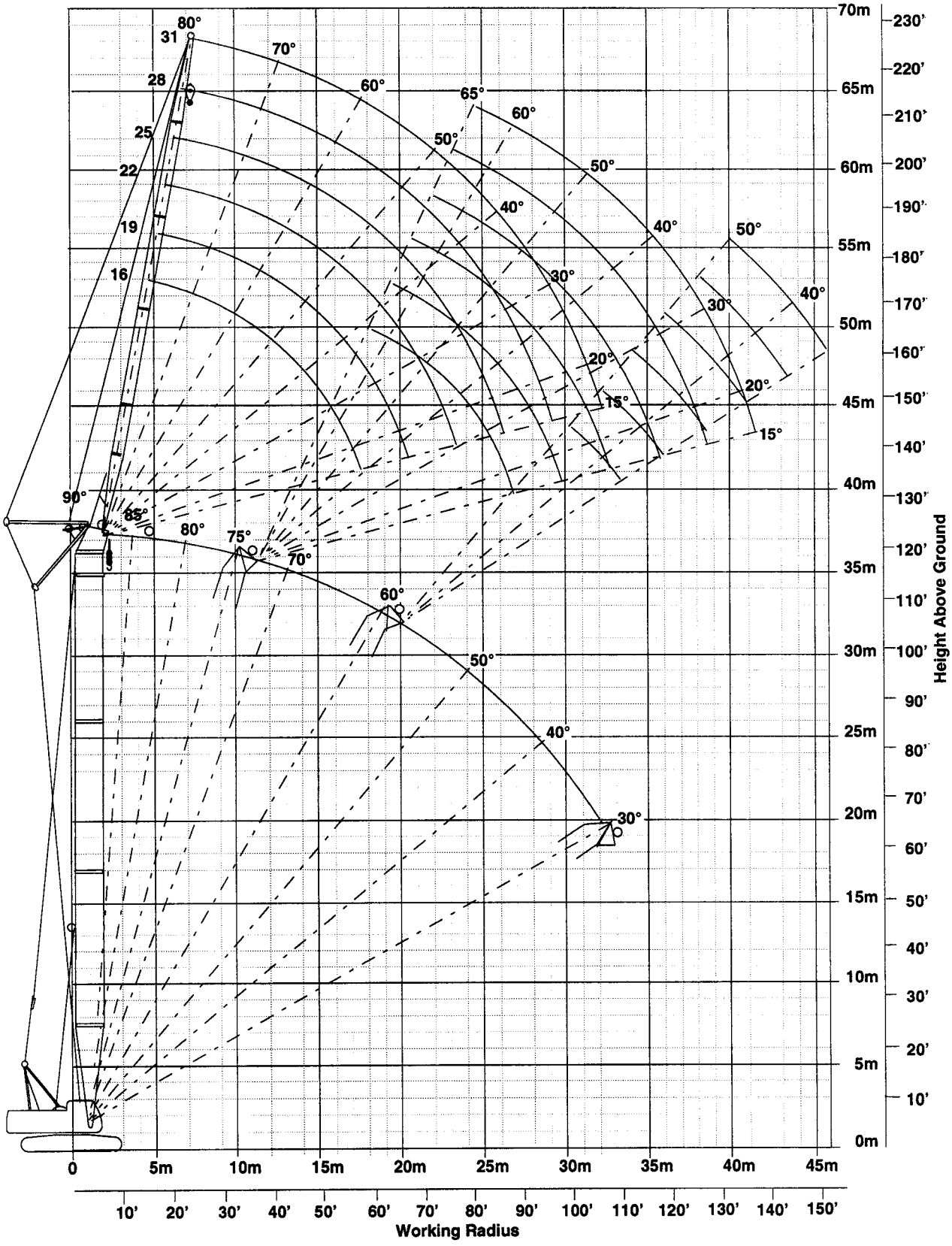
30m boom (mountable on up to 28m jib)



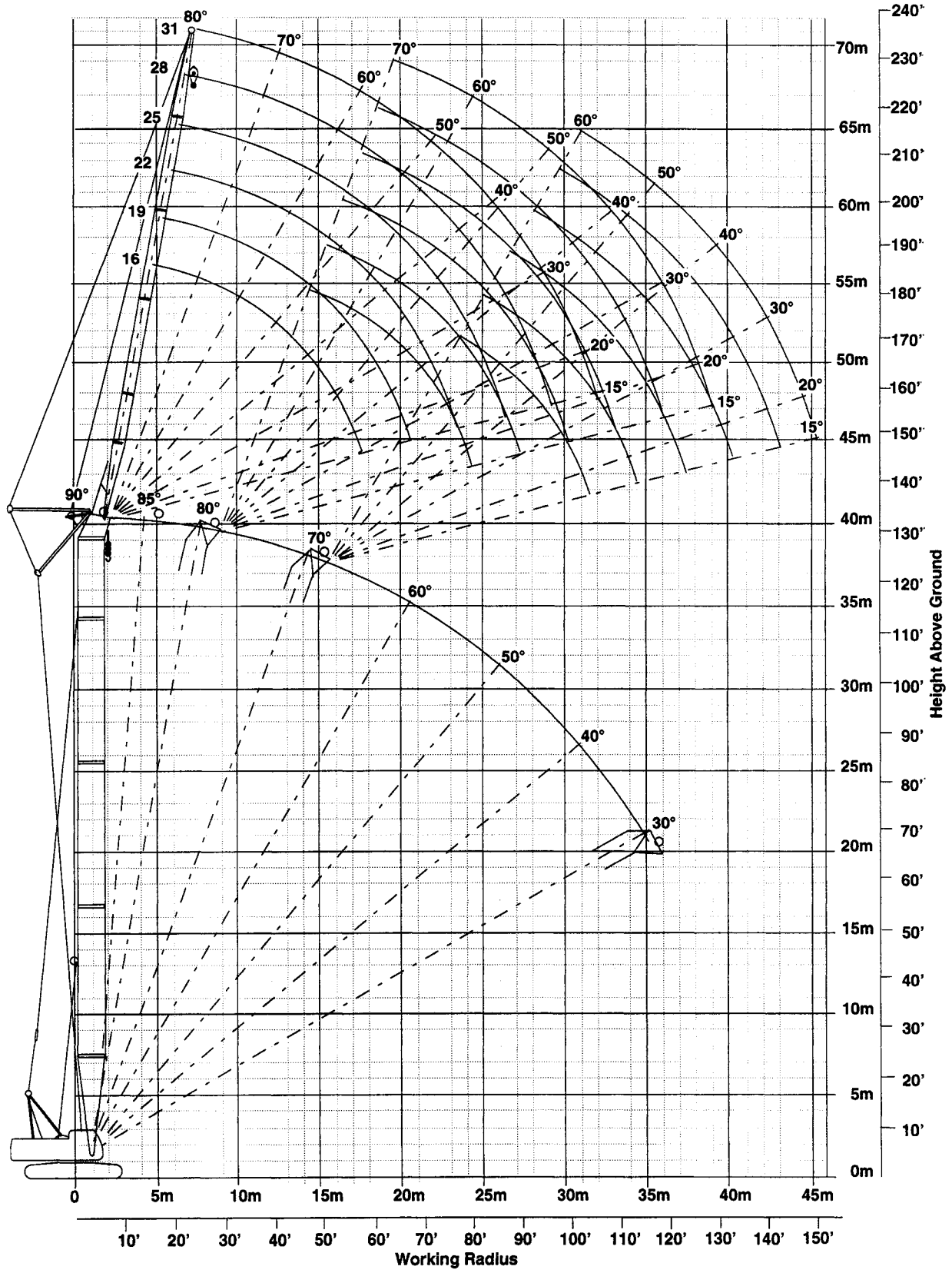
33m boom (mountable on up to 31m jib)



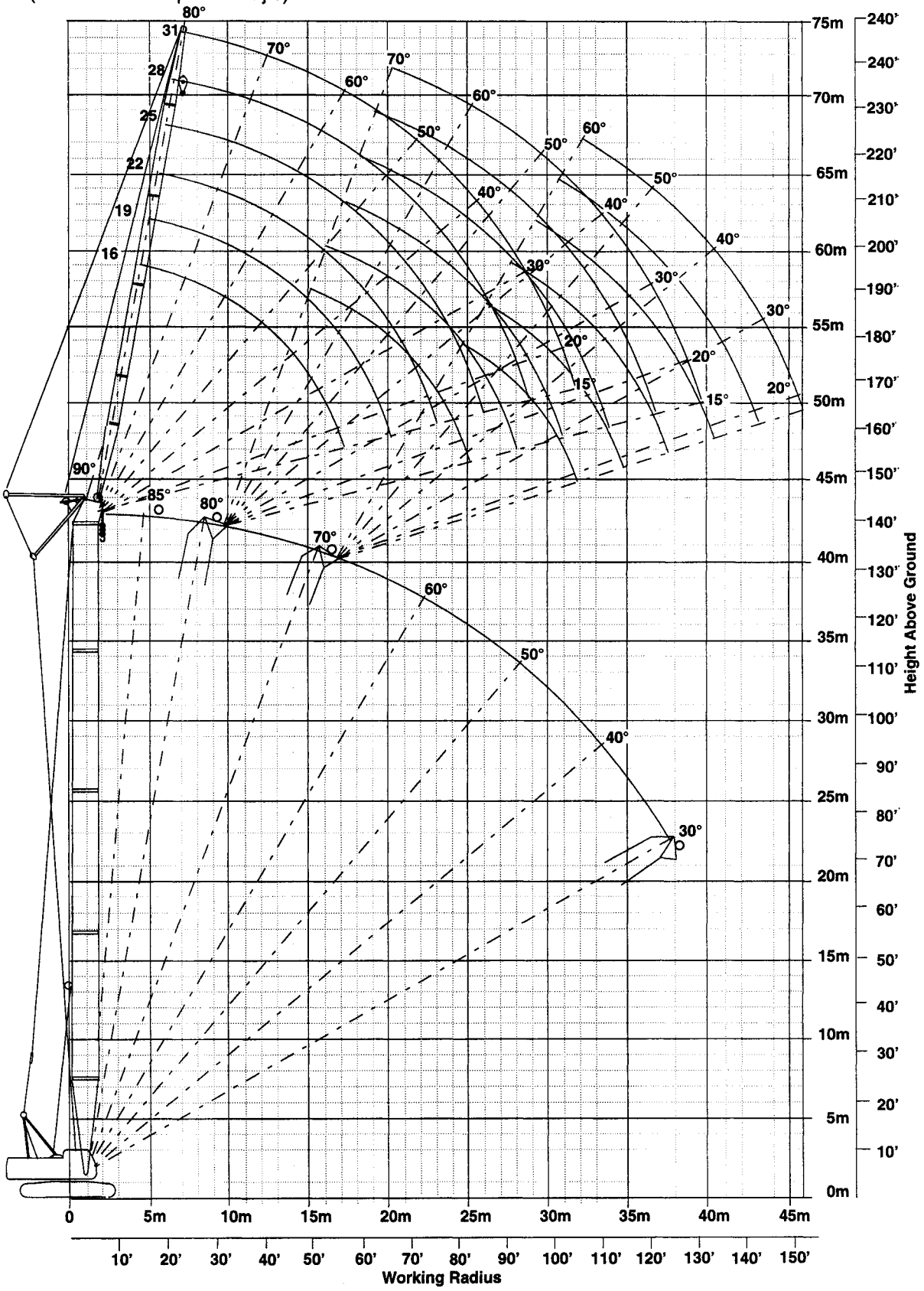
36m boom (mountable on up to 31m jib)



39m boom (mountable on up to 31m jib)



42m boom (mountable on up to 31m jib)



WORKING RANGE DIAGRAM - 46HI BOOM