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CHAPTER 1
GENERAL PROVISIONS

1.1. OBJECTIVE

The objective of this Code is to provide practical guidance on the safe use of tower crane on administrative, technical and training aspects to ensure:

1.1.1. Prevention of accidents arising from the improper operation, erection, installation, dismantling, telescoping, transport and maintenance of tower cranes;

1.1.2. Appropriate implementation and use of this Code.

1.2. APPLICATION

This Code applies to individuals involved in the erection/installation, inspection, operation, maintenance, repair, dismantling, telescoping, alteration, mobilization and transport of tower cranes consisting of mechanical design, electrical and civil engineering works.

1.3. DEFINITIONS

For the purposes of this Code, the following words and phrases are defined as:

1.3.1. Code - Refers to the “Code of Practice for Tower Crane Safety”;

1.3.2. Center of Rotation - The vertical axis about which the crane slews or rotates;

1.3.3. Climbing Crane - A tower crane installed and supported in the building or structure within which it stands, and which can be raised as the number of floor increases;

1.3.4. Competent Person - The person designated, trained and certified by the Department of Labor and Employment to assess the safety condition of the tower crane; to inspect and to recommend all matters related to safe use of tower crane;

1.3.5. Counter-jib - A secondary jib which carries the counter-weight or a counterbalancing device;

1.3.6. Counterweight - Weights added to the crane in such a position to provide a counterbalancing effect;

1.3.7. Erection Crew – A group of persons trained and designated by the employer to perform the erection/installation, dismantling and transport of tower crane;

1.3.8. Fixed-luffing jib - Mounted on pivots at the jib foot but unlike the luffing jibs, these are held by jib pendants at a fixed angle of inclination;

1.3.9. Freestanding Height - The maximum height at which a tower crane can operate without being held by ties;

1.3.10. Hoisting - The movement of the hoist block in the vertical direction;
1.3.11. Interference - A condition in which the jib can come into contact with another structure, crane or the hoisting ropes of another crane or any other obstacles;

1.3.12. Interference Zone - The area where interference can occur;

1.3.13. Jib - The main structure from where the load is suspended;

1.3.14. Licensed Engineer - A duly licensed engineer by the Professional Regulation Commission;

1.3.15. Limit Switch - A device that stops a particular crane motion at its predetermined extremities or limits of operation;

1.3.16. Load Capacity Chart - The chart that shows the crane’s lifting capability for different load radii;

1.3.17. Load Moment Limit Switch - A limit switch that prevents the crane from being loaded beyond its safe working load at a particular radius;

1.3.18. Load Radius - The distance between the center of the load to the center of the rotation;

1.3.19. Luffing Jib - Pivoted at the jib foot and supported by luffing cables much like the main jib on a mobile crane. The hoist rope, which supports the load usually passes over a sheave at the jib head, and the hook radius is altered by changing the angle of inclination of the jib;

1.3.20. Maintenance-in-charge – The person designated, trained and authorized by the employer to conduct the preventive and corrective maintenance of tower crane;

1.3.21. Public Area - The place where the public has unlimited access;

1.3.22. Radius Indicator - A device that shows the load radius;

1.3.23. Rigger - A person whose duty is to estimate, secure load and give appropriate signals for the purpose of safe load lifting;

1.3.24. Safe Working Load - The maximum load which can be safely handled by a crane under conditions as specified by the manufacturer or the competent person;

1.3.25. Service Conditions - In-service, with the crane handling loads up to the safe working load in allowable conditions; Out-of-service, with the crane not required for use or out of use due to unallowable conditions;

1.3.26. Slew - The rotary motion of a crane jib about the center of rotation;

1.3.27. Standards - The Occupational Safety & Health Standards (OSHS) of the Department of Labor and Employment (DOLE) of the Philippines;

1.3.28. Static Crane - A tower crane that is free standing or anchored to a building;

1.3.29. Mast - The part of the tower crane which provides elevation and support for the jib mounting;

1.3.30. Traveling - A movement of the crane along the rail track;

1.3.31. Trolleying - A movement of the trolley along the jib to vary the distance between the hook to the center of rotation.
CHAPTER 2
DUTIES AND RESPONSIBILITIES

2.1. DUTIES OF COMPETENT PERSON

The competent person should:
2.1.1. Be responsible to assess the safety condition of the tower crane;
2.1.2. Ensure the practical application of this Code;
2.1.3. Carry out inspection of tower crane.

2.2. DUTIES OF AN EMPLOYER

The employer should:
2.2.1. Provide operations manual of the tower crane;
2.2.2. Ensure that all employees who are involved in the installation, erection, operation and maintenance are well-trained in safety procedures;
2.2.3. Establish safety inspection program;
2.2.4. Assign only certified and competent tower crane operator;
2.2.5. Ensure that operators and other workers involved in the operation of tower crane are made aware of Standards, Code of Practices, instructions and procedures relating to prevention of accidents and injuries;
2.2.6. Provide supervision to ensure that workers perform their work with due regard to their safety;
2.2.7. Take immediate actions to stop the operation of tower crane when there are dangers to the safety of the operators and/or other workers involved in its operation;
2.2.8. Provide appropriate first-aid and welfare facilities and personal protective equipment (PPE) to tower crane operator and other employees involved in its operation;
2.2.9. Ensure not only the safety of the operator and other workers but also the safety of the public and properties within the vicinity.

2.3. DUTIES OF TOWER CRANE OPERATOR

The tower crane operator should:
2.3.1. Ensure that he is in good physical and mental condition and not at risk to impair safe operation of tower crane, of particular importance to consider are the following:
2.3.1.1. Physical dexterity;
2.3.1.2. Eyesight (with or without spectacles);
2.3.1.3. Hearing (with or without hearing aid);
2.3.1.4. Any medication which could impair attention, concentration and judgment;
2.3.1.5. Any drugs (tranquilizer, sedative, narcotics, etc.), alcohol and other substances usually abused.
2.3.2. Cooperate as closely as possible with their employer in the application of the prescribed safety and health measures.

2.3.3. Protect their own safety and health and that of other persons who may be affected by their acts or omission at work.

2.3.4. Ensure the proper use and maintenance of personal protective equipment (PPE), protective clothing and facilities placed at their disposal, and never misuse anything provided for their own and the protection of others.

2.3.5. Report to their immediate supervisor and to the workers’ safety representative any risk or situation which they cannot properly handle by themselves.

2.3.6. Except in an emergency, not interfere with, remove, alter or displace any safety device or other appliance furnished for their own and the protection of others, or interfere with any tower crane method or process adopted to avoid accident and injury, unless duly authorized.

2.3.7. Be aware of the limitations of the equipment and any part thereof.

CHAPTER 3
TOWER CRANE SELECTION AND EQUIPMENT REQUIREMENTS

The tower crane’s basic characteristics shall fit the job’s requirements to eliminate possible occurrence of unsafe conditions in the execution of the job.

3.1. CONDITIONS FOR THE SELECTION OF TOWER CRANE

3.1.1 In selection of tower crane over mobile crane, the following conditions shall be considered:

3.1.1.1. Need for a crane in a given location is long-term;
3.1.1.2. Site is constricted or congested;
3.1.1.3. Lift heights are extremes & the reach may be deep;
3.1.1.4. Need for mobility is little but lift frequency is high;
3.1.1.5. Cost of rentals;
3.1.1.6. Load placement is easier by a crane working from within rather than from outside.

3.2. CHARACTERISTICS OF TOWER CRANE

3.2.1. In selecting the most suitable type, size and number of tower crane for a particular application, consideration shall be made not only on factors such as weights, dimensions and lift radii of the heaviest and largest load, but also other characteristics of available cranes such as the following:

3.2.1.1. Type and size of the base for the crane;
3.2.1.2. Maximum free-standing height of the crane;
3.2.1.3. Maximum braced height;
3.2.1.4. Climbing arrangement;
3.2.1.5. Weight of the crane that will have to be supported by the building;
3.2.1.6. Jib length available;
3.2.1.7. Possible necessity of auxiliary guys;
3.2.1.8. Available head room between the maximum height position of the hook and the uppermost work level;
3.2.1.9. Area that has to be covered;
3.2.1.10. Lifting and lowering speeds;
3.2.1.11. Length of rope the hoist drum carries;
3.2.1.12. Number and size of rope needed to do the hoisting;
3.2.1.13. Service availability and cost;
3.2.1.14. Cost of off-site transport, erection, dismantling and charges for climbing the machine;
3.2.1.15. The capacity of crane must be determined and recommended by the competent person.

3.3. RESPONSIBILITY FOR SAFE AND RELIABLE CRANE

3.3.1. Selection of a tower crane for any job should be made only after a thorough examination of all factors involved. Those responsible for selection should ensure that the unit is going to be safe and reliable for as long as it will be used, under all anticipated conditions to which it will be exposed and operated.

3.4. RESPONSIBILITY FOR CRANE SELECTION

3.4.1. The responsibility of crane selection involves not only to get the job done as quickly and economical as possible, but also to eliminate all possibility of hazards to on-site personnel, public and property.

3.5. EQUIPMENT REQUIREMENTS

3.5.1. Any tower crane safety program should ensure that all necessary equipment is on the machine and in order;
3.5.2. The supplier, owner and users of tower crane should be held responsible to the availability of any equipment or instruction relating to safety.

3.6. IDENTIFICATION

3.6.1. Every major structural, electrical and mechanical component (see Annex) of a tower crane should have permanent durable plate bearing the following:
3.6.1.1. Manufacturer’s name;
3.6.1.2. Machine model number;
3.6.1.3. Serial number;
3.6.1.4. Year manufactured;  
3.6.1.5. Weight of the unit.  

3.6.2. Identification numbers should be clearly marked on all basic removable components and attachments of the tower crane to show that they belong to a specific machine.  

3.7. LOAD RATING  

3.7.1. Every tower crane should be equipped with a substantial and durable load chart, with clearly legible letters and figures and having the following information:  
3.7.1.1. Crane model number;  
3.7.1.2. Serial number;  
3.7.1.3. Date of manufacture;  
3.7.1.4. A full and complete range of the manufacturer’s approved crane load ratings of all stated operating radii (or jib angles) for each recommended counterweight, jib length, tower height or other installation conditions;  
3.7.1.5. Lifting speed instructions;  
3.7.1.6. Recommended parts of hoist reeving, size and type of rope for various crane loads;  
3.7.1.7. Essential precautionary or warning notes relative to limitations on equipment & operating procedures;  
3.7.1.8. Drum data, available line pull, permissible line pull, line speed and rope spooling capacity;  
3.7.1.9. Wind velocity operating limits.  

3.7.2. Load chart should be securely attached to the cab in a location easily visible to the operator while seated at his control station.  

3.7.3. When crane is operational from the remote control console, the load chart should be attached to a substantial plate secured to the console.  

3.8. CRANE CABIN  

3.8.1. Every operating cabin intended for attachment to the structure of the crane or placed at a remote location should meet the following requirements:  
3.8.1.1. Be constructed of fire-proof materials.  
3.8.1.2. Be designed and constructed to protect the operator and the control from different weather conditions.  
3.8.1.3. Be of sufficient size to allow operation without inconvenience, particularly with regard to roof height and floor space.  
3.8.1.4. Be provided with roof of adequate strength to protect the operator from falling objects and weather conditions.  
3.8.1.5. Be securely attached to whatever structure it is located on.
3.8.1.6. Be designed and constructed to provide the operator with a clear and unrestricted view of the load and jib point in all normal working positions, visibility to either side and as clear a view of the job site as possible.

3.8.1.7. Have windows constructed of safety glass or equivalent and designed to provide ventilation as needed. The front window should have a section which can be removed or held open if desired.

3.8.1.8. Fitted with a lock to prevent unauthorized entry when the unit is left unattended, unless the control unit can be separately locked. The cab doors should be restrained from opening and closing accidentally whenever the crane is in use.

3.8.1.9. Have safe access route to and from the cab. The means of access to the cabin should ensure that there is no danger of the operator being trapped in the cabin.

3.8.1.10. Where access is through the floor, there should be sufficient room in the cabin for the operator to stand beside the trap and raise it without difficulty.

3.8.1.11. If the vertical position of the control cabin is adjustable, the means of access and exit should be effective at all levels.

3.8.1.12. Have lighting in the cabin adequate to enable the operator to see clearly enough to perform his work.

3.8.1.13. Be provided with an operator’s seat that is fully adjustable.

3.8.1.14. Have all working surfaces to and from the cab be of the anti-skid type.

3.8.1.15. Have guardrails on all outside and access platforms. If they are too narrow for guardrails, handholds, steps, or safety line should be provided at convenient points above the platform.

3.8.1.16. Have the following accessories:
   3.8.1.16.1. Windshield wiper
   3.8.1.16.2. A CO2 or dry-chemical fire extinguisher
   3.8.1.16.3. A warning device to be sounded while slewing and traversing

3.9. WIND VANING

3.9.1. The main jib of the tower crane should be able to turn freely with the wind and align itself to the direction of the wind.

3.10. OPERATING CONTROLS

3.10.1. All controls being used during the normal operating cycle should be located within easy reach of the operator.

3.10.2. All controls should automatically return to neutral when released.

3.10.3. The controls should be arranged so that accidental displacement is prevented.
3.10.4. The voltage used in the controls should be between 25 - 50 volts.
3.10.5. The main power switch should be lockable and located within easy reach of the operator.
3.10.6. Each control should be clearly marked to indicate its function.
3.10.7. All controls should be installed to move in the direction of the resultant load movement or machine movement.

3.11. ELECTRICAL EQUIPMENT AND WIRINGS

3.11.1. All components connected electrically to a crane’s structure should be grounded.
3.11.2. All electrical equipment and wiring should be installed in accordance with the provisions of the Philippine Electrical Code.
3.11.3. Strain-relief connectors should be used in power cable connections.
3.11.4. All electrical equipment and connectors should be of weatherproof type.
3.11.5. Power feeders for the crane, which run inside the crane tower should be securely fastened at regular intervals and correctly grounded.

3.12. GEAR BOXES

3.12.1. Gear boxes should be designed so that gears will be automatically lubricated.
3.12.2. All gear boxes should be rigidly constructed and fitted with inspection covers.
3.12.3. Gear boxes should be oil tight.
3.12.4. The gears should be readily movable.

3.13. DRUM ASSEMBLIES

3.13.1. Ensure all drum assemblies are provided with the following:

- 3.13.1.1. Adequate power and operational characteristics to perform all hoisting, holding and lowering functions;
- 3.13.1.2. Suitable clutching or power-engaging devices to facilitate immediate starting and stopping of the drum motion;
- 3.13.1.3. Fail-safe brakes that are capable of supporting all rated loads and operate automatically should power fail;
- 3.13.1.4. Brakes and clutches with adjustments to compensate for wear, and maintain adequate force in springs when used;
- 3.13.1.5. All derricking mechanisms should be provided with positive locking device;
- 3.13.1.6. Drums of sufficient rope capacity, with recommended rope size and reeving to perform all raising and lowering
functions under recommended and actual service conditions;
3.13.1.7. Adequate means to ensure even spooling of the rope on the drum;
3.13.1.8. At least three (3) full wraps of rope remaining in the drum in all service conditions;
3.13.1.9. Drum end of the rope anchored by a clamp securely attached to the drum;
3.13.1.10. Drums with runs and flange guards of sufficient size to prevent the rope from jumping off the drum;
3.13.1.11. Grooved drums with correct groove pitch and depth for the diameter of the rope;
3.13.1.12. Flanges on grooved drums projecting either twice the rope diameter or 50 mm (2 inches) beyond the last layer of the rope, whichever of the two (2) is greater;
3.13.1.13. Drum rotation indicators located to afford easy sensing by the operator;

3.14. STOPPING MECHANISM (BRAKES)

3.14.1. Every brake on the tower crane should be fail-safe with the brake being automatically applied whenever there is power failure.
3.14.2. The brakes applied should not release until the power has been restored and only when deliberately released.
3.14.3. The restraining torque of the brake should be at least 25% greater than the maximum torque applied to the drum under service conditions, ignoring any effects caused by friction.
3.14.4. Where electro-mechanical brakes are used:
3.14.4.1. They should be designed to apply a braking torque as soon as the current is cut off;
3.14.4.2. Arrangement should be made to prevent the brake magnet from being energized by secondary current when the main supply is interrupted;
3.14.4.3. The brakes should not be released until the driving unit is energized and capable of transmitting torque to the drum.
3.14.5. All load holding brakes and clutches should have sufficient size and thermal capacity to control all rated loads with minimum recommended reeving.
3.14.6. Foot brake pedal should be roughened or covered with high friction materials so the operator’s foot will not easily slip off.
3.14.7. The springs that apply the brakes should be of the compression type, and should be stressed in excess of 50% of the torsional elastic limit of the material.
3.14.8. The wearing surface of all brake drums should be machined and smooth and free from defects.
3.14.9. The counterweights must be fixed securely to their levers.
3.14.10. The brake blocks and lining should be protected from rain, grease and oil.
3.14.11. All brakes should be provided with simple and easily accessible devices for easy detection of the wear of lining, except when the adjustment is automatic and not required during the life of the lining.
3.14.12. The brake on the slewing drive should be capable of preventing the jib of the crane from drifting, under wind pressure up to the maximum operating wind pressure specified by the manufacturer.
3.14.13. On rail-mounted cranes, each carriage drive should be equipped with hydraulic or magnetic brake of sufficient size, to stop the crane within a distance equivalent to 10% of the traveling speed of the crane.

3.15. LIFTING ACCESSORIES

3.15.1. Jib Stops
3.15.1.1. Luffing jib tower cranes, like mobile crane should have a jib stop which effectively prevents the jib from toppling or being pulled backwards over the tower.
3.15.1.2. Jib stop should combine the functions of disengaging the derrickng motor and physically stopping the jib as it reaches a predetermined maximum angle.

3.15.2. Sheaves
3.15.2.1. The sheave groove should be smooth and slightly larger than the rope to prevent the rope from being pinched or jammed in the groove.
3.15.2.2. The sheave groove should be smoothly contoured, free of surface defects and should possess rounded edges to ensure long and efficient rope life.
3.15.2.3. The sheave should be perfectly aligned so that rope and sheave flanges will not be subjected to severe wear and avoid rapid deterioration.
3.15.2.4. The depth of the sheave groove should be at least 1½ times the rope diameter.
3.15.2.5. The tapered side walls of the sheave groove should not make an angle of more than 26° with respect to the center line.
3.15.2.6. The bearings should be either permanently lubricated or equipped with means for lubrication.
3.15.2.7. If the sheaves are carrying ropes that can be momentarily unloaded, as in the case of hoist line, the sheave should be equipped either with cable keepers or with close-fitting guards that prevent the ropes from becoming fouled. The block is lying on the ground with the ropes loose.
3.15.2.8. Sheave flanges must be inspected at regular intervals for any sign of cracks.
3.15.2.9. When replacements on sheave parts become necessary, only equipment supplied or approved by the crane manufacturer should be fitted.

3.15.2.10. The groove surfaces on both sheaves and grooved drums and the complete surface on smooth drums should be perfectly smooth.

3.15.2.11. If imprint of outer wires of previous ropes is evident due to high contact pressure between the rope and drum surface, then the drum should be re-surfaced and contact pressure be reduced by:
   - decreasing the load on the rope; or
   - increasing the drum diameter; or
   - replacing the drum with one made of harder metal

3.15.3. Limit Switches

3.15.3.1. All tower cranes of every configuration should be equipped with built-in safety devices which operate automatically to prevent damage to the machine should the operator make an error.

3.15.3.2. Every tower crane should have the following:
   - A hook height limit switch that causes the hoist drum to stop whenever the load hook reaches a predetermined maximum height position.
   - Luffing jib limit switches that cause the derrick drum to stop whenever the jib is raised to an angle too high or lowered to an angle too low.
   - Trolley limit switches that cause trolley motion to stop whenever the trolley reaches a predetermined maximum out or maximum in position.
   - Overload limit switches that cause the hoist drum to stop whenever the load being lifted exceeded the maximum rated load for any radius or jib angle.
   - Travel limit switches for rail-mounted cranes that apply the carriage brakes whenever the crane nears the end of the track.

3.15.4. Guards and Protective Structures

3.15.4.1. The owner of the tower crane should ensure that all exposed moving parts such as gears, pulleys, belts, chains, shafts, flywheels, etc. which might constitute a hazard under normal operating conditions are guarded or fenced.

3.15.4.2. Every machine guard should allow for routine inspection and maintenance and be capable of supporting without permanent distortion, a man’s weight, unless the guard is located where it is impossible to step on it.

3.15.4.3. All electrical panels, components and wires should be
insulated in areas where the operator or maintenance personnel could accidentally come in contact with them.

3.16. SAFETY FEATURES

3.16.1. All tower cranes should be equipped with the following safety features and devices:

3.16.1.1. A metal receptacle secured permanently to machine for storing tools and lubricating equipment;
3.16.1.2. Adequate lighting for night operation;
3.16.1.3. Fire extinguishers with operating and maintenance personnel familiar with their use and care.
3.16.1.4. Jib angle indicators on all machines having jibs capable of moving on the vertical plane, with clearly visible indi- visible indicator and readable by the operator within 1° at his control station.
3.16.1.5. An effective audible warning signal mounted on the carriage of rail-mounted cranes, with control for the device within easy reach of the operator.
3.16.1.6. Shock-absorbing jib stops and derricking safety shut-offs on all luffing jib cranes.
3.16.1.7. In addition to providing safe means of access to the crane, it is recommended that safety lines with runners for the attachment of safety lanyards be fitted to tower crane jibs, and that safety platforms be attached to the trolleys of saddle jibs to facilitate inspection and maintenance.
3.16.1.8. Trolley radius markers that will accurately inform the operator of the radius of the load hook.
3.16.1.9. A device that will prevent automatic restarting of motors at the resumption of power during power interruption.

3.17. EQUIPMENT MANUALS AND RECORD

3.17.1. Manufacturer’s manuals containing all pertinent data relating to operation and maintenance for the specific model of crane in use should be provided in each machine. The manual should include, but not necessarily limited to the following information:

3.17.1.1. Equipment designation or type;
3.17.1.2. Name of equipment manufacturer;
3.17.1.3. Name of equipment designer, if other than the manufacturer;
3.17.1.4. Equipment model number and serial number;
3.17.1.5. Year of original sale of the manufacturer;
3.17.1.6. Weight of individual structural elements, mechanical components and individual counterweight;
3.17.1.7. A copy of the load chart plus any and all rated combinations and variations in capacity and geometry;
3.17.1.8. Inspection and maintenance procedure including:
- Material specifications on jib and tower elements
- Welding specifications for all structural components
- Bolting and torquing specifications

3.17.1.9 Lifting tackle specifications;
3.17.1.10. Erection procedures;
3.17.1.11. Operating precautions;

3.17.2. If the equipment is not provided with a logbook, then one should be started, maintained and kept on the worksite for the regular or periodic recording of all internal and external inspections, examinations, tests, repairs, maintenance and hours of service related to the machine. All entries should be dated and signed by the operator, repairman and supervisor.

3.17.3. Purchase, lease, or use of any piece of equipment which has been modified, altered, or otherwise subjected to any deviation from the original manufacturer’s specifications should be prohibited, in any way unless there is documented proof that the change is certified safe for operation by a competent authority.

CHAPTER 4
OPERATING PROCEDURES AND PRECAUTIONS

It must be recognized that written rules cannot cover all situations that may arise during the operation of the machine; in cases where no written rule applies the operator should be prepared to use his own judgment.

4.1. SAFETY REQUIREMENTS PRIOR TO OPERATION

4.1.1. Never use or allow the use of any tower crane not in perfect mechanical condition.
4.1.2. Before starting operations, inspect, test or maintain the crane in accordance with the recommendations in the manufacturer’s manual and this Code.
4.1.3. Replace all parts and components showing excessive wear, damage or other defects that might affect safe operation of the crane.
4.1.4. The operator should:
   4.1.4.1. Regularly check all parts subject to wear and report all cases of excessive wear without delay.
   4.1.4.2. Report any abnormal mechanical noises.
   4.1.4.3. Check all brakes and limit switches everyday.
   4.1.4.4. Inspect the main structure, wedges, support collars and shoring daily to make sure there are no apparent faults/hazards.
   4.1.4.5. Lubricate the crane regularly but only when it is at rest.
4.1.4.13. Keep fingers, feet and clothing away from belts, gears and ropes, unless the machine is shut down and no one can re-start it.

4.1.4.14. The operator should read the manufacturer’s manual to have knowledge of preventive maintenance in order to spot a malfunction in the machine before an accident occurs.

4.1.5. Never use or allow the use of any tower crane when weather conditions could cause hazards to personnel, property or the public.

4.1.6. Never operate or allow anyone to operate any tower crane until that person is thoroughly familiar with the machine and its safe operation.

4.1.7. Before putting the crane into operation check that all guards, controls, clutches, brakes, gears and the like are properly set.

4.1.8. If there is a warning sign on the crane or controls, do not turn on the crane or attempt to operate it until the problem is solved and the warning sign has been removed by the person who placed it.

4.1.9. Before operating the controls, blow the horn and make sure that all personnel clear the area.

4.1.10. Never move a rail-mounted crane without first making certain that no one will be endangered. When clear vision of the track area is impossible, assign a signalman and sound the horn before moving the crane.

4.1.11. The operator and the signalman should ensure that no one is within the radius of rotation of any part of the crane or load, unless he is authorized by the person-in-charge of the work to be in the area.

4.1.12. Determine the weight of all loads before slinging them or attempting to lift them. Make ample allowances and determine the available capacity of the equipment being used.

4.1.13. All lifting accessories must be considered part of the load. Calculate the entire load carefully and check it against the rated lifting capacity of the crane.

4.2. SAFETY REQUIREMENTS DURING OPERATION

4.2.1. The operator should:

4.2.1.1. Remain alert to possible malfunctioning of the machine while operating. If the crane malfunctions, shut it down until the problem is corrected.

4.2.1.2. Remain alert to any unusual noises, loss of control or bad response to control of the crane.

4.2.1.3. Make sure all controls work freely and easily with no sticking and binding.

4.2.1.4. Watch for oil leaks, stop and correct them immediately.

4.2.1.5. During load lifting, test the brake before the load clears one meter to assure the ability of the brake to hold the load.
4.2.1.6. If the crane is being operated by more than one operator, be sure to notify the next operator of any defects.

4.2.1.7. If the visibility of the signalmen is impaired by dust, darkness, fog or rain, strict supervision of the crane operation should be exercised.

4.2.1.8. Never allow anyone to climb the tower or get on the jib when it is in motion.

4.2.1.9. Wear all necessary protective equipment such as hard hats, safety glasses, safety shoes and gloves when working on or around tower cranes.

4.2.1.10. Never attempt to adjust, repair or lubricate a moving crane. Always lower the load to the ground, lock or support the hoist block and shut off the master control.

4.2.1.11. The operator should never allow his attention to be diverted from the operation of the crane.

4.2.1.12. Always position the load close to the tower to minimize the slew.

4.2.1.13. The rigger should always use appropriate hand signals (refer to Annex B).

4.3. HANDLING THE LOAD

4.3.1. The following should be ensured before making a lift:

4.3.1.1. The load has been correctly slung and well secured to prevent the movement or dislodgment of any part. All loose objects must be removed from the load and crane.

4.3.1.2. Taglines are used to control the load.

4.3.1.3. The load is free before lifting (not bolted, tied or fastened to the ground or another object) and that all sling legs are taking the load.

4.3.1.4. The jib head or trolley is directly over the load, the load ropes are directly over the center of gravity of the load and the hoist ropes are vertical.

4.3.1.5. The hoist ropes are not twisted around each other.

4.3.1.6. The hook should not be lowered to the ground allowing the hoist rope to become slack.

4.3.1.7. If there has been a slack, check:

4.3.1.7.1. If the rope is properly seated on the driver and in the sheaves.

4.3.1.7.2. The rope spooling on the drum for over winding.

4.3.1.7.3. All non-operating personnel have been warned or told to leave the immediate area before working a lift.

4.3.1.8. Always know the weight of any load that is to be lifted.

4.3.1.9. There should be a competent individual assigned on a full-time basis to be responsible for determining the
weight of the load to be lifted.

4.3.1.10. Operator should not make a lift unless he has first determined the weight of the load.

4.3.1.11. Never use the limit switches as stops. They should never be put out of operation and should be kept well-adjusted.

4.3.1.12. Know the radius of the load especially when utilizing the full capacity of the crane.

4.3.1.13. Avoid impact loading caused by sudden jerking when lifting or lowering. Raise the hoist rope gradually until the slack is eliminated.

4.3.1.14. The controls should not be moved immediately to maximum speed. Tension the hoist rope slowly before actually using maximum speed to avoid possible breakage of the rope.

4.3.1.15. Allowances should be made for wind loading and dynamic forces present in the normal operation of the crane and load, and to ensure that the safe working load is not exceeded during operation.

4.3.1.16. Ensure that the slingers keep their hands away from pinch points when the slack is being lifted.

4.3.1.17. When lifting heavy loads, care should be taken to prevent sudden loading or unloading of the hoist rope. Ease the load, lift a few inches off the ground and hold, to check the brakes.

4.3.1.18. For tower cranes with multi-speed hoist, slew and trolley controls, never operate the control directly from low speed to high speed. Operate it through each of the speed ranges when starting and stopping the movement.

4.3.1.19. Make sure that all personnel stand clear while loads are being lifted and lowered, and while the slings are being drawn from beneath the load.

4.3.1.20. Never carry load over the heads of personnel.

4.3.1.21. If the load does not ride properly, lower it and have it re-adjusted.

4.3.1.22. Never allow anyone to ride on a load that is being lifted.

4.3.1.23. Ensure that the load does not catch on obstructions when lifting and slewing.

4.3.1.24. If a load hangs, for instance a big formwork element hanging on to a concrete wall, do not try to lift the load and never try to slew it free. The overload cut-outs will not react to slewing, but the slewing may be powerful enough to cause a structural failure.

4.3.1.25. Ensure that sudden starts and stops are not made when slewing or rotating the crane:

- Rotational speeds must not swing out the load beyond the radius at which it can not be controlled;
- Rapid slewing of a suspended load causes the load to drift away from the crane, thus increasing the radius and could cause the crane to collapse.

4.3.1.26. The load should always be kept directly below the jib point or trolley.

4.3.1.27. Before slewing a load above the uppermost floor deck, be sure the slew path is clear.

4.3.1.28. Never allow anyone to work under a suspended load unless the load has been adequately supported from the floor, and all conditions have been approved by the supervisor in-charge of the operation.

4.3.1.29. Never use the crane to drag a load sideways. Make vertical lift only.

4.3.1.30. Neither the load nor the jib should ever be lowered to a point wherein less than three (3) full wraps of rope remain on the drum.

4.3.1.31. Do not lift loads with excess slings hanging loose. Never allow any excess cable or sling to be suspended beneath the crane.

4.3.1.32. Watch for jib kickback on luffing crane. Never operate with the jib at a higher angle than reflected on the capacity chart, for a sudden release of the load may throw the jib back over the tower.

4.3.1.33. Do not let the load strike the building.

4.3.1.34. Allow maximum clearance between the hook block and trolley sheaves.

4.3.1.35. The operator must never leave his position at the control while the load is suspended.

4.3.1.36. When loading or unloading a truck, ensure that its driver leaves the cab and always work at the rear of the truck.

4.3.1.37. When loading, the loads must be set on adequate blocking to prevent damage to the slings. They must be safely landed and properly blocked before being unhooked and unslung.

4.4. ELECTRICAL HAZARDS

4.4.1. To reduce the possibility of electrical accidents, the following measures should be taken:

4.4.1.1. Never move any part of the crane or load rope into the “absolute limit of approach” or the area surrounding every live power line unless the power line has been de-energized or properly insulated.

- Philippine Electrical Code provides the absolute limit of approach as shown in the table below:
<table>
<thead>
<tr>
<th>Line Voltage</th>
<th>Absolute Limit of Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>151 to 600</td>
<td>1.00 m.</td>
</tr>
<tr>
<td>2400</td>
<td>1.00 m.</td>
</tr>
<tr>
<td>7200</td>
<td>1.10 m.</td>
</tr>
<tr>
<td>23000</td>
<td>1.15 m.</td>
</tr>
<tr>
<td>34500</td>
<td>1.20 m.</td>
</tr>
<tr>
<td>46000</td>
<td>1.35 m.</td>
</tr>
<tr>
<td>69000</td>
<td>1.50 m.</td>
</tr>
<tr>
<td>115000</td>
<td>1.85 m.</td>
</tr>
<tr>
<td>138000</td>
<td>2.05 m.</td>
</tr>
<tr>
<td>161000</td>
<td>2.25 m.</td>
</tr>
<tr>
<td>230000</td>
<td>2.85 m.</td>
</tr>
</tbody>
</table>

4.4.1.3. Barriers should be installed to remind crane operator/driver of the limit approach.
4.4.1.3. Signaler or banks-man should warn the operator whenever the jib, the load or the hoist rope gets near to the limit of approach.
4.4.1.4. If practical, remove all power lines that are under the slew areas of the crane.
4.4.1.5. If it is impossible to move power lines, then have the local power company insulate or disable them.
4.4.1.6. The operator must pay attention to the signalman’s hand signals and warnings when working near power lines.
4.4.1.7. Slow down the operating cycle of the crane by reducing hoist, trolley and slew speeds when near power lines.
4.4.1.8 If a load has to be moved near overhead power lines, issue strict warnings to all ground personnel to stand clear of the load at all times.
4.4.1.9. If a load has to be guided by hand, a special check should be made with the signalman before the slinger touches the load.
4.4.1.10. Use taglines whenever possible. The best tagline is dry polypropylene rope. Manila and nylon ropes retain moisture and can conduct electricity.
4.4.1.11. Do not stockpile, load or unload any material near a power line.
4.4.1.12. Treat all overhead lines as live until you have reliable information otherwise.
4.4.1.13. Use extreme caution when working in proximity to radio transmission towers for the crane’s jib can act like antenna and become electrically charged. In this situation, hook a heavy copper earth strap to the crane (both boom and tower) and run it directly to earth. Never earth it to the building.
4.4.1.14. It is the responsibility of the owner/crane user controlling the crane to:
   - Provide a qualified signalman;
   - Provide adequate and advance notification to the electrical authority for the removal, insulation or
- Isolation and earthing of power lines;
- Ensure that the electrical authorities are fully informed as to when the operations are to begin, when they are due to be completed and when any location changes are planned;
- Report every incident involving contact with a live line to the electrical authority and safety inspector, so that inspections and repairs can be made to prevent damaged live lines from falling;
- Completely inspect the crane for possible damage caused by electrical contact;
- Wire rope should be replaced if it touches a power line since the arc is usually of sufficient power to either weld or badly pit the wires.

4.4.1.15. The electrical cables leading up the tower to the jib can be twisted and damaged, if the crane is slewed more than three (3) or four (4) revolutions in any one direction without reversing to unwind the twist in the cables.

4.5. MORE THAN ONE CRANE OPERATING IN THE SAME AREA

4.5.1. Minimize the probability of collision on cranes or the hoisting ropes or loads fouling each other by observing the following precautions:

4.5.1.1. The crane should be located in such a way that the operators have a clear view of other cranes operating within collision danger areas;

4.5.1.2. The operators should have direct communication with each other so that one operator may alert the other of impending danger;

4.5.1.3. Overall lifting program should be set out and controlled by one man who is in contact with all operators and slingers, and assigns priority of operation for the crane.

4.6. TRAVELING OF RAIL-MOUNTED CRANES

4.6.1. To reduce the possibility of accident due to traveling of rail mounted crane, the operator must evaluate thoroughly the local conditions, determine safe practices and exercise precautions such as the following:

4.6.1.1. The traveling procedures must be in accordance with the manufacturer’s instructions;

4.6.1.2. The slew brake should be set;

4.6.1.3. Never travel with load;

4.6.1.4. Travel limit switch should be installed and always in good condition;

4.6.1.5. Travel speed must be as low as possible;
4.6.1.6. Sudden starts and stops should be avoided;
4.6.1.7. Do not carry the jib at its highest angle;
4.6.1.8. Do not move the crane until the path of the travel is clear.

4.7. SIGNALING

4.7.1. A competent signalman must be always present if the operator cannot clearly see the hook and load and the path of travel of a rail-mounted crane at all times.
4.7.2. A signaler or signalman should be employed when the crane has to work close to overhead power lines.
4.7.3. Two-way radios should be used for all tower crane signaling operations.
4.7.4. If the operator losses contact with the signalman for any reason, he must stop the movement of the crane until communication is restored.
4.7.5. Two signalmen should be assigned where loads are picked up at one point and lowered at another, such may occur when placing concrete, one signalman to direct the lift and the other to direct the descend.
4.7.6. If it is desired to give instructions to the operator other than those provided for by the established signal system, the operator should be instructed to stop all hoisting motion first.
4.7.7. The signalman must:
4.7.7.1. Position himself so as to obtain a full view of the load at all times;
4.7.7.2. Be fully qualified by experience with the operation;
4.7.7.3. Be able to converse in the same language as the operator;
4.7.7.4. Be responsible for keeping the public and all unauthorized personnel outside the crane’s operating radius;
4.7.7.5. Direct the load so that it never passes over anyone;
4.7.7.6. Be in constant communication with the operator at all times by a two-way radio.

4.8. UNATTENDED MACHINE

4.8.1. The operator must never leave the controls of the crane while any load is suspended.
4.8.2. Before leaving the crane unattended the operator must:
4.8.2.1. Lower all loads;
4.8.2.2. Position the trolley near the tower at minimum radius;
4.8.2.3. Raise the hook to its highest position;
4.8.2.4. For luffing jib cranes, the jib should be brought at 15° position and the hook raised to its highest position;
4.8.2.5. All tower cranes must be allowed to swing freely in the wind. The friction clutches on the slewing gears must be fully opened;
4.8.2.6. Where the in-service condition requires a tower height greater than permissible for out-of-service conditions, the crane must be guyed or anchored to the building. Secure rail-mounted cranes to the tracks by installing rail clamps;

4.8.2.7. Place all controls in the off position;
4.8.2.8. Place the main power switch in the off position and lock the switch box;
4.8.2.9. Lock the control console;
4.8.2.10. Lock the control cab door.

4.9. EMERGENCY SHUTDOWN PROCEDURES

4.9.1. If crane is driven against electric overhead lines:
4.9.1.1. Do not leave the crane;
4.9.1.2. Move the crane out of the risk zone;
4.9.1.3. Do not allow any person to get nearer the crane;
4.9.1.4. If the electric line is not affected, cut the current of the electric line;
4.9.1.5. Do not leave the crane unattended even after being sure that the live wire is disconnected.

4.9.2. In the emergency repair of the crane:
4.9.2.1. Use lock-out/tag-out during emergency and normal repair of the crane;
4.9.2.2. Lock the main control and remove the key;
4.9.2.3. Place a warning sign on the main switch.

4.9.3. In case of leaks on pneumatic installations:
4.9.3.1. Immediately repair damage pneumatic parts before it can cause injuries and accidents;
4.9.3.2. Remove the pressure from the system sections and open the pipes (hydraulic and compressed air) according to manufacturer’s guidelines;
4.9.3.3. Place and fit correctly the hydraulic and compressed air pipes;
4.9.3.4. Do not invert the connections;
4.9.3.5. Fitting length and quality must correspond to specifications;
4.9.3.6. Work on hydraulic installations are carried out by persons having specific knowledge and experience with hydraulics.

4.9.4. If there are forecasted strong wind/typhoon:
4.9.4.1. Suspend the operation of the crane when there is danger due to forecasted strong wind;
4.9.4.2. Before commencing the work, inspect for possible abnormality or damage of every critical part of the crane after a strong wind with velocity of more than 30m/sec.
4.9.4.3. In case of existing damage on the jib, fasten it securely
to minimize further damage.

4.9.5. In case of structural failure:
4.9.5.1. Stop the operation of the crane;
4.9.5.2. Assess the damage on all structural components of the crane;
4.9.5.3. Replace all damaged structural components. Damaged sections or elements must be cut out and replaced in conformity with machine specifications;
4.9.5.4. Inspect and check every critical part of the crane after all damaged structural components have been replaced, before commencing the work;
4.9.5.5. Structural repairs or alterations should be performed by skilled persons with required special training and experiences.

4.9.6. In case of earthquake:
4.9.6.1. Stop operation of the crane;
4.9.6.2. The operator should stay inside the cabin and disconnect all energy sources;
4.9.6.3. Protect the head of operator with a helmet or similar device;

CHAPTER 5
ERECITON/INSTALLATION, CLIMBING, TELESCOPING, DISMANTLING AND TRANSPORT

5.1. ERECTION/INSTALLATION

5.1.1. Erection/installation of a tower crane should be well planned and carried out strictly in accordance with either the manufacturer’s manual or the competent person’s instructions.

5.1.2. The project engineer, site superintendent, foreman, building owner, architect, consultant or whoever is responsible for the use of crane should be also responsible for its safe operation under his control.

5.1.3. An engineering consultant should be retained to prepare and/or approve all foundation, shoring and installation drawings, as well as the planning of all phases of erection and use of the crane.

5.1.4. Every effort should be made to ensure complete safety of the public, property and all personnel upon arrival of the crane at the site until the time it leaves.

5.1.5. The following safety pointers should be given serious consideration:
5.1.5.1. A site drawing should be prepared showing exactly where the crane will be located and its operating and maximum slew radii, shoring locations, ground elevation, buried pipes, main power lines, other cranes, hoists, structures, buildings and other pertinent site features;
5.1.5.2. The crane must be located so that there is at least 3 m (10 ft.) clearance between the end of the jib and the nearest obstacle;
5.1.5.3 Rail-mounted, statically-mounted or mounted on temporary base cranes should never be located close to shoring structures, excavations, slopes, trenches, backfilled or uncompacted materials. Similarly, the base should not be over or close to cellars, buried pipes and main power lines;

5.1.5.4 The crane’s proposed location should be based on it’s proximity to other cranes, particularly when their working areas might overlap;

5.1.5.5 The crane should be located in such a way that it is not required to work over areas to which the public has access. If this is unavoidable, a signalman and warning signs should be posted to draw attention to the operation of the crane in the area and control access to the area when necessary;

5.1.5.6 If there are any power or telephone lines within the radius of rotation of the crane, the crane must be located so that there will be clearance from the extreme outer point of the radius.

5.1.6. An erection area for the extensive use of the crew must be provided to;
5.1.6.1. Permit the components to be stacked and handled, and the crane to be erected without interfering with or placing at risk the other site personnel;
5.1.6.2. Allow the movements of the mobile crane that will be used to erect the tower crane;
5.1.6.3. Permit good access for the trucks delivering the crane components.

5.1.7. Soil stability and bearing capacity must be taken into consideration whenever the unit is rail-mounted, ground supported or mounted on a temporary base.

5.1.8. Consideration must be given to the structural stability and bearing capacity whenever the unit is supported on or by any structure:
5.1.8.1. If the structure supporting the crane is concrete, ensure that the concrete has sufficient strength to support the crane before it is installed or climbed to a new position.
5.1.8.2. The ground foundation or structure, intended to support the crane, should be sufficiently strong and stable to carry the load without any sinkage or deflection.
5.1.8.3. If the crane is to be set up in areas having high water table or areas subject to flooding, the crane may be required to have deep foundations or special ground consolidation.
5.1.8.4. If it is necessary for the crane to be first erected on a temporary base and then transferred to the building, the guidelines must specify the following:
   - The concrete cure strength before having the
crane loads imposed upon them;
- The total height of the crane;
- The distance between supports in relation to the tower height projecting above the top support;
- The clearance between the tower and the floor openings accounting for climbing frames and any protruding reinforcement;
- The correct tower orientation, climbing equipment position and attachment;
- That the crane must be securely held by the climbing frames before the bolts attaching it to the base are released and that all wedges must be securely locked to prevent them from working loose and falling out during operation;
- The supporting beams should be securely anchored to the floor to provide lateral restraint. The number and size of the beams and bolts must be determined to suit each installation.

5.1.8.5. The steps of each climbing ladder must be at exactly the same level for both panels to engage the ladder steps during climbing.

5.1.8.6. The maximum floor loading at the edge of the hole for the tower should be allowable without shoring.

5.1.8.7. The kind and extent of shoring required should support the intended loads.

5.1.8.8. In securing the crane when it has reached its upper climb position, it is good practice to wedge on alternate floors and never at more than two levels. Usually, there are eight (8) wedges per floor.

5.1.9. If the crane is free-standing, the installation instructions must specify the following:

5.1.9.1. The maximum free-standing height, and if exceeded, the designs must be provided for ties and tie frames, guys or other suitable anchorages;

5.1.9.2. Procedures for balancing the crane before any ties are attached;

5.1.9.3. The position of tie frames relative to tower joints and where ties occur between tower joints;

5.1.9.4. Procedure for wedging the tower within the tie frame and that the wedges be locked in position;

5.1.9.5. The erection drawings and instructions must specify the following:

- The crane should be erected only during favorable weather conditions and never when wind velocity is more than the manufacturer’s specifications;
- The weights for ballast and counterweight should be in accordance with the crane manufacturer’s
instructions, and ensured or established by actual weighing clearly marked on them;
- If concrete weights are used, they must be of the correct mix;
- The correct torque for all structural bolts;
- The weights of all sub-assemblies that will be lifted into place by the mobile crane;
- The correct method of testing the erected crane.

5.1.10. The person supervising the erection must ensure the following:

5.1.10.1. The foundation or base is in accordance with the approved design drawings, is absolutely level and that the anchor bolts are correctly located;

5.1.10.2. All components are clearly marked for correct identification during assembly, and that only the correct structural sections and components for the particular crane are used;

5.1.10.3. The main structural components of the crane are inspected and any damaged or defects found are repaired in accordance with the manufacturer’s specifications and instructions;

5.1.10.4. The electrical, mechanical and hydraulic components are inspected in accordance with the manufacturer’s specifications and instructions;

5.1.10.5. All tower nuts, bolts and pins are undamaged and checked for correct size and grade;

5.1.10.6. All lifting tackle and auxiliary equipment are in good conditions and capable of safe handling of all anticipated loads;

5.1.10.7. Ensure that the trolley is correctly installed and that all sheaves are in good working order and well lubricated;

5.1.10.8. All tower crane components should be properly slung and handled to protect them from any damage;

5.1.10.9. The manufacturer’s manual for the crane being erected should be available on-site for use by the personnel who should be familiar with the erection procedures;

5.1.10.10. There is summary of assembly and dismantling procedures in form of a checklist;

5.1.10.11. Any departure from the manufacturer’s standards on substitution of parts or materials is allowed only if the details have been discussed with and approved by the manufacturer or competent person.

5.2. TOWER ASSEMBLY & ERECTION

5.2.1. The tower can be assembled by either installing each section sequentially on the base and previous section or by laying the sections flat, bolting them together and then erecting the complete tower.
5.2.1.1. If assembled flat, ensure that each section is supported by timber blocking.
5.2.1.2. Regardless of the assembly method used, ensure that each section is correctly orientated to the others and that the ladders are continuous.
5.2.2. During erection, the tower should be supported or guyed depending on its free-standing height.
5.2.3. In applying tension on the guys, ensure that the pull is even on each and that the tower remains perfectly plumb.

5.3. TURNTABLE & MAST ASSEMBLY

5.3.1. Check the backlash between the pinion & ring gears and apply suitable lubricant to the gears and slewing ring while on the ground level.
5.3.2. On the ground level, both fore and aft pendants should be installed and pinned in place.
5.3.3. Ensure that the turnbuckles are half extended.
5.3.4. In installing the mast, ensure that it is correctly orientated with respect to the turntable.

5.4. TURNTABLE & MAST ERECTION

5.4.1. In installing turntable and mast, hoist the turntable and mast assembly to the top of the tower then lower them gently into position ensuring that the connection bolt holes line up.
5.4.2. The assembly should be orientated correctly with respect to the tower and should be torqued into place.

5.5. JIB ASSEMBLY

5.5.1. Ensure that the sections are supported on timber blocking.
5.5.2. Short sections should be located as close to the tower as possible.
5.5.3. While the jibs are on the ground, torque the bolts to 100% of their recommended values.
5.5.4. Ensure that the trolley is correctly installed and that all sheaves are in good working conditions and well lubricated.

5.6. COUNTER JIB ERECTION

5.6.1. Counter jib should be erected/installed when the tower and turntable are already in place.
5.6.2. Counter jib should be installed in the following manner:
5.6.2.1. It must be slung to ensure that it remains level when installed;
5.6.2.2. Fit the jig into the turntable using the correct pins and secure them with cotter pins;
5.6.2.3. Lift up the back of the jib and install the pendants;
5.6.2.4. Lower the jib to hang by the pendants;
5.6.2.5. Adjust the turnbuckles so that the jib end is level breadth wise and tilting up at the right inclination;
5.6.2.6. Check that the pendant pins are in good condition and are retained by cotter pins.

5.7. MAIN JIB ERECTION AND FITTING COUNTERWEIGHTS

5.7.1. The main jib erection and counterweight fitting should be done in the following manner and sequence:
5.7.1.1. Install the counterweight jib;
5.7.1.2. Install manufacturer’s recommended portion of counter weight;
5.7.1.3. Install the main jib;
5.7.1.4. Install the remaining counterweight;
5.7.1.5. For cranes with counterweight trolley,
   - Install the counterweight jib;
   - Install all the counterweights at manufacturer’s recommended radius;
   - Install the jib;
   - Roll the counterweight trolley out to the end.

5.8. ELECTRICAL INSTALLATION

5.8.1. Electrical installations should be under the strict supervision of a competent electrician.
5.8.2. Before being put to use, the cranes electrical installation or part-installation should be inspected to ensure the adequacy of insulation and of earthing arrangements.
5.8.3. Appropriate isolating procedures should be strictly followed whenever any part of the electrical system is live.
5.8.4. The main power supply, including disconnect switches, transformers and other electrical equipment required to supply power to the crane should be provided and installed in accordance with Philippine Electric Code and local power authority regulations.

5.9. WIRE ROPE AND REEVING

5.9.1. The hoist and trolley ropes should be installed in accordance with the crane manufacturer’s instruction

5.10. ERECTION CHECKLIST

5.10.1. A detailed check of the crane should be made by the erection supervisor or competent person after the erection is completed.
5.10.2. Static and dynamic tests should be made to ensure the correct operation of the crane.

5.10.3. The check points should include the following:

5.10.3.1. Electrical -
- Main power supply and circuit breakers are correct;
- Main power cables are well protected and strain relieved every 6m (20 ft);
- Control cables are protected and strain relieved;
- Electrical cables are not damaged and clear of obstructions;
- Electrical panel cover screws are tightened;
- Control console is in acceptable condition and operating satisfactorily;
- Line fuses are of correct sizes and supply voltage are within limits;
- All motors are turning in correct direction;
- Crane is correctly earthed and all connections are secured.

5.10.3.2. Mechanical -
- Hydraulic power-pack is protected from damage and connections are leak-proof;
- Climbing mechanism is complete and functional;
- Slewring ring bearing are adequately lubricated;
- Gear backlash is within tolerance;
- All drive assemblies are acceptable and oil levels correct;
- General lubrication of crane is satisfactory;
- Alignment and condition of trolley drive and limit switch are satisfactory;
- Trolley wheels, frame, sheaves and cable tension are acceptable;
- Trolley track is smooth;
- Oil levels in hydraulic reservoir and gear reducer are correct;
- Ropes and pendants in good condition;
- Hoist drum is running freely;
- Hoist brakes are in good condition and operating;
- Operator’s manual is available on-site;
- There is sufficient rope on all drums (minimum of 3 full turns left on the drum when the hook is at its lowest working position);
- All machine guards are in place;
- All brakes operate automatically when power fails;
- Abnormal vibration noticed when crane operates;
- Load chart at the operator’s station;
- Jib stay ropes have correct tension;
- Counter jib is horizontal sideways;
- Counter weight consists of the correct number of concrete sections and these are positioned and fastened as prescribed;
- All sheaves can rotate freely;
- Trolley rope has correct tension, so that the trolley can tra-
verse with permitted loads without any slipping at the driving pulley;
- All ropes run freely without touching any crane part except the drums or sheaves grooves;
- Gear ring is fastened to the crane mast in the correct manner-
  - Circular form is not deformed;
  - Teeth and roller track have the correct height in relation to the pinion and support rollers;
  - Support rollers are securely fastened;
  - Amount of clearance between the support rollers and the roller track of the gear ring is correct.

5.10.3.3. Structural -
- Crane is correctly wedged in building or guyed;
- Shoring around floor openings is acceptable;
- Tower is plumbed;
- All tower bolts are installed and correctly torqued;
- Tower sections are not damaged;
- Anchor bolts are installed and torqued;
- Turntable are damaged and free of cracks;
- All slewing ring bolts are correctly torqued;
- All mast bolts are torqued;
- Jib and counter jib connections at turntable are correct;
- Pendant turn buckles are locked;
- Jib and counter jib angles are correct;
- Jib and counter jib sections are correctly bolted and torqued
- Counterweights are fastened and correct for the length of jib;
- All pin connections are cotter pinned;
- All component mounting bolts are tight;
- All access ladders are continuous;
- All safety platforms and walkways are in position and secured.

5.10.3.4. Electrical, mechanical and structural checks should be made at least once a month.

5.10.3.5. Functional check should be made after erection under no load conditions to ensure correct operation of all motions, limit switches and brakes.

5.10.3.6. Proof testing should made at its rated capacity by operating through all its motion.
- All tower bolts are installed and correctly torqued;
  - Tower sections are not damaged;
  - Anchor bolts are installed and torqued;
  - Turntable are damaged and free of cracks;
5.11. BOLTING PROCEDURES

5.11.1. Apply correct bolting and torquing procedures in tower crane erection.
5.11.2. All nuts and bolts must be well-lubricated, of correct size and grade and tightened sufficiently to develop a pre-tension greater than the dynamic loads that will be applied to them.
5.11.3. If a good torque wrench is not available, use the “turn-of-the-nut” method of achieving tightness.
5.11.4. Always follow the manufacturer’s recommendations when replacing any structural nut and bolt.
5.11.5. The grades of both nut and bolt should be the same.
5.11.6. The nut should have sufficient size and mechanical properties to withstand the ultimate tensile strength of the bolt.
5.11.7. Coarse threaded nuts and bolts should be used due to its greater resistance to stripping than fine-threaded types.
5.11.8. Coarse threaded nuts require fewer revolution to tighten, have less tendency to cross thread and do not require the careful handling of fine-threaded fasteners.
5.11.9. Hardened steel bearing washers should be free of dirt, loose scale, burrs, chips and be relatively smooth and flat.
5.11.10. In dealing with bolted fasteners, the following points should be observed:
   5.11.10.1. Never re-use nuts or bolts that have been heated with a torch during removal;
   5.11.10.2. Never mix different grades and sizes of nuts and bolts;
   5.11.10.3. Store all nuts and bolts indoors;
   5.11.10.4. Inspect all nuts and bolts for signs of corrosion, wear and damage prior to installation;
   5.11.10.5. Clean and lubricate all nuts and bolts;
   5.11.10.6. Check for bolt protrusion (all threads on the nuts should be engaged by the bolt);
   5.11.10.7. Never re-torque a loose nut and bolt.

5.12. SPECIAL CONSIDERATIONS FOR RAIL-MOUNTED CRANES

5.12.1. The track should be level, stable and of adequate strength.
5.12.2. The design of the foundation of rail-mounted crane should be based on actual soil conditions and the design should be approved by a structural engineer:
   5.12.2.1. If the capacity of the soil under the track cannot be determined on the basis of general site soil conditions, soil tests must be done to determine the actual capacity;
   5.12.2.2. The test should be conducted by either a qualified person or a recognized soil testing agency.
5.12.3. The track bed and track must be laid in accordance with the
manufacturer’s specification for grading, track bed, sleeper-spacing and rail weight.

5.12.4. Never locate the rails any closer than 6m (20 ft) from an unshored trench, excavation of back-filled area.

5.12.5. Consider installing the track on concrete pads and sleepers, if the crane installation is going to be long term:

5.12.5.1. The concrete pads must be -
- Designed as a beam supported by flexible props and supporting two (2) moving concentrated loads;
- Seated on a proper footing;
- Buried to provide lateral stability;
- Provided with cross ties;
- Equipped with a solid wooden girder along with a concrete soleplate so as to give the track flexibility and absorb vibration;

5.12.5.2. If wooden sleepers are to be placed on a ballasted base or foundation then ensure that -
- The rails are placed on girders, which are in turn attached to the sleepers;
- The ballast is either crushed stone or clean sand;
- If the supporting earth contains clay, and the ballast is made up of compact sand which prevents the clay from moving to the surface;
- The ballast extends at least 600 mm (24 in.) beyond the outer edges of the sleepers;
- The sleepers are properly spaced, sound and at least 200 x 250 mm (8” x 10”);
- The sleepers are placed at an intervals of not more than 500 mm (20 in.);
- The spacing of the sleepers decreases near the rail ends and that the track terminals on two (2) sleepers are placed side by side.

5.12.5.3. If wooden sleepers Regardless of the type of base or sleeper used, it is necessary to use rods between the rails.

5.12.5.4. All rail sections must be secured together with plates with at least four (4) bolts.

5.12.5.5. The track which must have tie rods spaced at equal intervals to maintain the correct gauge should be installed over a sleeper.

5.12.5.6. The rail should be flat-buttoned, of cross section area not less than the recommended dimension by the crane manufacturer.

5.12.5.7. The rails must be perfectly level and parallel and their spacing must take into consideration the motion between the rail and wheel flanges.

5.12.5.8. To prevent the crane from over-running the end of
the track, travel limit switches and shock-absorbing mechanical stop must be provided toward each end of the track.

5.12.5.9. The stops should be at a distance not less than one half (1/2) the track width, from the rail end.

5.12.5.10. The height of rail stops should be at least one half (1/2) the diameter of the wheel.

5.12.5.11. In addition to rail stops, all rail-mounted cranes require travel limit switches installed at least 2.5 m (8 ft) away from the rail stops to cut off power from the travel motors and apply the brakes.

5.12.5.12. All rail-mounted cranes should be equipped with wheel guards installed at both ends of each track or bogey.

5.12.5.13. When left out-of-service, the crane should be anchored to a concrete parking base in order to gain an extra margin of stability in high winds.

5.12.5.14. The parking base should consist of four (4) concrete blocks cast under the track:

- Weight and shape should be specified by the manufacturer;
- Location should be such that four (4) corners of the undercarriage are properly anchored to the center of each block.

5.12.5.15. Both rails of the track should be electrically bonded at each joint by means of a copper bar or heavy wire.

5.12.5.16. The tracks should be properly earthed to a terminal provided for by the Philippine Electrical Code.

5.12.5.17. The earthing system should be of low impedance and adequate current capacity to provide protection when faults occur.

5.12.5.18. Before placing the crane on the rails, the erection supervision should give the rail installation a complete and thorough examination.

5.13. CLIMBING

5.13.1. Climbing the crane, regardless of its type, should be a four (4) or five (5) –man operation: one (1) man to run the climbing unit; two (2) men to guide the panels into the climbing ladders; and one (1) or two (2) men to place the supports, wedges and generally observe the motion of the crane.

5.13.2. Before extending the height of the crane, checks should be made to ensure that:

5.13.2.1 The wind velocity does exceed the maximum as specified in the manufacturer’s instructions;

5.13.2.2 The correct amount of counter weight is in position on
the crane;
5.13.2.3 The final height will not be greater than the maximum free-standing height without the ties, or the maximum height above the highest tie, will be as specified by the manufacturer;
5.13.2.4 The jib is correctly oriented to the mast and direction of wind velocity and is locked to prevent uncontrolled slewing;
5.13.2.5 Climbing gear is correctly attached and functioning and the crane is properly balanced;
5.13.2.6 All climbing frames, ladders, locking devices and machinery is correctly installed, adjusted and in good working order;
5.13.2.7 Shoring is erected to the underside of the floors which will support the weights of the crane;
5.13.2.8 The climbing pawls are free and can move easily;
5.13.2.9 The support frame for the climbing ladders is from one floor above the level on which the crane is to be supported after climbing.

5.13.3. Prior to the climbing operation, the wedges or clamps should be released to allow for free upward movement of the tower.
5.13.4. The balancing load should be lifted by the crane and moved into a suitable position along the jib which will assure the correct balance of the crane for climbing.
5.13.5. After the crane has reached its final climb and is resting on its floor support beams, ensure that it is wedged with hardwood wedges between two (2) slabs in all four (4) directions.

5.14. TELESCOPING
5.14.1. In order to avoid risk of accident, the telescoping operations must be carried out according to the manufacturer’s instructions.
5.14.2. During telescoping operations, never slew the jib, move the trolley and operate the hoisting or lowering when the crane part is being lifted.
5.14.3. Never let the telescoping assembly rest on the cylinder.
5.14.4. Carry out telescoping only with a wind velocity not exceeding 60 km/hr.
5.14.5. After each climbing operation, check the perpendicularity of the crane.

5.15. DISMANTLING
5.15.1. The dismantling procedure of a tower crane is usually the reverse of the assembly operation.
5.15.2. The dismantling operation is far more difficult and hazardous due to the height involved and the interference of the structure for which the crane was used.
5.15.3. The dismantling operation should be carried out by a skilled crew under competent supervision and strictly in accordance with the manufacturer’s or agent’s instructions.

5.15.4. The requirements for dismantling and removing the crane must be considered at the outset of the project when selecting the type, size and location of the crane.

5.15.5. The crane is usually removed from the building by either a roof-mounted derrick or by a mobile crane:
   5.15.5.1. When using a derrick crane an engineering study should be made to determine how to anchor the derrick and what shoring requirements are needed to reinforce the roof deck;
   5.15.5.2. When a mobile crane is used, ensure that the ground or foundation support of the crane is adequate.

5.15.6. Check the following whether using a derrick or mobile crane:
   5.15.6.1. If crane sections are to be lowered to the roof deck for dismantling check that the deck can take the extra load;
   5.15.6.2. Know exactly the weight of all components to be lowered;
   5.15.6.3. Never release any of the tower crane’s pins, bolts and pendants until the sections or components are properly slung and balanced, and the total weight is being carried by another crane or the derrick;
   5.15.6.4. Keep the area immediately below all lowering and un-pinning operations completely clear of personnel, through the use of the barricades.

5.15.7. Tower cranes are particularly severed on their slewing rings and ringbolts and cracks have been found in many instances in the welding of the gusset plates in the tower rings. It is strongly recommended that:
   5.15.7.1. The joint between the gear ring in the crane base and the tower top-ring be broken whenever the crane is moved to a new site;
   5.15.7.2. The used bolts be destroyed;
   5.15.7.3. The tower ring be examined for weld cracks and for flatness of the bolting surfaces when dismantled and before each erection.

5.16. TRANSPORTING THE CRANE

5.16.1. In transporting the crane, considerations should be made to avoid damaging the machine. Damage to the crane usually does not show up until later when the crane is making a lift.

5.16.2. When lifting structural sections onto floats, do not attach the slings to the lattice members for they will bend.

5.16.3. The sections should be blocked and if sections are stacked on the float, there should be blocking beneath them.

5.16.4. Do not chain the sections down unless the sections are padded
where the chains are attached.

5.16.5. Never tighten the section with chain binders for they will overtighten the chain causing the main chord to deflect and bend.

CHAPTER 6
INSPECTION, TESTING & MAINTENANCE

6.1. INSPECTION

6.1.1. Regular inspection should be done to ensure the safety and reliability of the tower crane.

6.1.2. All inspection activities should be performed by or under the immediate supervision of competent person.

6.1.3. Inspection should be carried out only by persons who are competent to detect and assess potential hazards that could limit safe performance of the tower crane.

6.1.4. The inspector should have practical and theoretical knowledge of the equipment to enable him to detect not only defects and potential hazards, but also assess the impact of these defects/hazards to the strength and function of the equipment.

6.1.5. The inspection must determine if any observed defect presents possibility of failures, and if the crane will remain in safe condition until the next scheduled inspection, considering the rate of deterioration.

6.1.6. In order that safe inspection be carried out on tower cranes, walkways, ladders and platforms should be provided on the tower, jib and counter jib.

6.1.7. All persons working on the tower crane should be instructed to use safety belts and lanyards to prevent serious injury from fall.

6.1.8. The main power switch must be turned off before inspecting any of the electrical components.

6.1.9. All repairs to the electrical components should be done by or under the supervision of a competent electrician.

6.1.10. An equipment logbook should be kept and maintained throughout the machine’s working lift to record details of all modifications, alterations, repairs, inspections, examinations and maintenance.

6.1.11. Frequency of inspection -

6.1.11.1. Prior to initial use of new and reinstalled tower cranes after major alteration and repair, and every year thereafter;

6.1.11.2. For operational crane, visual inspection should be done by the operator or qualified inspection with the use of checklist recommended by the manufacturer;

6.1.11.3. In the absence of manufacturers manual, inspection should be implemented on daily, weekly and monthly intervals as recommended by the competent person;

6.1.11.4. Visual inspection by a qualified inspector at one to 12 month intervals, or specifically recommended by the manufacturer;
6.1.11.5. The following should be inspected at intervals defined above or specifically indicated (including observation during operation) for any defects that might appear between regular inspection -

- All control mechanisms for maladjustments interfering with proper operation - daily when in use,
- All control mechanisms for excessive wear of components and contamination by lubricants and other foreign matters,
- All crane function operating mechanisms for maladjustments interfering with proper operation and excessive wear of components,
- Load limit devices for proper operation and accuracy of setting,
- All hydraulic and pneumatic hoses particularly those that flex in normal operation,
- Electrical apparatus for malfunctioning, signs of excessive deterioration, dirt and moisture accumulation,
- Crane hooks for deformation or crane hooks with cracks or having more than 15% of normal throat openings or more than 10°,
- Wedges and supports of climbing crane for looseness or dislocation – daily, when in use,
- Braces or guys supporting crane masts (towers) and anchor bolts base connection for looseness or loss of pre-load a) braces and bolts after the first day and the first week of operation and then monthly or b) guys daily until pre-load stabilizes, then weekly until pre-load stability indicates that monthly checking will be adequate,
- Hydraulic system for proper fluid level – daily, when in use.

6.1.12. Ensure that the tower crane is safe by having the following inspections made on a 1-5 day basis:

6.1.12.1. Inspect all wire ropes (including standing ropes), sheaves, drums, rigging equipment and attachments;
6.1.12.2. Check for freedom of rotation of all swivels;
6.1.12.3. Visually inspect the jib and tower for straightness and for any evidence of physical damage, such as cracking, bending or other deformation of the steel elements or welds -

- Watch carefully for cracking or flaking of paint, since this may indicate yielding of the metal which may precede a failure,
- Be especially careful to look for bent lattice when checking the structural section,
Every component must be absolutely straight and free from bent.

6.1.12.4. Ensure that the crane is clean and free from tackle, grease and oil on all walking surface;
6.1.12.5. Check that all exposed moving parts are guarded;
6.1.12.6. Check that all counterweights are secured;
6.1.12.7. Check the adequacy of all shoring and bracing;
6.1.12.8. Check that the tower support beams are secured in the lateral direction and that they are not deformed;
6.1.12.9. Check that the bearing floors are not cracking;
6.1.12.10. Check the climbing unit and the ladders;
6.1.12.11. Check the torques of all tower, jib and base bolts and when tightening the tower bolts, slew the jib so that the counterweight is over the corner being tightened;
6.1.12.12. Check all the slewing ring bolts at least once a week -
   - The rear half circle of bolts must be tightened with no load on the hook when checking the torque of the slewing ring bolts and when re-tightening them;
   - The crane should then be slewed and the adjacent bolts should also be tightened;
   - Do not re-torque the bolts more than once.
6.1.12.13. Check the slewing rings, slewing gears and gusset plates in the tower ring for cracks;
6.1.12.14. Check that all the hardwood tower wedges are secured daily when the crane is working;
6.1.12.15. Check all gearboxes for oil leakage and for tightness of the bolts, a loose gear box will damage bearings and pinions;
6.1.12.16. Check all V-belts for proper tension, change all the belts in the same group, if one belt need to be replaced;
6.1.12.17. Check that electrical cables are free of obstacles and do not twist or bend over sharp edges;
6.1.12.18. Check for cuts and wear and for adequacy of terminals;
6.1.12.19. Check the tension of the screws on the contactors;
6.1.12.20. Check that the over-current relays are set correctly;
6.1.12.21. Check that the supply voltage is within the limits set by the crane manufacturer;
6.1.12.22. Clean the slip rings and check that they are free from burns;
6.1.12.23. Ensure that the power and control cables are tightly connected and strain relieved;
6.1.12.24. Be sure the crane is sufficiently lubricated and the lubricating oil reservoir are filled to their correct levels -
   - Replace the filters whenever the oil is changed and always refill with clean oil if the supply is found to be low and dirty;
   - Use oil that meets recommended specifications;
   - Be sure to check the level plugs in gear boxes.
6.1.12.25. Visually inspect the machine deck for fluid leaks -
- Hydraulic and oil system leaks must be corrected before the crane is operated;
- All hydraulic hoses must be visually inspected and replaced, if found faulty;
- Secure all caps and filler plugs for all systems.

6.1.12.26. Inspect and test all brakes and clutches for correct adjustment and operation -
- Check load breaks by lifting a capacity or near-capacity load a few inches from the ground and hold onto the break;
- There should be no slippage.

6.1.12.27. Check that all brakes and friction linings are free from oil;
6.1.12.28. Check that the backlash between all gears is within tolerance;
6.1.12.29. Check that the securing bolts of all motors are tight;
6.1.12.30. Inspect the main ring gear and pinion gear for damage and lubrication;
6.1.12.31. Check that all rope sheaves run easily and smoothly;
6.1.12.32. Check that the trolley rope is well tensioned to prevent undue wear on the sheaves;
6.1.12.33. Check that the hoist rope spools properly on the drum and runs freely over the sheaves; 6.1.12.34. Check the lift, slew and trolley machinery;
6.1.12.35. Check that the machine is equipped with serviceable and fully charged fire extinguisher;
6.1.12.36. Check the tracks and base of tail mounted cranes for -
- Loose connections and gaps between the rails;
- Incorrect electrical bonding and earthing;
- Inadequate drainage;
- Subsidence and uneven track;
- Bogey wear;
- Foreign material on the track such as building materials;
- Inoperative travel limit switches and loose rail stops;
- Adequacy of the rail clamps.
6.1.12.37. Check that all limit switches are properly set and functioning;
6.1.12.38. Test weights should be lifted weekly to check the overload limits;
6.1.12.39. Automatic safe load indicators should be tested by lifting a known load.

6.2. MONTHLY INSPECTIONS

6.2.1. In addition to the 1-5 day inspections, the following minimum checks should be made monthly:
6.2.1.1. Inspect the entire crane for structural damage and check for distortion or cracks in the slewing ring area and in the tower assembly;

6.2.1.2. Carefully inspect all welded connections for cracks - main chords and lacings and other structural items for paint flaking and cracking, darts, bends, abrasions and corrosion;

6.2.1.3. Inspect for worn-cracked or distorted parts such as pins, bearings, shafts, gears and rollers;

6.2.1.4. Inspect for cracked or worn sheaves and drums;

6.2.1.5. Inspect for excessive wear on brake and clutch system parts and linings;

6.2.1.6. Check relays and all electrical equipment in the control panel for corroded or burned contacts, loose screws, broken parts and damaged cables;

6.2.1.7. Check condition of all electric motors, current draw is within limits, air passages and fan blades are clear, bearings are well packed, electrical insulation to earth is within tolerance, brushes are not sticking or wearing, rings are clean and that the motor couplings are all in running condition;

6.2.1.8. Check all V-bolts for tension and alignment and also for signs of chafing and cuts;

6.2.1.9. Check the operation of all friction couplings;

6.2.1.10. Tighten mounting bolts on all motors, pumps and gear reducers;

6.2.1.11. Check all electrical connections for tightness;

6.2.1.12. Lubricate all running ropes;

6.2.1.13. Check all control mechanisms for excessive wear of components and contamination by lubricants or other foreign matter;

6.2.1.14. Inspect all hydraulic and pneumatic hoses, fittings and tubing and require their replacement under the following conditions-
- Any evidence of oil or air leaks on the surfaces of flexible hoses or at the points at which the hose in question joins the metal end couplings;
- Any abnormal deformation of the outer coverings of hydraulic hose;
- Any leakage at connections which cannot be eliminated by normal tightening;
- Any evidence of abrasive wear on the hoses.

6.3. TESTING

6.3.1. Testing is necessary to prove that only correct work has been carried out on the machine and that machine is capable of safe and reliable performance within its intended scope.
6.3.2. Immediately after the crane has been erected, it must run through a series of tests in order to correctly set limit switches.

6.3.3. The adjustment of the “trolley in” and “trolley out” limit switches should be done at no load and with the hook at its highest working height. The limit switches must be set to stop the trolley before it strikes the end stops on the main jib.

6.3.4. Hook height limit switch:

6.3.4.1. Prevent the hook assembly from fouling the trolley or head block by adjusting the distance between the lifting limit switch and trolley as follows -
- Use the minimum part reeve of the hoist in series;
- Raise the unloaded hook at maximum speed;
- Stop and check the appropriate amount of over-run;
- Add to this measured over-run distance an extra 250 mm (1 ft);
- Adjust the distance between the stop frame and the trolley to give this separation.

6.3.5. High jib and low jib limit switches must be adjusted by raising and inverting the jib slowly (without load) and allowing it to come in contact with the striker switches.

6.3.6. Travel limit switches should be installed on tail mounted cranes and must be adjusted to stop the travel motor and apply the brakes at least 2.5 m (8 ft) from the rail stop.

6.3.7. Overload limit switches should be checked by lifting a test weight equal to the rated safe working load to about 2 meters off the ground, and the switch adjusted to just permit the load to be lifted.

6.3.8. The setting of all limit switches must be checked periodically and their operation should be tested weekly.

6.3.9. In addition to testing after erection, 100% rated load tests should be carried out on all cranes that have been extensively repaired, altered or climbed to prove:

6.3.9.1. The structural integrity of the unit;
6.3.9.2. The adequacy of supporting structures and method of holding the crane;
6.3.9.3. The adequacy of all functions under rated loads;
6.3.9.4. Confirm the adequacy of all repairs and alterations.

6.3.10. After each change on the anchoring or ballasting arrangements, its security should be tested by the imposition on them of a load 25% greater than the maximum rated service load.

6.3.11. If for any reason the crane fails any portion of the functional test or rated load test, then it must be removed from service until the problem is corrected.

6.3.12. If the person carrying out testing considers that the maximum load that may be safely lifted is less than the normal working load of the unit, a loading diagram appropriate to the conditions should be posted in place of the load chart.
6.3.13. All cranes should be functionally tested at no load at the start of every work shift to ensure that no one tampered with the crane while it was unattended.

6.3.14. No units should be re-rated in excess of their original load ratings, unless the rating changes are approved either by the manufacturer or by an engineer capable of assessing the strength of the structure.

6.4. MAINTENANCE

6.4.1. In order to keep the crane operating safety, reliably and efficiently, it is essential to have preventive maintenance.

6.4.2. A preventive maintenance program should be developed based on the equipment manufacturer’s recommendations.

6.4.3. Keep track and monitor all maintenance by using equipment log book and recording of the details of hours worked, adjustments, checks, repairs, replaced parts, inspections, examinations and tests.

6.4.4. The maintenance personnel should adjust, extend or modify the manufacturer’s recommendations to suit the specific needs of the equipment.

6.4.5. All maintenance staff must be fully aware of the hazards involved in working on tower cranes and must have a good working knowledge of the machinery.

6.4.6. The following safety precautions should be taken as applicable:

6.4.6.1. Everyone working on the crane structure must wear a safety belt and lanyard and tie himself to the structure whenever there is possibility of falling;

6.4.6.2. Lock out and tag out the master power switch off and place a sign on it indicating that it should not to be switched on;

6.4.6.3. In no circumstance should the maintenance personnel be on or under any part of the machine when the power is on, or when the operator is at the controls without full knowledge and consent of the operator;

6.4.6.4. Be a good housekeeper, keep the hoist deck clean, free of concrete, oil, grease, rags, cables and other hazards.

6.4.6.5. Use only non-flammable solutions for cleaning, and be sure your shoes are clean and dry before climbing on the structure;

6.4.6.6. Keep hands, feet, and clothing away from gears, ropes, drums and sheaves;

6.4.6.7. Never wear loose clothing, which may become entangled with moving machinery;

6.4.6.8. Be sure that safety equipment such as fire extinguishers are available and in good condition;
6.4.6.9. Before returning a crane to operational service, subject all components which have been affected by maintenance or repair to a visual inspection, followed by an operational check by the operator to ensure that the components are functional;

6.4.6.10. Always replace protective guards and panels before operating the machine;

6.4.6.11. Never re-start operations until all personnel are clear of the crane;

6.4.7. Before being put back into service, damaged equipment requiring significant or extensive structural repairs should be completely re-tested by a qualified personnel.

6.4.8. Each tower, jib or mast section which has been involved in a mishap causing structural failure and suspected of having been overstressed must be removed from service, until a competent person has issued a certificate stating that any necessary repairs done are satisfactory and that the structural integrity has not been impaired.

6.4.9. Any structural tubes or other thin-walled structural sections which have been buckled, dented or deformed, are not to be repaired. They must be cut out and replaced with a new component.

6.4.10. Defects such as the following must be corrected immediately to ensure safe operation:

6.4.10.1. All critical parts of functional operating mechanisms which are cracked, broken, corroded, bent or excessively worn;

6.4.10.2. Defective load hooks must be discarded and repairs by welding or reshaping are not acceptable;

6.4.10.3. Any corroded structural members must be cleaned to bare metal and then repainted;

6.4.10.4. Do not paint over rust or old paint.

6.4.11. All replacement parts and repairs must have at least the same safety factor and reliability as the original part, and be in accordance with the original specifications of the equipment’s manufacturers.

6.4.12. Stop the machinery while lubricating, except in cases where the lubrication system is designed for step application while the machinery is in motion.

6.4.13. All repairs and adjustments should be made only by properly designated and authorized personnel.
# Annex A
## Hand Signals

<table>
<thead>
<tr>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hoist</strong></td>
<td>With forearm vertical, forefinger pointing up, move hand in small horizontal circle.</td>
</tr>
<tr>
<td><strong>Lower</strong></td>
<td>With arm extended downward, forefinger pointing down, move hand in small horizontal circle.</td>
</tr>
<tr>
<td><strong>Bridge Travel</strong></td>
<td>Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.</td>
</tr>
<tr>
<td><strong>Trolley Travel</strong></td>
<td>Palm up, fingers closed, thumb pointing in direction of motion, jerk hand horizontally.</td>
</tr>
<tr>
<td><strong>Stop</strong></td>
<td>Arm extended, palm down, move arm back and forth.</td>
</tr>
<tr>
<td><strong>Emergency Stop</strong></td>
<td>Both arms extended, palms down, move arms back and forth.</td>
</tr>
<tr>
<td><strong>Multiple Trolleys</strong></td>
<td>Hold up one finger for block marked &quot;1&quot; and two fingers for block marked &quot;2&quot;. Regular signals follow.</td>
</tr>
<tr>
<td><strong>Move Slowly</strong></td>
<td>Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal.</td>
</tr>
<tr>
<td><strong>Magnet Is Disconnected</strong></td>
<td>Crane operator spreads both hands apart palms up.</td>
</tr>
</tbody>
</table>
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.

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.

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.
**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.

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**USE WHIP LINE**. (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.

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**MOVE SLOWLY**. Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal.

**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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