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Rigging and Lifting Program Guide for Nuclear Power Plants

2018 TECHNICAL REPORT

PORTIONS TRANSLATED

Rigging and Lifting Program Guide for Nuclear Power Plants

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PRODUCT DESCRIPTION

This report provides guidance for nuclear utilities to standardize lifting and rigging programs to the extent possible. In so doing, plants help to train workers so that they are safe and efficient and can move from plant to plant with less time invested in plant-specific training and qualification. This should increase safety and lower costs.

Background

Nuclear power personnel must be able to perform rigging and lifting and to use cranes safely. Workers must also apply rigging and lifting program knowledge when they move from site to site. In addition, the worker qualifications based on the program need to be portable to allow more efficient, effective use of the workers. Current Electric Power Research Institute (EPRI) program guidance is limited to small hoists and rigging hardware. Updated guidance is also being included in conjunction with anticipated issuance of new American Society of Mechanical Engineers (ASME) documents to address regulatory concerns prompted by serious industry rigging and lifting events.

Objectives

- Through a collaborative approach with utilities and subject matter experts, develop a rigging and lifting program that ensures that work is performed safely and efficiently and that can be broadly implemented by nuclear utility personnel across all plants with minimal customization

Approach

A Technical Advisory Group consisting of site lifting program coordinators and industry subject matter experts was formed to develop a consensus approach for addressing programmatic issues associated with lifting at nuclear power plants. Collaboration with EPRI's Standardized Task Evaluation (STE) Program ensured that changes to the STE program resulting from this program guidance are available or are being developed for incorporation into the STE program. EPRI closely monitored the development of related ASME standards to ensure that ASME's guidance is incorporated, where appropriate.

Results

This report provides utility personnel with guidance regarding the content of a site/fleet lifting program. The report attempts to standardize definitions of key terms, personnel roles and responsibilities, and lifting personnel qualification requirements to maximize portability of these key individuals from one nuclear plant to another. The report also standardizes nomenclature for different types of lifts and how each type should be managed. Any customization of the report should be primarily due to physical differences in plants. Differences due to regulatory

commitments should be assessed to determine if they affect portability of workers, undue cost versus safety benefit, and undue cost versus regulatory vulnerability. Based on that assessment, plants might consider modifying those commitments or de-committing altogether in accordance with plant regulatory processes.

Applications, Value, and Use

This report is intended to be used primarily by site/fleet lifting program coordinators. Although most references are for standards at U.S. nuclear power plants, they can be adopted by international utility personnel who have reconciled any regulatory differences. The report is valuable because it maximizes the portability of personnel associated with lifting activities and subsequently will reduce costs associated with using these skilled personnel across the fleet of nuclear power plants in the United States and abroad.

Keywords

Crane
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PRIMARY AUDIENCE: Lifting and rigging program owners, maintenance managers

SECONDARY AUDIENCE: Maintenance technicians, crane maintenance program personnel, work management personnel

KEY RESEARCH QUESTION

What are the essential elements of a rigging and lifting program for a nuclear power plant? What elements lend themselves well to standardization so that lifting and rigging personnel can move from plant to plant and be nearly "hardhat-ready" to work safely and efficiently? What controls are needed to minimize the potential for an adverse event involving lifting and rigging?

RESEARCH OVERVIEW

This report is the result of collaborative efforts using a technical advisory group (TAG) of utility subject matter experts, consultants, and workforce providers as well as research into industry standards (such as those of the American Society of Mechanical Engineers [ASME], U.S. Occupational Safety and Health Administration [OSHA], ASTM, and the U.S. Nuclear Regulatory Commission [NRC]) as to what constitutes a solid and portable program. More than a dozen TAG meetings were conducted to discuss all aspects of the program, resolve differences, and adopt consensus good practices. Updated guidance is also being included in conjunction with anticipated issuance of new American Society of Mechanical Engineers (ASME) documents to address regulatory concerns prompted by serious industry rigging and lifting events.

KEY FINDINGS

- Sites are encouraged to adopt the terminology in this report, including *Rigger I* and *Rigger II*, to standardize rigging personnel roles and responsibilities and optimize the portability of these personnel among existing nuclear sites.
- To standardize the skills necessary for qualification of Rigger I and Rigger II personnel, plants are encouraged to use and follow the EPRI Standard Task Evaluation (STE) for each of these positions.
- Qualification of personnel operating permanently mounted cranes—such as reactor building cranes, containment polar cranes, turbine building cranes, and auxiliary building cranes—should be in accordance with OSHA 1910.179.
- Qualification of personnel operating nonpermanently mounted cranes should be certified in accordance with OSHA 20CFR1926.1427. Although many lifts at nuclear plants are not classified by plant personnel as "construction" activities, there are enough sufficiently complex lifts that they could be considered construction lifts as defined by OSHA, or they are indeed construction lifts because they involve replacement of components with nonidentical (that is, not like-for-like) equipment.
- Working on or under a suspended load is prohibited, except when the load can be supported by blocking or cribbing (and the rigging is attached but not carrying the load), can be securely braced, or can be supported substantially by some other means that would prevent the load from moving. There is more specific guidance in the report on this subject.

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EXECUTIVE SUMMARY

WHY THIS MATTERS

This report provides guidance for utilities to standardize lifting and rigging programs to the extent possible to produce safe, efficient workers who can move from plant to plant with less plant-specific training and less time involved in plant-specific qualification. This should increase safety while reducing costs.

HOW TO APPLY RESULTS

This report should be reviewed against existing utility guidance. Areas of difference that are not tied to regulatory commitments should be considered for changes to the utility guidance. Changes to the existing regulatory guidance that provide significant benefits over that guidance should be considered using licensing change processes.

LEARNING AND ENGAGEMENT OPPORTUNITIES

- The EPRI Hoisting, Rigging, and Cranes Users Group discusses the implementation of such program guidance and provides important input to this report and any future revisions.
- Organizations such as the NRC, U.S. Department of Energy, and industry liability insurance companies; service providers; craft unions that provide riggers; and crane operators would be interested in this deliverable. EPRIU (the EPRI training organization) participated in the development of this deliverable so that adjustments to the STE program could be made. Generation facilities under the EPRI Generation Sector might be interested in those facets of the program that are common to all generation facilities.

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INTRODUCTION

1.1 Background

Nuclear power personnel need to be able to perform rigging and lifting and use cranes safely, and they must be able to move from site to site and apply the program knowledge. In addition, the worker qualifications based on the program need to be portable to allow more efficient and effective use of the workers. Current Electric Power Research Institute (EPRI) program guidance is limited to small hoists and rigging hardware. Updated guidance is also being included in conjunction with anticipated issuance of new American Society of Mechanical Engineers (ASME) documents to address regulatory concerns prompted by serious industry rigging and lifting events.

1.2 Purpose

The primary objective of this project was to use a collaborative approach with utilities and subject matter experts to develop a program that nuclear utility personnel can implement. The program ensures that work is performed safely and efficiently and can be implemented broadly across all plants with minimal customization of the program. Customization should be primarily due to plant physical differences. Differences due to regulatory commitments should be assessed to determine if they affect the portability of workers and can result in undue cost versus safety benefit and undue cost versus regulatory vulnerability. Based on that assessment, plants may consider modifying those commitments or de-committing altogether in accordance with plant regulatory processes.

Collaboration with the Standardized Task Evaluation (STE) Program will ensure that changes to the STE program resulting from this program guidance are available.

This report is not intended to be a how-to guide for lifting, rigging, crane operation, or material handling. It is intended to provide utilities with sound elements that can be put in place to ensure that personnel are trained and qualified, equipment is in satisfactory condition, and documentation is in place to satisfy various industry guidelines and requirements. EPRI has prepared some how-to products, and they will be referenced herein as appropriate.

1.3 Scope and Contents of the Report

Figure 1-1 illustrates the general structure and content of this report, identifying key sections that provide guidance to owners to effectively address hoisting, rigging, and crane issues.

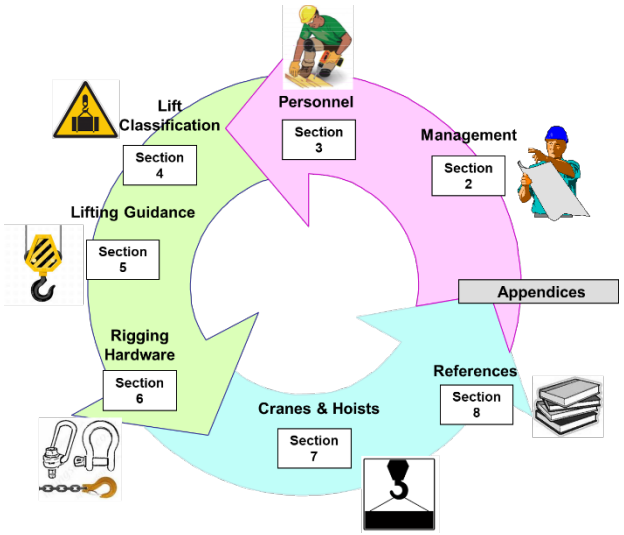

Figure 1-1
Scope and content of this EPRI report

1.3.1 Program Components

Each facility performing standard load movements should have a standard load movements program, which can be addressed by the facility's lifting and rigging program. Key components of the lifting and rigging program should include the following:

- Policies and procedures to ensure that the expectations for rigging and lifting of loads are defined. Include the following elements:
  - Clearly defined standards, roles, and responsibilities for personnel involved with rigging and lifting of loads
  - A facility procedure(s) or handbook(s) providing workers with a reference on technical information and safety expectations
  - Written or verbal lift plans commensurate with the complexity or uniqueness of the task performed for all lifts
  - Independent reviews verifying the safety of below-the-hook lifting devices brought on site by contract personnel
- Training to ensure that all personnel have appropriate knowledge and skills before they perform lifting and rigging activities. Include the following elements:
  - Initial and continuing training provided to facility personnel who perform rigging and lifting, develop lift plans, or perform rigging equipment inspections
  - Hazard awareness training provided to facility personnel regarding the general risks and hazards associated with lifting and rigging
  - Verification that training standards for supplemental personnel are equivalent to those for facility personnel performing similar rigging and lifting activities and moving loads
  - Proficiency verification of personnel before they perform rigging and lifting tasks

- Control, storage, and inspection of equipment to ensure that all rigging and lifting equipment is safe and suitable for service when issued. Include the following elements:
  - Clearly defined storage and inspection standards for rigging and lifting equipment
  - Periodic inspection of rigging and lifting equipment for improper storage and damage
  - Removal of damaged rigging and lifting hardware from service by segregation, tagging, or destruction upon discovery
  - Inclusion of special or nonstandard site- or vendor-fabricated lifting devices in the facilities' rigging inspection program
  - Verification that rigging equipment brought on site by supplemental personnel meets applicable certifications and facility standards
- Fundamental rigging and lifting practices to ensure safe implementation and operations by all personnel. Include the following elements:
  - The load handling activity considerations of ASME P30
  - Use of load binding indicators or binding release devices with stop work criteria when a load has the potential to bind or drag
- Supervision and oversight by line managers and supervisors who possess the appropriate level of knowledge to review lift plans and conduct field oversight. This should ensure the following:
  - The requirements for supervisory oversight of rigging and lifting are defined and communicated.
  - The oversight of rigging and lifting activities is performed by line managers and supervisors who are sufficiently knowledgeable to recognize and correct fundamental deficiencies and hazardous situations.
  - Pre-job briefings are conducted prior to rigging and lifting activities to identify potential hazards and compensatory actions required to prevent equipment damage and personnel injuries.

1.3.2 Governing Documents

The guidance in this report is based on numerous industry standards and U.S. regulatory documents that are listed in the references section. Detailed descriptions of several of these governing documents are provided in Appendix A of this report.

1.3.3 Basic Premises of This Report

1.3.3.1 Qualification vs. STE

Many organizations mistakenly think of the EPRI STE program as a qualification program. For the purposes of this report, a qualification can be granted only by a site line manager. It is each line manager's responsibility to ensure that individuals are qualified in accordance with site/fleet procedures.

EPRI does provide STEs for many tasks performed at a nuclear power plant. Each STE proves that site personnel are proficient in a given task. Task performance evaluation is the act of determining whether an individual is proficient at performing a task by demonstrating (for example, by performing, simulating, or discussing) task competence while under evaluation. As such, site personnel should consider the use of the EPRI STEs for establishing the scope of and means for standard task evaluation and integrate this component into their site-specific qualification criteria.

Once proficiency is demonstrated by means such as an STE, sites can qualify personnel based on those results and supervisory review.

1.3.3.2 Certification vs. Qualification

For the purposes of the report, an individual is "certified" when demonstrated to be in accordance with a certain standard (for example, U.S. Occupational Safety and Health Administration [OSHA], American National Standards Institute [ANSI]). A qualified person is one who has demonstrated the ability to solve or resolve problems relating to the subject matter and work, whether by possession of a recognized degree in an applicable field or certificate of professional standing or by extensive knowledge, training, and experience. In this context, qualification is a "qualitative" evaluation of an individual's capabilities and can vary among utilities. A person is deemed "qualified" by utility management as noted in 1.3.3.1. Tools such as the EPRI STE can be used by utilities to evaluate the knowledge and skills of an individual, which can provide part of the basis of qualification by a utility.

1.3.3.3 Material Handling and Transportation Guidance

Guidance regarding material handling is provided in EPRI report 1015271, *Nuclear Maintenance Applications Center: Material Handling Application Guide*, and as such is not included in the scope of topics covered in this report.

1.3.3.4 Comparison of U.S. and International Regulations, Codes, and Standards

Users of this report from utilities/organizations outside the United States should recognize that compliance with and implementation of the U.S. regulations, codes, and standards cited herein are strictly optional. Voluntary adoption of these U.S. documents should be done in concert with the implementation of regulations, codes, and standards imposed by their government and referenced in their respective licensing basis.

Additionally, the control of heavy loads is a concern for nuclear power plants. The United States has traditionally used U.S. Nuclear Regulatory Commission (NRC) NUREG-0612 as the guidance for addressing these loads to prevent damage to nuclear fuel. Many countries have established guidance similar to NUREG-0612, as documented in Nuclear Energy Agency CNRA/R (2017), "Nuclear Energy Agency Committee on Nuclear Regulatory Activities, Heavy Load Accidents in Nuclear Installations Working Group on Operating Experience (WGOE)." The international Technical Advisory Group (TAG) member indicated that, although he has no regulation similar to NUREG-0612 (probably because the Canada deuterium uranium [CANDU] design does not require lifting of heavy loads such as reactor heads over fuel during refueling), lifts over the calandria (that is, the reactor for CANDU plants) have been analyzed using methodology in NUREG-0612.

Another example is that Canadian plants use Canadian Standards Association (CSA) B167-16, "Overhead Cranes, Gantry Cranes, Monorails, Hoists, and Jib Cranes," for design, inspection, construction, testing, and maintenance. This standard largely references ASME and Crane Manufacturers Association of America (CMAA) standards for adoption.

Based on these reviews, it is believed that this report provides guidance that is useful worldwide.

1.4 Definitions of Key Terms and Acronyms

1.4.1 Industry Definitions and Nomenclature

certification. A process to demonstrate that an individual, organization, or item meets the requirements of and is in accordance with a certain standard. For example, an individual can be certified as an auditor to ANSI N45.2.13, an organization can be certified to ISO 9001:2015, and a fastener can be certified to A489-12, "Standard Specification for Carbon Steel Lifting Eyes."

competent person. A person capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous, or dangerous to employees and who is authorized to take prompt corrective measures to eliminate them.

cone of influence. See *fall zone*.

crane. A machine for lifting and lowering a load vertically and moving it horizontally with the hoisting mechanism as an integral part of the machine. The term is applicable to fixed and mobile machines and to powered or manually driven machines (EPRI 1025239). Note that for the purposes of this report, *crane* is used to indicate an overhead or gantry device.

fall zone. The area (including but not limited to the area directly beneath the load) in which it is reasonably foreseeable that partially or completely suspended materials could fall in the event of an accident.

lift zone. See *fall zone*.

mobile crane. A lifting device incorporating a cable-suspended latticed boom or hydraulic telescopic boom designed to be moved between operating locations by transport over the road (EPRI 1025239).

qualification. Earned when an individual successfully demonstrates, as determined by utility management, the ability to solve or resolve problems relating to the subject matter and work based on his or her certification, training, experience, and education.

1.4.2 Acronyms and Abbreviations

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
BWR	boiling water reactor
CANDU	Canada deuterium uranium
CFR	U.S. Code of Federal Regulations
CMAA	Crane Manufacturers Association of America

CNF	Committee on Cranes for Nuclear Facilities
CSA	Canadian Standards Association
DOE	U.S. Department of Energy
EPRI	Electric Power Research Institute
FME	foreign material exclusion
INPO	Institute of Nuclear Power Operations
IPTE	infrequently performed task or evolution
ITI	Industrial Training Institute
KPI	key performance indicator
kV	kilovolt(s)
LHE	load-handling equipment
NCCCO	National Committee for the Certification of Crane Operators
NEIL	Nuclear Electric Insurance Limited
NML	nuclear movement of loads
NOG	nuclear overhead gantry
NRC	U.S. Nuclear Regulatory Commission
NUM	nuclear underhung monorail
NUREG	U.S. Nuclear Regulatory Commission regulation
OSHA	U.S. Occupational Safety and Health Administration
PIC	person in charge
PWR	pressurized water reactor
SOER	Significant Operating Experience Report
STE	Standardized Task Evaluation
TAG	Technical Advisory Group
TR	technical report
TVA	Tennessee Valley Authority
UV	ultraviolet

1.5 Listing of Key Points

Throughout this guide, key information is summarized in "Key Points." Key Points are bold lettered boxes that succinctly restate information covered in detail in the surrounding text, making the key point easier to locate.

The primary intent of a Key Point is to emphasize information that will allow individuals to take action for the benefit of their plant. The information included in these Key Points was selected by EPRI personnel and the consultants and utility personnel who prepared and reviewed this guide.

The Key Points are organized according to seven categories: Costs, Technical, Human Performance, Observation, Benchmarking (Member Experience), Information, and Safety. Each category has an identifying icon, as shown below, to draw attention to it when quickly reviewing the guide.

Key Cost Point

Emphasizes information that will result in reduced purchase, operating, or maintenance costs.

Key Technical Point

Targets information that will lead to improved equipment reliability.

Key Human Performance Point

Denotes information that requires personnel action or consideration in order to prevent injury or damage or to ease completion of the task.

Key Observation Point

Identifies tasks or a series of tasks that can or should be observed by maintenance first line supervisors to improve the performance of the maintenance staff and improve the reliability of the component.

Key Benchmarking Point

Shares other companies' experiences with the task or technology so that readers will have a benchmark for best practices.

Key Information Point

Denotes information of special importance.

Key Safety Point

Identifies information that will lead to improved worker and industrial safety.

Appendix B contains a listing of all key points in each category. The listing restates each key point and provides reference to its location in the body of the report. By reviewing this listing, users of this guide can determine if they have taken advantage of key information that the writers of the guide believe would benefit their plants.

2
MANAGEMENT GUIDELINES

2.1 Responsibilities of Managers of Personnel Performing Lifting Tasks

Managers of individuals who perform lifting tasks have the responsibility to understand and support the lifting program processes, and to ensure adherence to the lifting program requirements, responsibilities, and processes. They should encourage individuals to provide feedback to identify concerns and the personal skills needed to perform lifting tasks. Managers should ensure that vendor and non-site individuals are qualified to perform lifting tasks and to participate in lifting activities before they are assigned to teams with lifting tasks. These management personnel should ensure that accidents and near misses are reported/investigated using a formal incident investigation process when rigging hardware, lifting equipment, and cranes are involved. And finally, managers should ensure that lifting program effectiveness is evaluated using key performance indicators (KPIs). Examples of KPIs are provided in Appendix C of this report.

Key Human Performance Point

Managers should ensure that supplemental workers receive an appropriate level of training for the specific site to which they are assigned and consistent with the scope of lifting/rigging activities that they will perform.

2.2 Safety Guidelines

2.2.1 General

There are many safety rules that must be observed by various lifting personnel to operate assigned lifting equipment safely. Each plant organization should ensure that the safety rules applicable to each type of equipment are provided to each crane operator prior to their assignment to operate a particular device and that a pre-lift briefing is performed prior to each lift or series of lifts.

Some specific cranes and hoists, or lifting locations in the plant, will dictate specific safety rules. Operators of lifting equipment should be trained to these safety rules and tested to ensure that they know and understand each safety rule that applies to the device that they are authorized to operate. Retraining on safety rules should be a routine part of lifting personnel qualification.

2.2.2 Safety Rules for Crane Operators

The following guidance is a summary of key safety rules described in EPRI 1022507:

1. Ensure that each crane operator is physically fit for duty. All nuclear plants have required fitness-for-duty programs that ensure periodic drug and alcohol testing of plant personnel and continuous behavior observation by the assigned supervisor and plant management. The crane operator should be observed for any signs of fatigue, stress (emotional as well as physical), and alertness that might indicate that he or she is not fit for duty. The crane operator is responsible for informing management if he/she is taking over-the-counter medications or prescribed medication or has health issues that might impair his/her operating skills.
2. Ensure that the crane operator is trained, authorized, and qualified to operate each crane. Each crane has its own operational characteristics that need to be understood by the operator assigned to the crane. This knowledge is vital in order for the crane operator to be able to focus their attention on the load and not be distracted by the crane mechanical or electrical activities.
3. De-energize the crane prior to allowing anyone to go on top of the crane or on the rails. Ensure that personnel are clear prior to re-energizing the crane.
4. Clear all personnel from the load path prior to moving the load.
5. Ensure that all personnel are clear prior to hoisting the load. Always take up slack in rigging slowly to avoid twisting the rigging or entangling personnel.
6. Ensure that both the crane operator and the person directing the load prior to any movement understand the rigging signals and maintain direct communication with the crane operator. Standard rigging signals as provided by ASME B30.2 (Overhead and Gantry Cranes) and ASME B30.5 (Mobile Cranes) should be used wherever possible. Appendix D includes illustrations of these standard hand signals.
7. Always maintain a safe distance to avoid bumping into another crane.
8. Perform a pre-operation inspection of the crane prior to use.
9. Perform an inspection of the work site following any repair work.
10. If power goes off, move the controller to the off position until power is available again.
11. Ensure that each crane cab is equipped with an appropriate fire extinguisher.
12. Remove loose rigging and store it in the proper place rather than leave it to hang loose on the hook.
13. Loads should be applied evenly to each side of the duplex (sister) hook.
14. When leaving the cab, or securing the crane, always open the main switch. Always turn off the main power breaker when leaving the crane. Never leave the controls energized when the cab is unattended.

15. When parking an outside crane, always set the brake and secure as specified by the equipment manufacturer and site regulations regarding parking of vehicles (often a security regulation). When the crane will not be used for a long period, the crane should be secured into a parked position that allows it to be secured to the crane stops. All hoists should be raised to their full up position and the trolley placed against its stops. The main power breaker should be opened. The load monitoring circuit and heater circuits should remain on.
16. Learn the proper securing requirements of the outside crane in use in case of a bad weather warning.
17. In case of a problem, always **stop** operation as soon as it is safe to do so.
18. Ensure that the rigging is the correct load rating for the load to be lifted.
19. Perform a job-site specific hazard evaluation. Performing a job safety analysis for each crane may identify specific hazardous conditions and additional safety rules. Normally this task is performed by the plant safety organization or designated personnel.

2.2.3 Providing Personnel Protection

The safety of personnel involved in rigging and hoisting operations largely depends upon care and common sense. The personnel protection practices described in EPRI 1007914, Section 3.7.1, should be considered and integrated into appropriate site procedures for lifting and rigging.

2.2.4 Rigging Safety Practices

The safe practices described in EPRI 1007914, Section 3.7.3, should be considered and integrated into appropriate site procedures for lifting and rigging. Adhering to the following simple guidelines should reasonably ensure that loads will not drift, be damaged in any way, or cause physical harm to members of the lifting/rigging team:

- As described in preceding sections of this report, all loads should be properly rigged to prevent the dislodgment of any part. Suspended loads should be securely slung and properly balanced before they are set in motion.
- The load should be kept under control at all times. Where necessary, when personnel may be endangered by the rotation, one or more guide ropes or tag lines should be used to prevent the rotation or uncontrolled motion of the load.
- Loads should be safely landed and properly blocked before being unhooked and unslung.
- Lifting beams should be plainly marked with their weight and designed working loads and should be used only for the purpose for which they were designed.
- The hoist rope should never be wrapped around the load. The load should be attached to the hook by slings or other rigging devices that are adequate for the load being lifted.
- Multiple-part lines should not be twisted around each other.
- The load line should be brought over the center of gravity of the load before the lift is started.
- If there has been a slack rope condition, care should be taken to ensure that the rope is properly seated on the drum and in the sheave.

- Hands should be kept away from pinch points as the slack of ropes and slings is being taken up.
- Ensure that all personnel stand clear while loads are being lifted and lowered or while the slings are being drawn from beneath the load.
- Impact loading caused by sudden jerking when lifting or lowering should be avoided. The sling should be lifted gradually until any slack is eliminated.
- Personnel should not ride on a load that is being lifted.
- Loads should not be left suspended in the air when the hoist or crane is unattended.
- Ensure that the load is free before lifting and that all sling legs are taking their appropriate share of the load.
- When using two or more slings, ensure that all of the slings are made from the same material and exhibit the same lifting strength.
- Loads should be lowered onto adequate blocking to prevent damage to the slings.
- When lifting loads with three or four slings, it is recommended that two slings carry the load.

2.2.5 Mobile Crane Personnel and Equipment Safety Guidance

Additional personnel and equipment safety precautions are also provided in the EPRI report *Mobile Crane Application Guide* (1025239), which addresses subjects that minimize the potential for injury to workers or significantly reduce the potential for damage to mobile crane equipment and materials. Accident prevention is by far the preferred method to avoid situations that would cause injury, equipment damage, and potential radiation releases challenging 10CFR 100 limits. Safe operation reduces the need for additional inspections and maintenance and reduces cost.

EPRI report 1025239 contains the industry's safety standards and precautions that are intended to increase the crane operator's skills and safety awareness. Most of the material was assembled from safety standards (such as ASME NQA-1, ASME B30.5, OSHA 29, CFR 1910.180, and 29CFR 1926 Subpart CC) and industry guidance (such as the *Crane Inspection Certification Bureau's Mobile Crane Operator's Manual*).

There are many safety rules that must be observed by each crane operator and lifting crew to perform a lift safely. Each plant organization should ensure that the safety rules applicable to each mobile crane are provided to all mobile crane operators prior to their assignment to operate a particular mobile crane and that a pre-lift briefing is performed prior to each lift or series of lifts. Additional briefs should occur whenever there is a change to the lifting plan or there are personnel changes/additions to the lifting team for the lifting plan.

Some specific mobile cranes or mobile crane locations in the plant will dictate specific mobile crane safety rules. Mobile crane operators should be trained to these safety rules and evaluated to ensure that they know and understand each safety rule that applies to the mobile crane that they are authorized to operate. Retraining and refresher training on safety rules should be a routine part of mobile crane operator qualification.

In addition to general mobile crane operations, the assembly/disassembly, transit, and lifting operation of a mobile crane are specifically dangerous situations. A mobile crane lift operation can be broken down into the following three phases, with each phase having necessary precautions, actions, and processes to ensure safety:

- Pre-lift: this includes the planning for and preparation of the lifting equipment, personnel, and worksite
- During the lift: the phase where accidents most often happen
- Post-lift: this includes restoration of the lifting equipment

2.2.6 Working on or Under Suspended Loads

2.2.6.1 Site Procedures for Defining a Suspended Load

Each site's rigging and lifting program procedures should define what is considered a suspended load and address work risks associated with any body part (including all) under a suspended load. This area is referred to as the *fall zone*, *lift zone*, or *cone of influence* (see Section 5.3.2 and Appendix K for more information).

2.2.6.2 Considerations for Inclusion in Program Procedures

Where available, hoisting routes that minimize the exposure of employees to hoisted loads must be used, to the extent consistent with public safety.

While the operator is not moving a suspended load, no employee must be within the fall zone, except for employees engaged in hooking, unhooking, or guiding a load; engaged in the initial attachment of the load to a component or structure; or operating a concrete hopper or concrete bucket.

When hooking, unhooking, or guiding the load, adhere to the following:

- The materials being hoisted should be rigged to prevent unintentional displacement.
- Hooks with self-closing hook latches or their equivalent should be used; however, J-hooks are permitted for setting wooden trusses.
- The materials should be rigged by a qualified rigger.

Procedures should also consider this guidance be applied during the initial connection of a load to a component or structure (such as setting a pump on its foundation or base).

When receiving a load, only employees needed to receive a load are permitted to be within the fall zone when a load is being landed, which might include radiation safety or hazardous chemical monitoring during the operation.

During a tilt-up or tilt-down operation, no employee can be directly under the load in a part of the fall zone where the load might be expected to swing if the tilt-up or tilt-down operation has unplanned motion (for example, due to a rigging hardware failure). Also during a tilt-up or tilt-down operation, only employees essential to the operation are permitted in the fall zone (but not directly under the load, as covered previously). An employee is essential to the operation if the employee is conducting one of the following operations and the employer can demonstrate that it is infeasible for the employee to perform that operation from outside the fall zone:

- Physically guide the load
- Closely monitor and give instructions regarding the load's movement
- Either detach it from or initially attach it to another component or structure (such as making an initial connection or installing bracing)
- Provide radiation safety or hazardous chemical monitoring during the operation

Key Safety Point

Boom free fall is prohibited when an employee is in the fall zone of the boom or load, and load line free fall is prohibited when an employee is directly under the load.

2.2.6.3 Key Points Regarding Working on Suspended Loads

Work on suspended loads is prohibited under normal conditions, but if the responsible manager or lift director decides that it is necessary to work on a suspended load, guidelines for safe operation should be established through consultation with the lift director and appropriate safety organization. Suspended loads that must be worked on should be secured against unwanted movement, hooks should be equipped with self-closing latches, and the load should be rigged by a qualified rigger.

Key Safety Point

Working on or under a suspended load is prohibited, except when the load can be supported by blocking or cribbing (and the rigging is attached but not carrying the load), can be securely braced, or can be supported substantially by some other means that would prevent the load from moving.

Key Safety Point

Suspended loads should never be purposely moved over personnel unless involved in activities above.

Key Safety Point

When work under a suspended load has been approved, the number of personnel performing the work should be minimized, and the time any body part is under a suspended load should be minimized to reduce the risk of crushing.

Some loads being lifted and set in place could require special handling control measures, such as inspecting, landing, setting, or controlling the load, that might require personnel to position their hands or other body parts under the load when no other method is feasible. These special handling control activities must be approved by the lift director and safety personnel prior to being performed. When any body part must be under a suspended load, the following applies:

- The load cannot be moving.
- The operator must remain at the lifting device controls.
- The person under the load must be in continuous sight of a signaler.
- Lifting equipment cannot be designed for free fall.
- Hooks must use self-closing latches or an equivalent.

Key Observation Point

With regard to working in a fall zone, the term *line of fire* implies vertical movement, whereas the term *danger zone* implies horizontal **or** vertical movement.

Key Safety Point

Materials must be rigged to prevent unintentional displacement.

The following factors should be considered when allowing work on suspended loads:

- Use of redundant rigging
- Double capacity of rigging and equipment
- Consequences of injuries
- Completion of a job safety hazard analysis

3
PERSONNEL GUIDELINES

This section describes the various roles and responsibilities expected of personnel associated with lifting activities at a nuclear power plant.

3.1 Personnel Guidelines

A typical lifting program for a power generating facility should consist of program administration, program owners, managers, supervisors of teams with lifting tasks, support groups, and users. This section describes a typical organization, its structure, and the responsibilities inherent to a successful lifting program. Standard terminology is considered key to enhancing portability of workers between plants.

Users of this report should recognize that organizational structures and responsibilities will vary among utilities and sites. The guidance provided in this appendix should be used for planning purposes and should not be interpreted as requirements.

Users of this report should also recognize that the responsibilities described in Sections 3.2.1–3.2.3 can often be performed by one individual, depending on the size of the utility and/or the number of sites.

3.2 Program Owner Personnel

Program administration should ideally consist of one professional from each site participating in the lifting program and can include multiple nuclear sites. The program administration should be established to manage the lifting and material handling program; ensure consistent implementation and adherence; measure the program's effectiveness; evaluate safe lifting practices; solicit user comments and feedback; assess feedback and evaluate cost-effective improvements; evaluate and potentially incorporate operating experience; maintain the lifting program documents; and revise, update, and distribute the lifting program manuals, procedures, and guidelines.

It is recommended that the individual designated as the lifting program manager/coordinator also manage the material handling program.

The qualification of the lifting program owner/manager should be commensurate with the qualification requirements of comparable other managers within the fleet or at the site. In most cases, a person at this level will possess a combination of rigging experience (typically more than five years), technical expertise achieved by taking advantage of various site and industry training opportunities, and a level of formal education as recommended by the utility.

This individual should be competent, and as defined in in 29CFR1926.32(f), they should be:

> ...capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

3.2.1 Program Manager Roles and Responsibilities

The lifting program manager(s) are typically fleet-level technical/safety professionals who provide guidance and support to the lifting program coordinators and ensure the following:

- Distribute all new/updated applicable industry (such as OSHA) regulations to the lifting coordinators.
- Evaluate user concerns or feedback regarding the lifting program requirements.
- Ensure that rigging hardware, lifting equipment, and crane inspection and operating procedures are current.
- Ensure that lifting coordinators communicate periodically.
- Establish criteria for consistent inspection, testing, and operation for the rigging hardware, lifting equipment, and cranes.

3.2.2 Lifting Program Coordinator Responsibilities

The lifting program coordinator should be the designated individual at a site who possesses rigging hardware, lifting equipment, and crane knowledge, training, or experience and is a subject matter expert on site. This individual is sometimes referred to as the *lifting coordinator*. At sites that are not part of a larger fleet, the responsibilities of the lifting program manager and lifting program coordinator may be performed by one individual.

This individual should be able to answer questions on crane operations; resolve crane concerns; interpret issues on standards, codes, criteria, and procedures; provide technical support for complex or specialized rigging lift planning efforts as necessary; prepare and review purchase specifications of cranes, rigging hardware, and lifting equipment; support lifting equipment inspection, maintenance, and retrofit activities; and serve as a general technical resource for lifting activities.

The lifting program coordinator should be the single point of contact for lifting needs and should coordinate with maintenance organizations to ensure that responsibilities assigned to maintenance personnel are performed. The lifting program coordinator responsibilities should include the following:

- Determine rigger and crane operator specialized training needs.
- With the program manager, provide and distribute consistent interpretation of all new/updated OSHA regulations, ASME/ANSI standards, and applicable manufacturer’s bulletins to support groups and users.
- Notify management of modifications required for safe lifting equipment operation and associated budgets to implement these modifications.
- Review and evaluate new technology information.

- Interface and communicate with other lifting coordinators and the program manager.
- Develop and issue consistent user-friendly inspection, testing, maintenance, and operating procedures.
- Approve the use of periodic inspection forms or format provided by vendors or contractors who may perform periodic inspections.
- Ensure that a "crane box" is located in each bridge or gantry crane cab, near the floor-operated "crane parked" location, or at key pick-up control point. Ensure that a crane box is located in each mobile crane cab and that it includes the appropriate contents noted below.
- Identify unique crane features, operating conditions, and pre-operational/quarterly inspection and testing exemption of lower limit switches. Ensure that these unique characteristics, features, operating conditions, or inspection requirements are documented and posted in the crane box.
- Review/analyze random periodic rigging hardware, lifting equipment and crane records (inspection, maintenance, operation), and random lifting operation records (training, qualifications, accidents) for the following:
  - Tracking the operational readiness of rigging hardware, lifting equipment, and cranes to develop a preventive maintenance program.
  - Generic lifting problem trends.
  - The need for retrofit, major modifications, or replacement.
  - Frequency of lubrication, adjustments, or tests.
  - Causes and trends related to lifting accidents that result in injury and/or property damage.
  - The need for additional safety devices or safety design features.
- Ensure that lift beams, fabricated rigging devices, and so on are designed and fabricated in accordance with the lifting program and ANSI B30.20 requirements.

3.3 Rigging Personnel

3.3.1 Introduction

For the purposes of this report, riggers are categorized as Rigger I and Rigger II. Sites are encouraged to adopt this terminology to achieve standardization of rigging personnel roles and responsibilities and to optimize portability of these personnel among existing nuclear sites.

Key Benchmarking Point

The user of this report should note that the Rigger I and II designations in this report do not necessarily match those used by the National Commission for the Certification of Crane Operators (NCCCO) for designating rigger personnel.

Key Cost Point

Sites are encouraged to adopt the terminology *Rigger I* and *Rigger II* to achieve standardization of rigging personnel roles and responsibilities and to optimize portability of these personnel among existing nuclear sites.

3.3.2 Rigging of Pre-Engineered Lifts Not Under a Rigger Qualification

The user should also note that in most rigging activities related to production work, there is a repetitive series of events that call for the same, permanently installed rigging equipment to be used for identical or nearly identical load handling activities.

Key Human Performance Point

Lifting tasks performed repetitively using simple rigging and existing plant equipment/tools (for example, operator lifting of oil strainers or baskets) should be controlled under site-specific task qualifications and are typically outside the scope of the hoisting, rigging, and crane program covered herein.

Individuals who perform these types of repetitive lifting activities might also be required to inspect the rigging equipment prior to using it.

The types of lifts that are typically exempted from the lifting program are often referred to as *pre-engineered production lifts*. The lifts tend to be repetitive, production-type lifting operations that are independent of the nature of the load. The probability of collision, upset, or dropping is reduced to a level acceptable to the responsible manager by preliminary operation evaluation, specialized lifting fixtures, detailed procedures, operation-specific training, and independent review and approval of the entire process. As previously noted, these types of lifts are typically performed by production personnel and are described in maintenance instructions that adequately describe the controls necessary to ensure the safety of the operation. Section 3.3.3.4 provides qualification requirements for signalpersons performing these types of lifts.

Key Information Point

Pre-engineered lifts are controlled and managed apart from the programmatic hoisting and rigging activities described in this report.

3.3.3 Rigging Personnel Roles and Responsibilities

3.3.3.1 Rigger I

This is the entry level for riggers. In general terms, the individuals who become qualified as Rigger I should have the ability to select the rigging methods and necessary rigging equipment for production load handling activities. Additionally, a qualified Rigger I should be able to identify the means and methods needed to handle unique loads, such as motors, gear boxes, pumps and similar items during maintenance events. A Rigger I should also be able to obtain and interpret weights, centers of gravity, and sling tensions.

In the context of the responsibilities noted below, the "user" in most cases will be designated as the rigger. Therefore, the rigger or user should:

- Be evaluated by an approved, qualified evaluator who is at least a Rigger II qualified rigger or an instructor who has been a qualified rigger in the past.
- Maintain proficient skills and advise supervision of additional training and qualification needs.
- Provide instruction for teammates during the lifting process(es).
- Plan lifts.
- Include teammates in lift plan development. Inform all replacement, additional, or shift-change teammates of lift plan and work status.
- Use the EPRI report *Rigger's Handbook* (3002001203) (when required by the utility's program).
- Obtain the weight and center of gravity of the load by drawings, engineering, or conservative estimating as appropriate, as reviewed by a Rigger II.
- Understand the limits of equipment and ensure that limits are not exceeded.
- Use rigging hardware and lifting equipment within their design capabilities and design features.
- Determine and understand the specific requirements for lifting in specific or local surroundings (such as environment, site procedures, and unique characteristics).
- Identify and comply with unique plant requirements for load travel path.
- Verify that surrounding structures and attachment points will support the applied loads.
- Ensure compliance to the lifting program requirements for the application, rigging configuration, inspection, operation, and use of rigging hardware and lifting equipment.
- Ensure that rigging hardware and lifting equipment are sized to exceed the load.

- Identify the rigging hardware and lifting equipment needed, and provide the equipment list to tool issue in advance.

Key Human Performance Point

Use edge protectors (that is, softeners) whenever possible. Edge protectors should be materials designed for that use.

- Ensure that the laydown area will support the load; contact the engineering organization as required.
- Perform frequent inspection of all rigging hardware and lifting equipment before, during, and after use. For hardware/equipment that fails the inspection criteria, tag the defective equipment as "remove from service," identify and record on the tag the discrepancy, and return to tool issue.
- Prior to use, ensure that all modified or fabricated rigging hardware satisfies the requirements of below-the-hook lifting devices.
- Identify and attach rigging with knowledge of hitch configurations and load angle factors, rigging capacities, and load integrity.
- Inspect hoist block, sheaves, wire rope, hook, and latch.
- Recheck rigging attachment points after the load is brought to a taut condition.
- Ensure that tag line and rigging hardware and lifting equipment are installed and secured.
- Ensure that the tag line person knows the travel path and their responsibilities (to stabilize the load to prevent load swing).
- Understand and comply with signalperson responsibilities.
- Perform signaling for common loads.
- Perform final equipment inspection and return to tool issue.
- Observe other lifts to develop knowledge base or to identify inadequate rigging to prevent failures.
- Perform hand chain or lever-operated hoist tension rigging to control the drifting of a load using two hoists positioned at the same elevation so that only the load creates tension on each hoist.
- Operate winches (for example, base-mounted drum hoists) only as directed by a Rigger II or in accordance with a documented lift plan prepared and approved by a Rigger II, lifting coordinator, or engineer.
- Perform complex load lifts only under the direction of a Rigger II or in accordance with a documented lift plan prepared and approved by a Rigger II, lifting coordinator, or engineer.
- Obtain approval from engineering before rigging or attaching to lugs that have been modified or torch-cut or are suspect.

- Obtain approval from engineering before welding or altering any rigging hardware, lifting equipment, or lifting devices.
- Ensure that a Rigger II or crane operator directs the installation of crane wire rope replacement.
- Ensure that the rigging configuration is in accordance with the manufacturer's literature before lifting material using forklifts.
- Calculation of weights and center of gravity by Level I riggers must be supervised by a Rigger II.

3.3.3.2 Rigger II

In general, the individuals who become qualified as Rigger II should have the added ability to develop the rigging methods and the use of specialized rigging equipment for unique load handling activities. A qualified Rigger II person should have the capacity to assist in the planning and execution of the rigging events that might occur within the facility. Additionally, the Rigger II qualified person should be able to serve as a lift planner and a lift plan reviewer for contract rigging companies doing work for utility.

In addition to knowing and demonstrating Rigger I knowledge and skills, a Rigger II can select rigging components and procedures based on rigging capacity.

Key Technical Point

A Rigger II must first be qualified as a Rigger I.

A Rigger II can perform the following rigging tasks unsupervised:

- Calculate load weight and center of gravity independently.
- Identify lift points.
- Determine and select rigging based on calculated loads.
- Perform pre-use inspection of rigging and lift points.
- Perform rigging and signaling for personnel basket operations under the direction of qualified crane operators.
- Understand load dynamics and associated hazards. Load dynamics are especially applicable to underwater lifts or lifts under extreme weather conditions (high winds, for example).
- Review lift plans for special lifts.
- Provide oversight for standard/common lifts.

A Rigger II understands and can demonstrate the process and procedures involving the following:

- Chain hoists and drifting loads through small passageways
- The use of jacks for lifting a load
- The use of industrial rollers to transport a load on level and inclined surfaces
- The use of winches (such as base-mounted drum hoists) and a multi-part line system that integrate rigging blocks to gain mechanical advantage
- Rigging loads that have connection points that are not on the same plane
- Up-end and down-end a load

3.3.3.3 Lift Director

A lift director should be capable and competent to oversee and manage critical lift activities and should hold a Rigger II qualification. Due to his/her training, experience, knowledge, skill, and ability, a lift director will be qualified by management and able to perform nearly any common, complex, or critical lift activity. For engineered lifts and those requiring additional analysis and/or contractor assistance, the lift director may be called upon to serve in a variety of roles related to the load handling activity.

The lift director should:

- Ensure that the program requirements for supervisory oversight of rigging and lifting are defined and followed
- Be sufficiently knowledgeable to recognize and correct fundamental deficiencies and hazardous situations
- Ensure that pre-job briefings are conducted prior to rigging and lifting activities to identify potential hazards and compensatory actions required to prevent equipment damage and personnel injuries
- Understand the general operating characteristics of load handling equipment (LHE), such as overhead cranes and mobile cranes
- Understand the limitations of LHE selected for load handling activities within the facility
- Understand and be able to execute the steps necessary to complete any lift by implementing the action items as related to personnel, LHE usage, rigging method, sequence of lift, safety, and site control elements as required
- Be capable of reviewing lift plans for special, critical, and NUREG-0612 heavy load lifts

A lift director is typically a position and/or designation that is specific to each nuclear site. As such, these personnel are not readily portable among nuclear power utilities.

3.3.3.4 Signalpersons

An individual performing signaling functions should meet qualification requirements of OSHA 29CFR 1926.1428. This qualification is often included in rigger or crane operator qualifications as a matter of efficiency. Signalpersons should be identified in accordance with site policy. Items such as colored vests/reflective clothing are often helpful to ensure that signalpersons are readily identifiable.

Key Human Performance Point

Ensure that supplemental employees are briefed on site signalperson identification practices.

Generally, a person is either a qualified rigger or a qualified crane operator. The requirements for a signalperson are broken out separately because OSHA has specific qualification requirements, as previously stated, and because riggers and crane operators should be qualified signalpersons.

Key Cost Point

Using workers who are qualified to be **only** signalpersons is not considered an efficient deployment of personnel.

Supervisors have the latitude to use a signalperson who is not a qualified rigger to perform signaling functions for identical or near-identical load handling activities using permanently installed rigging equipment as described in Section 3.3.2, “Rigging of Pre-Engineered Lifts Not Under a Rigger Qualification.”

Those performing signaling functions should do the following:

- Understand the utility-specific lifting program processes.
- Maintain proficient skills in lifting operations.
- Be responsible and accountable for directing the safe transport of the load.
- Request work assignments to retain proficiency.
- Provide instruction for teammates during planning and lifting processes.
- Be involved and know the lift plan. Discuss with the operator the blind or inaccessible areas, how signaling will be performed, and who will be signaling.
- Know the location of the crane mainline disconnect.
- Suspend or discontinue signaling of crane operations in weather that causes unsafe conditions.
- Not direct a lift requiring side pull on the hoist, unless approved by the lifting coordinator.
- Be responsible, with crane operator, for compliance with operating procedures involving personnel baskets to lift individuals.

- Be aware of the environment and capabilities of the crane, rigging hardware, and lifting equipment/devices.
- Ensure by inspection or verification with rigger that the correct rigging configuration is being used, or do not direct lifting of the load.
- Determine and secure the load path by roping off as necessary. Prior to the lift, review the load path, set point, and laydown areas for acceptable conditions.
- Ensure that shipping crates are appropriately designed and approved for material handling when using cranes or hoists to raise, suspend, move, transport, or lower materials in shipping crates.
- Transport loose parts in material handling containers.
- Ensure that the swing path of counterweight is roped off.
- During lifting operations, remain attentive to the lifting task, focus on the transport of the load, and avoid distraction by other individuals.
- Ensure that individuals are not positioned between the load and surrounding objects.
- Be in constant communication (radio or visual) with the operator at all times.
- Watch for individuals entering the load path, and ensure that individuals clear the area.
- Be responsible, with the rigger, for ensuring that the laydown area will support the load (contact engineering as required).
- During operation of the crane, if any equipment is suspected to be damaged, discontinue operation and inspect equipment.

3.3.4 Rigging Personnel Training

A detailed discussion of training opportunities for rigging personnel is provided in Appendix E of this report.

3.3.5 Rigging Personnel Qualification

Qualified riggers must be used for any hooking, unhooking, or guiding a load, assembly, disassembly of equipment, and other tasks. These personnel must meet the industry definition of *qualified* in order to rig the load. Follow local regulations in determining the level of qualification necessary for the position. Qualified riggers must be trained, tested, and designated by the appropriate utility person.

3.3.6 Maintaining Portability of Rigging Personnel to Different Plants

To standardize the skills necessary for qualification of Rigger I and Rigger II personnel, plants are encouraged to use and follow the EPRI STE for each of these positions. The STEs provide detailed lists of skills typical for each level of rigging typically encountered at a nuclear power plant.

Key Cost Point

To standardize the skills necessary for qualification of Rigger I and Rigger II personnel, plants are encouraged to use and follow the EPRI STE for each of these positions.

3.3.7 Qualification Frequency for Rigging Personnel

Plants should consider a qualification cycle of every three years for rigging personnel. At some sites, this qualification period coincides with every other refueling outage, which typically occurs every three years. This three-year qualification cycle should be applied to both Rigger I and Rigger II personnel.

3.3.8 Requalification of Rigging Personnel

In cases where a rigger's qualification has been revoked or suspended, the appropriate plant management personnel should defer to using the processes described in their standard maintenance training/qualification programs.

3.4 Crane and Hoist Operating Personnel

3.4.1 Roles and Responsibilities

The roles and responsibilities of cab-operated bridge and gantry crane operators and floor-operated bridge and gantry crane operators are provided in EPRI report 1007914. In general, the operator should be certified in accordance with the utility's approved certification program (for example, OSHA 29CFR 1926.1427). See Section 3.4.2.2. The operator should also attend the appropriate utility-specific training. Utility-specific training should cover such subjects as the details
of a particular crane that will be operated, safe load paths (such as required by NUREG-0612 or NML-1), or other subjects needed because of the physical characteristics of the plant or regulatory commitments.

3.4.2 Training and Qualification

3.4.2.1 Crane Operator Training

A detailed discussion of training opportunities for crane and hoist operating personnel is provided in Appendix E of this report.

Key Human Performance Point

Appropriate plant personnel should ensure that supplemental crane operators receive orientation training on specific cranes that they have not operated recently.

3.4.2.2 Crane Operator Qualification

Qualification of crane operators is governed primarily by OSHA regulation 1926.1427.

Permanently Mounted Cranes

Qualification of personnel operating permanently mounted cranes, such as reactor building cranes, containment polar cranes, turbine building cranes, and auxiliary building cranes, should be in accordance with OSHA 1910.179. These permanently mounted cranes are to be operated by "designated" personnel defined by OSHA as selected or assigned by the employer or the employer's representative as being qualified to perform specific duties. Therefore, the EPRI guidance contained in *Nuclear Maintenance Applications Center: Crane Maintenance and Application Guide: Maintenance and Application of Overhead Cranes (Containment, Fuel Building, Turbine Building, and Intake Structure)* (1022507) should apply. This guidance is also consistent with ASME B30.2, which states:

> Crane operators shall be required by the employer to pass a written and oral examination and a practical operating examination unless able to furnish satisfactory evidence of qualifications and experience. Qualifications shall be limited to the specific type of equipment for which the operator is being examined.

Non-Permanently Mounted Cranes

Although many lifts at nuclear plants are not classified by plant personnel as "construction" activities, a sufficiently large number of lifts are complex enough that they could be considered construction lifts as defined by OSHA or are indeed construction lifts because they involve replacement of components with non-identical (that is, not like-for-like) equipment. OSHA 29CFR 1926.1427 provides the following options for obtaining certification:

- Option 1: Certification by an accredited crane operator testing organization.
- Option 2: Qualification by an audited employer program (auditor must be an accredited crane operator testing organization).
- Option 3: Qualification by the U.S. military. For purposes of this section, an operator who is an employee of the U.S. military is considered qualified if he/she has a current operator qualification issued by the U.S. military for operation of the equipment. An employee of the U.S. military is a federal employee of the Department of Defense or Armed Forces and does not include employees of private contractors. (This option would typically not be applicable for commercial nuclear facilities and would not be portable from a military application to the nuclear power industry.)
- Option 4: Qualification by a government licensing department/office. (This option is currently applicable only to government agencies, and, if used, might preclude the portability of individuals to utilities other than those entities.)

It is recommended that plants select Option 1 or 2 based on fleet/site needs and cost benefits and portability of workers. In the case of government agencies, sites within this fleet should select Option 1, 2, or 4.

Key Information Point

An individual qualified to the requirements of OSHA 1926.1427 should also be considered qualified under 1910.1427.

Key Information Point

Crane operators should be knowledgeable about rigging practices. This should be through crane operator training or an option that the operator has been at one time been qualified as a Rigger I or Rigger II.

3.4.2.3 Qualification Period

Like riggers, plants should consider a qualification cycle of every three years for crane operators. At some sites, this qualification period coincides with every other refueling outage, which typically occurs every three years.

3.4.2.4 Medical Requirements

Crane operators at nuclear plants should be physically capable of operating the crane and under a fitness-for-duty program as described for U.S. plants in 10CFR26; Canadian Nuclear Safety Commission REGDOC 2.2.4, “Fitness for Duty”; or similar regulations for other countries. Appropriate plant personnel should also ensure crane operator compliance with medical requirements required by local jurisdictions.

3.4.2.5 Recertification

Revocation and reinstatement of these qualifications should be in accordance with each fleet/site qualification program.

3.4.2.6 Methods to Maintain Portability of Crane and Hoist Operating Personnel to Different Plants

To standardize the skills necessary for qualification of crane and hoist operating personnel, plants are encouraged to use the EPRI STE for this position. The STEs provide detailed lists of skills typical for each level of crane operation typically encountered at a nuclear power plant.

3.4.2.7 Qualification of Contracted Crane Operators

Contracted operating engineers who will operate station cranes should be required to prove current crane operator certification by presenting a certification license/card that must contain the following information:

- Photo of individual
- Name of operator
- A listing of the types of cranes that he/she is qualified to operate
- The issue and expiration date of the crane operator certification

Additionally, the contracted crane operator must have a medical examiner's certification that the individual is medically qualified to perform duties or satisfactory completion of the utility's crane operator medical examination.

Specific cranes at a site might require additional qualifications to operate. This is based upon the unique features of the crane, the unique operating conditions associated with the crane, or nuclear regulatory requirements. A qualified crane operator should obtain a site-specific or crane-specific qualification by the following:

- Certification for the specific type of crane
- Training at the site or station concerning the unique crane features, the unique operating conditions, or site-specific procedures associated with operating the crane
- Successfully completing a bypass examination (assessment) or acknowledgment by an evaluator that the individual demonstrates the necessary skills and abilities to operate the crane

3.5 Crane Operator-in-Training

A crane operator-in-training should have sufficient training to operate the crane that they are operating. They must be under the continuous observation of a trainer, and both the trainer and operator-in-training must be positioned to see the load at all times. Care should be taken to understand any limitations on lifts by operators-in-training as described in OSHA 29CFR 1926.1427 (such as personnel or certain distance from power lines), as follows:

- If any part of the equipment, load line, load or rigging if operated up to the equipment's maximum working radius could get within 20 ft (6.1 m) of a power line that is up to 350 kV or within 50 ft (15.2 m) of a power line that is greater than 350 kV
- If the equipment is used to hoist personnel
- In multiple-equipment lifts
- If the equipment is used over a shaft, cofferdam, or in a tank farm
- In multiple-lift rigging operations (except where the operator's trainer determines that the operator-in-training's skills are sufficient for this high-skill operation)

Key Human Performance Point

As noted in Section 5, crane operators-in-training are not to operate the crane during critical lifts.

3.6 Inspectors of Hoisting, Rigging, and Crane Equipment

Individuals designated to inspect hoisting and rigging hardware—either prior to a lift or periodically in accordance with the site's preventive maintenance program—should minimally be qualified as a Rigger I or be assisted by a qualified rigger when the operation requires rigging. This can address third-party inspectors, among other things.

According to EPRI guidance, individuals designated to inspect mobile and overhead cranes should be able to achieve two specific maintenance objectives. First, they should ensure that all weight-handling equipment is maintained in a safe operating condition, whenever it is needed. Second, they should confirm that equipment is serviced at specified intervals, in accordance with the manufacturer's specifications and recommendations; federal, state, and local laws; and industry standards (such as OSHA and ANSI/ASME).

Maintenance tasks involving inspections and frequencies are provided in EPRI reports 1025239 for mobile cranes and 1022507 for overhead bridge cranes.

3.7 Hoisting, Rigging, and Crane Equipment Maintenance Personnel

Plants should implement guidance contained in ASME B30 standards regarding the training and qualification of personnel maintaining hoisting, rigging, and crane equipment. The qualification process for these maintenance personnel should be similar to that used for personnel performing other maintenance tasks and should be consistent with current site/fleet procedures. Appendix F provides a list of these ASME B30 series standards.

3.8 Hoisting and Crane Maintenance Strategies

Each site should designate a person or persons responsible for establishing and implementing a maintenance strategy for hoisting, rigging, and crane equipment. These individuals should be qualified in accordance with current site/fleet procedures and might have collateral roles and responsibilities. Titles for these individuals vary among sites; they might include *crane engineer*, *component engineer for cranes*, and so on.

The strategies should be commensurate with the purpose for which the equipment is used, the environment under which it is operated and stored, the number of times it is used, and the amount of load it experiences based on its capacities. Maintenance guidance is provided in EPRI reports 1025239 for mobile cranes and 1022507 for overhead bridge cranes.

4
LIFT CLASSIFICATIONS AND APPLICATIONS

This section classifies the types of lists into three major categories and defines what constitutes each type of lift. This section also provides guidance on when load cells are appropriate.

4.1 Classification of Lifts

4.1.1 Introduction

For the purposes of this report, lifts have been classified/categorized based on the purpose and type of lift being undertaken, taking into account the risk associated with a malfunction or accident occurring. The user should note that the lifts have not been classified based on the rigger level selected or qualified to perform them. As shown on Figure 4-1, the three classifications for lifts are “standard lifts,” “special lifts,” and “critical lifts.” Note that NUREG- 0612 Heavy Load Lifts are a type of critical lift.

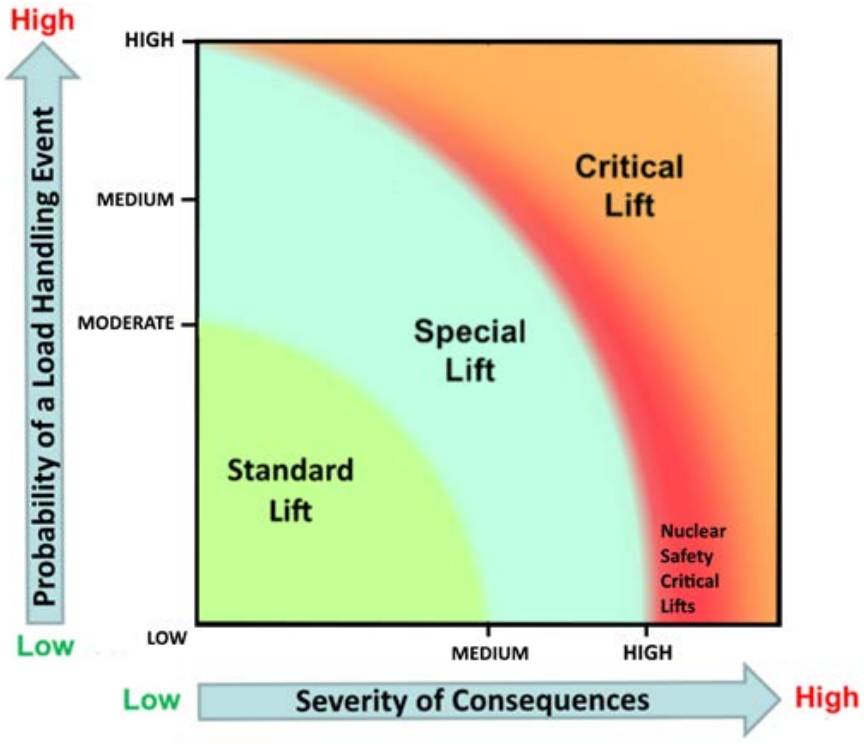

Figure 4-1
Risk classification of lifts

Preliminary lift plans should be developed for the purposes of lift classification based on the proposed handling equipment, the proposed load, and the environment surrounding the proposed lift path. Lifts should be separated into three classifications: standard, special, and critical. The classification is based upon the risk associated with the lift according to Figure 4-1.

By definition, nuclear safety critical lifts are a subset of critical lifts. However, a critical lift is not a nuclear safety critical lift, unless that lift meets the definition of a nuclear safety critical lift.

Lifts with high probability factors shall not be performed until actions are taken to mitigate those factors. For other lifts that approach a high probability, consideration should be given to mitigating any high probability factors in order to reduce the risk of the lift. High probability factors include the following:

- The weight of the load has not been calculated or measured.
- The lift involves a mobile crane setup on terrain that has not been evaluated and determined suitable for expected loading.
- The load has an unknown or shifting center of gravity.
- The lift involves lifting devices, rigging hardware, or slings without safe working load markings.
- The lift is performed with the crane working clearances to adjacent electrical power lines within plus 10% of minimum clearances specified in the ASME standard for the respective crane.
- Sling angles are less than 30% above horizontal.
- The load is submerged in liquid and not visible.
- The preliminary lift plan shall be re-evaluated to validate that all high probability factors are eliminated.

As shown on Figure 4-1, the lifts are classified based upon risks associated with their respective execution. Each of these three lift classifications will be described in the following sections, but in summary, the three lifts are categorized as shown in Table 4-1.

Table 4-1
Lift classification based on consequences and probability

Type of Lift	Standard	Special	Critical (Including NUREG-0612 Heavy Load)
Severity of Consequence	Low to medium consequences	Medium to high consequences	High consequences
Probability of a Load Handling Event (1)	Low to moderate probability	Moderate to high probability	High probability (2, 3)

Notes:

1. Initial assessment as noted during the development of the lift plan.
2. By definition, NUREG-0612 lifts are a subset of critical lifts. However, a critical lift is not a NUREG-0612 lift unless that lift meets the definition of a NUREG-0612 lift.
3. Lifts with high probability factors shall not be performed until actions are taken to mitigate those factors. For other lifts that approach a high probability, consideration should be given to mitigating any high probability factors in order to reduce the risk of the lift. Only in extreme circumstances and with high levels of approval should plant personnel allow a lift with high probabilities of a load handling event (such as lifts to save a life or prevent a serious safety event).

Key Safety Point

Factors that increase the probability of a load handling event should be driven from high to as low as reasonably achievable.

Key Technical Point

NUREG-0612 lifts are a subset of critical lifts, but not all critical lifts are NUREG-0612 lifts.

Section 5 describes the recommended treatment for each type of lift, and plant personnel are encouraged to adopt the terminology provided in this report to maximize opportunities for portability of rigging/lifting personnel among nuclear power plants and utilities by using standard terms.

4.1.2 Quantification of Risk

The risk associated with a lift is determined by the probability and consequences of a malfunction or accident. Tables 4-2 and 4-3 contain the probability factors and consequence factors that are used in the determination.

Table 4-2
Probability factors

Rating	Factors Affecting the Probability of a Malfunction or Accident
Medium	Weight of load is estimated.
	Lift involves guides or other alignment methods.
	Load is submerged in liquid and visible.
	Lift uses more than one hook.
	Lift uses more than one crane.
	Center of gravity of load is above load attachment points.
	Drifting of load between one or more overhead attachment points.
	Load >90% capacity for any crane with a radius-based capacity or a planned engineered lift for an overhead crane.
	Load imposed on either crane >70% of its capacity when two radius-based cranes are being used.
	Lift involves rigging, attachments, lifting devices, or methods that are not covered in OSHA, ASME, or industry rigging handbook requirements.
	Lift performed in switchyard near energized electrical equipment.
	Lift using engineered temporary lift assemblies.
	Lift performed with a floating crane.
	Lift requires access into a confined space or tight area limiting movement of personnel or overhead handling equipment.
	Lifts performed that involve rolling, up-ending, or down-ending components.
	Lifts performed that require side-loading outside the plane of sheave rotation.
	Lift performed in severe weather conditions.
	Lift performed when signalperson does not have direct line of sight with the crane operator.
	Center of gravity of load is >12 in. (305 mm) from geometric center.
Moderate	Sling angles for load >30° and <45° above horizontal.
	Lift performed using more than two attachment points.
	Lift performed in emergency conditions (as defined by plant-specific processes).
	Lift performed using snatch blocks or base-mounted drum hoist (that is, tugger).
	Lift performed that requires side-loading inside the plane of sheave rotation.
	Lift performed using a below-the-hook lifting device.
	Lift performed with a potential for binding.
	Lift performed with an intermediate hoist.
Low	None of the factors listed in this table is present in the lift.

Table 4-3
Load event consequences

Rating	Results of a Malfunction or Accident
High	Could result in a high-energy system, such as steam, electrical, or hydraulic systems, being breached
	Could result in injury/death to personnel located on or under the load
	Could destroy a high-value item
	Could destroy a long-lead procurement item
	Could adversely affect the availability of safe shutdown equipment
	Could cause a hazardous chemical release
	Could result in loss of a heat sink
	Could result in a loss of all three fission product barriers
	Could result in release of radioactive material exceeding 10CFR Part 100 limits
	Could result in configuration of the fuel such that the coefficient of criticality, K_{eff}, is larger than 0.95, which is near the point of nuclear fuel criticality
	Could result in volatile load being compromised
	Could result in water leakage that uncovers any irradiated fuel or causes a dilution event
	Could cause physical or consequential damage in excess of the insurance deductible to plant structures, systems, or components
	Could result in an outage longer than 10 weeks, or could cause a significant spread of contamination or uncontrolled radioactive release to the environment
Medium	Could damage a special (risk-significant) system, structure, or component
	Could result in a medium-energy system, such as steam, electrical, or hydraulic systems, being breached
	Could damage a high-value item
	Could damage a long-lead procurement item
	Could result in an unplanned shutdown
	Could result in the loss of a system that would prevent any non-nuclear emergency system, such as fire protection, from fulfilling its duties
	Could result in a loss of any single fission product barrier
	Could result in a decrease in the Mitigating Systems Performance Index
	Could result in a derating of plant output
	Could result in a reportable environmental spill not contained on site
	Could result in contamination of groundwater
	Could cause a critical path delay of a unit outage of more than 24 hours
	Could result in physical or consequential damage in excess of the insurance deductible
	Could result in a forced outage longer than 10 weeks
Low	None of the results listed in this table could occur from performing this lift

Probability is a measure of the difficulty to perform a lift. Table 4-2 contains factors that affect the probability of a malfunction or accident. The user should review the table and determine which factors apply to the lift being performed. The rating of low, moderate, or medium for any applicable factors provides a probability level. If more than one factor applies to a lift, the user shall increase in increments within the probability rating for each additional factor.

Consequences are the result of a load drop event. Table 4-3 contains possible consequences of a load handling event. The user shall review the table and determine which consequences apply if a malfunction or accident occurs. The rating of low, medium, or high for any applicable consequences provides a consequence level from a malfunction or accident. If more than one result applies to a lift, the user shall increase in increments within the probability rating for each additional factor.

The management of the different lift categories is covered in Section 5.

4.1.3 Standard Lifts

A standard lift has low to medium consequences of a lift event with low to moderate probabilities of occurrence, as shown in Figure 4-1.

4.1.4 Special Lifts

A special lift using overhead handling equipment requires, due to the medium risk associated with the lift and medium to high consequences of a lift event, the establishment of additional controls at the facility to identify, minimize, and manage the risk associated with making the lift, as described in Section 5.

4.1.5 Critical Lifts

4.1.5.1 General

A critical lift using overhead handling equipment requires, due to the high risk associated with the lift, the establishment of further additional controls at the facility to identify, minimize, and manage the risk associated with making the lift, as described in Section 5. The types of critical lifts are covered further in the following.

4.1.5.2 NUREG-0612 Heavy Load Lifts

Heavy Load Lifts are defined in NUREG-0612 as follows:

> Movement of heavy loads to minimize the potential for heavy loads, if dropped, to impact irradiated fuel in the reactor vessel and in the spent fuel pool, or to impact safe shutdown equipment.
>
> Heavy loads in this context are defined as the weight of a fuel assembly and its associated handling tool unless otherwise defined in the site safety analysis report.

A facility that moves loads that fall under the control of NUREG-0612 should establish a control-of-heavy-loads program. At least one of the following should be employed during the handling of NUREG-0612 lifts:

- **Controlled ranges of motion**. Interlocks or physical stops should be used to prevent the movement of loads to positions where a drop could threaten the performance of an essential safety function.
- **Enhanced safety handling systems**. Enhanced safety handling systems should be designed to have an extremely low likelihood of system failure through designs incorporating single-failure-proof features and/or significantly increased margins of safety. Enhanced safety handling systems should consist of the following two elements:
  - Cranes or hoists that meet the requirements of Section 4110(a)
  - Lifting devices that satisfy either of the following criteria:
    - Lifting devices that meet the Critical Lift requirements of Table 5100-1 should be used for recurrent lifts in critical areas.
    - Commercially procured rigging selected to satisfy the criteria of Section 5200.
- **Engineering controls**. Bounds for safe handling should be based on analysis of the consequences of a postulated load drop, equipment failure, and/or unintended load motion, with respect to a critical load handling evaluation. These bounds should define the safer load path, maximum safe load height, maximum safe load weight, and other critical parameters as applicable. These bounds should be specified in load handling procedures:
  - Analyses of a postulated load drop, equipment failure, and/or unintended load motion analysis should as a minimum include the following considerations; other considerations might be appropriate for the particular load drop being analyzed (reactor vessel head assembly, spent fuel cask, and so on):
    - The load is dropped in a credible orientation, considering single failure points in the rigging, reeving system, and crane hoist drive system, that results in the most severe consequences.
    - The load may be dropped at any location in the crane travel area.
    - Analyses should be based on an elastic-plastic curve that represents a true stress-strain relationship of the materials.
    - The analysis should determine realistic damage states with an appropriate margin for uncertainty. The analysis should consider minimal damping to ensure that the calculated energy absorbed by the dropped load and the impacted structure and/or equipment bounds the actual energy absorption.
    - Postulated load drops need not be analyzed if their consequences (in terms of drop energy per unit impact area) are bounded by the analysis of another load drop.
    - Mechanical, electrical, or control equipment failure.
    - Unintended load motion caused by human error or equipment failure.

- Evaluation of radiation dose consequences should consider the maximum effective release of radioactive material based on decay and potential damage state, available filtering and confinement systems, and credible atmospheric dispersion of the release in determining offsite dose consequences.
- Equipment that is reliable, regularly operated, and well maintained may be credited to mitigate the effects of the load drop.

– The following criteria define the acceptable consequences of the postulated load drop:

- Release of radioactive material that can result from damage to spent fuel based on calculations involving accidental dropping of a postulated load produces doses that are equal to or less than one-quarter of 10CFR Part 100 limits—300 REM thyroid, 25 REM whole body.
- Damage to fuel and fuel storage racks based on calculations involving accidental dropping of a postulated load does not result in a configuration of the fuel such that the coefficient of criticality (Keff) is larger than 0.95.
- Damage to the reactor vessel or the spent fuel pool based on calculations of damage following accidental dropping of a postulated load is limited so as not to result in water leakage that could uncover the fuel. Makeup water provided to overcome leakage should be from a borated source of adequate concentration if the water being lost is borated.
- Damage to equipment in redundant or dual safe shutdown paths, based on calculations assuming that a postulated load drop will be limited so as not to result in loss of required safe shutdown functions.

4.1.5.3 Additional Requirements for NUREG-0612 Heavy Load Lifts

Compliance with detailed requirements for NUREG-0612 heavy load lifts is the responsibility of each utility and should support the utility's commitments to this regulation.

4.1.5.4 Other Types of Lifts That Could Be Critical

This section covers other types of lifts that could be classified as critical. These classifications might vary among sites and different types of nuclear facilities.

Key Information Point

Other subsets of critical lifts can include planned engineered lifts, lifting of personnel, and critical lifts at U.S. Department of Energy (DOE) nuclear facilities.

Key Information Point

Using the lift classification guidance in this report will ensure consistency with the critical lift classification described in the Nuclear Energy Insurance Limited (NEIL) definition. As such, if a program is following the guidance in this report and ASME NML-1, it will comply with NEIL as it relates to classifying a lift as critical.

Planned Engineered Lifts

Lifts in excess of the rated load might be required from time to time on a limited basis for specific purposes, such as new construction or major repairs. Every planned engineered lift exceeding the rated load shall be treated as a special and separate event. ASME B30.2-3.2.1.1 requires that the following procedures be met when lifting more than the crane's rated capacity:

- Limitations and planned requirements shall be applicable, as follows:
  - Planned engineered lifts shall be limited to powered cranes having a load rating of 5 tons and above.
  - When planned engineered lifts are made, the load shall not exceed 125% of the crane load rating, except as provided in the following.
  - Planned engineered lifts shall be limited to two occurrences on any crane within any continuous 12-month period, except as provided in the following. If greater lift frequency is desired, consideration shall be given to rerating or replacing the crane.
  - The crane manufacturer shall be consulted if the planned engineered lift exceeds 125% of rated load or if the frequency of planned engineered lifts exceeds two during a continuous 12-month period.
- Each planned engineered lift shall comply with the following requirements:
  - A written review of the crane service history shall be prepared, including reference to previous planned engineered lifts, structural repairs, and modifications of original design.
  - The design of the structural, mechanical, electrical, pneumatic, and hydraulic components of the crane shall be reviewed, by means of applicable calculations for the load to be lifted, and approved by the crane manufacturer or a qualified person, in accordance with accepted crane design standards if the load to be lifted exceeds 125% of rated load, or if the frequency of planned engineered lifts exceeds two during a continuous 12-month period.
  - The design of the crane-supporting structure shall be reviewed and approved by a qualified person for conformance to applicable design criteria. The crane support shall be inspected, and any deterioration or damage shall be taken into consideration in design calculations for the load to be lifted.
  - Immediately before making the lift, the crane shall be inspected in accordance with periodic inspection requirements.

  - The lift shall be made under controlled conditions under the direction of a designated person in accordance with a previously prepared lift plan. All persons in the area of the crane shall be alerted that the lift is being made.
  - The operator shall test the crane at the planned engineered load by lifting the load a short distance and setting the brakes. The lift shall be continued only if the brakes stop and hold the load. Any failure to hold the load shall be corrected before proceeding with the lift.
  - The crane shall be inspected in accordance with periodic inspection requirements after the lift is completed and prior to being used for the lifting of any other load.
  - A record of the planned engineered lift, including calculations, inspections, and all distances moved, shall be placed on file for availability to appointed personnel.
- The rated load testing described in ASME B30.2 (2011), Paragraph 2-2.3.2, is not applicable to planned engineered lift provisions.

Key Technical Point

ASME B30.2 requirements should be used while conducting load testing for engineering lifts.

Personnel Lifts

The following excerpts are taken from 29CFR 1926.550, which states, in part:

> At each job site, prior to hoisting employees on the personnel platform, and after any repair or modification, the platform and rigging shall be proof tested to 125 percent of the platform's rated capacity by holding it in a suspended position for five minutes with the test load evenly distributed on the platform (this may be done concurrently with the trial lift). After proof testing, a competent person shall inspect the platform and rigging. Any deficiencies found shall be corrected and another proof test shall be conducted. Personnel hoisting shall not be conducted until the proof testing requirements are satisfied.

ASME B30.23-2016, "Personnel Lifting Systems," provides detailed implementation guidance for compliance to 29CFR1926.550, and it defines a personnel lift as the use of hoisting and accessory equipment used to lift, lower, hold, or transport personnel in a platform, by wire rope or chain, from hoist equipment, or by a platform that is mounted on a boom of the hoist equipment.

Similarly, EPRI report 1007914 provides guidance regarding personnel lifts and the design, rigging, maintenance, and safe operation of lifting platforms and personnel baskets. Detailed guidance is provided regarding the need for a trial lift, personnel platform loading, rigging, safe work practices, and traveling of the crane. The following appendices in this report provide guidance regarding personnel that is consistent with ASME B30.23-2016:

- Appendix G, "Personnel Platform Planning and Authorization Form"
- Appendix H, "Personnel Lift Platform Pre-Lift Inspection Form"
- Appendix I, "Lifting Personnel Near Electric Power Lines"

Critical Lifts for DOE Nuclear Facilities

Critical lift designation implements administrative and physical controls to minimize the possibility of equipment failure or human error to a hoisting or forklift operation involving a load that poses unacceptable consequences if mishandled. At DOE facilities, a lift should be designated as a critical lift when any of the following criteria are met, unless otherwise specifically defined in safety basis:

- If loss of control of the item being lifted would likely result in declaration of a "site area emergency" or "general emergency" as defined in the facility emergency plan or construction site emergency plan. All DOE facilities are required to have an emergency plan based on potential accident scenarios resulting in radiological or chemical releases according to DOE-O223, "Emergency Plan Implementing Procedure." Each facility shall determine the potential release quantities in the event of the loss of control. Designate the lift as a critical lift if the potential release could result in a "site" or "general" emergency. For construction sites, apply requirements in 29CFR 1910 and/or 29CFR 1926.
- The item being lifted is unique or vital to a system, facility, or project operation and if damaged would be irreplaceable or not repairable.
- The cost to replace or repair the item being lifted or the delay in operations of having the item damaged would have a negative impact on the facility, organizational, or DOE budget to the extent that it would affect program commitments.
- The item, although noncritical, is to be lifted above or in proximity to a critical item or component.
- The load being lifted is 90% or more of a mobile crane's configured load chart rating.
- Two mobile cranes are lifting the load, and the load share equals more than 70% of one or both crane's chart rating for the maximum radius that will be experienced. In no case shall two crane lifts be performed in excess of 75% of either crane's load rated capacity at the planned radius.

5
LIFTING GUIDELINES

This section provides guidance regarding the planning of lifts and how each type of lift should be conducted that was classified considering the guidance provided in Section 4 of this report. In general, every lift performed in a nuclear facility should have a single individual in charge of the lift. This individual should be at least qualified to Rigger I and be a member of the rigging crew.

Special lifts and critical lifts should have a lift director providing independent oversight of the lift. The lift director should have the following qualifications:

- Be capable and competent to oversee and manage critical lift activities
- Hold a Rigger II qualification
- Be able to perform nearly any common, complex, or critical lift activity due to his/her training, experience, knowledge, skill, and ability
- Be designated by the site maintenance director

5.1 Planning and Execution of Lifts

Figure 5-1 illustrates the generic process for performing safe lifting/rigging tasks at power plants, and as noted in Figure 5-1, planning of lifts is a key step in the process. Figure 5-1 is a simplified and updated version of the process described in EPRI report 1007914.

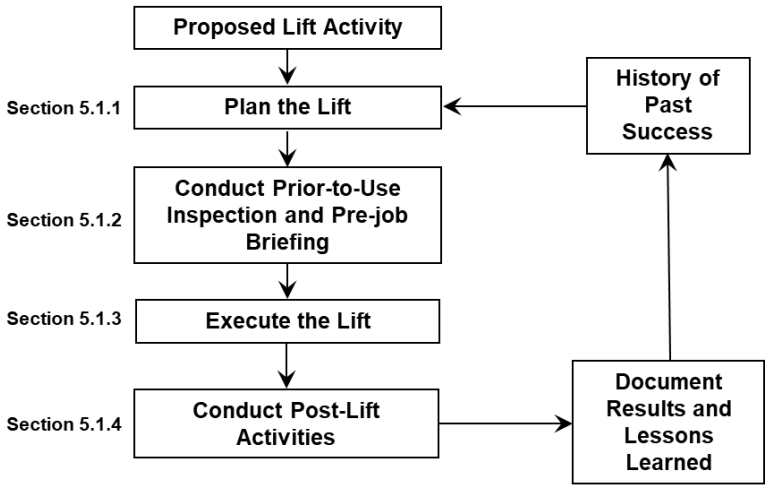

Figure 5-1
Generic process for performing a safe lifting/rigging task

5.1.1 Plan the Lift

The purpose of this step in the generic process is to ensure that a technical person or group of technical personnel has adequately planned and evaluated the lift.

Key Human Performance Point

Under no circumstance should a lift be conducted relying solely on one individual's "skill-of-the-craft" knowledge and/or experience.

As such, the verification of personnel qualification and/or certification, when appropriate, is inherent for effectively implementing the process described in this section.

To ensure safe and effective lifting, each lift should be planned and evaluated depending on the type of lift being undertaken, as classified in Section 4 of this report.

Program procedures should emphasize the importance of planning the lift, to include the following tasks and activities:

- Determine if the load is to be carried over or in direct vicinity of safe shutdown equipment or irradiated fuel.
- Determine the type of lift (for example, standard, special, or critical).

Key Technical Point

Note that the lift classification may be changed over time, based on changes to risk probabilities or consequences that can be reduced during lift planning.

- Determine if the lift is an infrequently performed task or evolution (IPTE).
- Determine if the load path will go over foreign material exclusion (FME) areas.
- Determine if lift requires or will impose other hazards restrictions (for example, lifting the ESW pump house roof plugs will impose restrictions per hazard barrier program).
- Determine the fall zone and lift path areas and control methods.
- Determine the load weight (actual or "not greater than").
- Determine the center of gravity of the load.
- Determine the lifting and rigging equipment required, ensuring that capacities will not be exceeded.
- Determine the required L&R equipment attachment points.
- Determine the laydown requirements (floor loading, cribbing, and so on)
- Determine the communications to be used.
- Acquire ground stability review (mobile cranes only).
- Determine "stop lift" criteria.

- Walk down the lift site to note obstructions on plan.
- Complete the appropriate plans/forms. (Appendix J provides examples of documents used to develop a lift plan that can be used for any of the types of lifts described herein.)
- Acquire the appropriate approvals.
- Determine who is responsible for the lift. This is referred to in this report as the *person in charge*.

Key Benchmarking Point

Consistent with INPO SOER 91-1, "Conduct of Infrequently Performed Tests or Evolutions," site guidance for infrequently performed tests or evolutions should be considered when planning and evaluating a lift.[1]

5.1.2 Conduct Prior-to-Use Inspection and Pre-Job Briefing

Program procedures should emphasize the importance of conducting inspections of rigging hardware and a pre-job brief. These activities should include the following tasks and activities:

- Assign personnel to positions, ensuring qualifications
- Discuss the lift plan
- Discuss error-prevention tools
- Discuss OSHA-required pre-job brief questions

5.1.3. Execute the Lift

Program procedures should describe how the following activities should be addressed during lifting of the load:

- Acquire and inspect lifting and rigging equipment
- Install/position lifting and rigging equipment
- Walk down the load path for obstructions/hazards; remove or mitigate
- Establish FME controls as required
- Establish laydown area (barricades and cribbing if required)
- Establish and test (if applicable) communications
- Complete proper notifications as required by plan
- Establish and control the fall zone and lift path area (including the mobile crane swing zone)

[1] Access to INPO reports and materials is restricted to organizations authorized by INPO. The information is confidential and for the sole use of the authorized organization.

- Meet ground stability review requirements—mobile cranes only
- Perform lift-and-hold test
- Perform lift following lift plan

5.1.4 Conduct Post-Lift Activities

After lifting the load, program procedures should describe how the following activities are performed and documented:

- Complete proper notification as required by the plan
- Remove lifting and rigging equipment
- Inspect and return lifting and rigging equipment to proper storage
- Remove fall zone, load path, and FME area controls
- Provide lift critique items to supervisor (post-job brief)

5.2 Managing Different Types of Lifts

As noted in Section 4, determination of the lift category should be risk-based and should consider both the severity of consequences and the probability of a malfunction/accident. Table 5-1 summarizes how each type of lift should be treated.

Table 5-1
Treatment of different types/classifications of lifts

Type of Lift	Standard (1)	Special (1)	Critical (1)	
			General	NUREG-0612 Heavy Load
Planned By	Qualified rigger or engineering	Qualified rigger or engineering	Qualified rigger or engineering	Qualified rigger or engineering per procedure
Formal Procedure Required?	No	No	No	No
Lift Plan	Verbal	Written	Written or per procedure	Written and per procedure
Reviewed by:	Peer review during pre-job brief	Lift director	Lift director	Lift director
Senior Management Review?	No	No	Yes	Yes
Person in Charge of the Lift (2)	Rigger I or II	Rigger II	Rigger II	Rigger II

Notes:

1. All types of lifts should be evaluated to determine if IPTE requirements are applicable. If so, appropriate requirements, such as independent oversight, should be followed.
2. To avoid confusion during a lift, care should be taken when using the terminology *person in charge* or its acronym, PIC, with the terminology of picking a lift.

The following sections describe the recommended treatment for each type of lift, and plant personnel are encouraged to adopt the terminology provided in this report to maximize opportunities of portability of rigging/lifting personnel among nuclear power plants and utilities by using standard terms.

5.2.1 Standard Lifts

Guidance for planning a standard is provided in EPRI 1009706, *Rigger's Handbook*, and ASME P30.1-2014, Chapter 4, "Planning for Load Activities." Typically, a Rigger I (or higher) would be adequate to plan a standard lift, and a documented lift plan would not be necessary. In many cases, a verbal lift plan is adequate.

For these types of lifts, the planner can obtain a peer review from another rigger, and because these lifts are the simplest of the three categories, the lift team can opt to use the pre-job briefing as the most efficient means to ensure that all members of the lift team are prepared and aware of any special considerations. Similarly, a senior management review of the lift planning would not be necessary. Finally, oversight by a Rigger I or II would be appropriate.

5.2.2 Special Lifts

Guidance for planning a special lift is provided in EPRI 1009706, *Rigger's Handbook*, because this type of lift is not specifically designated in ASME P30.1-2014, "Planning for Load Activities." Typically, a Rigger II would be appropriate to plan a special lift, and a written lift plan is recommended. Guidance for developing a lift plan for a special lift is provided in EPRI 1009706, *Rigger's Handbook*.

For these types of lifts, the planner should obtain a review from a Rigger II or from site engineering personnel, especially in cases where the lift might impact protected equipment. In most cases, a senior management review of the lift planning would be necessary. Finally, oversight by the site program owner or fleet program coordinator would be appropriate.

5.2.3 Critical Lifts

5.2.3.1 General

Guidance for planning a critical lift is provided in EPRI report 1009706, *Rigger's Handbook*, and ASME P30.1-2014, Chapter 5, "Planning for Load Activities." Typically, a Rigger II would be needed to plan a critical lift, and a written lift plan is recommended. This is especially important when a planned engineered lift or a personnel lift is being undertaken. Guidance for developing a lift plan for a critical lift is provided in EPRI 1009706, *Rigger's Handbook*, and ASME P30.1-2014, "Planning for Load Activities."

For these types of lifts, the planner should obtain a review from the lift director, engineering, or operations personnel, especially in cases where the lift could impact protected equipment. In most cases, a senior management review of the lift planning would be necessary. Finally, oversight by the site program owner or fleet program coordinator would be appropriate.

Key Human Performance Point

As noted in Section 3, crane operators-in-training are not to operate the crane during critical lifts.

5.2.3.2 Heavy Load Lifts

Guidance for planning a NUREG-0612 Heavy Load Lift is detailed in the regulation and should be described in detail in site/fleet procedures. Other countries have similar regulations, as referenced in NEA/CNRA/R (2017) 4, "Heavy Load Accidents in Nuclear Installations." Because detailed requirements for these lifts are contained in site/fleet procedures, a Rigger I or II would be appropriate to plan a Heavy Load Lift, and a written lift plan should be developed in accordance with site/fleet procedures.

For these types of lifts, the planner should obtain a review from the lift director, engineering, or operations personnel. In most cases, a senior management review of the lift planning would be necessary. Finally, oversight by the lift director, engineering personnel, or senior management would be most appropriate.

Appendix J provides an example of a typical lift plan.

5.3 Additional Lift Considerations

An effective hoisting, rigging, and crane program should ensure that additional lift considerations, such as pinch points and lift zones, are adequately addressed in site/fleet procedures. Note that in some programs, a more general term, such as *line of fire*, is used, with the general term including pinch points of appendages, whole body positioning if load should swing or fall, and snap-back phenomena (vertical and horizontal).

5.3.1 Pinch Points

Program procedures should stress the importance of rigging safety and avoiding pinch points that could result in the loss of fingers, toes, or other appendages. In general, procedures to remind riggers to protect their hands by taking a defensive posture and adhering to the following rigging safety guidance:

- Do not position a rigger's hand so it can be caught between the load and an adjacent object when the load is initially lifted and when guiding the load.
- Do not allow a rigger to slow swinging loads by hand.
- Sideways movement and/or tilting when the load is lifted should be anticipated by the rigger.
- The rigger should use a tool to guide the cable or line onto a winching drum of a hoist.

Key Safety Point

If it is not possible to release the chain, sling, or choker, ensure that the rigger's hands are clear of pinch points. Riggers should keep their hands far enough away so that a frayed wire or splinter on the cable cannot catch their glove and jerk their hand into a pinch point.

5.3.2 Lift Zones

The hoisting, rigging, and crane program procedures should cover lift zones. The lift zone is sometimes referred to as a *fall zone* or *lift area for lift zone*, *zone of influence* and *fall zone for cone of influence*. In any case, the lift zone is an area in which the failure of a lift could result in injury to personnel.

The dimensions of each lift zone will vary from lift to lift and should be determined by the lift team based on lift characteristics, such as load dimensions, load height off ground, load weight, potential of lifting equipment failure, capability of the surface (such as a floor) below to support the load if dropped, weather, ground conditions, rigging configuration, and crane configuration.

It is recommended that the lift zone be identified (for example, by caution tape) and entry restricted by the person in charge to those necessary to execute the lift during the actual lifting operation.

Key Safety Point

Operating experience has shown that non-permanent lifting equipment inherently has more risk of failure/tip-over than permanently installed lifting equipment.

Key Safety Point

Materials must be rigged to prevent unintentional displacement.

Guidance regarding the control of lift areas and an example of one approach to lift zone dimensions are provided in Appendix K.

6
RIGGING HARDWARE

6.1 Procurement of Rigging Hardware

6.1.1 Classification of Related Equipment

With very few exceptions, the scope of equipment covered in this report would not be used to perform a nuclear safety-related function. In the vast majority of cases, the equipment addressed in this report would be classified as non-safety-related. Some utility-specific licensing commitments or program requirements could require that the equipment might be classified as augmented quality. As such, the extent to which each plant's nuclear quality assurance program, as defined in 10CFR50, Appendix B, applies to the control of this equipment will vary from site to site.

6.1.2 Evaluation of Alternative Equipment

Worn or damaged equipment (including spare parts) should be replaced with items that are physically identical to the original item and furnished from the original equipment manufacturer whenever possible. This might not be possible for the following reasons:

- The original item is obsolete.
- The replacement item has been modified by the manufacturer.
- The manufacturer is no longer capable of furnishing the item.

If one of these scenarios occurs, the alternative replacement should be evaluated by the utility's engineering organization to ensure that the current item is suitable for its intended application.

Key Human Performance Point

Evaluations of alternative lifting/rigging equipment that is not physically identical to the original equipment should be performed by engineering or other technical personnel.

6.1.3 Specification of Related Equipment

6.1.3.1 Specification of Technical Requirements

Individuals preparing requisitions or specifications should ensure that appropriate rigging/lifting equipment is procured for the safe performance of work activities. Care should be taken to ensure that rigging hardware is procured from audited and/or approved suppliers to be reasonably assured the material is not counterfeit, substandard, or fraudulent. Additional guidance regarding the prevention, detection, and control of such items is provided in the following EPRI reports:

- *Plant Support Engineering: Counterfeit and Fraudulent Items* (1021493)
- *Plant Support Engineering: Counterfeit and Fraudulent Items: Mitigating the Increasing Risk, Revision 1* (3002002276)
- *Counterfeit, Fraudulent, and Substandard Items, EPRI Computer-Based Training* (1020954)

As noted in EPRI 3002002276:

> Globalization of the supply chain and new manufacturing technologies are enabling an increase in the numbers of items being counterfeited. The growth of new manufacturing capabilities and demand for low-cost items in rapidly developing regions has increased the number of CFIs that make their way into the global supply chain.
>
> While we must continue to purchase the spare and replacement items required to support operations and maintenance, it is incumbent upon plant personnel and suppliers to remain vigilant and implement appropriate measures to detect, prevent, and control CFIs. As discussed in NRC Information Notice 2008-04, it is the responsibility of each licensee to ensure that CFIs do not impact the safety of their plant(s) [3]. There are clear precautions and measures that licensees and their suppliers should implement to reduce the risk that counterfeit items will end up in inventory—or worse, installed in plants.

6.1.3.2 Specification of Quality and Documentation Requirements

The specification of quality and documentation requirements should be dependent upon the extent that each plant's program credits the respective supplier's quality assurance program during the acceptance of the procured items. As such, the quality and documentation requirements that are specified will vary based upon the classification assigned to each item being procured.

Typical quality and documentation requirements that are often specified include the following:

- Certificates of conformance to manufacturer design requirements and purchase order requirements
- Performance of proof-tests and test results
- Personnel qualification and/or certification

6.2 Storage of Rigging Hardware

6.2.1 Equipment Susceptibility to Various Types of Damage

Adequate storage for all rigging hardware is to be provided in accordance with the manufacturer or the plant's engineering organization's recommendations. Storage locations should be established in areas where rigging hardware is adequately protected. Lifting/rigging hardware is susceptible, to varying degrees, to the following types of damage while in long-term storage (for example, a warehouse or maintenance facility):

- Corrosion, damage from humidity/condensation
- Airborne contamination (dust, salt, dirt, rain, snow, fumes)
- Deterioration from light/ultraviolet (UV), halogen exposure, or chemicals
- Magnetic damage
- Physical damage from other items in proximity
- Physical damage during handling
- Thread damage
- Physical distortion (kinking) due to stacking
- Deterioration from temperature

EPRI report 1007914 provides detailed guidance regarding equipment susceptibility to damage and the effects of the following parameters:

- Temperature
- Sunlight and UV radiation
- Chemically active environments
- Radiation
- Static electricity
- Exposure to boron

6.2.2 Storage Levels

The generic process described in EPRI report TR-107101, *Packaging, Shipping, Storage and Handling Guidelines for Nuclear Power Plants*, can be useful in developing specific packaging and storage requirements for various pieces of lifting/rigging hardware.

Key Technical Point

Typically, to ensure that the lifting/rigging hardware is adequately protected, the storage facility should meet the storage requirements for ANSI Level B or C items, as described in ANSI N45.2.2, "Packaging, Shipping, Receiving, Storage and Handling of Items for Nuclear Power Plants."

6.3 Maintenance of Rigging Hardware

Maintenance of rigging hardware can encompass inspections prior to using the hardware as well as after (that is, pre-use and post-use inspections). The frequencies of periodic inspections are provided in both EPRI documents and industry standards (for example, ASME B30.9 recommends a one-year interval for slings). If equipment is outside its inspection interval, it should be unavailable for issue until it receives the periodic inspection. This practice should include infrequently used rigging hardware.

Extensive maintenance guidance for rigging hardware is provided in EPRI 1007914, *Lifting, Rigging, and Small Hoists Usage Program Guide*.

6.4 Documentation

Documentation associated with the procurement, storage, issuance, use, and maintenance of rigging hardware should meet site/fleet procedural requirements.

6.5 Usage of Slings

EPRI report 1007914 provides detailed guidance regarding the usage of various types of slings. In general, the rigger needs to document the loads and expected sling tensions and ensure that the rigging is not damaged prior to use and remains protected (such as with edge protectors) during use. EPRI report 1007914 also provides detailed guidance for the usage of the following types of rigging hardware, miscellaneous rigging equipment, and below-the-hook lifting devices:

- Drums
- Sheaves
- Hooks
- Rings, links, and swivels
- Shackles
- Eyebolts
- Swivel hoist rings
- Turnbuckles
- Blocks
- Welded lugs
- Wedge sockets
- Cable clamps
- Skids, rollers, and air pallets
- Cribbing

- Jacks
- A-frames and mobile gantries
- Beam trolleys
- Spreader and equalizer beams

6.6 Proper Usage of Reeving

EPRI report 1007914 provides detailed guidance regarding the usage of various types of reeving. Guidance is provided regarding the use of sheaves and blocks for a symmetrical reeving arrangement as well as for symmetrical boom point reeving arrangements.

6.7 Proper Usage of Small Hoists

Manually lever-operated hoists and chain hoists are sometimes used to level a load, such as during a stationary blade removal operation. These small hoists offer finer controls than most overhead cranes and, as such, provide better control of the position of the load and the speed of the lift. General guidance for employing these types of small hoists is provided in EPRI report 1007914.

7
CRANES AND HOISTS

This section provides guidance and cross-references to other EPRI reports regarding the procurement and operation of cranes and hoists, including mobile cranes.

7.1 Procurement of Cranes and Hoists

Procurement of replacement cranes and hoists as well as replacement subcomponents, parts, and assemblies should be based on the safety classification of the equipment being replaced. In some applications, the crane or hoist will have been classified as nuclear safety-related. As such, care should be taken to ensure that the appropriate quality assurance requirements are specified (10CFR50, Appendix B, ASME NQA-1, 10CFR21, and so on) when procuring from an audited and approved nuclear supplier. If this is not feasible, a commercial-grade item dedication should be implemented.

For non-safety-related cranes and hoists, plant engineering personnel should determine the appropriate technical, quality, and supplier documentation requirements.

The replacement crane or hoist should meet the requirements of the following industry standards:

- NUREG 554, Single-failure-proof (that is, older cranes).
- NOG-1: Could be used to classify and design multiple girder overhead cranes at nuclear facilities, as follows:
  - NOG Type 1: Single-failure-proof
  - NOG Type 2: Not single-failure-proof but designed to withstand design basis seismic event while in use
  - NOG Type 3: Conventional cranes designed in accordance with CMAA-70
- NUM-1: This standard covers underhung cranes, top-running bridge and gantry cranes with underhung trolleys, traveling wall cranes, jib cranes, monorail systems, overhead hoists, and hoists with integral trolleys used in nuclear facilities. All of the preceding cranes, whether single or multiple-girder, are covered by this standard, with the exception of multiple-girder cranes with both top-running bridge and trolley, which are covered by ASME NOG-1.

Key Information Point

The user of this report should note that ASME Standard NOG-1 had not been endorsed by the NRC at the time of publication.

7.2 Operation of Cranes and Hoists

EPRI report 1022507 provides detailed guidance regarding the operation of cranes and hoists. In general, crane operators should understand everything about their crane. They must know its capacity, operating characteristics, speed, the crane signals, the safety rules, and so forth.

7.2.1 Mobile Cranes

EPRI report 1025239 provides detailed guidance in the following areas regarding the safe operation of mobile cranes.

Before any lifting operations, the crane should be inspected and its functionality verified. See the inspection guidelines in Section 12 of EPRI 1025239.

7.2.2 Signaling and Emergency Shutdown

EPRI report 1022507 provides detailed guidance regarding signaling and emergency shutdown of cranes and hoists.

7.3 Maintenance of Cranes and Hoists

Guidance regarding the maintenance of cranes is provided in the following EPRI reports:

- *Nuclear Maintenance Applications Center: Crane Maintenance and Application Guide.* EPRI, Palo Alto, CA: 2011. 1022507.
- *Nuclear Maintenance Applications Center: Mobile Crane Application Guide.* EPRI, Palo Alto, CA: 2012. 1025239.

7.4 Modification of Cranes and Hoists

Modifications to cranes and hoists should be made in accordance with the plant design process. Applicable codes and standards should be followed. Consultation with the manufacturer should ensure that important aspects of the modification are considered and that the risk of voided warranties or a liability is understood or avoided.

8
REFERENCES

8.1 Industry Codes and Standards

American National Standards Institute (ANSI) B18.15-1985. Forged Eyebolts.

American National Standards Institute (ANSI) N45.2.2. Packaging, Shipping, Receiving, Storage and Handling of Items for Nuclear Power Plants.

American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B30.9c-2000. Slings.

American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B30.10-1999. Hooks.

American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B30.20-1999. Below-the-Hook Lifting Devices.

American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B30.21-1999. Manual Lever Operated Hoists.

American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) A10.4. Personnel Hoists.

American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B30.1. Jacks.

American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B30.7. Base Mounted Drum Hoists.

American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B30.8. Floating Cranes and Floating Derricks.

American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B30.11. Monorails and Underhung Cranes.

American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B30.16. Overhead Hoist (Underhung).

American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B30.23. Personnel Lifting.

American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) N14.6. Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds or More for Radioactive Material.

American Society for Mechanical Engineers (ASME) NQA-1 – 2015. Quality Assurance Requirements for Nuclear Facility Applications.

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Machinery's Handbook 25th Edition Copyrighted 1998.

NANTeL Generic Material Handling Training Material, November 2016.

Planning for Load Handling Activities. American Society of Mechanical Engineers, New York, NY: 2014. ASME P30.1-2014.

Ratchet Strap Inspection Requirements. Lawrence Livermore National Laboratory, Livermore, CA: 2017. LLNL-PRES-739217.

Rigging Hardware. United Brotherhood of Carpenters Apprenticeship and Training Fund of North America, Washington, D.C. July 1997.

Rigging Manual III. International Association of Bridge, Structural and Ornamental Iron Workers, Washington, D.C. 1977.

Rules for Construction of Cranes, Monorails, And Hoists (with Bridge Or Trolley Or Hoist Of The Underhung Type). American Society of Mechanical Engineers, New York, NY: 2004. ASME NUM 1:2004.

Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder). American Society of Mechanical Engineers, New York, NY: 2015. ASME NOG-1-2015.

Rules for the Movement of Loads using Overhead Handling Equipment in Nuclear Facilities (Draft). American Society of Mechanical Engineers, New York, NY: 2018. ASME NML-1-2018.

Wire Rope Sling User's Manual. Wire Rope Technical Board, Stevensville, MD. February 2003.

Wire Rope User's Manual. Wire Rope Technical Board, Stevensville, MD. February 2003.

Workbook—Rigging Manual III. International Association of Bridge, Structural and Ornamental Iron Workers, Washington, D.C. 1977.

8.2 EPRI Documents

Nuclear Maintenance Applications Center: Crane Maintenance and Application Guide. EPRI, Palo Alto, CA: 2011. 1022507.

Guidelines for Using Synthetic Slings for Lifting and Rigging. EPRI, Palo Alto, CA: 2003. 1007676.

Lifting, Rigging, and Small Hoist Usage Program Guide. EPRI, Palo Alto, CA: 2003. 1007914.

Nuclear Maintenance Applications Center: Mobile Crane Application Guide. EPRI, Palo Alto, CA: 2012. 1025239.

Packaging, Shipping, Storage, and Handling Guidelines for Nuclear Power Plants. EPRI, Palo Alto, CA: 1997. TR-107101.

Radiation Effects on Organic Materials in Nuclear Plants. EPRI, Palo Alto, CA: 1981. NP-2129.

Rigger's Handbook. EPRI, Palo Alto, CA: 2004. 1009706.

8.3 Utility Procedures and Documents

Administrative Procedure 0-ADM-717. "Heavy Load Handling," Turkey Point Nuclear Plant, Florida Power & Light Company, September 2001.

Administrative Procedure 0-ADM-719. "Rigging Controls," Turkey Point Nuclear Plant, Florida Power & Light Company, February 2002.

Administrative Procedure 0-ADM-726. "Rigging Operations," Turkey Point Nuclear Plant, Florida Power & Light Company, August 2002.

"Control of Lifting, Rigging, and Cranes at Comanche Peak and Arkansas Nuclear One." The Nuclear Exchange, NX-1039, December 2001.

"Fork Lift Operation Observation." South Texas Project, Palacios, TX: February 2012. STP7853.

"Hanford Site Hoisting and Rigging Manual." DOE/RL-92-36

Report No. 28099. *Rigger's Handbook*, Duke Power Company, 1995.

"Rigging and Lifting Program." Exelon Generation, Kennett Square, PA: 2017. MA-AA-716-021, Revision 28.

8.4 U.S. Regulatory Documents

Occupational Safety & Health Administration (OSHA) 29CFR 1910.184. Slings.

Occupational Safety & Health Administration (OSHA) 29CFR 1910.306. Hoists – Wiring.

Occupational Safety & Health Administration (OSHA) 29CFR 1910.550. Cranes and Derricks.

Occupational Safety & Health Administration (OSHA) 29CFR 1926.552. Material Hoists, Personnel Hoists, and Elevators.

Occupational Safety & Health Administration (OSHA) 29CFR 1926.553. Base Mounted Drum Hoists.

Occupational Safety & Health Administration (OSHA) 29CFR 1926.554. Overhead Hoists.

U.S. Department of Energy. Hoisting and Rigging. Standard 1090-2001, Chapter 11, Wire Rope and Slings, 2001.

U.S. Department of Labor. Occupational Safety and Health Administration. General Industry Standards, Material Handling and Storage. 1910.184 Slings, March 7, 1996.

U.S. Nuclear Regulatory Commission (NRC). "A Survey of Crane Operating Experience at U.S. Nuclear Power Plants from 1968 through 2002." NUREG-1774. July 2003.

U.S. Nuclear Regulatory Commission (NRC). “Control of Heavy Loads at Nuclear Power Plants.” NUREG-0612. December 1980.

U.S. Nuclear Regulatory Commission (NRC). “Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants.” 10CFR50.65. July 1991.

U.S. Nuclear Regulatory Commission, (NRC). “Single-Failure-Proof Cranes for Nuclear Power Plants.” NUREG-0554. May 1979.

8.5 International Documents

NEA/CNRA/R (2017), Nuclear Energy Agency Committee on Nuclear Regulatory Activities, Heavy Load Accidents in Nuclear Installations Working Group on Operating Experience (WGOE).

Canadian Standards Association (CSA) B167-16 “Overhead cranes, gantry cranes, monorails, hoists, and jib cranes” (2017).

8.6 Glossary of Terms

Industry definitions and nomenclature for key terms are provided in Section 1. When needed, definitions of other terms used in this report can be obtained from any of the following related EPRI reports:

- *Nuclear Maintenance Applications Center: Crane Maintenance and Application Guide.* EPRI, Palo Alto, CA: 2011. 1022507.
- *Lifting, Rigging, and Small Hoist Usage Program Guide*. EPRI, Palo Alto, CA: 2003. 1007914.
- *Nuclear Maintenance Applications Center: Material Handling Application Guide.* EPRI, Palo Alto, CA: 2012. 1025240.
- *Nuclear Maintenance Applications Center: Mobile Crane Application Guide.* EPRI, Palo Alto, CA: 2012. 1025239.

A
OVERVIEW OF GOVERNING DOCUMENTS

A.1 Industry Standards

A.1.1 ANSI B30.2: Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)

This standard applies to the construction, installation, testing, operation, inspection, and maintenance of overhead and gantry bridge cranes.

This standard is designed to do the following:

- Guard against and minimize injury to workers and otherwise provide the protection of life, limb, and property by prescribing minimum safety requirements
- Provide direction to owners, employers, supervisors, and others concerned with or responsible for its application
- Guide government agencies and other regulatory bodies in the development, promulgation, and enforcement of appropriate safety directives

NUREG-0612 endorsed the 1976 edition of this standard. Many cranes at nuclear power plants were originally purchased, manufactured, and installed in accordance with the 1967 edition of this standard. Utilities generally performed a reconciliation study to evaluate the differences between the editions.

Although the more current revisions of the standard are recommendations, OSHA and most insurance companies generally endorse the latest edition. As a best practice, the current revision should be followed, when possible, for maintenance, operation, and inspection. It should also be checked for crane modifications to determine design compliance.

This standard provides the minimum requirements for safe crane performance. Adherence to this standard does not necessarily ensure reliable crane performance, as defined by the ability to operate on demand. This standard does provide assurance of crane safety, as defined by the absence of a crane failure resulting in a load drop, at a level acceptable to the general industry.

A.1.2 CMAA-70: Specifications for Electric Overhead Traveling Cranes

CMAA-70, "Specifications for Electric Overhead Traveling Cranes," is a publication developed by the Crane Manufacturer's Association of America. This specification is a detailed document that lists the codes and standards associated with the safe and proper operation of overhead cranes. The following is a list of the various sections and a brief overview of their contents.

The first section identifies and lists the various responsibilities different individuals and/or groups have related to safe crane operation.

The next section covers all of the requirements for qualification, on-the-job training, and classroom training necessary to be a licensed crane operator.

Crane and hoist safety and design requirements are then listed. Deviations from the approved requirements are covered in this section, as well as initial acceptance inspections and load test requirements. These requirements pertain to all modified, purchased, rented, salvaged, and installed hoists and cranes.

Operator rules are included in CMAA-70. Topics in this section include preoperational tests, general rules for the operator, rigging, proper sizing of slings and other components, moving the load, parking the crane, crane overloading, high work on cranes or hoists (including fall protection requirements), and hand signals.

Critical lifts, high-consequence lifts, and special high-consequence lifts are discussed in detail. A critical lift is one where the lifted item could be damaged in the lift and the damage could cause significant delays or not be detected and cause a safety hazard that might later result in the release of flammable, radioactive, corrosive, or toxic material. A high-consequence lift is one in which dropping, upset, or collision of the lifted item could cause significant work delay, undetected damage, or the release of radioactive or other undesirable material. A special high-consequence lift is the same as the high-consequence lift, but where the load equals or exceeds 75% of the rated capacity. Personnel platforms and baskets are covered in this section, along with records and certification maintenance.

Crane inspection, testing, and maintenance are covered in detail. This section contains all the requirements for monthly and annual inspections as well as load testing. “Planned Engineered Lifts” are also mentioned. These are lifts in excess of the rated capacity that may be required from time to time for special purposes. The term *planned engineered lifts* applies only to electric hoists at five tons and above.

The standard can be purchased at www.mhia.org\industrygroups\cmaa.

A.1.3 ASME NOG-1: Rules for Construction of Overhead and Gantry Cranes

The Committee on Cranes for Nuclear Power Plants was first established in 1976. In 1980, the name and scope of the committee were revised from Committee on Cranes for Nuclear Power Plants to Committee on Cranes for Nuclear Facilities (CNF). The CNF has a main committee and two subcommittees. It reports to the ASME Board of Nuclear Codes and Standards. Its scope is to develop codes and standards for the design and installation of cranes at nuclear facilities. The first document developed was NOG-1. It is broken into three classifications of cranes. Type III cranes are standard cranes with no real special nuclear requirement, except for a higher standard of quality than other design standards. Type II cranes require seismic qualification. Type I cranes are seismically qualified and are designed to handle critical loads. Type I cranes are single-failure-proof and meet the requirements of NUREG-0612 and NUREG-0554. The document is complete, and the NOG subcommittee meets two times a year to address enhancements and revisions.

The codes and standards developed by this committee are not at all similar to the ASME B30 standards. The B30 standards are safety standards only. The CNF standards are design, installation, and testing standards. No other industry or government standard addresses issues important for nuclear facility cranes, such as quality assurance, dynamic seismic analysis, and single-failure-proof crane features.

The NOG-1 code was developed under procedures accredited as meeting the criteria for American National Standards. The consensus committee that approved the code was balanced to ensure that individuals from competent and concerned interests have had an opportunity to participate.

This code covers electric overhead and gantry multiple-girder cranes with top-running bridges and trolleys used at nuclear facilities as well as components of cranes at nuclear facilities. This code applies to the work of any person or organization participating in the specification, design, manufacture, shipment, storage prior to erection and use, erection, testing, and inspection of the cranes covered by this code.

A copy of the ASME NOG-1 can be obtained from the Secretary, ASME Committee on Cranes for Nuclear Facilities, American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY, 10017.

A.1.4 ASME NML-1

ASME NML-1, “Rules for the Movement of Loads Using Overhead Handling Equipment in Nuclear Facilities,” was developed by the ASME Committee on Cranes for Nuclear Facilities to define the requirements and guidelines for a safe, effective load handling program at commercial nuclear facilities using overhead handling equipment.

As indicated by the title, this standard is for the movement of **all** loads within a nuclear facility. To apply a graded approach to the level of controls required for the variety of lifts performed in a nuclear facility, lifts are separated into three different classifications—standard, special, and critical.

The classification of a lift is based upon the risk of performing the lift. The risk is quantified by evaluating factors that may increase the probability of a malfunction or load handling event and evaluating the consequences that would occur if a malfunction or load handling event occurred.

The lift with the least risk is a standard lift, a lift with moderate risk is a special lift, and a lift with the highest risk is a critical lift. Lifts that are characterized in NUREG-0612 are classified as critical lifts. However, due to their regulatory nature, NUREG-0612 lifts carry more requirements than any other lift classification.

Additional portions of the standard provide requirements for crane design, inspection, and testing. Crane operator, Crane inspector, rigger, and signalperson qualification and/or certification requirements are also provided.

This standard covers the movement of loads using overhead handling systems at commercial nuclear facilities, including spent fuel cask handling. This standard does not cover the movement of other irradiated fuel assemblies that are bounded by a facility accident analysis.

This standard applies to all lifting and handling operations, including personnel training and qualification/certification, maintenance, inspection, testing, rework, and modification of overhead handling systems and other lifting devices and equipment covered by this standard.

The application of this standard begins at the point of initial fuel load at the affected unit under construction.

A.1.5 ASME NUM-1

ASME NUM-1 is titled "Rules for Construction of Cranes, Monorails, and Hoists (with Bridge or Trolley or Hoist of the Underhung Type)," and the most recent edition at the time this report was published was 2016. The standard covers underhung cranes, top-running bridge and gantry cranes with underhung trolleys, traveling wall cranes, jib cranes, monorail systems, overhead hoists, and hoists with integral trolleys used in nuclear facilities. All of the preceding cranes, whether single- or multiple-girder, are covered by this standard, with the exception of multiple-girder cranes with both a top-running bridge and trolley, which are covered by ASME NOG-1.

A.2 U.S. Regulatory Documents

A.2.1 NUREG-0612: Control of Heavy Loads at Nuclear Power Plants

The control of heavy load drops is applicable to structures, systems, and components required to mitigate the effects of postulated load drops and bring the plant to a safe shutdown condition. Load handling systems are designed to minimize the possibility of such accidents.

Generic Technical Activity A-36 was established to systematically examine the staff's licensing criteria, adequacy of measures in effect at operating plants and recommend necessary changes to assure the safe handling of heavy loads. The task involved review of plant information, evaluation of historical data, performance of accident analyses and criticality calculations, development of guidelines for operating plants, and review of licensing criteria. The review indicated that the major causes of load handling accidents include operator errors, rigging failures, lack of adequate inspection, and inadequate procedures. The results of the review culminated in the issuance of NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants 63CII," in July 1980. NUREG-0612 described a resolution of Task A-36.

NUREG-0612 presents an overall philosophy that provides a defense-in-depth approach for controlling the handling of heavy loads. The approach is directed to preventing load drops. The following summarizes this defense-in-depth approach:

- Ensure that there is a well-designed handling system.
- Provide sufficient operator training, load handling instructions, and equipment inspection to ensure reliable operation of the handling system.
- Define safe load travel paths and procedures and operator training to ensure, to the extent practical, that heavy loads are not carried over or near irradiated fuel or safe shutdown equipment.

- Provide mechanical stops or electrical interlocks to prevent movement of heavy loads over irradiated fuel or in proximity to equipment associated with redundant shutdown paths.
- Where mechanical stops or electrical interlocks cannot be provided, provide a single-failure-proof crane or perform load drop analyses to demonstrate that unacceptable consequences will not result.

By Generic Letters dated December 22, 1980 and February 3, 1981, all U.S. utilities were requested to evaluate their plants against the guidance of NUREG-0612 and to provide their submittals in two parts—Phase I (six-month response) and Phase II (nine-month response). Phase I responses were to address Section 5.1.1 of NUREG-0612, which covers the following areas:

- Definition of safe load paths
- Development of load handling procedures
- Periodic inspection and testing of cranes
- Qualifications, training, and specified conduct of operators
- Special lifting devices should satisfy the guidelines of ANSI N14.6
- Lifting devices that are not specially designed should be installed and used in accordance with the guidelines of ANSI B30
- Design of cranes to ANSI IB30.2 or CMAA-70

Phase II responses were to address Sections 5.1.2–5.1.6 of NUREG-0612, which cover the need for electrical interlocks/mechanical stops, or alternatively, single-failure-proof cranes or load drop analyses in the spent fuel pool area (PWR), containment building (PWR), reactor building (BWR), other areas, and the specific guidelines for single-failure-proof handling systems.

The NRC interpreted Phase II of NUREG-0612 as an enhancement to Phase I. Thus, prior to undertaking a review of the utilities' Phase II response for all of the operating reactors, and as a test of the adequacy of the Phase I program, the NRC decided to undertake a pilot program with a limited number of plants. The findings from the pilot program would then provide a basis for a decision on whether to proceed with the review of the Phase II submittals for all operating reactors, to reduce the scope of the review, or to totally eliminate the review.

Based on the NRC pilot program and the review of a limited number of operating license Phase II submittals, the NRC concluded that the objective identified in Section 5.1 of NUREG-0612 for providing "maximum practical defense-in-depth" is satisfied by the Phase I compliance and that the Phase II analyses did not indicate the need to require further generic action.

A.2.2 NUREG-0554: Single-Failure-Proof Cranes for Nuclear Power Plants

A general requirement for design and operation of light-water reactors is that fuel storage and handling systems be designed to ensure adequate safety under normal and accident conditions. Overhead cranes are used to lift and transfer heavy component parts, such as spent fuel casks and reactor vessel heads. When a load being handled by a crane can be a direct or indirect cause of release of radioactivity, the load is labeled a critical load.

NRC has licensed reactors on the basis that the safe handling of critical loads can be accomplished by adding safety features to the handling equipment, by adding special features to the structures and areas over which the critical load is carried, or by a combination of the two. When reliance for the safe handling of critical loads is placed on the crane system itself, the system should be designed so that a single failure will not result in the loss of the capability of the system to safely retain the load. This report identifies features of the design, fabrication, installation, inspection, testing, and operation of single-failure-proof overhead crane handling systems that are used for handling critical loads. These features are limited to the hoisting system and to braking systems for trolley and bridge. Other load-bearing items, such as girders, should be conservatively designed but need not be considered single-failure-proof.

The general value of existing standards is recognized in this report, and reliance is placed on quality levels indicated in CMAA Specification 70 and ANSI B30.2.0-1967 as supplemented by the recommendations in the following sections of this report.

The typical plant layout for PWRs is such that two different cranes may be required to handle critical loads. One of these cranes is located in the spent fuel storage and transfer area, where the largest critical load would be a spent fuel shipping cask. The other crane is located inside the containment structure over the reactor vessel, where it is used to lift the reactor vessel head during refueling periods. This crane is typically called a *polar crane* because of the circular track for the bridge structure.

In the plant layout for the majority of the BWRs, a single crane handles critical loads near the reactor vessel and at the spent fuel storage area. However, for recent BWR plant designs (BWR Mark 6), two cranes could be needed to handle critical loads.

A.2.3 OSHA Standard 1926.1427

Although OSHA 1926.1427 is titled “Cranes and Derricks Used in Construction,” for the purposes of this report, the qualification guidance for crane operators provided in the OSHA 1926.1427 standard is deemed applicable to crane operators at nuclear power plants.

There are enough complex maintenance, repair, replacement, and design-modification activities in a nuclear power plant such that OSHA 1926.1427 should be the regulation governing crane operators in the United States because these activities meet the general description of the term *construction* according to the OSHA definitions and interpretations.

Countries other than the United States might have different regulations.

B
LISTING OF KEY POINTS

B.1 Key Cost Points

Key Cost Point

Emphasizes information that will result in overall reduced costs and/or increase in revenue through additional or restored energy production.

Page Number	Key Cost Point
3-4	Sites are encouraged to adopt the terminology *Rigger I* and *Rigger II* to achieve standardization of rigging personnel roles and responsibilities and to optimize portability of these personnel among existing nuclear sites.
3-9	Using workers who are qualified to be **only** signalpersons is not considered an efficient deployment of personnel.
3-11	To standardize the skills necessary for qualification of Rigger I and Rigger II personnel, plants are encouraged to use and follow the EPRI STE for each of these positions.

B.2 Key Technical Points

Key Technical Point

Targets information that will lead to improved equipment reliability.

Page Number	Key Technical Point
3-7	A Rigger II must first be qualified as a Rigger I.
4-3	NUREG-0612 lifts are a subset of critical lifts, but not all critical lifts are NUREG-0612 lifts.
4-10	ASME B30.2 requirements should be used while conducting load testing for engineering lifts.
5-2	Note that the lift classification may be changed over time, based on changes to risk probabilities or consequences that can be reduced during lift planning.
6-3	Typically, to ensure that the lifting/rigging hardware is adequately protected, the storage facility should meet the storage requirements for ANSI Level B or C items, as described in ANSI N45.2.2, “Packaging, Shipping, Receiving, Storage and Handling of Items for Nuclear Power Plants.”

B.3 Key Human Performance Points

Key Human Performance Point

Denotes information that requires personnel action or consideration in order to prevent personal injury, equipment damage, and/or improve the efficiency and effectiveness of the task.

Page Number	Key Human Performance Point
2-1	Managers should ensure that supplemental workers receive an appropriate level of training for the specific site to which they are assigned and consistent with the scope of lifting/rigging activities that they will perform.
3-4	Lifting tasks performed repetitively using simple rigging and existing plant equipment/tools (for example, operator lifting of oil strainers or baskets) should be controlled under site-specific task qualifications and are typically outside the scope of the hoisting, rigging, and crane program covered herein.
3-6	Use edge protectors (that is, softeners) whenever possible. Edge protectors should be materials designed for that use.
3-9	Ensure that supplemental employees are briefed on site signalperson identification practices.
3-11	Appropriate plant personnel should ensure that supplemental crane operators receive orientation training on specific cranes that they have not operated recently.
3-14	As noted in Section 5, crane operators-in-training are not to operate the crane during critical lifts.
5-2	Under no circumstance should a lift be conducted relying solely on one individual's "skill-of-the-craft" knowledge and/or experience.
5-6	As noted in Section 3, crane operators-in-training are not to operate the crane during critical lifts.
6-1	Evaluations of alternative lifting/rigging equipment that is not physically identical to the original equipment should be performed by engineering or other technical personnel.
E-2	Appropriate plant personnel should have a tiered approach to training and qualification of riggers. This approach allows the rigger to be classified according to their respective skill level, training, and experience.

B.4 Key Observation Points

Key Observation Point

Identifies tasks or a series of tasks that can or should be observed by maintenance first line supervisors to improve the performance of the maintenance staff and improve the reliability of the component.

Page Number	Key Observation Point
2-7	With regard to working in a fall zone, the term *line of fire* implies vertical movement, whereas the term *danger zone* implies horizontal **or** vertical movement.
E-3	Crane operator training should be periodically reviewed by supervision to ensure that training procedures are being followed, crane operators are engaged in the training, and that equipment and operational procedure changes have been incorporated.

B.5 Key Benchmarking Points

Key Benchmarking Point

Shares other companies' experiences with the task or technology so that readers will have a benchmark for best practices.

Page Number	Key Benchmarking Point
3-4	The user of this report should note that the Rigger I and II designations in this report do not necessarily match those used by the National Commission for the Certification of Crane Operators (NCCCO) for designating rigger personnel.
5-3	Consistent with INPO SOER 91-1, "Conduct of Infrequently Performed Tests or Evolutions," site guidance for infrequently performed tests or evolutions should be considered when planning and evaluating a lift.

B.6 Key Information Points

Key Information Point

Denotes information of special importance.

Page Number	Key Information Point
3-5	Pre-engineered lifts are controlled and managed apart from the programmatic hoisting and rigging activities described in this report.
3-13	An individual qualified to the requirements of OSHA 1926.1427 should also be considered qualified under 1910.1427.
3-13	Crane operators should be knowledgeable about rigging practices. This should be through crane operator training or an option that the operator has been at one time been qualified as a Rigger I or Rigger II.
4-8	Other subsets of critical lifts can include planned engineered lifts, lifting of personnel, and critical lifts at U.S. Department of Energy (DOE) nuclear facilities.
4-9	Using the lift classification guidance in this report will ensure consistency with the critical lift classification described in the Nuclear Energy Insurance Limited (NEIL) definition. As such, if a program is following the guidance in this report and ASME NML-1, it will comply with NEIL as it relates to classifying a lift as critical.
7-1	The user of this report should note that ASME Standard NOG-1 had not been endorsed by the NRC at the time of publication.

B.7 Key Safety Points

Key Safety Point

Identifies information that will lead to improved worker and industrial safety.

Page Number	Key Safety Point
2-6	Boom free fall is prohibited when an employee is in the fall zone of the boom or load, and load line free fall is prohibited when an employee is directly under the load.
2-6	Working on or under a suspended load is prohibited, except when the load can be supported by blocking or cribbing (and the rigging is attached but not carrying the load), can be securely braced, or can be supported substantially by some other means that would prevent the load from moving.
2-6	Suspended loads should never be purposely moved over personnel unless involved in activities above.
2-7	When work under a suspended load has been approved, the number of personnel performing the work should be minimized, and the time any body part is under a suspended load should be minimized to reduce the risk of crushing.
2-7	Materials must be rigged to prevent unintentional displacement.
4-3	Factors that increase the probability of a load handling event should be driven from high to as low as reasonably achievable.
5-7	If it is not possible to release the chain, sling, or choker, ensure that the rigger's hands are clear of pinch points. Riggers should keep their hands far enough away so that a frayed wire or splinter on the cable cannot catch their glove and jerk their hand into a pinch point.
5-7	Operating experience has shown that non-permanent lifting equipment inherently has more risk of failure/tip-over than permanently installed lifting equipment.
5-7	Materials must be rigged to prevent unintentional displacement.
K-3	Do not walk under the boom of a crane when not necessary; when a suspended load is being moved; or when the boom is loaded or moving.
K-3	Do not unnecessarily stand under an empty crane hook being lowered/ raised.

C
EXAMPLES OF KEY PERFORMANCE INDICATORS

This appendix provides illustrative examples of KPIs currently in use by nuclear utilities.

C.1 Example 1: Lifting and Rigging Performance Indicator Basis

In this example, the purpose of the performance indicators is to provide a tool to monitor and report lifting rigging and material handling events to the station. The utility designated certain event codes to be included for this performance indicator.

The performance indicator is based on a rating index number from 0 to 100 that is calculated as follows:

Rating Number (Score) = 100 - (# occurrences) (point value)

The point value of the occurrence is based on the severity of the event. Table C-1 provides examples of events and their point values. Selection will be by the site program coordinator.

Each incident or event counts only one time. If more than one code applies, the code with the largest point value is used. Grading is as follows:

GREEN = 85–100

WHITE = 70–84

YELLOW = 40–69

RED = 0–39

The site program coordinator collects data and produces the performance indicator based on monthly and rolling six-month data.

Table C-1
Suggested point values

LOW = 15	MID LOW = 25	MID = 50	HIGH = 100
Failure to comply with lifting rigging and heavy load procedures (minor)	Person in charge not assigned	Loss of load control resulting in minor personnel injury and/or minor equipment damage	Loss of load control resulting in "Recordable" personnel injury and/or "Major" equipment damage
Use of rigging without an inspection tag/label	Category A/B lift plan not reviewed by third party	Load contacts building (minor damage)	Load contacts building (major damage)
No or improper pre-lift brief	Rigger/flagger not qualified	Load path/cone of influence not established/controlled	Walking or working under suspended load
Not walking down crane rails	Improper distance from energized transmission components	"Reportable" injury	—
Swing radius or cane not barricaded	Improper or no softeners when required	—	—
Spotters not properly positioned	Near miss	—	—
Loads not secured or stable prior to lifting	—	—	—
Knowledge of load weight	—	—	—
Rigging materials not properly stored	—	—	—

Figures C-1 and C-2 illustrate the results of using this KPI.

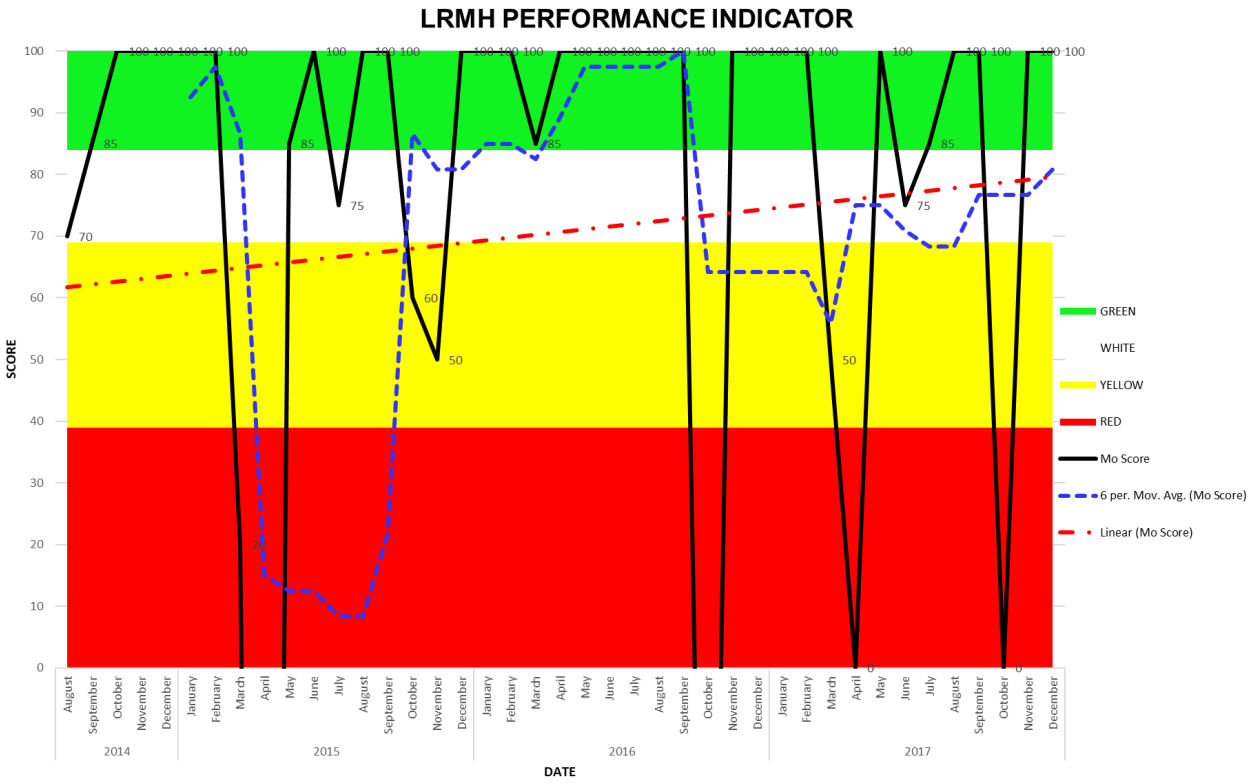


Figure C-1
Results of using KPI

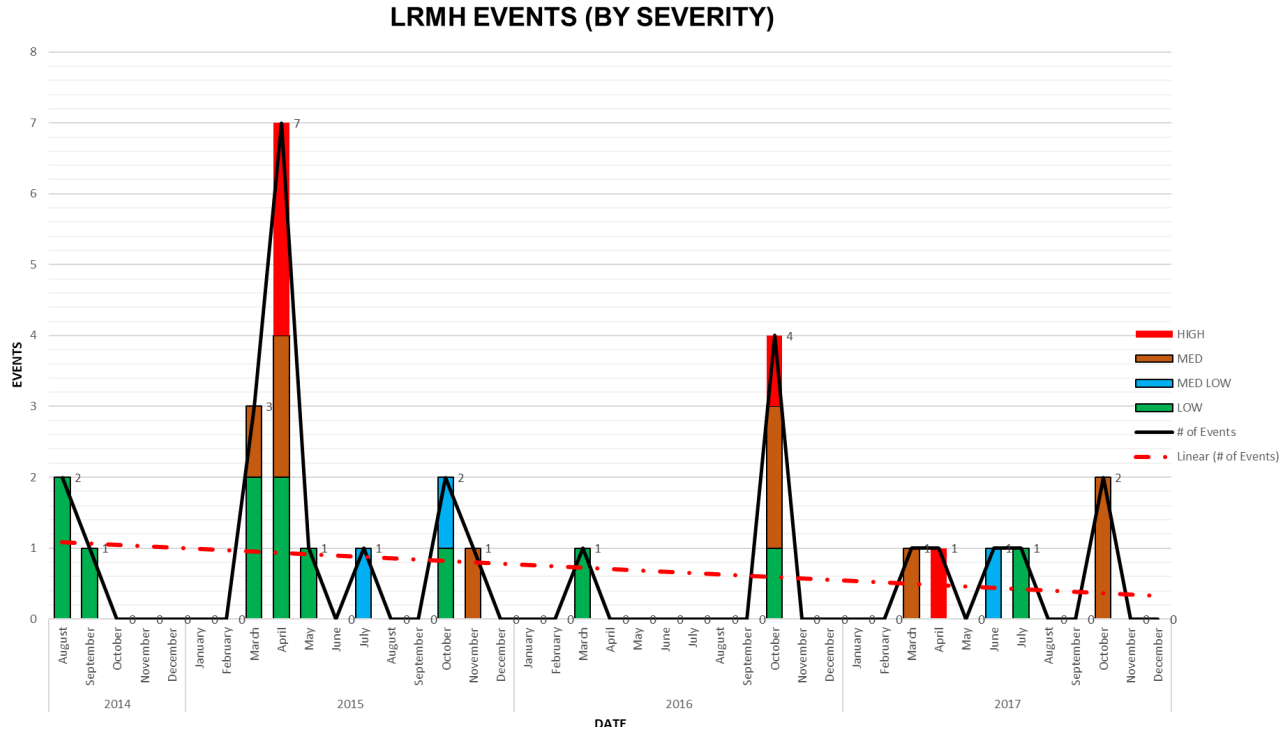


Figure C-2
Measure of events (by severity)

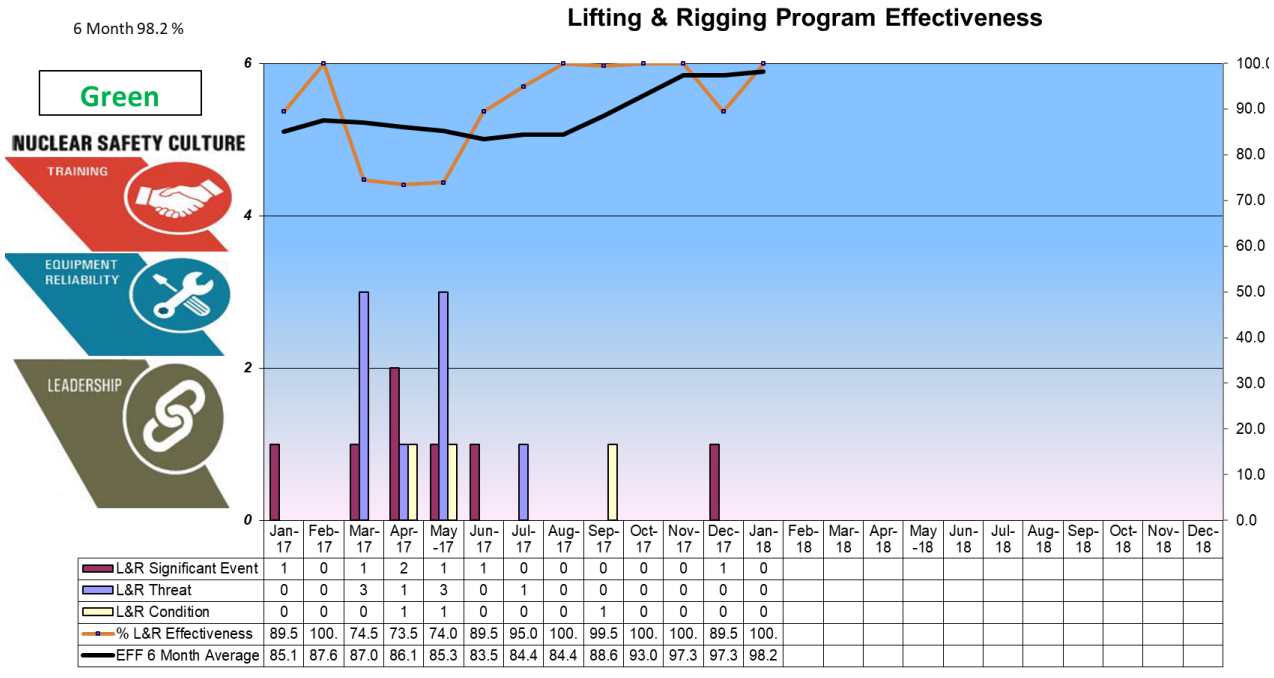
C.2 Example 2: Generating Monthly Program Effectiveness

In this example, the monthly program effectiveness is generated by calculating the impact of any L&R issues/events over the one-month period. The average points for the last six months of events at the station are divided by the number of units at the station and subtracted from 100 to calculate the indicator. The significance of the L&R issues/events is rated in three categories from most to least significant:

- L&R Significant Event (21 pts): Injury or dropped load. Rigging failure. Bump or make contact with the load/crane. Unqualified rigger performing rigging without qualified oversight in the field. Damage caused by lifting and rigging. Body part under/in the load/cone of protection (without approved JSHA).
- L&R Threat (10 pts): Used, out-of-date rigging. Used rigging not properly inspected. Inadequate rigging for the load. Uncontrolled load, rigging not stored properly when not in use, lift zone not properly established with flagging and required signage, edge protectors or softeners not used on edges when needed.
- L&R Condition (1 pt): Signalperson not wearing required vest. Not knowing the weight of the load to choose the proper rigging. Not knowing the center of gravity of the load. Improper use of rigging equipment. Rigging procedure compliance including risk determination. Required EN-MA-119 documents not completed, OP1005.002 heavy load documentation not completed, or 1025.068 material handling risk oversight documentation not completed.

Goal: green 95% to 100%, white is < 95% or >= 90, yellow is < 90% >= 80, red is < 80%.

Figure C-3 graphically illustrates the results of using this performance indicator.

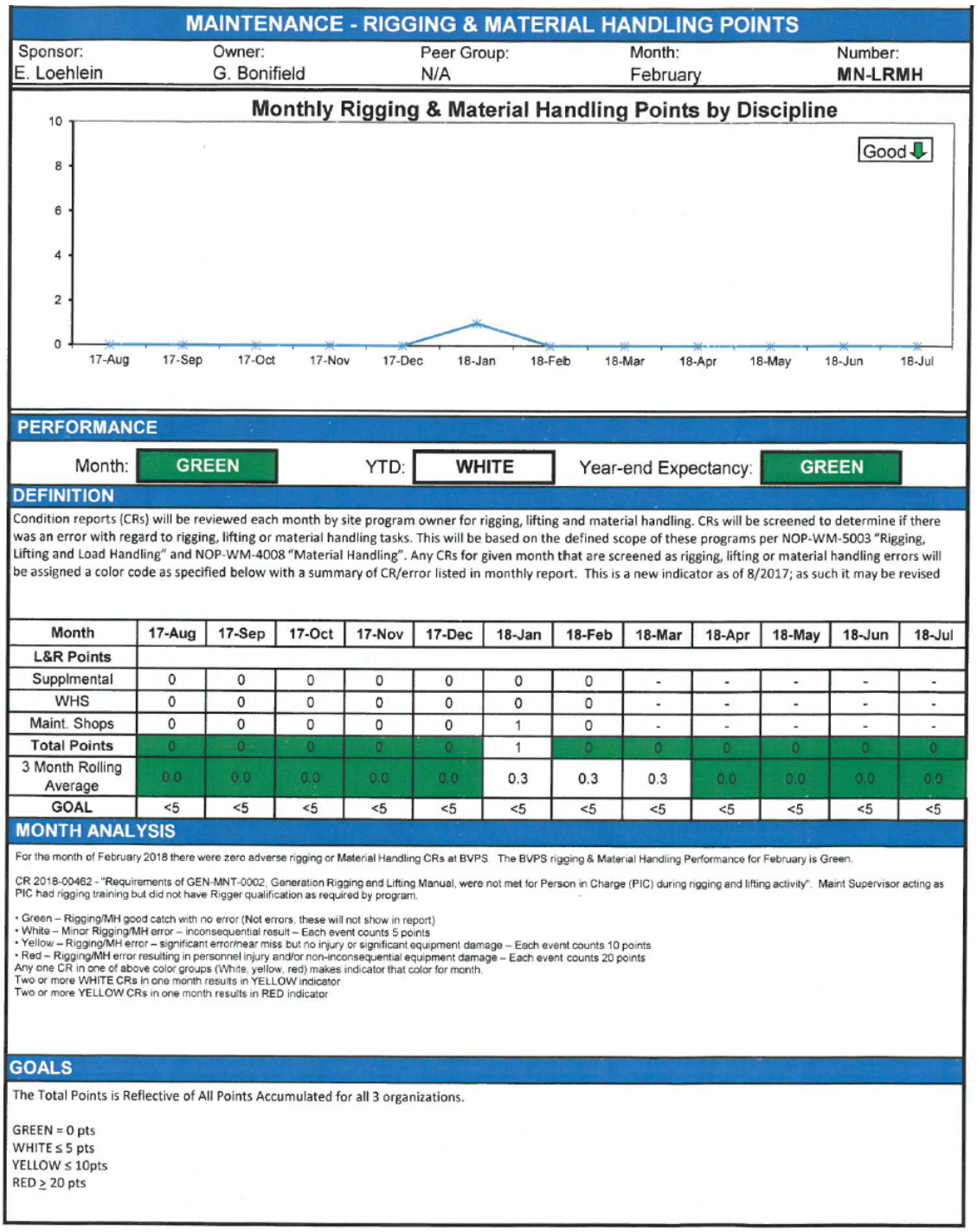


	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18
L&R Significant Event	1	0	1	2	1	1	0	0	0	0	0	1	0											
L&R Threat	0	0	3	1	3	0	1	0	0	0	0	0	0											
L&R Condition	0	0	0	1	1	0	0	0	1	0	0	0	0											
% L&R Effectiveness	89.5	100.	74.5	73.5	74.0	89.5	95.0	100.	99.5	100.	100.	89.5	100.											
EFF 6 Month Average	85.1	87.6	87.0	86.1	85.3	83.5	84.4	84.4	88.6	93.0	97.3	97.3	98.2											

Figure C-3
Program effectiveness using KPIs

C.3 Graphical Representation of KPIs

Figure C-4 illustrates a graphical representation of KPIs being tracked on a monthly basis.



MAINTENANCE - RIGGING & MATERIAL HANDLING POINTS

Sponsor:	Owner:	Peer Group:	Month:	Number:
E. Loehlein	G. Bonifield	N/A	February	**MN-LRMH**

Monthly Rigging & Material Handling Points by Discipline

PERFORMANCE

Month: GREEN YTD: WHITE Year-end Expectancy: GREEN

DEFINITION

Condition reports (CRs) will be reviewed each month by site program owner for rigging, lifting and material handling. CRs will be screened to determine if there was an error with regard to rigging, lifting or material handling tasks. This will be based on the defined scope of these programs per NOP-WM-5003 "Rigging, Lifting and Load Handling" and NOP-WM-4008 "Material Handling". Any CRs for given month that are screened as rigging, lifting or material handling errors will be assigned a color code as specified below with a summary of CR/error listed in monthly report. This is a new indicator as of 8/2017; as such it may be revised

Month	17-Aug	17-Sep	17-Oct	17-Nov	17-Dec	18-Jan	18-Feb	18-Mar	18-Apr	18-May	18-Jun	18-Jul
L&R Points												
Supplmental	0	0	0	0	0	0	0	-	-	-	-	-
WHS	0	0	0	0	0	0	0	-	-	-	-	-
Maint. Shops	0	0	0	0	0	1	0	-	-	-	-	-
Total Points	0	0	0	0	0	1	0	0	0	0	0	0
3 Month Rolling Average	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.0	0.0	0.0	0.0
GOAL	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

MONTH ANALYSIS

For the month of February 2018 there were zero adverse rigging or Material Handling CRs at BVPS. The BVPS rigging & Material Handling Performance for February is Green.

CR 2018-00462 - "Requirements of GEN-MNT-0002, Generation Rigging and Lifting Manual, were not met for Person in Charge (PIC) during rigging and lifting activity". Maint Supervisor acting as PIC had rigging training but did not have Rigger qualification as required by program.

- Green – Rigging/MH good catch with no error (Not errors, these will not show in report)
- White – Minor Rigging/MH error – inconsequential result – Each event counts 5 points
- Yellow – Rigging/MH error – significant error/near miss but no injury or significant equipment damage – Each event counts 10 points
- Red – Rigging/MH error resulting in personnel injury and/or non-inconsequential equipment damage – Each event counts 20 points

Any one CR in one of above color groups (White, yellow, red) makes indicator that color for month.
Two or more WHITE CRs in one month results in YELLOW indicator
Two or more YELLOW CRs in one month results in RED indicator

GOALS

The Total Points is Reflective of All Points Accumulated for all 3 organizations.

GREEN = 0 pts
WHITE ≤ 5 pts
YELLOW ≤ 10pts
RED ≥ 20 pts

Figure C-4
KPIs tracked on a monthly basis

D
HAND SIGNALS

This appendix illustrates commonly used hand signals used in lifting and rigging activities. Figures D-1, D-2, and D-3 show common hand signals for forklift operations, controlling overhead and gantry cranes, and controlling mobile cranes, respectively.

Raise The Tines

Lower The Tines

Tilt Mast Back

Tilt Mast Forward

Move Tines In Direction Finger Points

Dog Everything

STOP

Note: The operator should only respond to signals given by the designated signal person, EXCEPT for the STOP signal which can be given by anyone

For forklift activities not addressed by standard hand signals, special signals shall be decided upon by the operator and signal person in advance.

Figure D-1
Standard hand signals for controlling forklift operations

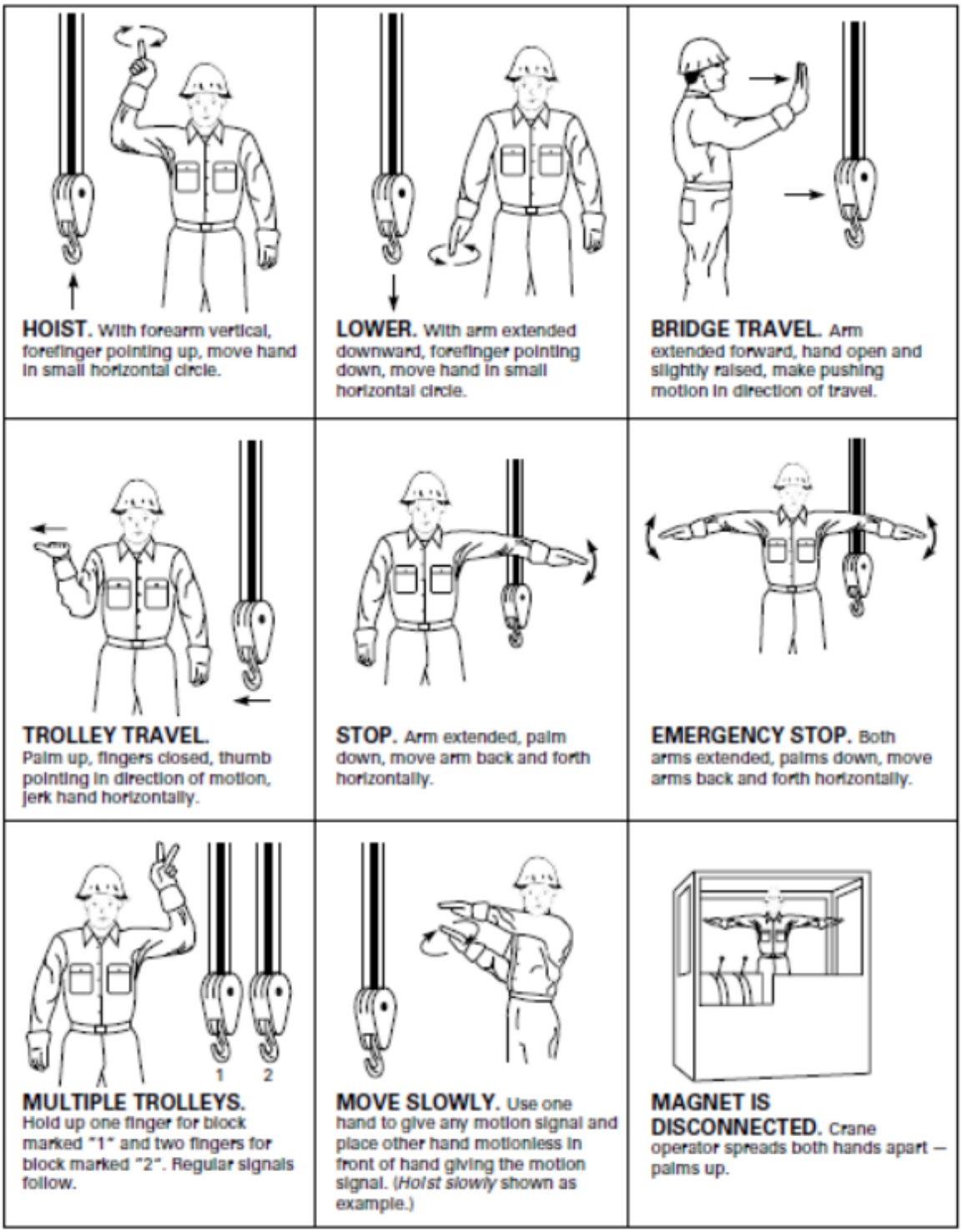
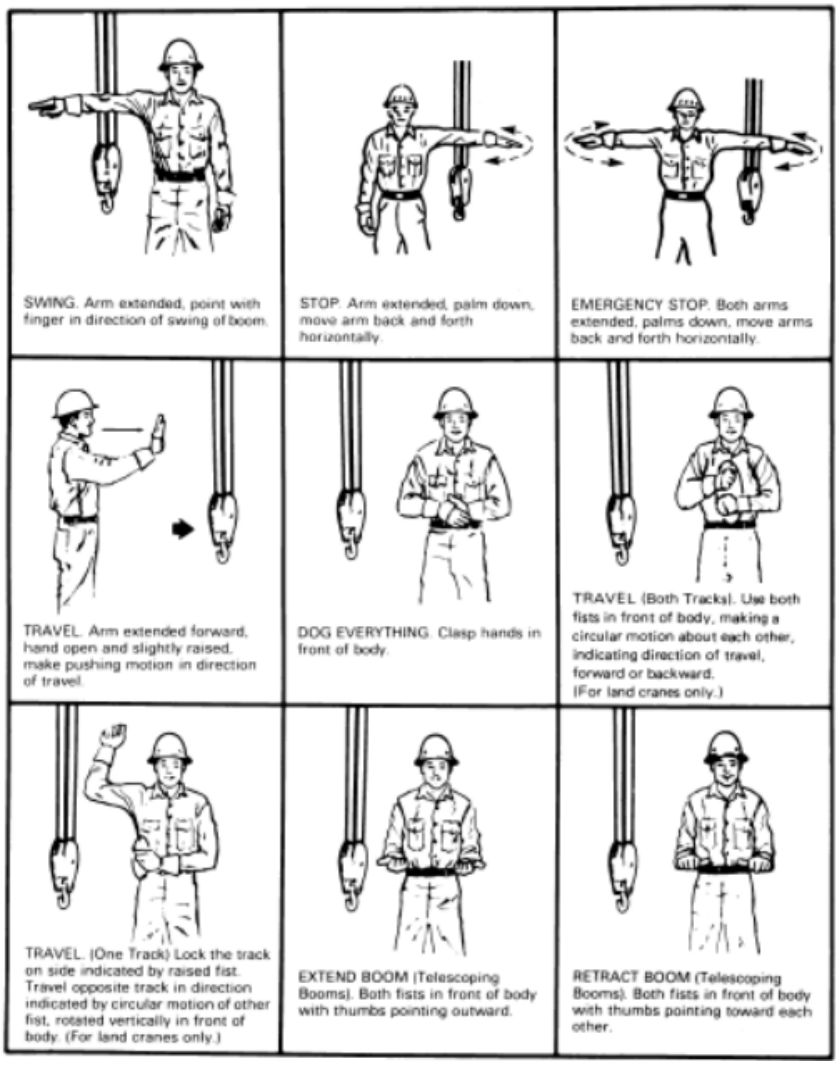


Figure D-2
Standard hand signals for controlling overhead and gantry cranes (ASME B30.2)



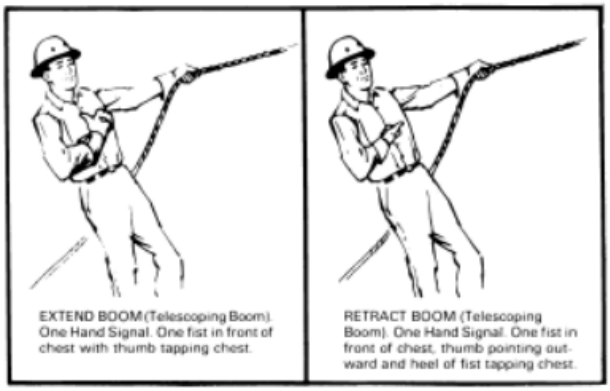


Figure D-3
Standard hand signals for controlling mobile cranes (ASME B30.5)

E
TRAINING OF LIFTING PERSONNEL

This appendix provides supplementary information regarding the training of lifting personnel.

E.1 Introduction

The training provided to lifting personnel is an important element to ensure that lifts performed at nuclear power plants are done effectively and safely without injury to personnel or damage to equipment. However, training in and of itself is not the focus of this EPRI report. As shown in Figure E-1, the training completed by a particular rigger or crane operator is a precursor to an evaluation by utility personnel that can lead to a rigger's or crane operator's qualification by that utility.

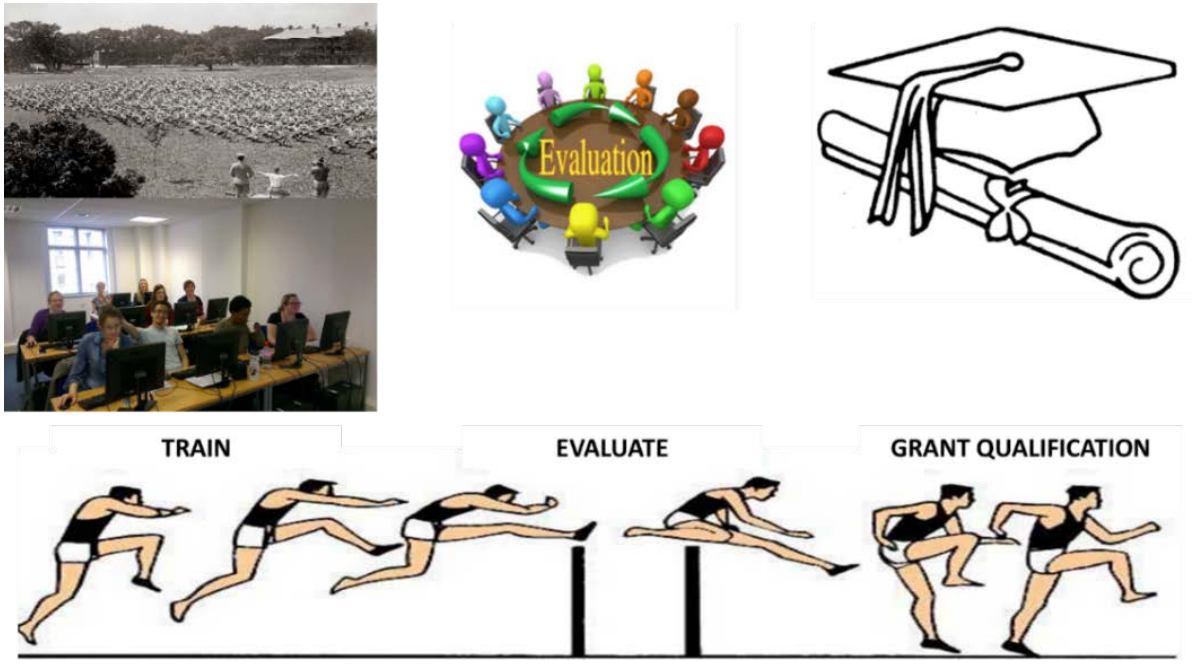


Figure E-1
Training, evaluation, and qualification of lifting personnel

The methods and sources of training lift personnel can vary significantly from one individual to another. Evaluating the training that an individual has completed should take into account the following factors:

- Credentials of the organization that provided the training
- Method(s) by which the training was provided (classroom, computer-based, on-the-job, mentoring, hands-on, and so on)

- Technical scope and content of the training completed
- How long ago the training was administered
- Related experience of the individual being evaluated

E.2 Sources of Training for Rigging Personnel

Riggers should receive training leading to passing a knowledge and practical rigging skill evaluation that requires the use of rigging equipment in safe configurations. The actual or simulated operation shall enable personnel to demonstrate basic knowledge and skills at a level that ensures the safety of personnel and equipment.

Key Human Performance Point

Appropriate plant personnel should have a tiered approach to training and qualification of riggers. This approach allows the rigger to be classified according to their respective skill level, training, and experience.

The following organizations provide training to riggers and lifting personnel:

- Crane Inspection & Certification Bureau
- Crane Institute of America
- Industrial Training International (ITI)
- National Center for Construction Education & Research
- National Commission for the Certification of Crane Operators (NCCCO)
- The Rigging Institute

There is significant variation of subject matter that is covered by each of the listed organizations. Also note that the levels of riggers described by each organization do not necessarily correspond to the two-level designation (that is, Rigger I and Rigger II) defined and used in this report.

Inclusion of these industry organizations should not be interpreted as an endorsement of any of them by EPRI or any of the organizations that participated in the development of this report.

E.3 Crane and Hoist Operator Training

Useful guidance regarding crane and hoist operator training is provided in EPRI 1022507, Section 8.2.1. Hoisting, rigging, and crane operating procedures should address this aspect of the program and should consider the following guidance.

Crane operator training is an essential component of a safe and effective crane operation program. Training should not be neglected or eliminated because of false assumptions that it is time-consuming or too costly.

An effective training program should be considered an investment that pays dividends each time the equipment is operated or maintained. Trained operators are safer and more effective. Effective training programs can also result in reduced insurance premiums and reduce the frequency of costly regulatory inspections.

The lift program manager/owner, in cooperation with the training department, should be considered the owners of the training program and be proactive and actively involved with its development and implementation. Management should not wait until an accident involving major equipment damage or personnel injury occurs before becoming involved with the training program. Management should actively provide program oversight to ensure that the training is kept effective and up to date.

A strong training evaluation program should be included that objectively monitors both student and instructor performance in the classroom and field. A simple recordkeeping system is also needed to document the training actually performed. Accurate training records can be extremely valuable in justifying management's responsibilities to provide a safe and effective work environment.

Equipment operators should receive continuing/refresher training and be re-evaluated on a periodic basis. The training should be reviewed periodically by the lifting program manager/ owner to ensure that the equipment and operational procedure changes are incorporated.

Key Observation Point

Crane operator training should be periodically reviewed by supervision to ensure that training procedures are being followed, crane operators are engaged in the training, and that equipment and operational procedure changes have been incorporated.

Each operator should be qualified on the specific type/piece of equipment that they are required to operate.

All crane operator training should be developed such that it is performance-based. Knowledge-based and skill-based objectives should be developed based on a comprehensive job and task analysis for each specific type of crane. Crane operation, to be safe and efficient, requires skill, extreme care, good judgment, alertness, concentration, and a rigid adherence to proven safety rules and practices. Therefore, when a candidate is about to undergo training to become a qualified crane operator, the training should include both knowledge-based and practical skills, as described in the rest of this appendix.

E.3.1 Knowledge-Based Training

Knowledge-based training must include a review of the applicable ASME and OSHA standards and site-specific procedures. The crane operator should be trained and evaluated in these procedures to ensure that the operator's knowledge is at the required level. Among the procedures specifically addressed in training should be the following:

- Rigging practices: knowledge of standard rigging requirements as they pertain to the proper use of rigging, load estimations, balancing loads, sling angles, and center of gravity.
- Communications: knowledge of rigging hand signals and operation of voice communication systems.
- Safe load paths: knowledge of how to determine operational restrictions dealing with restricted travel paths and interlock zones.
- General safe crane operation: knowledge of safe crane operation dealing with personnel under loads, swinging loads, crane speeds, and braking distances.
- Equipment operation procedures: knowledge of equipment operation procedures dealing with the operational characteristics of the individual cranes. These procedures normally will contain the restrictions to operation, such as hoist, trolley, and bridge movements. Details are also given dealing with manual operation of the crane or multiple hoist movements.
- Adverse or emergency operation procedures: knowledge of adverse weather operational conditions for outside cranes where heavy winds or thunderstorms are a factor. Emergency operation conditions, such as loss of load brake or loss of power.
- Component identification: the operator must be able to recognize crane components when performing pre-operational inspections.

E.3.2 Practical Skills Training

Each crane operator should be given training through inspecting and operating the equipment under the guidance of a qualified equipment operator. The candidate should have a formal prescribed training agenda or checklist to follow during the training. Use of a formal checklist ensures that all important operations and skills are tested and evaluated. Training can take as long as needed but should always be concluded by having the candidate demonstrate the ability to inspect and operate the equipment properly and safely without assistance from the trainer.

E.3.3 Knowledge-Based and Skill-Based Evaluation

At the conclusion of the training, a formal evaluation must be completed. The evaluation should include the knowledge, independent inspection, and operation of the crane. When the evaluation is completed, both the trainer and candidate should sign and date the evaluation document to signify that both agree that the evaluation has been completed and that the candidate is qualified to operate the equipment.

Documentation of the evaluation should be maintained in accordance with the site documentation retention requirements.

F
ANSI B30 SERIES STANDARDS

Table F-1 provides a listing of standards in the ANSI B30 series pertaining to hoisting, rigging, and cranes.

Table F-1
ASME B30 series standards

Title	Number
Jacks, Industrial Rollers, Air Casters, and Hydraulic Gantries	B30.1 - 2015
Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)	B30.2 - 2016
Tower Cranes	B30.3 - 2016
Portal and Pedestal Cranes	B30.4 - 2015
Mobile and Locomotive Cranes	B30.5 - 2014
Derricks	B30.6 - 2015
Winches	B30.7 - 2016
Floating Cranes and Floating Derricks	B30.8 - 2015
Slings	B30.9 - 2014
Hooks	B30.10 - 2014
Handling Loads Suspended from Rotorcraft	B30.12 - 2011
Storage/Retrieval (S/R) Machines and Associated Equipment	B30.13 - 2011
Side Boom Tractors	B30.14 - 2015
Overhead Underhung and Stationary Hoists	B30.16 - 2017
Cranes and Monorails with Underhung Trolley or Bridge)	B30.17 - 2015
Stacker Cranes (Top or Under Running Bridge, Multiple Girder with Top or Under Running Trolley Hoist)	B30.18 - 2016
Cableways	B30.19 - 2016
Below-the-Hook Lifting Devices	B30.20 - 2013
Lever Hoists	B30.21 - 2014
Articulating Boom Cranes	B30.22 - 2016

Table F-1 (continued)
ASME B30 series standards

Title	Number
Personnel Lifting Systems	B30.23 - 2016
Container Cranes	B30.24 - 2013
Scrap and Material Handlers	B30.25 - 2013
Rigging Hardware	B30.26 - 2015
Material Placement Systems	B30.27 - 2014
Balance Lifting Units	B30.28 - 2015
Self-Erecting Tower Cranes	B30.29 - 2012
Design of Below-the-Hook Lifting Devices	BTH-1 - 2011
Design of Below-the-Hook Lifting Devices	BTH-1 - 2014
Design of Below-the-Hook Lifting Devices	BTH-1 - 2017
Performance Standard for Hand Chain Manually Operated Chain Hoists	HST-2 - 2014
Performance Standard for Overhead Electric Wire Rope Hoists	HST-4 - 2016
Performance Standard for Air Chain Hoists	HST-5 - 2014
Performance Standard for Air Wire Rope Hoists	HST-6 - 2015
Planning for Load Handling Activities	P30-1

G
PERSONNEL PLATFORM PLANNING AND AUTHORIZATION FORM

Figure G-1 provides an example of a personnel platform planning and authorization form consistent with the guidance provided in ASME B30.23-2016.

1. Location: _____ Date: _____
2. Purpose of lift: _____
   _____
3. Hoisting eqpt. mfg: _____ Model #: _____ Serial #: _____
4. Expected radius: _____ (maximum); _____ (at work location)
5. (A) Rated load at radius: _____ (B) Maximum lift load: _____ [50% of 5(A)]
6. Platform ID: _____ Platform rating: _____
7. Platform weight: _____ Type: (Pin On) _____ (Suspended) _____
8. (A) Number of platform occupants: _____ (B) Approx. wt. (With equip): _____
9. Total lift weight: _____ [7 + 8(B)] [No more than 5(B) above]
10. Personnel lift supervisor: _____
11. What are the alternatives to this personnel lift? _____
    _____
    _____
12. Why are they not being used? _____
    _____
13. Pre-lift briefing held: ___/__/___ AM/PM
    Attendees: _____
    _____
    _____
14. Anticipated hazards (wind, weather, visibility, power lines): _____
    _____
15. Lift accomplished date: _____ Time: _____
16. Remarks: _____
    _____
    _____

_____
Personnel Lift Authorizer Signature Date

Figure G-1
Personnel platform planning and authorization form example

H
PERSONNEL LIFT PLATFORM PRE-LIFT INSPECTION FORM

Figure H-1 provides an example of a personnel lift platform pre-lift inspection form consistent with the guidance provided in ASME B30.23-2016.

Inspector: _____ Date: _____

Platform ID: _____

		Sat	Unsat
1.	Markings		
	Platform (all information legible)		
	Suspension system		
2.	Structure		
	Load-supporting welds/bolts		
	Load-supporting members		
	Barrier from toeboard to intermediate rail		
	Handrail		
	Fall protection device anchorage points		
	Gate-locking mechanisms		
	Platform flooring		
	Suspension attachment points		
3.	Attachment Mechanisms		
	Pins/ears/bolt-ups/eyes (circle)		
	Wire rope/chain/rigid leg (circle)		
	Master links		
4.	Special Purpose Items		
	(Overhead protection, flotation, platform controls)		
	List: (1) _____		
	(2) _____		
	(3) _____		

5. General comments: _____

_____

_____

_____

Lift Director Signature

GENERAL NOTE: Sat = satisfactory; Unsat = unsatisfactory.

Figure H-1
Personnel lift platform pre-lift inspection form example

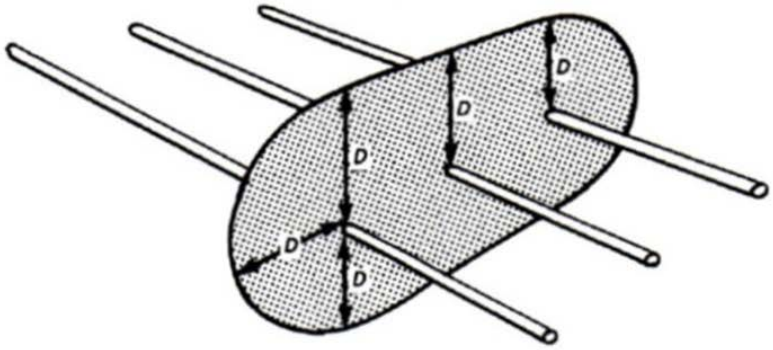
I
LIFTING PERSONNEL NEAR ELECTRIC POWER LINES

This appendix provides an overview of industry guidance for lifting personnel near electric power lines. Mandatory Appendix I to ASME B30.23-2016 provides detailed guidance for lifting personnel near electric power lines. The ASME standard provides the following four situations that should be considered when lifting personnel near electric power lines:

- Condition A: Power lines are de-energized and grounded. This is the safest and preferred condition
- Condition B: Power lines are energized with the hoisting equipment outside the prohibited zone, but there is a potential for the hoisting equipment or platform to be energized.
- Condition C: Power lines are energized with the hoisting equipment inside the prohibited zone, and there is a possibility that the hoisting equipment or platform can become energized. Lifting personnel in this condition is prohibited.
- Condition D: Hoisting equipment is in transit with the boom lowered, and no personnel are on the platform.

The ASME standard also provies required clearances around high-voltage power lines, as shown in Figure I-1.

Required Clearance for Normal Voltage in Operation Near High-Voltage Power Lines and Operation in Transit With No Load and Boom or Mast Lowered

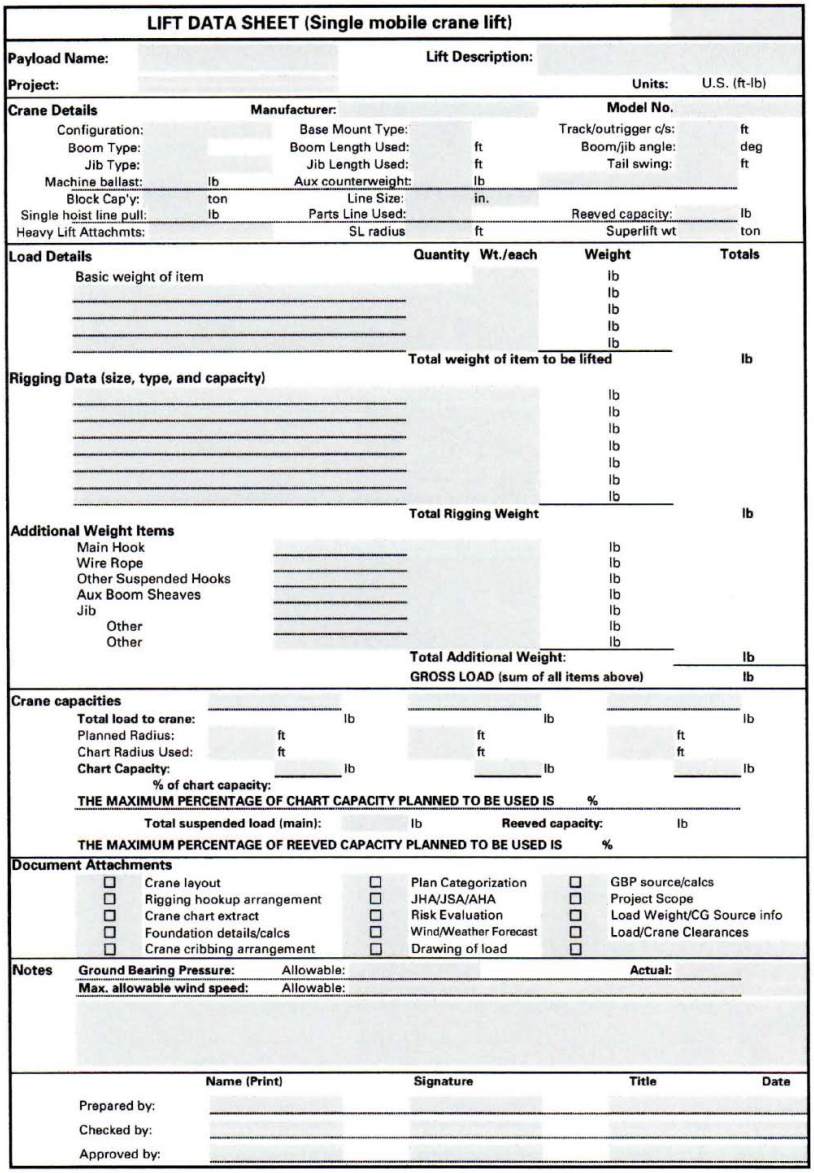


Normal Voltage, kV (Phase to Phase)	Minimum Radial Distance, *D*, ft (m)	
When Operating Near High-Voltage Power Lines		
Up to 50	10	(3.05)
Over 50 to 200	15	(4.6)
Over 200 to 350	20	(6.1)
Over 350 to 500	25	(7.62)
Over 500 to 750	35	(10.67)
Over 750 to 1,000	45	(13.72)
While in Transit With No Load and Boom or Mast Lowered		
Up to 0.75	4	(1.22)
Over 0.75 to 50	6	(1.83)
Over 50 to 345	10	(3.05)
Over 345 to 750	16	(4.87)
Over 750 to 1,000	20	(6.10)

Figure I-1
Required clearance for personnel lifts near high-voltage power lines

J
EXAMPLE FOR LIFT PLAN DEVELOPMENT

The purpose of this appendix is to provide examples of documents used to develop a lift plan that can be used for any of the lifts categorized in this report. Additional guidance regarding the development of lift plans can be found in EPRI 1009706, *Rigger's Handbook*, and ASME P30.1-2014, "Planning for Load Activities."



LIFT DATA SHEET (Single mobile crane lift)

Payload Name: **Lift Description:**

Project: **Units:** U.S. (ft-lb)

Crane Details **Manufacturer:** **Model No.**

Configuration:		Base Mount Type:		Track/outrigger c/s:	ft
Boom Type:		Boom Length Used:	ft	Boom/jib angle:	deg
Jib Type:		Jib Length Used:	ft	Tail swing:	ft
Machine ballast:	lb	Aux counterweight:	lb		
Block Cap'y:	ton	Line Size:	in.		
Single hoist line pull:	lb	Parts Line Used:		Reeved capacity:	lb
Heavy Lift Attachmts:		SL radius	ft	Superlift wt	ton

Load Details **Quantity** **Wt./each** **Weight** **Totals**

Basic weight of item lb
lb
lb
lb
lb
Total weight of item to be lifted **lb**

Rigging Data (size, type, and capacity)

lb
lb
lb
lb
lb
lb
lb
Total Rigging Weight **lb**

Additional Weight Items

Main Hook lb
Wire Rope lb
Other Suspended Hooks lb
Aux Boom Sheaves lb
Jib lb
Other lb
Other lb
Total Additional Weight: **lb**
GROSS LOAD (sum of all items above) **lb**

Crane capacities

Total load to crane:	lb	lb	lb
Planned Radius:	ft	ft	ft
Chart Radius Used:	ft	ft	ft
Chart Capacity:	lb	lb	lb
% of chart capacity:			

THE MAXIMUM PERCENTAGE OF CHART CAPACITY PLANNED TO BE USED IS **%**

Total suspended load (main): lb **Reeved capacity:** lb

THE MAXIMUM PERCENTAGE OF REEVED CAPACITY PLANNED TO BE USED IS **%**

Document Attachments

☐ Crane layout	☐ Plan Categorization	☐ GBP source/calcs
☐ Rigging hookup arrangement	☐ JHA/JSA/AHA	☐ Project Scope
☐ Crane chart extract	☐ Risk Evaluation	☐ Load Weight/CG Source info
☐ Foundation details/calcs	☐ Wind/Weather Forecast	☐ Load/Crane Clearances
☐ Crane cribbing arrangement	☐ Drawing of load	☐

Notes **Ground Bearing Pressure:** Allowable: **Actual:**

Max. allowable wind speed: Allowable:

	Name (Print)	**Signature**	**Title**	**Date**
Prepared by:				
Checked by:				
Approved by:				

Figure J-1
Lift data sheet example (ASME P30.1-2014)

EXAMPLE PRE-LIFT SAFETY CHECKLIST

Pre-Lift Check	Yes	N/A
Payload weight / CG verified?		
Lift correctly categorized?		
Plan in place?		
Plan is viable?		
Required approvals / permits?		
Weather / wind OK?		
Power lines/undergrounds?		
Site control / area barricaded?		
Contingency considerations?		
Emergency plan needed?		

Rigging Check	Yes	N/A
Correct rigging?		
Rigging inspections current?		
Inspected before use?		
Rigging correctly assembled?		
Protection used as req'd?		
Rigging properly tagged?		
Sling angles acceptable?		
Lift points inspected?		
D/d ratio adequate?		
Tag lines?		

Crane Setup Check	Yes	N/A
Annual inspection?		
Daily checks conducted OK?		
Adequately supported?		
Mats where required?		
Setup checked/level?		
Adequate parts of line?		
Obstructions/clearance?		
Configuration correct?		
Controls / functions OK?		
Services / ancillary eqpt.?		

Personnel Check	Yes	N/A
Lift director in place?		
Qualified rigger in place?		
Qualified signalperson(s)?		
Communication (hand/radio)?		
Operator certified/qualified?		
Nonessential persons out?		
Rigger roles identified?		
Other craft roles identified?		
Rigging engineer present?		
Pre-lift meeting held?		

PRE-LIFT BRIEFING

I confirm that the lift plan has been explained to me, that we have discussed it, and that I understand the operation and my role and responsibilities.

NAME (PRINT)	SIGNATURE	CRAFT/TRADE

NAME (PRINT)	SIGNATURE	LIFT DIRECTOR

Figure J-2
Pre-lift safety checklist example (ASME P30.1-2014)

K
LIFT ZONES

This appendix provides guidance on controlling a lift zone and an example of how the dimensions of a lift zone may be determined. Rigging and lifting program procedures should include a discussion of lift zones and how dimensions are to be determined.

K.1 Control of Lift Zones

The lift zone should be controlled in such a manner as to avoid personnel injury and damage to equipment. In general, the following steps should be taken:

- Determine the lift zone dimensions based on lift characteristics, such as load dimensions, load height off ground, load weight, potential of lifting equipment failure, weather, ground conditions, rigging configuration, and crane configuration.
- Clear the lift zone of all lift non-essential personnel.
- Control the lift zone with a dedicated spotter and/or barricade tape with signage to prevent lift non-essential personnel from getting within the fall zone. Installing yellow caution tape with signage in accordance with utility procedures can be used to supplement a spotter to continuously control access to the lift area. If a spotter cannot continuously control access to the lift area, red danger barricade tape and signage should be erected in accordance with utility procedures.
- Erect additional area controls for mobile cranes to ensure that the counterweight swing area remains clear of all personnel during movement.
- When loads are moved over potentially occupied buildings, consider personnel in the areas of the building under the lift zone. Evacuation or load drop analysis might be required in these situations.
- When a load is moved through multiple levels of a building, all affected levels should be barricaded with signage to warn of the lift.
- Supervisors and lift directors should ensure that every lift zone is properly controlled by dedicated personnel or with adequate barricades and signage before lifting commences.

K.2 Example of Determining the Dimensions of Lift Zones

In this example, this zone (that is, three-dimensional space), unless defined in a job safety analysis or procedure or by established boundary controls, is the height of the object plus the distance that it is raised, up to a maximum of 10 ft (3 m) continuously around the object being moved. The lift zone for lift less than 10 ft (3 m) is illustrated in Figure K-1.

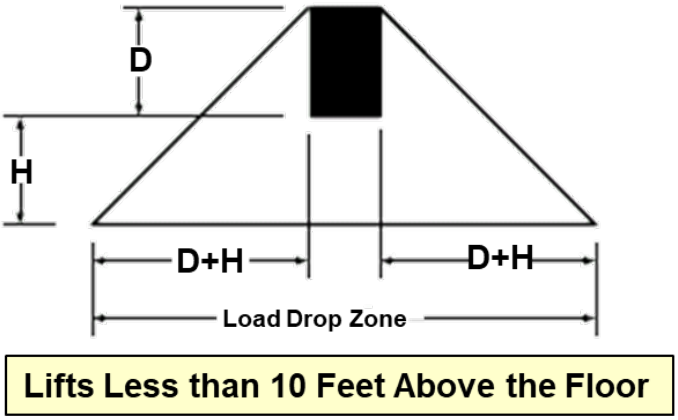


Figure K-1
Lift zone for lifts less than 10 ft (3 m)

For loads suspended at heights greater than 10 ft (3 m), the zone has a radius of 10 ft (3 m) plus the height of the object. For the purposes of this report, these are the minimum requirements that any load drop zone must have. The lift zone for lifts higher than 10 ft (3 m) is illustrated in Figure K-2.

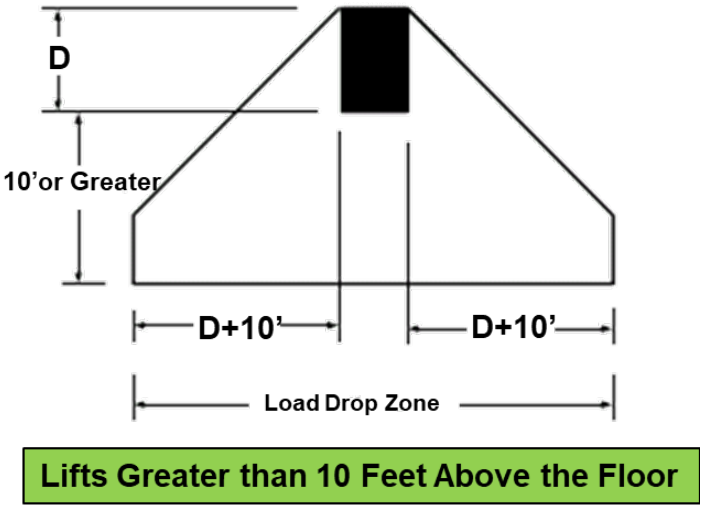


Figure K-2
Lift zone for lifts higher than 10 ft (3 m)

Site/fleet procedures should clearly define when it is permissible for personnel to enter the lift zone and who on the lift team can authorize entry. These procedural requirements may vary depending upon the type of lift being conducted. As stated in the related EPRI reports and OSHA standards, procedures should ensure that prior to a lift, the following should be verified:

- The load path is clear of obstruction and other activities
- A continuous, unobstructed ingress and egress path is established
- Controls for monitoring boundary of zone are established

Key Safety Point

Do not walk under the boom of a crane when not necessary; when a suspended load is being moved; or when the boom is loaded or moving.

Key Safety Point

Do not unnecessarily stand under an empty crane hook being lowered/raised.

L
TRANSLATED TABLE OF CONTENTS

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3002012805

最终报告，2018 年 10 月

EPRI 项目经理
G. Boles

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YES  NO

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产品描述

在可能的范围内，本报告为核能公用事业公司提供了标准化起重吊装大纲导则。这样做有助于核电站培训工人，使其能安全高效地进行作业，并让其能以更少的时间通过特定电站的培训和资格认定，便于其在电站间流动。这将有助于提升安全性，并降低成本。

背景

核电站员工必须能够安全地应用起重机进行起重吊装作业。当工人在厂址间流动时，他们也必须会应用起重吊装大纲知识。此外，基于此大纲的工人资格认定应具有可移植性，以便于更加高效地使用工人。当前的美国电力研究院（EPRI）大纲导则范围限于从小型吊车到索具。更新后的导则也将被纳入进来，以及美国机械工程师学会（ASME）预计将发布的新文件，以应对由行业起重吊装严重事件引起的监管问题。

目标

- 通过与公用事业公司和主题专家合作来制定一个起重吊装大纲，确保能安全高效地进行起重吊装作业，并能被公用事业公司员工在各个电站间广泛应用，使定制化降到最低。

方法

组建一个由现场吊装大纲协调员和行业主题专家构成的技术顾问组，来制定一个共识方法，以应对与核电站起重吊装有关的纲领性问题。与 EPRI 的标准化任务评价（STE）大纲协作，确保提供或制定因本大纲导则导致的 STE 大纲变更，以纳入 STE 大纲。EPRI 密切监控 ASME 相关标准的制定，以确保在适当的地方纳入 ASME 导则。

结果

本报告为公用事业公司员工提供了现场/机组起重大纲内容导则。本报告致力于将关键术语、员工职责和起重员工资格认定要求标准化，以使这些关键员工在核电站间流动的可移植性最大化。本报告还致力于将各种起重的命名以及各种起重的操作进行标准化。本报告的任何定制化应主要归因于核电站的实体差异。应对监管承诺差异进行评价， 以确定其是否会影响工人的可移植性、是否会造成不当成本与安全效益、以及不当成本与监管弱点。基于这一评价，核电站可能会按照核电站监管流程考虑改进这些承诺或完全收回承诺。

应用场合、价值与使用

本报告主要供现场/机组起重吊装大纲协调员使用。虽然大部分所涉内容都针对的是美国核电站的标准，但在经过监管差异调整后，其可以被国际公用事业公司员工采用。本报告意义重大，因为它最大化了与起重活动有关的人员可移植性，因此可以降低在美国国内外核电站机组间使用这些技能人员的相关成本。

关键词
起重机
吊升
起重
鉴定
安全性优势

目录

插图清单

表格目录

Guide des programmes de manutention et de levage pour les centrales nucléaires

3002012805

Rapport final, octobre 2018

Chef de projet EPRI
G. Boles

La totalité ou une partie des exigences du programme d'assurance qualité nucléaire EPRI (EPRI Nuclear Quality Assurance Program) s'appliquent à ce produit.

YES (NO)

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DESCRIPTION DU PRODUIT

Le présent rapport fournit aux centrales nucléaires une orientation visant à normaliser leurs programmes de manutention et de levage dans la mesure du possible. Cela permet aux centrales de former les travailleurs aux questions de sécurité et d'efficacité tout en réduisant l'investissement de temps nécessaire à la formation et au renforcement des capacités du personnel d'une centrale à une autre. Cela devrait renforcer la sécurité et réduire les frais.

Contexte

Les membres du personnel d'une centrale nucléaire doivent pouvoir réaliser les opérations de manutention et de levage, et utiliser les grues en toute sécurité. Les travailleurs doivent également appliquer des connaissances relatives à la manutention et au levage lorsqu'ils changent de site. De plus, les qualifications dont disposent les travailleurs en fonction des exigences du programme doivent être transférables pour optimiser leur travail. L'orientation de programme actuelle de l'Electric Power Research Institute (EPRI) se limite aux petits matériels de levage et de manutention. La présente mise à jour s'inscrit dans le cadre de la publication prévue de nouveaux documents de l'American Society of Mechanical Engineers (ASME) pour répondre aux exigences réglementaires, notamment à la lumière de certains incidents graves qui se sont produits dans le secteur en rapport avec les opérations de manutention et de levage.

Objectifs

- Par le biais d'une approche collaborative avec les sociétés de distribution d'énergie et les experts en la matière, l'objectif consiste à élaborer un programme de manutention et de levage permettant de réaliser un travail efficace en toute sécurité, un programme pouvant être mis en œuvre globalement par les employés de sociétés de distribution d'énergie, quel que soit le site, avec un minimum de personnalisation.

Approche

Un groupe consultatif technique composé de coordinateurs de programme de levage sur site et d'experts du secteur a été créé pour élaborer une approche fondée sur le consensus des parties prenantes dans le but de relever les enjeux programmatiques liés aux opérations de levage dans les centrales nucléaires. Une collaboration avec le programme d'évaluation de tâche normalisée (Standardized Task Evaluation, STE) de l'EPRI permet de garantir que les modifications apportées au programme STE dans le cadre de la présente orientation soient disponibles ou soient développées pour être intégrées au programme STE. L'EPRI suit de près le développement des normes connexes de l'ASME afin d'assurer leur intégration, le cas échéant.

Résultats

Le présent rapport fournit aux employés de sociétés de distribution d'énergie une orientation pour élaborer leurs programmes de levage de site/flotte. Il tente de normaliser les définitions des mots-clés, les rôles et responsabilités du personnel, et les qualifications requises des employés travaillant aux opérations de levage pour maximiser la transférabilité de ces employés d'une

centrale nucléaire à une autre. Le rapport normalise également la nomenclature des différents types de matériel de levage et de leur gestion. Toute personnalisation du rapport doit essentiellement découler de différences physiques entre les centrales. Les différences dues à des engagements envers les exigences réglementaires devraient être évaluées afin de déterminer si elles affectent la transférabilité des travailleurs, si la réduction des coûts a lieu aux dépens de la sécurité ou aux dépens de la conformité envers les réglementations en vigueur. En fonction de cette évaluation, les centrales envisageront peut-être de modifier les engagements pris, voire de les éliminer, conformément aux processus réglementaires applicables à ces centrales.

Applications, valeur et utilisation

Le présent rapport est principalement destiné aux coordinateurs de programme de levage de site/flotte. Bien que la plupart des références aient trait aux normes applicables aux centrales nucléaires aux États-Unis, elles peuvent être adoptées par les employés de sociétés de distribution d'énergie d'autres pays, sous réserve qu'ils prennent en considération les différences entre les réglementations applicables. Le rapport est utile du fait qu'il maximise la transférabilité du personnel chargé des activités de levage et qu'il permet donc de réduire les frais liés à leur travail dans la flotte des centrales nucléaires aux États-Unis comme ailleurs.

Mots-clés

Grue
Manutention
Levage
Certification
Sécurité

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原子力発電所のリギングおよびリフティングプログラムガイド

3002012805

最終報告書　2018 年 10 月

EPRI プロジェクトマネージャー
G. Boles

本成果物には、EPRI 原子力品質保証プログラム (Nuclear Quality Assurance Program) の要件の全てまたは一部が適用される。

YES  NO

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成果物記述書

本報告書は、原子力事業者がリフティングおよびリギングプログラムを可能な限り標準化するための指針を示す。このことは、発電所において、安全かつ効率的に働く、発電所独自のトレーニングや資格認定にあまり時間をかけずに別の発電所に移動できるような作業員を育成するために役立つ。これにより安全性が高まり、コストが下がるはずである。

背景

原子力発電所の作業員は、リギングやリフティングを行う能力を備え、クレーンを安全に使用できなければならない。また作業員は、別の発電所に移動したときにも、リギングやリフティングプログラムの知識を活用できなくてはならない。さらに、作業員のより効率的で効果的な活用を可能にするためには、このプログラムに基づく作業員の資格認定にも可搬性がなければならない。現在の電力研究所（EPRI）のプログラム指針は、小型ホイストとリギングハードウェアに限られている。また、業界のリギングやリフティングに関する重大な事象によって生じた規制上の懸念に対処するために、発行の予定されている米国機械学会（ASME）の新文書と呼応した指針の更新も含まれている。

目的

- 事業者と分野別専門家の共同のアプローチを通じて、安全かつ効率的な作業を保証し、原子力事業者の従業員があらゆる発電所で最小限のカスタマイズで幅広く実施できるような、リギングおよびリフティングプログラムを開発すること。

取り組み方

原子力発電所でのリフティングに関するプログラム上の問題点に対処するための統一された方法を開発するために、現場のリフティングプログラムコーディネーターと業界の分野別専門家からなる技術諮問グループが結成された。EPRI の標準化タスク評価（STE）プログラムの協力により、このプログラム指針から生じる STE プログラムの変更を、STE プログラムに取り込むために利用できること、もしくは、そのために開発中であることが保証される。EPRI は、ASME の指針が適宜取り入れられることを確実にするため、関連する ASME 規格の策定を注意深く監視した。

結果

本報告書は、事業者の従業員に、サイト／原子力発電所リフティングプログラムの内容に関する指針を提供する。本報告書では、重要な用語の定義、作業員の役割や責任、リフティング担当者の資格要件を標準化することにより、このような重要な要員の原子力

発電所間の可搬性を最大化しようとしている。また本報告書では、リフティングのさまざまな種類を表す専門語と種類ごとの管理方法も標準化している。本報告書のカスタマイズは、第一に発電所の物理的な相違点に応じて行われる必要がある。作業員の可搬性、安全上の利益に対する過度のコスト、規制の脆弱性に対する過度のコストに影響があるかどうかを判断するために、規制上のコミットメントから来る相違点も評価する必要がある。発電所ではこの評価に基づき、その発電所の規制プロセスに従って、このようなコミットメントを変更したり、完全に取り消したりすることを検討する可能性がある。

適用、価値、および使用

本報告書は主に、サイト／原子力発電所のリフティングプログラムのコーディネーターが使用することを意図している。参考文献の大多数は、米国の原子力発電所における規格であるが、規制の相違点を考慮に入れれば、米国以外の事業者の作業員が採用することも可能である。本報告書に価値があるのは、リフティング作業に関わる作業員の可搬性を最大化した結果、そのような熟練した作業員を米国内外の原子力発電所全体で活用することにより、関連コストを削減できるからである。

キーワード

クレーン
巻き上げ
リフティング
認定
安全性

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원자력 발전소를 위한 줄걸이 작업 및 인양 작업 프로그램

3002012805

최종 보고서, 2018년 10월

EPRI 프로젝트 매니저
G. Boles

본 제품에는 EPRI 원자력 품질 보증 프로그램의 요건이 전부 또는 일부 적용됩니다.

YES (NO)

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제품 명세

본 보고서는 가능한 범위에서 원자력 시설물의 인양 작업 및 줄걸이 작업의 표준화 지침을 제공합니다. 그렇게 하는 데 있어서 발전소는 근로자가 안전하고 효율적으로 작업할 수 있도록 그리고 근로자가 발전소 고유의 훈련 및 자격 취득에 더 적은 시간을 투입하고서도 발전소와 발전소 간에 이동할 수 있도록 근로자를 훈련시키는 데 도움을 줍니다. 이렇게 함으로써 안전은 증대되고 비용은 절감될 것입니다.

배경

원자력 발전 요원은 줄걸이 작업 및 인양 작업을 수행할 수 있고 또한 크레인을 안전하게 사용할 수 있어야 합니다. 또한 근로자는 현장과 현장 간 이동 시 줄걸이 작업 및 인양 작업 프로그램과 관련한 지식을 활용하여야 합니다. 덧붙여, 이 프로그램에 기반을 둔 근로자 자격 부여 프로그램은 근로자를 보다 더 효율적이고 보다 더 효과적으로 활용할 수 있도록 휴대 가능하여야 합니다. 현재 미국전력연구소(EPRI) 프로그램의 지침은 소형 호이스트 및 줄걸이 작업 하드웨어에 한정되어 있습니다. 또한 산업계의 심각한 줄걸이 작업 및 인양 작업 사고로 촉발된 법적 규제 문제를 해결하기 위해 미국기계학회(ASME)의 예상되는 새 문서들의 발행과 함께 갱신된 지침이 추가되는 상황입니다.

목표

- 작업을 반드시 안전하고 효율적으로 수행할 수 있도록, 그리고 핵 시설 요원들이 최소한의 맞춤화로 모든 발전소에 걸쳐 광범위하게 실행할 수 있도록 시설물 및 주제 관련 문제 전문가들과의 공동 접근책을 모색하여 줄걸이 작업 및 인양 작업 프로그램을 개발하는 데 목표가 있습니다.

접근책

원자력 발전소의 인양 작업 관련 프로그램 문제를 해결하기 위한 공동으로 합의된 접근책을 개발할 목적으로 현장의 인양 작업 프로그램 코디네이터 및 산업계 주제 관련 문제 전문가들로 구성된 기술자문단이 구성되었습니다. EPRI의 표준화 작업 평가(Standardized Task Evaluation, STE) 프로그램과의 협업을 통해 본 프로그램 지침에 따른 STE 프로그램의 수정 사항을 활용할 수 있도록 또는 이러한 수정 사항을 STE 프로그램에 통합시킬 수 있도록 개발이 진행 중입니다. EPRI는 적절한 경우 ASME의 지침을 반드시 통합할 수 있도록 관련 ASME 표준의 개발 상황을 면밀히 모니터링했습니다.

결과

본 보고서는 현장/작업 그룹의 인양 작업 프로그램의 내용과 관련된 지침을 시설 요원들에게 제공합니다. 본 보고서는 핵심 용어의 정의, 요원의 역할과 책임, 인양

작업자의 자격 요건을 표준화하여 핵심 요원들의 원자력 발전소와 원자력 발전소 간 이동성을 극대화하고자 시도합니다. 본 보고서는 또한 다양한 유형의 인용 장비의 명칭과 각 유형을 관리하는 방법을 표준화합니다. 본 보고서의 맞춤화 작업은 주로 발전소의 물리적 차이점이 있을 경우에 이루어져야 합니다. 규정상의 책임에 따른 차이점들을 평가하여 그러한 차이점이 근로자의 이동성, 과도한 비용 대비 안전 혜택, 그리고 과도한 비용 대비 규제의 취약성에 영향을 미치는지 판단해야 합니다. 그러한 평가를 바탕으로 발전소는 발전소 규제 절차에 따라 그러한 책임을 수정하거나 또는 완전히 취소하는 것을 고려할 수도 있습니다.

적용, 가치, 이용

본 보고서는 주로 현장/작업 그룹의 인양 작업 프로그램 코디네이터가 활용할 수 있도록 하는 데 그 목적이 있습니다. 비록 대부분의 참고 자료는 미국 원자력 발전소의 표준들에 활용하도록 하기 위한 것이지만, 규정상의 차이점들을 조정해 온 국제 시설 요원들이 채택하여 활용할 수도 있습니다. 본 보고서는 인양 작업 활동과 관련있는 요원의 발전소와 발전소 간의 이동성을 극대화하고 또한 차후에 미국 및 해외 원자력 발전소의 작업 그룹 전반에 걸쳐 이들 숙련된 요원을 활용하는 데 소요될 비용을 절감할 수 있을 것이므로 유용합니다.

키워드

크레인
호이스트 작업
인양 작업
자격 부여
안전

목차

그림 목록

도표 목록

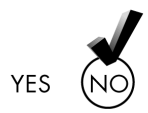
Guia para programa de rigging e içamento para usinas nucleares

3002012805

Relatório final, outubro de 2018

Gerente de projeto EPRI
G. Boles

Os requisitos do Programa de Garantia de Qualidade Nuclear do EPRI se aplicam a este produto total ou parcialmente.



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DESCRIÇÃO DO PRODUTO

Este relatório apresenta orientações às concessionárias de utilidades nucleares para padronizar os programas de rigging ao máximo possível. Dessa forma, as usinas ajudam a treinar os funcionários para que estejam seguros, sejam eficientes, e possam ser transferidos de uma usina para a outra com menor investimento de tempo necessário para treinamento e qualificação específicos da usina. Isso deve aumentar a segurança e diminuir as despesas.

Panorama

A equipe da usina nuclear deve ser capaz de realizar rigging e içamento e de usar guindastes com segurança. Os funcionários também devem aplicar o conhecimento do programa de rigging e içamento quando vão de um site para outro. Além disso, as qualificações dos funcionários baseadas no programa precisam ser portáteis para permitir seu uso mais eficiente e eficaz pelos funcionários. As orientações do Electric Power Research Institute (EPRI) existentes atualmente estão limitadas a talhas pequenas e equipamento de rigging. As orientações atualizadas também estão sendo incluídas, juntamente com a emissão antecipada de novos documentos da Sociedade Norte-americana de Engenheiros Mecânicos (ASME) que tratam de questões regulatórias exigidas por eventos graves envolvendo rigging e içamento do setor.

Objetivos

- Por meio de uma abordagem colaborativa com concessionárias de utilidades e especialistas no assunto, desenvolver um programa de rigging e içamento que garante que o trabalho é realizado de maneira segura e eficiente, e que possa ser amplamente implementado pela equipe da concessionária de utilidades nucleares em todas as usinas com o mínimo de personalização

Abordagem

Um grupo de aconselhamento técnico, composto de coordenadores do programa de içamento do site e especialistas no assunto do setor, foi formado para desenvolver uma abordagem de consenso para tratar de questões programáticas associadas ao içamento em usinas nucleares. A cooperação com o Programa de avaliação de tarefas padronizado (STE) do EPRI garantiu que as alterações feitas ao programa de STE resultantes das orientações deste programa estão disponíveis ou estão em elaboração para serem incorporadas ao programa de STE. O EPRI monitorou de perto a elaboração de normas da ASME relacionadas para garantir que a orientação da ASME seja incorporada, quando apropriado.

Resultados

Este relatório apresenta orientações relacionadas ao conteúdo de um programa de içamento de site/frota para equipes de concessionárias de utilidades. O relatório busca padronizar definições de termos-chave, papéis e responsabilidades da equipe, e requisitos de qualificação da equipe de içamento para maximizar a portabilidade desses indivíduos-chave de uma usina nuclear para outra. O relatório também padroniza a nomenclatura para diferentes tipos de içamento e como

cada tipo deve ser gerenciado. Qualquer personalização do relatório deve-se principalmente às diferenças físicas entre as usinas. Diferenças devidas a compromissos regulatórios devem ser avaliadas para determinar se afetam a portabilidade dos funcionários, despesas indevidas versus benefícios de segurança, e despesas indevidas versus vulnerabilidade regulatória. Com base nessa avaliação, as usinas podem considerar a possibilidade de modificar esses compromissos ou de desfazer esses compromissos como um todo, de acordo com os processos regulatórios da usina.

Aplicações, valor e uso

Este relatório se destina principalmente a ser usado por coordenadores de programas de içamento de sites/frotas. Embora a maioria das referências sejam a padrões utilizados em usinas nucleares nos EUA, elas podem ser adotadas por equipes de concessionárias de utilidades internacionais que tenham conciliado quaisquer diferenças regulatórias. O relatório é valioso porque maximiza a portabilidade da equipe associadas às atividades de içamento e, portanto, reduzirá as despesas associadas com a utilização dessa equipe qualificada nas frotas de usinas nucleares nos Estados Unidos e em outros países.

Palavras-chave

Guindaste
Elevação
Içamento
Qualificação
Segurança

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Guía del programa de elevación y aparejos para centrales nucleares

3002012805

Informe final, octubre de 2018

Jefe de Proyecto de EPRI
G. Boles

Este producto está sujeto a la totalidad o a parte de los requisitos del Programa de garantía de calidad nuclear de EPRI.

YES NO

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DESCRIPCIÓN DEL PRODUCTO

Este informe proporciona una guía para que las empresas de servicios del sector nuclear estandaricen los programas de aparejos y elevación en la medida de lo posible. Al hacer esto, las centrales contribuyen en la formación de los trabajadores para que estos se mantengan seguros y sean eficientes y puedan trasladarse de una central a otra invirtiendo menos tiempo en formación y cualificación específicas para la central. Esto debería aumentar la seguridad y reducir los costes.

Antecedentes

El personal del sector de la energía nuclear debe ser capaz de realizar operaciones con aparejos y de elevación, así como usar las grúas, de forma segura. Los trabajadores también deben aplicar los conocimientos del programa de aparejos y elevación cuando se trasladen de un lugar a otro. Asimismo, las cualificaciones del trabajador basadas en el programa deben ser transferibles para que permitan un uso más eficiente y eficaz de los trabajadores. La guía actual del programa de Electric Power Research Institute (EPRI) se limita a pequeños equipos de elevación y aparejos. También se incluye una guía actualizada junto con la publicación de nuevos documentos de la Sociedad Americana de Ingenieros Mecánicos (ASME) para abordar las cuestiones reglamentarias relativas a eventos graves ocurridos durante el uso de aparejos y las tareas de elevación.

Objetivos

- Siguiendo un método colaborativo con empresas de servicios y expertos en la materia, se busca desarrollar un programa sobre el uso de aparejos y equipos de elevación que garantice que el trabajo se realice de forma segura y eficiente y que pueda aplicarse ampliamente por parte del personal de las empresas de servicios del sector nuclear en todas las centrales con una mínima personalización.

Planteamiento

Se creó un grupo de asesoría técnica compuesto por coordinadores del programa de elevación in situ y expertos en la materia del sector, al objeto de desarrollar un método consensuado para abordar los problemas programáticos relacionados con las tareas de elevación en centrales nucleares. La colaboración con el programa de evaluación de tareas estandarizadas (STE) de EPRI garantizó que los cambios en dicho programa derivados de la guía de este programa estuvieran disponibles o se estén desarrollando para su incorporación a dicho programa STE. EPRI supervisó de cerca el desarrollo de las normas ASME correspondientes para garantizar la incorporación de las orientaciones de dichas normas cuando fuera necesario.

Resultados

Este informe ofrece al personal de las empresas de servicios una guía sobre el contenido de un programa de elevación in situ o en el parque. El informe pretende estandarizar las definiciones de términos clave, las funciones y responsabilidades del personal y los requisitos de cualificación

del personal encargado de las tareas de elevación, al objeto de maximizar la capacidad de trasladar a dichas personas clave de una central nuclear a otra. Asimismo, el informe también estandariza la nomenclatura de distintos tipos de equipos de elevación y cómo debe gestionarse cada uno de ellos. Cualquier personalización del informe debe responder, fundamentalmente, a las diferencias físicas entre centrales. Deben evaluarse las diferencias debidas a compromisos reglamentarios para determinar si estas afectan a la portabilidad de los trabajadores, los costes indebidos frente al beneficio de la seguridad y los costes indebidos frente a la vulnerabilidad reglamentaria. De acuerdo con dicha evaluación, las centrales pueden considerar la modificación de dichos compromisos o ignorarlos de acuerdo con los procedimientos reglamentarios de la central.

Aplicaciones, valor y uso

Este informe está destinado al uso, fundamentalmente, por parte de los coordinadores del programa de elevación in situ o en el parque. Aunque la mayoría de referencias se refieren a normas de centrales nucleares de EE. UU., estas pueden ser adoptadas por el personal de empresas de servicios internacionales que hayan reconciliado cualquier diferencia normativa. El informe tiene valor porque maximiza la portabilidad del personal asociado con las actividades de elevación y, por tanto, reducirá los costes relacionados con el uso de este personal cualificado en todo el parque de centrales nucleares de los Estados Unidos y en el extranjero.

Palabras clave

Grúa
Izado
Elevación
Calificación
Seguridad

CONTENIDO

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