CRANE AND HEAVY LIFT INSPECTION, SUPPLEMENTAL GUIDANCE TO IP 71111.20 and IP 71111.13

Effective Date: 09/01/2018

CORNERSTONE: INITIATING EVENTS
MITIGATING SYSTEMS
BARRIER INTEGRITY

APPLICABILITY:

- This OpESS applies to all licensed operating commercial nuclear reactors.
- This OpESS supplements sample selection for Inspection Procedure (IP) 71111.20, "Refueling and Other Outage Activities," and IP 71111.13, "Maintenance Risk Assessments and Emergent Work Control."
- Performance of this OpESS is voluntary.

OpESS 2007/03-01 OBJECTIVES

01.01 Support NRC review of licensees' activities related to heavy lift activities and heavy lift equipment reliability

01.02 Ensure licensees' procedures align with their commitments for conducting heavy lift activities

OpESS 2007/03-02 BACKGROUND

02.01 NRC Guidance on Heavy Loads

In NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants," dated July 1980, the NRC staff provided regulatory guidelines to assure the safe handling of heavy loads in areas where a load drop could impact stored spent fuel, fuel in the reactor core, or equipment that may be required to achieve safe shutdown or permit continued decay heat removal. Generic Letter (GL) 80-113, "Control of Heavy Loads," dated December 22, 1980, as supplemented by GL 81-07, "Control of Heavy Loads," dated February 3, 1981, requested that all licensees describe how they satisfied the guidelines of NUREG-0612 to reduce the likelihood and severity of a load drop at their facility. The staff requested that licensees explain any additional modifications that would be necessary to fully satisfy these guidelines.

The responses to GL 80-113 and GL 81-07 generally became part of the licensing bases for heavy load handling programs at nuclear power plants. The staff issued safety evaluation reports addressing the NUREG-0612 Phase I heavy load guidelines (i.e. procedures; operator training; design, testing, and maintenance of cranes and lifting equipment) to every licensee. NUREG-0612 Phase II guidelines sought to further reduce load handling accidents and their consequences, but in GL 85-11, "Completion of Phase II of 'Control of Heavy Loads at Nuclear Power Plants' NUREG-0612," the staff determined that a detailed review of licensee responses to Phase II guidelines was not necessary. Phase II guidelines included use of a single-failure-proof crane, restricting crane travel to safe areas by design, and performing load drop analyses.

02.02 Operating Experience

2005-2007 Operating Experience

On April 11, 1996, the NRC staff issued Bulletin 96-02, "Movement of Heavy Loads over Spent Fuel, over Fuel in the Reactor Core, or over Safety-Related Equipment," in part to alert addressees to the importance of meeting existing regulatory guidelines associated with the control and handling of heavy loads at nuclear power plants while the plant is operating. The NRC staff also issued Regulatory Issue Summary (RIS) 2005-25, "Clarification of NRC Guidelines for Control of Heavy Loads," dated October 31, 2005, as a means to assist with licensees' understanding of the regulatory requirements for compliance with 10 CFR 50.71(e) and 10 CFR 50.59 as these requirements relate to the heavy load handling program implementation. The staff followed up with RIS 2005-25, Supplement 1, "Clarification of NRC Guidelines for Control of Heavy Loads," on May 29, 2007, to communicate regulatory expectations associated with the safe handling of heavy loads and load drop analyses.

At the time, NRC inspectors were continuing to identify heavy load issues, particularly associated with reactor vessel head lifts, suggesting that: (1) the generic communications were not fully effective in clarifying regulatory expectations, and (2) there were instances where licensees had not followed their commitments made in generic letter responses, were not following their procedures during head lifts, or had not updated their analyses for changes such as an increase in weight of a replacement reactor vessel head.

Industry and NRC Response

By letter dated September 14, 2007, NEI proposed an industry initiative to enhance the description of heavy load handling programs in plant Final Safety Analysis Reports (FSARS), and, where appropriate, develop realistic load drop consequence analyses to define bounds for the safe handling of reactor vessel heads over the reactor vessel, and spent fuel casks over the spent fuel pool structure. The NRC staff considers these areas of the nuclear power plant safety significant with regard to maintaining irradiated fuel covered with water for adequate cooling. In July 2008, NEI published 08-05, "Industry Initiative on Control of Heavy Loads."

On December 1, 2008, NRC staff issued RIS 2008-28, "Endorsement of Nuclear Energy Institute Guidance for Reactor Vessel Head Heavy Load Lifts." which approved (with some clarifications) the methodologies of NEI 08-05 for use by licensees to revise their licensing basis for handling of reactor vessel heads and other heavy loads consistent with the provisions of 10 CFR 50.59.

2013 Operating Experience

On March 31, 2013, an offsite vendor and crane subcontractor were performing a heavy lift of the 535-ton main generator stator at Arkansas Nuclear One Unit 1 (ANO-1). The temporary lifting rig failed, resulting in the stator dropping through the turbine deck and falling another 30 feet before coming to rest on the floor of the train bay. This accident resulted in the death of one worker, a reactor trip of ANO-2, flooding from a ruptured firemain, and a loss of offsite power at ANO-1.

NRC issued a Yellow inspection finding following this event. Root and Contributing Causes that led to the ANO-1 event include the following:

Root Cause Summary

- The project to remove the stator was not organized in a manner that provided sufficient oversight of the vendor's design and testing for the temporary lift assembly. This resulted in use of a lift assembly that could not support the loads anticipated for the lift.
- The licensee's project management procedure provided insufficient guidance to identify and manage risk items with high consequence, particularly for cases where the probability of the event was judged to be very low.
- The subcontractor failed to perform required load testing of the modified temporary lift assembly prior to its use at ANO-1 in accordance with OSHA regulations.

Contributing Cause Summary

- Contractors informed the licensee that some components of the crane assembly had been used to lift loads in excess of the weight of the ANO-1 stator at other stations. However, the configuration used for the crane at ANO-1 was different from that employed for the lifts at other stations.
- Licensee procedures did not provide clear guidance regarding the level of review required to approve the design and testing of vendor-supplied special lift equipment, including how an alternate standard should be identified and approved for use.
- Supplemental project personnel lacked sufficient knowledge of industry standards and guidance for the use of temporary lift assemblies. Therefore, they accepted the sub-contractor's assertion that load testing was not required based on a combination of engineering analysis and previous use.
- Weak implementation of administrative controls by the licensee.
- Undue licensee confidence in the vendor's capabilities.
- Ineffective corrective actions by the licensee in response to a previous condition report regarding personnel involved in high risk decisions.

OpESS 2007/03-03 INSPECTION GUIDANCE

The following inspection guidance may be applied as appropriate to support baseline inspection activities. Inspector judgement should be used when determining the extent to which this OpESS should be used to inform inspection activities under the applicable baseline IP.

03.01 Refueling and Other Outage Activities

The recommended inspection activities described below support IP 71111.20, "Refueling and other Outage Activities." These activities will help inspectors ensure that heavy lifting evolutions at their facilities are being performed in a manner consistent with safety and in accordance with industry initiatives outlined in NEI 08-05. Figure 1 provides a flowchart to assist inspectors in evaluating licensee integration of NRC's generic guidance and that provided by NEI 08-05.

a. Determine whether the crane used to lift the reactor vessel head is "single-failure-proof" or has been evaluated as equivalent to "single-failure-proof."

(Note: many BWRs with Mark I and II containments have single-failure-proof cranes; no PWR polar cranes are fully single-failure-proof. In the response to the Generic Letters (GL 80-113 and GL 81-07) addressing "Control of Heavy Loads," some licensees classified the polar crane as equivalent to "single-failure proof" based on modifications to reduce the risk of "two-blocking" and other potential causes of load drops.) Section 3 of NEI 08-05 provides guidelines acceptable to the NRC staff for establishing the reactor building crane as equivalent to single failure proof for reactor vessel head lifts only. Review the licensee's basis and other documentation designating the crane as "single-failure-proof" or equivalent.

b. Review licensee procedures for crane preventive maintenance against applicable industry standards.

1. Verify that the licensee has a preventive maintenance program in place based on vendor recommendations for their type of crane (i.e. single-failure-proof or non-single-failure-proof), and that crane testing and inspection procedures are completed prior to use (i.e., yearly or just before use) for reactor disassembly, [per ANSI/ASME B30.2 "Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist.)"]

2. Review licensee's implementation of crane preventive maintenance, testing, and inspection procedures prior to reactor disassembly/head lift. If possible, observe licensee's actual performance of the crane testing and inspection procedure.

3. Verify that the special lifting device used for reactor vessel head lifts is tested consistent with the applicable standard (typically, ANSI/ANS N14.6, "Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 pounds (4,500 kg) or More for Nuclear Materials").

c. Verify reactor vessel head lift procedures conform to an acceptable safety basis. Acceptable safety bases include: (1) use of a single-failure-proof crane or equivalent conforming to the guidelines in Section 3 of NEI 08-05, or (2) a valid load drop analysis conforming to the guidelines in Section 2 of NEI 08-05.

d. If the licensee uses a load drop analysis, use the following inspection guidance:

1. Verify that the licensee's load drop analysis bounds their lifting procedures with regard to maximum lift height of the reactor vessel head over the reactor vessel. An actual ("sampling") verification that the licensee is following these procedural limits (including horizontal safe load paths) should also be confirmed by direct

observation during a reactor vessel head lift, if possible, during the outage. Compare the height assumed in the load drop analysis with that listed in the procedural limitation to verify commitments are met.

2. Verify that the load drop analysis (and any associated procedures) have been updated to reflect any significant change in the weight of the heavy load to be lifted or in the capability of the crane to carry such loads. A new reactor head may weigh more than the head weight considered in the load drop analysis, or the addition of lead shielding or permanent structures to the existing reactor vessel head may add significant weight.

3. Verify that the licensee's load drop analysis bounds its lifting procedures with regard to medium (i.e., water or air) through which the drop would occur.

4. Verify that the methodology and acceptance criteria used in the licensee's load drop analysis are consistent with Section 2 of NEI 08-05 (Note: Existing analyses previously subject to NRC licensing review or detailed inspection should be evaluated considering the guidance of NRR Office Instruction LIC-202, "Managing Plant-Specific Backfits and 50.54(f) Information Requests"). The staff considers the more conservative acceptance criteria of Appendix F, "Rules for Evaluation of Service Loadings with Level D Service Limits," to the American Society of Mechanical Engineers' Boiler and Pressure Vessel Code, Section III, Division 1, acceptable for the reactor coolant system piping and reactor vessel when using the analytical methods proposed in the industry guidance. Inspectors should notify NRR staff of otherwise technically adequate analyses providing a best-estimate evaluation of the consequences of a postulated reactor vessel head drop that does not fully satisfy the guidance specified in Section 2 of NEI 08-05.

03.02 Additional Considerations for Managing Planned Outage Activities that have High Potential Consequences but Low Probability

The recommended inspection activities described below support IP 71111.20, "Refueling and other Outage Activities," and IP 71111.13, "Maintenance Risk Assessments and Emergent Work Control." These activities will help inspectors ensure that activities involving high potential consequences but low probability receive adequate licensee oversight. These activities will also help inspectors ensure adequate licensee oversight of vendor and contractor activities that are high consequence/low probability.

a. Activities involving high potential safety consequences include but are not limited to:

- Movement of heavy loads
- Activities that could upset an operating unit
- Activities that could cause loss of power, compressed air, or cooling water
- Activities that could cause flooding
- Activities that could impact fuel transfer or the integrity of radiological barriers

b. The following recommended inspector guidance is summarized from a review of lessons learned following the 2013 ANO stator drop:

- Verify that heavy lift equipment such as cranes are load tested in the same configuration in which they will be used at the site (i.e., contractors should not load test pieces of the heavy lift system and then reassemble the pieces into a different configuration for a lifting operation).
- Review project management procedures to confirm that high risk projects are organized and managed with (1) effective support by subject matter experts, and (2) effective vendor and technical oversight.
- Ensure project management procedures properly identify high consequence risks, and either eliminate or mitigate project risk through a structured risk management process.
- Ensure the licensee performs risk assessments when required by procedure. When project scope changes, the licensee should refer back to their risk assessment procedures to determine whether an additional risk assessment is required.
- Evaluate licensee procedures for management and oversight of supplemental personnel. These procedures should address:
    - Definition of responsibilities for oversight of supplemental personnel
    - Assessment of risk for contractor activities
- Other considerations for licensee oversight of contractor activities
    - Does the licensee have a recurring training program for project management personnel on risk recognition and conservative decision making?
    - Do project management procedures require a review of contract language to ensure detailed engineering calculations, quality requirements, and standards are provided for temporary lifting assemblies?
    - Evaluate the effectiveness of the licensee's risk screening for any "first-of-a-kind" evolutions.

OpESS 2007/03-04 REFERENCES

04.01 NRC Generic Communications and NUREGs

a. NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants" – Discusses the risks associated with handling heavy loads at nuclear power plants. Section 5.1 outlines Phase I and Phase II recommendations which are addressed in the resulting generic letters.

b. GL 80-113 and GL 81-07, both titled "Control of Heavy Loads" – In these GLs, the NRC requested information from licensees on how they would address the Phase I and Phase II recommendations in NUREG-0612.

c. GL 85-11, "Completion of Phase II of 'Control of Heavy Loads at Nuclear Power Plants' NUREG-0612" – NRC announced that the staff did not intend to perform a detailed review of all Phase II submissions from the previous GLs.

d. Bulletin 96-02, "Movement of Heavy Loads over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety-Related Equipment" – Based on operating experience regarding plans to move spent fuel casks at Oyster Creek, the staff expressed concerns about

licensees' analyses of load paths, and consideration for evolutions that may be outside their licensing basis. The Bulletin focuses on heavy load movements while the reactor is at power.

e. RIS 2005-25, Supplement 1, "Clarification of NRC Guidelines for Control of Heavy Loads" – In light of several inspection findings related to licensee movements of heavy loads outside their licensing basis, the staff issued this RIS to re-iterate the recommendations of NUREG-0612 and to remind licensees of past GCs and other requirements related to heavy loads.

f. RIS 2008-28, "Endorsement of Nuclear Energy Institute Guidance for Reactor Vessel Head Heavy Load Lifts." – The RIS notified industry of methods approved by the NRC staff for evaluating changes to a facility's licensing basis related to reactor vessel head and other heavy load lifts.

g. IN 2014-12, "Crane and Heavy Lift Issues Identified During NRC Inspections" - In light of additional issues discovered related to inspections conducted in accordance with guidance from OpESS 2007-03 for IP 71111.20, this IN was issued to communicate with the addressees for their review for applicability.

h. IN 2016-11, "Potential for Material Handling Events to Cause Internal Flooding" - This IN was issued to communicate with the addressees for their review for applicability after material handling issues had been discovered that had a potential to cause internal flooding that may exceed flood levels considered in their design bases.

04.02 NRC and Industry Documents related to 2005-2007 Operating Experience

a. NEI 08-05, "Industry Initiative on Control of Heavy Loads" – Summary guidance provided by industry to ensure licensees provided information in the FSAR and other documents regarding safe handling of heavy loads.

04-03 Inspection Procedures and Applicable Reports

a. IP 71111.20, "Refueling and Other Outage Activities" – In conjunction with this OpESS update and implementation of ANO-1 lessons learned, Section 03.01 of IP 71111.20 is being updated to ensure inspectors consider sampling licensee procedures for managing outage work and approving vendor work packages. Applicable activities include first-of-a-kind and other activities with a potential high safety consequence; certification of vendor equipment (such as temporary heavy lifting equipment); contract oversight; and oversight of supplemental personnel. Additional guidance was added on the types of activities inspectors should look at to ensure licensees are maintaining defense in depth during outage activities.

b. IP 71111.13, "Maintenance Risk Assessments and Emergent Work Control" – This procedure provides guidance for inspectors to verify that appropriate risk assessments and corresponding work controls and risk management actions are implemented during planned and emergent maintenance activities.

c. Memo from Neil O'Keefe to Bill Dean and Kriss Kennedy dtd June 8, 2017, "Inspection Procedure 95003: Evaluation of NRC Assessment and Inspection Procedures" – Outlines recommendations coming out of the ANO-1 95003 supplemental inspection. This OpESS and the update to IP 71111.20 are based in part on Recommendation 1.

d. "ANO-1, NRC Supplemental Inspection Report 05000313/2016007 and 05000368/2016007" – This report provides an overview of inspection findings, plant performance, and safety culture at ANO-1 at the time of the stator drop event.

OpESS 2007/03-05 REPORTING RESULTS/TIME CHARGES/ADDITIONAL ISSUES

If information from this OpESS is used to inform a baseline inspection sample, reference the OpESS number in the scope section of the report.

In addition, if any findings or violations are identified in conjunction with this OpESS, include a statement similar to the following in the description section of the finding write-up:

> "This finding was identified in connection with a review of Operating Experience Smart Sample (OpESS) 2007/03."

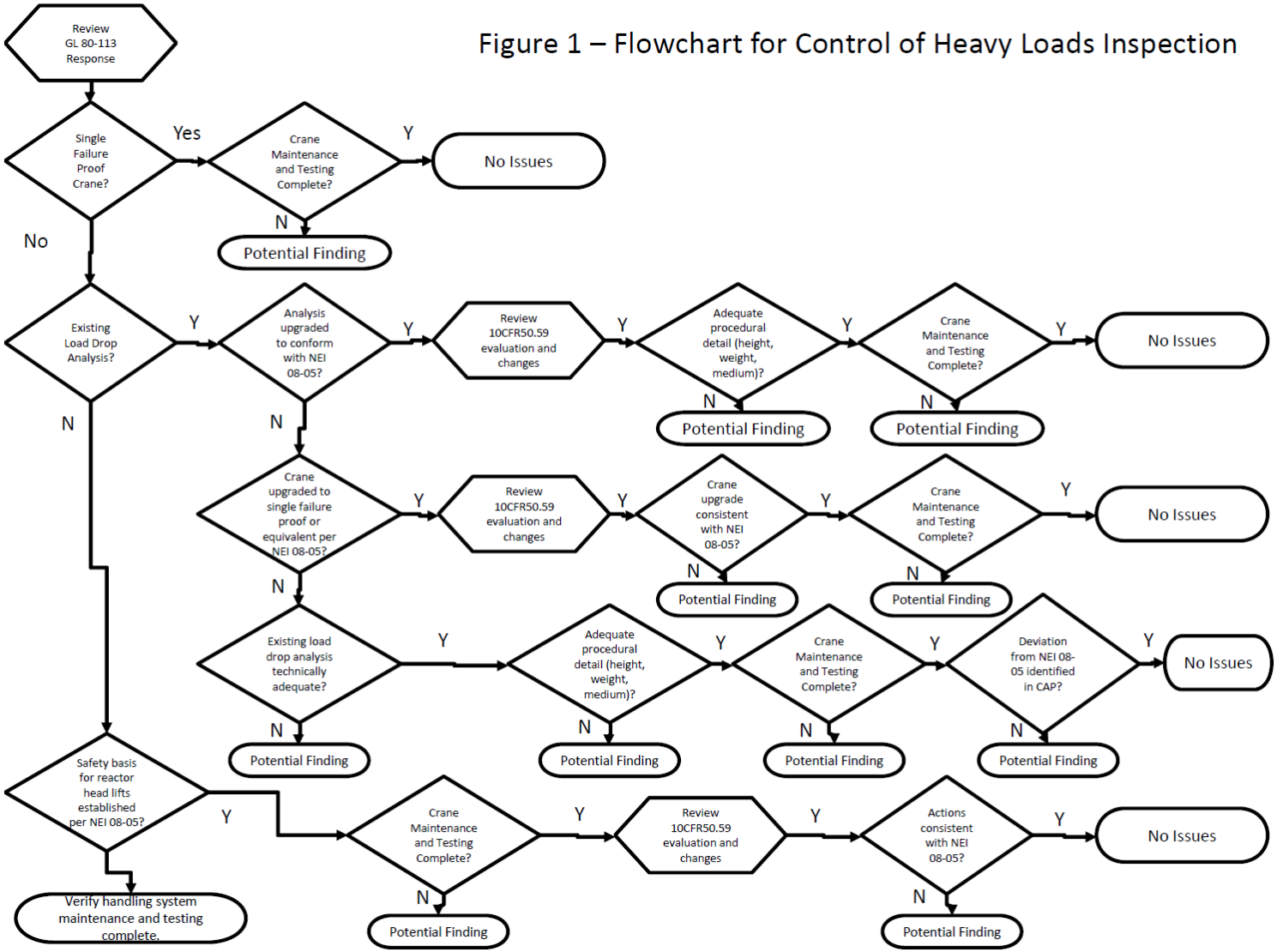
Inspection time for this OpESS is to be charged to the normal baseline procedure under which it is being used.

OpESS 2007/03-06 CONTACTS

For technical support regarding the performance of this OpESS and emergent issues, contact Eric Thomas (NRR/DIRS/IOEB) at (301)415-6772 or Eric.Thomas@nrc.gov, or Steve Jones (NRR/DSS/SBPB) at (301) 415-2712 or Steve.Jones@nrc.gov.

For administrative, reporting, or documentation questions, contact Bridget Curran (NRR/DIRS/IRGB) at (301) 415-1003 or Bridget.Curran@nrc.gov.

Figure 1 – Flowchart for Control of Heavy Loads Inspection



Attachment 1—Revision History for OpESS 2007/03

Commitment Tracking Number	Accession Number Issue Date Change Notice	Description of Change	Description of Training Required and Completion Date	Comment Resolution and Closed Feedback Form Accession Number (Pre-decisional, Non-public Information)
	7/15/2007	Initial OpESS issued to assist inspectors in clarifying NRC expectations for licensee heavy load programs. There was no Revision 1.	None	N/A
	ML13316C040 9/12/2008	Revision 2 issued to update OpESS format and include insights from NEI 08-05	None	N/A
	ML18151A450 09/11/18 CN 18-031	Revision 3 - Document updated to match IMC 0040 OpESS format Document revised to include guidance on managing planned activities including those conducted by vendors/contractors. Vendor-supplied lifting equipment should be load tested in the configuration in which it will be used on site. Licensee oversight of vendor activities should be requisite with the potential risk. This revision was made in response to recommendations from the ANO-1 Lessons Learned report (ML17160A290)	None	ML18169A111