STP-NU-015

A GUIDE TO AMERICAN CRANE STANDARDS

For Electric Overhead Traveling Cranes, Hoists, and Related Equipment for Nuclear Facilities

ASME STANDARDS TECHNOLOGY, LLC

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A Guide to American Crane Standards for Electric Overhead Traveling Cranes, Hoists and Related Equipment for Nuclear Facilities

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ASME Committee on Cranes for Nuclear Facilities

ASME STANDARDS TECHNOLOGY, LLC

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FOREWORD

Numerous standards applicable to the design and manufacturing of overhead cranes exist in the United States. Heretofore there have been no published guidance criteria to assist the prospective owner or user of cranes in determining which standards should be invoked for a particular application or facility. This is particularly the case for nuclear facilities and other applications where crane requirements often exceed the minimum industry standards. The ASME Committee on Cranes for Nuclear Facility produced this "Guide to American Crane Standards" to provide such guidance.

ASME has been involved in nuclear codes and standards since 1956. The Society created Section III of the Boiler and Pressure Vessel Code, which addresses nuclear reactor technology, in 1963. ASME Standards promote safety, reliability and component interchangeability in mechanical systems.

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ABSTRACT

This document provides information and guidance regarding applicable U.S. industry and government documents and standards to users specifying requirements for overhead and gantry cranes for nuclear facilities. This includes documents and standards written specifically for cranes, as well as others having provisions specific to cranes. Some are codified in U.S. law. Others are national or industry consensus standards. Of the latter, some are applicable to nearly all crane applications and are typically invoked by owner specifications. Others apply to special-purpose crane applications and are not necessarily appropriate for commercial or standard industrial cranes.

1 OVERVIEW

The purpose of this document is to provide information and guidance regarding applicable U.S. industry and government documents and standards to users and specifiers of overhead and gantry cranes for nuclear facilities. This includes documents and standards written specifically for cranes, as well as others having provisions specific to cranes. Some are codified in U.S. law. Others are national or industry consensus standards. Of the latter, some are applicable to nearly all crane applications and are typically invoked by owner specifications. Others apply to special-purpose crane applications and are not necessarily appropriate for commercial or standard industrial cranes.

It is common for one standard to list many others as references, and to invoke specific provisions of the referenced standards. This document does not attempt to cover every standard which may have some application to cranes, or which may become part of a "chain" of references. The intent is to cover the primary crane standards and selected additional standards in an attempt to be helpful to the user without being overly lengthy.

The guidance in this document includes summaries of the provisions of each standard, and when appropriate, recommendations as to when it should be invoked. Note, however, that the determination of standards, codes, regulations and laws applicable to a project and the load handling equipment used is the responsibility of the owner.

2 DOCUMENTS ADDRESSED IN THIS GUIDE

ASME Standards

- NOG-1, Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)
- NUM-1, Rules for Construction of Cranes, Monorails and Hoists (with Bridge or Trolley or Hoist of the Underhung Type)
- B30 Standards
- HST-1, Performance Standard for Electric Chain Hoists
- HST-4, Performance Standard for Overhead Electric Wire Rope Hoists
- HST-5, Performance Standard for Air Chain Hoists
- HST-6, Performance Standard for Air Wire Rope Hoists
- NQA-1, Quality Assurance Requirements for Nuclear Facility Applications

Nuclear Regulatory Commission (NRC) and Other U.S. Government Documents

- NUREG-0554, Single-Failure-Proof Cranes for Nuclear Power Plants
- NUREG-0612, Control of Heavy Loads at Nuclear Power Plants
- NUREG-0800, Standard Review Plan
- NRC Generic Letter (GL) 83-42
- NRC Bulletin 96-02
- NRC Regulatory Issue Summary 2005-25
- 10 CFR 50 Appendix B
- 10 CFR 21
- 10 CFR 1910.179 [Occupational Safety and Health Act (OSHA)]

Industry and National Consensus Standards

- CMAA (Crane Manufacturers Association of America) 70, Specifications for Top Running Bridge & Gantry Type Multiple Girder Electric Overhead Traveling Cranes
- CMAA (Crane Manufacturers Association of America) 74, Specifications for Top Running & Under Running Single Girder Electric Traveling Cranes Utilizing Under Running Trolley Hoist
- CMAA (Crane Manufacturers Association of America) 78, Standards and Guidelines for Professional Services Performed On Overhead and Traveling Cranes and Associated Hoisting Equipment
- MMA (Monorail Manufacturers Association) 27.1, Specifications for Patented Track Underhung Crane and Monorail Systems
- MMA (Monorail Manufacturers Association) 27.2, Specifications for Enclosed Track Underhung Crane and Monorail Systems

- AIST (Association of Iron & Steel Technology) Technical Report No. 6, Specification for Electric Overhead Traveling Cranes for Steel Mill Service
- NFPA (National Fire Protection Association) 70, National Electrical Code, (NEC) Article 610
- AWS (American Welding Society) D14.1, Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment
- AWS (American Welding Society) D1.1, Structural Welding Code—Steel
- NEMA (National Electrical Manufacturers Association), Industrial Control and Systems (ICS) 8, Crane and Hoist Controllers

3 ASME STANDARDS

As explained in detail in Sections 1.1 and 3.2, ASME standards NOG-1 and NUM-1 address different configurations of overhead cranes, and differing levels of "type" classification. However, the two standards are formatted differently, as shown in Figure 1.

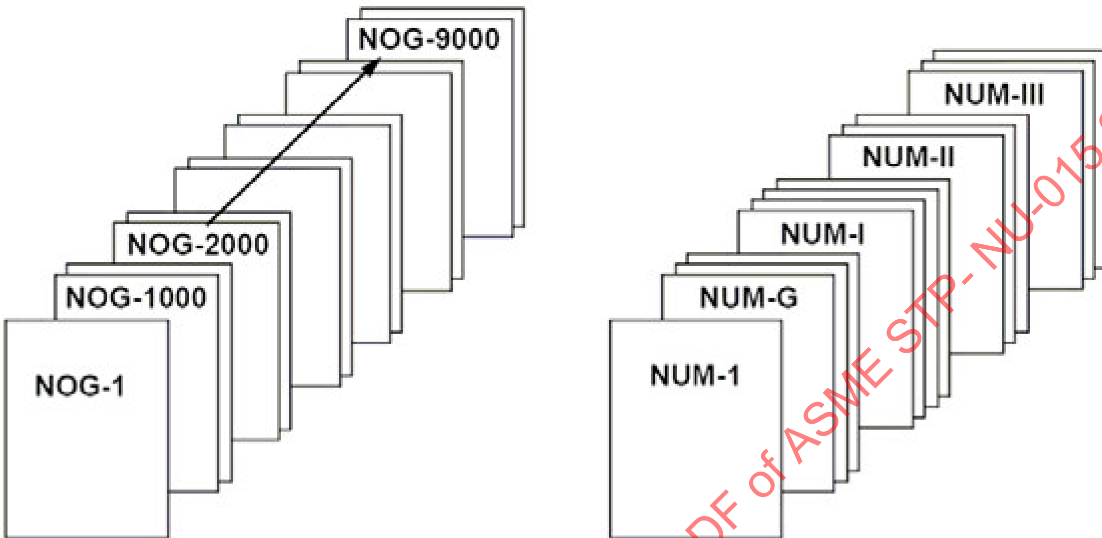

Figure 1 - Formats of NOG-1 and NUM-1 Standards

NOG-1 has 9 sections. Each section covers requirement for Type 1, II and III cranes. Distinctions between requirements for Type 1, II and III equipment (if any) are noted in each paragraph.

NUM-1 is split into 4 major sections:

- For Type I equipment requirements, use NUM-I section in conjunction with NUM-G, NUM-II, and NUM-III.
- For Type II equipment requirements, use NUM-II section in conjunction with NUM-G and NUM-III.
- For Type III equipment requirements, use NUM-III section and NUM-G.

3.1 NOG-1, Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder) [1]

NOG-1 [1] is a national consensus standard first issued in 1983 and revised several times since. It was authored and is maintained by the ASME Committee on Cranes for Nuclear Facilities (CNF). It applies primarily to electric overhead traveling (EOT) cranes of the top-running bridge and gantry configurations, typically having two bridge girders and a top-running trolley carrying one or more hoists. The standard is intended for use in applications where a higher-than-normal level of safety features and quality assurance is appropriate to the application. Originally intended for use by the commercial nuclear power industry, this standard has become of interest in other "critical load" handling applications, such as space launch facilities, facilities handling rocket motors and space flight hardware, nonpower nuclear materials handling and others. NOG-1 invokes a number of other industry standards including ASME B30, American Gear Manufacturers Association (AGMA), AWS D1.1, CMAA and OSHA. NOG-1 divides cranes into three types discussed below.

(a) Type III Cranes

Type III cranes do not handle critical loads and are therefore not seismically qualified or single-failure-proof (SFP). This makes them very similar in design features to CMAA 70 cranes. In fact, for many design guidelines for Type III cranes, NOG-1 refers the user to CMAA Specification No. 70. There are some differences that may be important to users, including but not limited to girder deflection limits, girder camber and bolted structural connections. It is recommended that owners of nuclear and other special-application facilities study the differences in detail before deciding whether to specify NOG-1 Type III or CMAA 70.

(b) Type II Cranes

Type II cranes do not handle critical loads and therefore do not need SFP features. They are, however, required to remain in place, with or without rated load imposed, during a facility-specific seismic event. (Note, however, that unless otherwise specified by the user, they are not required to support the critical load during and after the earthquake. The distinction here is that the critical load on the hook must not cause the crane to come down, but the load itself may drop as a result of the seismic event.) NOG-1 also mandates material certifications and nondestructive testing for certain components, materials, welds and fasteners for Type II cranes, and a quality assurance program consistent with ASME NQA-1 and 10 CFR 50, Part B. NOG-1 is the only U.S. standard that provides detailed guidelines for the design of Type II cranes. CMAA 70, for example, does not address seismic qualification for cranes.

It is therefore recommended that NOG-1 Type II standards be specified for any crane that must not fall, or must retain all of its own components (preventing them from dislodging and falling) during and after the seismic event. Note that the owner should specify the applicable seismic criteria for the design of the Type II crane. These could be criteria from the Uniform Building Code (UBC), but for nuclear power plants are typically seismic response spectra at the crane rail developed specifically for the facility from ground response spectra as affected by the design of the crane supporting structure.

NOG-1 specifies methodology for seismic analysis and qualification (which may also include testing) as well as for modeling bridge and gantry cranes for such analysis. It also specifies quality control and nondestructive testing for certain crane components to ensure their capability to meet the seismic criteria. For nonseismic aspects of Type II crane design, the user is frequently referred to CMAA Specification No. 70.

(c) Type I Cranes

Type I cranes handle critical loads and must have SFP features such that any credible failure of a single component will not result in the loss of the crane's capability to stop and hold the critical load. They also must meet the seismic qualification criteria applicable to Type II cranes, with the further provision that they must support the critical load during and after the seismic event.

NOG-1 specifies redundant or secondary load paths for hoisting machinery and for the wire rope reeving system to preclude the rated load from falling in event of a single component failure. It offers hoisting machinery arrangements with diagrams, designed to fulfill this need. It specifies detection of improper threading of the wire rope at the drum and shutdown of the hoisting motion to prevent wire rope damage that could otherwise be catastrophic, as well as electrical limit devices to detect overhoisting, overlowering, overload, overspeed and overtravel of trolley or bridge. NOG-1 also mandates material certifications and extensive nondestructive testing for key components, materials, welds and fasteners for Type I cranes, and a quality assurance program consistent with ASME NQA-1 and 10 CFR 50, Part B. For many components, design criteria are more conservative than industry standards such as CMAA 70 or the American Institute of Steel Construction (AISC) Manual of Steel Construction.

A Type I crane will typically be larger and heavier (and more costly) than a crane of the same capacity designed to a normal industry standard such as CMAA 70.

3.2 NUM-1, Rules for Construction of Cranes, Monorails and Hoists (with Bridge or Trolley or Hoist of the Underhung Type) [2]

Whereas NOG-1 applies to double-girder top-running bridge and gantry cranes, its companion ASME standard NUM-1 covers bridge and gantry cranes, jib cranes, and monorail hoists with under-running (underhung) trolley/hoist or bridge. The standard adds considerably to previously existing industry standards. In the case of jib cranes, there was no industry design standard prior to NUM-1.

Although formatted differently, NUM-1 is like NOG-1 in providing for Types I, II and III equipment. One important distinction is that NUM-1 provides for two categories of Type I equipment. Type I(a) is essentially the same as NOG-1 Type I. Type I(b) differs, by providing for increased design factors (or "safety factors") in lieu of redundancy for a number of components. This was done out of recognition that the styles of cranes and hoists typically covered by the NUM-1 standard are usually of low capacity (typically 20 tons or less) and frequently utilize standard "package" hoisting and traveling equipment. The Type I(b) approach enables the supplier and owner to use oversized standard components in many cases, instead of designing the components to comply with Type I(a) criteria.

If the owner requires NUM-1 equipment that must also comply with NUREG-0554, he should specify Type I(a). If the requirement is for additional safety features without need for NRC regulatory compliance, Type I(b) may be suitable.

NUM-1 Type III equipment is in many respects similar to hoist and crane equipment covered in CMAA 74 and ASME HST-1, HST-4, HST-5 and HST-6. However, NUM-1 provides many specific guidelines of potential value to the owner that are not included in other industry standards. It is therefore recommended that NUM-1 be carefully considered for special-application load handling equipment in the smaller capacity ranges.

3.3 ASME B30 Standards

ASME B30 is a series of safety standards applicable to lifting equipment. Subsection numbers denote the type of equipment. The B30 standards considered likely to be applicable to cranes and hoists include:

- B30.2, Overhead and Gantry Cranes—Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist
- B30.10, Hooks
- B30.11, Monorails and Underhung Cranes
- B30.16, Overhead Hoists (Underhung)
- B30.17, Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)

These are safety standards rather than design standards. The minimum requirements of B30 must be met in all lifting equipment to which they apply. However, the B30 standards do not specify design criteria sufficiently to be used as stand-alone specifications.

The owner may choose to separately specify compliance with the applicable B30 standards, though it is unnecessary to do so when CMAA 70, CMAA 74, NOG-1 or NUM-1 is invoked as a basic design standard, as these encompass B30 criteria.

3.4 ASME HST Standards

ASME maintains a set of standards for hoists that are suspended from lugs, hooks or trolleys, or are base, deck, wall or ceiling mounted. Although these are primarily performance standards, they do include some design requirements. The HST standards likely to be applicable to overhead cranes and hoists include the following:

- HST-1, Performance Standard for Electric Chain Hoists [8]
- HST-4, Performance Standard for Overhead Electric Wire Rope Hoists [9]
- HST-5, Performance Standard for Air Chain Hoists [10]
- HST-6, Performance Standard for Air Wire Rope Hoists [11]

These standards cover duty service classifications, configurations and mechanical and electrical design requirements. Hoists designed in accordance with these standards are generally suitable for use in monorail systems or on cranes designed per ASME NUM-1 Type III or CMAA Specification No. 74. The HST standards do not cover requirements for nuclear or other special-purpose applications, such as seismic qualification, SFP features, recoverability or quality assurance programs.

3.5 NQA-1, Quality Assurance Requirements for Nuclear Facility Applications [12]

This ASME document outlines requirements for establishment and execution of quality assurance programs for siting, design, construction, operation and decommissioning of nuclear facilities. Its use leads to specific quality-assuring activities and provisions applicable to all phases of design and manufacturing of equipment, including but not limited to material certifications, testing and inspections and documentation thereof. Part I applies to activities that could affect the quality of structures, systems, and components of nuclear facilities.

Nuclear facility owners may specify that their equipment suppliers implement and maintain Quality Assurance programs that conform to NQA-1. Compliance with NQA-1, or other quality assurance provisions specified by the equipment owner, is specified in ASME NOG-1 and NUM-1 for Type I and Type II cranes and load handling equipment.

Part II contains Subparts 2.1–2.21, which supplement Part I with requirements for specific components, systems and activities. The owner should evaluate the applicability of subparts to cranes, and include them in the equipment specification or by reference to NOG-1 or NUM-1. For cranes and related equipment, Subpart 2.2, Quality Assurance Requirements for Packaging, Shipping, Receiving, Storage and Handling of Items for Nuclear Power Plants, is usually applicable. Subpart 2.7, Quality Assurance Requirements for Computer Software for Nuclear Facility Applications, may be applicable to cranes, either to software supplied as part of the crane operating or control system, or to analytical software, such as that used for seismic analysis.

Subpart 2.15, Quality Assurance Requirements for Hoisting, Rigging, and Transporting of Items for Nuclear Power Plants, applies to construction load-handling equipment and applications. Its contents are being evaluated by the ASME CNF for the purpose of including applicable provisions, if any, in future editions of NOG-1 and NUM-1. When it has been included in NOG-1 and NUM-1, it will be removed from NQA-1.

Part III consists of Nonmandatory Appendices providing guidance on implementation of various aspects of the requirements in Part I.

4 NRC DOCUMENTS AND U.S. GOVERNMENT STANDARDS

4.1 NUREG-0554, Single-Failure-Proof Cranes for Nuclear Power Plants [13]

This document was issued by the U.S. Nuclear Regulatory Commission in 1979. (There have been no revisions.) It replaced an earlier draft document, Regulatory Guide 1.104, on the same topic. NUREG-0554 is considered "guidance" by the NRC. Its provisions are in the form of recommendations; that is, "should" is used rather than "shall" throughout the document. However, when nuclear power plant owners invoke NUREG-0554 in crane specifications, they typically intend that the crane designer consider all of its guidelines as mandatory.

Appendix 3.1 to NUREG-0554, "Checklist of Most Important NUREG-0554 Requirements," was written by the NRC separately from the NUREG (and apparently not formally issued or added to the base document). This Appendix does not cover all the guidelines of the NUREG. It is assumed that NRC licensees (U.S. nuclear power generation plants) and their crane suppliers are expected to demonstrate compliance with all guidelines, and that any deviations are potentially subject to acceptance by the licensee and the NRC.

The primary intent of NUREG-0554 is to preclude dropping the critical load. A SFP crane design conforming to NUREG-0554 could be assumed acceptable to the NRC and therefore to satisfy regulatory concerns, upon review and acceptance of its design features. Such a design may be enhanced to provide additional features to protect against the potential for a dropped load, depending on the level of protection desired by the owner.

Although NUREG-0554 specifies provisions for emergency lowering and manual positioning of the rated load, it does not consider issues such as operational recoverability from component or system failures, or electrical redundancy/supervisory control. These are frequently important to owners of facilities handling highly radioactive or other hazardous materials, or fragile, explosive, flammable or valuable loads where the consequences of loss of operability or unwanted motion may be unacceptable. In the absence of industry standards, the owner must write his own specifications covering such criteria.

4.2 NUREG-0612, Control of Heavy Loads at Nuclear Power Plants [14]

This NRC document, issued in 1980, provides guidelines to operators of nuclear power plants for handling heavy loads, particularly those moved by overhead cranes. The guidance is based on a philosophy of "defense in depth" against serious load-handling accidents by implementation of training, inspections, safe load paths, administrative controls and analysis of the consequences of dropped loads. The objectives are to preclude damage to nuclear fuel, impairment of equipment necessary for safe shutdown of the reactor or release of radioactive material to the environment.

If a load must unavoidably be handled in an area where its falling could result in unacceptable consequences, NUREG-0612 guides the owner to use a SFP crane designed in accordance with NUREG-0554, in addition to the implementation of other appropriate safeguards.

Appendix C to NUREG-0612 provides guidelines for modification of existing cranes, including commentary on implementation of NUREG-0554 for operating plants with cranes that may need to be upgraded with single-failure-proof features.

Note that NUREG-0612 does not offer complete guidelines for SFP crane design. It also is not intended to impose additional guidance to that given in NUREG-0554, and therefore need not be invoked if NUREG-0554 is already specified. However, its Appendix C suggests optional methods for compliance with certain of the NUREG-0554 guidelines, particularly for existing cranes.

4.3 NUREG-0800, Standard Review Plan (Formerly NUREG-75/087) [15]

This NRC document was published to provide guidance to its own staff responsible for review of applications to construct and operate nuclear power plants. Although compliance with standard review plans is not mandatory, familiarity with them can be of considerable benefit to plant owners in their efforts to secure regulatory acceptance. Some sections of NUREG-0800 are applicable to crane design and may be invoked in owners' specifications. These would typically be Sections 3.7.2, Seismic System Analysis, and 3.7.3, Seismic Subsystem Analysis.

4.4 Generic Letter 83-42 [16]

This NRC letter to all nuclear power plant operators, dated December 19, 1983, informs them that certain electrical system problems can cause loss of control of the load in certain instances. The potential problem areas include phase loss and phase reversal in AC powered motor and control systems. Appendix 3.1 to NUREG-0554 refers to Generic Letter 83-42.

For new or upgraded SFP cranes, 83-42 can be treated as an addendum to NUREG-0554. However, it is not limited to cranes designated as SFP. All cranes in U.S. nuclear power plants should potentially be evaluated against the criteria in this letter.

4.5 Bulletin 96-02: Movement of Heavy Loads over Spent Fuel, over Fuel in the Reactor Core or over Safety-Related Equipment [17]

This bulletin was issued by the NRC to nuclear plant operators on April 11, 1996. It alerts them to the importance of complying with existing regulatory guidelines related to control of heavy loads, requests that they review their plans and capabilities for handling heavy loads, and requires that they report to the NRC their compliance with the requirements of the bulletin. It clarifies the regulatory intent regarding NUREG-0612 and related NRC documents.

Bulletin 96-02 expresses concern on the part of the NRC that licensees may believe they comply with guidelines for control of heavy loads based on prior reviews of the subject, when in fact the NRC did not necessarily take the same view and may not consider all of the licensees' conclusions to be valid. The required reports are to address handling heavy loads with the reactor at power, with consideration to the possibility of damage to safety-related equipment, fuel in the reactor core or spent fuel. The reports also must consider the potential complications resulting from the breach of a dry storage cask.

Bulletin 96-02 does not address the design of cranes or other load-handling equipment. Its implementation may lead to the conclusion that a crane once considered safe enough should be upgraded with SFP features.

4.6 NRC Regulatory Issue Summary 2005-25: Clarification of NRC Guidelines for Control of Heavy Loads [18]

This Regulatory Issue Summary (RIS) was issued by the NRC on October 31, 2005, followed by Supplement 1 dated May 29, 2007. It summarizes, clarifies and emphasizes regulatory guidance provided in previous NRC documents, primarily NUREG-0612 but also including NUREG-0554, NUREG-1774 and GL 96-02. It addresses a range of issues including safe load paths, procedures for load handling, crane operators, crane design, crane inspection, testing and maintenance, special lifting devices, slings, consequence evaluations of load drops, upgrade of existing cranes to SFP and seismic qualification of crane structures.

The RIS states that the Advisory Committee on Reactor Safeguards (ACRS) has endorsed several recommendations, including a recommendation that the NRC endorse ASME NOG-1 (Type I) as an acceptable design basis for single-failure-proof cranes.

4.7 10 CFR Part 50, Appendix B [19]

Part of the Code of Federal Regulations (CFR), which is U.S. federal law, this document mandates quality assurance provisions for the design, construction and operation of structures, systems and components used in nuclear power plants licensed by the NRC.

A quality assurance program in accordance with ASME NQA-1, if properly established and implemented, may meet the criteria of Part 50, Appendix B.

Note that some U.S. nuclear power plants, as well as other facilities handling nuclear materials may have as part of their license or regulatory requirements quality provisions based on standards other than Appendix B. In such cases the applicable standards should be identified by the owner for implementation by the equipment supplier.

4.8 10 CFR Part 21 [20]

10 CFR "Part 21, Reporting of Defects and Noncompliance", is a provision of U.S. federal law. It obligates individuals or organizations having knowledge of a potential safety deficiency in a component or equipment used in a nuclear power plant to report the potential problem to the NRC. This includes crane components or systems that, if they failed, could create a substantial safety hazard at a facility regulated by the NRC.

4.9 29 CFR Part 1910.179 [21]

29 CFR, Labor, is the section of U.S. federal law commonly known as OSHA (for Occupational Safety and Health Act). Part 1910.179 is the section of the regulation dealing with overhead cranes. It applies to all overhead cranes, including those in nuclear facilities. Its main intent is to ensure the safety of persons operating or maintaining the equipment or having reason to be on or near it. OSHA is a safety code, not a design standard. It requires the owner of the equipment to make sure it meets federal standards for such things as access, footwalks and handrails, ladders, brakes, guards, rail sweeps, bumpers, operational limits and warning devices. Owners typically specify that their suppliers of new equipment or equipment modifications comply with the applicable OSHA provisions. The owner retains the responsibility for compliance, including inspection and maintenance. Part 1910.179 invokes ASME B30.2.

5 INDUSTRY AND NATIONAL CONSENSUS STANDARDS

5.1 Crane Manufacturers Association of America (CMAA) Specification No. 70 [22]

Widely accepted in the United States, and often invoked in crane procurement specifications for other countries, this standard is produced by the CMAA engineering committee and published for CMAA by its parent organization, Material Handling Industry of America (MHIA).

CMAA 70 provides minimum design standards for multiple-girder, top-running bridge and gantry cranes. It establishes six classes of service, A through F, based on loading spectrum and frequency of operation. It has a section on building design considerations including clearances, runway tolerances and runway conductors. Design sections include structural, mechanical and electrical.

CMAA specifications are primarily intended for commercial industrial applications. They do not address special requirements such as seismic qualification, SFP features or enhanced safety options, recoverability features or quality assurance programs.

5.2 CMAA Specification No. 74 [23]

A companion standard to CMAA 70 Specification No. 74 applies to single-girder cranes, both top-running and underhung, that utilize under-running trolley hoists. Since it anticipates the use of standard commercial monorail hoists, its mechanical and electrical design sections omit hoists for the most part, and deal primarily with bridge and trolley travel equipment.

5.3 CMAA Specification No. 78 [24]

This standard, titled "Standards and Guidelines for Professional Services Performed on Overhead and Traveling Cranes and Associated Hoisting Equipment", was first published in 2002. It was prepared by the Crane Manufacturers Service Committee, a standing committee of the CMAA.

As its title suggests, CMAA 78 offers guidance and recommendations on a variety of topics related to inspection and service of cranes. These include qualifications for crane inspectors and technicians, job site safety guidelines and recommended practices for inspection, maintenance and testing.

5.4 Monorail Manufacturers Association ANSI Standard MH 27.1, Specifications for Patented Track Underhung Cranes and Monorail Systems [25]

This industry standard provides design requirements for underhung cranes and monorail systems that use patented track, which is a specially rolled, extruded or fabricated section having a flat, hardened lower flange as the running surface for the wheels of an underhung end truck or monorail hoist.

The standard covers duty service classifications, runway and monorail track design and tolerances, track switches, openers, and lift or drop sections, carriers, trolleys, cranes, brakes and electrical systems. It does not address special requirements such as seismic qualification, SFP features or enhanced safety options, recoverability features or quality assurance programs.

5.5 Monorail Manufacturers Association ANSI Standard MH 27.2, Specifications for Enclosed Track Underhung Cranes and Monorail Systems [26]

This industry standard is a parallel or companion standard to MH 27.1, for enclosed track runways and monorail beams rather than patented track. It covers essentially the same information as MH 27.1.

5.6 Association of Iron & Steel Technology (AIST) Technical Report No. 6 [27]

This report, entitled “Specification for Electric Overhead Traveling Cranes for Steel Mill Service”, was prepared by a committee of the AIST consisting of steel mill crane owners, engineers and crane manufacturers. Since many steel mill cranes handle loads frequently and often operate in hot and dirty environments, one of the primary objectives of this standard is to promote equipment designs that result in long-term reliability and ease of maintenance and repair.

Technical Report No. 6 establishes four classes of crane service, based on load spectrum and frequency of use. Structural, mechanical and electrical design sections provide specific design criteria. These are in some cases more conservative than those of CMAA specifications, in keeping with the primary objectives of the standard, and typically result in a heavier and potentially more durable crane.

AIST No. 6 does not address some of the criteria pertinent to critical load handling cranes such as SFP features, formal quality assurance programs, recoverability features or seismic qualification.

5.7 National Electrical Code (NFPA 70) [28]

The National Electrical Code (NEC) is prepared by the National Electrical Code Committee and published by the National Fire Protection Association, Inc. (NFPA). Article 610, Cranes and Hoists, is applicable to the installation of electrical equipment and wiring used in connection with cranes, hoists, monorail hoists and runways. It includes provisions for, among others, hazardous locations, wiring methods, types of conductors and their rating, fittings, contact conductor systems (such as sliding shoe runway conductors), disconnecting means, protective features, controllers and grounding.

The NEC (specifically Article 610) is referenced in CMAA 70 and 74, NOG-1, and NUM-1.

5.8 ANSI/AWS D14.1, Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment [29]

Notwithstanding its title, the scope section of this standard states that it applies to cranes for nuclear facilities as well as industrial cranes, mill cranes and other overhead material handling equipment. The standard is produced by the American Welding Society (AWS).

D14.1 is comprehensive, covering among other subjects welding symbols, testing, filler metals, base metals, allowable stresses, weld joint design, qualification of welders and welding procedures, weld quality and inspection, weld repair and correction of defects.

CMAA Specifications 70 and 74 and ASME NUM-1 all invoke AWS D14.1 with respect to welding.

5.9 ANSI/AWS D1.1, Structural Welding Code—Steel [30]

AWS D1.1 is broader in scope than D14.1, covering the requirements for fabricating and erecting welded steel structures. The code is intended for commonly used carbon and low-alloy construction steels, excluding those with yield strengths greater than 100 ksi (690 MPa), base metals thinner than

1/8 in. (3 mm), pressure vessels or piping and also excluding base metals other than carbon and low-alloy steel. It is invoked by ASME NOG-1. ASME NUM-1 refers to D1.1 as well as D14.1, “as applicable”.

Sometimes owners’ crane specifications invoke D1.1 rather than D14.1. In most cases this should not cause problems for the crane designer or manufacturer.

5.10 National Electrical Manufacturers Association (NEMA), Industrial Control and Systems (ICS) [31]

NEMA publishes several ICS standards. One is ICS 8 [31], entitled Crane and Hoist Controllers. It applies to controllers for low-voltage (600 volts and under) DC, wound-rotor AC, and inverter duty AC motors in crane service. This document includes general standards for crane controllers, as well as standards for control systems, various types of crane motors, power circuit limit switches, contactors, brakes, resistors and wireless controls.

Other NEMA ICS standards with application to cranes include:

- ICS-1, General Standards for Industrial Controls and Systems
- ICS-2, Industrial Control Devices, Controllers and Assemblies
- ICS-3, Industrial Systems
- ICS-6, Enclosures for Industrial Controls and Systems