Wire Rope Inspection Report

Safety Division, Code 360

<Date>

FWR: #

Prepared for:

Clifton Arnold, Lifting Device and Equipment (LDE) Program Executive, NASA Headquarters

Andy Norris, LDE Subject Matter Expert, Marshall Space Flight Center

Prepared by:

Brian Montgomery, LDE Manager

Goddard Space Flight Center

**EXECUTIVE SUMMARY**

Safe operation of ground-based Lifting Devices and Equipment (LDE) is critical to the success of the National Aeronautics and Space Administration (NASA) mission. NASA has over 1,500 Overhead Cranes (OHC) in operations, with quantities varying by Center. Most of the OHC at NASA are located above typical ceiling heights of 7 or 8 feet. These cranes can be located as high as a few hundred feet with an average height throughout NASA of 60 to 80 feet. To access these cranes, personnel must either use an aerial lift or climb a fixed ladder to an access level. Approximately 10 years ago, NASA instituted a practice requiring each Center to perform a physical “hand-over-hand” inspection of wire rope on each of these cranes. This practice entailed accessing the hoist drum to inspect the wire rope length in accordance with the thorough inspection method each month, which placed personnel in a potentially hazardous situation. The current Wire Rope Inspection (WRI) policy and inspection practice are not based on the operational status of the OHC being inspected. Monthly OHC WRI of idle, standby and inactive OHC unnecessarily increases personnel exposure to working at height risks.

There is a vast difference at each Center as to the method and frequency of WRIs; some allow operators to perform a simple inspection of the wire rope during the pre-use inspection, while others require qualified inspectors to inspect the wire rope. This has generated confusion on the frequency of inspections, as some interpret the practice as requiring monthly inspections regardless of the crane’s usage, while others only perform a pre-use inspection prior to crane usage per shift and provide post-operational documentation to the Center Lifting Devices and Equipment Manager (LDEM).

Lifting experts from NASA assessed similar Federal Agencies, such as the Department of Defense (Air Force/Navy), Department of Energy (DOE), and private industry requirements (American Society of Mechanical Engineers [ASME], American Petroleum Institute [API], and European Standard). As a result of this research, the best course of action to reduce the risk to NASA personnel is to follow the requirements of both ASME B30.2, Overhead and Gantry Cranes and B30.30, Ropes.

The information contained in this report provides path forward recommendations, which were presented to the Office of Safety and Mission Assurance (OSMA) senior management through the extensive research provided in this report. OSMA has determined that the elevated risk to personnel is not justified by the Agency operational use of OHC and WRI when compared to the extremely low risk of a wire rope failure.

**TABLE OF CONTENTS**

[1 Introduction and Purpose 5](#_Toc81382157)

[2 Survey of Centers 6](#_Toc81382158)

[3 Applicable Codes and Standards 7](#_Toc81382159)

[3.1 OSHA 29 CFR 1910.179, Overhead and Gantry Cranes 8](#_Toc81382160)

[3.2 NASA-STD-8719B, Lifting Standard 10](#_Toc81382161)

[3.3 ASME 11](#_Toc81382162)

[3.3.1 ASME B30.2, Overhead and Gantry Cranes 11](#_Toc81382163)

[3.3.2 ASME B30.30, Ropes 11](#_Toc81382164)

 [12](#_Toc81382165)

[3.3.3 ASME A17.1, Handbook on Safety Code for Elevators and Escalators 12](#_Toc81382169)

[3.3.4 ASME B30, Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings 12](#_Toc81382170)

[3.4 Crane Manufacturers Association of America (CMAA), Document #78 13](#_Toc81382173)

[3.5 American Petroleum Institute 13](#_Toc81382174)

[3.6 Air Force 13](#_Toc81382175)

[3.7 Navy P-307 14](#_Toc81382176)

[3.8 Department of Energy 14](#_Toc81382178)

[3.9 International Organization for Standardization (ISO) 14](#_Toc81382179)

[3.10 Wire Rope Technical Review Board Manual 14](#_Toc81382180)

[4 Applicable Code Evaluations 15](#_Toc81382181)

[4.1 Evaluation of Expected Wire Rope Life 15](#_Toc81382182)

[4.2 Evaluation of Severity of Environment 17](#_Toc81382183)

[4.3 Evaluation of Percent of Capacity Lifts 18](#_Toc81382184)

[4.4 Evaluation of Frequency Rates of Operation 18](#_Toc81382185)

[4.5 Evaluation of Exposure to Shock Loads 19](#_Toc81382188)

[5 Mitigation Factors 21](#_Toc81382189)

[5.1 Annual and Semi-Annual Inspections 21](#_Toc81382190)

[5.2 Pre-Operational Inspections 21](#_Toc81382191)

[5.3 Training 22](#_Toc81382192)

[5.4 Frequency of Operations Monitoring 22](#_Toc81382193)

[5.5 Inspection Hazard Mitigation 22](#_Toc81382194)

[5.6 OHC WRI Risks 23](#_Toc81382196)

[6 Conclusion 24](#_Toc81382198)

**LIST OF APPENDICES**

[Appendix A. References 26](#_Toc81382825)

[Appendix B. Definitions 27](#_Toc81382826)

[Appendix C. Abbreviations and Acronyms 28](#_Toc81382827)

[Appendix D. Risk Assessment 29](#_Toc81382828)

[Appendix E. Code Research 34](#_Toc81382829)

[Appendix F. Center Responses 54](#_Toc81382830)

[Appendix G. OSHA Letter of Interpretation 78](#_Toc81382831)

**LIST OF TABLES**

[Table 1. ASME B30, Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings 13](file:///C%3A%5CUsers%5Cjcgedeon%5CDesktop%5CSMA%20Wire%20Rope%20Report-Edits.docx#_Toc81382223)

[Table 2. Frequent Inspection Chart (CMAA) 15](#_Toc81382224)

[Table 3. Risk Consequences 29](#_Toc81382225)

[Table 4. NASA WRI Report 31](#_Toc81382226)

[Table 5. Title X 32](#_Toc81382227)

[Table 6. List of Pre-Shift Inspection Items 38](#_Toc81382228)

[Table 7. Frequent Inspection Chart 39](file:///C%3A%5CUsers%5Cjcgedeon%5CDesktop%5CSMA%20Wire%20Rope%20Report-Edits.docx#_Toc81382229)

[Table 8. List of Frequent Inspection Items 40](#_Toc81382230)

[Table 9. Definition of CMAA Crane Service Class in Terms of Load Class and Load Cycles 42](#_Toc81382231)

[Table 10. Title X 43](#_Toc81382232)

[Table 11. Title X 43](#_Toc81382233)

**LIST OF FIGURES**

[Figure 1. Sample Crane Wire Rope System 7](file:///C%3A%5CUsers%5Cjcgedeon%5CDesktop%5CSMA%20Wire%20Rope%20Report-Edits.docx#_Toc81382216)

[Figure 2. Wire Rope Gross Damage and Potential Problems 12](file:///C%3A%5CUsers%5Cjcgedeon%5CDesktop%5CSMA%20Wire%20Rope%20Report-Edits.docx#_Toc81382217)

[Figure 3. Wire Rope Maintenance—Lubrication (Vereet, pp 15) 17](file:///C%3A%5CUsers%5Cjcgedeon%5CDesktop%5CSMA%20Wire%20Rope%20Report-Edits.docx#_Toc81382218)

[Figure 4. Bending Fatigue of Wire Rope (Vereet, pp 15) 19](file:///C%3A%5CUsers%5Cjcgedeon%5CDesktop%5CSMA%20Wire%20Rope%20Report-Edits.docx#_Toc81382219)

[Figure 5. Safety Mitigation Principals 22](#_Toc81382220)

[Figure 6. Risk Assessment Code (RAC) 29](#_Toc81382221)

[Figure 7. Title X 52](#_Toc81382222)

# Introduction and Purpose

Wire rope is composed of a few hundred to thousands of individual strands of wires working together to withstand a load that has been applied to either end. At NASA, most of the wire rope used is on OHC and other LDE, such as slings or below hook lifting devices. NASA has over 1,500 OHC, with quantities varying by Center. These cranes are used for simple Facilities projects, such as lifting a sump pump to lifting multi-billion-dollar space flight hardware. At some Centers, cranes are used to lift personnel to perform work in a vast array of missions.

The purpose of this report is to review Federal Regulations, Voluntary Consensus Standards (VCS), and best practices associated with WRI requirements within the government and industry. This report provides an analysis to NASA Headquarters regarding the limited risks that wire ropes present to the Agency based on the interpretation of Section 29 CFR 1910.179 (m) of the Occupational Safety and Health Administration (OSHA) requirements that allow inspections of OHC wire rope based on the operational status of the crane. This report also provides details and recommendations for the reduction of personnel exposure to safety risk associated with working at heights while inspecting wire rope on inactive lifting devices.

The NASA LDE community is seeking to incorporate the requirements of the National Technology Transfer and Advancement Act of 1995, PL 104-113§ 12(d), which states that “Federal Agencies and departments shall use technical standards that are developed or adopted by VCS bodies, using such technical standards to carry out policy objectives or activities determined by the Agencies and departments.” As such, the Agency will be using the inspection criteria as established in both ASME B30.2, (Overhead and Gantry Cranes and B30.30, Ropes. These documents have specific allowances for extending WRIs by allowing the owner to perform a risk analysis (see Appendix D) to assure that there will be no additional risk to not performing such monthly inspection.

According to NASA-STD- 8719.9B, Lifting Standard, all inspections for lifting devices shall comply with the applicable OSHA regulations. OSHA requires a thorough monthly chain and WRI for active in-service LDE. OSHA has also issued a letter stating that it would only be a deminus violation (see Appendix G) if a currently accepted industry standard, such as ASME, was followed in lieu of OSHA. This study will evaluate the ASME B30, Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings codes to identify the recommended inspection frequencies for LDE at NASA in accordance with ASME standards.

# Survey of Centers

A survey was conducted for each NASA Center and Facility to assess WRI policy and practices and to inventory each location’s cranes and corresponding usage. The survey responses from each NASA Center can be found in Appendix F.

The age of NASA cranes ranges from new to almost 80 years old. Most of the cranes average 30-50 years old and are used infrequently at loads much less than their rated Safe Working Load (SWL). The highest crane is 465 feet at Kennedy Space Center (KSC), and the average height at each Center is approximately 100 feet. The average SWL is approximately 65 tons, with the exception of a few cranes with 300+ ton SWLs.

The survey found the busiest cranes are used either twice a day for short periods of time or an average of twice a week. Typically, the loads are not lifted more than 10 feet above the ground, with the exception of KSC.

Across the Agency, the cranes are designed for moderate to heavy usage even though most Centers noted they rarely exceed 50% of the SWL. A few Centers noted occasions where cranes are used for 75% of the SWL with some of these Centers stating that this was extremely rare.

Inspection of cranes is a Center Management Operations (CMO) function. Training of operators is mostly completed in house, with some Centers providing operators with frequent inspections training as part of the pre-use inspection.

Operators access the crane range from either a fixed or portable ladder, a mobile aerial platform, stairs to the hoist, or an elevator; all of which are at heights above 4 feet. It is mandated that any inspection at these heights would use Fall Protection as directed by the Safety and Mission Assurance (SMA) organizations Fall Protection Administrator.

# Applicable Codes and Standards

This section addresses the requirements of various VCS; other governmental Agencies; and private industry regulations, guidance, and policies associated with WRIs. WRIs are a critical part (subsystem) of various LDE (see Figure 1), including cranes, elevators, derricks, hoists, and slings. OSHA establishes regulations that are explicitly listed in 29 CFR 1910.179 and requires compliance with ASME B30.2.

OSHA crane inspection frequency classifications are frequent (pre-use) and periodic (1-12 months) based on the crane’s operational use 29 CFR 1910.179(j)(1)(ii)(a) and 1910.179(j)(1)(ii)(b). For cranes not in regular use, the following applies:

1910.179(j)(4) *Cranes not in regular use*.

1910.179(j)(4)(i) A crane which has been idle for a period of one month or more, but less than six months, shall be given an inspection conforming with requirements of paragraph (j)(2) of this section and paragraph (m)(2) of this section before placing in service.

1910.179(j)(4)(ii) A crane which has been idle for a period of over six months shall be given a complete inspection conforming with requirements of paragraphs (j) (2) and (3) of this section and paragraph (m)(2) of this section before placing in service.

1910.179(j)(4)(iii) Standby cranes shall be inspected at least semi-annually in accordance with requirements of paragraph (j)(2) of this section and paragraph (m)(2) of this section.

Figure . Sample Crane Wire Rope System

The following sections provide a brief overview of WRI requirements. The term “pre-use" inspection is consistently noted by various organizations as meeting the OSHA frequent inspections requirement. See Appendix E. Code Research for an expanded list of applicable WRI requirements.

## OSHA 29 CFR 1910.179, Overhead and Gantry Cranes

1910.179(m)(1)

*Running ropes*. A thorough inspection of all ropes shall be made at least once a month, and a certification record that includes the date of inspection, the signature of the person who performed the inspection, and an identifier for the ropes that were inspected shall be kept on file where readily available to appointed personnel. Any deterioration, resulting in appreciable loss of original strength, shall be carefully observed and determined as to whether further use of the rope would constitute a safety hazard. Some of the conditions that could result in an appreciable loss of strength are the following:

1910.179(m)(1)(i) Reduction of rope diameter below nominal diameter due to loss of core support, internal or external corrosion, or wear of outside wires.

1910.179(m)(1)(ii) A number of broken outside wires and the degree of distribution or concentration of such broken wires.

1910.179(m)(1)(iii) Worn outside wires.

1910.179(m)(1)(iv) Corroded or broken wires at end connections.

1910.179(m)(1)(v) Corroded, cracked, bent, worn, or improperly applied end connections.

1910.179(m)(1)(vi) Severe kinking, crushing, cutting, or un-stranding.

1910.179(m)(2)

*Other ropes*. All rope that has been idle for a period of a month or more due to shut down or storage of a crane on which it is installed shall be given a thorough inspection before it is used. This inspection shall be for all types of deterioration and shall be performed by an appointed person whose approval shall be required for further use of the rope. A certification record shall be available for inspection, which includes the date of inspection, the signature of the person who performed the inspection, and an identifier for the rope that was inspected.

“Running ropes. A thorough inspection of all ropes shall be made at least once a month and a certification record which includes the date of inspection.”

**California OSHA**

As many of NASA’s Centers are located in the state of California, the requirements of California’s Occupational Safety standards were reviewed for regulatory requirements for WRIs.

Title 8, §5031. Inspection

(a) A qualified person shall visually inspect the crane's or derrick's controls, rigging, and operating mechanism prior to the first operation on any work shift. Any unsafe conditions disclosed by the inspection requirements of this article shall be corrected promptly. Defective components of equipment, which create an imminent safety hazard shall be replaced, repaired, or adjusted prior to use.

(b) Frequency of Inspections. Daily visual inspections by the operator or other qualified person shall be made of/for:

(1) All functional mechanisms for maladjustment interfering with proper operation.

(2) The operation of all limit switches without a load on the hook.

(3) Lines, tanks, valves, pumps, and other parts of air or hydraulic systems for deterioration or leakage.

(4) Hooks for deformation and cracks.

(5) Hoist or load attachment chains including end connections for excessive wear, twist, distorted, or stretched links interfering with proper function.

(6) Excessive wear, broken wires, stretch, kinking, or twisting of ropes and rope slings, including end connections.

(c) Periodic inspections shall be conducted at least four times a year. The annual certification, as required by Section 5021(a), can serve as one of the required periodic inspections. The periodic inspections shall be evenly spaced or as close to evenly spaced as scheduling permits through the year. Cranes shall not be operated more than 750 hours, between periodic inspections. The inspection shall include the following in addition to the items in subsection (b) above:

(1) Excessive wear of all functional operating mechanisms.

(2) Ropes, brakes, friction clutches, chain drives, and other parts subject to wear which may be readily inspected.

(3) Cranes handling molten metal shall be inspected at least weekly when in use and necessary repairs made.

(4) An inspection record shall be maintained which includes the date of the inspection, the signature of the person who performed the inspection, and the serial number or other identifier of the crane inspected. The most recent inspection record shall be maintained on file.

(d) In any year in which no quadrennial (every four years) proof load test is required on cranes or derricks, such equipment shall be examined by a qualified person as described in Section 5021. Such examination shall be made not later than the anniversary date of the quadrennial certification and shall conform with the requirements of Section 5022 (d) and the following:

(1) Crane hooks with cracks or with deformation of throat opening more than 15% in excess of normal opening or more than 10 degree twist from plane of unbent hook shall be removed from service.

(2) Ropes shall be inspected for proper lubrication, excessive wear, broken strands, and proper reeving. Note: Many variable factors are involved in determining the exact time for replacement of rope and timely replacement for safety. Conditions such as the following shall be sufficient reason for replacement:

* In running ropes, six randomly distributed broken wires in one rope lay, or three broken wires in one strand in one lay.
* Wear of 1/3 the original diameter of outside individual wires.
* Kinking, crushing, bird caging, or other damage resulting in distortion of the rope structure. Evidence of any heat damage.
* Reductions from nominal diameter of more than:
	+ 1/64 inch for diameters up to 5/16 inch
	+ 1/32 inch for diameters 3/8 inch to 1/2 inch
	+ 3/64 inch for diameters 9/16 inch to 3/4 inch
	+ 1/16 inch for diameters 7/8 inch to 11/8 inch
	+ 3/32 inch for diameters 1 1/4 inch to 1 1/2 inch
* In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.
* Reduction of rope diameter below nominal diameter due to loss of core support, internal or external corrosion, or wear of outside wires.

(3) In order to establish data for judging the proper time for replacement of hoisting rope, a continuing inspection record shall be maintained. The record shall cover factors of deterioration as listed in subsections (b), (c), and (d).

(4) Whenever it is considered necessary by the certificating agency or authorized representative and whenever it is practical and advisable to avoid disassembly of equipment, removal of pins, etc., LDEMs of structure or parts by electronic, ultrasonic, or other nondestructive methods shall be carried out.

## ASA-STD-8719B, Lifting Standard

All rope that has been idle for a period of a month or more due to shut down or storage of a crane on which it is installed shall be given a thorough inspection before it is placed in service. This inspection shall be for all types of deterioration and shall be performed by a qualified person whose approval shall be required for further use of the rope. A certification record shall be made available for inspection, which includes the date of inspection, the signature of the person who performed the inspection, and an identifier of the rope which was inspected.

Many years ago during a Center Occupational Safety audit, the auditor informed the Center that it did not comply with the applicable OSHA requirements for inspecting wire rope on an OHC, as referenced in the NASA standard. The Center non-compliance observations included WRI being conducted from the ground with binoculars on active, inactive, and idled cranes. Because of the implications of such an interpretation, the issue was raised to the Agency Lifting Program Manager at Headquarters. This person decided that the intent of OSHA and the NASA standard was that each Center shall inspect the entire length of wire rope on an OHC. This required inspectors to change how inspections were being performed and thus placing in a risky situation each month to perform a “thorough” WRI. Thus, the current monthly inspection requirement of wire rope on OHC and hoists is derived from the Agency’s interpretation of OSHA and NASA requirements for WRIs.

“4.1.3 LDE shall be designed, constructed, tested, inspected, maintained, and operated in accordance with the applicable OSHA regulations, the requirements in this standard, NCS as specified herein, and be based upon manufacturer recommendations….” ASME

## ASME

The most current versions of the ASME B30 and A17 Series Safety Standards that apply to wire rope on cranes and hoists are (see Table 1 for comparisons):

* B30.2 – 2016: Overhead and Gantry Cranes
* B30.4 – 2020: Portal and Pedestal Cranes
* B30.5 – 2018: Mobile and Locomotive Cranes
* B30.6 – 2020: Derricks
* B30.16 – 2017: Overhead Underhung and Stationary Hoists
* B30.17 – 2015: Cranes and Monorails
* B30.22 – 2016: Articulating Boom Cranes
* B30.30 – 2019: Ropes
* A17.1/CSA B44 HANDBOOK – 2016: Handbook on Safety Code for Elevators and Escalators
* A17.2 – 2020: Guide for Inspection of Elevators, Escalators, and Moving Walks

Each document contains similar WRI criteria regarding the type and scope of inspection (criteria), frequency of inspection, who performs the inspection, and who determines frequency.

### ASME B30.2, Overhead and Gantry Cranes

Frequent Rope Inspection: All ropes should be visually inspected at the start of each shift. These visual observations should be concerned with discovering gross damage.

### ASME B30.30, Ropes

Running rope in service shall be visually inspected daily, unless a qualified person determines it should be performed more frequently. The visual inspection shall consist of observation of all rope that can reasonably be expected to be in use during the day’s operations. The inspector should focus on discovering gross damage that may be an immediate hazard (See Figure 2).

### ImageASME A17.1, Handbook on Safety Code for Elevators and Escalators

Figure . Wire Rope Gross Damage and Potential Problems

Wire rope is given an annual inspection by a qualified elevator inspector. This inspection is performed at the machine room and along the length of the rope. The elevator code is referenced as the wire rope associated with elevators is a life safety feature of the system. Not only does it lift the cab of the elevator, its inspection is imperative to the safety of its passengers. The wire rope system of an elevator is similar to that of an OHC. Both have a main drum in which wire rope is wrapped and then such rope fed to the various sheaves that hold the cab. The wire rope cycle is similar, as it runs from the drum in the ceiling down to the cab and back up to the drum.

### ASME B30, Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings

The following table provides a synopsis of wire rope references with the ASME B30 series documents.



Table . ASME B30, Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings

## Crane Manufacturers Association of America (CMAA), Document #78

Recommends that cranes that are in an infrequent use have their wire rope be inspected semi-annually. Cranes in normal use—multiple lifts per day—have a monthly, frequent inspection.

The only difference between a pre-use inspection and frequent inspection is the requirement of documenting the inspection upon completion.

Note: NASA’s Lifting Standard requires all inspections to be documented.

## American Petroleum Institute

Visual inspections of wire rope should be performed by a qualified crane operator during pre-use and monthly inspections. Additional WRI should be performed by qualified inspectors during quarterly and annual inspections, as the results of pre-use and

monthly inspections warrant.

## Air Force

There are two standards associated with WRIs: Range Safety documents (91-710) and Occupational Safety code (91-230). For Range Safety WRIs are to be inspected monthly using a go-no-go tool as part of the pre-use inspection.

As for the Occupational Safety WRI requirements, the pre-use inspection can be considered the frequent thorough WRI, with appropriate documentation.

## Navy P-307

Requires that an operator to perform a pre-use inspection to determine the condition of the wire rope and to document such inspection. A detailed WRI is performed annually by a qualified person, as defined in ANSI E1.6.

## Department of Energy

DOE-STD-1090-2020, Hoisting and Rigging

In 2011, the DOE updated its hoisting and rigging manual to follow the VCS and ASME B30 series documents. Prior to this change, the DOE required a thorough WRI by a qualified person on annual basis.

## International Organization for Standardization (ISO)

ISO 4309, Cranes—Wire ropes—Care and Maintenance, Inspection, and Discard

At least the intended working section of rope for that day shall be observed with the objective of detecting any general deterioration or mechanical damage. A written report shall be furnished on completion of the inspection.

## Wire Rope Technical Review Board Manual

Normal wear and degradation are expected to occur in areas where the rope bends frequently, spools on a drum, at equalizer sheaves, or at end terminations. These areas endure greater stress and should be checked completely and frequently.

The inspector must also be able to physically touch or perform a hands-on examination of the rope. In most applications, a thorough inspection is made when the rope is relaxed or under minimal tension. However, Non-Destructive Testing (NDT) may be used where the rope cannot be relaxed.

Final Synopsis of Regulatory Documents

Each of the codes and federal Agencies are consistent on when to perform inspections on cranes and crane systems, such as those in use at NASA. Frequent or pre-use inspection of the wire rope constitute a thorough visual WRI by a trained person focused on the identification of gross damage. Periodic inspection conducted on a semi-annual or annual basis constitutes a thorough physical WRI by a qualified/certified person to find any discrepancy .

# Applicable Code Evaluations

To determine or modify WRI frequency, ASME B30.2 section 2-2.2.3 requires that the inspection frequency is to be determined by a qualified person (LDEM). Inspections need not be at equal calendar intervals and should be more frequent as the rope approaches the end of its useful life.

## Evaluation of Expected Wire Rope Life

NASA crane systems have been designed and specified to meet a minimum of CMAA Service Class B and/or Class C standards. For CMAA Service Classes see Appendix E.4. This is a requirement in NASA’s Lifting Standard. There are a few Centers that design some of the more commonly used cranes to Class D because of the criticality of the crane. In this type of service, the crane is designed to “*handle loads that average 50% of the rated capacity at 5 to 10 lifts per hour, averaging 15 ft. lift height, with not more than 50% of the lifts at rated capacity.”*

Many wire rope hoist units have been designed and specified to meet a minimum of ASME Wire Rope Hoist Standard (HST-4) H4 Service Class standards, which in terms of hoist usage levels is defined as “*high volume handling of heavy loads, frequently near the rated load capacity, with total running time not more than 50% of the work period.”*

Individual crane usage levels throughout the Agency are well below the CMAA Class B, and in most cases below the Class A and ASME HST-4 (H4 level described above). Typical usage is below 50% of the rated capacity with frequencies ranging from a few times daily to a few times per year in many cases.

Table 2. Frequent Inspection Chart (CMAA)



Factors Affecting Wire Rope Life

* The loss of metallic cross-sectional area caused by abrasion and unchecked corrosion.
* Structural imbalances or changes to the rope such as kinks, bird caging, high stranding, etc.
* The occurrence of wire breaks due to fatigue:
	+ Bending fatigue occurs as wire rope bends around the hoist drum and sheaves under load. The relationship between the wire rope diameter to the drum and sheave diameter is expressed as a (D/d) ratio. CMAA 70 recommends minimum (D/d) ratios for OHC applications for optimum wire rope service and life (i.e. 18:1).
	+ Excessive bending fatigue is the primary cause of broken wires. Broken wires will typically show up in the outer wires of a strand first.
* Only approximately 20% of the rope (the outer portion) is readily visible to the inspector. The condition of the inner 80% may only be detected by observing certain structural changes (such as reduction or increase in rope diameter, bird-caging, high stranding, etc.), visually by opening the rope for inspection or NDT inspection.
* Lack of proper wire rope lubrication may accelerate wear and corrosion over time, especially on the inner strand wires and core.

Mitigation Factors

* Annual “thorough physical” WRIs are performed by qualified LDE inspectors.
* Pre-operational crane inspections are performed by qualified crane operators to include thorough visual WRIs to identify “gross” damage per the various applicable codes, as noted previously.
* Wire rope visual inspections exceed ASME rejection criteria and wire rope is replaced when any damage or suspected damage is found.
* Wire rope useful life is always determined by its condition based on ASME rejection criteria.

Evaluation Conclusion

Expected wire rope life is relative to its condition at any given time. There has been no established method in industry other than ASME condition-based rejection criteria for determining wire rope service life. NASA’s LDE crane inspection Program adequately determines when replacement is necessary based on established ASME B30 standards rejection criteria.

The NDT inspection type required to adequately inspect 100% of wire rope requires specialized commercially-available equipment that uses Magnetic Flux Leakage technology along with the added labor cost to perform the inspection.

The LDEM may consider replacing older wire rope on the most frequently used cranes, especially ropes considered inadequately lubricated, such as cranes where regular lubrication may create a potential flight hardware contamination concern. The LDEM evaluates all reports of damage and abnormal WRI results to determine if replacement is necessary.

It is strongly recommended that a Program be implemented to better track wire rope replacement, which can help better estimate the expected rope life of LDE in the future.

## Evaluation of Severity of Environment

The following are the types of environments that OHC with wire rope operate within the Agency:

* Clean Room—Very low risk to wire rope damage due to adverse environmental exposures.
* Indoors—Low risk to wire rope damage due to adverse environmental exposure.
* Outdoor wire rope cranes—Moderate risk of exposure to unprotected wire rope.
* Corrosive (potential exposure to corrosive chemicals i.e., plating shop cranes)—High risk of exposure to unprotected wire rope. These cranes can be located indoors or outdoors.

Factors due to Severity of Environment

* The primary concern is unseen corrosion, sometimes referred to as fretting corrosion, which may have developed internally over time due to the lack of lubrication. The adverse effects of fretting-corrosion will accelerate wire rope internal wear and cause increased fatigue cracking to occur on individual wires.
* Other environmental issues, such as exposure to extreme temperatures or harsh chemicals are typically not an issue at NASA Facilities.

Mitigation

* Wire rope comes pre-lubricated from the manufacturer but should be cleaned and re-lubricated as needed per manufacturer’s recommendations (Figure 3).
	+ Indoor cranes without any potential severe environment will be inspected annually unless there has been no lubrication on the wire rope per the manufacturer.

Figure . Wire Rope Maintenance—Lubrication (Vereet, pp 15)

* Cranes working in a corrosive environment, such as those in plating-shops or near the oceans should be carefully monitored, and the wire rope should be thoroughly inspected on a more frequent basis.
	+ Those within a corrosive environment will be considered severe service and require a quarterly thorough WRI
* Two areas to pay particular attention to during inspections are:
	+ An increase in rope diameter by 1.5% of the nominal size. This may be an indication of internal corrosion buildup.
	+ Rope sections lying static over an equalizer sheave. These ropes are more susceptible to corrosion.

Severity of Environment Conclusion

The risk of wire rope issues due to direct exposure to adverse environments at NASA is low. However, the ropes that are known to be in corrosive environments or cannot maintain the recommended lubrication should be inspected on a more frequent basis.

## Evaluation of Percent of Capacity Lifts

Capacity lifts are defined as lifts of 100% of the crane’s SWL.

The primary concern with capacity lifts is the greater potential to damage the wire rope if shock loads were to occur, especially during constrained lift operations.

Mitigation

* Capacity lifts are carefully planned establishing safe stopping points to prevent inadvertent overload of the crane.
* A load cell in the rigging assembly is recommended to continually monitor the load on the crane hook during the lift to ensure overload does not occur.

It is strongly recommended that a Program be implemented to better track all lifts on site to have more accurate information regarding LDE usage, especially as it relates to percent of full capacity lifts.

Capacity Lift Conclusion

Typically, the only time a crane experiences a true 100% capacity lift at NASA is during its initial proof test and subsequent annual certification load tests.

## Evaluation of Frequency Rates of Operation

Frequency rates of OHC operations at NASA are low. One of the most frequently used cranes is estimated to average three to five lifts per day on an annual basis. Note: Lift counts are not currently tracked.

Factors From Frequent Rates of Operation

High rates of use and increased cyclic loading and unloading of wire rope can decrease rope life due to the accumulation of fatigue bending cycles and increased potential for damage.

Mitigation

Cranes that exhibit increasing frequency of use shall be evaluated by the LDEM for more frequent inspection intervals.

Frequency Rates Conclusion

Currently, there is no risk to wire rope on OHC at NASA due to high frequency rates of operation.

It is strongly recommended that a Program be implemented to better track all lifts on site to have more accurate information regarding LDE usage, especially as it relates to frequency of operation.

## Evaluation of Exposure to Shock Loads

Cycles until recommended replacement

Cycles until failure

Figure . Bending Fatigue of Wire Rope (Vereet, pp 15)

Shock loading a crane is when a dynamic load is introduced into the wire rope. This may occur if the load is still secure to the ground when trying to raise it up, or if the rope goes slack due to the load catching on an obstruction and then breaking free. It could also occur during rotation/turning of a load when the rope can go slack at Center of Gravity (CG), and then rotates past CG. This allows the load to transfer from the ground back to the wire rope at a rapid rate. The most likely cause of shock loading at NASA may occur when suddenly stopping a loaded crane while lowering the load.

Factors from Exposure to Shock Loads

Shock loading can introduce loads to the wire rope that exceed twice the lifted load. Even repeated minor shock loading can cause a wire rope fatigue failure.

Mitigation

Most of NASA OHC are Variable Frequency Drive controlled, facilitating load control, and thereby minimizing or eliminating sudden starts and stops during load handling.

NASA’s LDE crane operator/rigger training Program covers safe load handling procedures, which always include how to remain in complete control of the load to avoid shock loading the crane.

Exposure to Shock Loads

If shock loading were to occur on LDE, it is recommended that the crane be immediately inspected per the periodic inspection procedure in ASME B30. The discovery of rope damage from shock loading should result in the wire rope being replaced. If no damage is observed, the crane can resume its periodic WRI frequency.

It is recommended that an awareness Program be implemented to encourage personnel to report cases of shock loading without fear of reprisal.

Shock Load Conclusion

OHC at NASA are typically not involved in crane operations that have an inherent risk of shock loading the crane. The risk of shock loading cranes at NASA is minimized through lift planning and training.

# Mitigation Factors

NASA’s goal is to mitigate or reduce safety exposure risk to personnel working at elevated heights while conducting OHC WRI by adopting applicable VCS. This section addresses the proposed adoption of VCS to establish an annual frequency of wire rope thorough physical “hand-over-hand” inspection for most OHC. Frequency of critical lift crane thorough physical WRIs shall be semi-annual. Thorough physical WRI shall be supported by pre-operational WRIs, consisting of thorough visual inspection for gross damage.

The proposed mitigations provide clarification in Agency policy; Center operational requirements; and practices while ensuring continued safe operation of the crane, safety of personnel, or damage to flight hardware.

## Annual and Semi-Annual Inspections

Thorough physical “hand-over-hand” WRIs shall be performed on a semi-annual frequency for active critical lift cranes and annual frequency for active non-critical lift cranes. More frequent inspection frequency can be determined/implemented by the LDEM. Cranes not in use on a regular basis will only require inspection when they are placed back in service.

## Pre-Operational Inspections

Pre-operational inspections are performed by designated qualified personnel prior to each lift to include identifying “gross” wire rope damage that may be an immediate safety hazard. Crane operators are trained to recognize discrepancies and to notify their supervisors, who in turn will notify the LDEM immediately prior to proceeding with operations. The wire rope will be visually examined from the ground for “gross” damage in accordance with ASME B30.2, Section 2-2.2.2 criteria. This visual inspection will focus on the high-cycle rope zone just above the load block at ground level where damage such as broken wires is most likely to occur first.

ASME B30.2 provides the following guidelines for pre-operational WRIs as follows:

*2-2.2.2 Frequent Rope Inspection*

*(a) All ropes should be visually inspected at the start of each shift. These visual observations should be concerned with discovering gross damage, such as listed below, that may be a hazard.*

*(1) Distortion of the rope, such as kinking, crushing, un-stranding, bird caging, main strand displacement, or core protrusion.*

*(2) General corrosion.*

*(3) Broken or cut strands.*

*(4) Number, distribution, and type of visible broken wires (see paras. 2-4.3.1(b)(1) and (2) for guidance).*

*(b) When damage as described in 2-2.2.2(a)(1) through (a)(4) is discovered, the rope shall either be removed from service or given a more detailed periodic inspection as detailed in para. 2-2.2.3(b).*

## Training

LDE crane inspectors/technicians are trained and certified by an organization regularly engaged in this type of training. They are qualified to perform all required inspections and testing on OHC. LDE maintenance technicians are qualified to make electrical and mechanical repairs when required.

Licensed crane operator/rigger personnel have been trained and licensed through the Center LDE Training Program per NASA STD 8719.9 requirements. This includes in-depth training in performing pre-operational inspections, which includes WRIs per ASME inspection/rejection criteria. A sample pre-operational inspection form is included as Appendix D in this document.

## Frequency of Operations Monitoring

Verification of crane use will be monitored by assessing the work activities that have occurred in the Facility over the past month. Inspection results and frequencies will be continually monitored and may be adjusted at any time at the LDEM’s discretion. Adjustments shall be assessed and documented prior to change.

## Inspection Hazard Mitigation

Extending inspection intervals will reduce instances that inspectors are exposed to fall hazards associated with accessing cranes for hand-over-hand WRIs.



Figure 5. Safety Mitigation Principals

## OHC WRI Risks

Inspections for gross damage of wire rope help to decrease the risk in wire rope failures while underload. However, attempts to reduce risk in one area may inadvertently increase risk in other areas (e.g. working at heights). NASA policy to conduct thorough physical “hand-over-hand” monthly inspection of OHC wire rope requires two inspection technicians working at heights from aerial lift, ladders, and platforms. The current policy and inspection practice are not based on the operational status of the OHC being inspected. Monthly OHC WRI of idle, standby, and inactive OHC unnecessarily increases personnel exposure to working at height risks.

OSHA records annually significant numbers of mishaps resulting in fatal accidents, lost time injuries, and property damage associated with personnel working at heights (see Website: [https://www.osha.gov/pls/imis/accidentsearch.html](https://gcc02.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.osha.gov%2Fpls%2Fimis%2Faccidentsearch.html&data=04%7C01%7Csusan.h.roney%40nasa.gov%7Cf5a4124aaccd4ac51a6008d90e3fa806%7C7005d45845be48ae8140d43da96dd17b%7C0%7C0%7C637556488819714207%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=%2B6bzMhAyNCP%2FLbVQFOdchf6QC4HLcuA7UBX0ToNf9Xk%3D&reserved=0)). Risks associated with aerial lift operations include lift overturns, falls, contacting power lines, and/or boom collapses. Additionally, the following risks exist when using ladders for WRI due to unstable placement, slippage, falls, electrocution, and environmental concerns/conditions.

Falls from heights remain the biggest cause of United States occupational fatalities in the construction industry. According to a report by the NIOSH Fatality Assessment and Control Evaluation Program, 42% of deaths between 1982 and 2015 in construction involved falls; 54% of workers killed had no access to a personal fall arrest system; and 20% of fatalities occurred in the victims’ first two months on the job.

Injuries caused by falls are more likely to be life-threatening than most other types of injuries. The chances of surviving a fall from more than 20 feet are low, but even 4 feet can prove deadly when landing on the wrong body part or surface. Spinal, head, or neck injuries are a common result of falls, regardless of the height, and can leave the worker severely disabled or lead to death. OSHA reports falls from heights remain the leading cause of workplace fatalities in 2017/2018. As of February 2019, 566 out of 1623 occupational deaths in the U.S. were caused by falls, which equals roughly 35% of all death causes.

Most of the OHC at NASA are located as high as a few hundred feet with an average height throughout NASA of 60 to 80 feet. It is the intent of NASA to mitigate personnel exposure to this hazard.

# Conclusion

OHC are essential to the NASA mission. These cranes can be located as high as a few hundred feet with an average height throughout the Agency of 60 to 80 feet. Agency OHC are equipped with wire rope that spans the length of this height with additional rope located on the drum. Current NASA WRI practice requires monthly physical “hand-over-hand” inspection regardless of the operational status of the OHC. This practice puts inspection personnel at increase exposure to safety risk associated with working at heights. OSHA reports falls from working at heights remain the leading cause of workplace fatalities.

Other Government Agencies and Departments surveyed have reduced personnel exposure to working at heights risk by performing WRI on only active OHCs. Whereas, WRIs are accomplished by OHC lift teams, as part of pre-shift or pre-lift operations without using aerial lifts or ladders. Consensus by most Federal Agencies requires a thorough physical inspection and examination of wire rope on an annual basis for active OHC.

After reviewing other governmental Agencies and VCS, the LDE committee believes there is no increase in risk to move thorough “hand-over-hand’ physical inspection frequency to once a year with crane operators performing a thorough visual WRI prior to the start of their shift. If the operator is to find any issues with the wire rope, they would contact the LDEM. This method of inspection is consistent within many Agencies, companies, and VCS. This only applies to certified OHC in an active certification status that have no significant open wire rope deficiencies that otherwise meet all NASA Lifting Standard (NASA-STD-8719.9B) requirements.

Research shows NASA can significantly limit overall safety exposure risk to OHC WRI personnel by reducing the amount of time inspection crews spend working at heights on inactive, idle, and/or standby cranes. In support of the data, NASA proposes adoption of ASME WRI requirements to meet or exceed OSHA regulations and reduce risk to inspection personnel. Implementing the proposed procedural change to the NASA Lifting Standard will limit WRI to active OHC and reduce the probability of falling and injuries from height incidents.

It is therefore recommended that NASA-STD-8719.9 be updated to reflect the following changes:

* Limit WRI requirements to active OHC systems
	+ Thorough visual inspections, pre-operational.
	+ Thorough physical “hand-over-hand” inspection, annually or more frequently as assessed by the Center PSM.
* Develop OHC electronic operational log that includes tracking the capacity of lifts and frequency of operation.
* Implement a program that encourages personnel to report cases of shock loading without fear of reprisal.
* Develop a Program to track wire rope replacement to help estimate the expected rope life of LDE in the future.
* Define thorough visual and thorough physical “hand-over-hand” inspection criteria
* Develop a thorough pre-operational visual WRI process.
	+ Pre-operational training in accordance with OSHA 1910.179, Center OHC OPRs be responsible for performing and documenting all WRIs.
	+ Monthly OHC lift summary reports to the Center LDEM, in a timely manner.
* Develop a thorough physical “hand-over-hand” Annual WRI (AWRI) process for each active OHC. AWRI shall be conducted by an approved third-party organization or for internal Center AWRI inspections, all instructors shall be trained by an approved third party.
* Train OHC operators or lift crew members to perform gross damage pre-operational visual inspections.
* Establish LDEM guidance for WRI periodicity assessments and evaluations.
* LDEM considerations when determining modified WRI frequencies:
	+ Certified critical lift cranes.
	+ Crane usage and percentage of rate capacity lifts shall be evaluated.
	+ Condition of ropes with current flaws such as broken wires, kinks, and corrosion shall be evaluated and documented by the LDEM.
	+ Lubrication of wire rope must follow the manufacturer’s recommendation. If lubrication cannot be accomplished for existing rope, the WRI frequency shall be evaluated by the LDEM.
	+ Environmental conditions shall be evaluated to determine the effect on the condition of the WRI and its life expectancy.
	+ A documented risk assessment shall be completed (example shown in Appendix D)

The WRI criteria above is based on the minimum requirements as outlined by OSHA and ASME. Deviation and waivers shall follow Center policies as required by NPR 8715.1b and NASA STD- 8719.9

Appendix A. References

1. OSHA 29 CFR 1910.179, Overhead and Gantry Cranes
2. NASA-STD-8719.9B, NASA Lifting Standard
3. ASME B30.2, Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
4. ASME B30.30, Ropes
5. ASME A17.1, Handbook on Safety Code for Elevators and Escalators
6. NAVFAC P-307 Weight Handling Management Program
7. ISO 4309 Cranes—Wire ropes—Care and Maintenance, Inspection, and Discard
8. ISO 927 Cranes—Inspections
9. Wire Rope User’s Manual, 4th Edition, Wire Rope Technical Board
10. Nuclear Regulatory Commission Crane and Heavy Lift Inspection, Supplemental Guidance to IP 71111.20 and IP 71111.13
11. DOE—PNNL 18129, Pacific Northwest National Laboratory, Hoisting and Rigging Manual, Chapter 7 “Wire Rope”
12. DOE—DOE/RL-92-36, Hanford Site Hoisting and Rigging Manual, Chapter 8, “Wire Rope”
13. API 2D, Operation and Maintenance of Offshore Cranes
14. DOE-STD-1090-2011, Hoisting and Rigging
15. WireCo—Union Wire Rope Users Handbook
16. Vereet, Roland, (unknown date). Casar Technical Documentation, pp 15, Figure 10, Germany, retrieved from http://www.ropetechnology.com/bro\_engl/casar\_technical\_documentation.pdf

Appendix B. Definitions

**ASME B30 Series:** Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings

**“Gross” Damage:** A term used in ASME B30.2, section 2-2.2.2 to describe the type of wire rope damage and abnormalities to look for during pre-operational and frequent inspections.

**Qualified Person:** A person who, by possession of a recognized degree in an applicable field or a certificate of professional standing or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.

**Variable Frequency Drive:** A type of adjustable-speed drive used in electro-mechanical drive systems, such as OHC, to control AC motor speed and torque by varying motor input frequency and voltage.

Appendix C. Abbreviations and Acronyms

|  |  |
| --- | --- |
|  API | American Petroleum Institute |
| ASME | American Society of Mechanical Engineers |
| CFR | Code of Federal Regulations |
| CMAA | Crane Manufacturers Association of America |
| CMO | Center Management Operations |
| DOE | Department of Energy |
| HST | Hoist Standard |
| ISO | International Organization for Standardization  |
| KSC | Kennedy Space Center |
| LDE | Lifting Devices and Equipment |
| LDEM | Lifting Devices and Equipment Manager |
| NASA | National Aeronautics and Space Administration |
| NCS | National Consensus Standards |
| NDT | Non-Destructive Testing |
| VCS | Voluntary Consensus Standard |
| NDT | Non-Destructive Testing |
| OSHA | Occupational Safety and Health Administration, U.S. Department of Labor |
| PPE | Personal Protective Equipment |
| SMA | Safety and Mission Assurance |
| STD | Standard |
| SWL | Safe Working Load |
| VCS | Volunteer Consensus Standards  |

Appendix D. Risk Assessment

|  |
| --- |
| **Likelihood Rating** |
| Likelihood  | 5 | Highly Likely | Expected to happen. Controls have minimum to no effect. |
| 4 | Likely | Likely to happen. Controls have significant limitations or uncertainties. |
| 3 | Possible | Could happen. Controls exist, with some limitations or uncertainties. |
| 2 | Unlikely | Not expected to happen. Controls have minor limitations or uncertainties. |
| 1 | HighlyUnlikely | Extremely remote possibility that it will happen. Strong controls in place. |

|  |
| --- |
|  |
| Likelihood | 5 |  |  |  |  |  |
| 4 |  |  |  |  |  |
| 3 |  |  |  |  |  |
| 2 |  |  |  |  |  |
| 1 |  |  |  |  |  |
|  | 1  | 2 | 3 | 4 | 5 |
| Consequences |



Figure 6. Risk Assessment Code (RAC)

Table 3. Risk Consequences

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CONSEQUENSCES**  | **Subcategories** | **1** | **2** | **3** | **4** | **5** |
| HSE (Health, Safety, Environment) | *System, Facility* | Minor damage to asset | Moderate impact or degraded performance | Loss of non-critical asset | Damage to critical asset | Loss of critical asset or emergency evacuation |
| *Environment* | Minor or non-reportable hazard or incident | Moderate hazard or reportable violation | Significant violation: event requires immediate remediation | Major violation: event causes temporary work stoppage | Catastrophic hazard |
| Technical | *Performance* | Minor impact to mission objectives or requirements | Incomplete compliance with a key mission objective  | Non-compliance; significant impact to mission | Non-compliance; major on Center or mission | Failure to meet mission objectives or Center  |
| Center Capabilities | *Infrastructure* | Minor Impact or reduced effectiveness | Moderate impact or damage to infrastructure | Significant damage to infrastructure or reduced support | Mission delays or major impact to Center operations | Extended loss of critical capabilities  |
| *Workforce* | Minor impact to human capital | Moderate impact to human capital | Significant impact; loss of critical skill | Major impact: loss of skill set | Loss of core competency |
| Cost | Organizational or CMO Impact | <2% Budget increase or <$1M CMO threat  | 2-5% Budget Increase or $1M-$5M CMO threat | 5-10% Budget Increase or $5M-$10M CMO threat | 10-15% Budget Increase or $10M-$60M CMO threat | >15% Budget Increase or > $60M CMO threat |
| Schedule |  | Minor milestone slip | Moderate milestone slip; schedule margin available | Project milestone slip: no impact to a critical path. | Major milestone slip: impact to a critical path | Failure to meet critical milestone  |

Table 4. NASA WRI Report

|  |  |  |  |
| --- | --- | --- | --- |
| **Risk assessment for extending thorough inspection frequency of wire rope from a monthly to a semi-annual interval** | **Code Reference:** ASME B30.2, section 2-2.2.3 Periodic Rope Inspection | **Date:**  | Image result for wire rope reeving diagram**Reeving:** 8 part |
| **Crane:**  | **Wire Rope Class/Type:**  | **Nominal Diameter:**  | **Maximum Line Pull:** |
| **Location:**  | **Wire Rope In-Service Date:**  | **First Measured Diameter:**  | **Wire Rope WLL:**  |
| **Crane Capacity:**  |  | **Last Measured Diameter:**  |  |
| **A.****Specific Factors to Consider**  | **B.****Actual Conditions/ Comments** | **C.****Potential Adverse Effects**  | **D.****Potential Causes of Adverse Effects** | **E.****Existing Controls** | **6****Risk Rating** | **7****Proposed Risk Reduction Measures** | **8****Risk Rating with Proposed Risk Reduction Measure** |
| **Likelihood** | **Consequence** | **Risk Level** | **Likelihood** | **Consequence** | **Risk Level** |
| **Expected Rope Life** |  |  |  |  |  |  | **LOW** |  |  |  | **LOW** |
| **Severity of Environment** |  |  |  |  |  |  | **LOW** |  |  |  | **LOW** |
| **Percent of Capacity Lifts** |  |  |  |  |  |  | **LOW** |  |  |  | **LOW** |
| **Frequency Rates of Operation** |  |  |  |  |  |  | **LOW** |  |  |  | **LOW** |
| **Exposure to Shock Loads** |  |  |  |  |  |  | **LOW** |  |  |  | **LOW** |

Table 5. Title X

|  |  |  |  |
| --- | --- | --- | --- |
| **Risk assessment for extending thorough inspection frequency of wire rope from a monthly to an annual interval** | **Code Reference:** ASME B30.2, section 2-2.2.3 Periodic Rope Inspection | **Date:**  | Image result for wire rope reeving diagram**Reeving:** 8 part |
| **Crane:** XXX | **Wire Rope Class/Type:** 6 x 37 / RRL, EIPS | **Nominal Diameter:** 3/8” (.375”) | **Maximum Line Pull:** 2,500 lbs. |
| **Location: High Bay**  | **Wire Rope In-Service Date: 2000** (20 yrs.) | **First Measured Diameter:** .384” | **Wire Rope WLL:** 3,320 lbs. |
| **Crane Capacity:** 20,000 lbs. |  | **Last Measured Diameter:** .381” |  |
| **A.****Specific Factors to Consider**  | **B.****Actual Conditions/ Comments** | **C.****Potential Adverse Effects**  | **D.****Potential Causes of Adverse Effects** | **E.****Existing Controls** | **6****Risk Rating** | **7****Proposed Risk Reduction Measures** | **8****Risk Rating with Proposed Risk Reduction Measure** |
| **Likelihood** | **Consequence** | **Risk Level** | **Likelihood** | **Consequence** | **Risk Level** |
| **Expected Rope Life** | **1.** New rope in good condition**2.** Unable to visually inspect the internal 80% of the rope | **1.** None**2.** Possible undetected internal damage such as wear, broken wires, and corrosion over time. | **1.** None **2**. Lack of lubrication  | **1.** Periodic ASME inspection with strict rejection criteria**2.** Periodic ASME inspections paying attention to structural changes and signs of corrosion in the rope | **3** | **3** | **Moderate** | **1.** Continue periodic ASME inspections **2.** NDT inspection or consider replacing wire rope | **1** | **1** | **LOW** |
| **Severity of Environment** | **1.** Indoors | **1.** None | **1.** None | **1.** Continue monitoring  | **1** | **1** | **LOW** | **1**. None needed | **1** | **1** | **LOW** |
| **Percent of Capacity Lifts** | **1.** Verylow percentage of capacity lifts | **1.** Shock loading potential  | **1.** Loss of control during restrained lifts or load flopping operations | **1.** Engineered/ planned lifts using trained operators | **2** | **3** | **LOW** | **1.** Engineered lifts using trained operators | **2** | **2** | **LOW** |
| **Frequency Rates of Operation** | **1.** Estimated 5 lifts per day on average | **1.** Wire fatigue and breaks | **1.** Accumulated bending cycles and lack of lubrication | **1.** Monitor frequency of use | **2** | **2** | **LOW** | **1.** Continue monitoring frequency of use | **1** | **2** | **LOW** |
| **Exposure to Shock Loads** | **1.** None have occurred or have been reported | **1.** Wire rope failure | **1.** Loss of control during restrained lifts or load flopping operations | **1.** Engineered/ planned lifts using trained operators | **2** | **2** | **LOW** | **1.** Engineered lifts**2.** Trained operators | **2** | **2** | **LOW** |

Appendix E. Code Research

OSHA 1910 General Industry

1910.179(j)(4) *Cranes not in regular use*.

1910.179(j)(4)(i) A crane which has been idle for a period of one month or more, but less than six months, shall be given an inspection conforming with requirements of paragraph (j)(2) of this section and paragraph (m)(2) of this section before placing in service.

1910.179(j)(4)(ii) A crane which has been idle for a period of over six months shall be given a complete inspection conforming with requirements of paragraphs (j) (2) and (3) of this section and paragraph (m)(2) of this section before placing in service.

1910.179(j)(4)(iii) Standby cranes shall be inspected at least semi-annually in accordance with requirements of paragraph (j)(2) of this section and paragraph (m)(2) of this section.

1910.179(j)(1)(ii)(a) Frequent inspection—Daily to monthly intervals.

1910.179(j)(1)(ii)(b) Periodic inspection—1 to 12-month intervals.

1910.179(j)(2) *Frequent inspection*. The following items shall be inspected for defects at intervals as defined in paragraph (j)(1)(ii) of this section or as specifically indicated, including observation during operation for any defects which might appear between regular inspections. All deficiencies such as listed shall be carefully examined and determination made as to whether they constitute a safety hazard:

1910.179(j)(2)(i) All functional operating mechanisms for maladjustment interfering with proper operation. Daily.

1910.179(j)(2)(ii) Deterioration or leakage in lines, tanks, valves, drain pumps, and other parts of air or hydraulic systems. Daily.

1910.179(j)(2)(iv) Hoist chains, including end connections, for excessive wear, twist, distorted links interfering with proper function, or stretch beyond manufacturer's recommendations. Visual inspection daily; monthly inspection with a certification record which includes the date of inspection, the signature of the person who performed the inspection and an identifier of the chain which was inspected.

1910.179(j)(2)(vi) All functional operating mechanisms for excessive wear of components.

1910.179(j)(2)(vii) Rope reeving for noncompliance with manufacturer's recommendations.

[1910.179(j)(3)](https://gcc02.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.osha.gov%2Flaws-regs%2Finterlinking%2Fstandards%2F1910.179(j)(3)&data=04%7C01%7Csusan.h.roney%40nasa.gov%7Cd06d67bee16744d5669808d8ed439fb3%7C7005d45845be48ae8140d43da96dd17b%7C0%7C0%7C637520221978425942%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=YTBQwlYSIkRRniBSOkFBC2%2BVHvHDQVnmJISQhMN7bvk%3D&reserved=0) Periodic inspection. Complete inspections of the crane shall be performed at intervals as generally defined in paragraph (j)(1)(ii)(b) of this section, depending upon its activity, severity of service, and environment, or as specifically indicated below. These inspections shall include the requirements of paragraph (j)(2) of this section and in addition, the following items. Any deficiencies such as listed shall be carefully examined and determination made as to whether they constitute a safety hazard:

1910.179(j)(3)(i) Deformed, cracked, or corroded members.

1910.179(j)(3)(ii) Loose bolts or rivets.

1910.179(j)(3)(iii) Cracked or worn sheaves and drums.

1910.179(j)(3)(iv) Worn, cracked or distorted parts such as pins, bearings, shafts, gears, rollers, locking, and clamping devices.

1910.179(j)(3)(v) Excessive wear on brake system parts, linings, pawls, and ratchets.

1910.179(j)(3)(vi) Load, wind, and other indicators over their full range, for any significant inaccuracies.

1910.179(j)(3)(vii) Gasoline, diesel, electric, or other powerplants for improper performance or noncompliance with applicable safety requirements.

1910.179(j)(3)(viii) Excessive wear of chain drive sprockets and excessive chain stretch.

1910.179(j)(3)(x) Electrical apparatus, for signs of pitting or any deterioration of controller contactors, limit switches, and pushbutton stations.

1910.179(m)(1) *Running ropes*. A thorough inspection of all ropes shall be made at least once a month and a certification record which includes the date of inspection, the signature of the person who performed the inspection, and an identifier for the ropes that were inspected shall be kept on file where readily available to appointed personnel. Any deterioration, resulting in appreciable loss of original strength, shall be carefully observed and determination made as to whether further use of the rope would constitute a safety hazard. Some of the conditions that could result in an appreciable loss of strength are the following:

1910.179(m)(1)(i) Reduction of rope diameter below nominal diameter due to loss of core support, internal or external corrosion, or wear of outside wires.

1910.179(m)(1)(ii) A number of broken outside wires and the degree of distribution or concentration of such broken wires.

1910.179(m)(1)(iii) Worn outside wires.

1910.179(m)(1)(iv) Corroded or broken wires at end connections.

1910.179(m)(1)(v) Corroded, cracked, bent, worn, or improperly applied end connections.

1910.179(m)(1)(vi) Severe kinking, crushing, cutting, or un-stranding.

1910.179(m)(2) *Other ropes*. All rope which has been idle for a period of a month or more due to shut down or storage of a crane on which it is installed shall be given a thorough inspection before it is used. This inspection shall be for all types of deterioration and shall be performed by an appointed person whose approval shall be required for further use of the rope. A certification record shall be available for inspection which includes the date of inspection, the signature of the person who performed the inspection and an identifier for the rope which was inspected.

**NASA Standard 8719.1**

4.1.3 LDE shall be designed, constructed, tested, inspected, maintained, and operated in accordance with the applicable OSHA regulations, the requirements in this standard, NCS as specified herein, and be based upon manufacturer recommendations.

**American Society of Mechanical Engineers**

ASME B30.2, Overhead and Gantry Cranes

2-2.1.4 Frequent inspection

1. A frequent inspection is a visual and audible examination of the crane.
2. Equipment shall be inspected at intervals dependent on the use of the equipment as follows:
* Normal service-monthly
* Heavy service-weekly to monthly
* Severe service-daily to weekly
1. The following items shall be inspected:
	* Rope in accordance with para. 2-2.2.2

2-2.2.2 Frequent Rope Inspection

* 1. All ropes should be visually inspected at the start of each shift. These visual observations should be concerned with discovering **gross** damage, such as listed below, that may be a hazard.

(1) Distortion of the rope, such as kinking, crushing, unstranding, birdcaging, main strand displacement, or core protrusion

(2) General corrosion

(3) Broken or cut strands

(4) Number, distribution, and type of visible broken wires

b) When damage as described in paras. 2-2.2.2(a)(1) through (a)(4) is discovered, the rope shall either be removed from service or given an inspection as detailed in para. 2-2.2.3(b).

2-2.2.3 Periodic Rope Inspection

*a) The inspection frequency shall be determined by a qualified person and shall be based on such factors as:*

*(1) expected rope life as determined by experience on the particular installation or similar installations*

*(2) severity of environment*

*(3) percent of capacity lifts*

*(4) frequency rates of operation*

*(5) exposure to shock loads Inspections need not be at equal calendar intervals and should be more frequent as the rope approaches the end of its useful life.*

ASME B30.16, Overhead Underhung and Stationary Hoists

16-2.1.4 Frequent Inspections

*Frequent inspections shall be performed at intervals defined in para. 16-2.1.2(b)(2) ...*

*The following items shall be inspected … Hoist rope for gross damage, which may be an immediate hazard, such as the following:*

30-1.8.1 Inspection

* 1. *General*. All inspections shall be performed by a designated person. Any deficiencies identified shall be examined and a determination made by a qualified person as to whether they constitute a hazard and, if so, what steps need to be taken to address the hazard.
	2. *Frequent*
		+ 1. Running rope in service shall be visually inspected daily, unless a qualified person determines it should be performed more frequently. The visual inspection shall consist of observation of all rope that can reasonably be expected to be in use during the day’s operations. The inspector should focus on discovering gross damage that may be an immediate hazard.
			2. Specific types of damage include the following:
				1. Distortion to the uniform structure of the rope.
				2. Broken wires.
				3. Corrosion.
				4. Gross damage or deterioration of the end connection(s).
				5. Evidence of heat, electrical, or lightning damage.
				6. Localized change in lubrication condition.
			3. When damage is discovered, a qualified person shall inspect the affected section(s) to determine if the rope needs to be removed from service using criteria defined in para. 30-1.8.2.
			4. Rope Not in Regular Use
1. Wire rope that has been idle for a period of one month to six months due to shut down or storage of the machine shall be inspected in accordance with para. 30-1.8.1(b).
2. Wire rope that has been idle for a period of over six months due to shut down or storage of the machine shall be inspected in accordance with para. 30-1.8.1(c).

ASME A17.1, Handbook on Safety Code for Elevators and Escalators (2019)

Appendix N

General Note: Factors such as the environment, frequency of usage and type of usage, quality of maintenance, age and condition, and remote monitoring (see Table N-2) that are related to the equipment should be taken into account by the authority having jurisdiction prior to establishing the inspection and test intervals. It is recommended that a risk analysis, using the methodology of ISO 14798, Lifts (Elevators), Escalators and Moving Walks—Risk Assessment and Reduction Methodology be used to establish the intervals of inspections and tests for components and systems of the equipment. Where a risk analysis is not performed, the intervals specified in Table N-1 are recommended for periodic tests (see Section 8.6) and periodic inspections (see Section 8.11).

ASME A17.2, Guide for Inspection of Elevators, Escalators, and Moving Walks

* + 1. Periodic Inspections

a) Wire Rope Inspection. Examine suspension ropes and note if they conform to code requirements. Always place the stop switch in the “STOP” position while inspecting the rope.

(1) Internal breakage of wire ropes is difficult to detect and, consequently, may be a greater hazard than surface wear. The surface of the rope may show little or no wear, but if the rope is bent over a short radius, individual wires will snap and in extreme cases the rope may be broken by hand. Such failures are more likely to occur in governor and compensating ropes where the ropes are lightly loaded and the ratio of sheave diameter to rope diameter is smaller.

(2) When replacing suspension ropes, all ropes in a set must be replaced. The ropes in the set must all be from the same manufacturer and of the same material, grade, construction, and diameter.

(3) The lengths of all wire ropes in a set of suspension ropes, and consequently the rope tensions, should be substantially equal if maximum rope life and efficiency are to be obtained. If the tensions are not within tolerance, adjustment is recommended.

(4) If ropes are dirty or overlubricated, a proper inspection may not be possible unless the dirt or excess lubricant is removed.

b) Wire Rope Inspection Procedure. Note that it is not possible to describe the inspection procedure for every type of WRI nor to outline every detail of the inspection procedure. Select the location from which a proper examination of the rope can best be made. For example, the suspension ropes of an overhead drum machine cannot be examined from the top of the car. See Item 2.27.1.1.

**Crane Manufactorers Association of America**

Pre-Shift Inspection

A visual and operational inspection of the crane shall be performed at the start of each shift or when it is first used during each shift.

Performance of Inspection

The Pre-Shift Inspection should be performed by the crane operator unless the employer or supervisor has assigned this responsibility to another designated person.

Scope of Pre-Shift Inspection should include, but not be limited to the items in Table 6.

Table 6. List of Pre-Shift Inspection Items

|  |  |
| --- | --- |
| Inspection Item | Description of Inspection Check Points |
| Tagged Crane or Hoist | Check that the crane or hoist is not tagged with an out-of- order sign. |
| Control Devices | Check that all motions agree with control device markings. |
| Brakes | Check that all motions do not have excessive drift and that stopping distances are normal. |
| Hook | Check for damage, cracks, nicks, gouges, deformations of the throat opening, wear on saddle or load bearing point, and twist. Refer to the manual furnished by the OEM of the crane or hoist. |
| Hook Latch | Check that hook latch, if provided, is not missing and that it operates properly. |
| Wire Rope | Check for broken wires, broken strands, kinks, any deformation or damage to the rope structure, or loss of lubricant. |
| Load Chain | Check load chain, including end connections for excessive wear, twist, distorted links or stretch, beyond the OEM recommendations. |
| Reeving | Check that the wire rope or load chain is properly reeved, and that rope or load chain parts are not twisted about each other. Make sure wire rope is properly seated in drum grooves. |
| Hoist Limit Switches | Check that the hoist upper/lower limit devices stop lifting or lowering motion of the hoist load block before striking any part of the hoist, crane, or floor. **Caution: exercise extreme care during this test to avoid striking any part of the hoist or trolley with the hoist load block in the event of a faulty limit switch.** |
| Travel Limits | Check bridge and trolley travel limits for proper function. **Caution: Exercise extreme care during this test to avoid striking end stops.** |
| Oil Leakage | Check for any sign of oil leakage on the crane and on the floor area beneath the crane. |
| Unusual Sounds | Check for any unusual sounds from the crane or hoist mechanism while operating the crane and hoist. |
| Warning and Safety Labels and WarningDevices | Check that warning and other safety labels are not missing and that they are legible. Check that audible and visual warning devices are operational. |

Frequent Inspection

* The Frequent Inspection is a visual and operational inspection performed monthly, or as often as daily, based on service, environmental and application factors, as determined by a qualified person or as outlined in Table 7.
* A crane that has been idle for a period of one month or more, but less than one year, shall be given a frequent inspection in accordance with Table 7.

Table 7. Frequent Inspection Chart

|  |
| --- |
| NUMBER OF SHIFTS OPERATED PER DAY |
| CMAA SERVICECLASS | ASME 830.2 SERVICECLASS | STAND-BY 1 SHIFT 2 SHIFTS | 3 SHIFTS |
|  |  | FREQUENCY OF INSPECTION |  |
| A |  | SEMI-ANNUALLY SEMI-ANNUALLY SEMI-ANNUALLYMONTHLY MONTHLYMONTHLY MONTHLYMONTHLY SEMI-MONTHLY TO MONTHLYWEEKLY 3-5 DAYSDAILY DAILY | SEMI-ANNUALLY MONTHLYSEMI-MONTHLY TOMONTHLY WEEKLY TO SEMI- MONTHLY DAILYDAILY |
| B | NORMAL |
| C |  |
|  |
| D | HEAVY |
| E |  |
|  | SEVERE |
| F |  |

* Performance of the Inspection

The Frequent Inspection shall be performed by a qualified person in accordance with Sections 2.1 and 2.2. The qualified person shall determine whether conditions found during the inspection constitute a hazard and whether a more detailed inspection is required.

* Scope of Frequent Inspection shall include, but not be limited to the items in Table 8.

Table 8. List of Frequent Inspection Items

|  |  |
| --- | --- |
| Inspection Item | Description of inspection Check Points |
| Tagged Crane or Hoist | Check that the crane or hoist is not tagged with an out-of- order sign. |
| Control Devices | Check that all motions agree with control device markings. |
| Brakes | Check that all motions do not have excessive drift and that stopping distances are normal. |
| **\*Hook** | Check for damage, cracks, nicks, gouges, deformation of the throat opening, wear on saddle or load bearing point, and twist. Refer to the manual furnished by the original manufacturer of the crane or hoist. |
| Hook Latch | Check that hook latch, if provided, is not missing and that it operates properly. |
| **\*Wire Rope** | Check for broken wires, broken strands, kinks, any deformation or damage to the rope structure, or loss of lubricant. |
| **\*Load Chain** | Check load chain, including end connections for excessive wear, twist, distorted links or stretch, beyond themanufacturer’s recommendations. |
| Reeving | Check that the wire rope or load chain is properly reeved, and that rope or load chain parts are not twisted about each other. Make sure wire rope is properly seated in drumgrooves. |
| Hoist Limit Switches | Check that the hoist upper/lower limit devices stop lifting or lowering motion of the hoist load block before striking any part of the hoist, crane or floor. **Caution: exercise extreme care during this test to avoid striking any part of the hoist or trolley with the hoist load block in the event of a faulty limit switch.** |
| Travel Limits | Check bridge and trolley travel limits for proper function.**Caution: Exercise extreme care during this test to avoid striking end stops.** |
| Oil Leakage | Check for any sign of oil leakage on the crane and on the floor area beneath the crane. |
| Unusual Sounds | Check for any unusual sounds from the crane or hoist mechanism while operating the crane and hoist. |
| Warning and Safety Labels and WarningDevices | Check that warning and other safety labels are not missing and that they are legible. Check that audible and visual warning devices are operational. |

* Documentation of Inspection

Items in Table 8 marked with(\*) shall be documented with a certification record which includes date of inspection, the signature of the person who performed the inspection and the serial number or identifier of the hook, chain, or wire rope inspected.

* All other items of Table 8 should be documented. Inspection reports should identify the specific hazard or maintenance problem and kept on file for three years. Safety hazards shall be reported to the responsible person immediately upon discovery.

Class A (Standby or Infrequent Service)

This service class covers cranes which may be used in installations such as power houses, public utilities, turbine rooms, motor rooms, and transformer stations where precise handling of equipment at slow speeds with long, idle periods between lifts are required. Capacity loads may be handled for initial installation of equipment and for infrequent maintenance.

Class B (Light Service)

This service covers cranes which may be used in repair shops, light assembly operations, service buildings, light warehousing, etc., where service requirements are light, and the speed is slow. Loads may vary from no load to occasional full rated loads with two to five lifts per hour, averaging 10 feet per lift.

Class C (Moderate Service)

This service covers cranes that may be used in machine shops or paper mill machine rooms, etc., where service requirements are moderate. In this type of service the crane will handle loads which average 50% of the rated capacity with 5 to 10 lifts per hour, averaging 15 feet, not over 50% of the lift at rated capacity.

Class D (Heavy Service)

This service covers cranes which may be used in heavy machine shops, foundries, fabricating plants, steel warehouses, container yards, lumber mills, etc., and standard duty bucket and magnet operations where heavy duty production is required. In this type of service, loads approaching 50% of the rated capacity will be handled constantly during the working period. High speeds are desirable for this type of service with 10 to 20 lifts per hour averaging 15 feet, not over 65% of the lifts at rated capacity.

Class E (Severe Service)

This type of service requires a crane capable of handling loads approaching a rated capacity throughout its life. Applications may include magnet, bucket, magnet bucket combination cranes for scrap yards, cement mills, lumber mills, fertilizer plants, container handling, etc., with 20 or more lifts per hour at or near the rated capacity.

Class F (Continuous Severe Service)

This type of service requires a crane capable of handling loads approaching rated capacity continuously under severe service conditions throughout its life. Applications may include custom designed specialty cranes essential to performing the critical work tasks affecting the total production Facility. These cranes must provide the highest reliability with special attention to ease of maintenance features

**Crane Service Class in Terms of Load Class and Load Cycles**

The definition of CMAA crane service class in terms of load class and load cycles is shown in Table 9.

Table 9. Definition of CMAA Crane Service Class in Terms of Load Class and Load Cycles

|  |  |  |
| --- | --- | --- |
| LOAD CLASS | LOAD CYCLES | k= MEANEFFECTIVE LOAD FACTOR |
| N1 | N2 | N3 | N4 |
| L1 | A B CD | B C DE | C DEF | D E FF | 0.35-0.53 |
| L2 | 0.531 -0.67 |
| L3 | 0.671 – 0.85 |
| L4 | 0.851 -1.00 |
|  | Irregular | Regular use | Regular use | Regular use |  |
| occasional | in | in | in severe |
| use followed | intermittent | continuous | continuous |
| by long idle | operation | operation. | Operation |
| periods |  |  |  |

**Load Classes:**

L1 = Cranes which hoist the rated toad exceptionally and, normally, very light loads.

L2 = Cranes which rarely hoist the rated load, and normal loads of

about 113 of the rated load.

L3 = Cranes which hoist the rated load fairly frequently and normally, loads between 113 and 213 of the rated load.

L4 = Cranes which are regularly loaded close to the rated load.

**Load Cycles/Life of Crane**

|  |  |  |
| --- | --- | --- |
| N1 | = | 20,000 to 100,000 cycles |
| N2 | = | 100,000 to 500,000 cycles |
| N3 | = | 500,000 to 2,000,000 cycles |
| N4 | = | Over 2,000,000 cycles |

Table 10. Title X



Frequency of Frequent Inspections

**Periodic Inspection—**A periodic inspection is a detailed visual and operational inspection where individual components are examined to determine their condition. Inspection frequency can be quarterly to annually and is based on service, environmental, and application factors, as designated by a qualified person.

Below are guidelines for frequency of inspection based on ASME and CMAA OHC service classifications:

Table 11. Title X



Frequency of Periodic Inspections

**Other Similar Federal Agencies**

Navy P-307

Category 2 and 3 cranes. (Cranes with certified capacities of 20,000 pounds or greater are Category 2. Cranes with certified capacities less than 20,000 pounds are Category 3.)

9.1.2.1.1 Walk Around Check. The operator shall perform a walk-around check as noted below on those cranes equipped with a safe access means. For Category 1 and 4 cranes, the walk around check shall be from the ground, inside the machinery house if applicable, the operator’s cab, and the walkways and ladders between the ground, machinery house, and operator’s cab. The boom may remain in its normal operating range. It is not intended that the boom and A-frame be climbed. For cab-operated Category 2 and 3 cranes with access ladders and walkways, the check shall be from the ground, the walkways, the cab, and if safe access is provided, the trolley. The walk around check for non-cab-operated cranes may be performed from the ground. The operator shall ensure the crane is currently certified. Enter the certification expiration date on the ODCL. If the crane is not currently certified, this condition shall be reported to the supervisor and the crane shall not be operated. The check shall include walking around and/or over the exterior of the crane, observing anything that is out of order or place. As a minimum, the operator shall observe and report the condition of the following:

d. Wire Rope. Check wire rope for unusual wear, fraying, bird caging, corrosion, and kinking. Check end connections where visible, particularly wedge sockets for proper configuration, seating, and condition of wire rope. Check chafing blocks for adequate guidance of lines and excessive wear.

e. Reeving. Check for condition of wire rope or load chain reeving. Check to ensure wire rope fleet angle has not caused overriding of drum flange. Check to ensure wire rope or load chain is running true in the hook block and boom point sheaves. Check to ensure wire rope or load chain is laying correctly on the drum or sprockets. (Crane team riggers may check this item.)

9.2 Pre-Use Check (Non-Cab Operated Category 3 Cranes).

a. For all cranes, the operator shall perform a pre-use check prior to the first use of the crane each day (whether the crane is used in production, maintenance, testing, or being relocated). In addition, the first operator in each subsequent shift that day shall perform an operational check of the crane, to include the hoist upper limit switch. For cranes used in construction, the pre-use check shall be performed prior to each shift the crane is used. The pre-use check shall use applicable checks and exceptions of paragraphs 9.1 and 9.1.2.1 as a guide. The pre-use check need not be documented. Problems found shall be reported to the supervisor.

1. For bridge, wall, and gantry cranes, a documented pre-use check shall be performed at least once each calendar month the crane is in use. The pre-use check shall be in accordance with paragraph 9.1.2. The checklist shall be completed and signed by a qualified operator. The operator shall forward the checklist to the supervisor for review and signature.

3.4.1.1 Type Designation and Frequency

a. Type “A” Inspection (Appendix C). Calendar month basis—each 4 calendar months (plus 10 days) after certification. Hour meter basis—each 500 engine operating hours (plus 50 operating hours).

1. Type “B” Inspection (Appendix C). Calendar month basis—at every third type “A” inspection. Hour meter basis—each 2,000 engine operating hours (plus 200 operating hours), except that a type “B” inspection shall be performed annually as a minimum.

Item 52 in Appendix C requires every crane.

Wire Rope, Fastenings, and Terminal Hardware.

Thoroughly inspect the entire length of running ropes and standing ropes. The depth and detail of the inspection shall be that necessary to ensure that the entire rope is acceptable with special attention paid to areas of expected wear or damage, areas not normally visible to the operator during operation or pre-use check, and rotation-resistant rope. During the inspection, pay the wire rope out as far as possible. For sections that cannot be spooled off the drum, visual inspection of the wire rope on the drum is sufficient. Where it is not possible to pay out to the lowest layer, the crane shall not be used for applications where the uninspected rope (i.e., covered layers) would be spooled off the drum under load. The first layer of wire rope shall be properly reinstalled on the drum to provide adequate support for the upper layers. Remove wire rope dressing from selected areas exposed to significant wear, exposure, and abuse. Diameter measurements shall be taken at several places over the length of the rope. Record minimum dimension measured in the “remarks” block. Pay particular attention to sections in contact with equalizer sheaves and saddles or where corrosion may develop because of poor drainage; these sections shall be exposed and examined during “C” inspections for boom hoists and “B” inspections for all other hoists. Inspect wear blocks to ensure rope is not contacting structure. Lubricate areas after inspection.

Inspect for defects noted below and for proper lubrication. Inspect poured sockets, wedge sockets, swage fittings, eyes, swivels, trunnions, and fasteners for undue looseness, wear, cracks, corrosion, and other damage. A special area to inspect is the base (lug or bail) to shank transition area for swaged sockets. Undue looseness in poured sockets is defined as looseness or evidence of slippage of wires in the securing material, evidence of deterioration of the securing material, looseness of wire rope strands or wires adjacent to the socket or any looseness resulting from cracks or other defects in the basket. Evidence of looseness between the securing material and the basket resulting solely from seating of the material in the basket is acceptable. Drum end fittings need only be disconnected or disassembled when experience or visible indications deem it necessary.

Note: Inspection of extend/retract cables internal to telescoping booms may be limited to inspection through boom inspection ports in lieu of OEM required boom disassembly, unless there is evidence of deterioration or damage requiring disassembly of boom for complete inspection or replacement. For cranes without inspection ports, this Note may be utilized if the extend/retract cables, sheaves, and cable end connections can be visually inspected from either end of the boom. Additionally, perform measurement/adjustment to extend/retract cable tension/slack in accordance with OEM instructions.

Army

EM 385-1

Was not applicable as the intent of this standard was the use of mobile cranes not OHC.

Air Force

Air Force Space Command Manual 91-710, Volume 3, 2019

Range Safety User Requirements Manual—Volume 3 Launch Vehicles, Payloads, and Ground Support Systems Requirements

6.3.2.1.5. Cranes and hoists shall be inspected and tested, at a minimum, IAW the requirements specified by OSHA, ASME, AFMAN 91-203, and/or per manufacturer’s recommendations.

Air Force Space Command Manual 91-710, Volume 6, 2019

Range Safety User Requirements Manual—Volume 6 Ground and Launce Personal Equipment, Systems, and Material Operation Safety Requirements

6.3.3.4.4. Wire rope shall be inspected at least monthly using a go/no-go gauge at numerous random locations to assess reduction in diameter along the entire length of rope. Any broken wire or other observed defects shall be reported for further evaluation.

Air Force Occupational Safety, Fire, and Health Standards, 91-203, 2019

12.1.5.1. Frequent. A visual/prior to use inspection will be performed by the operator or designated person daily or prior to use. **(T-0)** A daily inspection is only required if specified by a TO, manufacturer’s instructions or other governing directive. Otherwise, a prior to use inspection will be required prior to the first use of the day for any MHE, unless MAJCOM or installation has more stringent directives. **(T-1)** The inspection shall be documented on an AFTO Form 244 or MAJCOM or locally devised paper or automated systems IAW paragraph **12.1.1,** annotating the date, time, initials of the person performing the inspection and any discrepancies noted during the inspection. **(T-1)** The record of inspection shall be maintained by the using Agency until the next periodic inspection has been performed. **(T-1).**

12.1.5.3. Mandatory Monthly Inspections. Wire ropes, chains, and hooks associated with overhead and gantry cranes shall be thoroughly inspected monthly. **(T-0)** Inspections for each item shall be documented (separate documentation) on the AFTO Form 95 or MAJCOM or locally devised paper or automated system IAW paragraph **12.1.1** and maintained on file for one year. **(T-1)** Documentation will include date and time of the monthly inspection, signature of the inspector, an identifier for the equipment inspected and condition of the equipment. **(T-0)** Inspection criteria will be IAW applicable paragraphs from this chapter and applicable manufacturer instructions, as required. **(T-1)**

12.11.1. Wire ropes, chains, and hooks associated with overhead and gantry cranes shall be thoroughly inspected monthly. **(T-0)** Wire ropes, chains, hooks and related hoisting equipment shall be inspected prior to initial use and when repaired IAW applicable paragraphs of this chapter. **(T-0)** Inspections for each item shall be documented on the AFTO Form 95, or other appropriate inspection and maintenance form or automated system and maintained on file for one year. **(T-1)** Refer to paragraph **12.1.1** Documentation will include the date of the monthly inspection, signature of the inspector, an identifier for the equipment inspected, and condition of the equipment. **(T-0)**

Note: A frequent inspection may also be used to document the thorough monthly inspection of hooks, chains, and wire ropes associated with overhead and gantry cranes, provided it includes applicable requirements above and from paragraphs **12.11.2**, **12.11.3** and **12.11.5**

12.11.2.2. Inspections.

12.11.2.2.1. Frequent Inspections. All running ropes in service shall be visually inspected daily or prior to use. **(T-0)** The inspection shall be documented on AFTO Form 244 or MAJCOM or locally devised paper or automated systems, which includes date of inspection, signature of inspector, an identifier for ropes inspected and rope condition. **(T-0)** Inspection shall be kept on file by the supervisor for a minimum of one year and made readily available. **(T-1)** Sections of rope normally hidden or difficult to see during inspection or maintenance procedures, such as parts passing over equalizer sheaves, shall be given close inspection, as these are points most likely to fail. **(T-0)** Any degradation in conditions described below could result in loss of original strength, shall be carefully noted and shall be considered for rejection: **(T-0)**

12.11.2.2.1.1. Reduction of rope diameter below nominal diameter due to loss of core support, internal or external corrosion or wear of outside wires. **(T-0)** Rope calipers and micrometers are normally used to determine changes in wire rope diameters. **(T-0)**

12.11.2.2.1.2. Broken outside wires and the degree of distribution or connection of such broken wires. **(T-0)**

12.11.2.2.1.3. Worn outside wires. **(T-0)**

12.11.2.2.1.4. Corroded or broken wires at end connections. **(T-0)**

12.11.2.2.1.5. Corroded, cracked, bent, worn or improperly applied end connections. **(T-0)**

12.11.2.2.1.6. Severe kinking, crushing, cutting or un-stranding. **(T-0)**

12.11.2.4.3. A rope which has been in service, but idle for one month or more, shall be thoroughly examined before being put back into service. **(T-0)** This examination shall be for all types of deterioration, particularly corrosion, and shall be performed by a designated person, whose approval shall be required for further use of the rope. **(T-0)** The inspection shall be documented on an AFTO Form 95 or MAJCOM or locally devised paper or automated systems, which includes date of inspection, signature of inspector, an identifier for ropes inspected and rope condition. **(T-0)** The inspection shall be kept on file by the user for a minimum of one year and made readily available. **(T-1)**

**T-0 Determined** by respective non-AF authority (e.g. Congress, White House, OSD, JS)

**T-1** Non-compliance puts Airmen, commanders, or the U.S. Air Force strongly at risk of mission or program failure, death, injury, legal jeopardy or fraud, waste, or abuse.

**T-2** Non-compliance may degrade mission or program effectiveness or efficiency and has potential to create moderate risk of mission or program failure, injury, legal jeopardy or fraud, waste, or abuse.

**T-3** Non-compliance may limit mission or program effectiveness or efficiency and has a relatively remote potential to create risk of mission or program failure, injury, legal jeopardy or fraud, waste, or abuse.

Department of Energy

DOE-STD-1090-2011, DOE Hoisting and Rigging

6.1 Operation, inspection, maintenance, and testing of overhead and gantry cranes shall comply with ASME B30.2, Overhead and Gantry Cranes (Top-Running Bridge, Single or Multiple Girder, Top-Running Trolley Hoist); ASME B30.11, Monorail Systems and Underhung Cranes; and ASME B30.17, Overhead and Gantry Cranes (Top-Running Bridge, Single Girder, Underhung Hoist, in addition to applicable OSHA standards. Only equipment built to the appropriate design standards shall be used in DOE installations. The following additions and exceptions to the above cited standards shall also be implemented.

DOE-STD-1090-2007, DOE Hoisting and Rigging

7.2.3.2 A qualified inspector shall inspect all ropes at least annually. This inspection shall include examination of the entire length of the rope, without detaching it from the hoist drum. More frequent intervals shall be determined by a qualified person, and shall be based on such factors as expected rope life as determined by experience on the

particular installation or similar installations, severity of environment, percentage of capacity lifts, frequency rates of operation, and exposure to shock loads. The qualified inspector shall carefully note any deterioration such as described below resulting in appreciable loss of original strength and determine whether further use of the rope constitutes an acceptable risk.

Reduction of rope size below nominal diameter, whether due to loss of core support, internal or external corrosion, or wear of outside wires (see Table 7-1).

The number and distribution or concentration of broken outside wires.

Worn outside wires.

Sections of rope that are normally hidden during inspection or maintenance procedures, such as parts passing over sheaves (these are points most subject to deterioration).

Corroded or broken wires at end connections.

6. Corroded, cracked, bent worn, or improperly applied end connections.

7. Kinking, crushing, cutting, or un-stranding.

b. All rope on cranes that have been idle for one month or more due to shut down or storage shall be inspected before the crane is returned to service. A dated and signed report of the rope inspection, including results, shall be filed.

c. No precise rules can be given for determining the exact time to replace rope because many variables are involved.

Safety in this respect depends largely on the use of good judgment by an appointed person in evaluating remaining strength in a used rope, after allowance for deterioration disclosed by inspection. Safety of rope operation depends on this remaining strength.

**ISO**

ISO 4309, Cranes—Wire ropes—Care and Maintenance, Inspection, and Discard, 2017

Daily Visual Inspections

At least the intended working section of rope for that particular day shall be observed with the objective of detecting any general deterioration or mechanical damage. This shall include the points of attachment of the rope to the crane (see Figure A.2).

The rope shall also be checked to ensure that it is sitting correctly on the drum and over the sheave(s) and has not been displaced from its normal operating position.

Any appreciable change in condition shall be reported and the rope examined by a competent person in accordance with 5.3.

If, at any time, the rigging arrangement is modified, such as when the crane has been moved to a new site and re-rigged, the rope shall be subjected to a visual inspection as described in this subclause.

Periodic Inspections—Frequency

The frequency of the periodic inspection shall be determined by the competent person, who shall take account of at least the following:

1. The statutory requirements covering the application in the country of use.
2. The type of crane and the environmental conditions in which it operates.
3. The classification group of the mechanism.
4. The results of previous inspection(s).
5. Experience gained from inspecting ropes on comparable cranes.
6. The length of time the rope has been in service.
7. The frequency of use.
8. The crane manufacturer’s recommendations.

Extent of Inspection

Each rope shall be inspected along its entire length. However, in the case of a long length, and at the discretion of the competent person, only the working length plus at least five wraps on the drum may be inspected. In such a case, and where a greater working length is subsequently foreseen after the previous inspection and prior to the next one, that additional length should also be inspected before the additional length of rope is used.

Particular care shall nevertheless be taken at the following critical areas and locations:

* Drum anchorage
* Any section at, and in the vicinity of, a rope termination
* Any section that travels through one or more sheaves
* Any section that travels through a safe load indicator, which incorporates Sheaves
* Any section that travels through the hook block
* In the case of cranes performing a repetitive operation, any part of the rope that lies over a sheave while the crane is in a loaded condition
* That part of the rope which lies over a compensating sheave
* Any section that travels through a spooling device
* Those sections that spool on the drum, particularly crossover zones that are associated with multi- layer spooling
* Any section that is subjected to abrasion by external features (e.g. hatch combings)
* Any part of rope that is exposed to heat

Note: For areas requiring particularly close inspection, see Annex A.

If the competent person judges it necessary to open up the rope to establish if there is any detrimental internal deterioration, this should be done with extreme care to avoid damaging the rope (see Annex D). In this regard, an MRT can provide an additional source of useful information (see 5.6).

ISO 9927-1, Crane Inspections, 2013, Part 1, General

Daily Inspection

Before the commencement of each work shift, the crane shall be given a visual inspection and functional test to find any evidence of deficiencies.

Such inspections may be carried out by the operator. The functional tests should be made without load, where appropriate from the control station.

Frequent Inspection

Frequent Inspections are service inspections and shall be carried out with the manufacturer’s routine servicing, at no more than three-monthly intervals, unless the crane is not in service. The frequency shall be based upon the frequency and severity of use of the crane while in service and the working environment.

It shall not be inferred that dismantling of any part is necessary during this inspection, but opening of covers (for example, limit switch covers), required for service and inspection purposes, shall be included.

The inspection procedure shall include verification that the current logbook and operator's manual(s) are available on the crane and that this documentation is up to date.

The inspection shall include all items specified in instructions written in accordance with this international standard for frequent inspections.

A written report shall be furnished on completion of the inspection.

A competent person may recommend that frequent inspections be carried out more often.

**American Petroleum Institute (API)**

API 2D Operation and Maintenance of Offshore Crane, 2015

5.1.2.2 Infrequent Usage Production Duty Cycle

Infrequent usage applies to those cranes that are used for 10 hours or less per month, based on the averaged use over a quarter. These cranes shall be subject to a pre-use inspection and an annual inspection. However, if the crane sits idle for three months or more the crane shall be subject to a monthly inspection and a full function operation check. Crane usage should be reviewed on a periodic basis by the crane owner to ensure proper inspection intervals.

Note: Special attention should be given to wire rope on these cranes during pre-use inspections.

5.1.2.3 Moderate Usage Intermittent Duty Cycle

Moderate usage applies to those cranes that are used for more than 10 hours/month, but less than 50 hours/month based on the averaged use over a quarter. These cranes shall be subject to pre-use, quarterly, and annual inspections. Crane usage should be reviewed on a periodic basis by the crane owner to ensure proper inspection intervals.

5.1.2.4 Heavy Usage

Heavy usage applies to those cranes that are used for 50 hours or more per month based on an average use over a quarter. These cranes shall be subject to pre-use, monthly, quarterly, and annual inspections. Cranes assigned this category usage need not be reviewed to determine the number of hours used each month, unless otherwise specified by the crane owner.

5.1.3.4 Monthly Inspection

The monthly inspection shall be performed once per month, for all cranes assigned a heavy usage category.

A qualified crane operator shall perform this inspection. A qualified inspector may also perform these inspections.

5.1.3.5 Quarterly Inspection

The quarterly inspection shall be performed once every three months for all cranes assigned a moderate or heavy usage category. A qualified inspector shall perform this inspection.



Figure 7. Title X

6.2 Wire Rope

6.2.1 Introduction

Wire rope is a structural component of the crane requiring periodic replacement. A loss of strength can result from wear, abuse, and other forms of deterioration. The wire rope shall be carefully selected, inspected and maintained in accordance with Annex F. Initial wire rope dimensional measurements should be collected and documented in the cranes file at the time of installation and should be referred to during subsequent WRIs. Rotation-resistant wire rope has special characteristics that require additional precautions.

6.2.2 Inspection

6.2.2.1 The crane owner’s WRI program should be established taking into consideration crane type, Facility type, frequency of usage, history of maintenance, wire rope manufacturers’ recommendations, and the crane manufacturer’s recommendations.

6.2.2.2 Visual inspections of wire rope should be performed by a Qualified Crane Operator during pre-use and monthly inspections. Additional WRI (see F.2) should be performed by Qualified Inspectors during quarterly and annual inspections, as the results of pre-use and monthly inspections warrant.

6.2.2.3 Inspection tools to determine the condition of the wire rope should include, but not be limited to, the following:

* Steel tape measure
* Sheave groove gauges for worn sheaves used in accordance with API 9B
* Quality calipers and/or micrometers accurate to at least 0.001 in. (0.025 mm) accuracy
* Chalk

6.2.2.4 During quarterly and annual inspections, or when ropes are changed on a crane, a number of areas affecting performance and rope life should be checked and corrective action taken as appropriate (see F.2 and F.3).

Wire Rope Technical Review Board

Access for Inspection

There are two types of inspections, and access requirements are different for each. Daily, work shift, or frequent inspections may not require examining the entire length of a rope. These inspections are visual observations and are concerned with discovering gross damage and potential problems. Periodic inspections, where permanent records are normally mandated by OSHA, ASME, and other regulatory Agencies, require more stringent attention to specific details through the entire length of the rope—including diameter, lay measurement, bro­ken wire counts, evidence of rope core failure, abuse, and wear.

Wear occurs throughout the length of any wire rope, especially running wire ropes that move on and off drums and sheaves. Even supporting or standing ropes undergo stress and vibration throughout the length. Both running and standing ropes require proper inspection, each with specific requirements.

The rope must be seen up close, which requires adequate light and good vision; this may include the use of artificial lighting and magnification. The inspector must also be able to physically touch or perform a hands-on examination of the rope. In most applications, a thorough inspection is made when the rope is relaxed or under minimal tension. However, NDT may be used where the rope cannot be relaxed.

The total rope system must be inspected, since the movement and condition of drums, sheaves, fairleads, equalizer sheaves, and other components have a direct bearing on wear and ability of a rope to perform properly.

End attachments are critical points of stress because these are where the load is transferred to other components as tension is applied and released in the rope. The first wire breaks may occur at an end termination.

Rope degradation may not always be readily visible. Broken wires, wear, and corrosion may be hidden by lubricant, dirt, or other foreign material on the rope. Sections of rope must be wiped clean with a cloth or wire brushed to count broken wires or to view wear or corrosion.

Normal wear and degradation are expected to occur in areas where the rope bends frequently, spools on a drum, at equalizer sheaves, or at end terminations. These areas endure greater stress and should be checked completely and frequently.

Another area of concern is core integrity. There are specific indicators of interior rope damage such as loss of rope diameter, evidence of valley breaks or breaks against the core that result in high or protruding wires, and rust or corrosion products in the rope valleys. Core integrity can only be verified by prying open the rope with awls or picks. However, this is usually a last resort to substantiate a decision to condemn and remove a rope from service and should only be done by a qualified person. as the inspection may damage the rope and make it unusable.

Appendix F. Center Responses

Armstrong Flight Research Center

1. How many overhead cranes (OHC) does your Center have? 11
	1. How old is your oldest OHC? 20
	2. What is the range of SWL for your OH Cranes? ½ to 35 ton
	3. Do you allow non-NASA organizations to use NASA owned equipment, such as tenant or leased spaces? Yes, but only with a contract or MOU
2. What is the height range of your OHC, how high is the hoist/bridge? 12 to 85 feet
	1. How is the access to the hoists to your cranes, ladder, steps/stairway, aerial lift? Sick bay (walk up too), ladder, catwalk, lift
	2. When inspecting the hoist, does the inspector have to wear Fall Protection equipment? When required
3. What is the typical load weight used by your OHC? (does not include load/proof testing) This can be given in percentage, such as less than 50% or mostly below 50% but occasionally close to >75% <25%, rarely above 50%
	1. What is the average height lifted by your OHC? Are they low to the ground, or is there a need to lift more than 10 feet regularly? <10 feet
4. How often is your busiest crane used, daily, weekly, monthly? Busiest crane may see 2 lifts per day during project work but typically sees 2-3 times a week. Monthly
5. What is your typical CMAA design Category, A-F? D – Heavy Service
	1. How many sheaves is your biggest block and what is your typical number of sheaves? 4
	2. What type of wire rope are on your Cranes? Stainless Steel, Coated, Galvanized, etc. and IWRC (rotational?) IWRC
6. Other than indoor or outdoor, is there any type of environments your Cranes are exposed to, such as clean room, caustic, sea air, etc. Clean Room
	1. Do you lift any special hazardous items, fueled tanks, haz mats, etc. Not typically
	2. If a critical crane has not been used for a few months, do you perform any special inspections? Monthly is always done
7. Who does you crane inspections, frequent and periodic, and what are their qualifications (typical)? Are your inspections done in house or out of house (freq and per.) Third party
8. Do you know the typical time it takes to perform a frequent inspection? This would include the hand-over-hand inspection. 2-4 hours on average
9. Who owns your cranes, the Center, projects, or individual organizations? For example, facilities or engineering, etc. Branches with different organizations
10. Are your crane operators trained in house or out of house? Who performs this training? How long is the training to operate a crane? In-house, 1 day
11. Is there anything special about your inspection program that could assist others in reducing costs? Such as crane operators performing frequent and WRIs. No

Ames Research Center

1. How many overhead cranes (OHC) does your Center have? 119
	1. How old is your oldest OHC? TBD
	2. What is the range of SWL for your OH Cranes? 150 lbs. (Jib) to 75 ton
	3. Do you allow non-NASA organizations to use NASA owned equipment, such as tenant or leased spaces? No
2. What is the height range of your OHC, how high is the hoist/bridge? About 100 feet
	1. How is the access to the hoists to your cranes, ladder, steps/stairway, aerial lift? Ladder, stairs, lift
	2. When inspecting the hoist, does the inspector have to wear Fall Protection equipment? Occasionally
3. What is the typical load weight used by your OHC? (does not include load/proof testing) This can be given in percentage, such as less than 50% or mostly below 50% but occasionally close to >75% <25%, rarely above 50% (not sure, still learning Center operations.)
	1. What is the average height lifted by your OHC? Are they low to the ground, or is there a need to lift more than 10 feet regularly? Usually <10 feet, however, some lifts are between floors.
4. How often is your busiest crane used, daily, weekly, monthly? Busiest crane may see 2 lifts per day during project work but typically sees 2-3 times a week. 2 lifts/day (fabrication)
5. What is your typical CMAA design Category, A-F?
	* + 1. Not sure, will contact our engineering department when the Center reopens. Most likely “D – Heavy Service (10-20 lifts per hour, avg 65% SWL)”
	1. How many sheaves is your biggest block and what is your typical number of sheaves? 4? (Site is currently closed.)
	2. What type of wire rope are on your Cranes? Stainless Steel, Coated, Galvanized, etc. and IWRC (rotational?) IWRC
6. Other than indoor or outdoor, is there any type of environments your Cranes are exposed to, such as clean room, caustic, sea air, etc. Plating Shops, Clean Room, Sea Air
	1. Do you lift any special hazardous items, fueled tanks, haz mats, etc. Not typically
	2. If a critical crane has not been used for a few months, do you perform any special inspections? Monthly
7. Who does you crane inspections, frequent and periodic, and what are their qualifications (typical)? Are your inspections done in house or out of house (freq and per.) Maintenance department manages our contract with Konecranes
8. Do you know the typical time it takes to perform a frequent inspection? This would include the hand-over-hand inspection. 1-4 hours on average?
9. Who owns your cranes, the Center, projects, or individual organizations? For example, facilities or engineering, etc. Branches with different organizations
10. Are your crane operators trained in house or out of house? Who performs this training? How long is the training to operate a crane? In-house, contractor from the Ames Health and Safety Office, 1.5 days
11. Is there anything special about your inspection program that could assist others in reducing costs? Such as crane operators performing frequent and WRIs. Not sure.

Glenn Research Center

1. How many overhead cranes (OHC) does your Center have? See attached excel spreadsheet
	1. How old is your oldest OHC? 1940’s -1950 Estimated about 80 years
	2. What is the range of SWL for your OH Cranes? See attached excel spreadsheet
	3. Do you allow non-NASA organizations to use NASA owned equipment, such as tenant or leased spaces? Yes, under Government furnished equipment for contracts. This is seldom done
2. What is the height range of your OHC, how high is the hoist/bridge? 15’-70’
	1. How is the access to the hoists to your cranes, ladder, steps/stairway, aerial lift? Varies but mostly aerial lift.
	2. When inspecting the hoist, does the inspector have to wear Fall Protection equipment? Most of the time
3. What is the typical load weight used by your OHC? (does not include load/proof testing) This can be given in percentage, such as less than 50% or mostly below 50% but occasionally close to >75% See attached excel spreadsheet
	1. What is the average height lifted by your OHC? Are they low to the ground, or is there a need to lift more than 10 feet regularly? Mostly low to ground
4. How often is your busiest crane used, daily, weekly, monthly? Busiest crane may see 2 lifts per day during project work but typically sees 2-3 times a week
5. What is your typical CMAA design Category, A-F? I would say all of our cranes were designed to Class C, however, they are used more in line with Class A or B.
	* + 1. A – Standby, Infrequent Service
			2. B – Light Service, (occasional full capacity lift, 2-3 lifts per hour)
			3. C – Moderate Service, (avg 50% of SWL, 5-10 lifts per hour)
			4. D – Heavy Service (10-20 lifts per hour, avg 65% SWL)
			5. E- Severe Service (at SWL, >20 lifts per hour)
			6. F- Continuous Service (self expl.)
	1. How many sheaves is your biggest block and what is your typical number of sheaves?
		1. 60 Ton Block with 6 or more sheaves
	2. What type of wire rope are on your Cranes? Stainless Steel, Coated, Galvanized, etc. and IWRC (rotational?) Mostly EIPS with IWRC
6. Other than indoor or outdoor, is there any type of environments your Cranes are exposed to, such as clean room, caustic, sea air, etc. Some are clean room, but most are air condition environment
	1. Do you lift any special hazardous items, fueled tanks, haz mats, etc. Bldgs. 49,105,301 & 333 use a bottle sling or cage to lift K-bottle cylinders (i.e. nitrogen, helium, etc.) Seldom to none
	2. If a critical crane has not been used for a few months, do you perform any special inspections? No
7. Who does you crane inspections, frequent and periodic, and what are their qualifications (typical)? TFOME Crane Dept. (contractor). Are your inspections done in house or out of house (freq and per.) All Inspections are done in house by the TFOME Crane Dept.
8. Do you know the typical time it takes to perform a frequent inspection? This would include the hand-over-hand inspection. 1-4 hours on average. Bigger Cranes may take up to 8 hours.
9. Who owns your cranes, the Center, projects, or individual organizations? For example, facilities or engineering, etc. NASA Facilities
10. Are your crane operators trained in house or out of house? In-House. Who performs this training? TFOME Training Specialists. How long is the training to operate a crane? 1.5 Days, every 4 years.
11. Is there anything special about your inspection program that could assist others in reducing costs? Such as crane operators performing frequent and WRIs. You will find attached a word document explaining our inspection process and the justification we used to develop the process.

Goddard Space Flight Center

1. How many overhead cranes (OHC) does your Center have? 125
	1. How old is your oldest OHC? 30
	2. What is the range of SWL for your OH Cranes? Capacity Range from 500 lbs. to 70,000 lbs.
	3. Do you allow non-NASA organizations to use NASA owned equipment, such as tenant or leased spaces? No
2. What is the height range of your OHC, how high is the hoist/bridge? Between 10’-85’
	1. How is the access to the hoists to your cranes, ladder, steps/stairway, aerial lift? All
	2. When inspecting the hoist, does the inspector have to wear Fall Protection equipment? Yes
3. What is the typical load weight used by your OHC? (does not include load/proof testing) This can be given in percentage, such as less than 50% or mostly below 50% but occasionally close to >75% Mostly below 50%
	1. What is the average height lifted by your OHC? Are they low to the ground, or is there a need to lift more than 10 feet regularly? Mostly low to the ground and below 10’
4. How often is your busiest crane used, daily, weekly, monthly? Busiest crane may see 2 lifts per day during project work but typically sees 2-3 times a week Only one or two cranes (busiest) may see multiple lifts daily.
5. What is your typical CMAA design Category, A-F? C and D’s.
	* + 1. A – Standby, Infrequent Service
			2. B – Light Service, (occasional full capacity lift, 2-3 lifts per hour)
			3. C – Moderate Service, (avg 50% of SWL, 5-10 lifts per hour)
			4. D – Heavy Service (10-20 lifts per hour, avg 65% SWL)
			5. E- Severe Service (at SWL, >20 lifts per hour)
			6. F- Continuous Service (self expl.)
	1. How many sheaves is your biggest block and what is your typical number of sheaves? 4
	2. What type of wire rope are on your Cranes? Stainless Steel, Coated, Galvanized, etc. and IWRC (rotational?) Standard OEM replacement depending on crane model
6. Other than indoor or outdoor, is there any type of environments your Cranes are exposed to, such as clean room, caustic, sea air, etc. Clean rooms and labs
	1. Do you lift any special hazardous items, fueled tanks, haz mats, etc.
	2. If a critical crane has not been used for a few months, do you perform any special inspections? Critical cranes are inspected monthly
7. Who does you crane inspections, frequent and periodic, and what are their qualifications (typical)? Are your inspections done in house or out of house (freq and per.) In-house, were certified at one time
8. Do you know the typical time it takes to perform a frequent inspection? This would include the hand-over-hand inspection. ½ to 1 hour
9. Who owns your cranes, the Center, projects, or individual organizations? For example, facilities or engineering, etc. Individual organizations
10. Are your crane operators trained in house or out of house? Who performs this training? How long is the training to operate a crane? In house by classes taught by contractor
11. Is there anything special about your inspection program that could assist others in reducing costs? Such as crane operators performing frequent and WRIs. None in particular

Jet Propulsion Laboratory

1. How many overhead cranes (OHC) does your Center have? 54
	1. How old is your oldest OHC?
	2. What is the range of SWL for your OH Cranes? Capacity ranges from 500 lbs. to 30,000 lbs.
	3. Do you allow non-NASA organizations to use NASA owned equipment, such as tenant or leased spaces? Not typically, but sometimes subcontractors or partners may operate LDE to integrate their assemblies under JPL’s supervison
2. What is the height range of your OHC, how high is the hoist/bridge? Between 10’-55’
	1. How is the access to the hoists to your cranes, ladder, steps/stairway, aerial lift? All
	2. When inspecting the hoist, does the inspector have to wear Fall Protection equipment? Yes
3. What is the typical load weight used by your OHC? (does not include load/proof testing) This can be given in percentage, such as less than 50% or mostly below 50% but occasionally close to >75% Mostly below 50%
	1. What is the average height lifted by your OHC? Are they low to the ground, or is there a need to lift more than 10 feet regularly? Mostly low to the ground and below 10’
4. How often is your busiest crane used, daily, weekly, monthly? Busiest crane may see 2 lifts per day during project work but typically sees 2-3 times a week Only one or two cranes (busiest) may see multiple lifts daily.
5. What is your typical CMAA design Category, A-F? Between A & B with occasional Cs.
	* + 1. A – Standby, Infrequent Service
			2. B – Light Service, (occasional full capacity lift, 2-3 lifts per hour)
			3. C – Moderate Service, (avg 50% of SWL, 5-10 lifts per hour)
			4. D – Heavy Service (10-20 lifts per hour, avg 65% SWL)
			5. E- Severe Service (at SWL, >20 lifts per hour)
			6. F- Continuous Service (self expl.)
	1. How many sheaves is your biggest block and what is your typical number of sheaves?
	2. What type of wire rope are on your Cranes? Stainless Steel, Coated, Galvanized, etc. and IWRC (rotational?) Standard OEM replacement depending on crane model
6. Other than indoor or outdoor, is there any type of environments your Cranes are exposed to, such as clean room, caustic, sea air, etc. Clean rooms and labs
	1. Do you lift any special hazardous items, fueled tanks, haz mats, etc.
	2. If a critical crane has not been used for a few months, do you perform any special inspections? Critical cranes are inspected monthly by Konecranes regardless of use
7. Who does you crane inspections, frequent and periodic, and what are their qualifications (typical)? Are your inspections done in house or out of house (freq and per.) Konecrane does all OHC inspections (frequent and periodic)
8. Do you know the typical time it takes to perform a frequent inspection? This would include the hand-over-hand inspection.
9. Who owns your cranes, the Center, projects, or individual organizations? For example, facilities or engineering, etc.
10. Are your crane operators trained in house or out of house? Who performs this training? How long is the training to operate a crane? In house by classes taught by Quality Assurance Training Center, Technician Leads, and crane custodians familiar with each crane
11. Is there anything special about your inspection program that could assist others in reducing costs? Such as crane operators performing frequent and WRIs. None in particular

Johnson Space Center

Kennedy Space Center

1. How many overhead cranes (OHC) does your Center have?
	* 1. 38 assets that are specifically bridge cranes.
	1. How old is your oldest OHC?
		1. Oldest crane is the VAB 2x250 ton cranes and the 175-ton crane. For the 250 cranes: Operational in August 1965.
	2. What is the range of SWL for your OH Cranes?

Range from ½ ton to 325 tons.

* 1. Do you allow non-NASA organizations to use NASA owned equipment, such as tenant or leased spaces?

No.

1. What is the height range of your OHC, how high is the hoist/bridge?
	* 1. Range is ~6-12 FT to ~465 FT (max hook heights)
	1. How is the access to the hoists to your cranes, ladder, steps/stairway, aerial lift?
		1. Access can vary, includes elevators, ladders, stairways, scissor lifts/JLGs.
	2. When inspecting the hoist, does the inspector have to wear Fall Protection equipment?
		1. Some cranes require using Fall Protection while up on the bridge/trolley. Some others do not.
2. What is the typical load weight used by your OHC? (does not include load/proof testing) This can be given in percentage, such as less than 50% or mostly below 50% but occasionally close to >75%
	* 1. This varies from crane to crane, but the majority are normally less than 50% with flight processing cranes (such as the VAB 325 ton and RPSF 200 ton) mostly below 50% but occasionally >75% (for example heaviest booster segment + lifting beam is approx. 193 tons)
	1. What is the average height lifted by your OHC? Are they low to the ground, or is there a need to lift more than 10 feet regularly?
		1. For a majority of the cranes, they don’t need to lift very high. Loads are lifted 3-10 FT. However, the 250- and 325-ton cranes need to lift items at least over the 16th floor (~200 FT) to move into and out of the high bays.
3. How often is your busiest crane used, daily, weekly, monthly? Busiest crane may see 2 lifts per day during project work but typically sees 2-3 times a week
	* 1. Busiest cranes are probably the ones at the Launch Equipment Shop (2 bridge cranes), used multiple times daily. However, these are the odd ones out and most cranes are only used regularly for processing flow/limited projects.
4. What is your typical CMAA design Category, A-F?
	* + 1. A – Standby, Infrequent Service
			2. B – Light Service, (occasional full capacity lift, 2-3 lifts per hour)
			3. C – Moderate Service, (avg 50% of SWL, 5-10 lifts per hour)
			4. D – Heavy Service (10-20 lifts per hour, avg 65% SWL)
			5. E- Severe Service (at SWL, >20 lifts per hour)
			6. F- Continuous Service (self expl.)
		1. Most of our larger cranes are Class D.  We do have some Class C cranes as well.
	1. How many sheaves is your biggest block and what is your typical number of sheaves?
		1. The 325-ton cranes have 16 parts of line therefore 8 sheaves each in the upper and lower sheave nests.  The 250-ton cranes have 28 parts of line therefore having 14 sheaves in each sheave nest. Smaller capacity cranes are typically 2 or 4 sheaves.
	2. What type of wire rope are on your Cranes? Stainless Steel, Coated, Galvanized, etc. and IWRC (rotational?)
		1. Our cranes use IWRC normally 6x19 or 6x36 rope. Majority are bright steel, but some applications use stainless steel or galvanized.
5. Other than indoor or outdoor, is there any type of environments your Cranes are exposed to, such as clean room, caustic, sea air, etc.
	* 1. Most KSC Industrial Area cranes are in clean rooms.
	1. Do you lift any special hazardous items, fueled tanks, haz mats, etc.
		1. Some flight hardware lifts include fueled spacecraft and solid propellant booster segments.
	2. If a critical crane has not been used for a few months, do you perform any special inspections?
		1. If crane is operational, regular maintenance is performed whether or not the crane is used within that time for operations.
6. Who does you crane inspections, frequent and periodic, and what are their qualifications (typical)? Are your inspections done in house or out of house (freq and per.)
	* 1. Crane inspections/maintenance are performed in house by our certified crane technicians.
7. Do you know the typical time it takes to perform a frequent inspection? This would include the hand-over-hand inspection.
	* 1. Depends on the size of the crane. Monthly inspections take 1-2 hours for smaller cranes up to a full day for the larger ones. Annual takes between 4 hours for smaller cranes up to 2 weeks for larger ones.
8. Who owns your cranes, the Center, projects, or individual organizations? For example, facilities or engineering, etc.
	* 1. NASA owns our cranes.
9. Are your crane operators trained in house or out of house? Who performs this training? How long is the training to operate a crane?
	* 1. Operators/technicians are trained in house. It takes approximately 1 year for a technician to be certified.
10. Is there anything special about your inspection program that could assist others in reducing costs? Such as crane operators performing frequent and WRIs.
	* 1. Our operators are also maintenance techs

Langley Research Center

1. How many overhead cranes (OHC) does your Center have? 400
2. How old is your oldest OHC? 80
3. What is the range of SWL for your OH Cranes? ½ to 50 ton
4. Do you allow non-NASA organizations to use NASA owned equipment, such as tenant or leased spaces? Yes. We don’t have tenants or leased spaces. I do allow construction contractors to use the equipment as long as they: they show proof of training (NACB, CIA, etc.), provide proof of passing a physical, provide a letter on company letterhead appointing them as a crane operator for the company, and they demonstrate capability to a LaRC crane operator.
5. What is the height range of your OHC, how high is the hoist/bridge? 15 to 200 feet. Most in the 25-foot range.
	1. How is the access to the hoists to your cranes, ladder, steps/stairway, aerial lift? Ladder, stairs, lift
	2. When inspecting the hoist, does the inspector have to wear Fall Protection equipment? Occasionally.
6. What is the typical load weight used by your OHC? (does not include load/proof testing) This can be given in percentage, such as less than 50% or mostly below 50% but occasionally close to >75% <25%, rarely above 50%
	1. What is the average height lifted by your OHC? Are they low to the ground, or is there a need to lift more than 10 feet regularly? <10 Feet
7. How often is your busiest crane used, daily, weekly, monthly? Busiest crane may see 2 lifts per day during project work but typically sees 2-3 times a week.
8. What is your typical CMAA design Category, A-F?
	1. C – Moderate Service, (avg 50% of SWL, 5-10 lifts per hour)
	2. How many sheaves is your biggest block and what is your typical number of sheaves? 6 max, and 3 typically
	3. What type of wire rope are on your Cranes? Stainless Steel, Coated, Galvanized, etc. and IWRC (rotational?) IWRC
9. Other than indoor or outdoor, is there any type of environments your Cranes are exposed to, such as clean room, caustic, sea air, etc. Outdoors see sea air, but there is typically no surf/spray within 10 miles
	1. Do you lift any special hazardous items, fueled tanks, haz mats, etc. Not Typically
	2. If a critical crane has not been used for a few months, do you perform any special inspections? No, but we don’t have many critical lift cranes
10. Who does you crane inspections, frequent and periodic, and what are their qualifications (typical)? Are your inspections done in house or out of house (freq and per.) The monthly inspections are typically done by the operators, although there are a few facilities that contract out that work to the Safety Office support services contractor. Annual inspections are performed by the in-house Center maintenance contractor.
11. Do you know the typical time it takes to perform a frequent inspection? This would include the hand-over-hand inspection. 2-4 hours on average
12. Who owns your cranes, the Center, projects, or individual organizations? For example, facilities or engineering, etc. Center Operations Directorate “owns” the cranes, although the Directorates that are using the cranes are expected to fund any significant repairs or mods
13. Are your crane operators trained in house or out of house? Who performs this training? How long is the training to operate a crane? In-house by the SMAO support services contractor, with OJT by a Facility crane operator. Length of training varies by the skill of the operator. Classroom training take 3-4 hours with OJT frequently taking months.
14. Is there anything special about your inspection program that could assist others in reducing costs? Such as crane operators performing frequent and WRIs. Our crane operators perform the daily and monthly inspections, which means that the monthly inspection is frequently skipped if the equipment is not used that month.

Marshall Space Flight Center/Michoud Assembly Facility

1. How many overhead cranes (OHC) does your Center have?247-MSFC, 263-MAF
	1. How old is your oldest OHC? MSFC- I have 9 older than 1960 (No design records from ARMY, SHEPARD NILES CRANES), MAF-1942
	2. What is the range of SWL for your OH Cranes? 0.5Ton to 160Ton
	3. Do you allow non-NASA organizations to use NASA owned equipment, such as tenant or leased spaces? YES
2. What is the height range of your OHC, how high is the hoist/bridge? 10’-200’
	1. How is the access to the hoists to your cranes, ladder, steps/stairway, aerial lift? Aerial lift, steps/stairway
	2. When inspecting the hoist, does the inspector have to wear Fall Protection equipment? YES
3. What is the typical load weight used by your OHC? (does not include load/proof testing) This can be given in percentage, such as less than 50% or mostly below 50% but occasionally close to >75% {60%-less than 50%SWL, 20%-at 50%, 20% - 75% or greater} This is a best guess we do not document these type loads for non-critical lifts.
	1. What is the average height lifted by your OHC? Are they low to the ground, or is there a need to lift more than 10 feet regularly? LESS than 10’ regularly
4. How often is your busiest crane used, daily, weekly, monthly? Busiest crane may see 2 lifts per day during project work but typically sees 2-3 times a week…maybe 1 lift per day non project use.
5. What is your typical CMAA design Category, A-F?
	* + 1. A – Standby, Infrequent Service
			2. B – Light Service, (occasional full capacity lift, 2-3 lifts per hour)
			3. C – Moderate Service, (avg 50% of SWL, 5-10 lifts per hour)
			4. D – Heavy Service (10-20 lifts per hour, avg 65% SWL)
			5. E- Severe Service (at SWL, >20 lifts per hour)
			6. F- Continuous Service (self expl.)
	1. How many sheaves is your biggest block and what is your typical number of sheaves? N/A
	2. What type of wire rope are on your Cranes? Stainless Steel, Coated, Galvanized, etc. and IWRC (rotational?) ALL, LEFT and Right lays
6. Other than indoor or outdoor, is there any type of environments your Cranes are exposed to, such as clean room, caustic, sea air, etc. clean room for 10%, less than 2% are outdoors
	1. Do you lift any special hazardous items, fueled tanks, haz mats, etc. yes
	2. If a critical crane has not been used for a few months, do you perform any special inspections? Normal required inspections and Brake Checks before use
7. Who does you crane inspections, frequent and periodic, and what are their qualifications (typical)? Are your inspections done in house or out of house (freq and per.) FREQ-Inhouse (Certified by multi-organizations, union labor) PERIODIC-third party (same qualifications required as the in-house contractors)
8. Do you know the typical time it takes to perform a frequent inspection? This would include the hand-over-hand inspection.1-4hrs (2 inspectors)
9. Who owns your cranes, the Center, projects, or individual organizations? For example, facilities or engineering, etc. Facilities (c=Center Operations)
10. Are your crane operators trained in house or out of house? Who performs this training? How long is the training to operate a crane? Out of house, 2-3 day training with OJT required
11. Is there anything special about your inspection program that could assist others in reducing costs? Such as crane operators performing frequent and WRIs. I have a dedicated crew of 2 and up to 4 inspectors if needed who sole purpose is to perform frequent inspections on OH Cranes and hoist.

Stennis Space Center

1. How many overhead cranes (OHC) does your Center have?
	* + 1. Boom Crane - 1
			2. Bridge Crane - 38
			3. Gantry Crane - 2
			4. Jib Crane - 20
			5. Monorail Hoist - 31
			6. Total – 92
2. List of cranes with active PMs being performed.
	* + 1. Bridge Crane - 13
			2. Gantry Crane - 1
			3. Jib Crane - 6
			4. Monorail Hoist - 14
			5. Total – 31
	1. How old is your oldest OHC?
		1. Installation Date 9/25/66 L-63 Bridge Crane
	2. What is the range of SWL for your OH Cranes?
		1. 2,000 to 50,000 lbs.
	3. Do you allow non-NASA organizations to use NASA owned equipment, such as tenant or leased spaces?
		1. Yes
3. What is the height range of your OHC, how high is the hoist/bridge?
	1. Approximately 8’ to 140’
	2. How is the access to the hoists to your cranes, ladder, steps/stairway, aerial lift?
		1. Primarily aerial lifts are required, however, some of the cranes have access ladders or a platform.
	3. When inspecting the hoist, does the inspector have to wear Fall Protection equipment?
		1. Yes, some of the inspections require the use of Fall Protection Equipment.
4. What is the typical load weight used by your OHC? (does not include load/proof testing) This can be given in percentage, such as less than 50% or mostly below 50% but occasionally close to >75%.
	1. Mostly below 50% but occasionally close to >75%
	2. What is the average height lifted by your OHC? Are they low to the ground, or is there a need to lift more than 10 feet regularly?
		1. Most lifts are low to ground or high enough to place load on/off trucks.
5. How often is your busiest crane used, daily, weekly, monthly? Busiest crane may see 2 lifts per day during project work but typically sees 2-3 times a week
	* 1. Most cranes are used a few times per week, but often less than once a week.
6. What is your typical CMAA design Category, A-F?
	* + 1. A – Standby, Infrequent Service
			2. B – Light Service, (occasional full capacity lift, 2-3 lifts per hour)
			3. C – Moderate Service, (avg 50% of SWL, 5-10 lifts per hour)
			4. D – Heavy Service (10-20 lifts per hour, avg 65% SWL)
			5. E- Severe Service (at SWL, >20 lifts per hour)
			6. F- Continuous Service (self expl.)
	1. The majority of OHCs at SSC are design Category C – Moderate Service
7. How many sheaves is your biggest block and what is your typical number of sheaves?
	* 1. 8 sheaves. Typical amount is two.
	1. What type of wire rope are on your Cranes? Stainless Steel, Coated, Galvanized, etc. and IWRC (rotational?)
		1. IWRC
8. Other than indoor or outdoor, is there any type of environments your Cranes are exposed to, such as clean room, caustic, sea air, etc.
	1. None at this time for indoor cranes. There are two bridge cranes are located over chemical cleaning vats, however, the operations have been shut down.
	2. Do you lift any special hazardous items, fueled tanks, haz mats, etc.
		1. Negative.
	3. If a critical crane has not been used for a few months, do you perform any special inspections?
		1. If frequent inspections (monthly) have been performed, then only the normal operator inspections are performed prior to use. If no frequent inspections (monthly) have been performed, then frequent inspection and the normal operator inspections are performed prior to use.
9. Who does you crane inspections, frequent and periodic, and what are their qualifications (typical)? Are your inspections done in house or out of house (freq and per.)
	1. Frequent and periodic inspection are performed by in-house mechanics and electricians. The mechanics and electricians performing inspections receive training and certification conducted by third party crane certified trainers. Recertification training is conducted.
10. Do you know the typical time it takes to perform a frequent inspection? This would include the hand-over-hand inspection.
	1. Typical time to perform a frequent inspection is two hours.
	2. Visual inspection is performed but not hand-over-hand inspection. If a suspect area is observed, a more detailed inspection is performed.
11. Who owns your cranes, the Center, projects, or individual organizations? For example, facilities or engineering, etc.
	1. The Center (NASA SSC) owns the majority of the cranes and funds maintenance of the cranes. However, some of the cranes are the property of the individual organizations (Tenant Agencies) and they fund maintenance of the cranes.
12. Are your crane operators trained in house or out of house? Who performs this training? How long is the training to operate a crane?
	1. Operators are trained in house by the SACOM contractor (following a NACB training course). The training is approximately 8 hours for classroom and hands on.
13. Is there anything special about your inspection program that could assist others in reducing costs? Such as crane operators performing frequent and WRIs.
	1. Negative.

Wallops Flight Facility

1. How many overhead cranes (OHC) does your Center have? 88 active
	1. How old is your oldest OHC? Maybe 50 years but most 10-30 with some more recent upgrades (hoists, drives, power systems, etc.)
	2. What is the range of SWL for your OH Cranes? 500 to 140000 with the majority between 5000 and 20000
	3. Do you allow non-NASA organizations to use NASA owned equipment, such as tenant or leased spaces? Typically, not but only on certain cranes for certain projects
2. What is the height range of your OHC, how high is the hoist/bridge? 10 to 60 feet with most less than 30 feet
	1. How is the access to the hoists to your cranes, ladder, steps/stairway, aerial lift? Ladder or manlift – not all ladders are code compliant so not being used
	2. When inspecting the hoist, does the inspector have to wear Fall Protection equipment? Depends – if from scissor lift and not leaning out of basket then no, but if boom lift or leaning out of basket then yes. If accessing the bridge then it depends on the crane, but most require Fall Protection while on the bridge.
3. What is the typical load weight used by your OHC? (does not include load/proof testing) This can be given in percentage, such as less than 50% or mostly below 50% but occasionally close to >75%. Typically well less than 50%. Probably 75% would be about the max unless an unusual lift.
	1. What is the average height lifted by your OHC? Are they low to the ground, or is there a need to lift more than 10 feet regularly? Typically 10 feet or so to clear other equipment, rotate assemblies, etc. Most don’t have the height to lift much more than 10’ with slings and rigging gear.
4. How often is your busiest crane used, daily, weekly, monthly? Busiest crane may see 2 lifts per day during project work but typically sees 2-3 times a week Daily but that is just for a handful of cranes - most are used weekly or a few times per week and some are monthly or even less.
5. What is your typical CMAA design Category, A-F? This is not recorded for all our cranes, but most are probably Cat B and some are C or maybe D but only because they were procured that way and not because they are needed that way.
	* + 1. A – Standby, Infrequent Service
			2. B – Light Service, (occasional full capacity lift, 2-3 lifts per hour)
			3. C – Moderate Service, (avg 50% of SWL, 5-10 lifts per hour)
			4. D – Heavy Service (10-20 lifts per hour, avg 65% SWL)
			5. E- Severe Service (at SWL, >20 lifts per hour)
			6. F- Continuous Service (self expl.)
	1. How many sheaves is your biggest block and what is your typical number of sheaves? One 8 sheave, one 6 sheave, six 4 sheave, and the remainder two or single sheave.
	2. What type of wire rope are on your Cranes? Stainless Steel, Coated, Galvanized, etc. and IWRC (rotational?) Most is lubricated steel rope though some mainly for clean rooms or clean areas are non-lubricated stainless steel. Nearly all are IWRC Right Reg Lay. A few are rotation resistant rope.
6. Other than indoor or outdoor, is there any type of environments your Cranes are exposed to, such as clean room, caustic, sea air, etc. Most environments are benign, but we do have indoor cranes located in buildings 100 feet from the ocean that can get higher levels of sea air. We do have some clean room cranes. No other caustic/acidic areas.
	1. Do you lift any special hazardous items, fueled tanks, haz mats, etc. Only for specific cranes that lift hypergols, fueled spacecraft, solid rocket motors, etc.
	2. If a critical crane has not been used for a few months, do you perform any special inspections? All our cranes are kept in full service so we perform frequent/periodic inspections regardless of whether the crane has been used unless we tag the crane out and then it would be subject to a full periodic inspection and possibly testing upon recertification. Most of our cranes are used on a monthly basis.
7. Who does you crane inspections, frequent and periodic, and what are their qualifications (typical)? Are your inspections done in house or out of house (freq and per.) Inspections and testing for frequent/periodic are performed by an in-house contractor that has been fully trained and is qualified to perform that work. The average tenure is about 11 years direct experience.
8. Do you know the typical time it takes to perform a frequent inspection? This would include the hand-over-hand inspection. Depends on the size and type of crane but for a typical size crane it takes about 2 hours in the field and another hour for reporting and documenting.
9. Who owns your cranes, the Center, projects, or individual organizations? For example, facilities or engineering, etc. The Center, with the FOMs assigned from different codes.
10. Are your crane operators trained in house or out of house? Who performs this training? How long is the training to operate a crane? Operators are trained in-house by an on-site contractor (same one that does the inspections). For some projects, outside company training is accepted by NASA as being equivalent to our internal training. First step is as an Apprentice Non-Critical Operator which is a 2-day session including testing and hands-on practical test. 40 hours OJT and company qualification sign-off is required for obtaining a full Non-Critical license. Critical licensing requires an addition 40 hours critical operations with additional qualification sign-off and additional Critical operation training. Refresher training required every 4 years.
11. Is there anything special about your inspection program that could assist others in reducing costs? Such as crane operators performing frequent and WRIs. Most crane operators are not qualified nor adequately trained to perform frequent inspections. This would also be difficult to control and manage by the LDEM as there are hundreds of operators but only a few qualified inspectors. Qualified inspectors that have experience inspecting all the cranes on site plus rentals have a depth of knowledge that far surpasses an area operator that has gone through some training and is designated an inspector. Those inspectors and the engineering staff associated with that group is a valuable resource for upgrades, new crane procurement support, and for assisting users with unusual crane operations. They become resident experts of the codes and standards used to design, fabricate, inspect and test those cranes and as such augment the knowledge base held by the LDEM and are a resource for supporting the LDEM concerning updates to standards, mishaps, best practices, documentation and database processes, etc.

White Sands Test Facility

1. How many overhead cranes (OHC) does your Center have? 5
	1. How old is your oldest OHC? 57 years
	2. What is the range of SWL for your OH Cranes? 2 to 15 Ton
	3. Do you allow non-NASA organizations to use NASA owned equipment, such as tenant or leased spaces? No
2. What is the height range of your OHC, how high is the hoist/bridge? 15 to 56 feet
	1. How is the access to the hoists to your cranes, ladder, steps/stairway, aerial lift? Fixed Ladder and Landing and Mobile Aerial Platforms
	2. When inspecting the hoist, does the inspector have to wear Fall Protection equipment? Yes
3. What is the typical load weight used by your OHC? (does not include load/proof testing) This can be given in percentage, such as less than 50% or mostly below 50% but occasionally close to >75% <50%
	1. What is the average height lifted by your OHC? Are they low to the ground, or is there a need to lift more than 10 feet regularly? <10’ Mostly Low to the Ground
4. How often is your busiest crane used, daily, weekly, monthly? Busiest crane may see 2 lifts per day during project work but typically sees 2-3 times a week 2 lifts per day during project work.
5. What is your typical CMAA design Category, A-F? 1
	* + 1. A – Standby, Infrequent Service
			2. B – Light Service, (occasional full capacity lift, 2-3 lifts per hour)
			3. C – Moderate Service, (avg 50% of SWL, 5-10 lifts per hour)
			4. D – Heavy Service (10-20 lifts per hour, avg 65% SWL)
			5. E- Severe Service (at SWL, >20 lifts per hour)
			6. F- Continuous Service (self expl.)
	1. How many sheaves is your biggest block and what is your typical number of sheaves? 6
	2. What type of wire rope are on your Cranes? Stainless Steel, Coated, Galvanized, etc. and IWRC (rotational?) IWRC
6. Other than indoor or outdoor, is there any type of environments your Cranes are exposed to, such as clean room, caustic, sea air, etc. No
	1. Do you lift any special hazardous items, fueled tanks, haz mats, etc. Yes
	2. If a critical crane has not been used for a few months, do you perform any special inspections? Yes
7. Who does you crane inspections, frequent and periodic, and what are their qualifications (typical)? Are your inspections done in house or out of house (freq and per.) In-House, Certified Operators (Daily and Monthly), Out of House-3rd party, Yearly Inspection
8. Do you know the typical time it takes to perform a frequent inspection? This would include the hand-over-hand inspection. 2 to 4 hours approximately
9. Who owns your cranes, the Center, projects, or individual organizations? For example, facilities or engineering, etc. NASA
10. Are your crane operators trained in house or out of house? Who performs this training? How long is the training to operate a crane? Currently Being Revisited, OHBC: Out of House 2- ½ days for new operators and lift managers, In-House 2 hour for Refresher, Mobile: Out of House – 40 hours
11. Is there anything special about your inspection program that could assist others in reducing costs? Such as crane operators performing frequent and WRIs. No

Appendix G. OSHA Letter of Interpretation



**Special thanks to:**

Carl Bell, LDE Engineer, Goddard Space Flight Center

Kirstin Moore, Deputy LDEM, Goddard Space Flight Center

James Blake, LDEM, Glenn Research Center

Fred Battle, LDEM, Jet Propulsion Laboratory

Michael Cyr, LDEM, Jet Propulsion Laboratory

Sue Roney, Program Coordinator, Institutional Safety Management Division