

# APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

SLO-KSC-1991-031

TITLE HOISTING OF MODULE SEGMENT OR MODULE HANDLING CAGE (MHC) IN THE O&C BUILDING

DOCUMENT NUMBER/TITLE OMI L5144, MODULE SEGMENT/MHC TRANSFER, WORKSTAND TO WORKSTAND

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**REQUIRED APPROVAL**

CONTRACTOR       DESIGN       R & QA       OPERATIONS       SAFETY  
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**NASA SUSPENDED LOAD OPERATION  
ANALYSIS/APPROVAL**

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**OPERATIONS** - To hoist the Module segment or the Module Handling Cage (MHC) in the Operations and Checkout (O&C) Building.

**SUPPORTING DOCUMENTS** - The associated operational procedure and System Assurance Analysis (SAA) are as follows:

- OMI L5144, Module Segment/MHC Transfer, Workstand to Workstand
- SAA01FS027-002, 27.5 Ton Bridge Cranes - O&C

**GENERAL DESCRIPTION** - The task below requires up to four persons to be under the suspended European Space Agency (ESA) strongback to connect or disconnect the cable assembly, install or remove the safety caps, installing or removing shackles connect or disconnect the turnbuckles, rotate the roller assembly, remove and stow the brake, and secure the safety claws, as follows:

- OMI L5144, Module Segment/MHC Hoisting Operation

Module segment or MHC hoisting operations are performed in the O&C low bay using dual 27.5 ton bridge cranes. The technicians have to reach up under the suspended ESA strongback to connect or disconnect the cable assembly to or from the MHC lifting trunnions and install or remove the safety caps, connect or disconnect the turnbuckles with the cable assembly attached to the lifting eye with a shackle in two places, adjust the turnbuckles and remove the final slack from the cable assemblies, rotate the roller assembly to the open position on the two inside lateral roller wheel assemblies, remove and stow the brake, secure the four outside safety claws with their pins, remove the shackles, and attach a tagline to each shackle.

During contingency payload grounding operations, one person will be permitted to work under the suspended load.

**RATIONALE/ANALYSIS** - The suspended load task complies with the NASA Alternate Safety Standard as follows:

**Alternate Standard Requirement #1a** - These operations cannot be conducted without four technicians reaching up under the suspended ESA strongback, which extends out beyond the load and the test stand. All attach points for connecting or disconnecting the lifting hardware are located underneath the strongback.

Module segment and MHC hoisting operations in the O&C have been evaluated, and it has been determined that because of the location of the attach points, there are no operational or procedural means to eliminate personnel exposure to the suspended load.

The ESA strongback was designed specifically for these types of lifts that require dual cranes. The strongback is suspended directly over the load to align and then connect or disconnect the appropriate hardware, which is located inboard on the strongback. A support structure for the strongback is not feasible because there is no access over the Module or MHC, while resting in the test stand.

**Alternate Standard Requirement #1b** - The possible use of a secondary support system, to catch the load in the event of a crane failure, was analyzed. It was determined that the use of a secondary support system was not feasible because of positioning of the Module.

**Alternate Standard Requirement #1c** - The maximum number of personnel allowed under the suspended ESA strongback during hoisting of the Module segment or the MHC is four.

**Alternate Standard Requirement #1d** - Module segment and MHC hoisting operations will be accomplished as quickly and safely as possible to minimize exposure time. It will take four persons up to 2 hours to attach the associated equipment under the ESA strongback.

**Alternate Standard Requirement #4** - OMI L5144 has been revised to permit only the approved number of persons under the suspended ESA strongback. The OMI is available on site for inspection during the operation.

**Alternate Standard Requirement #6** - Suspended load operations associated with hoisting the Module segment or the MHC in the O&C involve dual 27.5 ton bridge cranes. The cranes are designed, tested, inspected, maintained, and operated in accordance with the NASA Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9.

The 27.5 ton crane hoists are equipped with two magnetic holding brakes (one on the motor shaft and one on the gear reducer input shaft extension), each capable of holding the load up to the crane's rated capacity. Each brake's ability to hold the rated load (27.5 tons) is verified annually. The cranes are designed to meet a 5 to 1 safety factor based on ultimate strength for the hoist load bearing components.

Dual 27.5 ton cranes are being utilized for these tasks. The weight of the load is 17,435 lbs, which is 15.9% of the cranes' capacity.

The lifting sling is rated at 17,435 lbs and is designed to meet a 5 to 1 safety factor based on ultimate strength.

The 27.5 ton cranes are load tested annually at 100% of their rated capacity. Detailed preventive maintenance is performed monthly, quarterly, semiannually, and annually on the cranes to ensure proper operation. A detailed inspection of the lifting slings is performed annually. Nondestructive testing of the slings and crane hooks is performed annually.

**Alternate Standard Requirement #7** - A System Assurance Analysis (SAA) has been completed on the 27.5 ton bridge cranes in the O&C. The SAA includes a Failure Modes and Effects Analysis/ Critical Items List (FMEA/CIL) and a hazard analysis (see supporting documents).

The SAA identifies one Single Failure Point (SFP), the hoist gear reducer, which transmits power and reduces rotational speed from the hoist motor to the rope drum. A sheared key or broken teeth would cause interruption of the load path at the gearbox. This failure would result in the load dropping, which could cause loss of life and/or payload.

There is no history of failure with the SFP in the critical failure mode. A detailed inspection of the gear reducer is performed monthly, and gear reducer oil samples are verified annually. The use of high-quality, reliable components and a comprehensive

maintenance, inspection, and test program (including preoperational checks) ensures that the crane systems operate properly.

The associated SAA CIL Sheets identify all the rationale for accepting the risk of the SFP including design information, failure history, and the operational controls in effect to minimize the risks (maintenance, inspection, test, etc.).

**Alternate Standard Requirement #8** - Visual inspections for cracks or other signs of damage or anomalies are performed on the hoist hooks, hoist beams, hoist cables, hoist rod assemblies, and hoist fittings, and crane functional checks are performed before each operation per NSS/GO-1740.9.

**Alternate Standard Requirement #9** - Trained and licensed crane operators shall remain at the hoist controls while personnel are under the load.

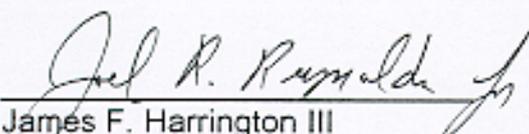
**Alternate Standard Requirement #10** - Appropriate safety control areas are established before initiating operations. Only the minimum number of people (manloaded in the procedure) will be permitted in this area.

**Alternate Standard Requirement #11** - A pretask briefing and a safety walkdown of the area are conducted prior to the lift to ensure that all systems and personnel are ready to support. All participants are instructed on their specific tasks and warned of any hazards involved. Following any crew change, the new personnel are instructed by the task leader on their specific tasks and warned of any hazards involved.

**Alternate Standard Requirement #12** - Personnel beneath the suspended load will be in voice contact with the hoist operator and/or task leader. Upon loss of communication, the operation shall stop immediately, personnel shall clear the hazardous area, and the load shall be safed. Operations shall not continue until communications are restored.

**Alternate Standard Requirement #13** - Personnel working beneath the load shall be in continuous sight of the hoist operator and/or task leader.

APPROVAL:      DATE: 8/29/94

  
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