NASA SUSPENDED LOAD OPERATION ANALYSIS/APPROVAL

OPERATION - To install the payload in the Payload Handling Fixture (PHF) using the NASA payload strongback during contingency landing site operations.

SUPPORTING DOCUMENTS - The associated operational procedure, System Assurance Analysis (SAA), and Reliability and Safety Study are as follows:

- OMI E5532 (Basic, 08/24/88), Payload Handling - CLS
- SAA09FT01-004 (Basic, 06/01/88), Link Belt 250-Ton HC-268 Truck Crane
- KSCL-5312-0839 (Preliminary Draft, 11/91), Reliability and Safety Study of the Demag TC4000 Truck Crane

GENERAL DESCRIPTION - This operation requires 3-16 persons (depending on the quantity of payload trunnions) to be under the suspended NASA payload strongback during installation of payloads in the PHF at contingency landing sites as follows:

- OMI E5532, Payload Installation in PHF

During this operation, the personnel working at the trunnions may be required to work under the suspended payload strongback. Only their hands would be exposed to the suspended load hazard and should be pushed free if the load should fall. While working under the suspended payload strongback, the payload trunnions are suspended above the retention fittings 6-12 inches.

This is a contingency OMI and the suspended load hazard most likely will be controlled. However, since this OMI has not been used to date, it cannot be verified that personnel will not be exposed to a suspended load hazard.

RATIONALE/ANALYSIS - The suspended load tasks comply with the NASA Alternate Safety Standard as follows:

Alternate Standard Requirement #1a - These operations cannot be conducted without placing personnel beneath the suspended payload strongback because they must reach under the strongback to connect and disconnect the payload trunnions.

Contingency landing site operations have been evaluated for alternate methods to complete these tasks. It has been determined that there are no operational or procedural means to eliminate personnel exposure to the suspended strongback because it extends out beyond the payload trunnions where the connections and disconnections are being made.

The NASA payload strongback was specifically designed for hoisting payloads. A support structure for the strongback is not a feasible design consideration because there is no access to position such a device over the PHF.

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 payload strongback over the payload and the PHF during contingency landing site operations.

Alternate Standard Requirement #1c - The maximum number of personnel permitted under the suspended payload strongback during contingency landing site operations is 3-16.

Alternate Standard Requirement #1d - Contingency landing site operations will be accomplished as quickly and safely as possible to minimize exposure time. It will take 3-16 persons up to 60 minutes to complete the work at the payload trunnions.

Alternate Standard Requirement #4 - OMI E5532 has been revised to permit only the approved number of persons under the suspended payload strongback. The OMI is available on site for inspection during the operation.

Alternate Standard Requirement #6 - Suspended load operations associated with contingency landing site operations involve the Link Belt (250-ton) HC-268 truck crane and the Demag (800-ton) TC4000 truck crane. 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 cranes' lifting mechanisms are equipped with dual means of braking.

The live wire rope for these cranes meets a design safety factor of 3.5 based on the ultimate strength. These cranes are designed to meet ANSI B30.5.

Dual mobile cranes will be used for suspended load operations at contingency landing sites. The 250-ton mobile crane is owned by NASA and the 800-ton mobile crane will be leased. The payload weight will not exceed 65,000 lbs., and the lifting sling weighs approximately 27,000 lbs. The suspended load will be within the cranes' rated capacity for the projected lifting radius and boom length.

The 250-ton mobile crane is load tested annually at 100% of the crane's rated capacity. Detailed crane preventive maintenance is performed monthly, semi-annually, and annually, including monthly

wire rope inspection and annual crane hook nondestructive evaluation. Two Demag (800-ton) TC-4000 mobile cranes have been identified for use: one located in Baton Rouge, Louisiana (Nichols) and one located in Montreal, Quebec (Guay Crane Service). Both cranes are inspected annually, and the crane designated for use is inspected prior to shipment to the contingency landing site by KSC crane engineering personnel. Nichols or Guay Crane Service personnnel will be at the contingency landing site.

The 250-ton and 800-ton mobile cranes will be load tested, operationally tested, and inspected at the contingency landing site prior to use.

The lifting sling is designed for a maximum allowable stress of 20,000 psi in tension and compression for the truss structure. The attachment mechanism of the lifting sling is designed to meet a 5:1 safety factor based on ultimate strength. A nondestructive evaluation of the lifting sling is performed annually.

Alternate Standard Requirement #7 - An SAA has been completed on the 250-ton mobile crane. The SAA includes a Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) and a hazard analysis (see supporting documents). The SAA identifies no single failure points (SFPs).

A Reliability and Safety Study has been performed on the 800-ton mobile crane. The study includes a FMEA/CIL and a hazard analysis (see supporting documents).

The study identifies two SFPs: the hydraulic motor and the pressure relief valve. The hydraulic motor transfers fluid power to the main hoist, and the pressure relief valve prevents overpressurization of the hydraulic motor. Component structural failure, a blown seal in the hydraulic motor, and failure of the relief valve in the open position would cause the load to lower.

There is no history of failure with the SFPs in the critical failure mode. 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.

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/ 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/task leader.

APPROVAL: DATE: CONCURRENCE: DATE:

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