APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

SLO-KSC 1993-010

TITLE: EXTERNAL TANK (ET) OFF-LOAD FROM TRANSPORTER USING VAB 325/250-TON AND 175-TON BRIDGE CRANES.

DOCUMENT NUMBER/TITLE: OMI T5001.003 ET LIFT FROM TRANSPORTER AND ROTATE TO VERTICAL

PREPARED BY: F.J. (Buddy) POITRAS DATE: 07/09/2008

REQUIRED APPROVAL

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

OPERATION:

External Tank (ET) Off-load from Transporter using VAB 325-Ton Crane or 250-Ton and 175-Ton Bridge Cranes.

SUPPORTING DOCUMENTS:

The associated operational procedure and System Assurance Analyses (SAA) are as follows:

1. OMI T5001.003 ET Lift from Transporter and Rotate to Vertical.
2. SAA09FY120-001 System Assurance Analysis of the 325-Ton Bridge Crane at the Vehicle Assembly Building (VAB).
3. SAA09FY12-006 System Assurance Analysis of the 175-Ton Bridge Crane at the Vehicle Assembly Building (VAB).
4. SAA09FT07-006 System Assurance Analysis of the ET Sling Set at the VAB.
5. SAA09FY12-005 System Assurance Analysis of the 250-Ton Bridge Crane at the Vehicle Assembly Building (VAB).

GENERAL DESCRIPTION:

1. Require four personnel to be directly under the suspended ET Forward Sling Set during installation of the forward Sling Set to the ET, and while the ET is on the Transporter.
2. Require up to seven personnel to be directly under the suspended ET/ET Forward Sling Set during initial stages of ET lift from Transporter.

The ET off-load from the Transporter using either the 325-ton or 250-ton and 175-ton bridge cranes in the Vehicle Assembly Building (VAB). With the ET/transporter in the off-load position, personnel board aerial lifts and position themselves adjacent to the forward attach points of either side of the ET intertank. Because of the weight and rigidity of the sling set cables and hoisting adapters, two personnel per side are required to stabilize and install the hoisting adapters on the ET.

The forward sling set, with hoisting adapters, is lowered so the hoisting adapters are adjacent to the forward lifting attach points on either side of the ET intertank. The personnel guide the hoisting adapters into position on the forward attach point on each side of the ET, then work to install and torque the fastening hardware.

The technicians are directly under the extreme ends of the sling set main beam during these operations.

Personnel on aerial lifts at the forward attach points guide/monitor the forward sling set/cables and forward lifting adapters until the ET is safely "floating" off the transporter attach fittings and is steadily suspended via the sling set.

At the aft end of the ET, personnel (a maximum of three) are under the suspended ET during initial ET lift to observe alignment and measure distance of the ET with respect to the aft transportation fitting. The personnel also secure the transportation fitting to the transporter and disconnect the fitting from the ET.

The personnel are directly under the suspended ET at the aft end of the transporter, and directly under the extreme ends of the forward sling set main beam at the forward end of the transporter, during these initial lift stages. All personnel are required to leave the area under the suspended load once the ET is satisfactorily demated from the transporter.

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

Alternate Standard Requirement #1a

The ET off-load from the transporter has been evaluated and it has been determined the operation cannot be practically/feasibly conducted without personnel beneath the load. Engineering evaluations included, but were not limited to the following:

1. Fabrication of additional GSE safety stands to support both the forward and aft slings sets in the event of a failure. These safety stands would require the use of the overhead crane to move and position the stands. Because of the size and positioning of the stands it was determined that the overall safety of the entire operation would be compromised in an effort to improve one specific phase of the operation.

2. Modifications to existing personnel lift platforms which could provide an overhead safety cage to protect personnel from a possible falling load. Evaluation of this proposal showed no feasible solution existed to provide a structurally sufficient enclosure due to overall weight limitations of existing platforms. The size and type of such an enclosed lift platform, which could positively protect personnel, would severely hinder operational procedures.
3. Numerous procedural alterations were evaluated / tested for practicality and subsequently rejected as unworkable. No operational methods could be devised to preclude the requirement for personnel working under the suspended loads in the specific operations listed in this document.

Alternate Standard Requirement #1b

The use of a secondary support system (stand) was evaluated and deemed not feasible for this operation. Because of the size and positioning of a stand to support the ET sling, the overall safety of the operation would be compromised.

Alternate Standard Requirement #1c

The maximum number of personnel allowed under the suspended load at any time is seven: Four (two per side of ET) at the forward end, and three at the aft end.

Alternate Standard Requirement #1d

Personnel required under the suspended load will perform their operations as quickly as possible (approx. 25 minutes) and remove themselves from exposure immediately upon task completion.

Alternate Standard Requirement #2

Suspended load operations are reviewed and approved on a case-by-case/specific need basis - see General Description and Alternate Standard Requirement #1.

Alternate Standard Requirement #3

Only those suspended load operations approved by the Center/Facility NASA Director of Safety, will be permitted, subject to this standard. A list of approved suspended load operations will be maintained by NASA Safety and made Available to OSHA personnel upon request.

Alternate Standard Requirement #4

OMI T5001.003 is written to allow up to seven personnel under the suspended load during sling installation and initial ET lift procedures. The OMI will be available on site for inspection during the operation.

Alternate Standard Requirement #5

During a suspended load operation, if a new procedure not covered by the original analysis is deemed necessary due to unusual or unforeseen circumstances, the NASA Center/facility Safety Office will be consulted and must approve and document the procedure before operations continue. Safety will coordinate with Operations, Engineering, and other organizations as appropriate. If the new procedure is to be performed on a regular basis, a detailed hazards analysis and approval as outlined in paragraph A.4.1 of NASA-STD-8719.9. are required.

Alternate Standard Requirement #6

Suspended Load Operations associated with the ET forward sling set installation and ET lift from the Transporter in the VAB involve the 175-Ton and either the 325- ton or 250-ton Bridge Cranes. The Cranes are designed, tested, inspected, maintained and operated in accordance with the NASA Safety Standard for Lifting Devices and Equipment, NASA-STD-8719.9. These cranes are designed to a minimum safety factor of 5 (based on the ultimate yield strength) for the hoist load-bearing components.

The cranes are equipped with redundant hoist drive systems (including hoist wire ropes and holding brakes), each capable of lifting and holding the load up to the crane rated capacity. The cranes have a dual braking system with overspeed braking.

The cranes were one-time proof loaded at 125 percent of rated capacity, are load tested annually at 100 percent of rated capacity, and have a monthly, semiannual and annual preventive maintenance program to ensure proper operation.

The wire rope is inspected monthly for discrepancies. Nondestructive testing of the crane hooks is performed annually.

The ET forward Sling set total weight is about 23,000 lbs. The ET weight ranges from approximately 58,000 lbs. (Super Lightweight Tank) to approximately 65,000 lbs (Lightweight Tank). The ET aft sling set weighs approximately 5,000 lbs. The total suspended weight for these operations will range from approximately 86,000 lbs to approximately 90,000 lbs depending on the ET.

Alternate Standard Requirement #7

System Assurance Analyses (SAAs) have been completed on the VAB 325-ton, 250-ton, and 175-ton bridge cranes. Each SAA includes a Failure Modes and Effects Analysis/Critical Item List (FMEA/CIL) and a hazard analysis (see Supporting Documents).

The SAA for the 325-ton crane identifies 1 Single Failure Point (SFP), the Programmable Logic Controller (PLC). The PLC controls motion for the hoist, bridge and trolley. The identified failure mode is an unsolicited command from the PLC could initiate or continue a crane motion in an uncommanded direction or speed. The PLC is designed to industry standards and is UL listed. Internal diagnostics verify all crane controls each time the crane is used and crane control functional checks are performed before each use. The PLC is electrically isolated from external voltages/currents. Crane software was validated and extensively tested per the acceptance test procedure. If a failure were to occur, the crane operators can secure the load by applying brakes.

The SAA for the 250-ton bridge crane identifies 11 SFPs in the main hoist system when the hoist is lifting or lowering. Failure of the motor-generator set (one each) or the main hoist motors (two each) would allow the load to lower without regenerative braking at approximately 10 feet/minute (2 inches/second). Failure of the remaining SFPs would allow the load to lower with regenerative braking at approximately 0.25 feet/minute (0.05 inches/second). There are no SFPs when the hoist is static.

The SAA for the 175-ton bridge crane identifies 3 SFPs in the main hoist system when the hoist is lifting or lowering. Failure of the motor-generator set (one each) or the main hoist motors (two each) would allow the load to lower without regenerative braking. There are no SFPs when the hoist is static.

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. If a failure were to occur, it can be recognized by a brake set light, ammeter or selsyn position indicator which are in view of both crane operators. The crane operators would secure the load by applying the brakes. Emergency (E) stop operators, remote from the crane operator's cab, can stop the crane if a failure indication is observed.

The associated SAA CIL sheets identify the rationale for accepting the risk of the SFPs, 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 NASA-STD-8719.9.

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

Prior to the suspended load operation, a meeting with the crane/hoist operator(s), signal person(s), person(s) who will work under the load, and the person responsible for the task shall be held to plan and review the approved operational procedures that will be followed, including procedures for entering and leaving the safety controlled area. A pretask briefing and a safety walkdown of the area will be 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 potential hazards. 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

The personnel beneath the suspended load will be in voice and / or Radio 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

Ground Controllers and E-stop operators are properly positioned during all phases of the lifting operation in full view of the load block, lifting fixtures and fixture attachpoints. One E-stop operator, remote from the crane operator's cab, can stop the crane if a failure indication is observed. The personnel working beneath the suspended load shall be in continuous sight of the hoist operator, signal person, and/or task leader.

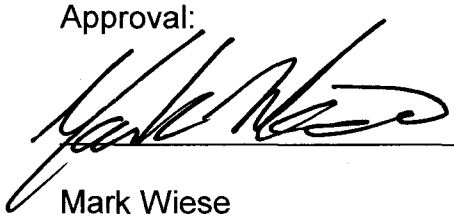
Alternate Standard Requirement #14

NASA shall conduct periodic reviews to ensure the continued safety of the procedures. As a minimum, NASA shall annually evaluate the implementation of this procedure at each Center with operations on the suspended load list.

Alternate Standard Requirement #15

A list of approved suspended load operations, list of cranes/hoists used for suspended load operations, and copies of associated hazards analyses will be provided to the OSHA Office of Federal Agency Programs via NASA Headquarters for distribution to the appropriate regional and area OSHA offices. Quarterly updates to the documentation will be provided as needed.

Approval:



Date: 7/14/08

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