APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

SLO-KSC 2008-006

TITLE: Ares-IX H77-0384 Adapter Beam Installation/Removal for Ballst Installation

DOCUMENT NUMBER/TITLE: US-HAN-0310 Install US-1 Ballast (VAB HB4) US-HAN-0440 Install US-1 Ballast (VAB HB3)
US-HAN-0400 Install Ballast in US-7 (VAB HB4)

PREPARED BY: Peter Wagner DATE: 12/10/2008

REQUIRED APPROVAL

CONTRACTOR _____ DESIGN _____ R & QA _____ OPERATIONS _____ SAFETY

NASA _____ DESIGN _____ R & QA _____ OPERATIONS _____ SAFETY

TYPE OR PRINT NAME	SIGNATURE	ORG.	DATE
Peter Wagner	D Chambers FOR PETER WAGNER OK 12/11/08	USA Eng	12/10/2008
Richard Carrillo	R Carrillo (CARRILLO)	NASA Eng	12/10/2008
John Garrett	John W. Garrett	USA Safety	12/10/2008
Kristin Kelley	Kristin Kelley	NASA LDEM	12/10/2008

CONTRACTOR DIRECTOR OF SAFETY

Jamie P. McLean for Jamie P. McLean 12/11/08

KSC FORM 20-200 NS (01/05)

NASA SUSPENDED LOAD OPERATION ANALYSIS/APPROVAL (SLOAA)

OPERATION: Ares IX H77-0384 Beam Adapter installation/removal to Ares IX ballasts and ballast installation into US-1 and US-7 using the 325-ton crane in VAB High Bay 4 and High Bay 3.

SUPPORTING DOCUMENTS: The associated operational procedure/systems assurance analyses are as follows:

1. SAA09FY120-01, Systems Assurance Analysis of the 325-Ton Bridge Cranes at the Vehicle Assembly Building (VAB)
2. SAA00215 System Assurance Analysis of the ARES I-X SRM Lifting Beam Adapter
3. SAA09FT08-017 System Assurance Analysis of the H77-0384 Lifting Beam

GENERAL DESCRIPTION: Four personnel are required to be directly under the suspended H77-0384 beam and Ares IX adapter during its attachment and disconnection to the Ares IX ballast eye bolts and during ballast alignment into segments US-1 and US-7. Operations include the following:

- Ares IX beam attachment/disconnect to the ballast eye bolts.
- Ballast installation and alignment into US-1 and US-7

The Ares IX ballasts are attached at eye bolts by wire rope of the H77-0384 beam adapter and beam which is connected to the 325-ton VAB bridge crane. Load cells are installed on the beam adapter links for weight determination of the lift. Four personnel are required to be under the suspended load of the beam and adapter at the connection of the links.

The Ares IX ballasts are then lifted to be aligned and installed into the segments (US-1 or US-7). Four personnel are required to be under the suspended load for alignment of the ballasts into the segments and disconnect of the wire rope from the ballasts.

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

Alternate Standard Requirement #1a: The operation cannot be performed without personnel beneath the suspended load because there are no operational means of performing the connection and disconnection of the Ares IX adapter beam wire rope to the ballasts without risking damage to flight hardware and personnel. Operational options for personnel to use tools to attempt to install the wire rope were investigated but were not feasible and induce additional risk of personnel injury due to the tight area and

flight hardware damage due to dropping of the tools. Design options to build different links still require personnel to be under the load for initial installation and removal of the wire rope. Use of web straps were investigated but levelness requirements for mating into the segment rails and weight readings on the wire rope during lift required the use of the H77-0384 beam and adapter which allows the ballasts to be adjusted to meet engineering requirements.

Design and fabrication of abatement stands is not feasible to support the entire H70-384 beam and adapter should a crane or lifting beam failure occur.

Alternate Standard Requirement #1b: Secondary support systems to assume support of (catch) the load were evaluated and were not feasible for these operations; see Alternate Standard Requirement #1a:

Alternate Standard Requirement #1c: We have determined that we need a maximum number of 4 personnel to perform the tasks and will operationally prevent any additional personnel during the operation.

Alternate Standard Requirement #1d: Personnel will accomplish the required suspended load tasks as quickly as possible to minimize time exposure. Total exposure time is approximately 5 minutes for connection and disconnection of the wire rope and 30 minutes for ballast alignment in the segment.

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 NASA Safety and Mission Assurance Director will be permitted. A list of approved suspended load operations will be maintained by the Center NASA Safety and Mission Assurance Directorate

Alternate Standard Requirement #4: The following Solumina WAD's are written to allow only the required personnel under the suspended load and are available on site during the operation:

Install Ballast in US7 VAB Bay 4	US-HAN-0400
Install US-1 Ballast (3 lifts) VAB Bay 4	US-HAN-0310
Install US-1 Ballast (1 lift) VAB Bay 3	US-HAN-0440

Alternate Standard Requirement #5: A new suspended load operation not covered by this SLOAA, deemed necessary due to unusual or unforeseen circumstances where real time action is required, shall be documented and approved by the Center NASA Safety and Mission Assurance Director.

Alternate Standard Requirement #6: Suspended load operations in the VAB associated with lifting segments and ballasts involve the use of one of the 325-ton bridge cranes. The 325-ton bridge cranes are designed, tested, inspected, maintained and operated in accordance with NASA-STD-8719.9, the NASA Standard for Lifting Devices and Equipment. The cranes are designed with a minimum safety factor of 5 (based on the ultimate material 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 to the cranes capacity. The cranes have a dual braking system with overspeed braking. A load test is performed annually to 100 percent of the rated capacity of the crane.

The 325-ton bridge cranes undergo a monthly, quarterly, semiannual and annual preventative maintenance program. The wire rope is inspected monthly for discrepancies. The hook undergoes an annual Non-Destructive Testing (NDT) inspection.

The H77-0384 segment lifting beams were proofloaded to 740,000 pounds and are load tested annually to 462,000. The beams also undergo a semiannual preventative maintenance and an annual NDT for load-bearing members and critical welds.

The Ares IX adapter beam was proofloaded to 268,000 pounds and the SWL is 176,000 pounds. The beam also undergoes an NDT for load-bearing members and critical welds. The beam is scheduled for use only with the Ares IX segments and is not scheduled for periodic load testing.

The H77-0384 and Ares IX adapter beam were both designed to a 5 to 1 safety factor for failure and 3 to 1 for yield. The safe working load of the H77-0384 lifting beam is 370,000 pounds and the Ares IX adapter beam is 176,000 pounds. The weight of the adapter beam is 6500 lbs. The heaviest ballast lift is approximately 25,000 lbs.

Alternate Standard Requirement #7: A System Assurance Analysis (SAA) has been completed on the VAB 325-ton bridge cranes. The 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 of 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 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 the brakes.

There is no history of failure with the SFP's 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 the selsyn position which is 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 operators 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 SFP's, including the design information, failure history and the operational controls in effect to minimize the risks (maintenance, inspection, test, etc.).

Alternate Standard Requirement #8: The 325-ton bridge crane undergoes a visual inspection and pre-operational checkout prior to each use per NASA-STD-8719.9.

Alternate Standard Requirement #9: A trained, licensed and certified operator will remain at the controls while personnel are under a suspended load. In addition, a qualified Emergency Stop operator is stationed in the vicinity of personnel working under the suspended load. All personnel responsible for the direction and/or performance of the operation undergo training that meets or exceeds the required certifications per NASA-STD-8719.9.

Alternate Standard Requirement #10: Control areas are established per the controlling WAD for the operation. Only essential personnel are allowed in the control area for the lifting operation.

Control areas are established using ropes and placards to ensure non-essential personnel are kept out of the area. For lifting operations a badge board is maintained in the immediate area. Only those personnel badged and with the approval of the Task Leader are allowed under the load.

Alternate Standard Requirement #11: Pre-operational briefings are held by the Task Leader and all essential personnel involved with the operation. Shift change pre-operational briefings are held if operations are to occur on multiple shifts.

Alternate Standard Requirement #12: Communications (by voice, radio and visual) are maintained with all personnel under a suspended load. Emergency procedures contain instructions and personnel are trained to discontinue operations if communications are lost. The hardware is safed and the area is cleared if additional hazards warrant clearing the control area. All personnel are cleared from under a suspended load during loss of communications.

Alternate Standard Requirement #13: All personnel remain within sight of the Move Director and the Emergency Stop operator.

Alternate Standard Requirement #14: The Center NASA Safety and Mission Assurance Directorate shall conduct periodic reviews to ensure the continued safety of suspended load procedures.

Alternate Standard Requirement #15: Center NASA Safety Assurance Directorate will provide copies of approved SLOAA's, a list of approved suspended load operations, a list of cranes/hoists used for suspended load operations and copies of the associated FMEA/CIL and hazards analyses to NASA Headquarters.

Barry N Bradley for 12/15/08

Mark Wiese
Chief, Launch Vehicle Processing Safety and Mission Assurance