APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

SLO-KSC 1991-003 Rev A

TITLE Orbiter Mate to Shuttle Carrier Aircraft at Dryden Flight Research Center

(Rev A. - updated GENERAL DESCRIPTION, item 5, from 3 personnel to 5 personnel) M. Herm

DOCUMENT NUMBER/TITLE OMI S5022, V9005

PREPARED BY Joe Torsani (Alternate LDEM) DATE 03/27/2009

REQUIRED APPROVAL

CONTRACTOR _____ DESIGN _____ R & QA _____ OPERATIONS _____ SAFETY

NASA _____ DESIGN _____ R & QA _____ OPERATIONS _____ SAFETY

TYPE OR PRINT NAME	SIGNATURE	ORG.	DATE
JOE TORSANI ALDEM		SA-B1	27MAR09
ANDREW LAMAIE NASA OHE		NE-M5	3/27/09
Mike McClure	Klint Combs For McClure per telecon	USA OHE	3/27/09
John W. Garrett	FOR	USA SE	3/30/09

CONTRACTOR DIRECTOR OF SAFETY

James P. McLean 03/30/09

KSC FORM 20-200 NS (01/05)

OPERATION: Orbiter Mate to the Shuttle Carrier Aircraft (SCA) at Dryden Flight Research Center (DFRC)

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

1. OMI S5022, Post Landing Deservicing/Mate to SCA-DFRC..
2. OMI V9005VL2, Hydraulic Standard Power up/down.
3. SAA290M01-001, Systems Assurance Analysis for the 55 Ton Main Hoists, Access Service Platform Hoists and the Wind Restraint Mechanism on the Mate/Demate Device at the Shuttle Landing Facility - KSC (SLF) and SLS-1 (DFRC).

GENERAL DESCRIPTION: This operation involves the mate of the Orbiter to the SCA using the Mate/Demate Device (MDD) at DFRC. After mate, the Orbiter is ferried to KSC, demated from the SCA and towed to the Orbiter Processing Facility (OPF) to be readied for its next flight. A detailed engineering review and hazards analysis of this operation has been conducted. This work has resulted in hardware and/or procedure modifications that minimize the exposure of employees to working under suspended loads. Due to the uniqueness of the activity and the limitations using present systems, hardware, and facilities, there remain some tasks where suspended load operations are required under specifically approved and controlled conditions. The Orbiter mate to the SCA requires a minimum number of personnel under the load to perform the following tasks:

1. Sweep the apron area under the suspended H70-0743 Orbiter Ferry Flight lifting sling to remove foreign object debris (1 person – 5 minutes).
2. Install/remove the H70-0768 Orbiter forward handling adapters (4 personnel – 30 minutes).
3. Install access stands under H70-0743 forward drop legs. (2 personnel - 15 minutes).
4. Install/remove forward/aft cups and liners (8 personnel – 1 hour).
5. Tow/spot SCA into the MDD apron and tow SCA/Orbiter out of the MDD passing under the suspended H70-0743 Orbiter Ferry Flight lifting sling (5 personnel – 30 minutes).
6. Install/remove the H70-0743 Orbiter Ferry Flight lifting sling on the Orbiter at the four Orbiter lifting attach points (2 forward, 2 aft) (2 personnel each attach point – 4 hours).
7. Collapse the nose landing gear (NLG) strut, install the A70-0999 NLG support stand for safing operations and remove the A70-0999 NLG support stand along with strut repressurization (3 personnel - 2 hours).

8. Install/remove aft H70-0570 Orbiter jacks to stabilize Orbiter during deservicing operations (6 personnel – 1 hour).
9. Remove earth ground, ground lock pins and armalon, associated with landing gear retraction and observe gear closure and assist NLG door closure (6 personnel - 90 minutes).
10. Monitor the aft Orbiter socket onto the aft SCA ball and forward bipod connection of the Orbiter/SCA in a dynamic lift until mating is achieved (4 personnel each aft attach point, 4 personnel forward attach point - 1 hour).

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

Alternate Standard Requirement #1a: Orbiter/SCA mate operations at the MDD at DFRC cannot be conducted without personnel beneath the suspended load. The tasks performed under the load have been analyzed and evaluated with the determination no feasible engineering design or procedural options are readily available to eliminate the suspended load operation. Redesign options of the MDD were suggested to allow hard points at particular levels. The design options added uncertainty whether the hard points would be able to be disengaged properly from the Orbiter which would affect the safety and integrity of the Orbiter. In addition, these design alternatives would pose other risks for personnel working at heights.

Alternate Standard Requirement #1b: Secondary support systems to assume support of (catch) the load were evaluated and were not feasible for this operation. Design criteria was too cumbersome to prevent the Orbiter and sling from being a suspended load and also prevented access to areas of critical work that needed to be performed.

Alternate Standard Requirement #1c: The number of personnel allowed under the suspended load for each task is as stated in the General Description. These personnel are also identified with safety vests to annotate the required personnel for the operation.

Alternate Standard Requirement #1d: Personnel will accomplish the required suspended load tasks as quickly and safely as possible to minimize time exposure; see General Description.

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 NASA Safety and Mission Assurance Division Chief will be permitted. A list of approved suspended load operations will be maintained by the NASA Safety and Mission Assurance Division.

Alternate Standard Requirement #4: OMI S5022 and V9005VI2 is written to allow only required personnel under the suspended load. The OMIs are available on site for inspection during the operation.

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 NASA Safety and Mission Assurance Division Chief.

Alternate Standard Requirement #6: The three 55 ton hoists at the MDD are designed, tested, inspected, maintained, and operated in accordance with the NASA Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9. The hoists are designed to a minimum safety factor of 5 (based on the ultimate yield strength) for the hoist load-bearing components. The H70-0743 Orbiter Ferry Flight lifting sling is designed with a safety factor of 5 against ultimate strength and a safety factor of 3 against yield.

The hoists are equipped with two holding brakes and an emergency overspeed brake, each capable of holding the hoist rated capacity.

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

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

When performing the mate operation, one hoist is connected to the forward attach point of the H70-0743 Orbiter Ferry Flight lifting sling and two hoists are connected to the aft attach points. The Orbiter will not exceed 240,000 pounds (varies with Orbiter and payload configuration), the Orbiter Ferry Flight lifting sling weighs approximately 26,000 pounds and the attached wind restraint tubes weigh approximately 25, 000 pounds. The three hoists simultaneously lift a maximum load of approximately 145 tons which is within their rated capacity.

Alternate Standard Requirement #7: A System Assurance Analysis (SAA) has been completed on the 55 ton hoists at the MDD. The SAA includes a

Failure Modes and Effects Analysis/Critical Item List (FMEA/CIL) and a hazard analysis (see Supporting Documents). The SAA identifies no single failure points for the MDD 55 ton hoists.

Alternate Standard Requirement #8: Visual inspections for cracks or other signs of damage or anomalies are performed on the hoist hooks and lifting sling assembly along with crane functional checks prior to each operation per NSS/GO-1740.9.

Alternate Standard Requirement #9: The hoist operators, Emergency (E) stop operators, and mechanical technicians are all trained and have current certifications. Operators will remain at the hoist controls while personnel are under the load.

Alternate Standard Requirement #10: Appropriate control areas are established and maintained prior to and during the operation. Only required personnel (man loaded in the procedure) are permitted in this area.

Alternate Standard Requirement #11: Personnel are briefed just prior to performing the task about the hazard involving the suspended load. A pretask briefing and a safety walkdown of the area are conducted prior to the lift to ensure all systems and personnel are ready to support. All participants are instructed on their specific tasks and warned of the hazards involved. Following any crew change, new personnel are instructed by the task leader on their specific tasks and warned of the hazards involved.

Alternate Standard Requirement #12: Personnel beneath the suspended load will be in radio, visual, or voice contact with the hoist controller and/or signal person. 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 attach points. One E-stop operator, remote from the hoist operator, can stop the crane if a failure indication is observed. Personnel working beneath the load shall remain in continuous sight of the operator and/or signal person.

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

Alternate Standard Requirement #15: The NASA Safety and Mission Assurance Division will provide copies of approved SLOAAs, 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.

APPROVAL: DATE:

Malcolm Henn for 3/30/09

Mark D. Wiese
Chief, S&MA Launch Vehicle Processing Division
Kennedy Space Center