APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

SLO-KSC-2005-001

TITLE Mars Reconnaissance Orbiter (MRO) / **Atlas** Integrated Suspended Load Operation

DOCUMENT NUMBER/TITLE X45-MUQ05-SPF, Spacecraft to B1194/CXX PLA Mate, X4X-PLF03-SPF Encapsulation Operations

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DATE **16** June **2005**

REQUIRED **APPROVAL**

CONTRACTOR ___DESIGN ___R&QA OPERATIONS ___**SAFETY**

NASA ___DESIGN ___R&QA ___OPERATIONS ___**SAFETY**

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1.0 OPERATION

Mars Reconnaissance Orbiter (MRO) spacecraft *(S/C)* lifting and mating operations ***(see*** Figure 1).

2.0 SUPPORTING DOCUMENTS

2.1 Applicable Documents

X45-MUQ05-SPF	Spacecraft to B1194/CXX PLA Mate - (LM **Atlas** Procedure)
X4X-PLF03-SPF	Encapsulation Operations **(LM Atlas** Procedure)
LOP 60.00.04	**Suspended** Load Operations (LM *Atlas* Practice)
Nos: LMA MRO-02-0125, JPL 0-26104, JPL MRO-28-314	Mars Reconnaissance Orbiter Spacecraft **Missile** Systems Prelaunch **Safety** Package (LMSSC Document)
SAA 01HS11-005	50-Ton **Bridge** Crane **PHSF**

2.2 Reference Documents

KNPR 87 15.3	KSC **Safety** Practices Procedural Requirements
NAS-STD-8719.9	**NASA** Standard for Lifting **Devices** and Equipment

3.0 GENERAL DESCRIPTION

The following integrated operations require four Lockheed Martin Atlas (LM – Atlas) personnel, for the purpose of physical guidance to be directly under the flight hardware, lifting fixture and hydraset during the last **stage** of **a** mate (within 1 inch) and the beginning of a lift (first 1 inch).

Case 1 - S/C mating to the Lockheed Martin Atlas Payload Adapter (PLA)

Case 2 - S/C with PLA mating to the LMA ground transport vehicle (GTV)

There is one final integrated operation that requires one Lockheed Martin **Atlas** and one LMSSC (MRO) personnel, for the purpose of critical clearance verifications to be directly **under the** flight **hardware,** lifting fixture and hydraset. These clearance verifications must **occur** after **lifting the** S/C off the MRO support stand and prior to mating of the SIC to the PLA.

4.0 RATIONALTIANALYSIS

The S/C **suspended** load operations **comply** with the **NASA** Alternate Safety Standard for Suspended Load Operations because:

Alternate Standard Requirement 1a: The **SIC** mating/separation ring is smaller in diameter than the outer diameter of the SIC. It is necessary to position LM Atlas personnel **beneath** the SIC to ensure proper mating, de-mating and lifting in order to prevent **damaging** the flight mating/separation ring surface.

Alternate Standard Requirement 1b: A secondary support system is not **feasible** because **the** SIC mating/separation ring represents the only **primary structure interface** for **the** S/C

Alternate Standard Requirement 1c: The LMA procedures (X45-MUQ05-SPF and **X4X-PLF03-SPF)** limit the number of personnel beneath the suspended load to no more than four.

Alternate Standard Requirement 1d: LM Atlas personnel will accomplish the mating, demating **and** lifting **operations** as quickly and **safely** as possible to minimize exposure. Specific procedures listed in section 2.0 will control these operations. For Case 1 and *Case* **2** mating operations, LM Atlas personnel are only under the load during the last I-inch prior to mate and for the first 1 inch during lifting.

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

Alternate Standard Requirement 4: Existing integrated operations procedures are complete and will be used (see Section 2.0). The procedures are written to only allow required personnel under suspended load.

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 Division Chief.

Alternate Standard Requirement 6: The suspended load operations covered by this report are performed at the PHSF using the 50-ton bridge crane. The cranes are tested, inspected, maintained and operated in accordance with the NASA Standard for Lifting Devices and Equipment NAS-STD-8719.9.

The cranes are load tested at 100% rated capacity annually and there is a preventative maintenance program to ensure proper operation. The cranes are load tested to 125% rated capacity when new or following a major repair or modification.

The LMSSC MRO MGSE lift fixture is designed with an ultimate factor of safety of 5.0 times the rated load and proof tested to a factor of 2.0 times the rated load annually. The fixture is designed to handle a substantially greater rated load than the maximum expected SIC weight.

When lifting the S/C the SJC will be connected to the crane with a LMSSC MRO hydraset and lift fixture. The hydraset will be used for the initial I-inch of travel during lifting and the final I-inch of travel during mating. Maximum weight of the S/C is approximately 4806 lbs (2180 kg).

Only LMSSC MRO crane operators trained and certified by KSC will be allowed to operate the KSC PHSF crane.

An individual will be stationed at the crane main circuit breaker during hoisting to immediately remove power, thus setting the brakes, should a failure occur with the crane controls.

The crane will be operated in a slow-speed mode when the SIC is in close proximity to other hardware.

Alternate Standard Requirement 7: System Assurance Analyses (SAA) has been performed on the PHSF SO-ton bridge crane. The SAA includes a Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) and a hazards analysis.

No critical single failure points were identified during this analysis,

Alternate Standard Requirement 8: Pre-operational inspections of the lifting equipment as well as crane functional checks will be performed prior to use. The LMSSC MRO MGSE lift fixtures have been proof tested, dye penetrant inspected, tagged and will be visually inspected prior to each S/C lift.

Alternate Standard Requirement 9: Only LMSSC MRO Crane operators trained and certified by KSC will be allowed to operate the crane when personnel are beneath suspended loads.

Alternate Standard Requirement 10: Section 2.0 procedures establish appropriate control areas before initiating operations. Only the minimum number of essential personnel (person-loadedin procedures) will be permitted in this area.

Alternate Standard Requirement 11: A pre-task briefing and a safety walk down of the control area will be performed immediately prior to each operation to ensure personnel are ready to support.

Alternate Standard Requirement 12: LM Atlas personnel beneath the **suspended** load will be in voice contact with the LMSSC MRO crane operator and the LM atlas system engineer **by** directing the crane operator throughout the operation. **At** any time during the operation anyone can call a safety hold. The LMSSC MRO **crane** operator will have full visual contact with the load throughout the operation.

Alternate Standard Requirement 13: The LM Atlas system engineer, the LMSSC MRO crane operator and the **LMSSC** MRO crane power cut-off switch operator will be in visual contact with the LM Atlas personnel beneath the suspended load throughout the operation.

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

Alternate Standard Requirement 15: The Center NASA Safety and Mission Assurance Division will provide copies of approved SLOA/As, a list of approved suspended load operations, a list of cranes/hoists used for **suspended** lead operations and **copies** of the associated FMEA/CIL and hazards analyses to **NASA** Headquarters.

Approval Date

for Bruce L. Jansen 7/21/05
Chief, ISS/Payload Processing Safely and Mission Assurance Division
Kennedy Space Center

Illustrating Personnel Under Suspended Loads (see SLOA/A)

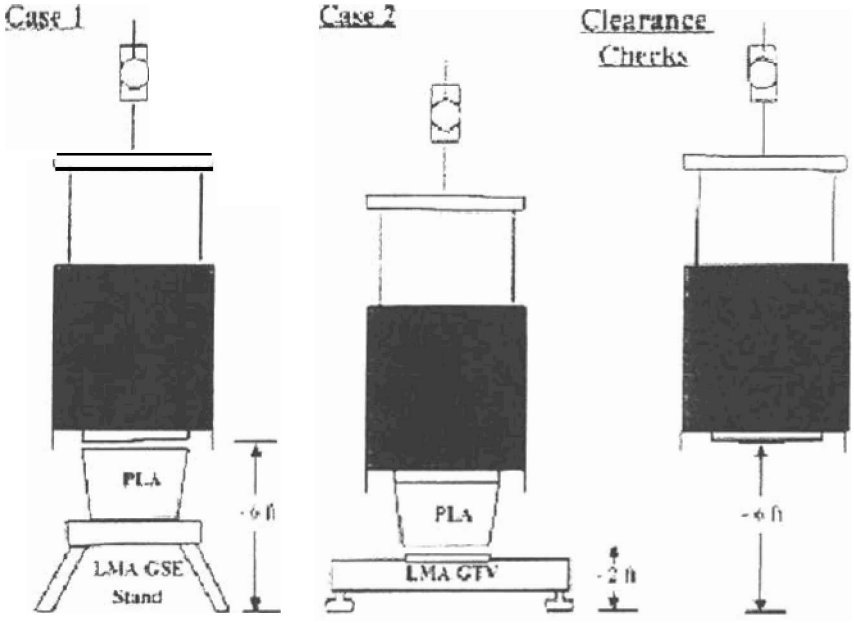

Figure 1 S/C Mating and Lifting Suspended Load Operations