NASA SUSPENDED LOAD OPERATION INTERIM ANALYSIS/APPROVAL

1. OPERATION
Orbiter Mate to the External Tank (ET) OMS S0004 SAA09 FY12-005 SAA09 FY12-006

2. REQUESTOR	ORGN.	PHONE	DATE	REQUEST NO.
Pete Wagner	LO/OHE	5388	9/18/92	SLO-KSC-1991-001A

3. CONTRACTOR	4. CONTRACT NO.	5. VEHICLE/GSE/EFFECTIVITY FACILITY	6. TIME PERIOD/DURATION
LSOC	NAS 10-10900	OV-102 / STS 52 / VAB	

7. DOCUMENT	8. TITLE	9. ITEM NO.
GP 1098	KSC Ground Safety Plan, Vol 1	Section 2.36
NSS/GO-1740.9	NASA Standard for Lift Devices and Equip	Para 2.7.18

10. REQUIREMENT

The two documents listed in block #7 do not allow personnel to work under suspended loads. The requirements are as follows:

GP 1098F-"A load will not be lifted, suspended, or transported over personnel..."

NSS/GO-1740.9-"Loads shall not be moved over people unless specifically authorized in a technical operating procedure."

11. DESCRIPTION

Allow personnel to be in the area of increased hazard directly under the suspended load for the operations involved in landing gear retraction of OV-102 Columbia orbiter after tow to the VAB for orbiter mating to the external tank (ET). The orbiter is usually transported after final processing from the Orbiter Processing Facility (OPF) to the VAB for mating operations but due to safety concerns with OV-105 post landing operations and time critical operations involved with its flight the orbiter is being towed. See detailed description of the operation, including manloading requirements.

12. DETAILED RATIONALE

The operation detailed is performed under the supervision of a qualified and certified move director with NASA and SPC safety providing on-site support. Only the essential number of personnel required to perform the operation shall be working under the suspended load. The lifting equipment has current prooftest and validation. All hoist operators have current certifications. The maximum number of people under the suspended load shall not exceed five (5) at any time.

13. REMARKS

14. REQUIRED APPROVAL

CONTRACTOR		NASA	
☐ DESIGNS	☐ R&QA	☐ DESIGNS	☐ R&QA
☐ OPERATIONS	☐ SAFETY	☐ OPERATIONS	☐ SAFETY

15. TYPE OR PRINT NAME	SIGNATURE	ORGN.	DATE
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KSC FORM OT-4130 (11/91) (ONE TIME FORM - REPRINT NOT AUTHORIZED)

General Description

This operation involves the mate of the orbiter to the ET utilizing the VAB 250-ton and 175-ton bridge cranes. A detailed engineering review and hazards analysis of this operation have been conducted. Due to the uniqueness of the activity and the limitations imposed when using present systems, hardware and facilities, steps are present when the orbiter is towed into the VAB where suspended load operations are required under specifically approved and controlled conditions. The orbiter mate to the ET after towing requires a minimum number of personnel under the load to perform the following tasks:

1. Hydraulic connection/disconnection from the orbiter left-hand ET umbilical for actuation of landing gear retraction. (5 personnel, 1 hour)

2. Bungee cocking verification in landing gear linkage. (3 personnel-30 minutes)

3. Nose landing gear door ground cable removal and landing gear hydraulic strut wipe down. (1 personnel - 10 minutes)

4. Armalon removal from landing gear doors and tile inspection verification around landing gear doors. (4 personnel - 1 hour)

Rationale/Analysis: The suspended load tasks comply with the NASA Alternate Safety Standard as follows:

Alternate Standard Requirement #1a: An indepth analysis was performed on the suspended load operations in OMI S0004. Orbiter/ET mate operations at the VAB cannot be conducted without personnel beneath the suspended load. The tasks performed under the load have been analyzed and evaluated with the determinaton that no feasible engineering design or procedural options are readily available to eliminate the suspended load operation.

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 maximum number of personnel identified for work to be performed under the suspended load for each task is 5. (Reference Description, items 1 thru 4 on page 2.) These personnel are also identified with safety vests to annotate the required personnel for the operation.

Alternate Standard Requirement #1c: Technicians will accomplish the required task as quickly and safely as possible to minimize time exposure. (Reference Description, items 1 thru 4 on page 2.)

Alternate Standard Requirement #4: OMI S0004 has been revised to require only the minimum number of technicians to work under the suspended loads. Steps in the procedure require personnel to be under the increased hazard only for those steps being worked. The OMI is available on site for inspection during the operation. (Reference Description, items 1 thru 4 on page 2.)

Alternate Standard Requirement #6 The VAB 175-ton and 250-ton bridge cranes are designed, tested, inspected, maintained, and operated in accordance with the NASA Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9. These cranes are designed to a minimum safety factor of 5 (based on the ultimate yield strength) for the hoist load-bearing components. The H70-0597 Orbiter lifting sling is designed with a safety factor of 5 against ultimate strength and a safety factor of 3 against yield.

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 cranes' rated capacity. The cranes have a dual braking system with overspeed braking.

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

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

When performing the mate operation, the 250-ton bridge crane is connected to the forward spreader beam of the H70-0597 orbiter lifting sling and the 175-ton bridge crane is connected to the aft spreader beam but disconnected after orbiter lift and rotation to vertical. The orbiter will not exceed 226,000 pounds (varies with orbiter and payload configuration) and the orbiter lifting sling weighs approximately 64,400 pounds. The maximum load lifted will not be over 290,000 pounds which is within the crane's rated capacity.

Alternate Standard Requirement #7: System Assurance Analyses, (SAA09FY12-005/SAA09FY12-006) have been completed on the 250-ton and 175-ton VAB bridge cranes. Each SAA includes a failure modes and effects analysis/critical item list (FMEA/CIL) and a hazard analysis.

The SAA's identify single failure points (SFP's) (31 for the 250-ton crane and 29 for the 175-ton crane) 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 10 feet/minute (2 inches/second). Failure of the remaining SFP's would allow the load to lower with regenerative braking at 0.25 feet/second (0.05 inches/second). There are no SFP's when the hoist is static.

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 a brake set light, ammeter, or selsyn position indicator (depending on the failure) which are in view of both crane operators. The crane operators would secure the load by applying the brakes. The longest estimated operator and system reaction time, i.e. without regenerative braking, to recognize the failure and set the brakes is 3 seconds and the load would have descended an estimated 12 inches. This estimate assumes a solid rocket booster segment being lowered at 10 feet/minute and failure occurring. In addition, Emergency Stop operators, remote from the crane operator's cab, can stop the crane if a failure indication is observed. In summary, there should be sufficient time to observe a failure and stop the crane before injuring personnel working under the suspended load.

The associated SAA CIL Sheets (pps. 319-361 for the 250-ton crane and pps. 305-345 for the 175-ton crane) identify all the rationale for accepting the risk of SFP's, 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 crane hook and lifting sling assembly with crane functional checks performed prior to each operation per NSS/GO-1740.9.

Alternate Standard Requirement #9: The crane operators, emergency pendant operators, and mechanical technicians are all trained and have current certifications. Operators will remain at the crane controls while personnel are under the load.

Alternate Standard Requirement 10: Appropriate safety clear areas shall be established and maintained prior to and during the operation. Only the minimum number of people will be 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 that 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, and voice contact with the crane 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 crane operator's cab, 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.

APPROVAL: DATE: SEP 18 1992

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APPROVAL: DATE:

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