APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

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TITLE MVAK SUSPENDED LOAD OPERATIONS

DOCUMENT NUMBER/TITLE OMI L0305 (LATEST ISSUE)/SL PRE-LAUNCH OPS (MODULE) AND TAP (LATEST ISSUE)/MVAK EXPERIMENT UNIQUE TRAINING TEST AND ASSEMBLY PROCEDURE (TAP)

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REQUIRED APPROVAL

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NASA SUSPENDED LOAD OPERATION
ANALYSIS/APPROVAL

OPERATIONS - The Module Vertical Access Kit (MVAK) is used to perform late access installation and contingency Line Replaceable Unit (LRU) changeout in the Spacelab at Launch Complex 39 (LC-39) Pad A or B. These tasks are practiced in the Vertical Access Simulator (VAS) in the Operations and Checkout(O&C)Building high bay during training.

SUPPORTING DOCUMENTS - The associated operational procedures and Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) are as follows:

- OMI L0305 (Latest Issue), SL* Pre-Launch Ops (Module) * Spacelab
- OMI L5109 (Latest Issue), SL Vertical Access Kit (MVAK) Equipment Installation/ Removal
- OMI L9003 (Latest Issue), SL Module Vertical Access Kit (MVAK) Familiarization/ Training
- FMEA # SSD92FO039 Crew Module Vertical Internal Access Kit
- MVAK Experiment Unique Training Test and Assembly Procedure (TAP) (Latest Issue)

GENERAL DESCRIPTION - The tasks listed below require two technicians to be directly under the suspended load (the mobility net and force gage during transfer to the module, the experiment package during installation/removal to/from module, the LRU during installation or removal, or the debris net during replacement) as follows:

OMI L0305

First Launch Attempt Scenario:

Crew Ingress Operations
Experiment and LRU Installation/Removal
Module Equipment Removal and Closeout
Crew Swap Operations
MVAK Joggle Equipment Removal
Crew Egress Operations

Scrub Turnaround Scenario:

Crew Ingress Operations
MVAK Module/Joggle Equipment Operations
Crew Swap Operations
Experiment and LRU Installation/Removal
Crew Egress Operations

Second Launch Attempt:

Crew Ingress Operations
Experiment and LRU Installation/Removal
Module Equipment Removal and Closeout
Crew Swap Operations
MVAK Joggle Equipment Removal
Crew Egress Operations

MVAK Experiment Unique Training:

Crew Ingress Operations
Experiment Mockup Installation
Experiment Mockup Removal
Module Equipment Removal and Closeout
Crew Egress Operations

OMI L5109:

MVAK Standard Hoist Lowering/Raising Procedures
MVAK Installation in STT* Joggle/SL - Orbiter Vertical *Spacelab Transfer Tunnel
MVAK Module Equipment Installation
Line Replaceable Unit (LRU) Replacement
MVAK Module Equipment Removal
MVAK Joggle Equipment Removal
LRU Handling Equipment Utilization - LRU Removal
LRU Handling Equipment Utilization - LRU Installation
MVAK Joggle Removal Contingency Condition
MVAK Installation in STT Joggle/SL for Contingency Condition

OMI L9003:

MVAK Standard Hoist Lowering/Raising Procedures
Initial Ingress
MVAK STT Joggle Equipment Installation - Orbiter Vertical
MVAK Module Equipment Installation/Removal
MVAK Joggle Equipment Removal
LRU Handling Equipment Utilization - LRU Removal
LRU Handling Equipment Utilization - LRU Installation
OTV* Camera Installation/Removal * Operational Television
Safety/Mobility Positioning Net Installation/Removal

During planned late installation of experiment packages or contingency access for component replacement, personnel can access the vertically configured Module via parachute harness, hang glider harness, or bosun's chair on a man-rated hoist.

The experiment packages or components are first lowered in the vertically configured Tunnel to the Joggle technician who is standing on the Joggle platform. The technician is directly under the package or component that is being lowered to him because of the confined space of the Tunnel.

The package or component is then lowered to the Module technician who is under the suspended load as he receives the package or component in the vertically configured Module, which is a confined space. Also, the technician can carry the package or component on his lap as he is lowered into the Module in the bosun's chair.

During the Push/Pull Test in the O&C VAS, two technicians (Module and Joggle techs) are working under a suspended load while the mobility net and force gage are transferred to the module.

During experiment package installation or removal at the pad (or simulated installation or removal during training in the O&C VAS), two technicians (the Module and Joggle techs) are working under a suspended load while raising or lowering the experiment package.

During experiment package rotation at the pad (or simulated rotation during training in the O&C VAS), two technicians (the Module and Joggle techs) are working under the suspended experiment package.

During Module and Joggle technician egress from MVAK at the pad (or in the O&C VAS during training), one technician is working below the other technician who is suspended and being hoisted out of the Joggle.

During LRU replacement at the pad (or simulated replacement during training in the O&C VAS), two technicians (the Module and Joggle techs) are working under a suspended load while raising or lowering the LRU.

During debris or safety net installation in the O&C VAS, one technician is working under the suspended debris or safety net.

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

Alternate Standard Requirement #1a - These operations cannot be conducted without placing personnel beneath the suspended mobility net and force gage, experiment package, LRU, or debris or safety net because of the confined spaces in the MVAK Tunnel and the Module while the Orbiter is in the vertical configuration.

MVAK operations at the pad or in the O&C VAS have been evaluated, and it has been determined that there are no procedural or operational means to eliminate personnel exposure to a suspended load. The MVAK equipment was specifically designed for these operations. The confined spaces in the Tunnel and the Module make it physically impossible for the technicians to move out from under the suspended load.

Alternate Standard Requirement #1b - The possible use of a secondary support system, to catch the load in the event of a crane failure, was analyzed. It was determined that the use of a secondary support system was not feasible because of limited access and confined areas in the MVAK at the pad and in the O&C VAS during training.

Alternate Standard Requirement #1c - The maximum number of personnel required under the suspended mobility net and force gage, experiment package, LRU, or debris or safety net is two.

Alternate Standard Requirement #1d - MVAK operations at the pad and training in the O&C VAS will be accomplished as quickly and safely as possible to minimize exposure time. It will take up to two persons no longer than 10 minutes to complete an individual task. However, the tasks are completed in sequence for up to 60 minutes.

Alternate Standard Requirement #4 - OMIs L0305, L5109, and L9003 have been revised to require only the approved number of persons under the suspended mobility net and force gage, experiment package, LRU, or debris or safety net during MVAK operations at the pad or training in the O&C VAS. The OMIs are available on site for inspection during the operations.

Alternate Standard Requirement #6 - Suspended load operations associated with MVAK operations at the pad and training in the O&C VAS involve three man-rated hoists. This analysis considers both the original (pneumatic) and upgraded (electric) MVAK hoists. The original hoists consists of three 225-lb, man-rated hoists operated by 125 psi shop air. The upgraded hoists consist of three 275-lb, man rated hoists operated by 28 VDC facility power.

The hoists are designed, tested, inspected, maintained, and operated in accordance with the NASA Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9. The rated load for each of the three original hoists is 450 lbs, and each hoist is designed with a minimum safety factor of 6.1 based on ultimate material strength. The maximum personnel hoisting capability is 50% of these hoist's maximum capability (225-lb). The man-rated load for the upgraded hoists is 275-lb and each hoist is designed with a safety factor 6.0 based on the ultimate material strength.

The hoist cables are 3/16 inch diameter steel wire rope with a safety factor exceeding 7.8 based on ultimate strength.

The three MVAK hoists of both the original and upgraded MVAK systems are equipped with an upper and lower limit switch as well as a load brake (primary) and an emergency brake. The primary brake (Weston gear action) is constantly engaged and can only be overcome by the driving action of the hoist. The emergency brake (sprag) provides redundant braking capability for movement in the down direction. The emergency brake is set to activate when the movement rate of decent is exceeded by 20%, i.e., 60 feet/minute. Both the primary brake and the emergency brake are fail-safe. Each brake's ability to hold the rated load is verified annually.

The MVAK hoists are load tested annually at 100% of their rated capacity. Detailed preventive maintenance is performed monthly, quarterly, semiannually, and annually on the hoists to ensure proper operation. Detailed wire rope inspection is performed prior to each use. Nondestructive evaluation is performed annually on the hoist hooks.

Alternate Standard Requirement #7 - A FMEA/CIL has been completed on the original MVAK hoists (see supporting documents), and although a formal analysis has not been approved on the upgraded hoists, both systems utilize the same drive trains. The original MVAK FMEA/CIL is a valid reference for the upgraded MVAK until a formal analysis is completed and approved for the new system.

The FMEA/CIL identifies no single failure points on the MVAK hoist assemblies.

Alternate Standard Requirement #8 - Visual inspections for cracks or other signs of damage or anomalies are performed on the hoist hooks, hoist spreaders, parachute harnesses, bosun's

chair attach clips and support clips, and package lifting eye bolts prior to each operation, and hoist functional checks are performed before each operation per NSS/GO-1740.9.

Alternate Standard Requirement #9 - Trained and licensed hoist operators shall remain at the hoist controls while personnel are under the suspended 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 - A pretask briefing and a safety walkdown of the area are conducted prior to the operations to ensure that all systems and personnel are ready to support. All participants are instructed on their specific tasks and warned of any hazards involved. 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 - Personnel beneath the suspended load will be in voice contact with the hoist operator and/or task leader via the Operational Intercommunications System. 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 - Personnel working beneath the load shall be in continuous sight of the hoist operator and/or task leader.

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