

APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

SLO-KSC- 1993-001

TITLE SLS-2 MVAK "Experiment Unique Training"

DOCUMENT NUMBER/TITLE T2-VAS-1004

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REQUIRED APPROVAL

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NASA SUSPENDED LOAD OPERATION
ANALYSIS/APPROVAL

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OPERATIONS - The Module Vertical Access Kit (MVAK) is used to accommodate 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:

- o OMI L0305 (Rev F, 08/21/92), SL* Pre-Launch Ops
(Module)
* Spacelab
- o FMEA # 90-A70-0558-03,-04 (Rev Basic, 11/10/88) Crew
Module Vertical Internal Access Kit
- o T2-VAS-1004 (Rev. Basic)SLS-2 MVAK "Experiment Unique
Training" Test and Assembly Procedure(TAP)

GENERAL DESCRIPTION - The tasks below require two technicians to be directly under the suspended load (during package transfer to the Module, the experiment package during installation or removal, the LRU during installation or removal, or the debris net during replacement) as follows:

OMI L0305	Initial Ingress Operations
	Rack 3 Research Animal Holding Facility (RAHF) Feeder Bar Installation-Storage Locker
	Rack 3 RAHF Rodent Cage Installation/Power-Up
	Rack 5 Feeder Bar Installation-Storage Locker
	Rack 4 Feeder Bar Installation-Storage Locker
	Rack 7 Research Animal Holding Facility (RAHF) Feeder Bar Installation-Storage Locker
	Rack 7 RAHF Rodent Cage Installation/Power-Up

Rack 9 Refrigerator/Freezer Contents Loading
Module Equipment Removal and Closeout
MVAK Crew Swap Operations
MVAK Joggle Equipment Removal

Scrub Turnaround:

Initial Ingress for MVAK Installation
MVAK Joggle/Module Equipment Installation
Initial Ingress for Experiment Operations
Rack 3 Research Animal Holding Facility
(RAHF) Feeder Bar Removal-Storage Locker
Rack 3 RAHF Rodent Cage Removal
Rack 5 Feeder Bar Removal-Storage Locker
Rack 4 Feeder Bar Removal-Storage Locker
Rack 7 Research Animal Holding Facility
(RAHF) Feeder Bar Removal-Storage Locker
Rack 7 RAHF Rodent Cage Removal
Rack 9 Refrigerator/Freezer Contents Removal

Second Launch Attempt:

Initial Ingress Operations
Rack 3 Research Animal Holding Facility
(RAHF) Feeder Bar Installation-Storage Locker
Rack 3 RAHF Rodent Cage Installation/Power-Up
Rack 5 Feeder Bar Installation-Storage Locker
Rack 4 Feeder Bar Installation-Storage Locker
Rack 7 Research Animal Holding Facility
(RAHF) Feeder Bar Installation-Storage Locker
Rack 7 RAHF Rodent Cage Installation/Power-Up
Rack 9 Refrigerator/Freezer Contents Loading

Rack 6 Ringers and Fixative Kit Installation
Module Equipment Removal and Closeout
MVAK Crew Swap Operations
MVAK Joggle Equipment Removal

T2-VAS-1004 Operation Support Setup 1 - MVAK Standard
Hoist Lowering Procedure

Operation Support Setup 2 - MVAK Standard
Hoist Raising Procedure

Rack 3 Research Animal Holding Facility
(RAHF) Feeder Bar Installation/Removal

Rack 3 RAHF Rodent Cage Installation/Removal

Rack 5 Feeder Bar Installation/Removal

Rack 4 Feeder Bar Installation/Removal

Rack 7 Research Animal Holding Facility
(RAHF) Feeder Bar Installation/Removal

Rack 7 RAHF Rodent Cage Installation/Removal

Rack 9 Refrigerator/Freezer Contents
Installation/Removal

Module Equipment Removal and Closeout
MVAK Crew Swap Operations

During planned late installation of Life Sciences Experiments 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.

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 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), one technician, the Joggle tech, is 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 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. Therefore, the hazard cannot be operationally or procedurally removed.

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 shuttle middeck 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. Transit times for hardware and personnel from the middeck to module average 5 minutes. However, the tasks are completed with both personnel and hardware suspended but not under the load in sequence for up to 60 minutes.

Alternate Standard Requirement #4 - OMIs L0305, L5109, L9003 and T2-VAS-1004 have been revised to require only the approved number of persons under the experiment package, LRU, or debris or safety net during MVAK operations at the pad or training in the O&C VAS. The OMIs and TAP 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 450-lb, man-rated hoists operated by 125 psi facility shop air. 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 hoists is 450 lbs, and each hoist is designed with a minimum safety factor of 6.1 based on 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 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 power and air failure-proof. Each brake's ability to hold the rated load (450 lbs) is verified annually.

One or two 450-lb hoists are being utilized at a time for these tasks. The weight of the equipment being hoisted does not exceed 125 lbs per the Spacelab Accommodations Handbook (a Marshall Space Flight Center Controlled document), which is 28% of each hoist's rated capacity. The maximum personnel hoisting capability is 225 lbs, which is 50% of the hoist's rated capacity. Equipment may be hoisted or lowered a maximum distance of approximately 50 feet.

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 cranes 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 MVAK hoists that are used at the pad and during training in the O&C VAS (see supporting documents).

The FMEA/CIL identifies no single failure points on the MVAK 450 lb hoists.

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 MVAK technician responsible for control of the hoist hook with the package as it is being lowered.

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