

# APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

SLO-KSC-2003-002 CH 2

TITLE PM Weight & C G Measurement - JEM Pressurized Module at SSPF

DOCUMENT NUMBER/TITLE JTP-35321 PM WEIGHT & C G MEASUREMENT

PREPARED BY JAXA DATE Oct. 2006

**REQUIRED APPROVAL**

CONTRACTOR \_\_\_\_\_ DESIGN \_\_\_\_\_ R & QA \_\_\_\_\_ OPERATIONS \_\_\_\_\_ SAFETY

NASA \_\_\_\_\_ DESIGN \_\_\_\_\_ R & QA \_\_\_\_\_ OPERATIONS \_\_\_\_\_ SAFETY

TYPE OR PRINT NAME	SIGNATURE	ORG.	DATE
NOBUO TAKEUCHI	<i>Nobuo Takeuchi</i>	JAXA SENTA	2006.10.31
KOKI OIKAWA	<i>Koki Oikawa</i>	JAXA JEM	2006.10.31
JIM DANIEL	<i>Jim Daniel</i>	Boeing NFD	11/2/2006
JEFF BENCH	<i>Jeff Bench</i>	NASA S&CI	11-2-06
PAUL KIRKPATRICK	<i>Paul Kirkpatrick</i>	GSRP	11/2/06
JOE TORSANI	<i>Joe Torsani</i>	SABI (JEM)	3 NOV 06

CONTRACTOR DIRECTOR OF SAFETY  
*Dennis Dailey, Dennis Dailey*

## NASA SUSPENDED LOAD OPERATION ANALYSIS/APPROVAL (SLOAA)

### OPERATION

1. To check the physical interference of Pressurized Module (PM) Keel trunnion to PM container.
2. To attach 2 lashing belts to the lifting rings of the lifting device kit after lifting PM, to move from the container to the dolly.
3. To remove 2 lashing belts from the lifting ring before lowering PM on the rotating rings of PM dolly.
4. To check the physical interference of PM cylinder to rotating rings.
5. To attach 6 rotating rings to PM.
6. To attach FTE support fitting to STBD rotating ring.
7. To attach 4 jack stands to the bottom of PM Dolly.
8. To remove FTE support fitting from STBD rotating ring.
9. To remove 6 rotating rings from PM.
10. To attach PDGF.
11. To remove PDGF.
12. To remove the PM from the PM stand.

NOTE: Change 2 incorporates previous changes and modifies this SLOAA in the following manner:

1. Add operations 12 to this SLOAA in support of Weight & CG Measurement.

### SUPPORTING DOCUMENTS:

The associated operational procedure/systems assurance analysis are as follows:

1. JTP-311003 Receiving and Setup-Pressurized Module
2. JTP-311012 Receiving and Inspection-PM Dolly/PM Step
3. SAA21CRS1-001, 30 Ton Highbay Bridge Cranes-Space Station Processing Facility (SSPF)
4. JTP-321032 DPA Measurement and CBCS target install.
5. JTP-351321 PM Weight & CG Measurement
6. E5006 Strongback Operations

### GENERAL DESCRIPTION:

1. When lifting PM from PM container, two workers under PM will check the physical interference between PM keel trunnion and trunnion block of PM container.
2. When attaching 2 lashing belts to the PM, to move from the container to the dolly, 4 workers will work under the PM.
3. When removing 2 lashing belts from the PM, to put it on PM Dolly, 4 workers will work under the PM.
4. When lowering the PM into the rotating rings, 8 JAXA and 2 Boeing CAPPS personnel will be under the strongback and PM to check the physical interference between PM cylinder and rotation ring.
5. When attaching 6 rotating rings to the PM, 2 workers have to work to stabilize each rotating ring under it, and 2 workers have to check the clearance between PM and a rotating ring.
6. When attaching FTE support fitting to the rotating ring, 2 workers have to tighten

bolts under FTE support fitting, and 4 workers have to stabilize FTE support fitting under it.

7. When attaching 4 jack stands to the PM, 4 workers will insert their hands under PM Dolly pitch to attach jack stands.
8. When removing FTE support fitting from the rotating ring, 2 workers have to remove bolts under FTE support fitting, and 4 workers have to stabilize FTE support fitting under it.
9. When removing 6 rotating rings from the PM, 2 workers have to work to stabilize each rotating ring under the rotating ring, and 2 workers have to check the clearance between PM and a rotating ring.
10. When attaching PDGF to the PM, 2 workers have to work to stabilize PDGF under them, 1 worker have to check the clearance between PM and PDGF, and 1 inspector have to check the clearance .
11. When removing PDGF from the PM, 2 workers have to work to stabilize PDGF under them, 1 worker have to check the clearance between PM and PDGF, and 1 inspector have to check the clearance.
12. When lifting/removing the PM out of the rotation rings, 8 JAXA and 2 Boeing CAPPS personnel will be under the PM and strongback to check the physical interference between the PM cylinder and rotation ring.

These tasks are completed in the following JTP-311003 sequences:

- Lifting PM from PM container.
- Attachment of 2 lashing belts to lifting rings.
- Transfer of PM to PM Dolly from PM container.
- Removal of 2 lashing belts from suspended PM.
- Replacement of PM to rotating rings of PM Dolly.
- Lifting PM to rotating ring.
- Attachment of FTE support fitting to PM.

These tasks are completed in the following JTP-311012 sequences:

- Lifting PM Dolly pitch.
- Attachment of 4 jack stands to PM Dolly pitch.
- Replace PM Dolly pitch on the SSPF floor.
- Attachment of 4 rotating rings to PM.
- 90 degree Rotation of PM.
- Attachment of 2 rotating rings to PM.

These tasks are completed in the following JTP-321032 sequences:

- Removal of FTE support fitting from rotating rings
- Removal of rotating rings from PM
- Attachment of bumper panels to PM
- Attachment of PDGF
- DPA measurement
- Removal of PDGF
- Removal of bumper panels from PM
- Attachment of rotating rings to PM
- Attachment of FTE support fitting to PM.

These tasks are completed in the following JTP-351321 sequences:

- Removal of FTE support fitting from rotating rings
- Removal of rotating rings from PM
- Attachment of bumper panels to PM
- Removal of PM from rotation rings using the strongback lifting fixture
- Weight and c.g. of PM Dolly in F/P 2 using the strongback lifting fixture
- Installation of PM into rotation rings using the strongback lifting fixture
- Removal of bumper panels from PM
- Attachment of rotating rings to PM
- Attachment of FTE support fitting to PM.

### **RATIONAL/ANALYSIS:**

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

#### **Alternate Standard Requirement #1a:**

These operations cannot be conducted without placing personnel or hands under the suspended PM and JEM GSE during PM setup operations. PM lifting kit, FTE support fitting, Rotating ring, and PDGF lifting operations at SSPF have been evaluated for alternate methods to complete these task, and it has been determined that there are no design, procedural, or operational means to eliminate personnel exposure to a suspended load, without exposing flight hardware to unacceptable damage.

#### **Alternate Standard Requirement #1b:**

1. The possible use of a secondary support system to catch the load in the event of a crane failure was analyzed. It was determined use of a secondary support system was not feasible because of vertical movement of suspended PM.
2. The possible use of a secondary support system to catch the load in the event of a crane failure was analyzed. It was determined use of a secondary support system was not feasible because of positioning of the PM over PM container and under the PM lifting kit.
3. The possible use of a secondary support system to catch the load in the event of a crane failure was analyzed. It was determined use of a secondary support system was not feasible because of positioning of the PM over PM dolly and under the PM lifting kit.
4. The possible use of a secondary support system to catch the load in the event of a crane failure was analyzed. It was determined use of a secondary support system was not feasible because of positioning of the PM over PM dolly and under the PM lifting kit.
5. The possible use of a secondary support system to catch the load in the event of a crane failure was analyzed. It was determined use of a secondary support system was not feasible because of horizontal movement of suspended rotating ring.
6. The possible use of a secondary support system to catch the load in the event of a crane failure was analyzed. It was determined use of a secondary support system was not feasible because of horizontal movement of suspended FTE support fitting.
7. The possible use of a secondary support system to catch the load in the event of a crane failure was analyzed. It was determined use of a secondary support system was not feasible because of positioning and attaching direction of jack stand parts.

8. Same as above No. 6.
9. Same as above No. 5.
10. The possible use of a secondary support system to catch the load in the event of a crane failure was analyzed. It was determined use of a secondary support system was not feasible because of horizontal movement of suspended PDGF.
11. Same as above No. 10.

**Alternate Standard Requirement #1c:**

1. The maximum number of personnel allowed under the load during checking keel trunnion is one.
2. The maximum number of personnel allowed under the load during attaching lashing belts is four.
3. The maximum number of personnel allowed under the load during removing lashing belts is four.
4. The maximum number of personnel allowed under the load during checking interference of PM cylinder with rotating rings is four.
5. The maximum number of personnel allowed under the load during checking interference of PM cylinder with rotating rings is 4. Two workers have to work to stabilize each rotating ring under it, and 2 workers have to check the clearance between PM and a rotating ring. This number is based on experience in TKSC/KSC.
6. The maximum number of personnel allowed under the load during attaching FTE support fitting to PM is 6. Two workers have to tighten bolts under FTE support fitting, and 4 workers have to stabilize FTE support fitting under it. This number is based on experience in TKSC/KSC.
7. The maximum number of personnel allowed under the load during attaching jack stopper part to Pitch part is four.
8. The maximum number of personnel allowed under the load during removing FTE support fitting to PM is 6. Two workers have to remove bolts under FTE support fitting, and 4 workers have to stabilize FTE support fitting under it. This number is based on experience in TKSC/KSC.
9. The maximum number of personnel allowed under the load during checking interference of PM cylinder with rotating rings is 4. Two workers have to work to stabilize each rotating ring under the rotating ring, and 2 workers have to check the clearance between PM and a rotating ring. This number is based on experience in TKSC/KSC.
10. The maximum number of personnel allowed under the load during attaching PDGF to PM is 4. Two workers have to work to stabilize PDGF under them, 1 worker have to check the clearance between PM and PDGF, and 1 inspector have to check the clearance. This number is based on experience in TKSC/KSC.
11. The maximum number of personnel allowed under the load during removing PDGF to PM is 4. Two workers have to work to stabilize PDGF under them, 1 worker have to check the clearance between PM and PDGF, and 1 inspector have to check the clearance. This number is based on experience in TKSC/KSC.

**Alternate Standard Requirement #1d:**

1. Checking keel trunnion will be accomplished as quickly and safely as possible to minimize exposure time. It will take one worker up to 10 minutes to check interference during PM lift under suspended load.

2. Attachment of lashing belts will be accomplished as quickly and safely as possible to minimize exposure time. It will take four workers up to 10 minutes to attach the lashing belts under suspended load.
3. Removal of lashing belts will be accomplished as quickly and safely as possible to minimize exposure time. It will take four workers up to 10 minutes to remove the lashing belts under suspended load.
4. Checking interference of PM cylinder with rotating rings will be accomplished as quickly and safely as possible to minimize exposure time. It will take four workers up to 20 minutes to check interference during PM lift to rotating ring under suspended load.
5. Attachment of rotating rings to PM will be accomplished as quickly and safely as possible to minimize exposure time. It will take four workers up to 2 hours to attach a rotating ring of 6 rings under suspended load. This number is based on experience in TKSC/KSC.
6. Attachment of FTE support fitting to rotating rings will be accomplished as quickly and safely as possible to minimize exposure time. It will take six workers up to 60 minutes to attach FTE support fitting under suspended load. This number is based on experience in TKSC/KSC.
7. Attachment of jack stopper parts to PM dolly will be accomplished as quickly and safely as possible to minimize exposure time. It will take four workers up to 10 minutes to attach 4 jack stopper parts under suspended load.
8. Removal of FTE support fitting from rotating rings will be accomplished as quickly and safely as possible to minimize exposure time. It will take six workers up to 60 minutes to attach FTE support fitting under suspended load. This number is based on experience in TKSC/KSC.
9. Removal of rotating rings from PM will be accomplished as quickly and safely as possible to minimize exposure time. It will take four workers up to 2 hours to attach a rotating ring of 6 rings under suspended load. This number is based on experience in TKSC/KSC.
10. Attachment of PDGF to PM will be accomplished as quickly and safely as possible to minimize exposure time. It will take four workers up to 60 minutes to attach PDGF under suspended. This number is based on experience in TKSC.
11. Removal of PDGF from PM will be accomplished as quickly and safely as possible to minimize exposure time. It will take four workers up to 60 minutes to attach PDGF under suspended. This number is based on experience in TKSC.

**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. The NASA Safety and Mission Assurance Division will maintain a list of approved suspended load operations.

**Alternate Standard Requirement #4:** The work authorizing documents are written to allow only required personnel under the suspended load. The work authorizing documents 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 suspended load operations addressed in this analysis involve the 30 ton SSPF bridge cranes. The cranes are designed, tested, inspected, maintained, and operated in accordance with the NASA Standard for Lifting Devices and Equipment, NASA-STD-8719.9.

The SSPF 30 ton crane hoists are equipped with two magnetic holding brakes, each capable of holding the load up to the crane's rated capacity. Each brake's ability to hold the rated load (30 tons) is verified annually. The cranes are designed to meet a 5 to 1 safety factor based on ultimate strength for the hoist load bearing components. The 30 ton cranes are load tested annually at 100% of their rated capacities. Detailed preventive maintenance is performed monthly, quarterly, semiannually, and annually on the cranes to ensure proper operation. Nondestructive testing of the crane hooks is performed annually.

PM Lifting kit is used for operations 1, 2, 3, and 4 described on page 1. Rotating ring lifting kit is utilized for operations 5 and 9. The sling included in the Rack turnover kit is utilized for operation 6 and 8, and the PM dolly sling is utilized for operation 7.

**PM Lifting Kit:** Dual 30 ton cranes are utilized for this task. The maximum weight of the PM lifting kit under double point lifting is 2,000 lbs and the payload may weigh as much as 31,000 lbs. The total load is 33,000 lbs.

The PM lifting kit is rated at 46,000 lbs and is designed to meet 5 or more to 1 safety factor based on ultimate strength

**The sling from the Rack turnover kit:** A 30 ton crane is utilized for this task. The maximum weight of the sling is 22 lbs and the payload may weigh as much as 550 lbs. The total load is 572 lbs.

The sling is rated a 3,300 lbs and is designed to meet 6 or more to 1 safety factor based on ultimate strength.

**Rotating Ring lifting kit:** A 30 ton crane is utilized for the task. The maximum weight of the rotating ring lifting kit is 30 lbs and the payload may weigh as much as 1,450 lbs. The total load is 1,480 lbs.

The rotating ring lifting kit is rated at 1,450 lbs and is designed to meet 5 or more to 1 safety factor based on ultimate strength.

**PM dolly sling:** A 30 ton crane is utilized for the task. The maximum weight of the PM dolly sling is 90 lbs and the payload may weigh as much as 21,000 lbs. The total load is 21,090 lbs.

The PM dolly sling is rated at 44,000 lbs (4 straps rated at 11,000 lbs each) and is designed to meet 5 or more to 1 safety factor based on ultimate strength.

The Rack sling jig: A 30-ton crane is utilized for the task. The maximum weight of the sling is 110 lbs and the payload may weigh as much as 1450 lbs. The total load is 1560 lbs.

The sling is rated at 1775 lbs and is designed to meet 5 or more to 1 safety factor based on ultimate strength.

The strongback is rated to hoist 65,000lbs. and is designed to the American Institute of Steel construction standards. The strongback has an annual visual inspection and the strongback's down rod links are proof loaded on an annual basis.

**Alternate Standard Requirement #7:** An SAA has been completed on the 30 ton bridge cranes in the SSPF. The SAA includes a Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) and a hazard analysis (see supporting documents). No critical single failure points were identified during this analysis

**Alternate Standard Requirement #8:** Visual inspections for cracks or other signs of damage or anomalies are performed on the hoist hooks, hoist beams, hoist cables, hoist rod assemblies, and hoist fittings, and crane functional checks are performed before each operation per NASA-STD-8719.9.

**Alternate Standard Requirement #9:** Trained and licensed crane operators shall remain at the hoist controls while personnel are under the load.

**Alternate Standard Requirement #10:** Appropriate safety control areas are established before initiating operations. Only the minimum number of people will be permitted in this area.

**Alternate Standard Requirement #11:** A pretask briefing and a safety walkdown of the area will be 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 potential hazards. 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:** The person beneath the suspended load will be in voice contact with the hoist operator and/or task leader. 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.

**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:

A handwritten signature in black ink that reads "John C. Dollberg". The signature is written in a cursive style and is positioned above a horizontal line.

11/3/06

John C. Dollberg  
Chief, ISS Payload Processing Division  
Kennedy Space Center