APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

TITLE: ALTA Pod Installation Test in VAB HB-4 on OV-105 SLO-KSC-2011-004

NUMBER/TITLE: SLO-KSC-2011-004

PREPARED BY: Michael McClure, USA Orbiter Handling DATE: 8/29/2011

CHECK APPROPRIATE BOX:

X Single Occurrence Operation Multiple Occurrence Operation ☐ Revision to Existing SLOAA

IF REVISION TO EXISTING SLOAA, SUMMARIZE CHANGES / RATIONALE:

REQUIRED APPROVAL:

CONTRACTOR	________DESIGN	________R & QA	________OPERATIONS	________SAFETY
NASA	________DESIGN	________R & QA	________OPERATIONS	________SAFETY

TYPE OR PRINT NAME	SIGNATURE	ORG.	DATE
Michael McClure	Michael McClure	USA Eng	9/13/11
John Garrett	John W. Garrett	USA Safety	9/13/11
Mark Gross	[signature]	USA Rel	9/13/11
William Robert Lantz	[signature] LANTZ	GP-O6	9/13/11
Joseph Torsani	[signature]	SA-G2	13 Sep 11
Alan Alemany	[signature]	SA-G2	9/13/11
Lisa Waters	Lisa Waters	USA S&MA	9/13/11
Michael Wetmore	Michael E. Wetmore	SA	9/15/11
Wilson Harkins		OSMA	

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ALTA Pod Installation Test on VAB HB-4 on OV-105

1.0 Background and Scope:

OV-101/Enterprise is on public display at the Stephen F. Udvar-Hazy Center near the Washington Dulles International Airport awaiting the arrival of OV-103/Discovery in 2012. Discovery will take Enterprise's place at the Center, and Enterprise will be ferried via one of NASA's Shuttle Carrier Aircraft (SCA) to the JFK International Airport in New York City where it will await the completion of a new facility at the Intrepid Air & Space Museum in NYC.

Presently, Enterprise is configured with two wooden display OMS pods in place of the Approach & Landing Test Article (ALTA) OMS pods that were installed on Enterprise for the test flights in the 1970s. The wooden display OMS pods were not designed for ferry flight, and in order to ferry Enterprise, the wooden OMS pods must be removed and the ALTA pods installed. NASA will only be responsible for the installation of the ALTA pods on Enterprise in preparation for ferry flight.

The ground support equipment (GSE) required for installing the ALTA pods is located at the Kennedy Space Center where it was used numerous times inside the Orbiter Processing Facilities (OPFs) to install and remove the Orbiter OMS pods. The normal procedure at KSC is not a suspended load operation because structure is used to abate the load and thus prevent injury to personnel in the event of a crane failure. In OPF 1 and 2, the load of the lifting fixture and the OMS pod is transferred from the overhead crane to the facility trolley beam, as shown in Figures 1 and 2. In OPF 3 the load stays on the crane hook, but load abatement jackscrews mounted on the lifting fixture in conjunction with load abatement platforms ensure that in the event of a crane failure the load would drop no more than a few inches, and then fall towards the Orbiter, see Figures 3 and 4. Additionally, a rotator jackscrew is used in the OPFs to rotate the OMS pods onto the Orbiter, see Figures 5, 6, and 7. This rotator also provides load abatement for the personnel located under the pod and lifting GSE.

Conversely, there is no structure surrounding Enterprise at the Udvar-Hazy Center, so the aforementioned trolley beam, load abatement jackscrews, and the rotator jackscrews are not an option, see Figures 8 and 9. Therefore, technicians will be required to work under suspended loads during ALTA pod installation. Building suitable structure at the Udvar-Hazy Center is unfeasible due to its size and complexity. Since the rotator jackscrew will not be available, a dual crane operation is necessary to rotate the ALTA pods to the correct orientation. Furthermore, in the OPF the OMS pods are lifted from the floor level with one overhead crane (see Figure 10) and the Udvar-Hazy Center does not have an overhead crane. Therefore, due to lack of availability of an overhead crane, and the lack of structure necessary to deploy the rotator jackscrew, two mobile cranes will be used at the Udvar-Hazy Center to lift and rotate the ALTA Pods into position. The operation at the Udvar-Hazy Center will be similar to a dual crane operation that was performed at Dryden Flight Research (DFRC) in the 1980s to lift, rotate, and install the ALTA pods onto Enterprise, see Figures 11 through 14.

However, the operations at Udvar-Hazy will use two mobile cranes instead of an overhead and mobile as in the DRFC operation (See Figures 21-23).

In order for the technicians, move directors, and handling engineers to gain experience and proficiency with installing ALTA pods using two mobile cranes and no surrounding structure, a test will be performed where the left hand ALTA pod will be lifted and rotated onto the deck of OV-105 in VAB HB-4. Attaching hardware will not be installed and the lifting fixture will remain attached to the ALTA Pod. **This SLOAA only covers the lifting and rotation of the left ALTA Pod onto OV-105 in VAB HB-4 using the cranes specified in Figures 21-25, and in Section A.4.7.** A separate SLOAA will be processed for the operations at the Udvar-Hazy Center at a later date. The knowledge and experience gained by performance of the VAB Test will be applied to the operations at the Udvar-Hazy Center. The ALTA Pod installation at Udvar-Hazy will likely use different cranes, but will be based on the configuration of the VAB Test covered in this SLOAA.

The VAB-Test operation was modeled using 3D CAD software to determine maximum lift radius and boom length for each of the cranes (refer to Figures 21-23). The inboard crane (75-Ton Link Belt), located at the aft of the Orbiter, will have a maximum lift radius of 45 ft. at a maximum boom length of 60 ft. (see Figure 21). Per its load chart, the capacity of the 75 Ton crane at that radius and boom length is 21,500 lbs (refer to Figure 24) The outboard crane (40-Ton Link Belt), located at the tip of wing, will have a maximum lift radius of 35 ft. at a maximum boom length of 60 ft (see Figure 21). Per its load chart, the capacity of the 40 Ton crane at that radius and boom length is 30,100 lbs (refer to Figure 25). Total lifted weight of the ALTA pod and lifting GSE is approximately 5.5 Tons (11,000 Lbs), which is well within the rated capacity of each crane individually.

The following operations will require personnel to work under a suspended load:

Suspended Load Operations and Approximate Exposure Times:

VAB Test - Port ALTA Pod Installation Only:

1. Align, adjust, insert and secure the port lifting fixture pivot shaft balls (See Figure 15) in the fwd and aft Orbiter mounted sockets (See Figures 15-18). The sockets create a hinge line for the pod/lifting fixture assembly to rotate about (See Figure 16).

    - Total number of operations: One
    - Total personnel under load for each operation: Two
    - Exposure time for this operation: 30 minutes

2. Rotate the port ALTA pod onto the deck for bolt hole alignment and installation. Two technicians are required to monitor and adjust the fwd and aft adjustment mechanisms and a third technician must monitor clearances and verify hole alignment at attach point 3 (See Figures 19 and 20).

-

    - Total number of operations: One
    - Total personnel under load for each operation: Three
    - Exposure time for this operation: One hour

3. Rotate the port ALTA pod off the Orbiter deck and then “float” the balls and remove the socket pins. Two technicians will need to monitor and adjust the fwd and aft adjustment mechanisms, and a third technician will need to monitor attach point. 3 (See Figures 19 and 20).

    - Total number of operations: One
    - Total personnel under load for each operation: Three
    - Exposure time for this operation: One hour

2.0 Requirements

The following requirements are from the NASA Lifting Standard 8719.9, Appendix A and are addressed individually for the ALTA Pod Installation Procedure:

A.4.1 All suspended load operations will be approved by the Center/facility NASA Director of Safety based upon a detailed engineering hazards analysis of the operation. The hazards analysis will be prepared by the responsible safety organization and coordinated through appropriate engineering and design offices. The analysis documentation will include the following:

a. A justification why the operation cannot be conducted without personnel beneath the load. Feasible procedure/design options will be investigated to determine if the work can be accomplished without personnel working under a load suspended from a crane/hoist.

In OPF-1/2 support of the suspended load is transferred from the overhead crane to a facility trolley beam and by definition is no longer suspended (See Figures 1 and 2). In OPF-3 there are load abatement platforms mounted to the surrounding structure in conjunction with deflector jack screws mounted on the fwd and aft adjustment mechanisms designed to force a falling OMS pod to fall away from technicians and onto the Orbiter (See Figures 3 and 4). A rotator jackscrew is also used in the OPF to rotate the pod onto the deck, and it provides additional load abatement (See Figures 5 through 7). The rotator will not work at the Center without supporting structure. None of this structure or any suitable substitute is available at the Udvar-Hazy Center (Refer to Figures 8 to 9). Therefore, the only way to abate the suspended load at the Center would be to build substantial platforms and structures, which is unfeasible due to size and complexity of said structures. In order to gain experience and proficiency with installing ALTA pods using two mobile cranes and no surrounding structure, the left hand ALTA pod will be lifted and rotated onto the deck of OV-105 in VAB HB-4. Attaching hardware will not be installed and the lifting fixture will remain attached to the ALTA Pod. The knowledge and experience gained by performance of the VAB Test will be applied to the operations at the Udvar-Hazy Center to be documented in a separate SLOAA.

b. Details of the precautions taken to protect personnel should the load drop. Secondary support systems, i.e., equipment designed to assume support of (catch) the load preventing injury to personnel should the crane/hoist fail, shall be evaluated and used whenever feasible. Secondary support systems will be constructed with a minimum safety factor of 2 to yield.

There are no secondary support (fall arrest) systems that can be utilized during the exposure timeframe for these lift operations. However, both mobile cranes will be connected to the load at all times when personnel are working under the suspended load, and the load will be less than one foot above the OMS deck, minimizing the dropping distance.

c. The maximum number of exposed personnel allowed. Steps shall be taken to limit the *number of personnel working under a load suspended from a crane/hoist. Only those essential personnel absolutely necessary to perform the operation will be allowed to work in the safety controlled area.*

The work steps involved in the suspended load operation will be performed by three technicians located on the A72-1320/21 50-01/02 door access platform (See Figure 11-12). One technician will need to be under the fwd adjustment mechanism to help align/adjust the fwd pivot shaft ball into its socket and then secure the ball with the tethered pins (See Figure 17). The 2nd technician will need to do the same for the aft pivot shaft ball (See Figure 18). And a 3rd technician will need to monitor the close tolerance bolt hole at attach point three (See Figure 19). All three technicians will need to maintain their positions until the bolt hole at attach point 3 is lined up and the bolt can be installed (See Figure 19).

d. The time of exposure. Steps shall be taken to ensure that personnel do not remain under the load any longer than necessary to complete the work.

Personnel will not remain under the suspended load any longer than necessary to complete the work safely. The maximum exposure times for each suspended load operation are detailed in Section 1 - Scope.

A.4.2 Each operation will be reviewed on a case-by-case basis.

A work plan written for the operation will be reviewed and approved by USA and NASA safety. A Ground Operations Risk Assessment (GORA) is also being performed by the team to identify and quantify all risks and develop mitigating controls. All of the controls will be incorporated into the written procedure.

A.4.3 Only those suspended load operations approved by the Center/facility NASA Director of Safety will be permitted, subject to this standard. A list of approved suspended load operations will be maintained by NASA Safety and made available to OSHA personnel upon request.

This document satisfies the above requirement and will be filed with the KSC Safety Office and is available on-line at http://ksc-lde.ndc.nasa.gov/. The SLOAA will also be referenced in the text of the work plan for ALTA Pod Installation.

A.4.4 The operational procedures document (e.g., Operations and Maintenance Instruction, Technical Operating Procedure, Work Authorization Document) will be revised to specify the necessary additional requirements identified by the hazard analysis discussed in paragraph A.4.1. The procedures will be available on site for inspection during the operation.

The written procedure will be available for review prior to performing the operations in question as well as on the floor during the lift. The procedures will allow only required personnel under the suspended load. Pre-task briefings will be conducted as required in accordance with pre-task briefing Operating Procedure.

A.4.5 During a suspended load operation, if a new procedure not covered by the original analysis is deemed necessary due to unusual or unforeseen circumstances, the NASA Center/facility Safety Office will be consulted and must approve and document the procedure before operations continue. Safety will coordinate with Operations, Engineering, and other organizations as appropriate. If the new procedure is to be performed on a regular basis, a detailed hazards analysis and approval as outlined in paragraph A.4.1 are required.

Any 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 NASA Headquarters OSMA and KSC Safety and Mission Assurance Division Chief.

A.4.6 The crane/hoist shall be designed, tested, inspected, maintained, and operated in accordance with the NASA Standard for Lifting Devices and Equipment (NASA-STD-8719.9). Test, inspection, and maintenance procedures will be developed and approved by qualified, responsible NASA engineers. Qualified specialists will perform the procedures and resolve noted discrepancies. NASA Quality Assurance will perform an independent annual inspection of all cranes/hoists involved in suspended load operations. The results of the annual inspections will be maintained and made available to OSHA personnel upon request.

The two critical lift certified cranes planned for this operation are: Link Belt HTC8675 75 Ton crane and Link Belt Model HSP-8040 40 Ton crane. Both cranes have undergone inspection and proof testing and will be in current certification at the time of the operations. The cranes have been designed, maintained, inspected and tested in accordance with NASA STD 8719.9.

A.4.7 Each crane/hoist involved in suspended load operations shall undergo a Failure Modes and Effects Analysis (FMEA) that shall be approved by the Center/facility NASA Director of Safety. The FMEA will determine Single Failure Points (SFP), assessing all critical mechanical functional components and support systems in the drive trains and critical electrical components.

Both cranes have been analyzed for Single Point Failure modes. Refer to SAA00210 for the Link Belt HTC8675 75-Ton crane and SAA09FT01-006 for the Link Belt Model HSP-8040 40-Ton crane. Passive components such as rope, drum, wire rope and hook are verified through preventive maintenance.

Link Belt HTC8675 75-Ton Crane

The SAA for the 75-Ton Link Belt identified the Winch Reduction Unit as a SFP that may result in dropping the load. The use of high quality components and a comprehensive maintenance, inspection and test program including pre-operational checks ensure that the crane systems operate properly. The SAA identified failure mode is gear disengagement due to structural failure of the gears or shaft. There is no history of failure of the Winch Reduction Unit on this crane. The hoist system is load tested at 100% rated load annually. The use of high quality components and a comprehensive maintenance, inspection and test program including pre-operational checks ensure that the crane systems operate properly.

Link Belt HSP 8040 40-Ton Crane

The SAA for the 40-Ton Link Belt identified the Winch Reduction Unit and the Winch Brake Assembly as SFPs that may result in dropping the load. The use of high quality components and a comprehensive maintenance, inspection and test program including pre-operational checks ensure that the crane systems operate properly.

The SAA identified failure mode for the Winch Reduction Unit for the 40-Ton Link Belt is gear disengagement due to structural failure of the gears or shaft. There is no history of failure of the Winch Reduction Unit on this crane. The hoist system is load tested at 100% rated load annually.

The identified failure mode for the 40-Ton Link Belt Winch Brake Assembly is that the brake slips or fails to engage due to structural failure. The analysis conservatively did not consider the effect of the hydraulic fluid counterbalance valve that locks the hydraulic fluid when the valve is in the neutral position. This locking of the hydraulic fluid provides an effective second means of braking. Additionally, there is no history of failure of the Winch Brake Assembly in the critical failure mode. The hoist system of each crane is load tested at 100% rated load annually.

A.4.8 Before lifting the load involved in a suspended load operation, the crane/hoist will undergo a visual inspection (without major disassembly) of components instrumental in assuring that the load will not be dropped (e.g., primary and secondary brake systems, hydraulics, mechanical linkages, and wire rope per NASA-STD-8719.9). Noted discrepancies will be resolved before the operation continues. This pre-lift inspection will be in addition to the inspections required in 29 CFR, 1910.179(j).

Prior to start of the operations, both mobile cranes will be inspected and run through all directions to assure proper operation and functionality of the fail safe devices. Any noted discrepancies will be resolved before operations commence for the day. This pre-lift inspection will be in addition to the inspections required in 1910.179(j).

A.4.9 A trained and licensed operator (certified per NASA-STD-8719.9) shall remain at the crane/hoist controls while personnel are under the load.

The mobile crane operators will be trained and licensed in accordance with NASA-STD-8719.9. In addition, each operator will have undergone hands-on specific training on the two cranes. The crane operator will remain at the crane controls when personnel are under the suspended load.

A.4.10 Safety controlled areas shall be established with appropriate barriers (rope, cones, etc.). All nonessential personnel shall be required to remain behind the barriers.

Non-essential personnel will be kept clear of the lift operation as noted in the procedure. A controlled area will be established for all crane operations in the work plan.

Appropriate barriers will be set-up prior to the start of the lift and removed only when the lift has been completed. A detailed discussion of the controlled area will be conducted at the pre-lift briefing to assure all participants are familiar with the defined boundary.

A.4.11 Prior to the suspended load operation, a meeting with the crane/hoist operator(s), signal person(s), person(s) who will work under the load, and the person responsible for the task shall be held to plan and review the approved operational procedures that will be followed, including procedures for entering and leaving the safety controlled area.

The pre-task briefing will cover the suspended load operations, and a Ground Ops Risk Assessment (GORA) will be performed prior to these operations to help identify risks and develop mitigating controls.

A.4.12 Communications (voice, radio, hard wired, or visual) between the operator(s), signal person(s), and the person(s) working under the load shall be maintained. Upon communication loss, operations shall stop immediately, personnel shall clear the hazardous area, and the load shall be safed. Operations shall not continue until communications are restored.

Communication and direct visual contact will be maintained at all times between the move director and the technicians, between the crane operator and move director, and between the crane operators and the technicians under the suspended load. Upon visual or communication loss the lift will be halted immediately and persons under the suspended load will move to a safe area outside the envelope of the suspended load until the line of sight and/or communication can be re-established. All lifts during ALTA pod installation, including the suspended load lifts in question, will be conducted with direct voice communication between the move director and crane operators using voice and hand signals. Communication between the move director and the technicians will be via wireless headsets.

A.4.13 Personnel working beneath the load shall remain in continuous sight of the operator(s) and/or the signal person(s).

See above response.

A.4.14 NASA shall conduct periodic reviews to ensure the continued safety of the procedures. As a minimum, NASA will annually evaluate the implementation of this procedure at each Center with operations on the suspended load list.

All hazardous procedures, including suspended load operations, will be reviewed in accordance with the standard TOPs review process as described in KNPR 8715.3. The appropriate NASA/KSC Safety organizations will review and approve all hazardous procedures well in advance of the commencement of the operation with at least seven days lead time after approval.

A.4.15 A list of approved suspended load operations, list of cranes/hoists used for suspended load operations, and copies of the associated hazards analyses will be *provided to the OSHA Office of Federal Agency Programs via NASA Headquarters for distribution to the appropriate regional and area OSHA offices. (NASA Headquarters, in conjunction with OSHA, will develop a format for transmittal of this information.) Quarterly updates to the documentation will be provided as needed.*

Figures to Help Illustrate the Operation

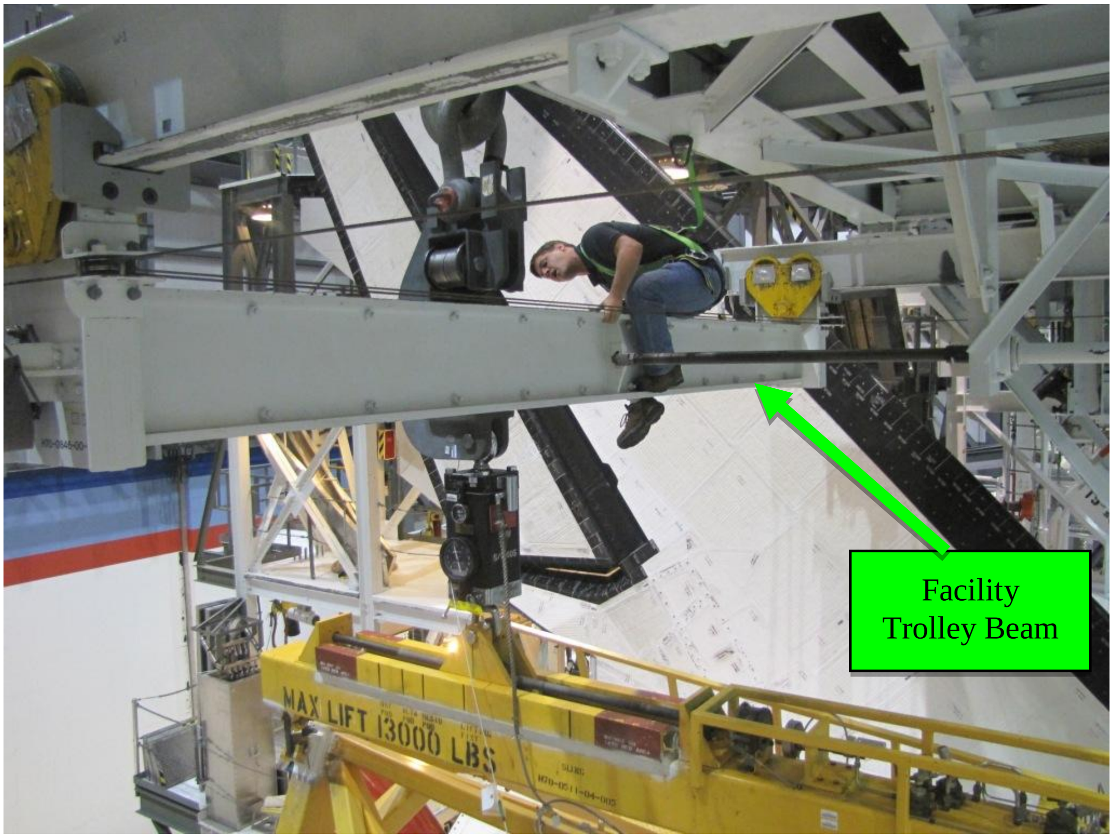

Photo 1 - Load is Transferred from OHC to Facility Trolley Beam in OPF-1/2

This photo shows the load of the lifting GSE and pod being transferred from the overhead crane to the facility trolley beam in the OPF-1/2. Once the load is supported by the trolley beam it is no longer considered a suspended load.

Figure 2 - OMS Pod on Facility Trolley Beam - Not a Suspended Load

This photo shows the load of the GSE and pod being supported by the facility trolley beam in OPF-1/2

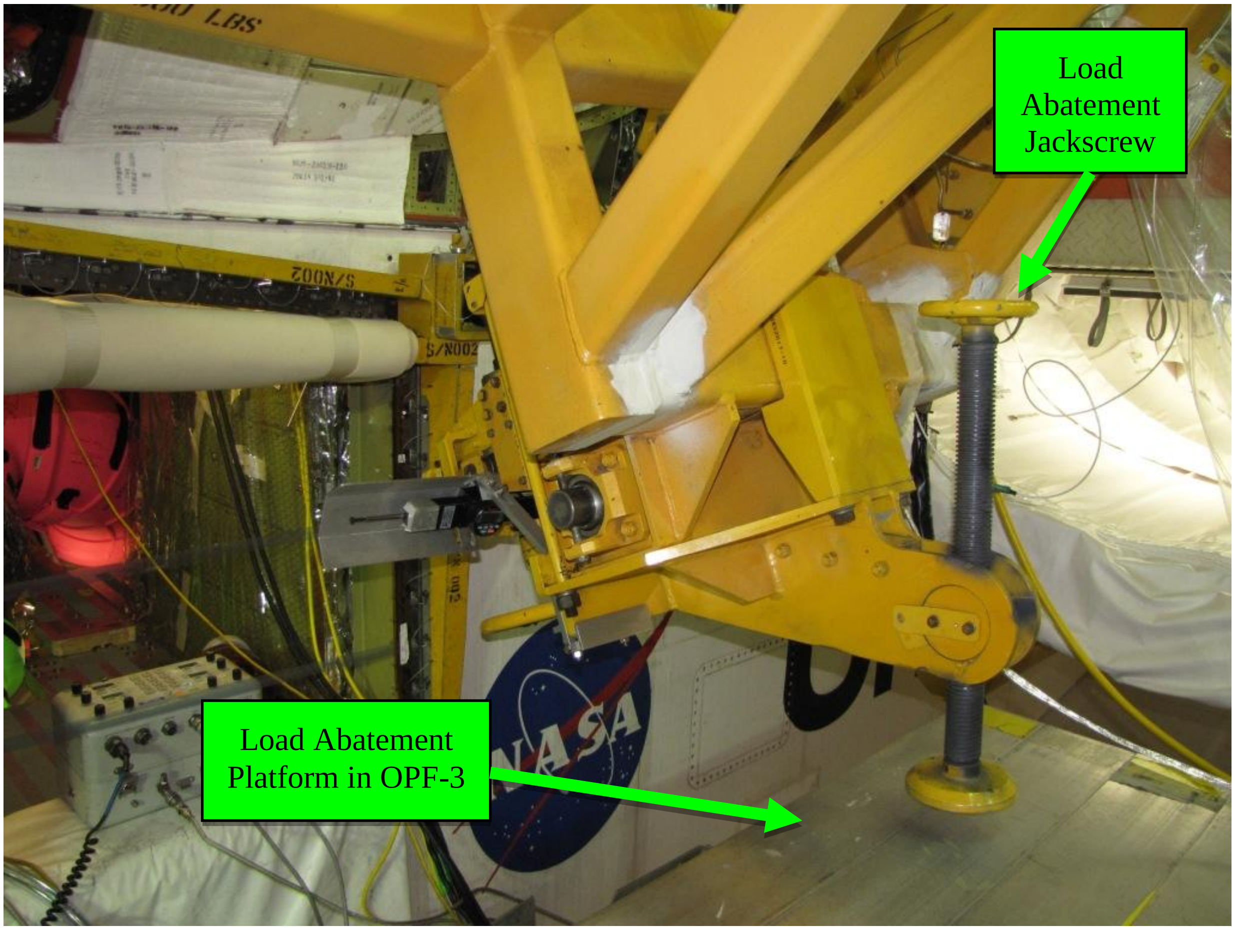

Figure 3 - Fwd Adjust Mechanism and Load Abatement Jackscrew and Platform

This photo shows the fwd adjustment mechanism and its suspended load abatement jackscrew and associated load abatement platform. The purpose of the load abatement jackscrew and platform is to force the pod to "fall" into the Orbiter as opposed to falling on personnel in the event of a catastrophic crane failure. The load abatement platforms are only used in OPF-3 because the load of the GSE and pod is suspended from the overhead crane (OHC). In OPF-1/2 the load is not suspended from a crane during this part of the operation; the load is supported by the facility trolley beam (see Figures 1 and 2). Without any surrounding structure (i.e., in the VAB or in the later operation at the Udvar-Hazy Center) the load abatement platforms are not an option because there is nothing to attach the platforms to (see Figures 19 and 20).

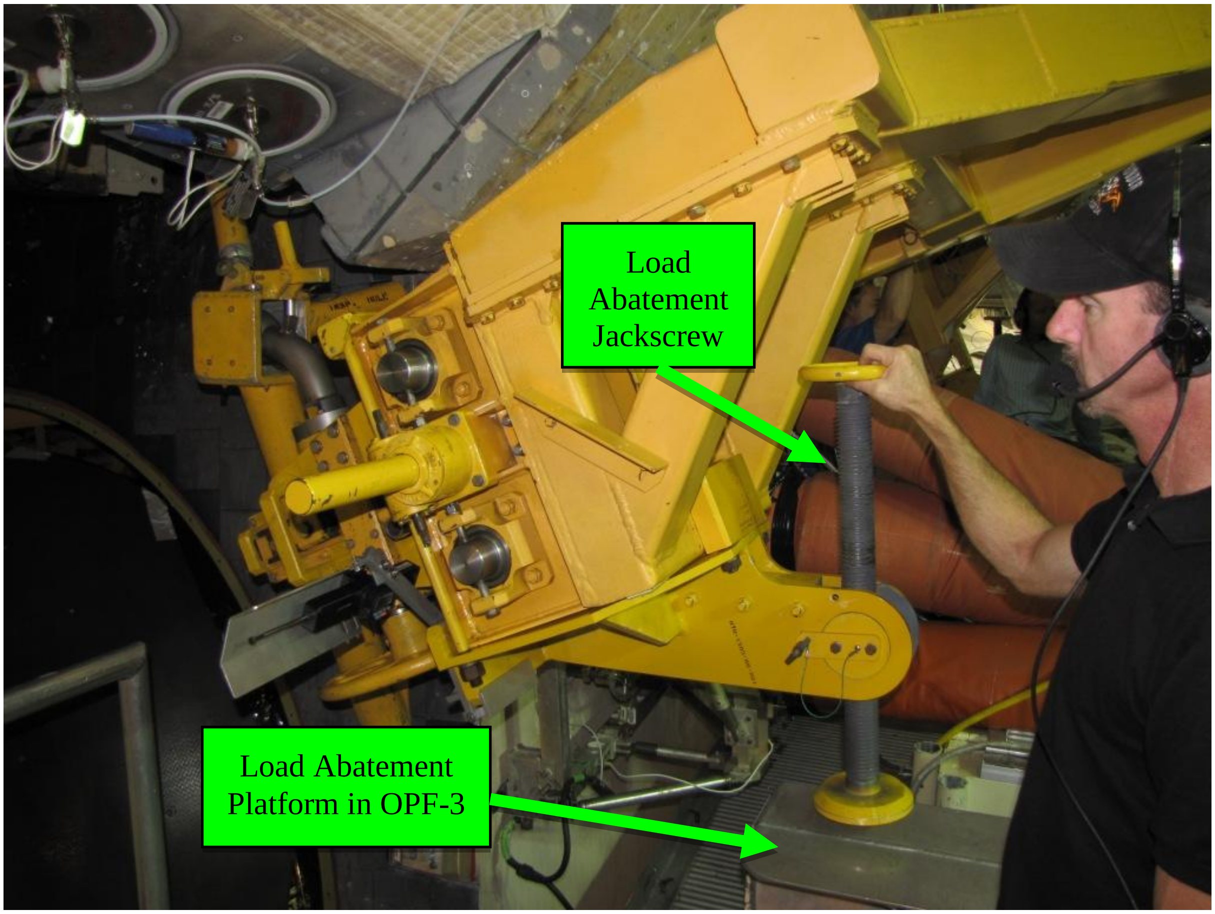

Figure 4 - Aft Adjust Mechanism and Load Abatement Jackscrew and Platform

This photo shows the aft adjustment mechanism and its suspended load abatement jackscrew and associated load abatement platform. The purpose of the load abatement jackscrew and platform is to force the pod to “fall” into the Orbiter as opposed to falling on personnel in the event of a catastrophic crane failure. The load abatement platforms are only used in OPF-3 because the load of the GSE and pod is suspended from the overhead crane (OHC). In OPF-1/2 the load is not suspended from a crane during this part of the operation; the load is supported by the facility trolley beam (see Figures 1 and 2). Without any surrounding structure (i.e., in the VAB or at the later operation at the Udvar-Hazy Center) the load abatement platforms are not an option because there is nothing to attach the platforms to (See Figures 19 and 20).

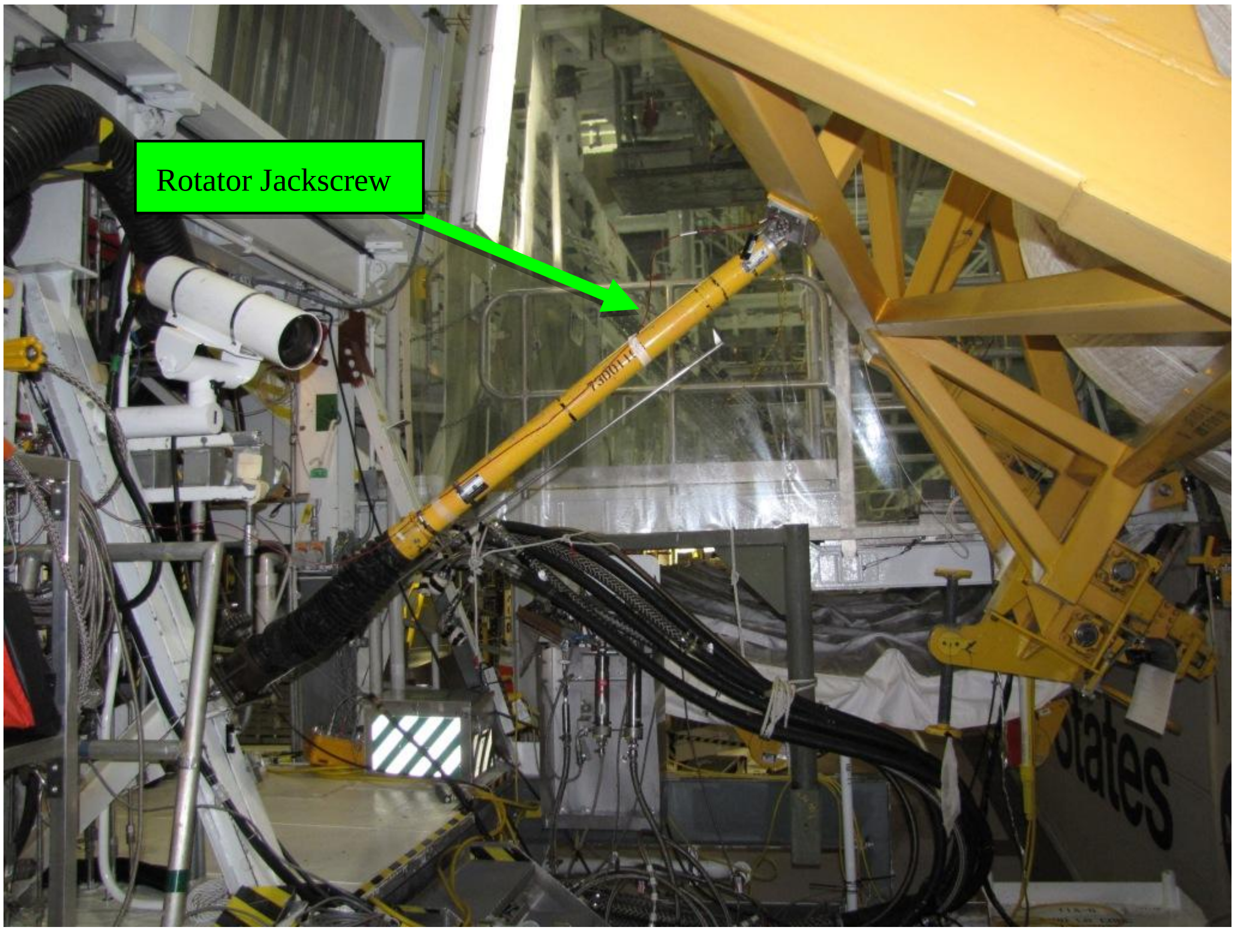

Figure 5 - Rotator Jackscrew Used in OPF to Rotate Pod onto the Deck

This photo shows the rotator jackscrew used to rotate the pod onto/off the deck. Without surrounding structure the rotator is not an option, therefore, it can't be used in the VAB or at the later operation at the Udvar-Hazy Center.

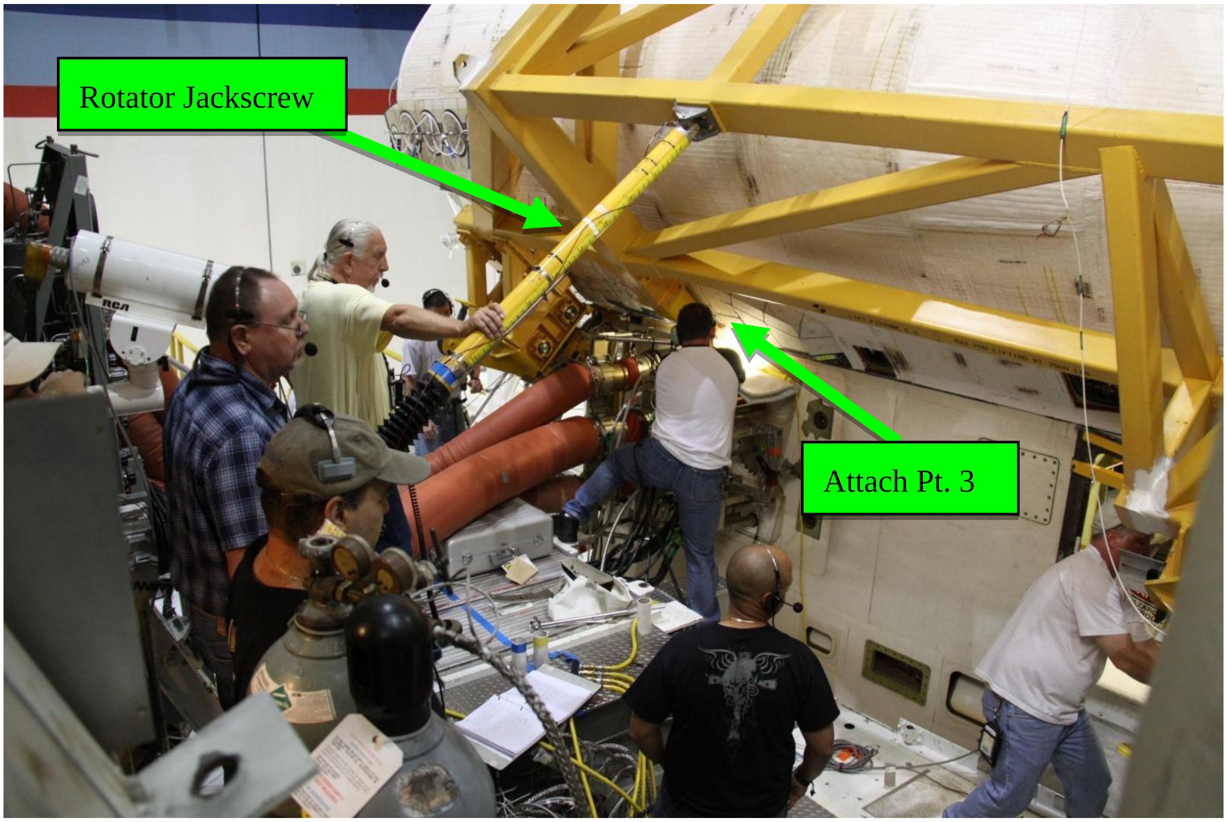

Figure 6- Technician Monitoring Attach Points

This photo shows an OMS pod being rotated onto the OMS deck using the rotator jackscrew. Three technicians are monitoring the fwd and aft adjustment mechanisms and attach point three as the pod is rotated into position. Without a rotator and load abatement platforms or facility trolley beam, the technicians will be working under a suspended load.

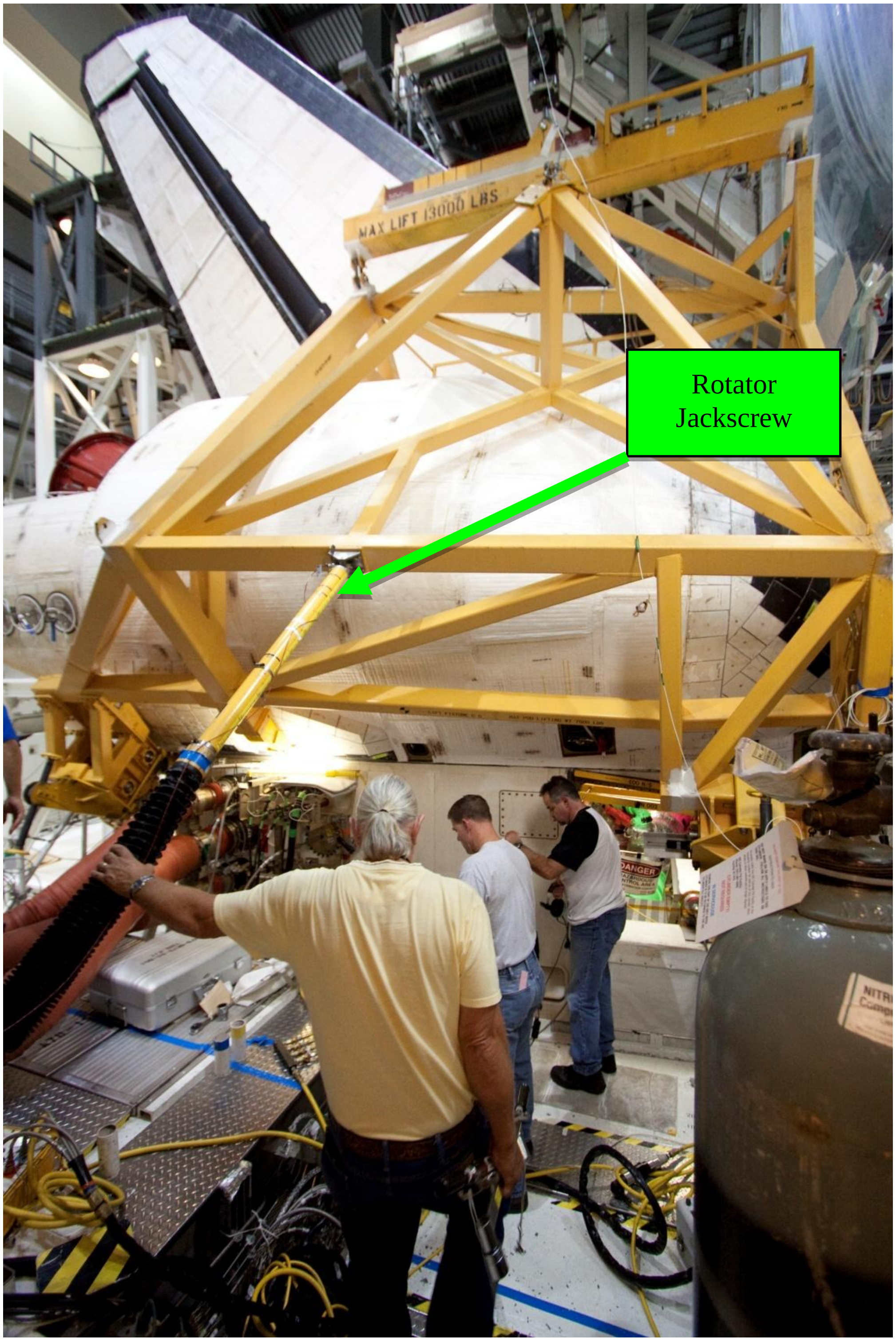

Figure 7 - OMS Pod Removal in OPF-2

This photo shows the pod being supported by the facility trolley beam in OPF-1/2, and the rotator jackscrew is connected between structure and the lifting fixture.

Figure 8 - Enterprise at the Udvar-Hazy Center (showing the left display pod)

This photo shows the Enterprise at the Udvar-Hazy Center. Without substantial surrounding structure, the rotator jackscrew and the load abatement platforms are not an option. The VAB test will be used to model these conditions and will be used to gain proficiency with installing ALTA pods using two mobile cranes and no surrounding structure.

Figure 9 - Enterprise at the Udvar-Hazy Center (showing the right display pod)

This photo shows the Enterprise at the Udvar-Hazy Center. Without substantial surrounding structure, the rotator jackscrew and the load abatement platforms are not an option. The VAB test will be used to model these conditions and will be used to gain proficiency with installing ALTA pods using two mobile cranes and no surrounding structure.

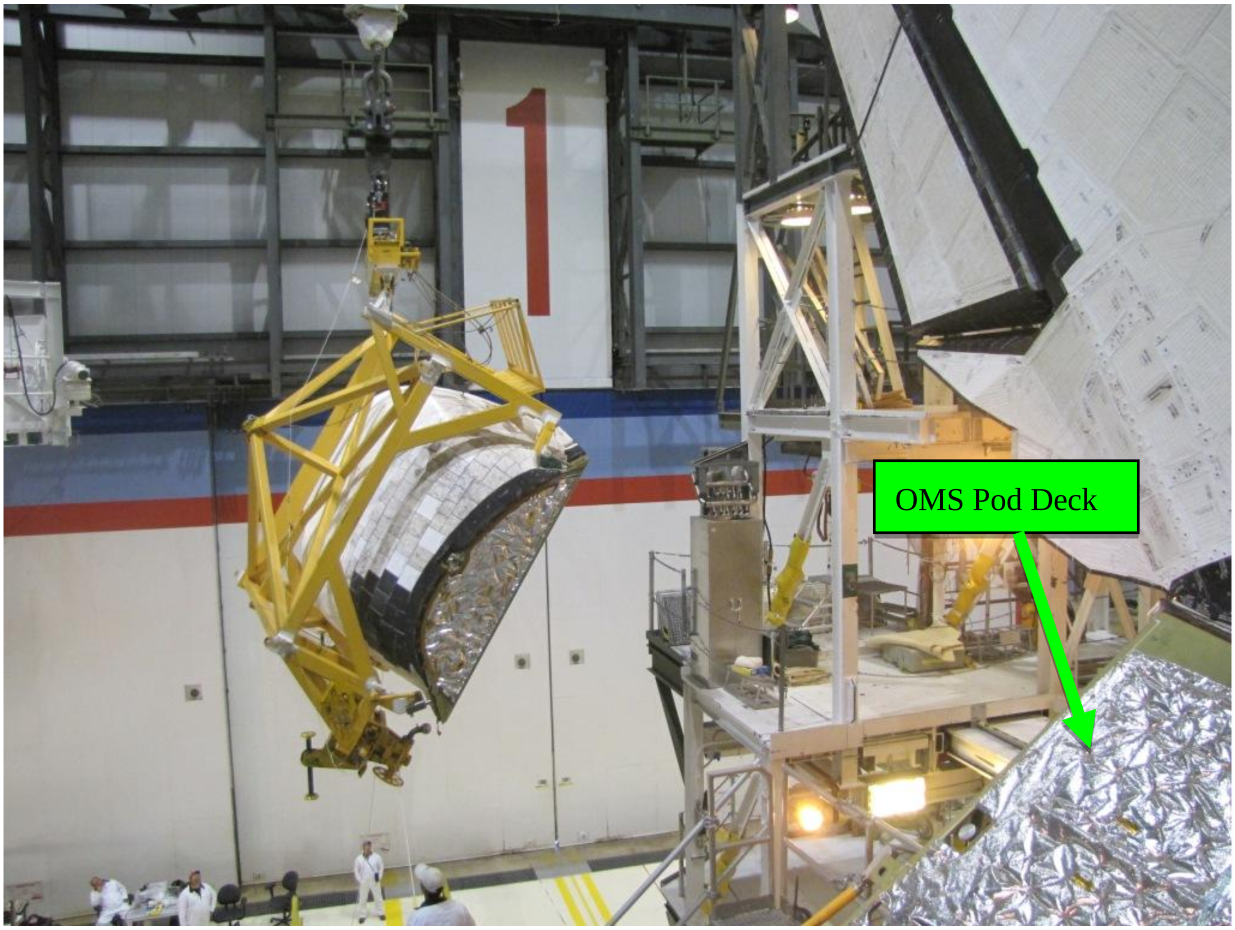

Figure 10 - Suspended OMS Pod

This photo shows an OMS pod suspended from the OHC in OPF 1. The dry weight of the OMS pods is approximately 5000 lbs each. The weight of the ALTA pod is approximately 3900 lbs. The combined weight on an ALTA pod and lifting fixture is approximately 11,000 lbs.

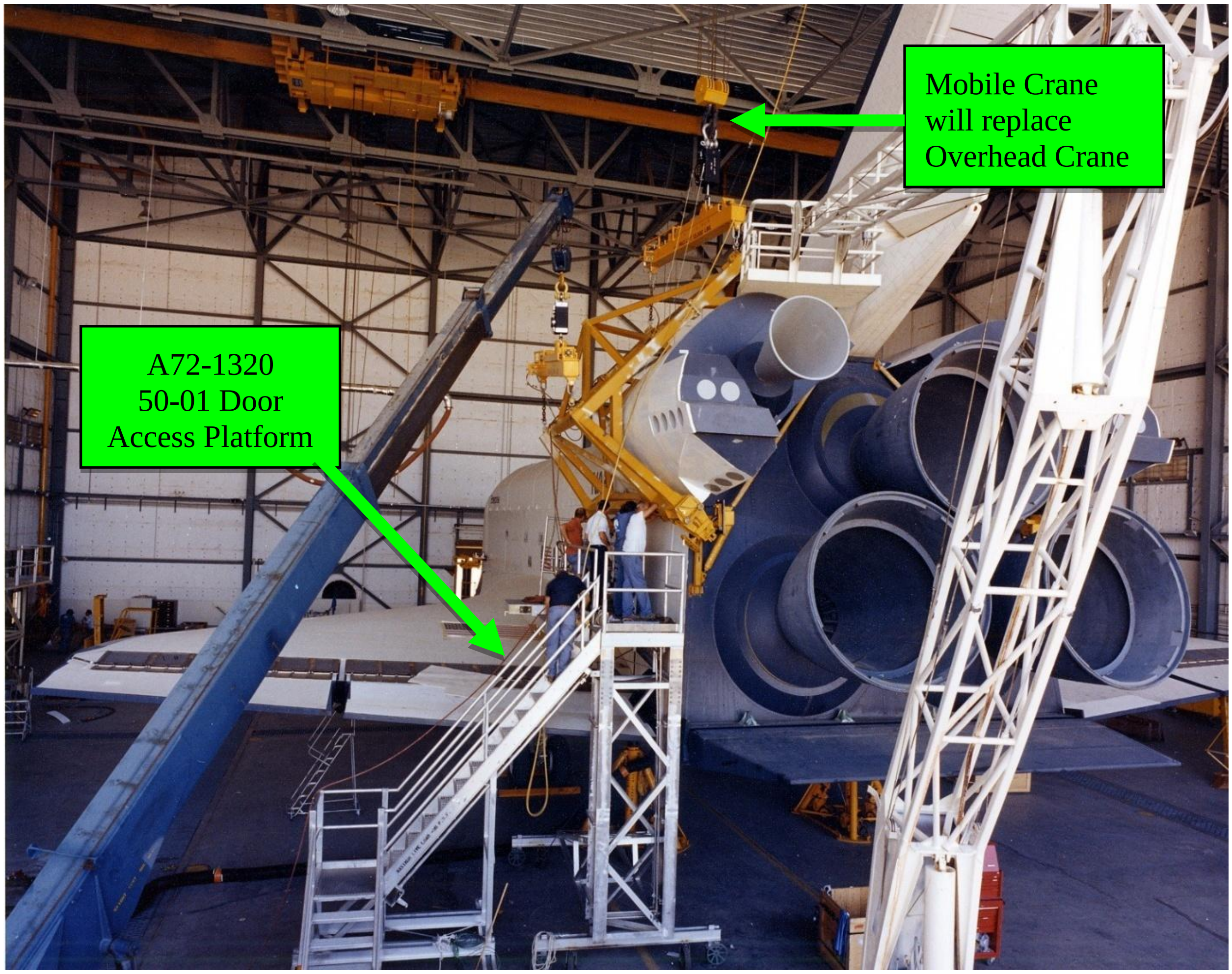

Figure 11 - Port ALTA Pod Installation Using Two Cranes

This photo was taken inside the NASA hangar at the Dryden Flight Research Center (DFRC) at Edwards AFB, CA, in the 1980s. It shows the left hand ALTA pod being installed on Enterprise using a pendant-controlled overhead crane (OHC) and mobile crane. Access to the fwd and aft adjustment mechanisms was via the A72-1320 platform. With the exception of the OHC this picture depicts the operation that is required for the VAB test (and for later the ALTA pod installation on Enterprise at the Udvar-Hazy Center).

Figure 12 - ALTA Pod Installation Using Two Cranes

This photo was taken inside the NASA hangar at the Dryden Flight Research Center (DFRC) at Edwards AFB, CA, in the 1980s. It shows the left hand ALTA pod being installed on Enterprise using a pendant-controlled overhead crane (OHC) and mobile crane. Access to the fwd and aft adjustment mechanisms was via the A72-1320 platform. With the exception of the OHC this picture depicts the operation that is required for the VAB test.(and for the later ALTA pod installation on Enterprise at the Udvar-Hazy Center).

Figure 13 - Lifting Fixture Suspended from Two Cranes

This photo was taken inside the NASA hangar at the Dryden Flight Research Center (DFRC) at Edwards AFB, CA, in the 1980s. It shows the left hand lifting fixture being removed from the ALTA pod using a pendant-controlled overhead crane (OHC) and mobile crane. During the VAB test, the plan is to only rotate the ALTA pod onto the deck, but attaching hardware will not be installed and the lifting fixture will remain attached. The lifting fixture would only be removed after the ALTA pod is installed at the Udvar-Hazy Center. The VAB test (and the later operation at Udvar-Hazy Center) will use two mobile cranes instead of a mobile crane and an overhead crane as shown in this picture.

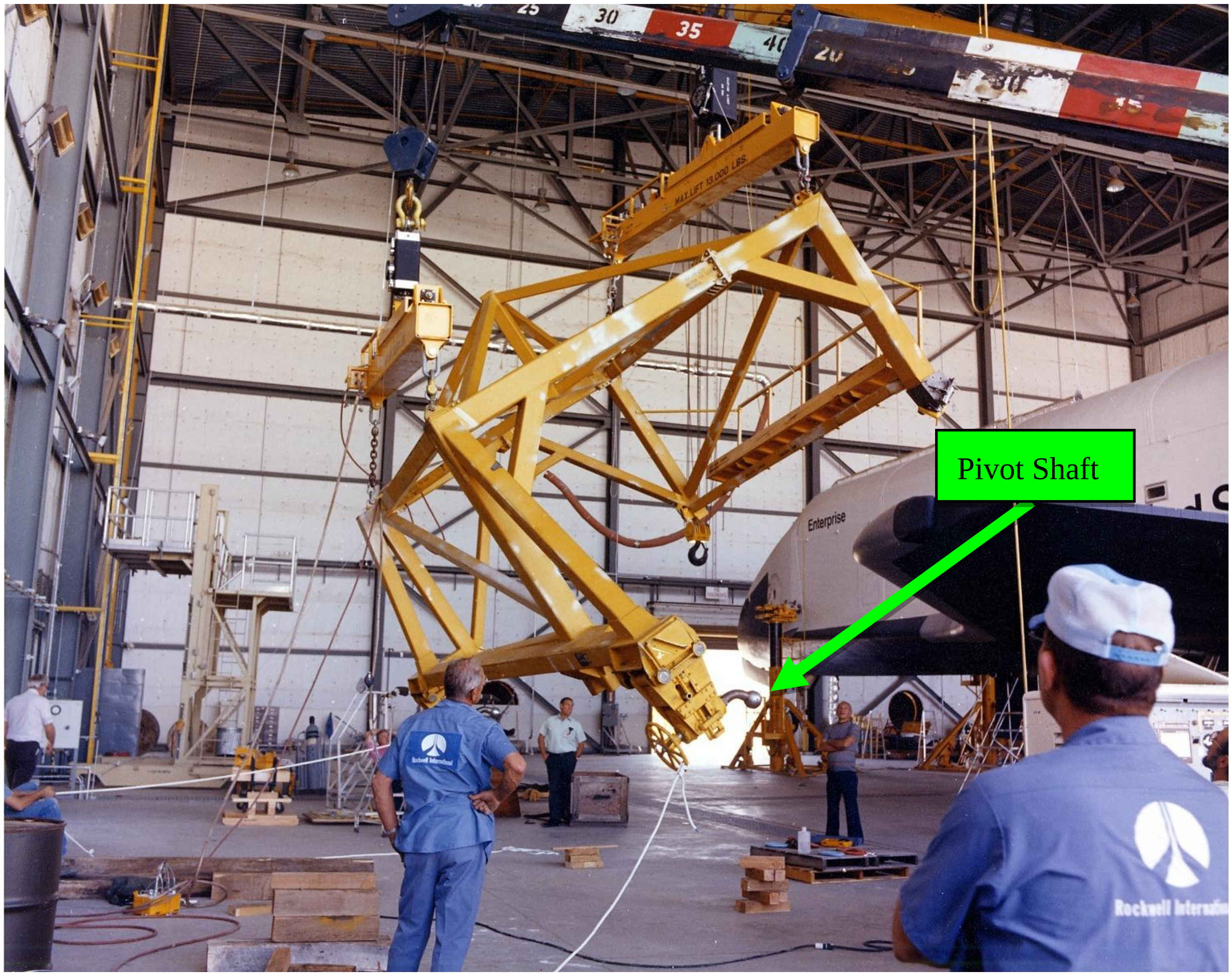

Figure 14 - Empty Lifting Fixture Suspended from Two Cranes

This photo was taken inside the NASA hangar at the Dryden Flight Research Center (DFRC) at Edwards AFB, CA, in the 1980s. It shows the left hand lifting fixture being lifted and rotated using a pendant-controlled overhead crane (OHC) and mobile crane. The operations at the VAB (and later, at the Udvar-Hazy Center) will use two mobile cranes to lift and rotate the lifting fixture and ALTA pod into position.

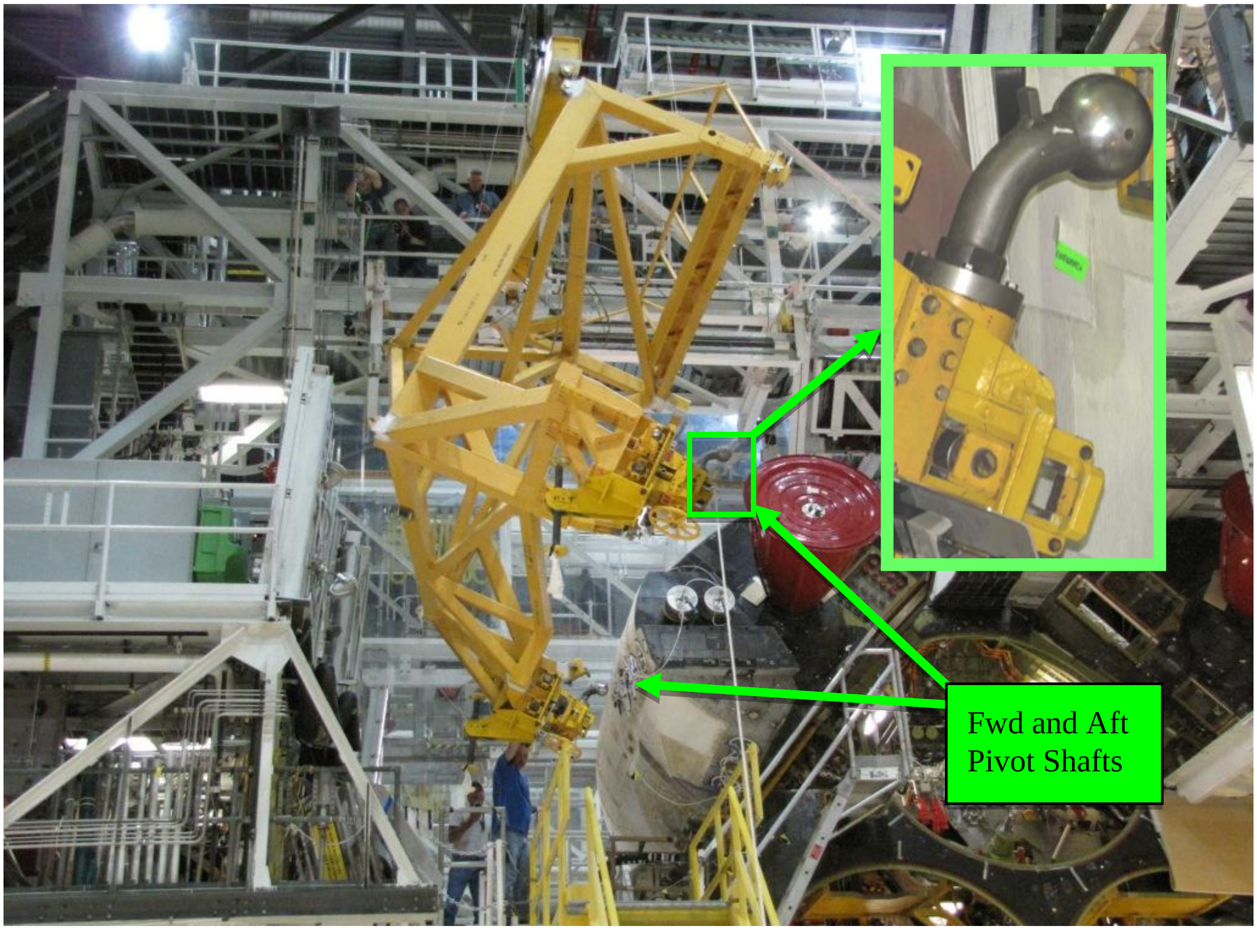

Figure 15 – Forward and Aft Pivot Shafts

This photo shows the OMS pod lifting fixture suspended from the overhead crane in the OPF-1/2. The arrows point to the Forward and Aft Pivot Shafts.

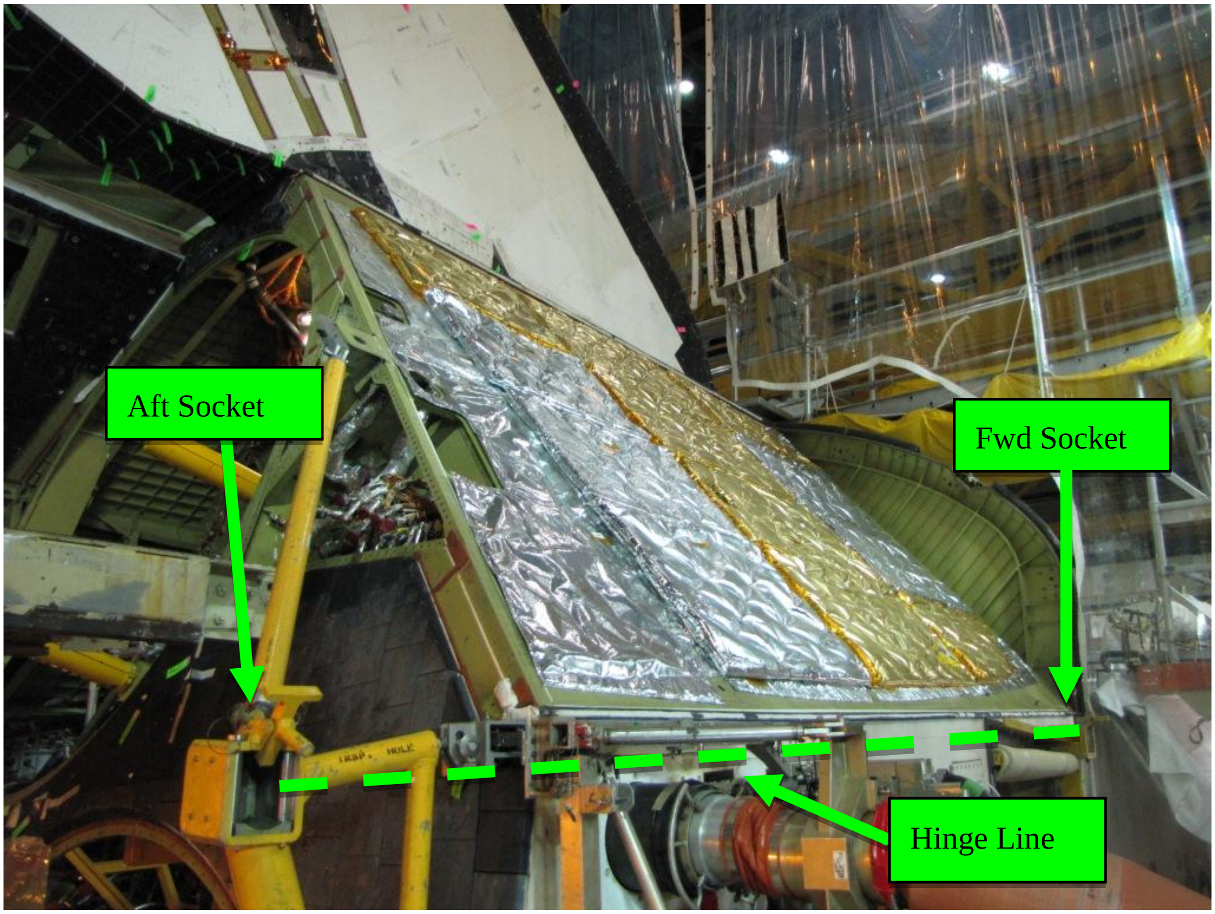

Figure 16 - Orbiter OMS Pod Deck with Fwd and Aft Sockets Installed

This photo shows the OMS deck of an Orbiter and the fwd and aft sockets installed. The sockets create a hinge line for the GSE/pod to rotate about once the pivot shafts are pinned to them.

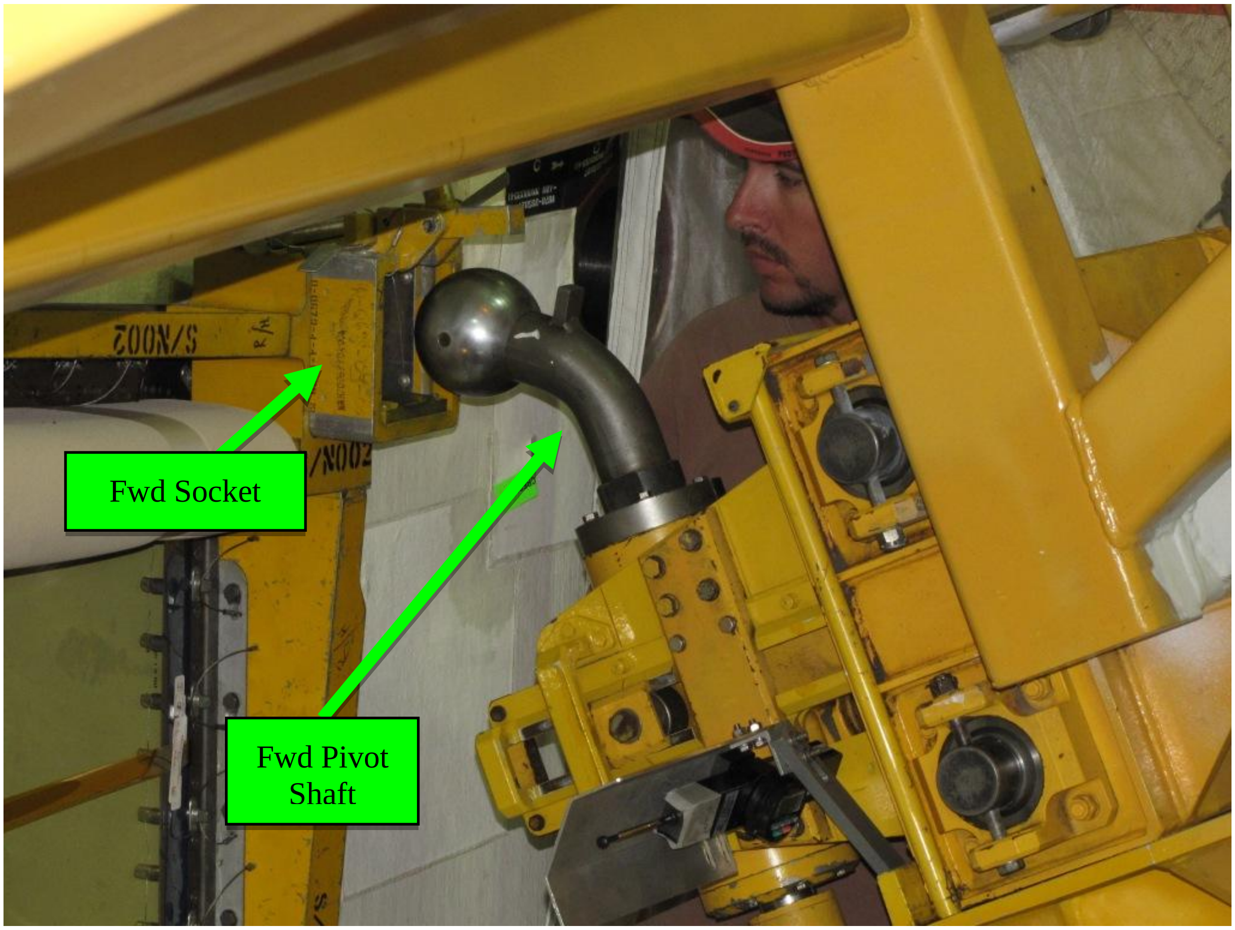

Figure 17 - Fwd Pivot Shaft Being Aligned with Fwd Socket

This photo shows a technician in position to align, adjust, insert and pin the fwd pivot shaft ball to the fwd socket. There are two tethered pins not shown in the photo that secure the pivot shaft ball inside the socket.

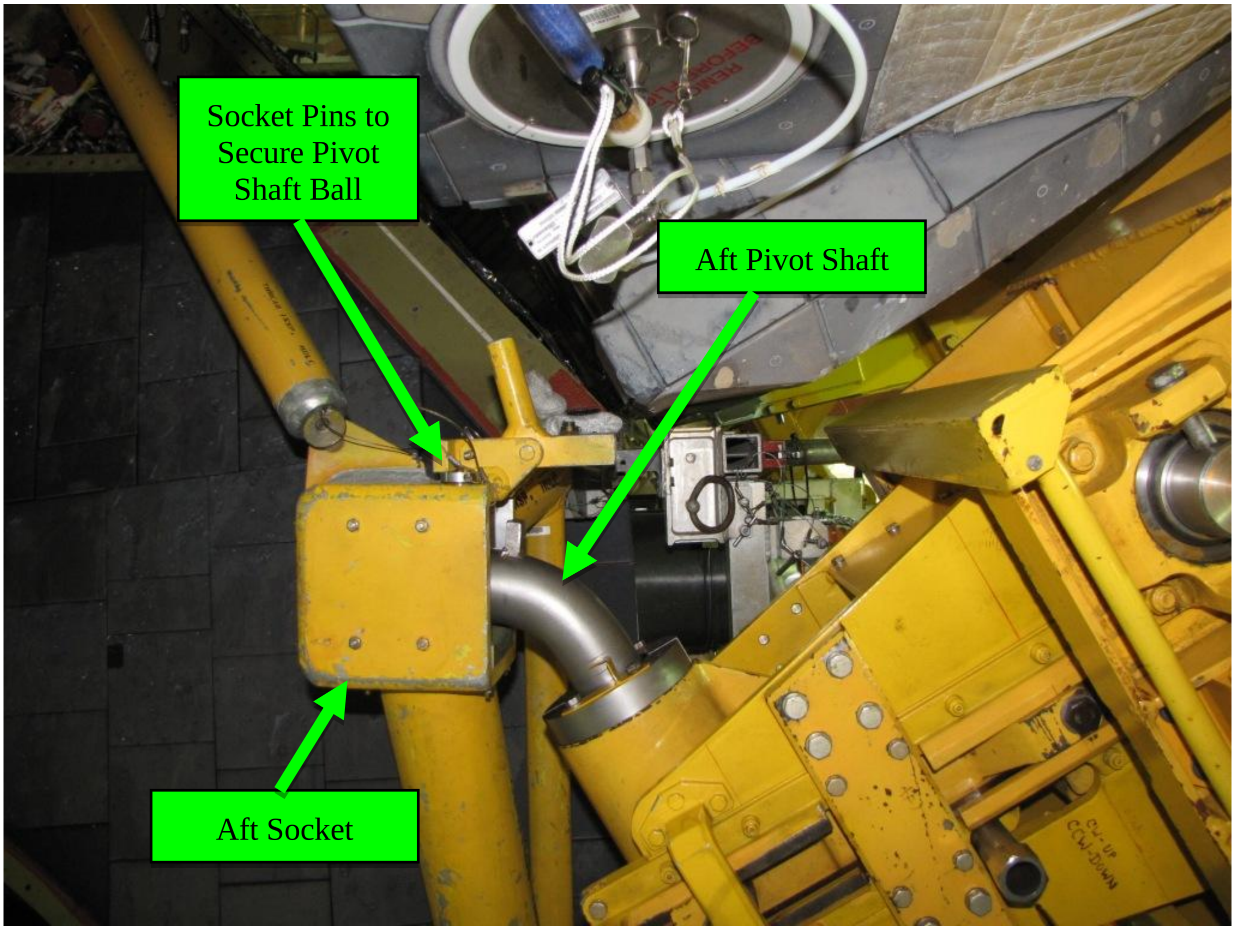

Figure 18 - Aft Pivot Shaft Pinned to the Orbiter Mounted Aft Socket

This photo shows the aft pivot shaft pinned to the aft socket. The fwd pivot shaft (not shown) is also pinned to the fwd socket, and the two sockets create a hinge line for the GSE/pod to rotate about.

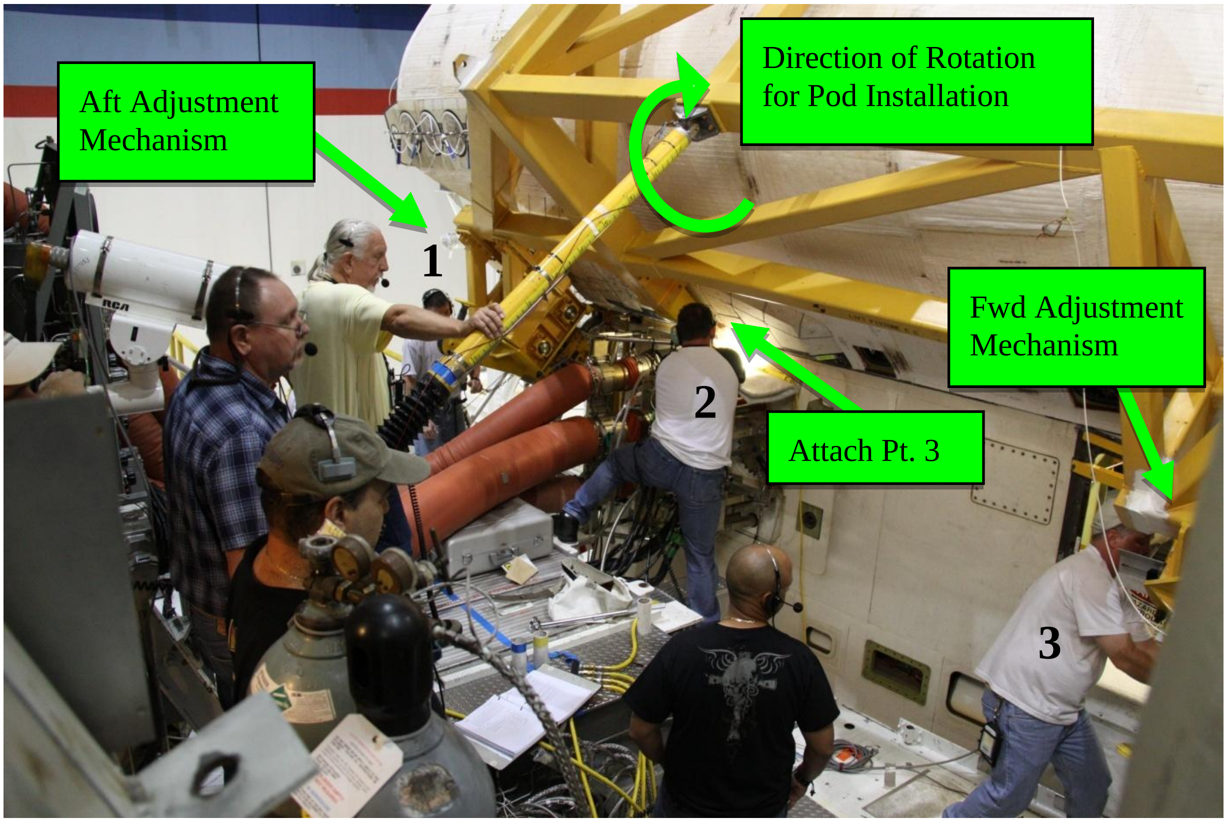

Figure 19 - Technician Monitoring Attach Points

This photo shows an OMS pod being rotated onto the OMS deck using the rotator jackscrew. Three technicians are monitoring the fwd and aft adjustment mechanisms and attach point three as the pod is rotated into position. Without the rotator jackscrew and load abatement platforms or facility trolley beam, the three technicians numbered in the picture will be working under a suspended load. Rotation of the ALTA pod onto the orbiter deck will be accomplished using two mobile cranes. NOTE: The picture shows the direction of rotation for ALTA Pod Installation. The direction of rotation for removal of the ALTA Pod in the VAB Test (and for the sling at the later operation at the Udvar-Hazy Center) will be in the opposite direction of what is shown. The technicians numbered one through three in the picture will be in the locations as shown for both installation and removal operations.

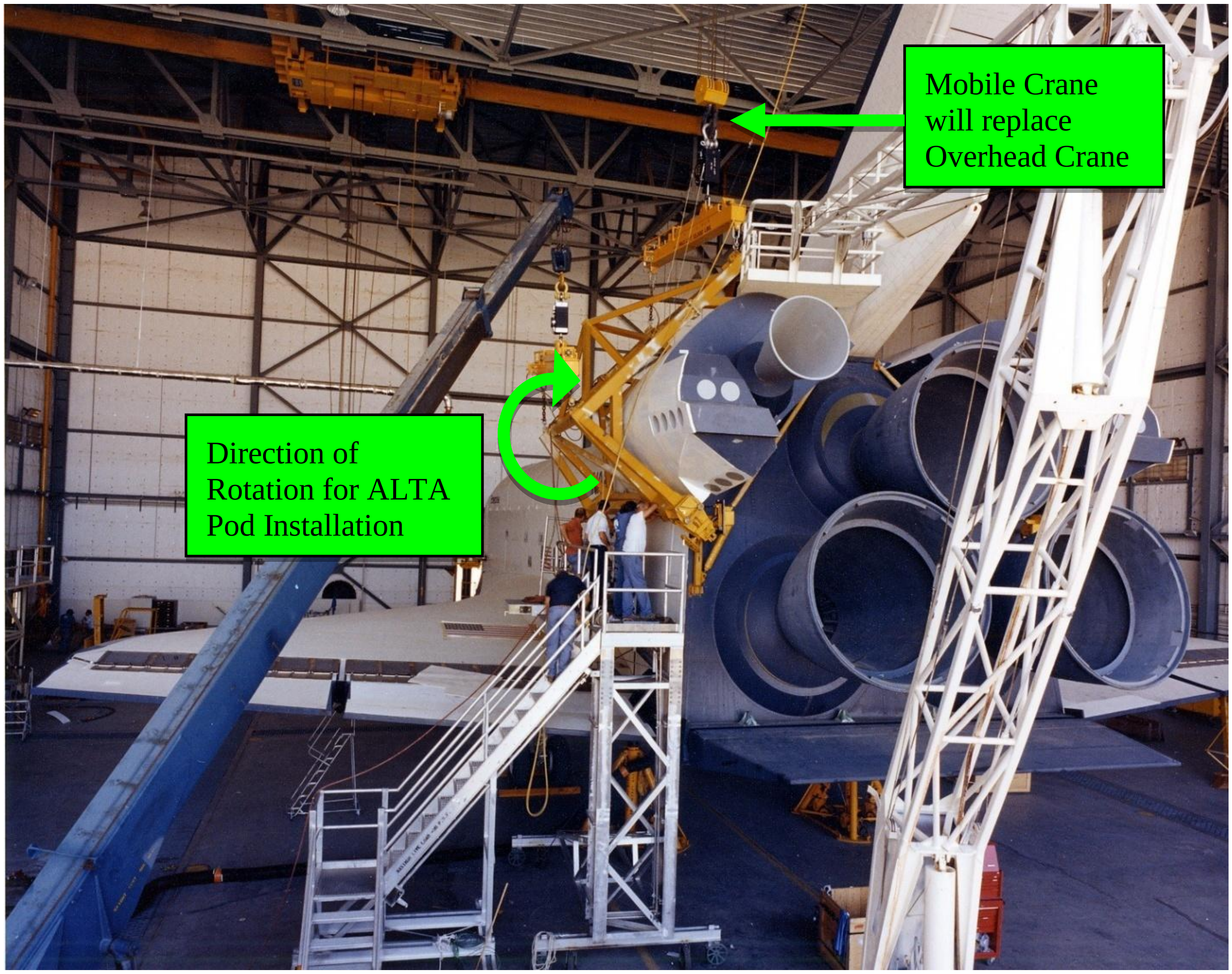

Figure 20 - Port ALTA Pod Installation Using Two Cranes

This photo was taken inside the NASA hangar at the Dryden Flight Research Center (DFRC) at Edwards AFB, CA, in the 1980s. It shows the left hand ALTA pod being installed on Enterprise using a pendant-controlled overhead crane (OHC) and mobile crane. With the exception of the OHC this picture depicts the operation that is required for the VAB test and for the later ALTA pod installation on Enterprise at the Udvar-Hazy Center. NOTE: The picture shows the direction of rotation for ALTA Pod Installation. The direction of rotation for removal of the ALTA Pod in the VAB Test and for the sling at the Udvar-Hazy Center will be in the opposite direction of what is shown.

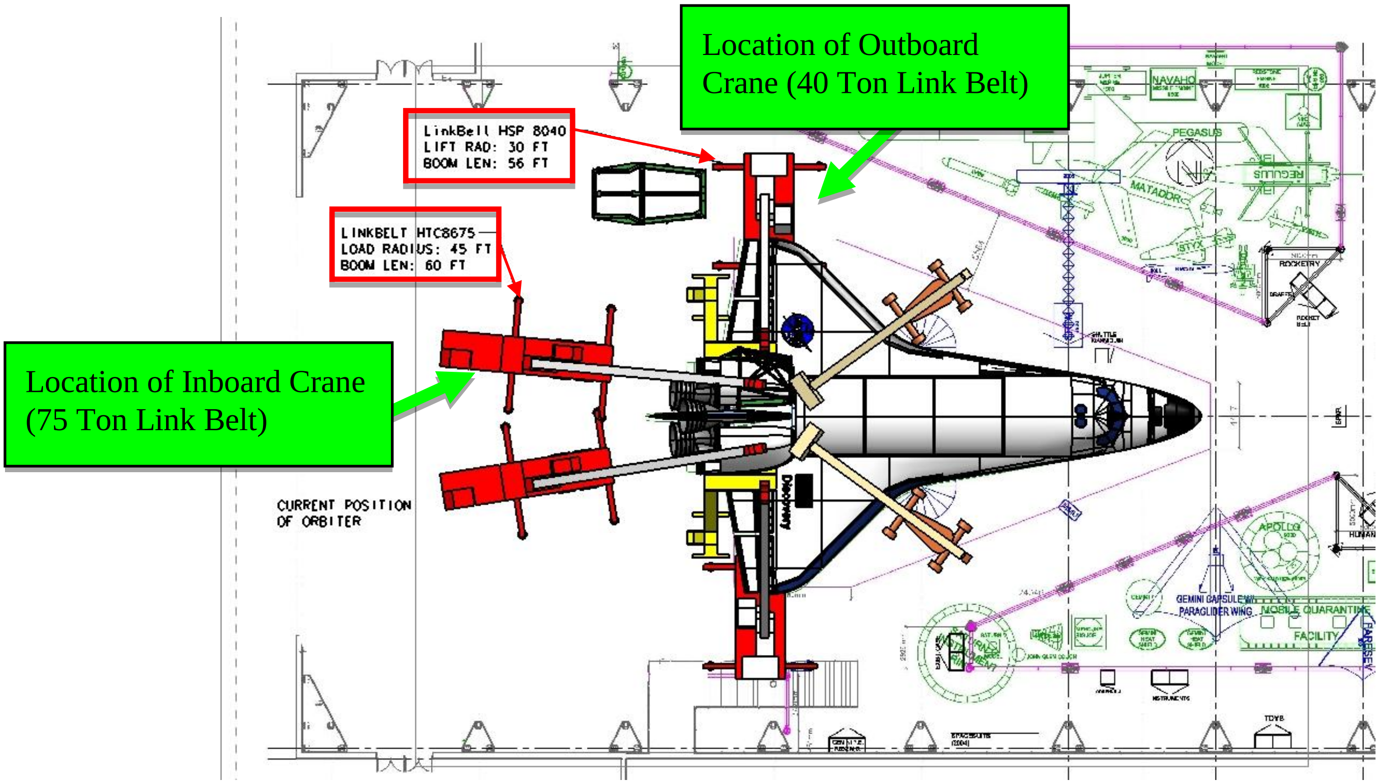

Figure 21 – Plan View of Dual Crane Setup

Plan View of the envisioned later dual mobile crane operations for ALTA Pod Installation at the Udvar-Hazy Center. The arrangement in the VAB Test will be identical to this, but will only involve the Port ALTA Pod. The figure depicts the location, lift radii, and boom lengths of the two mobile cranes that will be used for the VAB Test. The operations at the Udvar-Hazy center will likely use different cranes and will be covered in a separate SLOAA. NOTE: Only two mobile cranes will be used, their locations are shown on both sides of the Orbiter for illustrative purposes only.

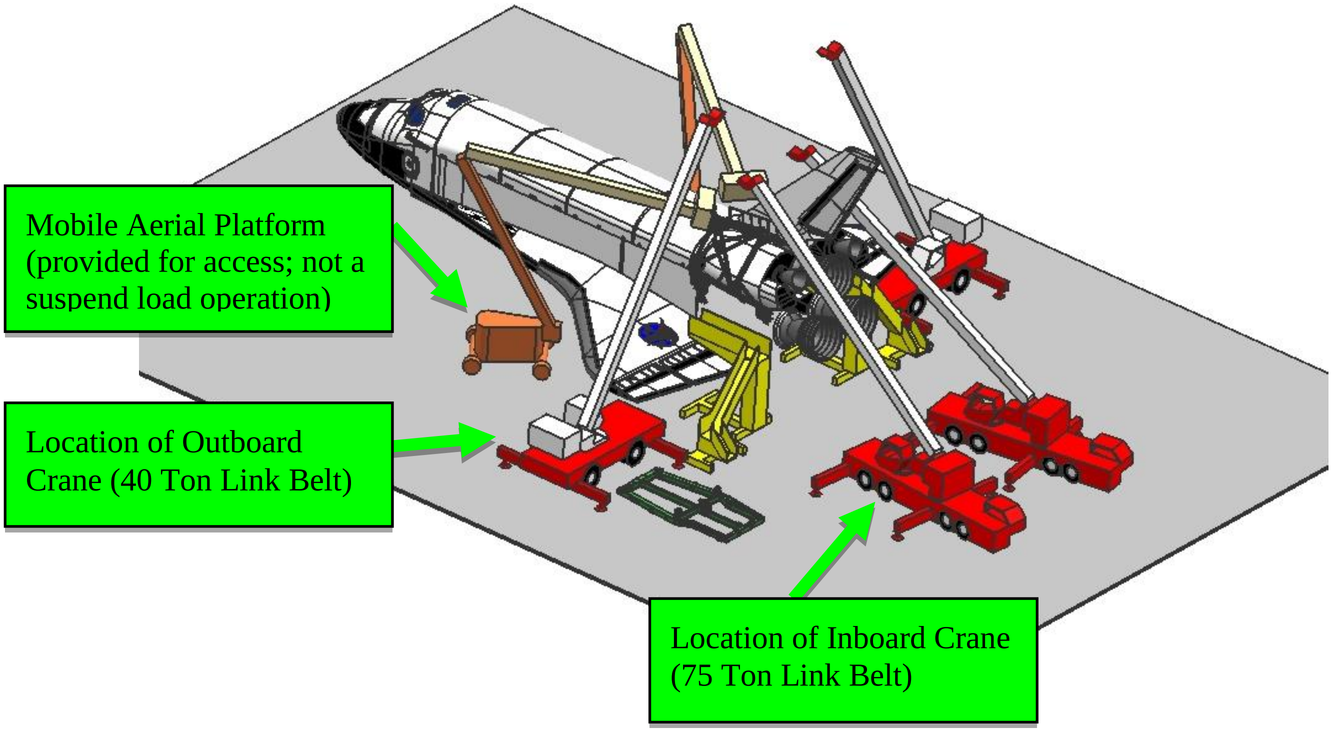

Figure 22 – Isometric View of Dual Crane Setup

Isometric view of the dual mobile crane operations for ALTA Pod Test at the VAB. NOTE: Only two mobile cranes will be used, their locations are shown on both sides of the Orbiter for illustrative purposes only. The arrangement in the VAB Test will only involve the left ALTA Pod.

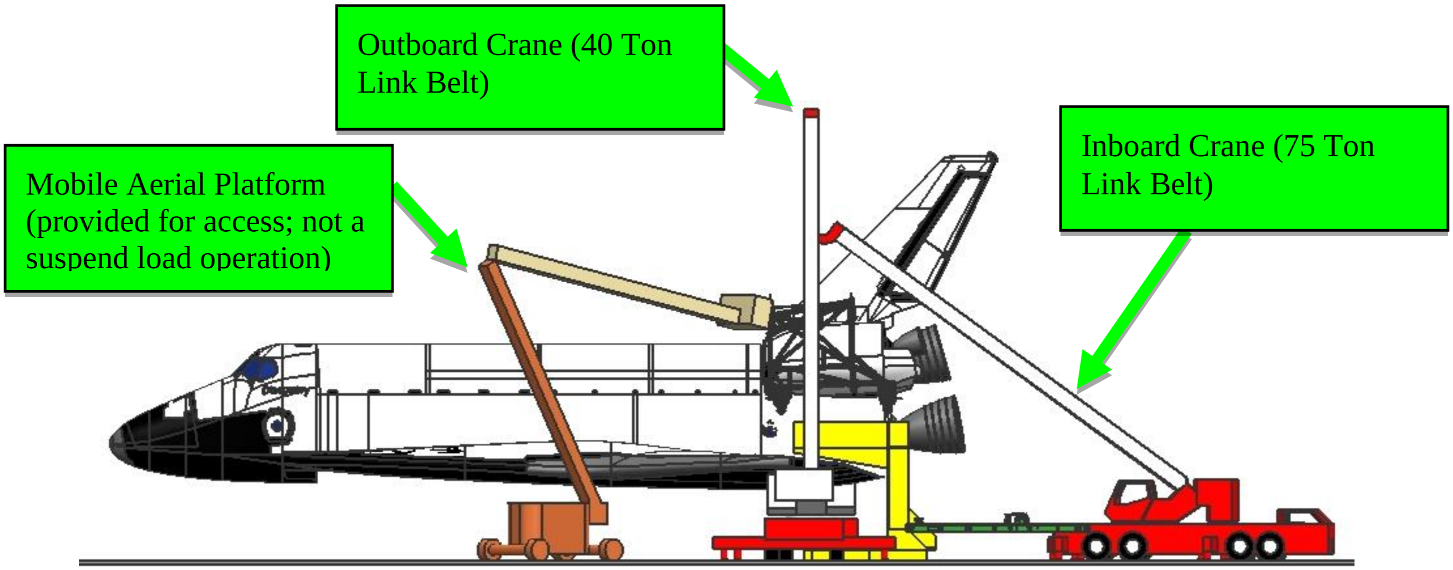

Figure 23 – Side View of Dual Crane Setup

Side view of the dual mobile crane operations for ALTA Pod Installation at the VAB.

12 5481 (supersedes 5457)–0706–F2LB

Main Boom Lift Capacity Charts -- Standard

12,000 lb Counterweight -- Fully Extended Outriggers -- 360° Rotation (All Capacities Are Listed In Pounds)											
Radius (ft)	Boom Length (ft)										Radius (ft)
	41	50	60	69.6/70	80	90	100	110	120	127	
8	150,000*										8
9	140,000*										9
10	127,500	75,100	74,000								10
12	113,600	75,100	74,000	43,900**							12
15	97,300	75,100	74,000	43,900**	38,000						15
20	73,100	72,500	72,000	43,900**	38,000	38,000	37,400				20
25	56,100	55,600	55,200	43,900**	38,000	38,000	32,700	29,400	23,300	19,600	25
30	41,900	41,300	40,600	38,000	38,000	37,900	29,000	26,200	23,300	19,600	30
35		32,800	33,300	33,600	33,800	33,900	26,000	23,500	21,500	19,600	35
40		25,800	26,500	26,800	27,000	27,200	23,400	21,200	19,400	18,400	40
45			21,500	21,900	22,200	22,300	21,200	19,200	17,600	16,400	45
50			17,700	18,200	18,400	18,600	18,700	17,400	15,800	14,900	50
55				15,200	15,500	15,600	15,800	15,800	14,400	13,600	55
60				12,800	13,100	13,300	13,400	13,500	13,200	12,500	60
65					11,200	11,400	11,500	11,600	11,700	11,500	65
70					9,500	9,700	9,800	9,900	10,000	10,000	70
75						8,300	8,400	8,500	8,600	8,600	75
80						7,000	7,200	7,300	7,300	7,400	80
85							6,100	6,200	6,300	6,300	85
90							5,200	5,300	5,400	5,400	90
95								4,500	4,600	4,600	95
100								3,700	3,800	3,900	100
105									3,200	3,200	105
110									2,600	2,700	110

* Special Conditions Or Wire Rope Required
** 63.6 A–max Mode

Figure 24 - Load Chart for Link Belt HTC8675 75 Ton Crane

At the expected maximum radius of 45 feet and boom length of 60 feet (see Figure 21), the capacity of the 75 Ton Crane (Inboard Crane in Figures 21-23) is 21,500 lbs, which is significantly greater than the entire combined weight of the ALTA Pod and Lifting Fixture of 11,000 lbs.

10 5400 (#5394 & #5304 consolidated)—010A—F7

Main Boom Lift Capacity Charts – Standard

Fully Extended Outriggers -- 360° Rotation (All Capacities Are Listed In Pounds)										
Radius (ft)	Boom Length (ft)									Radius (ft)
	33	40	50	57/60	70	80	90	100	105	
10	80,000	72,100	70,500	43,800**						10
12	73,800	72,100	65,600	43,800**						12
15	63,100	62,900	57,400	42,200**	35,000					15
20	47,300	47,100	46,800	35,000	35,000	30,500	27,100			20
25	30,100	35,900	35,700	35,000	35,000	26,300	23,400	20,900	17,500	25
30		29,200	29,800	30,100	30,300	22,900	20,400	18,600	17,500	30
35			24,400	24,800	25,000	20,200	18,000	16,200	15,700	35
40			19,500	19,800	19,900	18,000	16,000	14,500	13,900	40
45				15,900	16,100	16,200	14,300	13,000	12,200	45
50				13,100	13,200	13,400	13,000	11,700	10,700	50
55					11,100	11,200	11,300	10,600	9,500	55
60					9,300	9,500	9,600	9,600	8,400	60
65						8,000	8,100	8,200	7,500	65
70						6,800	7,000	7,000	6,600	70
75							6,000	6,000	6,000	75
80							5,100	5,200	5,200	80
85								4,400	4,500	85
90								3,800	3,800	90
95									3,200	95

* Special Conditions Or Wire Rope Required
** 57.0 A–max Mode

Figure 25 - Load Chart for Link Belt 8040 40-Ton Mobile Crane

At the expected maximum radius of 30 feet and boom length of 56 feet (see Figure 21), the capacity of the 40 Ton Crane (Outboard Crane in Figures 21-23) is 30,100 lbs, which is significantly greater than the entire combined weight of the ALTA Pod and Lifting Fixture of 11,000 lbs.

Maynette E Smith 9/14/11

Maynette Smith Date

Chief, S&MA Operations Processing Division