APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

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NASA SUSPENDED LOAD OPERATION ANALYSIS/APPROVAL (SLOAA)

OPERATION: FIRST STAGE OFF LOAD/LOAD FROM/TO THE ERECTOR AND MATE/DE-MATE TO/FROM THE LAUNCH MOUNT

SUPPORTING DOCUMENTS:

1. Systems Assurance Analysis - SAA 88CROOO-041, 20-TON Mobile Service Tower Bridge Crane
2. Launch Preparation Document - LPD V28, First Stage Erection
3. Launch Preparation Document – LPD V32, Contingency

GENERAL DESCRIPTION:

This task transports the Delta First Stage (Booster) from the build up area to the SLC-2W launch pad on Vandenberg Air Force Base (VAFB). The Booster is moved to the erection site on a transporter erector. It is positioned under the mobile service tower 20 ton bridge crane. The crane is used to hoist the front end of the booster, as the booster aft end rotates on trunnions which are attached to the booster. Once the booster is rotated vertical and lifted off the aft trunnion, the trunnion/struts are removed in order to mate with the launch mount. Personnel are required to work beneath the suspended first stage to remove struts, tape/film from ports, tagline bolts and install guide pins. This task is accomplished using NASA/USAF approved Launch Processing Procedure V28. De-mating is accomplished in the reverse order of mating utilizing NASA/USAF approved Launch Preparation Document V32.

RATIONALE/ANALYSIS:

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

ALTERNATE STANDARD REQUIREMENT #1a:

1. The booster aft end trunnion struts are installed while the vehicle is horizontal in order to allow the booster to be erected. Removal or installation during de-mate of the struts/pivot adapters cannot be accomplished without placing personnel beneath the suspended load (booster) because there is no other access to the hardware attach points.

2. The struts/pivot adapter must be removed in order to mate the booster to the launch mount

3. Design of a support structure for the booster is not feasible because access to the trunnion strut attach point would be blocked.

4. During the mating/de-mating operations, tag lines are installed on the vehicle using bolts from the pivot adapter. This requires people to reach under the suspended booster to install the bolts and remove the bolts just prior to mating the booster.

5. Just prior to mating the booster, it is lowered to within one foot of the launch mount and tape and film are removed from ports. This requires personnel to have their hands under the suspended

load. Immediately after the film and tape are removed, people are required to get inside the launch mount and install guide pins through the launch mount legs into the booster. This requires five people to be under the suspended booster in order to accomplish this task which takes approximately 10-20 minutes.

6. There are no operational or procedural changes that would eliminate personnel exposure to working under the suspended load.

ALTERNATE STANDARD REQUIREMENT #1b:
The possible use of a secondary support device to remove the struts/pivot adapter was evaluated. The first stage main engine thrust chamber makes a secondary support device not feasible, and still be able to remove the struts, which must be done in order to set the booster down (mate) on the launch mount.

No support device or fixture can be used to support the booster during the film/tape removal from the ports on the booster, or when removing the bolts securing the taglines.

Guide pins must be used to accurately guide the booster down on the launch mount. There is no protective device that could be use for this operation, as the booster is within one foot of the mating surface.

ALTERNATE STANDARD REQUIREMENT #1c:
In order to remove/install the struts, two people must support the strut, while one other person removes the bolt. Personnel are positioned to prevent working directly under the booster to the maximum extent possible.

To remove the tape and film from the ports and to remove the tagline bolts takes two people. The two employees are not directly under the suspended booster, but are reaching under the stage with their hands only.

It takes three people to install/remove the guide pins.

ALTERNATE STANDARD REQUIREMENT #1d:
Personnel required under the load will perform their operations as quickly as possible (approximately five minutes) and remove themselves from exposure immediately upon task completion.

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 NASA Safety and Mission Assurance Division Chief will be permitted. A list of approved suspended load operations will be maintained by NASA Safety and Mission Assurance Division.

ALTERNATE STANDARD REQUIREMENT #4:
The operating procedures to be used to erect the booster is Launch Preparation Document (LPD) V28, "FIRST STAGE ERECTION" and LPD V32, “CONTINGENCY” for de-mate. These procedures have been reviewed and

approved by both the Air Force and NASA personnel. The LPDs are available at both the Vandenberg launch facility and at the Florida launch facility for review.

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 Mobile Service Tower 20 ton crane used for these operations is inspected, tested, maintained and operated in accordance with the NASA Safety Standard for Lifting devices and Equipment, NSS/GO-1740.9.

The Delta first stage weighs approximately 11,110 pounds. The forward hoist fixture (P/N lB91836) is rated for 11,700 pounds. It was initially prooftested at 267 percent (33,000#) of rated load. After the initial proof test all welds were penetrant inspected per Mil-1-6866. Annual proof testing is performed at 225 percent (27,600#) of rated load. There are no single point failure welds.

SLC 2W 20 TON MST EXTERIOR BRIDGE CRANE:

A. GENERAL:

This is a new crane, designed and built by Heco-Pacific and installed by American Bridge under the NASA MELVS contract. The crane has been designed, tested, inspected, maintained and operated in accordance with the WSMCR 127-1, NASA Standard NSS/GO-1740.9, OSHA and applicable CMAA and ANSI standards.

The crane capacity is 40,000Lbs. with the heaviest actual lift at approximately 32,000Lbs. (80% of capacity) for the Strap on Solid Rocket Motors (SSRM). Other stages lifted include the first stage, Interstage, Second stage, Fairing and Spacecraft, none of which exceed 12,000Lbs.

B. CRANE SAFETY FEATURES:

1. Minimum safety factor of 5 to 1 on all mechanical and structural elements, including MST crane support structure.
2. Three hoist brake systems, tested individually, including Electro-mechanical disc brake on hoist motor, Electro-mechanical a shoe brake on gear reducer and air-operated disc brake on cable drum. An overspeed switch automatically sets the drum brake if drum speed exceeds maximum normal operating speed by about 10%. The drum brake system has been tested by deliberately inducing overspeed in the drum. In addition, a dynamic analysis has been performed showing that under free-fall emergency braking, the crane system loads do not exceed the 125% proof test loads.
3. Dual upper limit switches-initial is paddle type and final switch is gear operated on drum rotation.
4. Emergency stop buttons on both pendants. Pendant circuitry allows only one pendant functional at a time except for the emergency stop buttons.
5. Emergency stop buttons in hoist drum room and mechanical equipment room (control console location),
6. Crane proofloaded to 125% of capability initially and annually and functionally tested prior to each use.

7. Trip bar installed across cable drum which shuts off crane power if cable over wraps.
8. Thermal overload switch on drum brake resistor to shut off power under excessive braking conditions.
9. Electrical disconnects provided in crane drum mom and near bridge runway per OSHA standards to safely allow crane maintenance.

C. CRANE OPERATING SAFEGUARDS:

1. All crane operators trained and certified.
2. All technicians and pad engineers on headsets during lift operations.
3. Technician stationed in crane drum room (with emergency stop) during all crane operations.

ALTERNATE STANDARD REQUIREMENT #7:
A System Assurance Analysis (SAA) has been performed on the Mobile Service Tower 20 ton crane. The SAA includes a failure modes and effects analysis (FMEA) and a hazard analysis. No single failure points were identified.

ALTERNATE STANDARD REQUIREMENT #8:
A visual inspection of the crane and a functional test will be performed before lifting **the** load.

ALTERNATE STANDARD REQUIREMENT #9:
A trained/certified operator will remain at the controls while personnel are under the load.

ALTERNATE STANDARD REQUIREMENT #10:
Safety control areas and the requirement to rope off the area are documented in the operating procedure (V28).

ALTERNATE STANDARD REQUIREMENT #11:
Prior to all operations the engineering task leader, known as the Assistant Test Conductor (ATC) conducts a pre-task briefing to identify safety hazards, safety control areas, crew assignment, communications assignments (and backup) and general test conduct. The ATC uses the operating procedure to conduct the task. Deviations to the procedure require approval from various groups, including safety, if the deviation affects the safety of the operation or changes the hazard level of the task.

ALTERNATE STANDARD REQUIREMENT #12:
Communication assignments and communications conduct are included in the pre task briefing. The requirement to stop the hoisting operation is clearly understood if communication is lost.

ALTERNATE STNDARD REQUIREMENT #13:
Personnel required to work under the suspended load are in continuous sight of the ATC at all times.

ALTERNATE STANDARD REQUIREMENT # 14:
The NASA Safety and Mission Assurance Division will 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.

OPERATION - Second Stage off-load from the transporter and mate/de-mate to/from the core vehicle.

SUPPORTING DOCUMENTS:

1. Systems Assurance Analysis - SAA 88CROOO-041, 20-TON Mobile Service Tower Bridge Crane
2. Launch Preparation Document - LPD V22, Second Stage Erection and Mating
3. Launch Preparation Document – LPD V32, Contingency

GENERAL DESCRIPTION:

1. Requires up to four technicians to be under the suspended Second Stage to facilitate nozzle stiffener removal/installation and to install/remove nozzle protective pads.

2. Requires up to six technicians to be partially under or directly adjacent to a portion of the suspended second stage to enable removal/installation of the aft roll ring.

3. Requires two technicians to be partially under the suspended second stage to enable cleaning of the interstage and second stage mating surfaces.

The Second Stage off-load and mate procedures for suspended load operations use the overhead 20 ton bridge crane attached to the Mobile Service Tower (MST).

After the Second Stage is vertical five technicians are required to work under the suspended stage for approximately five minutes, to remove the nozzle stiffener and an additional 20 minutes to install the protective nozzle pads. All personnel are required to leave the area under the suspended load once the stiffener removal and the pad installation is complete.

After placing the stage into pre-mate position six technicians are evenly distributed around the circumference of the stage to enable removal of the aft roll ring. The technicians require approximately 30 minutes to disassemble and remove the aft roll ring assembly.

The final item performed prior to mating the Second Stage to the core vehicle is the cleaning of the mating surfaces. This operation generally requires one technician (however two have been used on occasion if the surface has heavy residue) to place his hands under the suspended stage for approximately five minutes.

After successful completion of the operation the load is released and the forward hoist assembly is detached. This task is accomplished using NASA/USAF approved Launch Processing Document (LPD) V22. De-mating is accomplished in the reverse order of mating utilizing NASA/USAF approved Launch Preparation Document V32.

RATIONALE/ANALYSIS:

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

ALTERNATE STANDARD REQUIREMENT #la:

1. Removal of the nozzle stiffener cannot be accomplished without placing personnel beneath the suspended load due to the location of the nozzle stiffener attach hardware.

2. Nozzle stiffener must be removed prior to installation of the nozzle protective pads and installed during de-mate. Protective pads must be installed on the second stage nozzle prior to initiating the hoist operation and removed after de-mate. Roll ring must be removed prior to second stage mate. Mating surfaces must be clean and free of residue prior to final mate.

3. Design of a support structure for the second stage is not feasible with hoisting apparatus installed.

4. There are no operational or procedural changes that would eliminate personnel exposure to working under the suspended load.

ALTERNATE STANDARD REQUIREMENT #1b:

The possible use of a secondary support device was evaluated. The second stage nozzle and location of aft roll ring attach points makes a secondary support device not feasible, and still be able to remove the stiffener and install the pads, which must be done to protect the nozzle prior to initiating the hoisting operation.

ALTERNATE STANDARD REQUIREMENT #lc:

Nozzle stiffener removal and pad installation is efficiently accomplished with five personnel. This permits the stiffener to be removed quickly while minimizing personnel exposure time. To remove the aft roll ring, four people must support the ring while two others remove the attaching hardware. Personnel are positioned to prevent working directly under the stage to the maximum extent possible.

Wiping the mating surfaces is required to ensure that no obstructions are present which: could damage the stage, prevent proper installation of the stage, or prevent proper separation of the stage.

The maximum number of personnel required under or partially under the load at any one time is four.

ALTERNATE STANDARD REQUIREMENT #1d:

Personnel required under the load will perform their operations as quickly as possible (approximately five minutes to remove the nozzle stiffener, 20 minutes to install protective pads, 30 minutes to disassemble and remove the aft roll ring assembly and five minutes for cleaning) and remove themselves from exposure immediately upon task completion.

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 NASA Safety and Mission Assurance Division Chief will be permitted. A list of approved suspended load operations will be maintained by NASA Safety and Mission Assurance Division.

ALTERNATE STANDARD REQUIREMENT #4:

The operating procedures to be used to elect and mate the Second Stage is Launch Preparation Document (LPD) V22, "SECOND STAGE ERECTION" and LPD V32, "CONTINGENCY" for de-mate. These procedures have been reviewed and approved by both the Air Force and NASA personnel. The LPDs are available at both the Western Test Range and the Eastern Test Range for review.

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 Mobile Service Tower 20 ton crane used for these operations is inspected, tested, maintained and operated in accordance with the NASA Safety Standard for Lifting devices and Equipment, NSS/GO-1740.9.

The weight of the Delta second stage is approximately 2,060 pounds. The forward hoist fixture (P/N 1B91867-1) is rated for 2821 pounds. It was initially proof tested at 267 percent (7,530#) of rated load. After the initial proof test, all welds were penetrant inspected per Mil-1-6866. Annual proof testing is performed at 225 percent (27,600#) of rated load. There are no single point failure welds.

SLC 2W 20 TON MST EXTERIOR BRIDGE CRANE:

A. GENERAL:

This is a new crane, designed and built by Heco-Pacific and installed by American Bridge under the NASA MELVS contract. The crane has been designed, tested, inspected, maintained and operated in accordance with the WSMCR 127-1, NASA Standard NSS/GO-1740.9, OSHA and applicable CMAA and ANSI standards.

The crane capacity is 40,000Lbs. with the heaviest actual lift at approximately 32,000Lbs. (80% of capacity) for the Strap on Solid Rocket Motors (SSRM). Other stages lifted include the first stage, Interstage, Second stage, Fairing and Spacecraft, none of which exceed 12,000Lbs.

B. CRANE SAFETY FEATURES:

1. Minimum safety factor of 5 to 1 on all mechanical and structural elements, including MST crane support structure.
2. Three hoist brake systems, tested individually, including Electro-mechanical disc brake on hoist motor, Electro-mechanical a shoe brake on gear reducer and air-operated disc brake on cable drum. An overspeed switch automatically sets the drum brake if drum speed exceeds maximum normal operating speed by about 10%. The drum brake system has been tested by deliberately inducing overspeed in the drum. In addition, a dynamic analysis has been performed showing that under free-fall emergency braking, the crane system loads do not exceed the 125% proof test loads.
3. Dual upper limit switches-initial is paddle type and final switch is gear operated on drum rotation.

4. Emergency stop buttons on both pendants. Pendant circuitry allows only one pendant functional at a time except for the emergency stop buttons.
5. Emergency stop buttons in hoist drum room and mechanical equipment room (control console location).
6. Crane proofloaded to 125% of capability initially and annually and functionally tested prior to each use.
7. Trip bar installed across cable drum which shuts off crane power if cable over wraps.
8. Thermal overload switch on drum brake resistor to shut off power under excessive braking conditions.
9. Electrical disconnects provided in crane drum mom and near bridge runway per OSHA standards to safely allow crane maintenance.

C. CRANE OPERATING SAFEGUARDS:

1. All crane operators trained and certified.
2. All technicians and pad engineers on headsets during lift operations.
3. Technician stationed in crane drum room (with emergency stop) during all crane operations.

ALTERNATE STANDARD REQUIREMENT #7:

A System Assurance Analysis (SAA) has been performed on the Mobile Service Tower 20 ton crane. The SAA includes a failure modes and effects analysis (FMEA) and a hazard analysis. No single failure points were identified.

ALTERNATE STANDARD REQUIREMENT #8:

A visual inspection of the crane and a functional test will be performed before lifting the load.

ALTERNATE STANDARD REQUIREMENT #9:

A trained/certified operator will remain at the controls while personnel are under the load.

ALTERNATE STANDARD REQUIREMENT #10:

Safety control areas and **the** requirement to rope off the area are documented in the operating procedure (V22).

ALTERNATE STANDARD REQUIREMENT #11:

Prior to all operations the engineering task leader(ATC) conducts a pre-task briefing to identify safety hazards, safety control areas, crew assignment, communications assignments (and backup) and general test conduct The ATC uses the operating procedure to conduct the task. Deviations to the procedure require approval from various groups, including safety, if the deviation affects the safety of the operation or changes the hazard level of the task.

ALTERNATE STANDARD REQUIREMENT #12:

Communication assignment and communications conduct are included in the pre task briefing. The requirement to stop the hoisting operation is clearly understood if communication is lost.

ALTERNATE STANDARD REQUIREMENT #13:

Personnel required to work under the suspended load are in continuous sight of the ATC at all times.

ALTERNATE STANDARD REQUIREMENT # 14:
The NASA Safety and Mission Assurance Division will 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.

OPERATION - Strap on Solid Rocket Motor (SSRM) off-load/load from/to the transporter and mate/de-mate to/from the core vehicle.

SUPPORTING DOCUMENTS:

1. Systems Assurance Analysis - SAA 88CROOO-041, 20-TON Mobile Service Tower Bridge Crane
2. Launch Preparation Document - LPD V26, Solid Motor Erection and Mating
3. Launch Preparation Document – LPD V32, Contingency

GENERAL DESCRIPTION:

Requires up to four technicians (up to two each side) to be partially under the suspended SSRM to facilitate aft trunnion removal and installation during de-mate.

The SSRM off-load and mate/de-mate procedures use the overhead 20 ton bridge crane attached to the top of the Mobile Service Tower (MST).

After the SSRM is vertical two technicians are required to work under the suspended SSRM for approximately five minutes to remove the aft trunnions and again, for approximately five minutes during de-mate. All personnel are required to leave the area under the suspended load once the aft trunnion removal/installation is complete.

This task is accomplished using NASA/USAF approved Launch Processing Document (LPD) V26. De-mating is accomplished in the reverse order of mating utilizing NASA/USAF approved Launch Preparation Document V32.

RATIONALE/ANALYSIS:
The suspended load task complies with the NASA Alternate Safety Standard as follows:

ALTERNATE STANDARD REQUIREMENT #la:

1. Removal/installation of the trunnions cannot be accomplished without placing personnel beneath the suspended load (SSRM) due to the location of the trunnion hardware. The trunnion nuts are inside the aft end of the SSRM.

2. Trunnion must be removed in order to mate the SSRM to the core vehicle and installed for de-mating.

3. Design of a support structure for the SSRM is not feasible because access to the trunnion nuts would be blocked.

4. There are no operational or procedural changes that would eliminate personnel exposure to working under the suspended load.

ALTERNATE STANDARD REQUIREMENT #1b:

The possible use of a secondary support device was evaluated. Because of the size, design, and positioning of the SSRM, the overall safety of the operation would be compromised.

ALTERNATE STANDARD REQUIREMENT #lc:
In order to remove/install the trunnions, one person must support the trunnion, while one other person removes the bolts. Personnel are positioned to prevent working directly under the SSRM to the maximum extent possible.

ALTERNATE STANDARD REQUIREMENT - #1d:
It is estimated that less than 5 minutes per side is required to remove/install the aft trunnions.

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 NASA Safety and Mission Assurance Division Chief will be permitted. A list of approved suspended load operations will be maintained by NASA Safety and Mission Assurance Division.

ALTERNATE STANDARD REQUIREMENT #4:
The operating procedures to be used to erect the booster is Launch Preparation Document(LPD) V26, "SOLID MOTOR ERECTION" and LPD V32, “CONTINGENCY” for de-mate.. These procedures have been reviewed and approved by both the Air Force and NASA personnel. The LPDs are available at both the Vandenberg launch facility and at the Florida launch facility for review.

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 Mobile Service Tower 20 ton crane used for these operations is inspected, tested, maintained, and operated in accordance with the NASA Safety Standard for Lifting devices and equipment, NSS/GO-1740.9.

SLC 2W 20 TON MST EXTERIOR BRIDGE CRANE:

A. GENERAL:
This is a new crane, designed and built by Heco-Pacific and installed by American Bridge under the NASA MELVS contract. The crane has been designed, tested, inspected, maintained and operated in accordance with the WSMCR 127-1, NASA Standard NSS/GO-1740.9, OSHA and applicable CMAA and ANSI standards.

The crane capacity is 40,000Lbs. with the heaviest actual lift at approximately 32,000Lbs. (80% of capacity) for the Strap on Solid Rocket Motors (SSRM). Other stages lifted include the first stage, Interstage, Second stage, Fairing and Spacecraft, none of which exceed 12,000Lbs.

B. CRANE SAFETY FEATURES:

1. Minimum safety factor of 5 to 1 on all mechanical and structural elements, including MST crane support structure.
2. Three hoist brake systems, tested individually, including Electro-mechanical disc brake on hoist motor, Electro-mechanical a shoe brake on gear reducer and air-operated disc brake on cable drum. An overspeed switch automatically sets the drum brake if drum speed exceeds maximum normal operating speed by about 10%. The drum brake system has been tested by deliberately inducing overspeed in the drum. In addition, a dynamic analysis has been performed showing that under free-fall emergency braking, the crane system loads do not exceed the 125% proof test loads.
3. Dual upper limit switches-initial is paddle type and final switch is gear operated on drum rotation.
4. Emergency stop buttons on both pendants. Pendant circuitry allows only one pendant functional at a time except for the emergency stop buttons.
5. Emergency stop buttons in hoist drum room and mechanical equipment room (control console location).
6. Crane proofloaded to 125% of capability initially and annually and functionally tested prior to each use.
7. Trip bar installed across cable drum which shuts off crane power if cable over wraps.
8. Thermal overload switch on drum brake resistor to shut off power under excessive braking conditions.
9. Electrical disconnects provided in crane drum mom and near bridge runway per OSHA standards to safely allow crane maintenance.

C. CRANE OPERATING SAFEGUARDS:

1. All crane operators trained and certified.
2. All technicians and pad engineers on headsets during lift operations.
3. Technician stationed in crane drum room (with emergency stop) during all crane operations.

ALTERNATE STANDARD REQUIREMENT #7:

A System Assurance Analysis (SAA) has been performed on the Mobile Service Tower 20 ton crane. The SAA includes a failure modes and effects analysis (FMEA) and a hazard analysis. No single failure points were identified.

ALTERNATE STANDARD REQUIREMENT #8:

A visual inspection of the crane and a functional test will be performed before lifting the load.

ALTERNATE STANDARD REQUIREMENT #9:

A trained/certified operator will remain at the controls while personnel are under the load.

ALTERNATE STANDARD REQUIREMENT #10:

Safety control areas and the requirement to rope off the area are documented in the operating procedure(V26).

ALTERNATE STANDARD REQUIREMENT #11:

Prior to all operations the engineering task leader(ATC) conducts a pre-task briefing to identify safety hazards, safety control areas, crew assignment, communications assignments (and backup) and general

test conduct. The ATC uses the operating procedure to conduct the task. Deviations to the procedure require approval from various groups, including safety, if the deviation affects the safety of the operation or changes the hazard level of the task.

ALTERNATE STANDARD REQUIREMENT #12:

Communication assignment and communications conduct are included in the pre task briefing. The requirement to stop the hoisting operation is clearly understood if communication is lost.

ALTERNATE STANDARD REQUIREMENT #13:

Personnel required to work under the suspended load are in continuous sight of the ATC at all times.

ALTERNATE STANDARD REQUIREMENT # 14:

The NASA Safety and Mission Assurance Division will 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.

OPERATION - Spacecraft off-load/load from/to the transporter and mate/de-mate to/from the core vehicle.

SUPPORTING DOCUMENTS:

1. Systems Assurance Analysis - SAA 88CROOO-041, 20-TON Mobile Service Tower Bridge Crane
2. Launch Preparation Document - LPD V7, Spacecraft Erection
3. Launch Preparation Document – LPD V32, Contingency

GENERAL DESCRIPTION:

1. Requires two technicians to install/remove four bolts which attach the aft environmental shield to the direct mate adapter after spacecraft canister is hoisted above the trailer.
2. Requires two technicians to remove/install the four bolts which attach the environmental shield and to remove the environmental shield prior to lowering the spacecraft onto the second stage.
3. Requires up to two technicians to be partially under the suspended spacecraft to enable cleaning of the payload attach fitting and second stage mating surfaces.
4. Requires four technicians to install/remove two guide pins into the direct mate adapter prior to lowering the spacecraft onto the second stage.
5. Requires four technicians to visually guide the spacecraft during the mating/de-mating operation.

The spacecraft erection and mate procedures use the overhead 20 ton bridge crane attached to the Mobile Service Tower (MST).

With the spacecraft transporter trailer in the offload position, the forward lifting assembly is lowered utilizing the 20 ton crane and connected to the forward attach point of the spacecraft handling canister. The rigger then instructs the Crane Operator to raise the spacecraft sufficiently to install the lower bolts which attach the environmental shield to the direct mate adapter.

The rigger then instructs the Crane Operator to raise the spacecraft to canister into the pre-mate position. The final item performed prior to mating the spacecraft to the core vehicle is the cleaning of the mating surfaces. This operation generally requires one technician (however, two have been used on occasion if the surface has heavy residue) to place his hands under the suspended load for approximately five minutes. Up to an additional thirty minutes to one hour are required for bolt and environmental shield removal, installation of the guide pins and guiding the spacecraft onto the second stage. Spacecraft guidance required to preclude damage to spacecraft during mate/de-mate.

After successful completion of the mating operation the load is released and the forward hoist assembly is detached. This task is accomplished using NASA/USAF approved Launch Processing Document (LPD) V7. De-mating is accomplished in the reverse order of mating utilizing NASA/USAF approved Launch Preparation Document V32.

RATIONALE/ANALYSIS:

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

ALTERNATE STANDARD REQUIREMENT #la:

1. Environmental shield must be installed (and removed) to maintain cleanliness.
2. Mating surfaces must be clean and free of residue prior to final mate.
3. Guide pins must be installed to ensure proper spacecraft alignment.
4. Spacecraft guidance required to preclude damage to spacecraft during mate.
5. Design of a support structure for the spacecraft is not feasible with the handling canister installed.
6. There are no operational nor procedural changes that would eliminate personnel, exposure to working under the suspended load.

ALTERNATE STANDARD REQUIREMENT #1b:

The possible use of a secondary support device was evaluated. Because of the size, positioning and sensitive nature of spacecraft, the overall safety of the operation would be compromised.

ALTERNATE STANDARD REQUIREMENT #lc:

Wiping the mating surfaces is required to ensure that no obstructions are present which: could damage the stage, prevent proper installation of the stage, or prevent proper separation of the stage. Environmental shield installation/removal and guide pin operations are required to ensure proper installation of the spacecraft The maximum number of personnel required under or partially under the load at any one time is two.

ALTERNATE STANDARD REQUIREMENT #1d:

Personnel required under the load will perform their operations as quickly as possible and remove themselves from exposure immediately upon task completion.

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 NASA Safety and Mission Assurance Division Chief will be permitted. A list of approved suspended load operations will be maintained by NASA Safety and Mission Assurance Division.

ALTERNATE STANDARD REQUIREMENT #4:

The operating procedures to be used to erect and mate the spacecraft is Launch Preparation Document (LPD) V7, "SPACECRAFT ERECTION AND MATE" and LPD V32, “CONTINGENCY” for de-mate. These procedures have been reviewed and approved by both the Air Force and NASA personnel. The LPDs are available at both the Western Test Range and the Eastern Test Range for review.

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 Mobile Service Tower 20 ton crane used for these operations is inspected, tested, maintained and operated in accordance with the NASA Safety Standard for Lifting devices and Equipment, NSS/GO-1740.9.

Nominal Spacecraft weight is approximately 5,975 pounds. The Spacecraft canister (P/N lD60819-503) weighs 3,325 Lb. and is rated for 10,365 Lb. It was initially prooftested at 267 percent (23,500#) of rated load. After the initial prooftest all welds were penetrant inspected per NUI-1-6866. Annual prooftesting is performed at 225 percent (10,365#) of rated load. There are no single point failure welds.

SLC 2W 20 TON MST EXTERIOR BRIDGE CRANE:

A. GENERAL:

This is a new crane, designed and built by Heco-Pacific and installed by American Bridge under the NASA MELVS contract. The crane has been designed, tested, inspected, maintained and operated in accordance with the WSMCR 127-1, NASA Standard NSS/GO-1740.9, OSHA and applicable CMAA and ANSI standards.

The crane capacity is 40,000Lbs. with the heaviest actual lift at approximately 32,000Lbs. (80% of capacity) for the Strap on Solid Rocket Motors (SSRM). Other stages lifted include the first stage, Interstage, Second stage, Fairing and Spacecraft, none of which exceed 12,000Lbs.

B. CRANE SAFETY FEATURES:

1. Minimum safety factor of 5 to 1 on all mechanical and structural elements, including MST crane support structure.
2. Three hoist brake systems, tested individually, including Electro-mechanical disc brake on hoist motor, Electro-mechanical a shoe brake on gear reducer and air-operated disc brake on cable drum. An overspeed switch automatically sets the drum brake if drum speed exceeds maximum normal operating speed by about 10%. The drum brake system has been tested by deliberately inducing overspeed in the drum. In addition, a dynamic analysis has been performed showing that under free-fall emergency braking, the crane system loads do not exceed the 125% proof test loads.
3. Dual upper limit switches-initial is paddle type and final switch is gear operated on drum rotation.
4. Emergency stop buttons on both pendants. Pendant circuitry allows only one pendant functional at a time except for the emergency stop buttons.
5. Emergency stop buttons in hoist drum room and mechanical equipment room (control console location).
6. Crane proofloaded to 125% of capability initially and annually and functionally tested prior to each use.
7. Trip bar installed across cable drum which shuts off crane power if cable over wraps.
8. Thermal overload switch on drum brake resistor to shut off power under excessive braking conditions.
9. Electrical disconnects provided in crane drum mom and near bridge runway per OSHA standards to safely allow crane maintenance.

C. CRANE OPERATING SAFEGUARDS:

1. All crane operators trained and certified.

2. All technicians and pad engineers on headsets during lift operations.
3. Technician stationed in crane drum room (with emergency stop) during all crane operations.

ALTERNATE STANDARD REQUIREMENT #7:
A System Assurance Analysis (SAA) has been performed on the Mobile Service Tower 20 ton crane. The SAA includes a failure modes and effects analysis (FMEA) and a hazard analysis. No single failure points were identified.

ALTERNATE STANDARD REQUIREMENT #8:
A visual inspection of the crane and a functional test will be performed before lifting the load.

ALTERNATE STANDARD REQUIREMENT #9:
A trained/certified operator will remain at the controls while personnel are under the load.

ALTERNATE STANDARD REQUIREMENT #10:
Safety control areas and the requirement **to** rope off the area are documented in the operating procedure (V7).

ALTERNATE STANDARD REQUIREMENT #11:
Prior to all operations the engineering task leader (ATC) conducts a pre-task briefing to identify safety hazards, safety control areas, crew assignment, communications assignments (and backup) and general test conduct. The ATC uses the operating procedure to conduct the task. Deviations to the procedure require approval from various groups, including safety, if the deviation affects the safety of the operation or changes the hazard level of the task.

ALTERNATE STANDARD REQUIREMENT #12:
Communication assignment and communications conduct are included in the pre task briefing. The requirement to stop the hoisting operation is clearly understood if communication is lost.

ALTERNATE STANDARD REQUIREMENT #13:
Personnel required to work under the suspended load are in continuous sight of the ATC at all times.

ALTERNATE STANDARD REQUIREMENT # 14:
The NASA Safety and Mission Assurance Division will 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:**

Douglas W Newsome for 8/24/01

Calvert A. Staubus
Chief,
ELV Safety and Flight Assurance Office
Kennedy Space Center