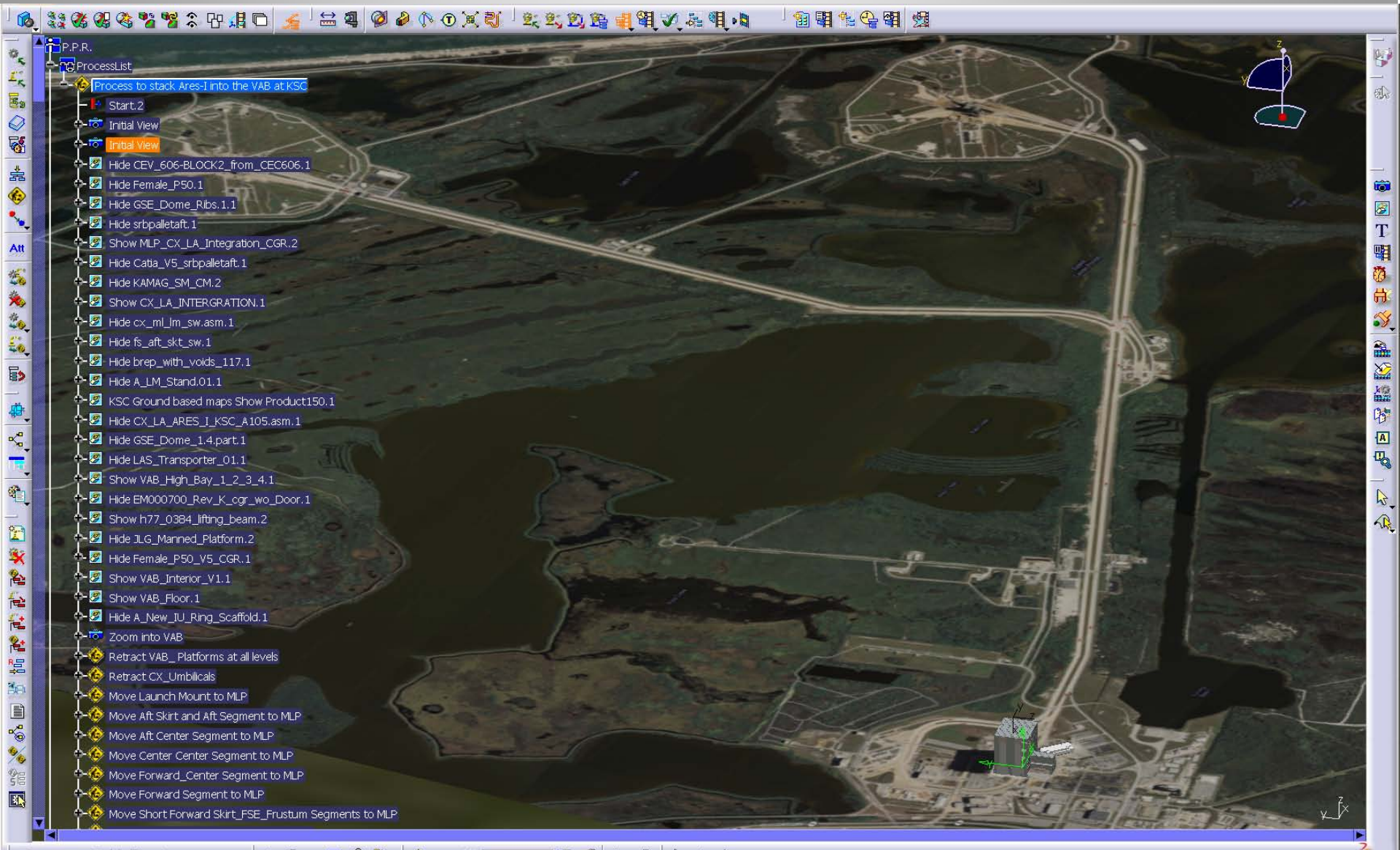
Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

AERIAL VIEW OF KSC LAUNCH SHUTTLE COMPLEX

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

DELMIA SCREEN PROCESS CONTROL LAYOUT

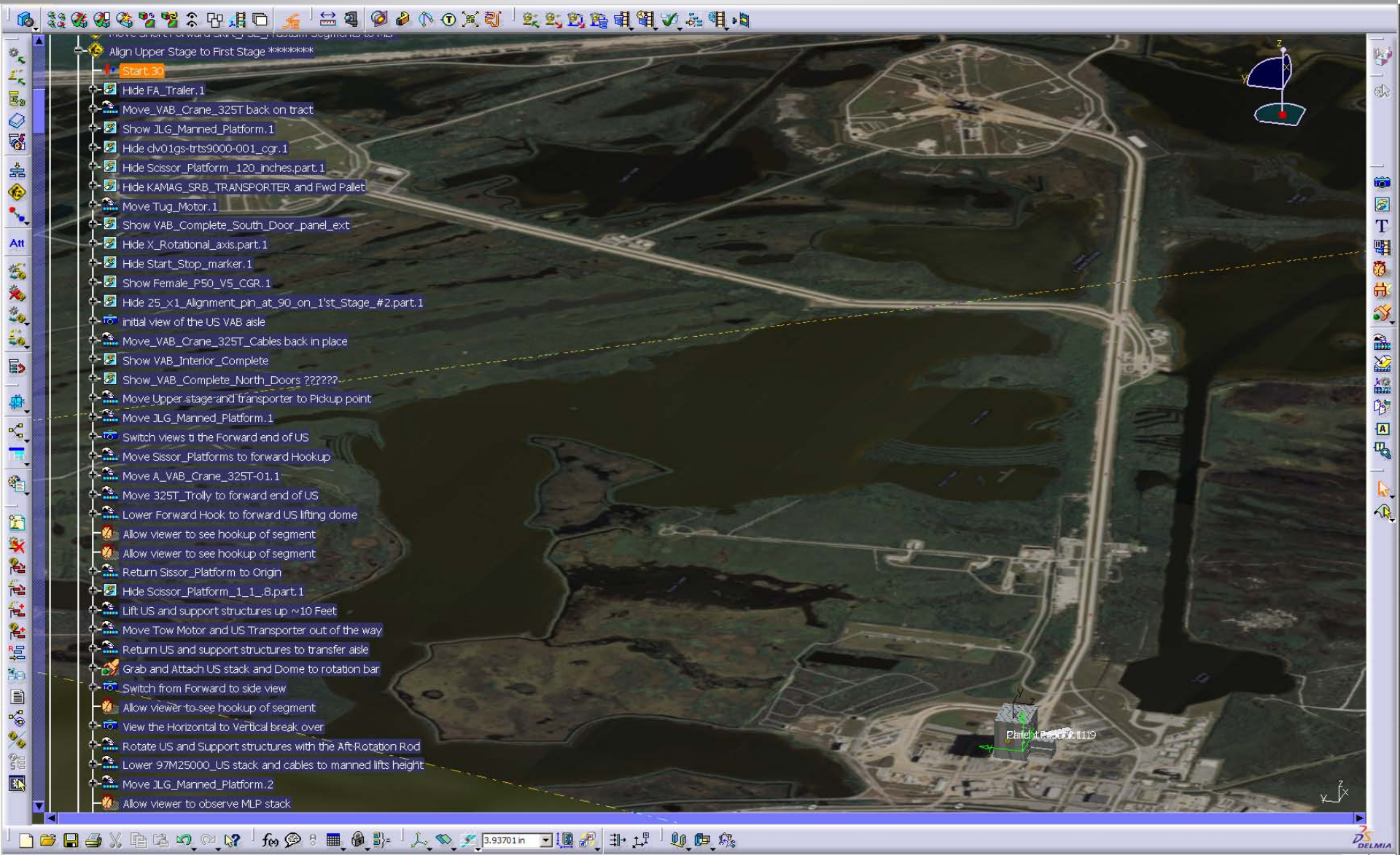
View 1



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

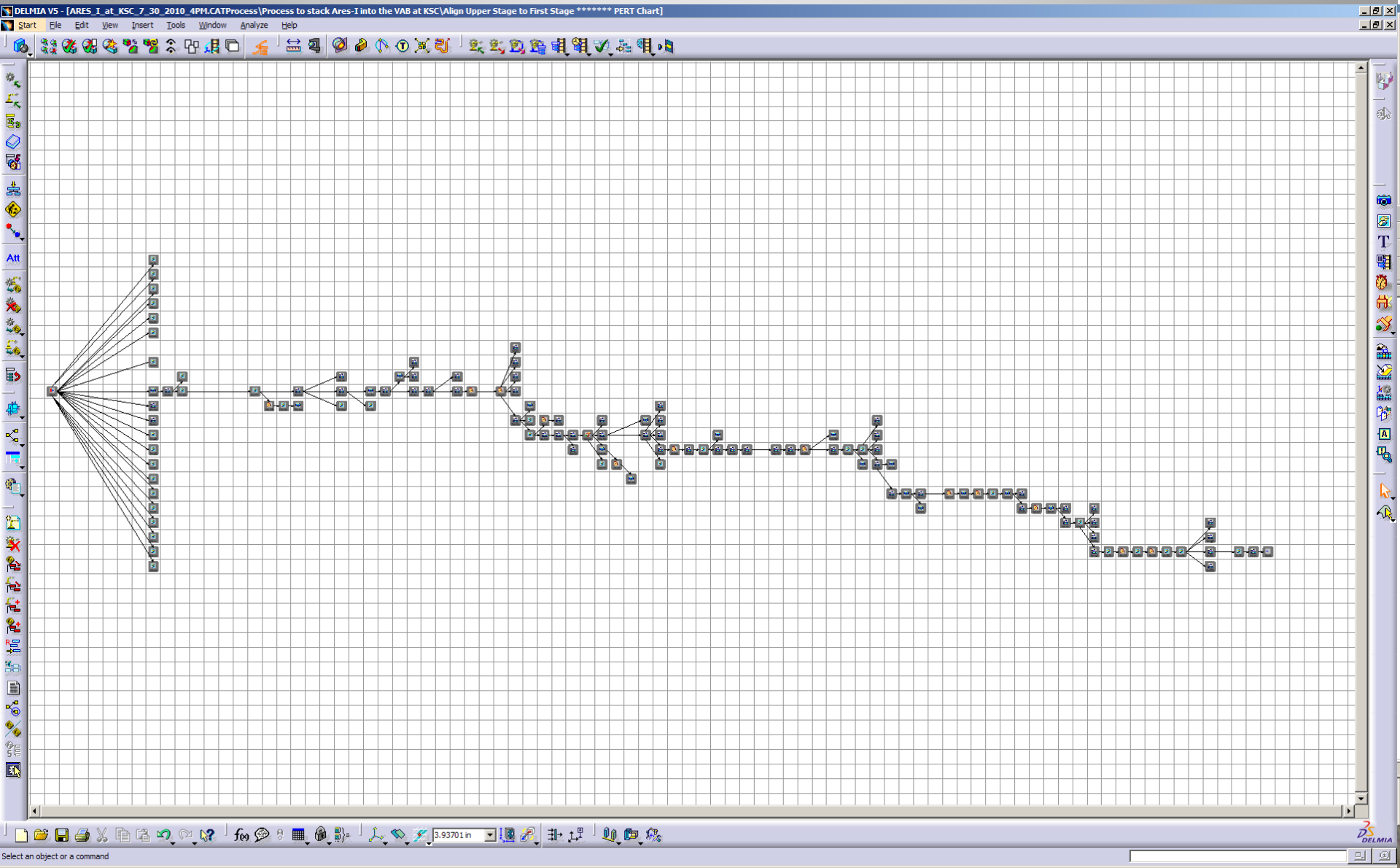
DELMIA SCREEN PROCESS CONTROL LAYOUT

View 2



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

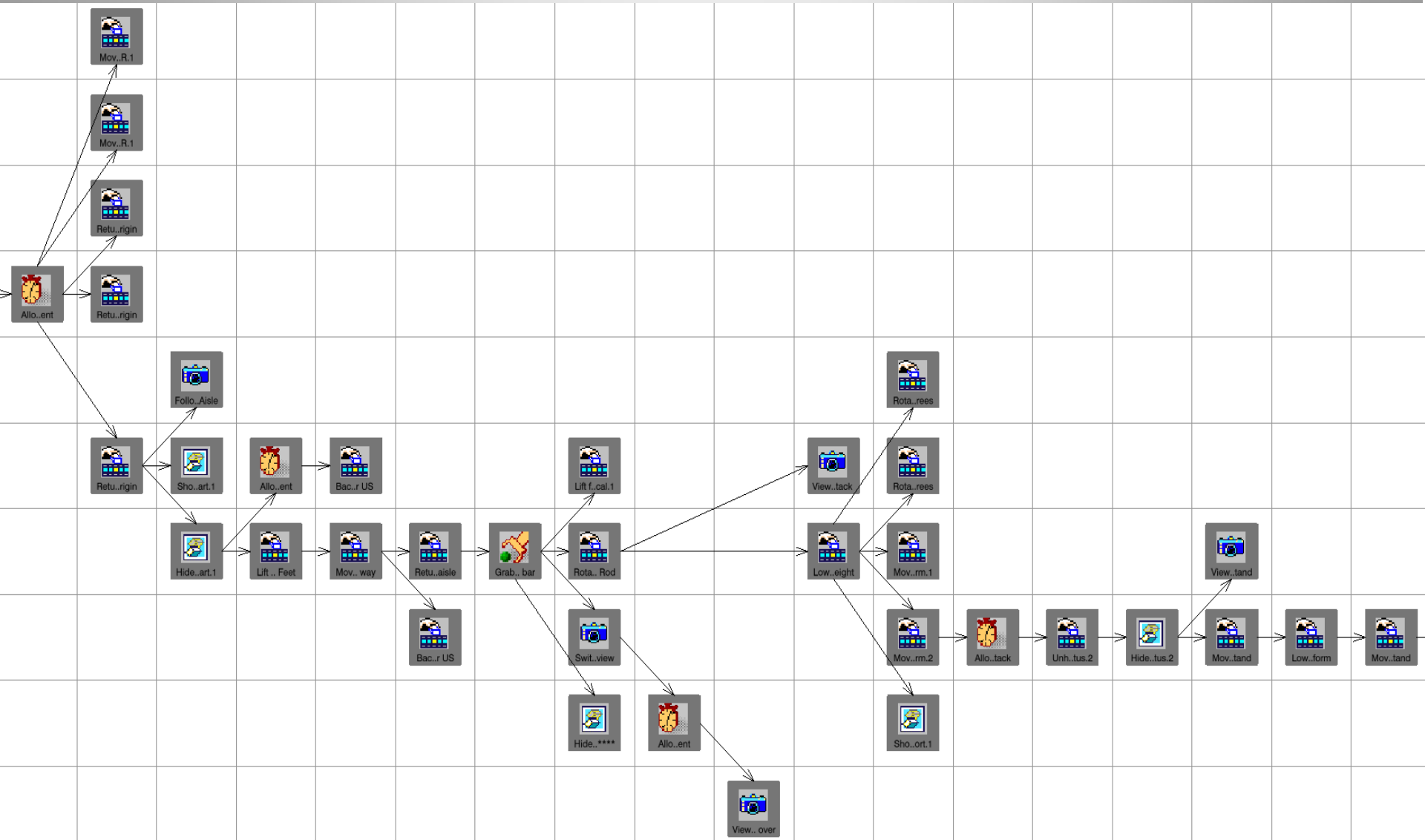
UPPER STAGE MOVE SUBROUTINE



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

UPPER STAGE MOVE

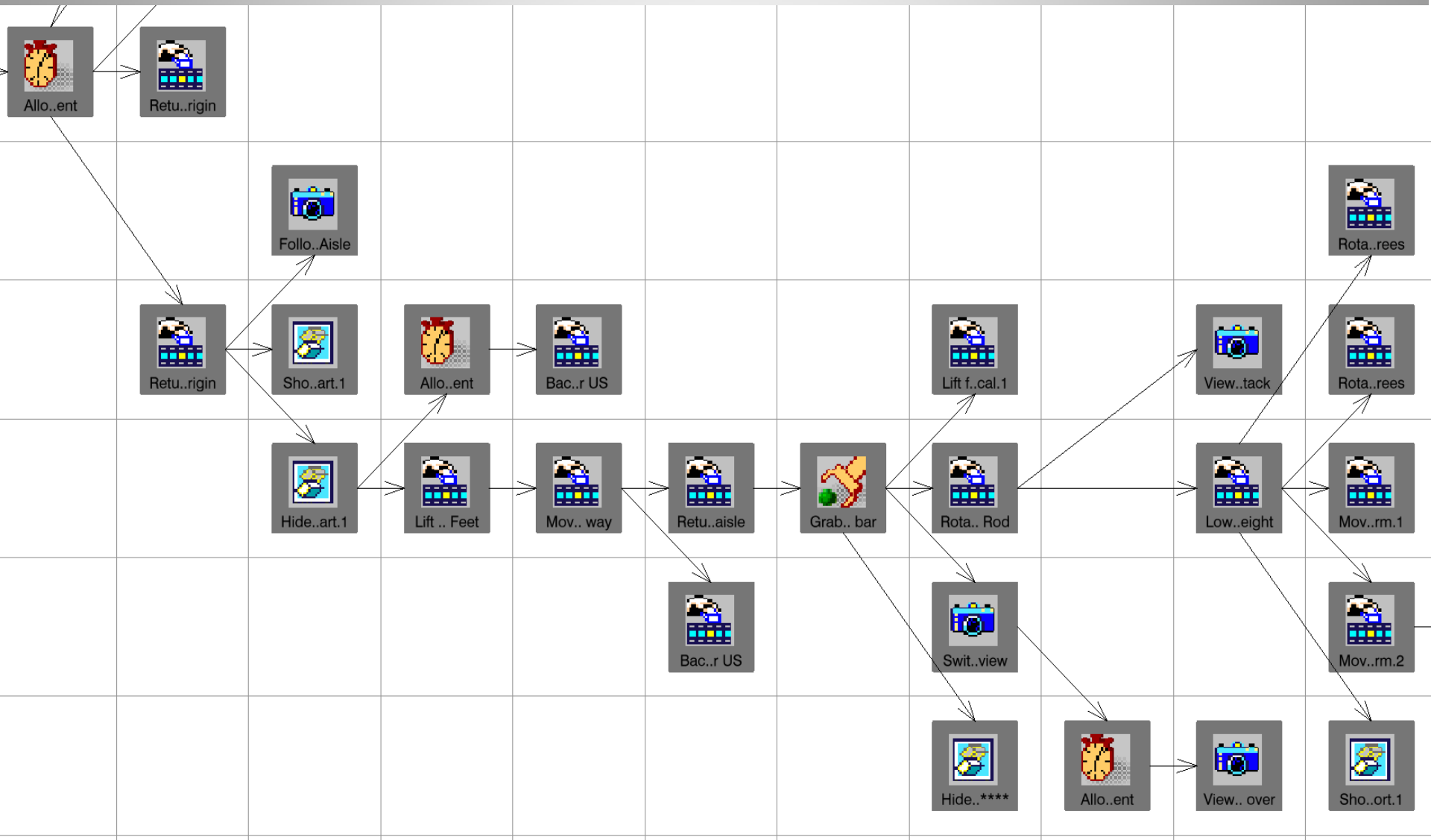
SUBROUTINE BREAKDOWN



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

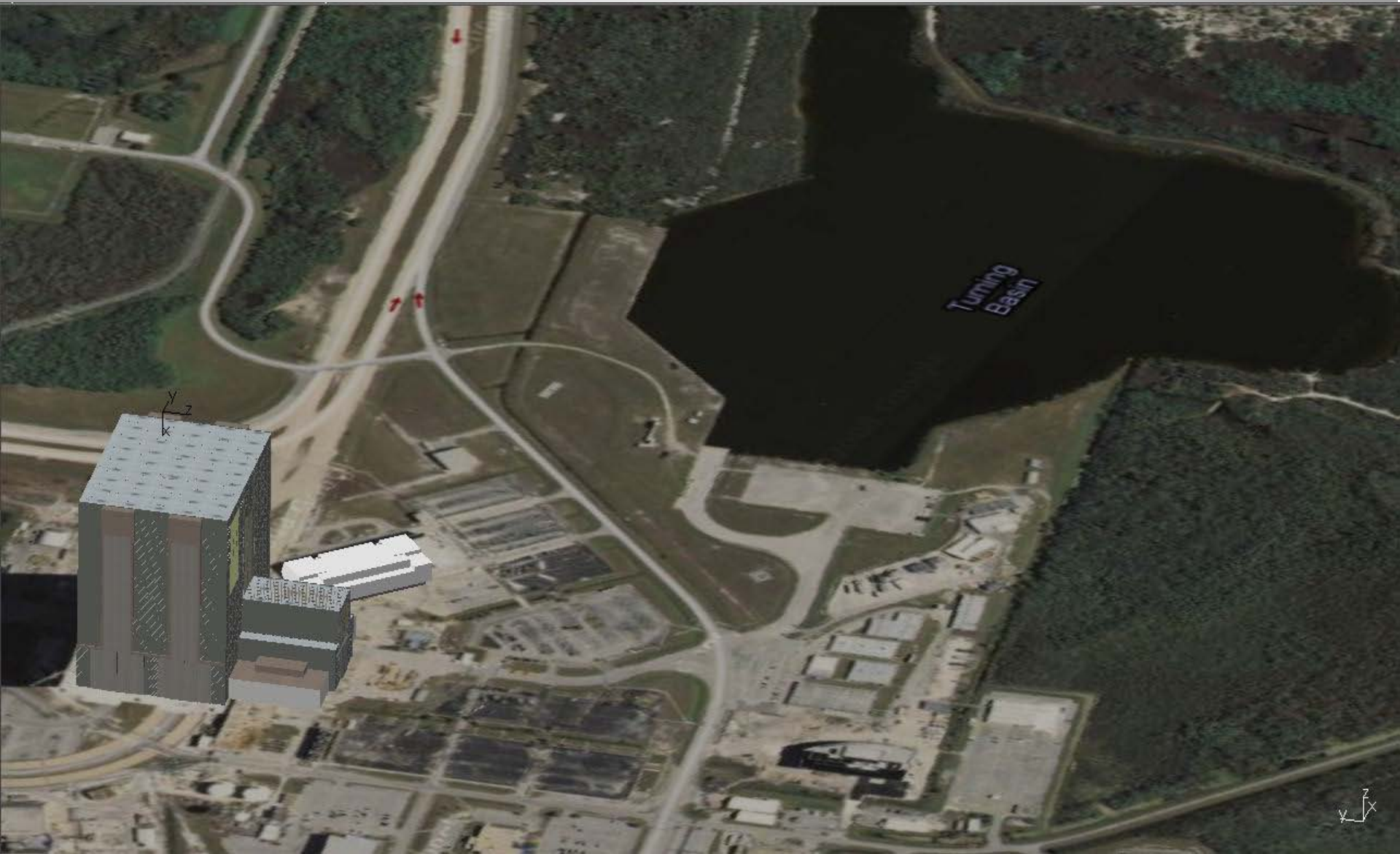
UPPER STAGE MOVE

SUBROUTINE BREAKDOWN



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

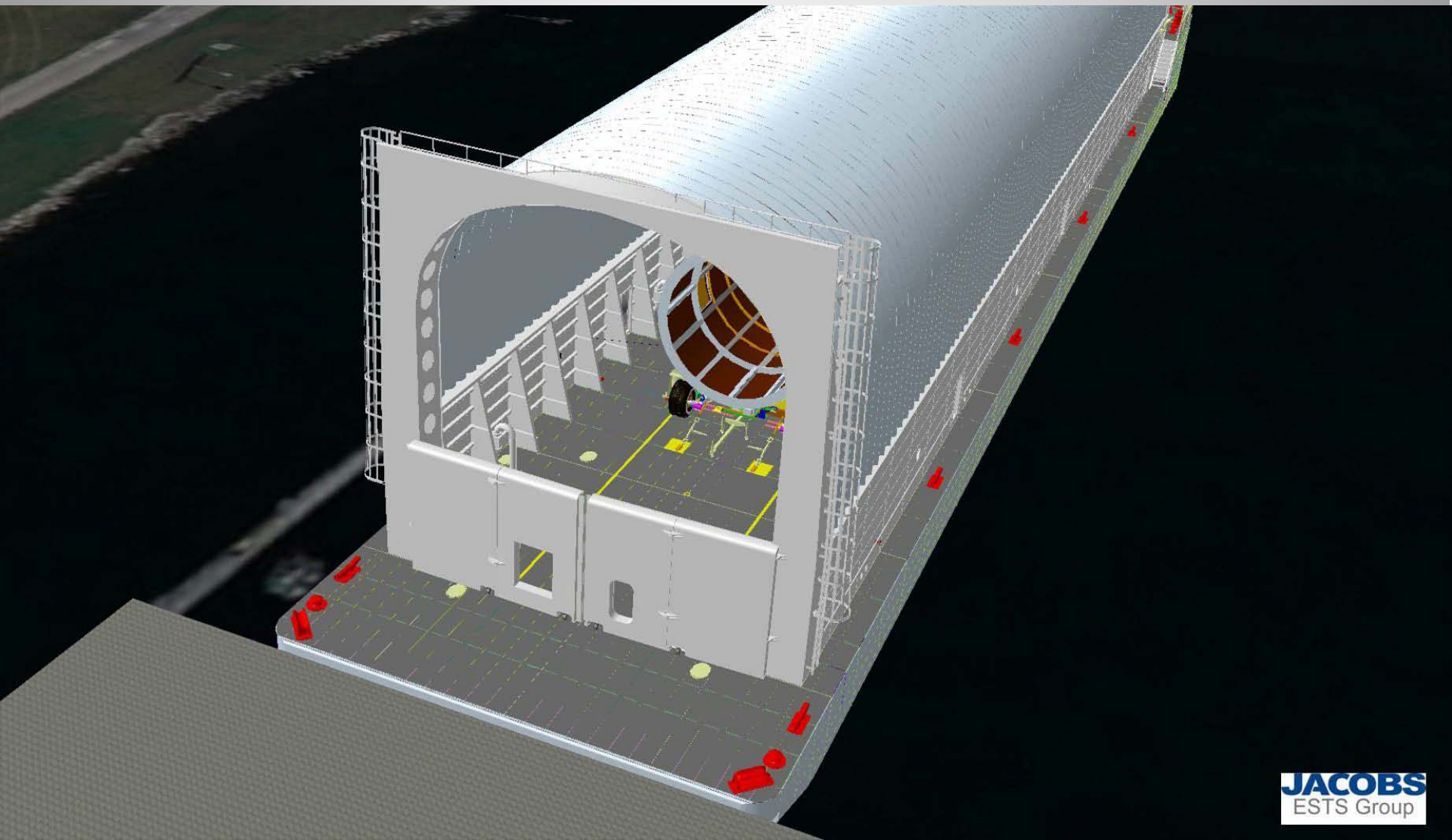
OVERHEAD IMAGE OF THE VAB AND THE TURNING BASIN



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

PEGASUS BARGE AT THE TURNING BASIN

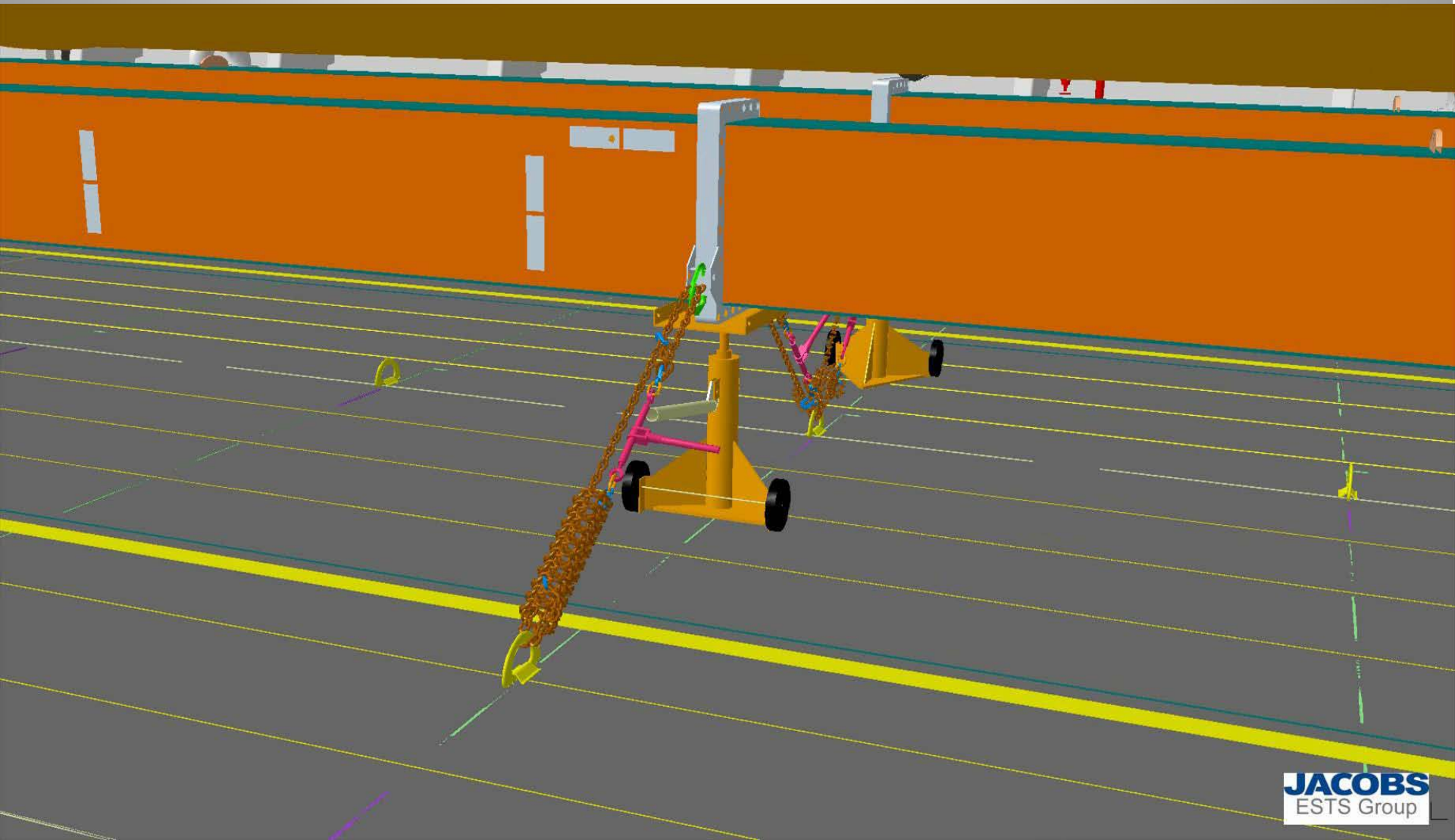
(IMAGE PROVIDED BY JACOBY BERRY)



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

REMOVING MID-SECTION SPRING TENSIONERS

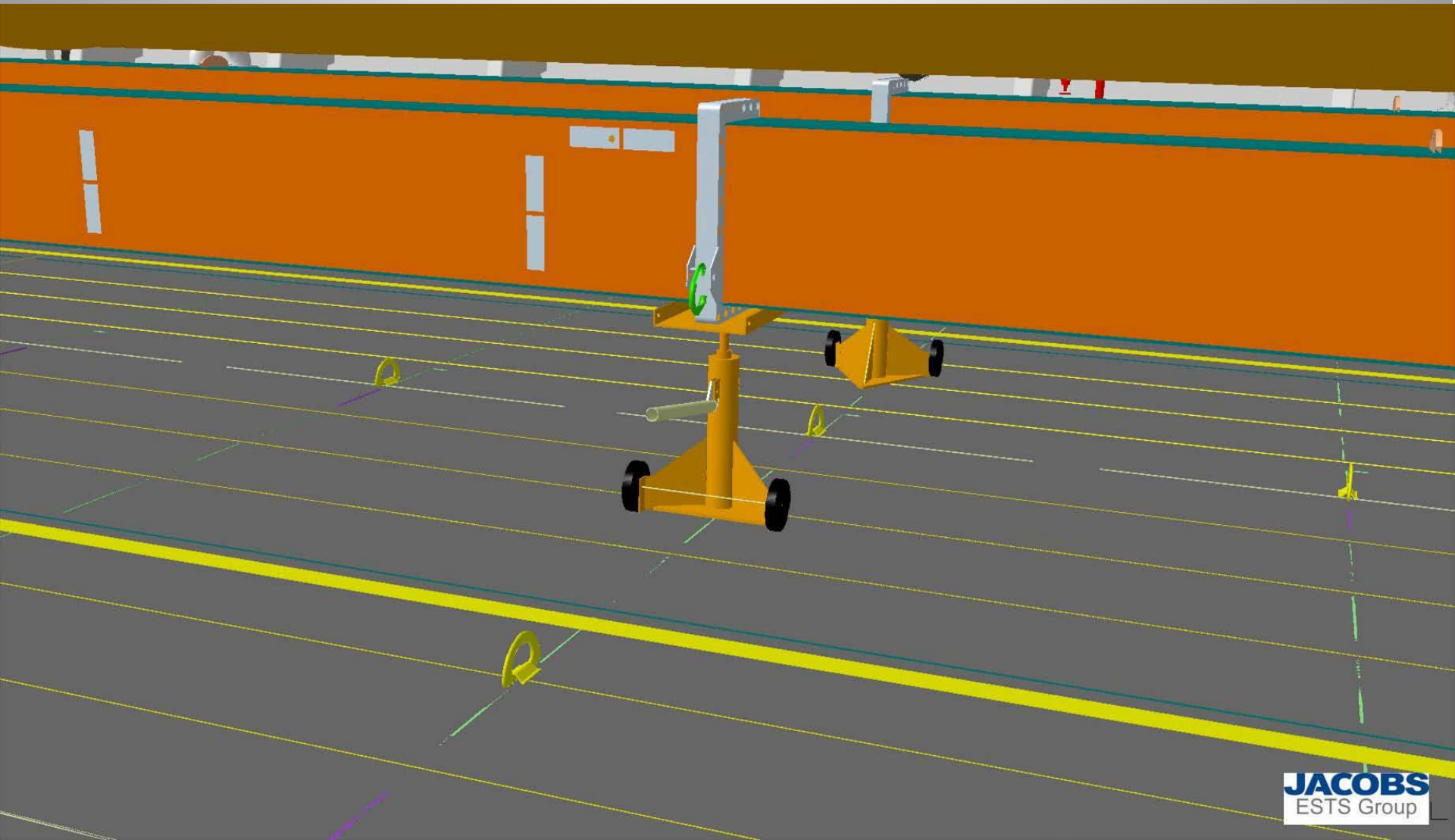
(IMAGE PROVIDED BY JACOBY BERRY)



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

REMOVING MID-SECTION SPRING TENSIONERS

(IMAGE PROVIDED BY JACOBY BERRY)

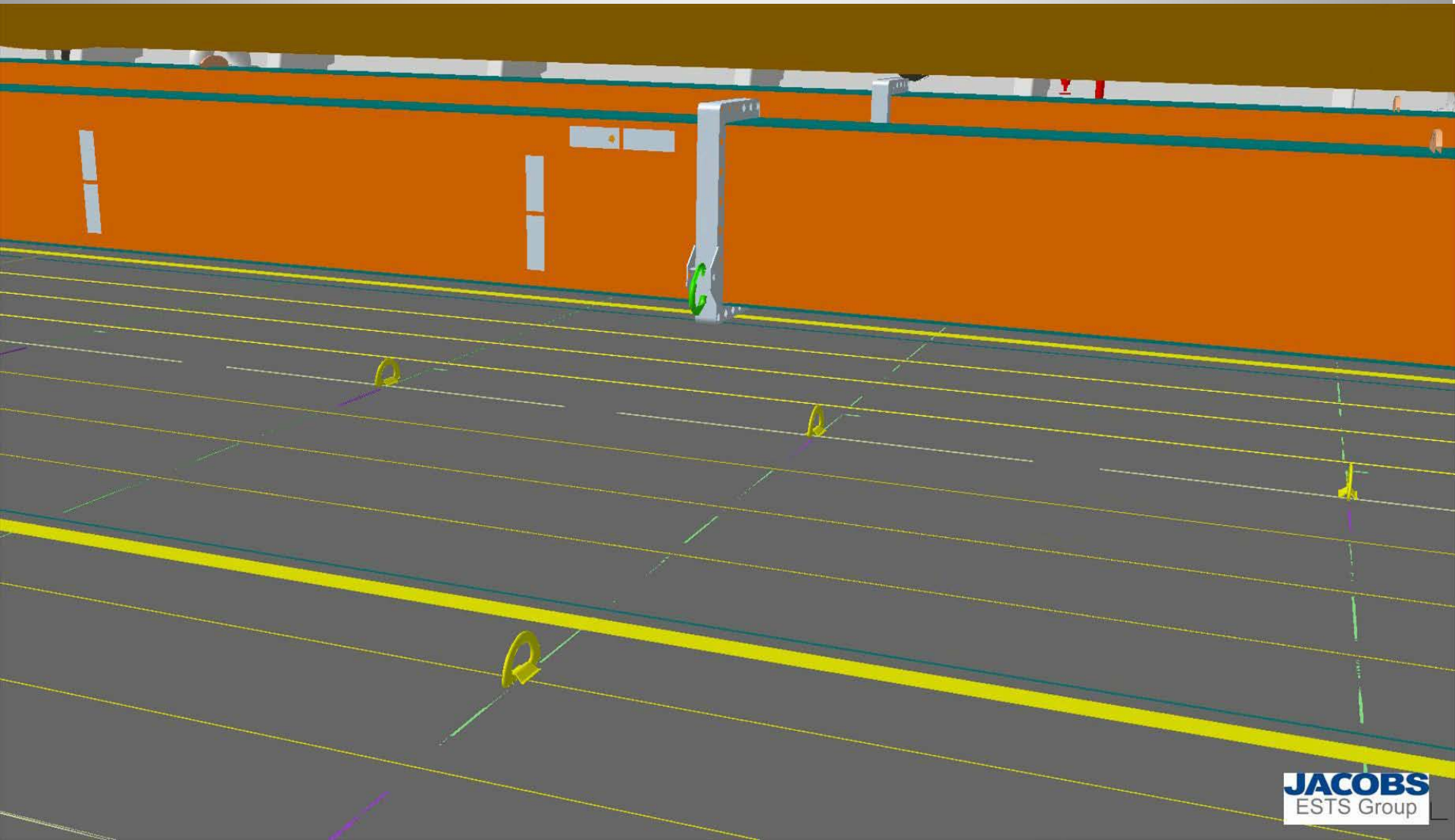


JACOBS ESTS Group

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

SPRING TENSIONERS REMOVED

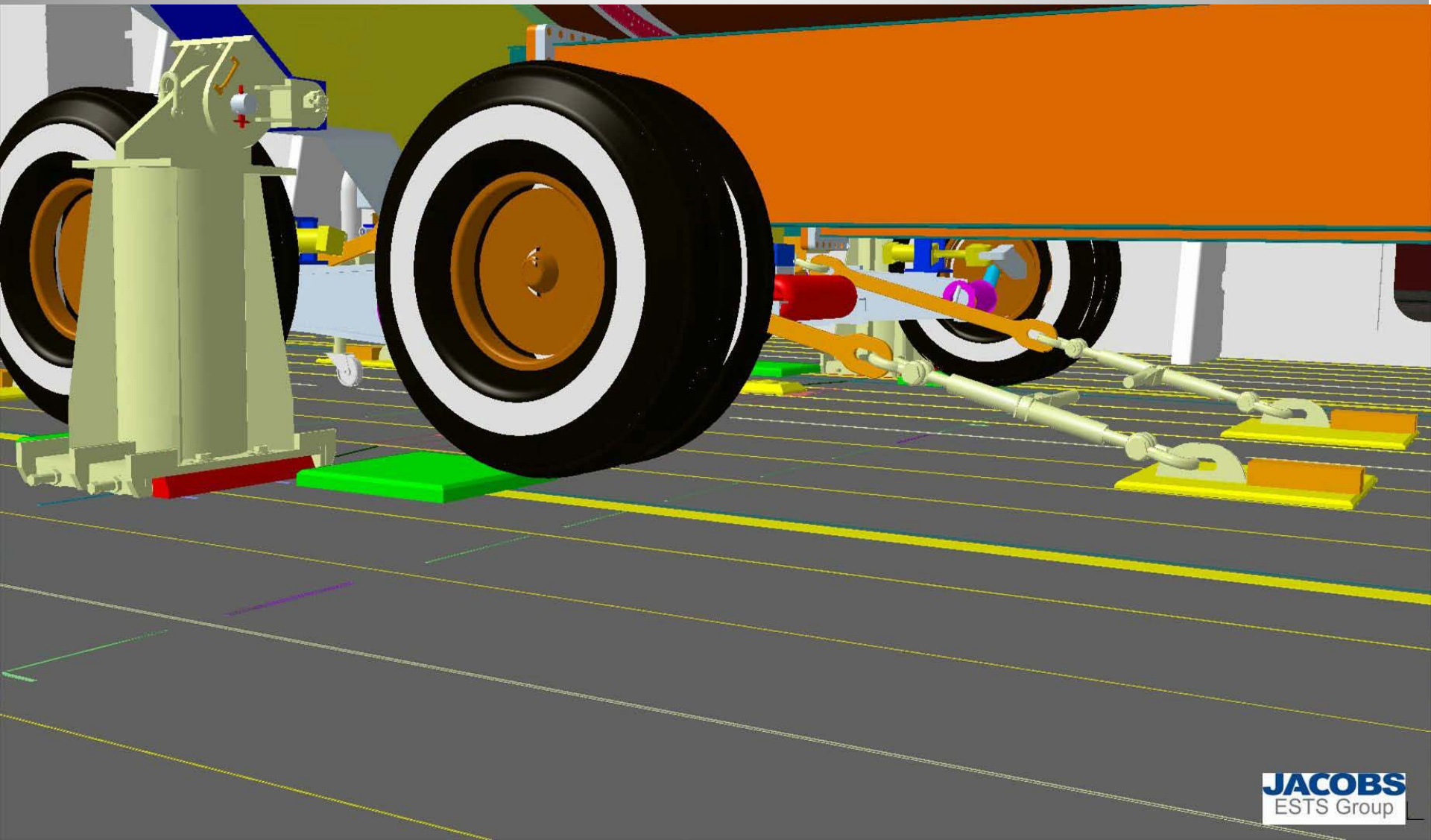
(IMAGE PROVIDED BY JACOBY BERRY)



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

AFT REAR TENSIONERS TIE DOWNS

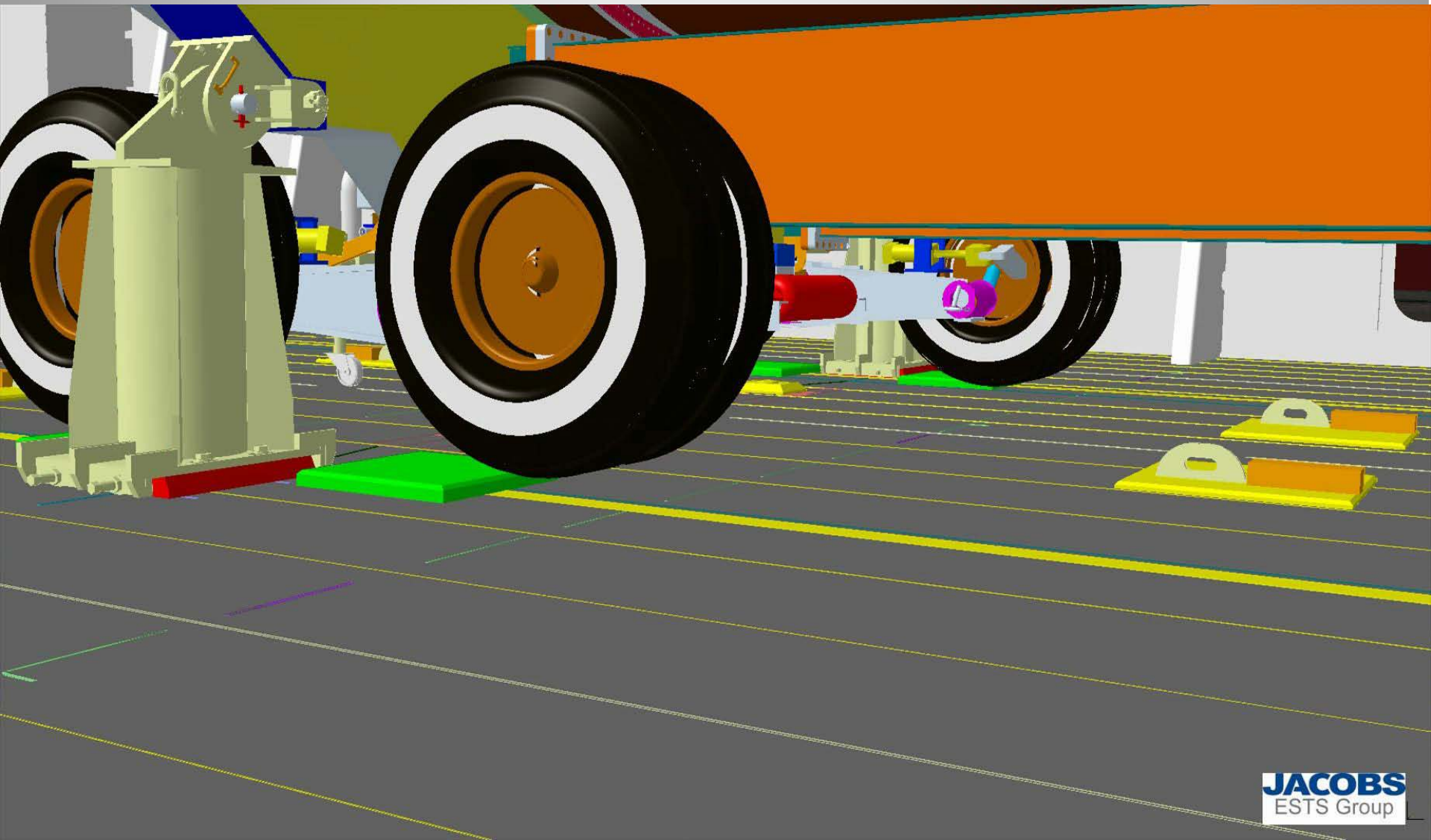
(IMAGE PROVIDED BY JACOBY BERRY)



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

AFT REAR TENSIONERS TIE DOWNS REMOVED

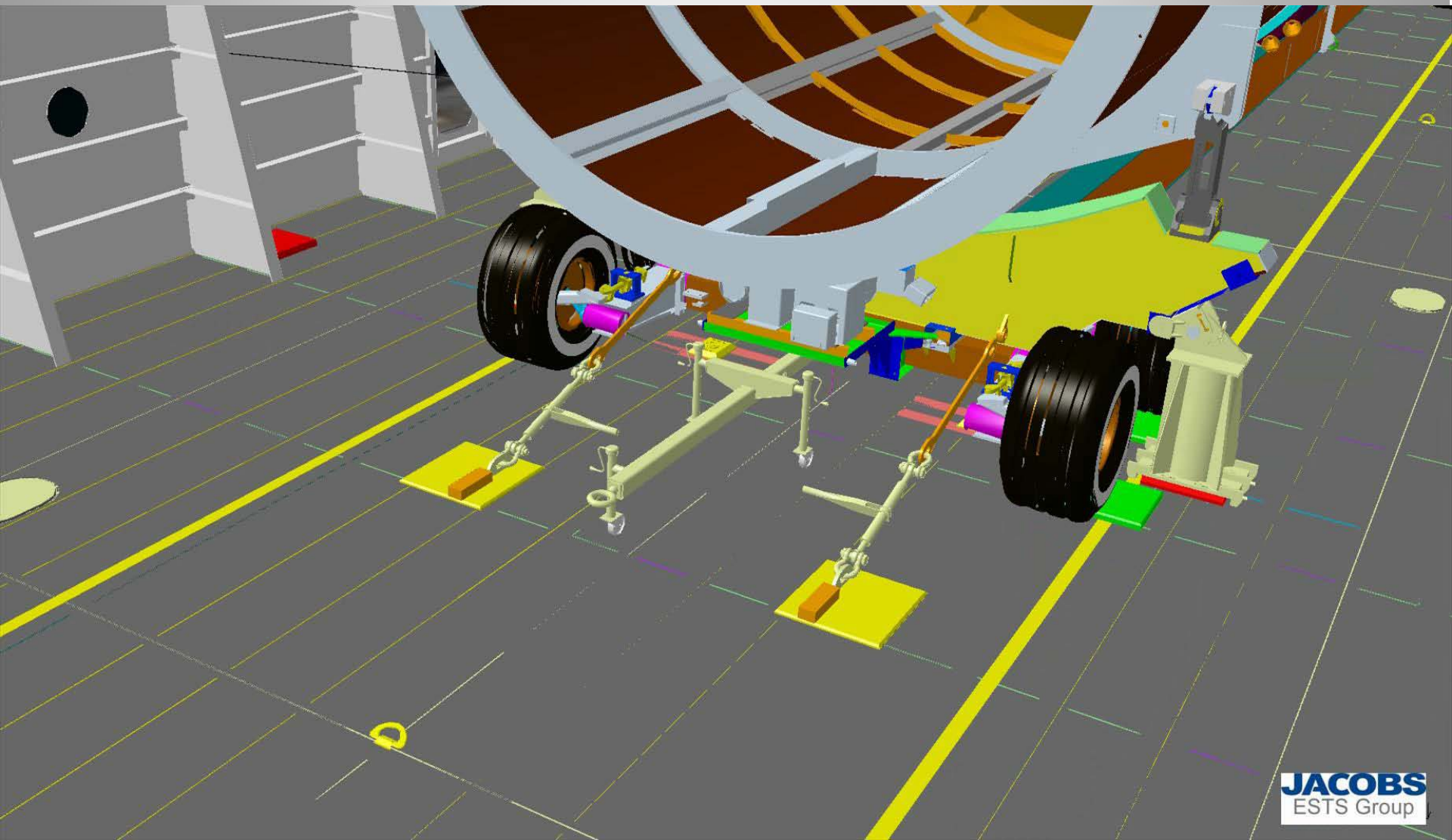
(IMAGE PROVIDED BY JACOBY BERRY)



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

AFT FORWARD TENSIONERS TIE DOWNS

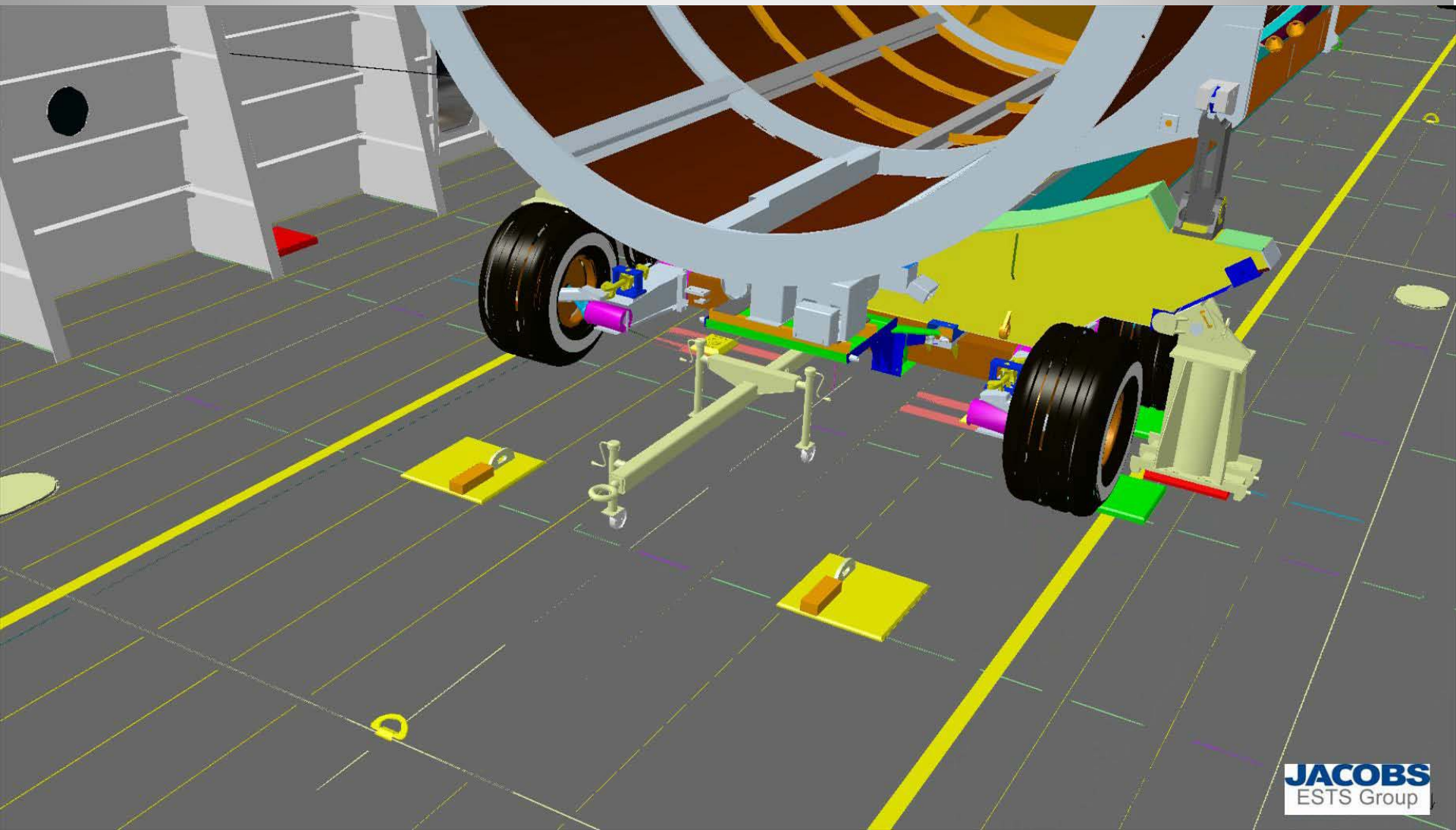
(IMAGE PROVIDED BY JACOBY BERRY)



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

AFT FORWARD TENSIONERS TIE DOWNS REMOVED

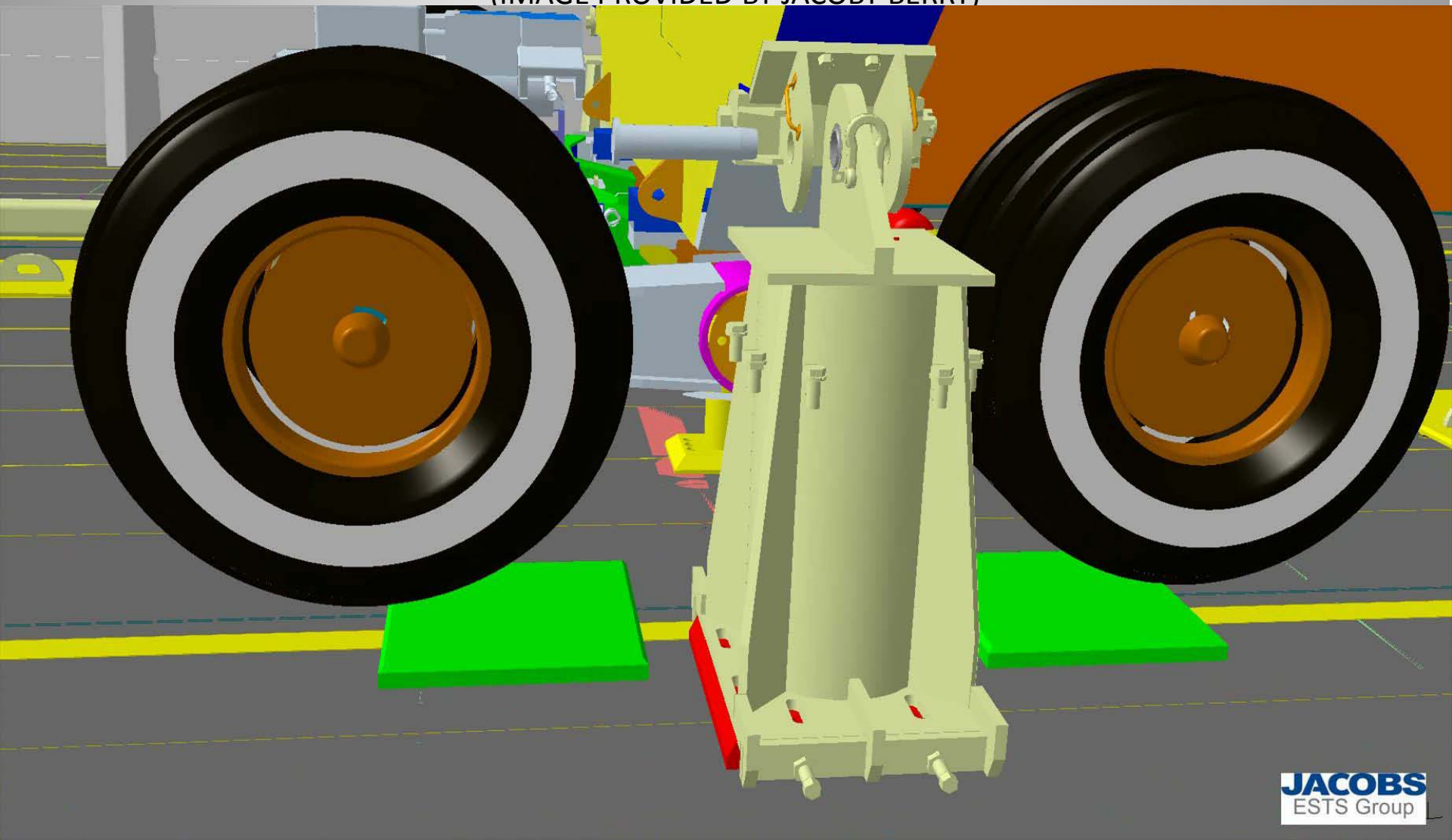
(IMAGE PROVIDED BY JACOBY BERRY)



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

REMOVING THE AFT HOLDDOWN POST

(IMAGE PROVIDED BY JACOBY BERRY)

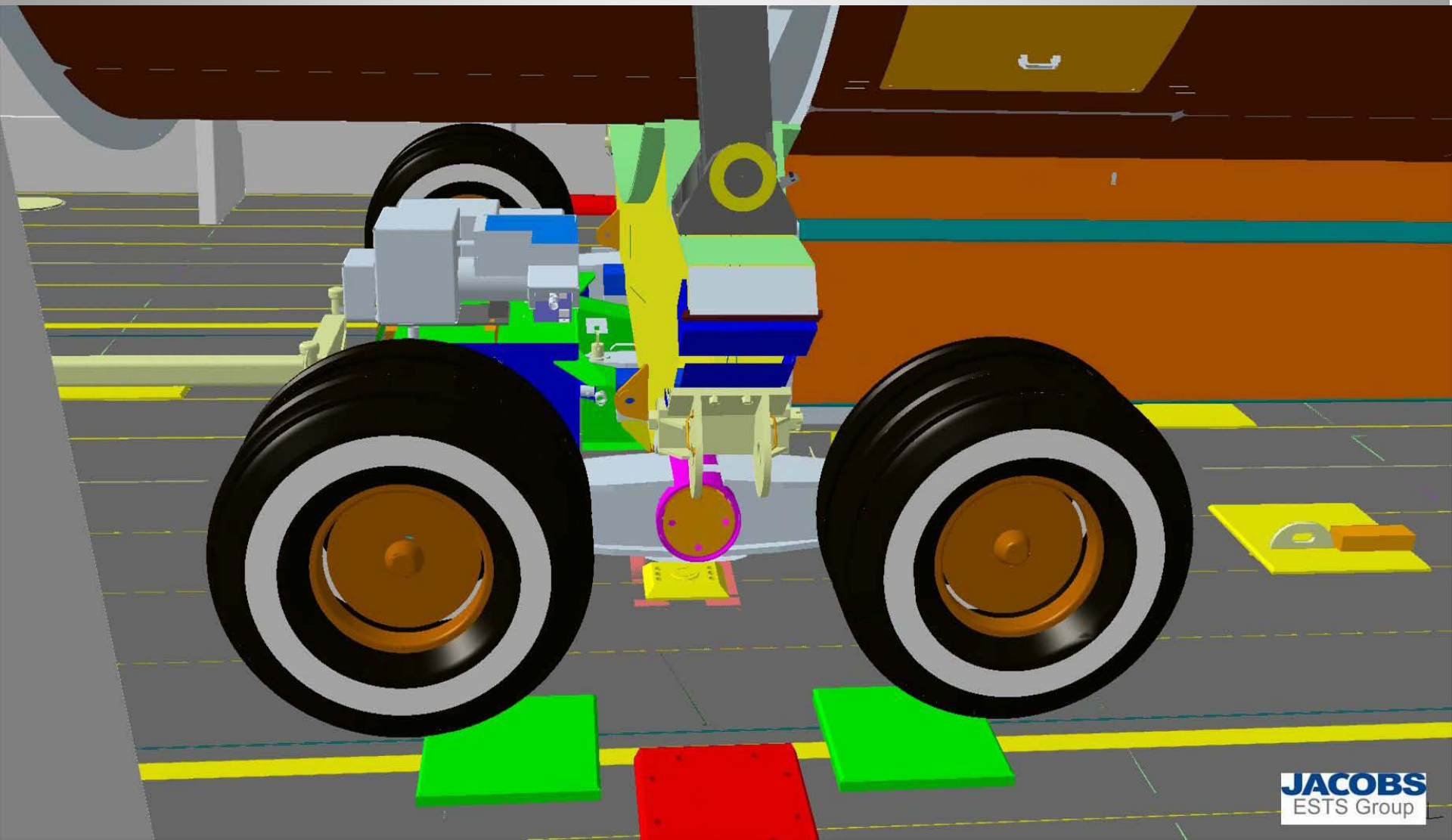


JACOBS ESTS Group

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

HOLDDOWN POST AND MOUNT REMOVED

(IMAGE PROVIDED BY JACOBY BERRY)



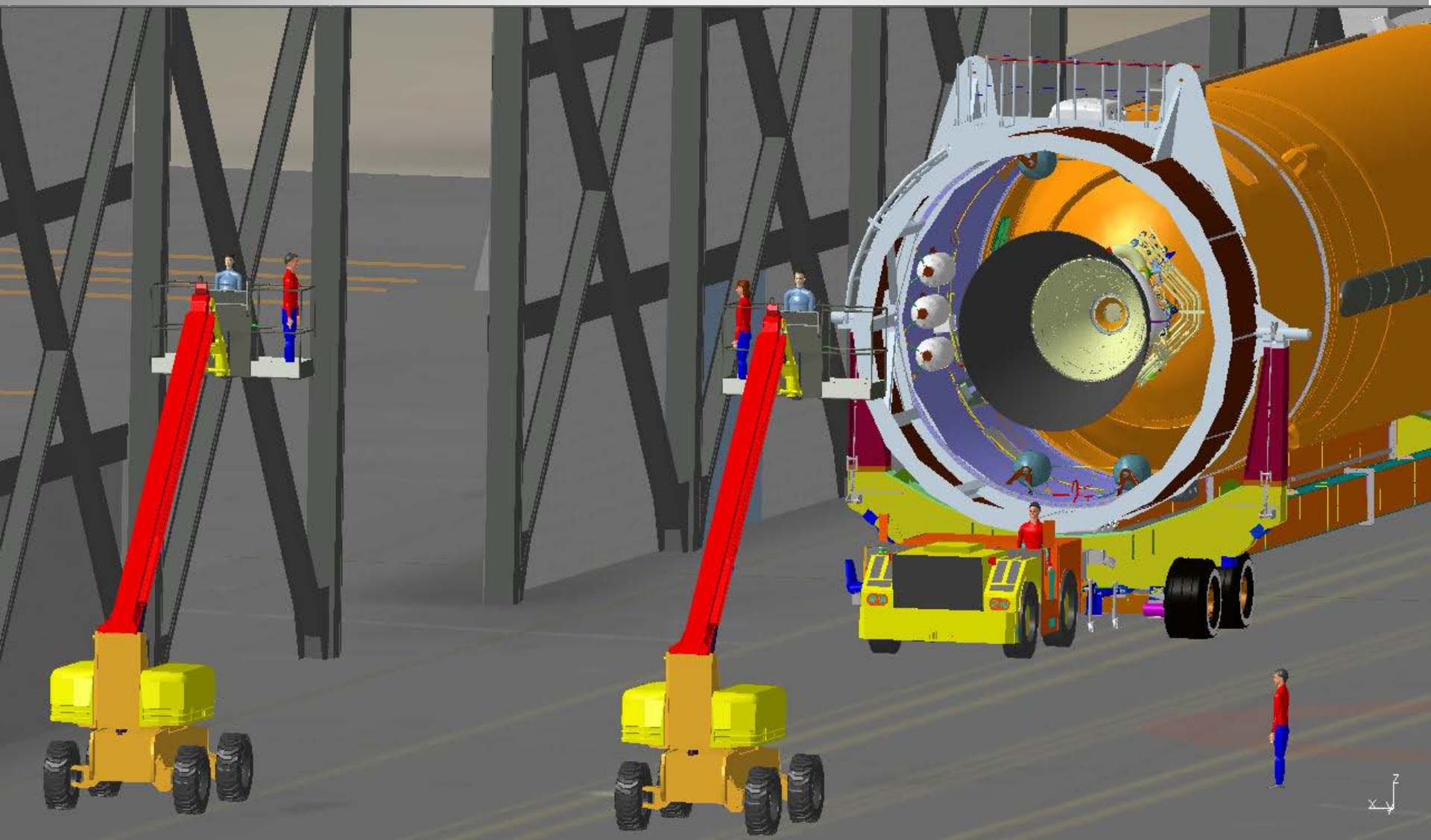
Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

US LEAVING THE PEGASUS BARGE

(IMAGE PROVIDED BY JACOBY BERRY)

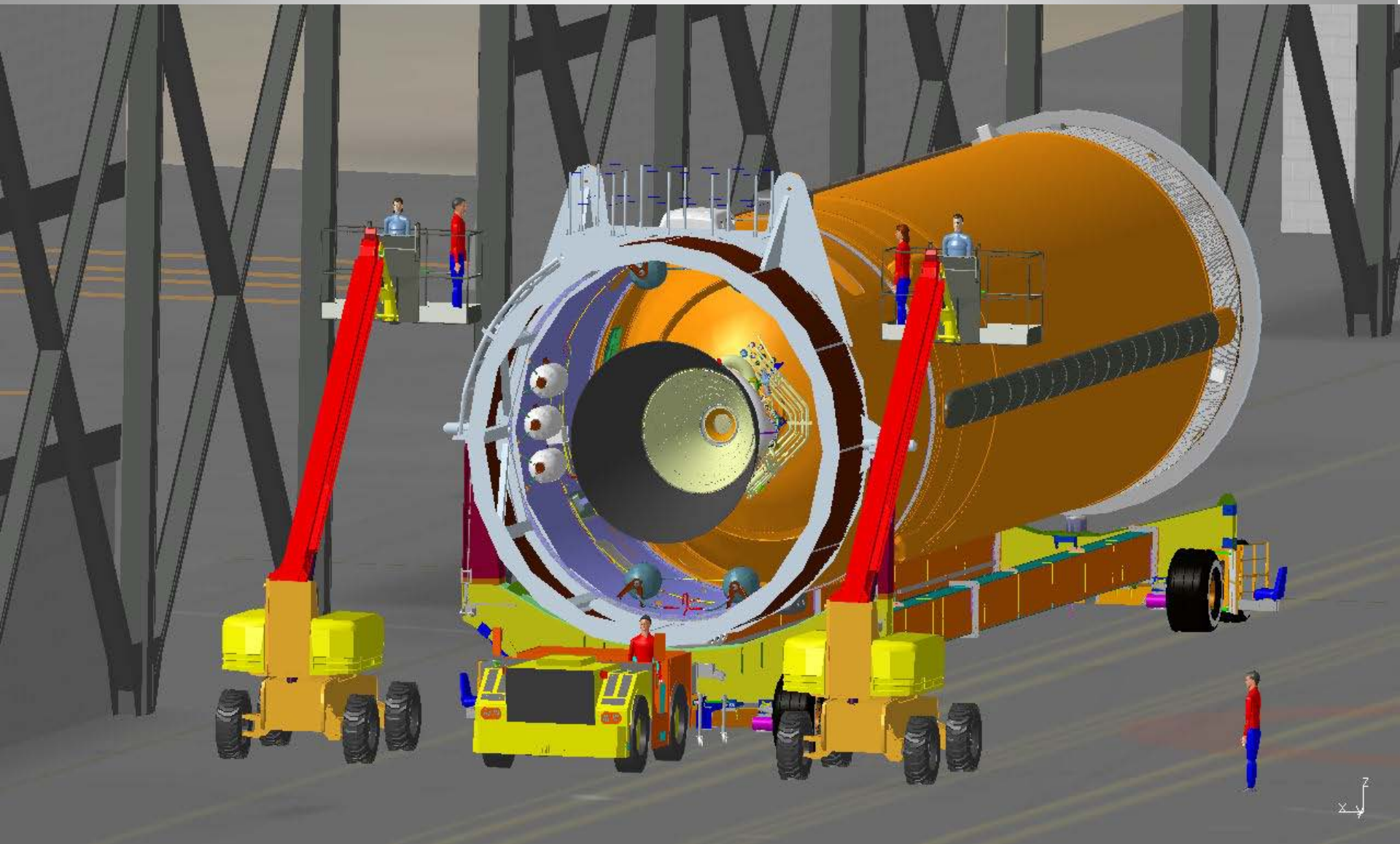
Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

UPPER STAGE ARRIVING AT TRANSFER AISLE



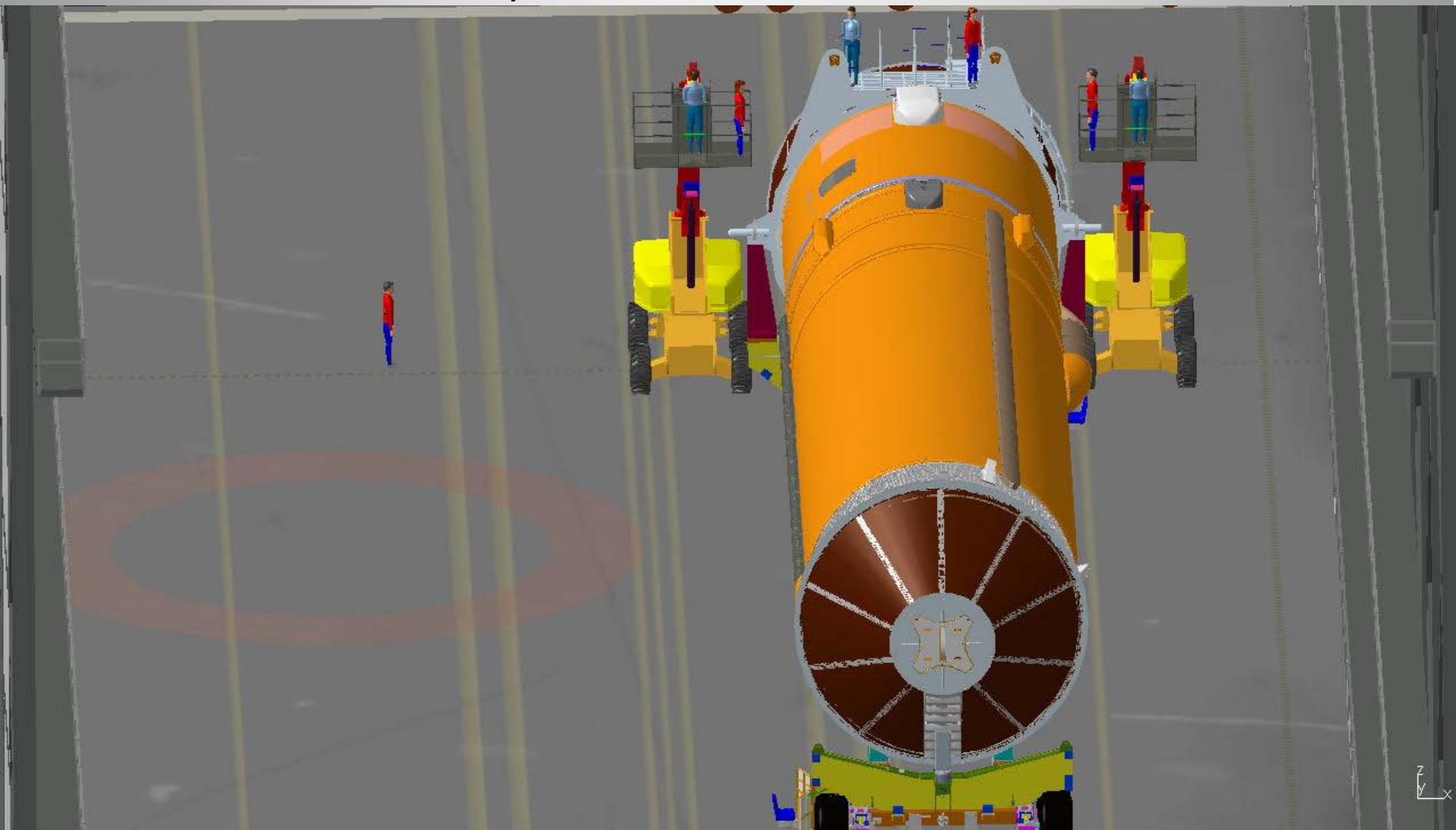
Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

UPPER STAGE RECEIVING/INSPECTION IN TRANSFER AISLE



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

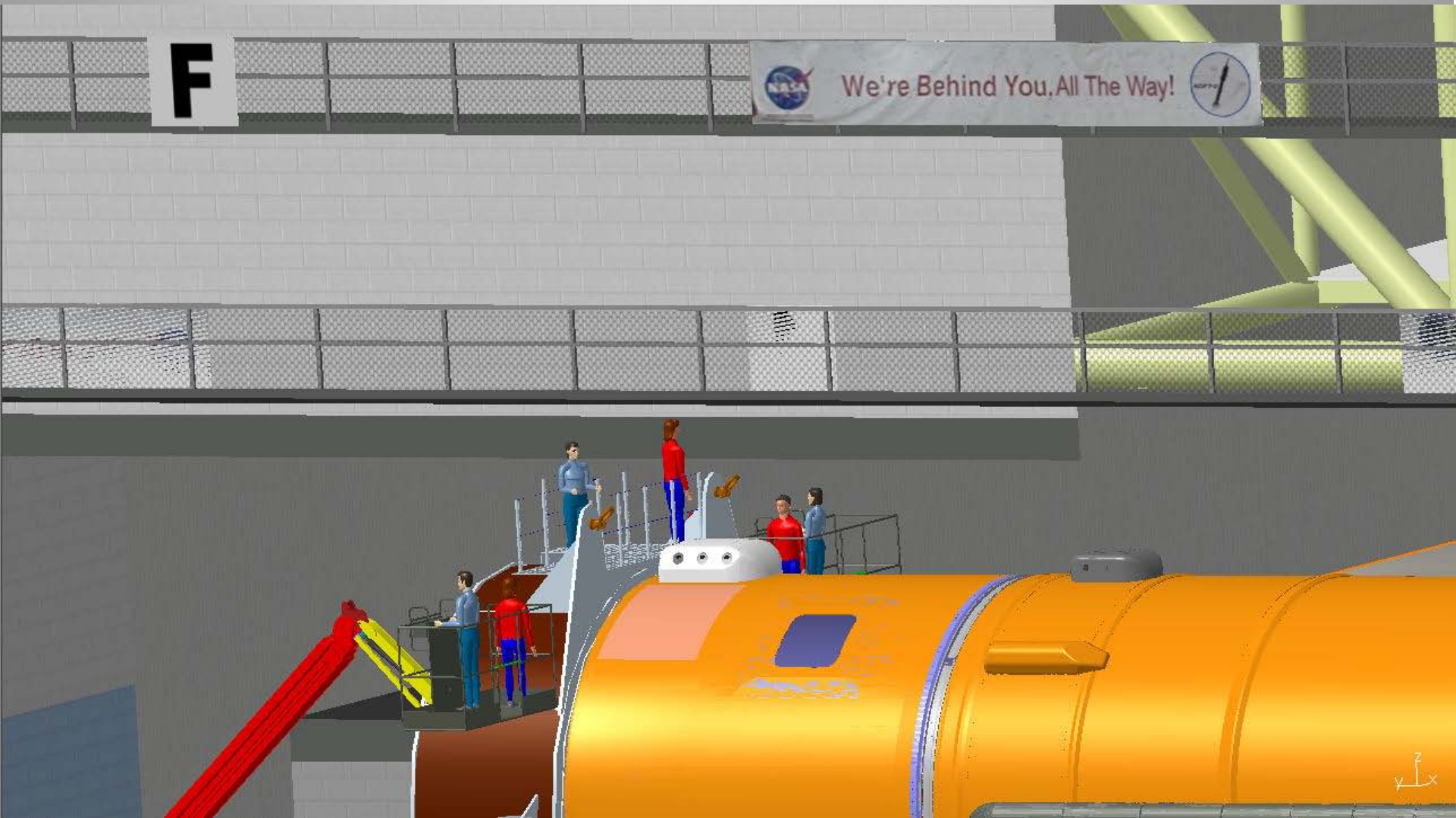
OVERHEAD VIEW OF UPPER STAGE RECEIVING/INSPECTION IN TRANSFER AISLE



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

CONNECT CABLING TO UPPER STAGE AFT LIFTING HARDWARE

View 1



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

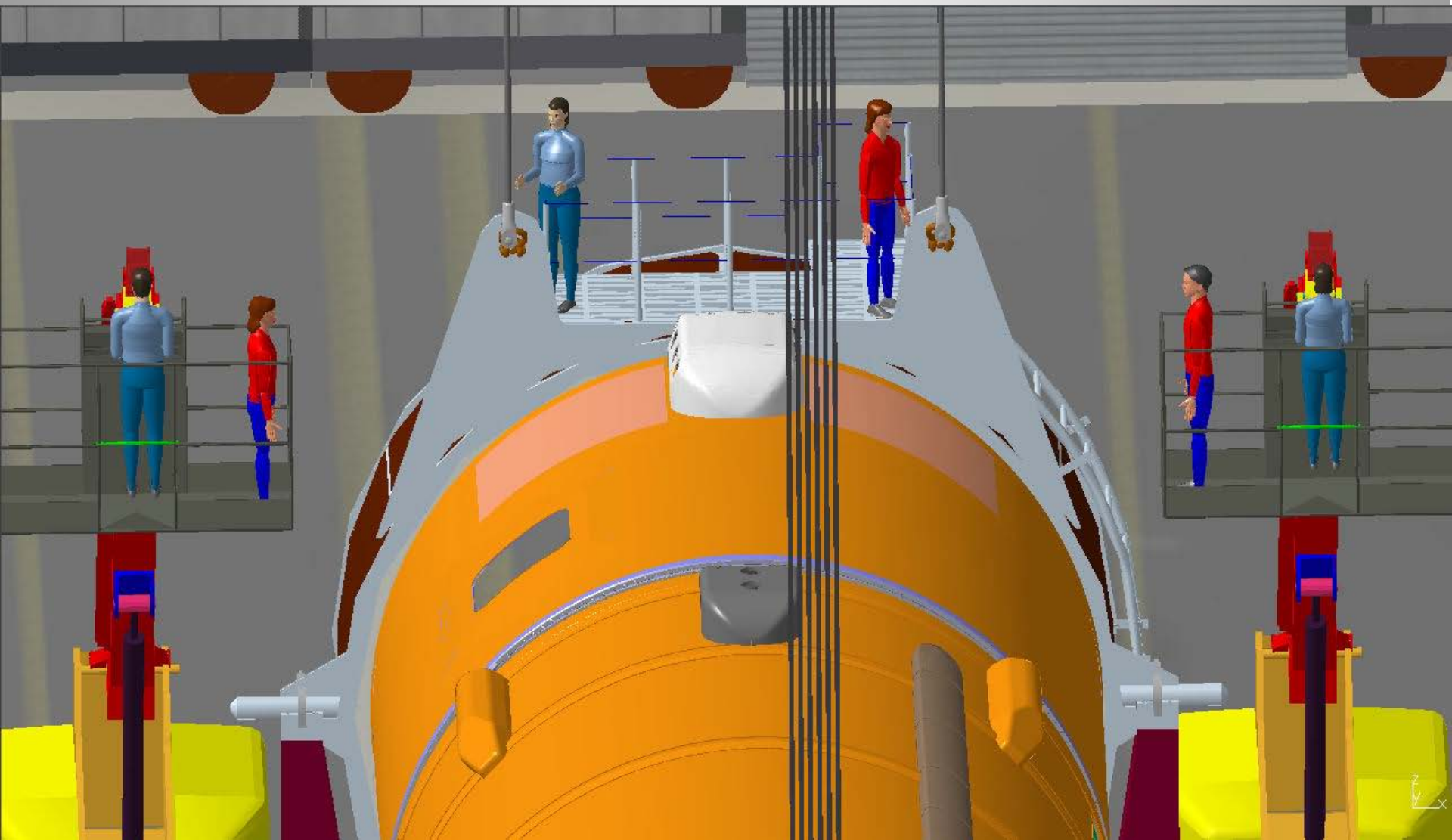
CONNECT CABLING TO UPPER STAGE AFT LIFTING HARDWARE

View2

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

CONNECT CABLING TO UPPER STAGE AFT LIFTING HARDWARE

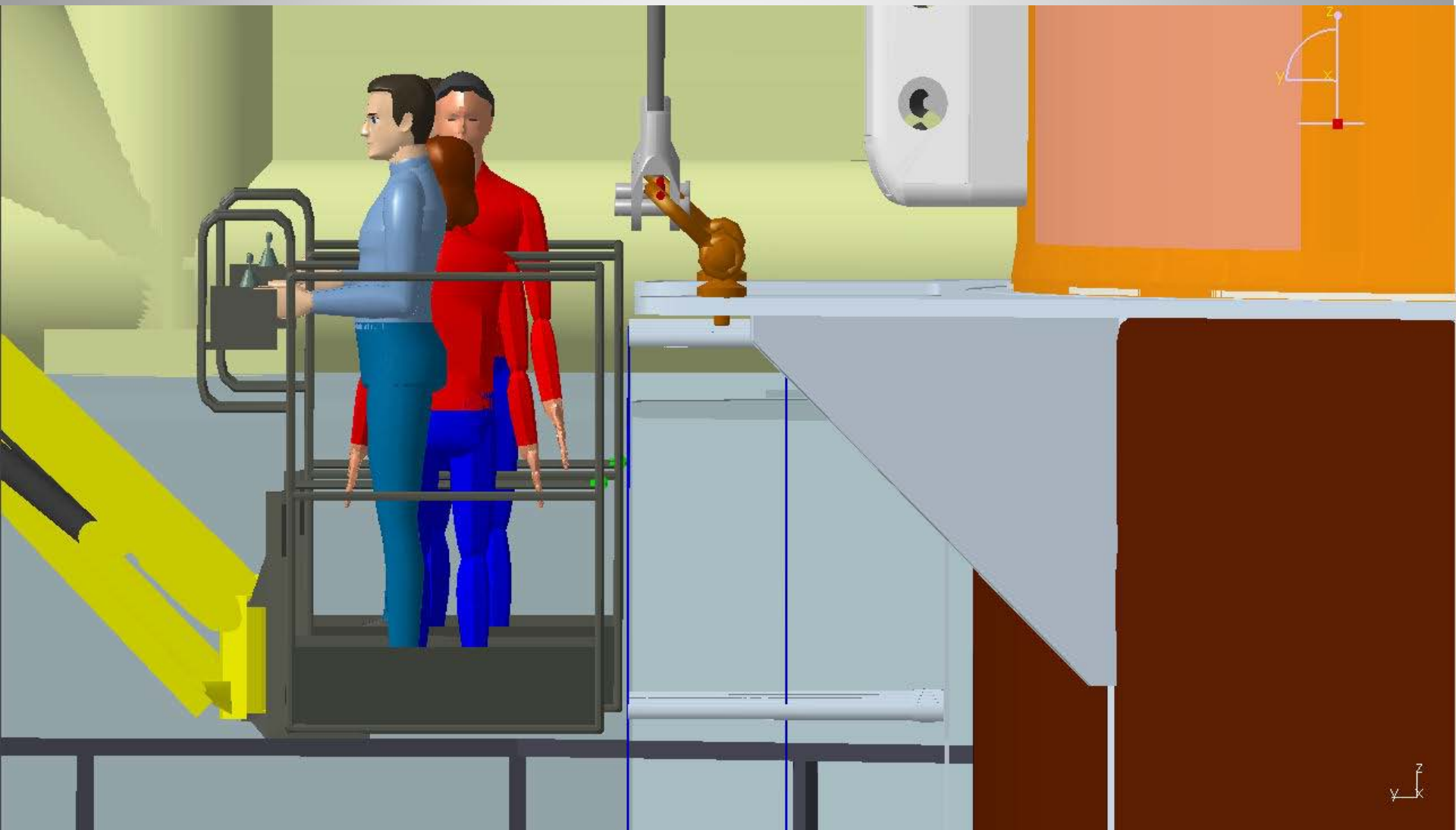
View 3



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

CONNECT CABLING TO UPPER STAGE AFT LIFTING HARDWARE

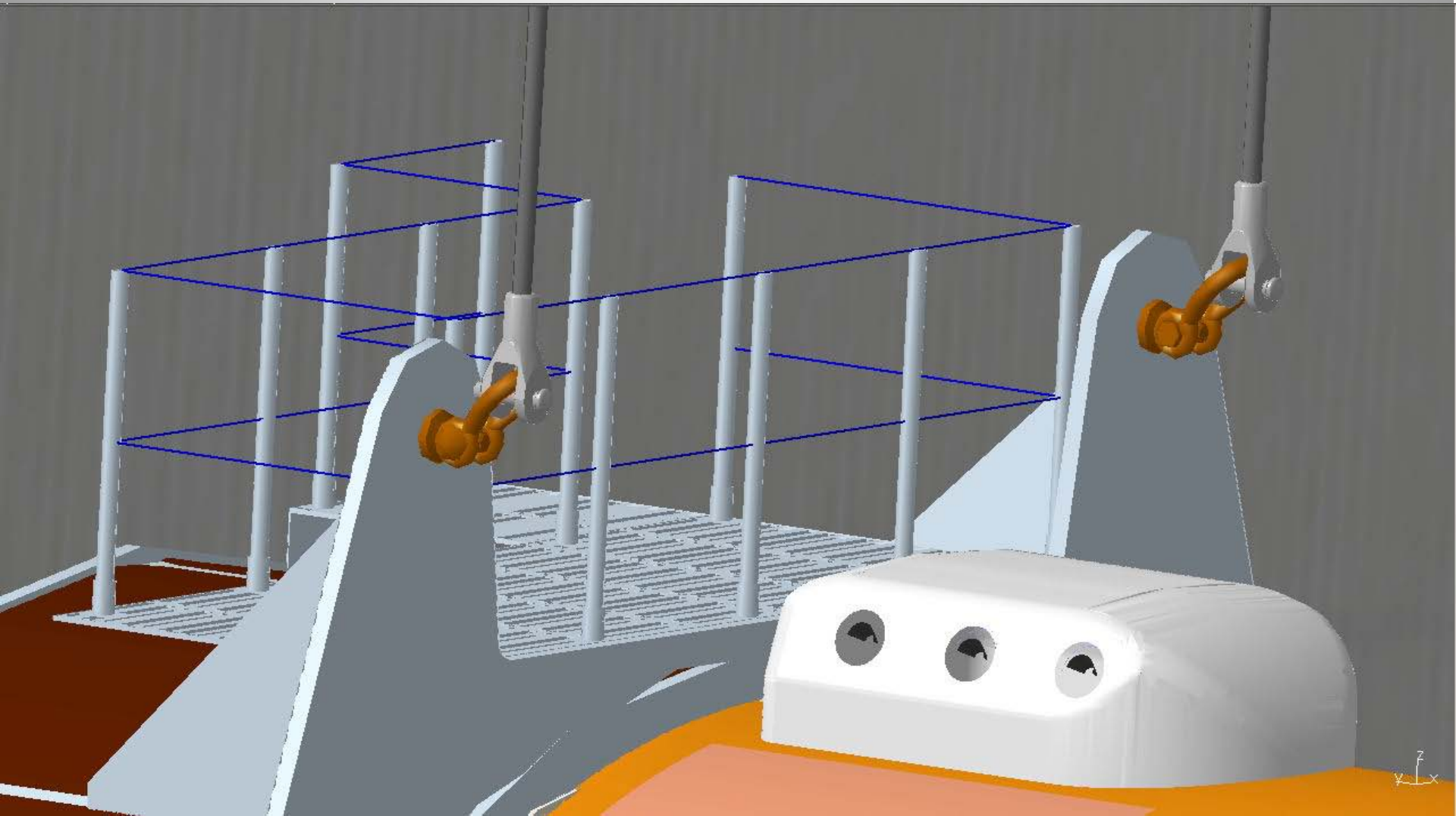
View 4



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

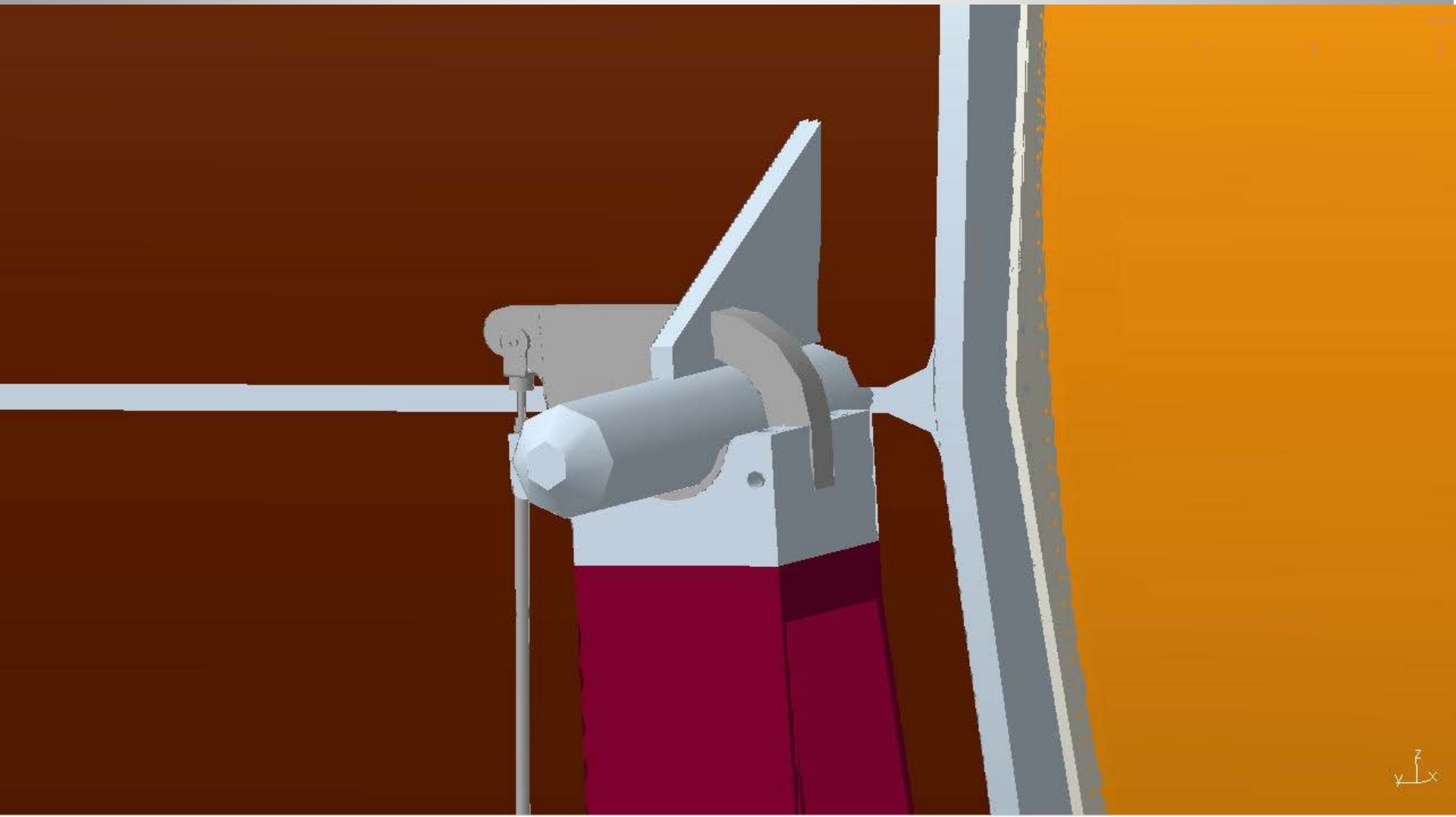
CONNECT CABLING TO UPPER STAGE AFT LIFTING HARDWARE

View 5



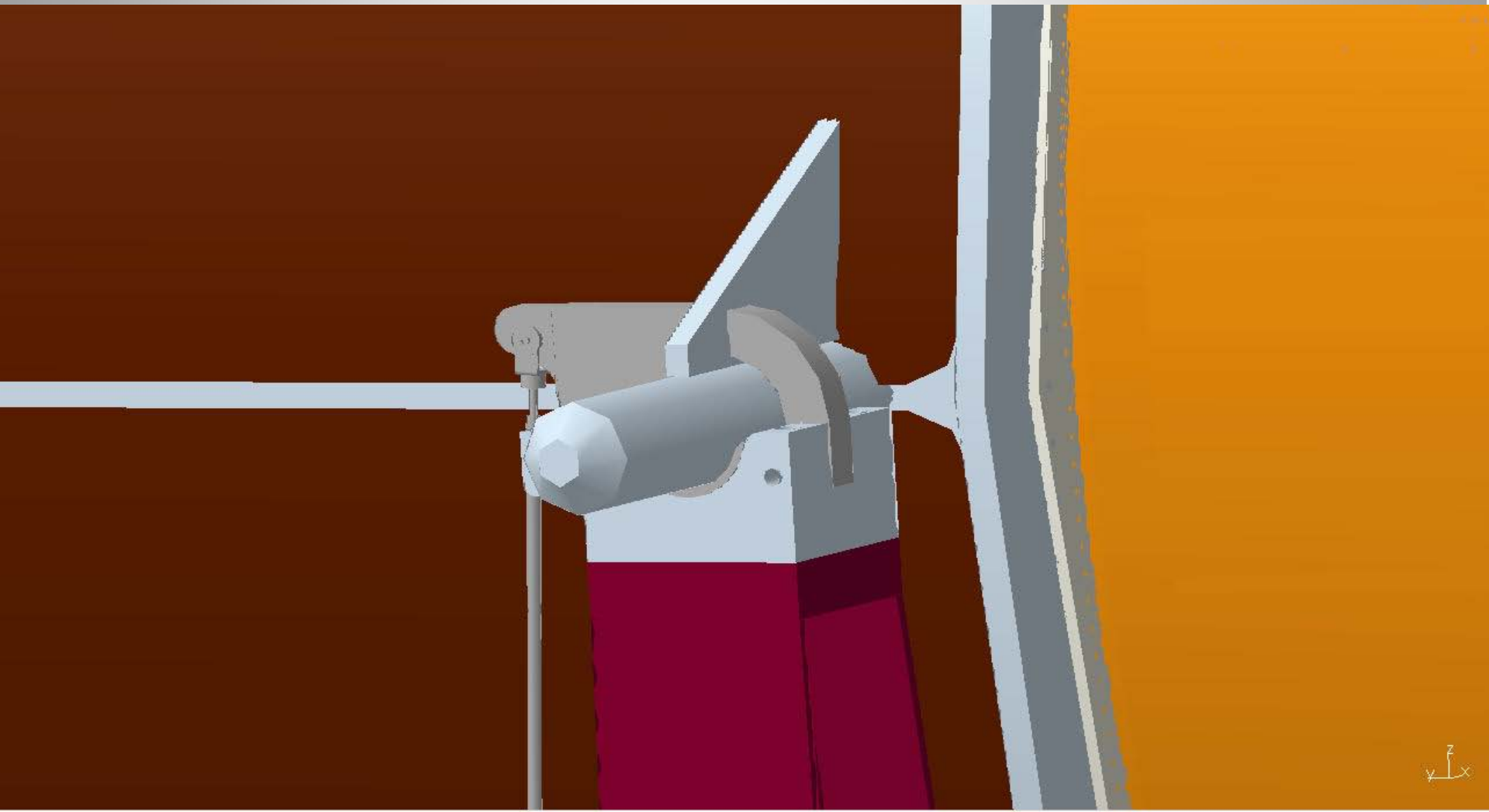
Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

CONNECT CABLING TO UPPER STAGE AFT LIFTING HARDWARE



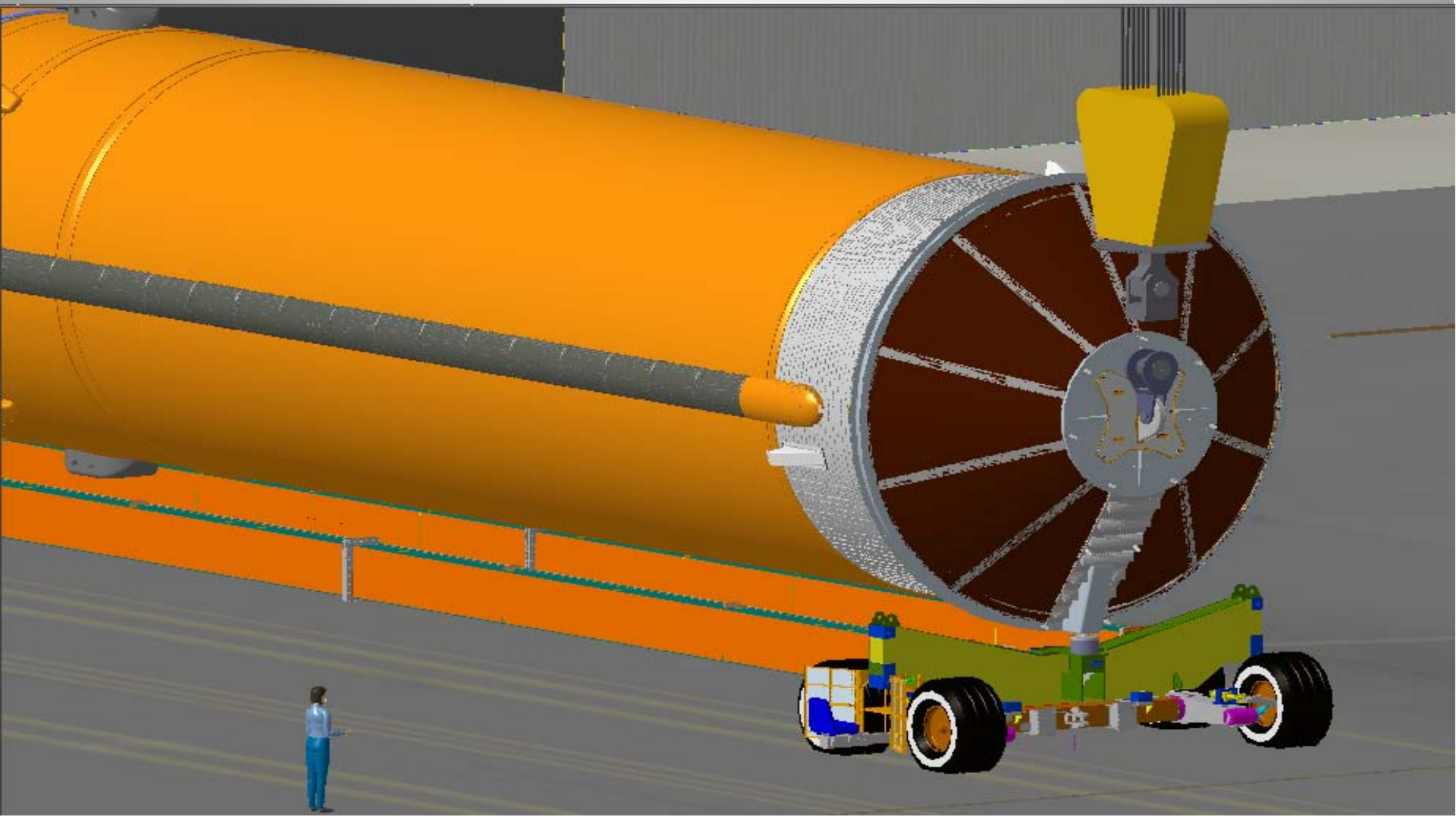
Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

UPPER STAGE TRANSPORTER
AFT CONNECTOR



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

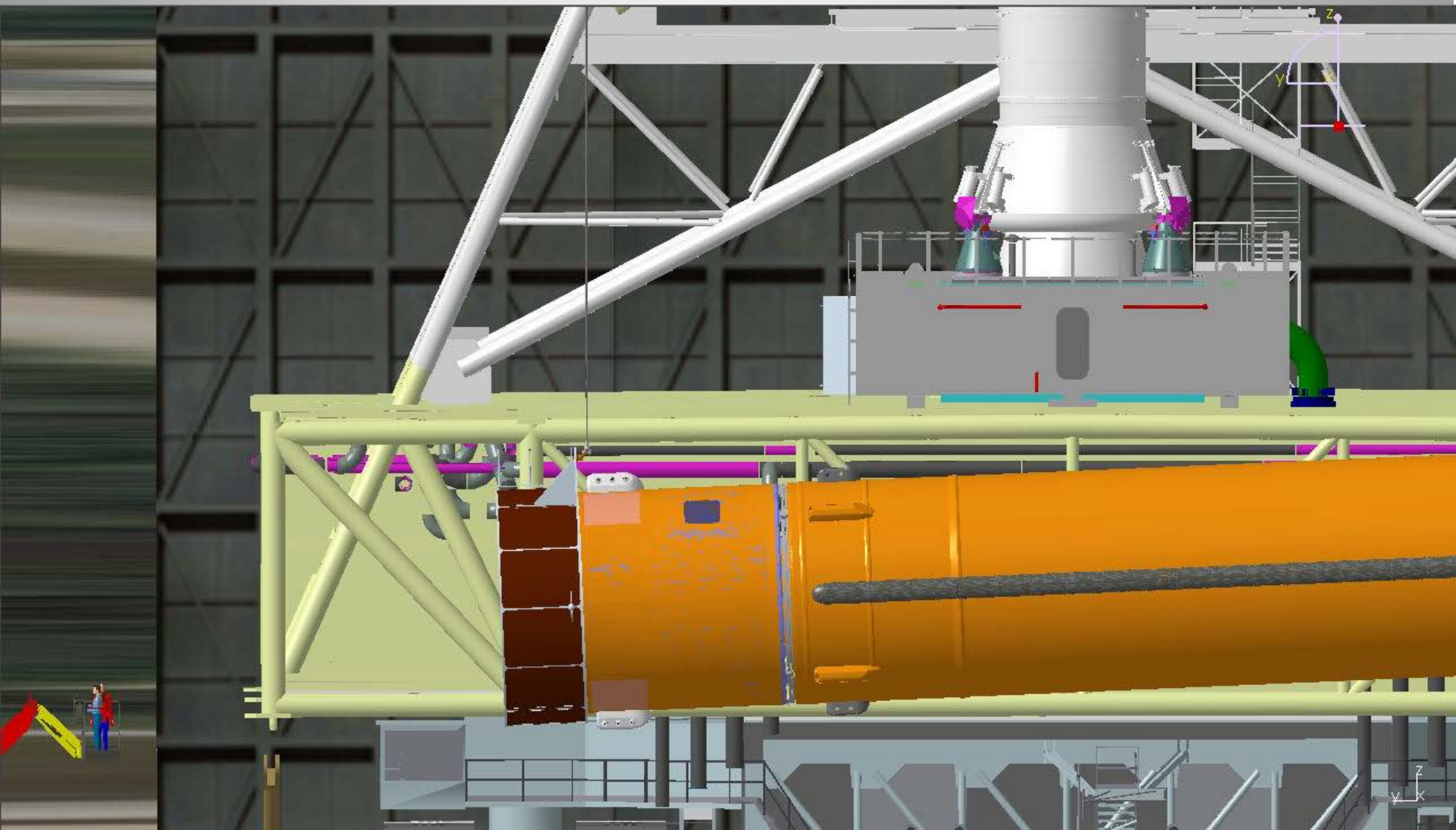
UPPER STAGE TRANSPORTER FORWARD CONNECTOR



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ROTATE HORIZONTAL TO VERTICAL

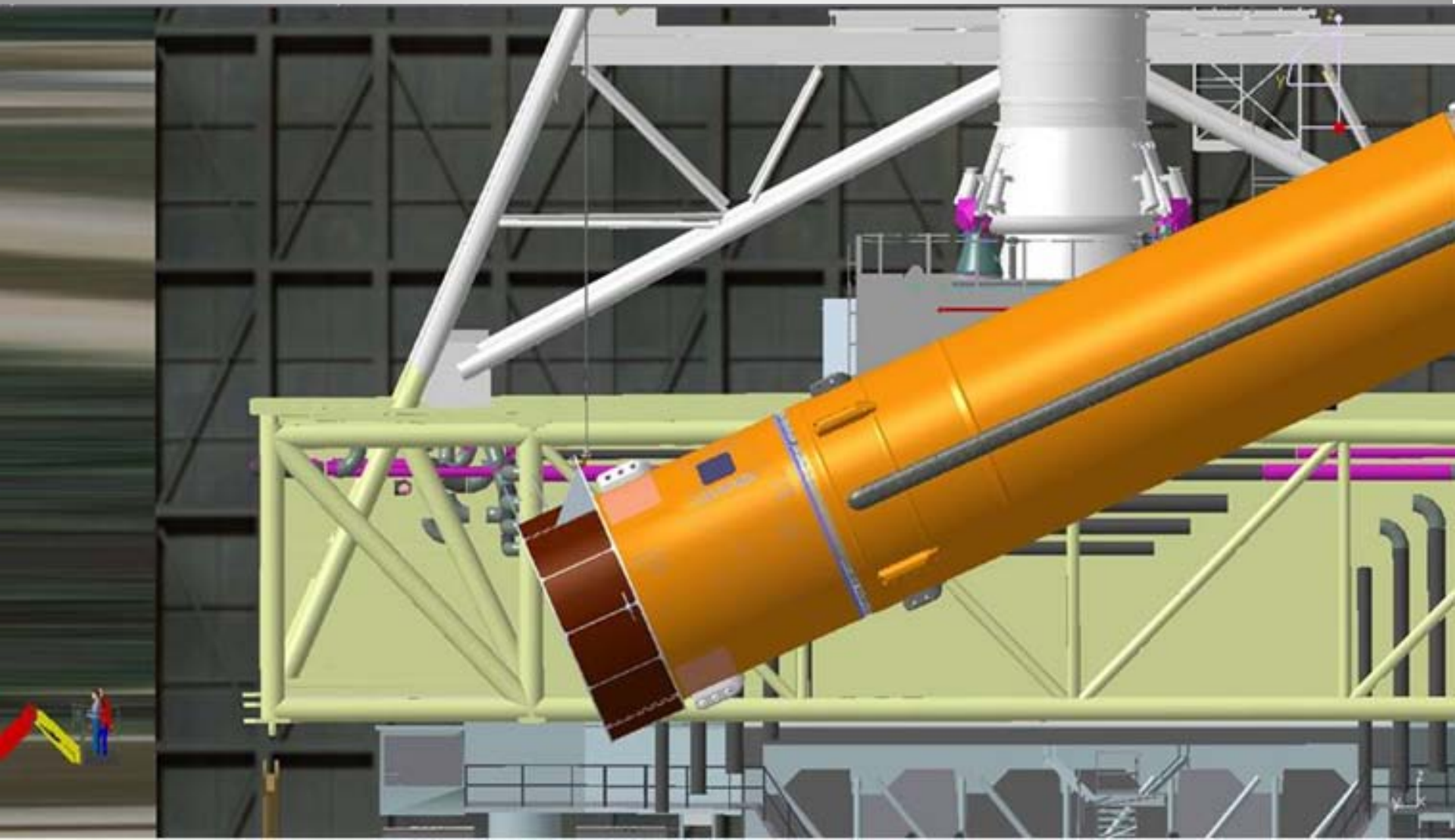
View 1



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

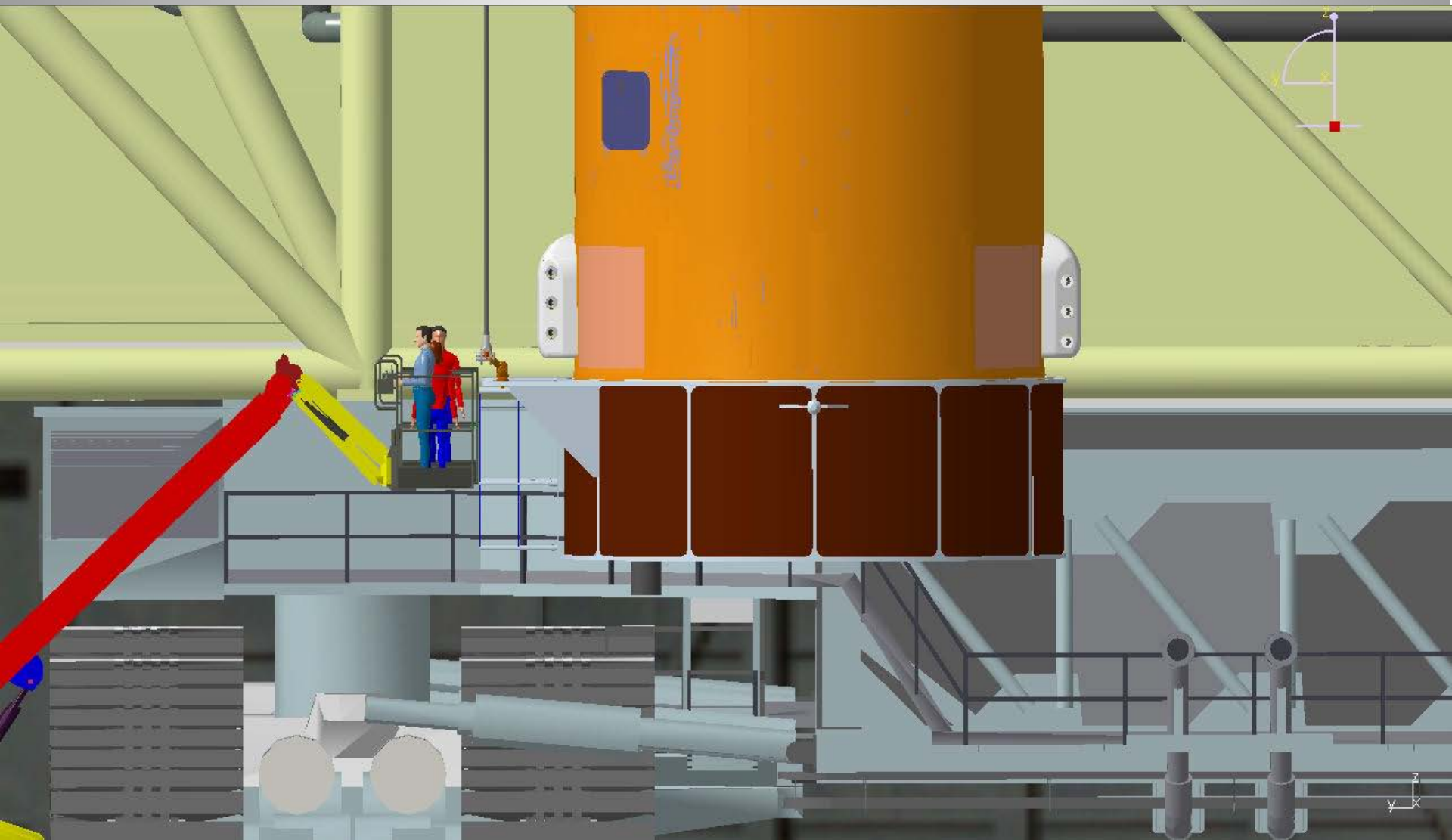
ROTATE HORIZONTAL TO VERTICAL

View 2



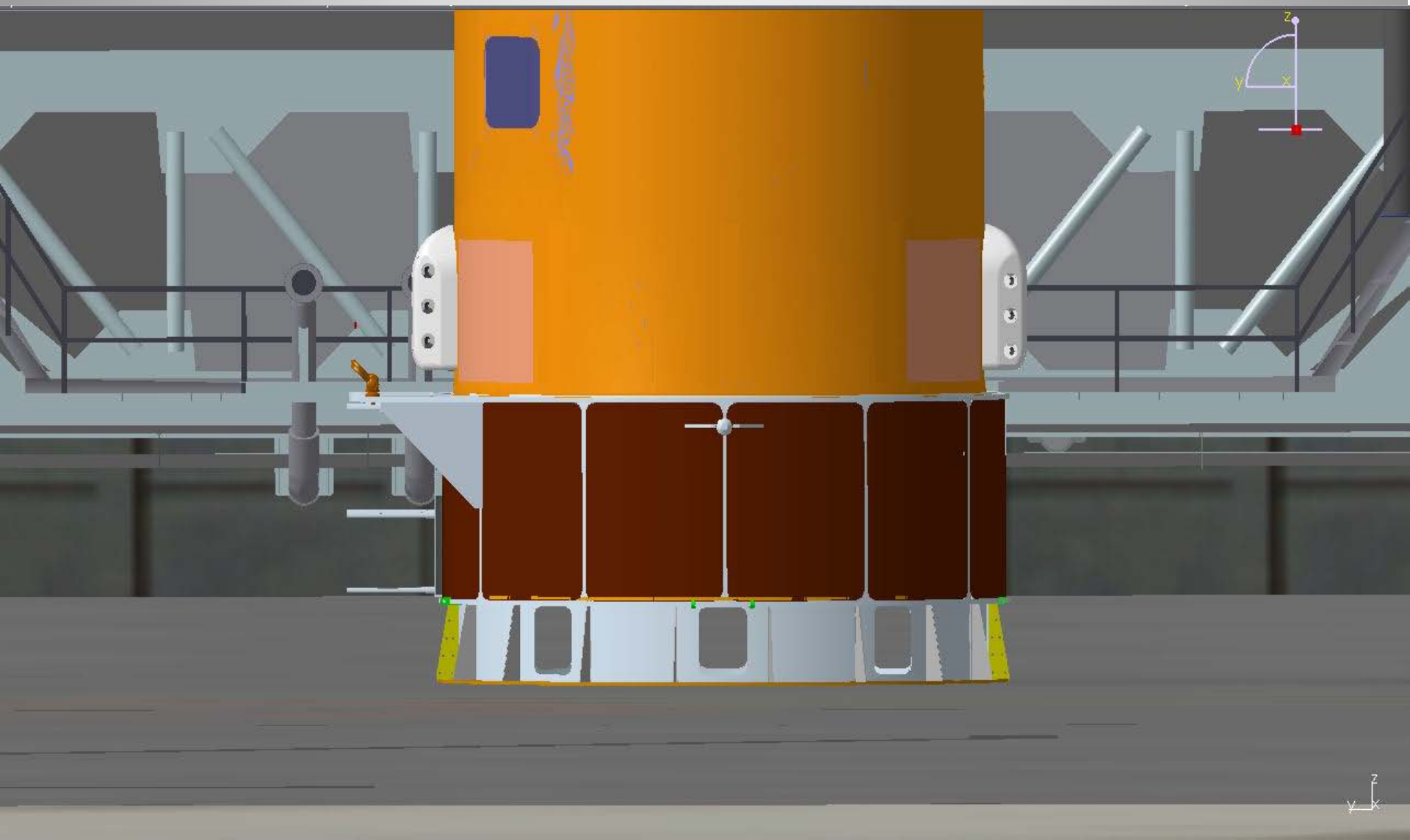
Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

DISCONNECT REAR BOLT RING CABLING



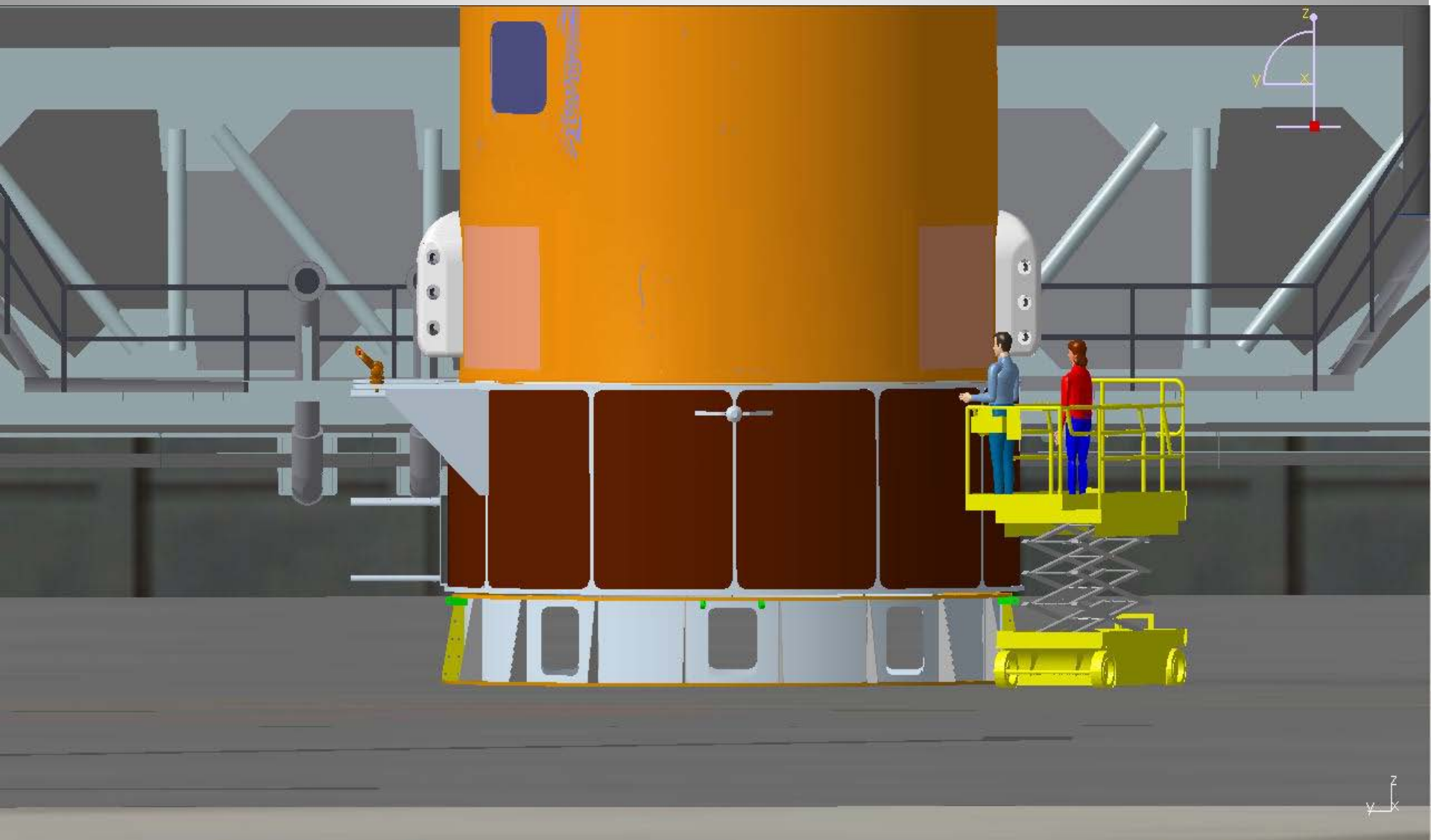
Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

LOWER UPPER STAGE TO INSPECTION STAND



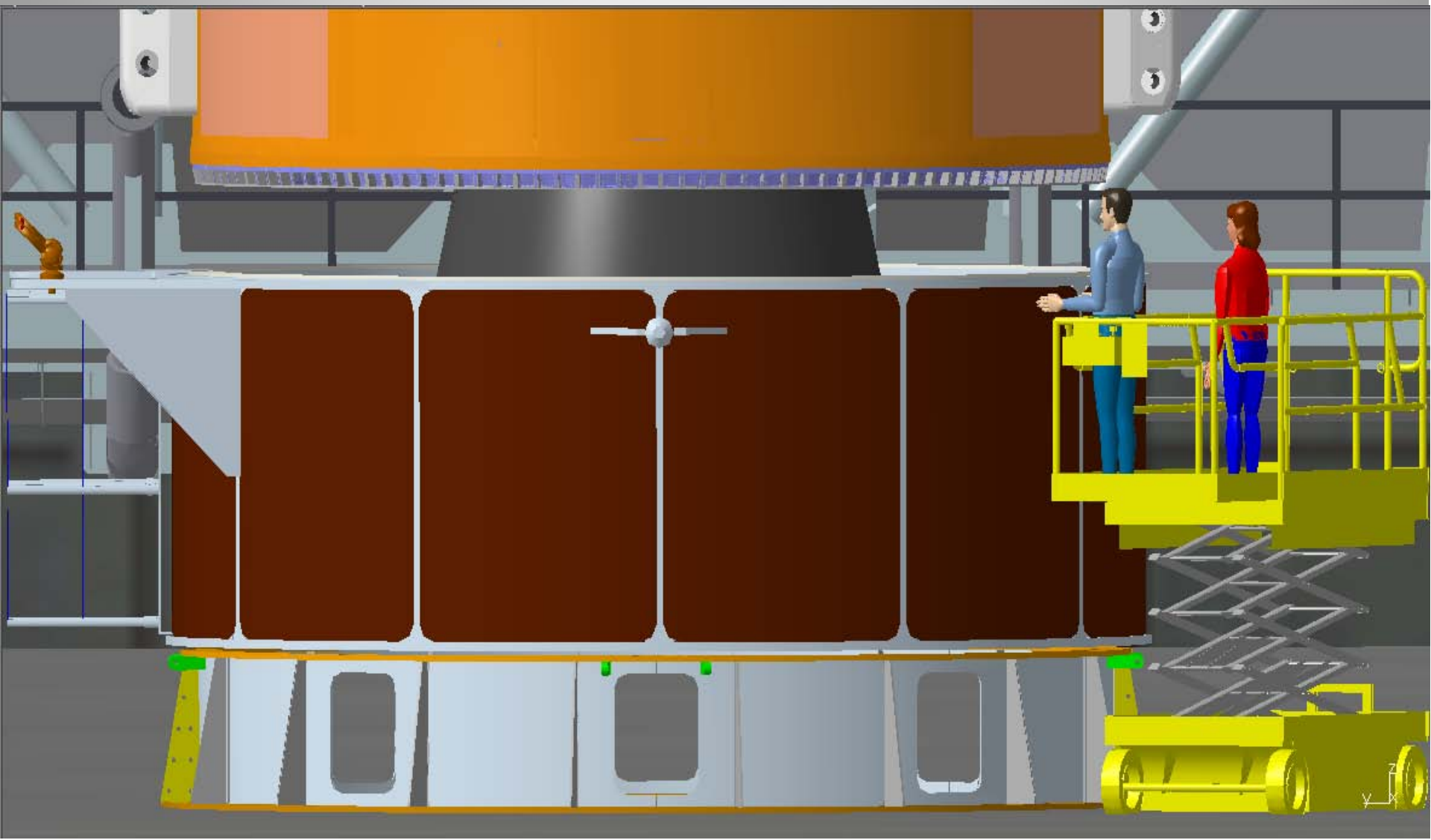
Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

DISCONNECT REAR BOLT RING FROM UPPER STAGE



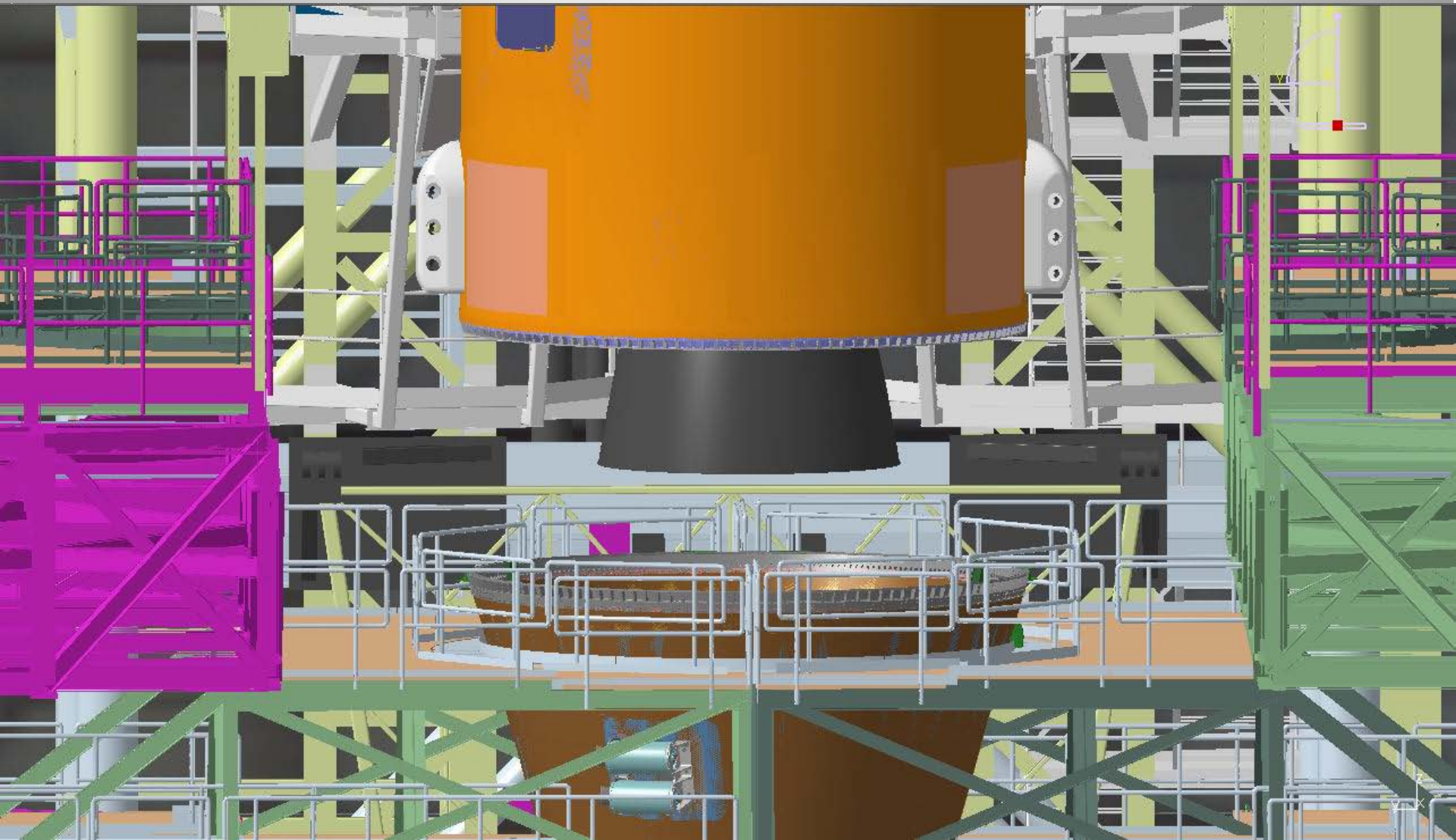
Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

LIFT UPPER STAGE AND INSPECT AFT FANGE



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

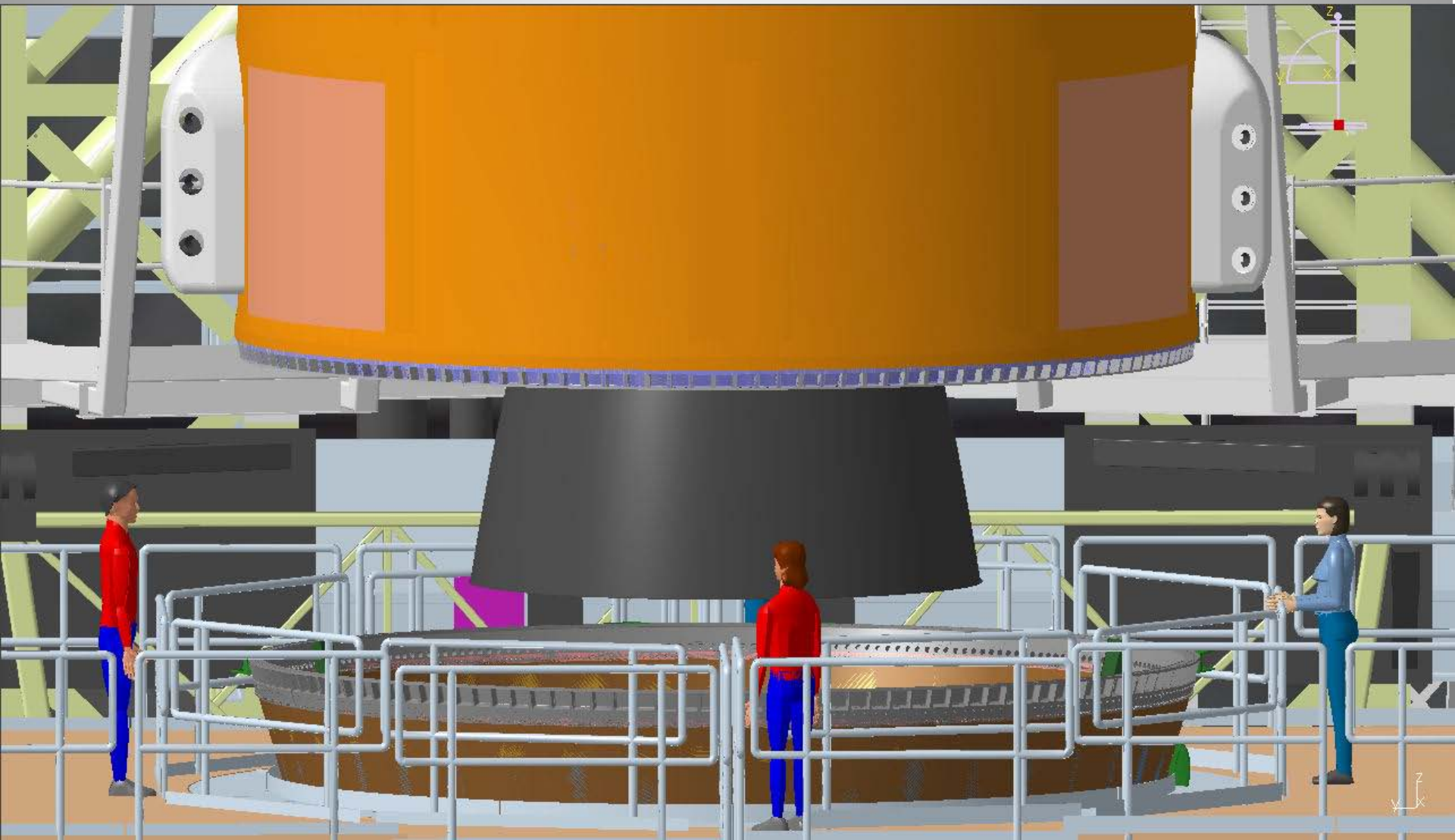
TRANSFER UPPER STAGE TO INTEGRATED STACK



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

MATE UPPER STAGE TO FIRST STAGE

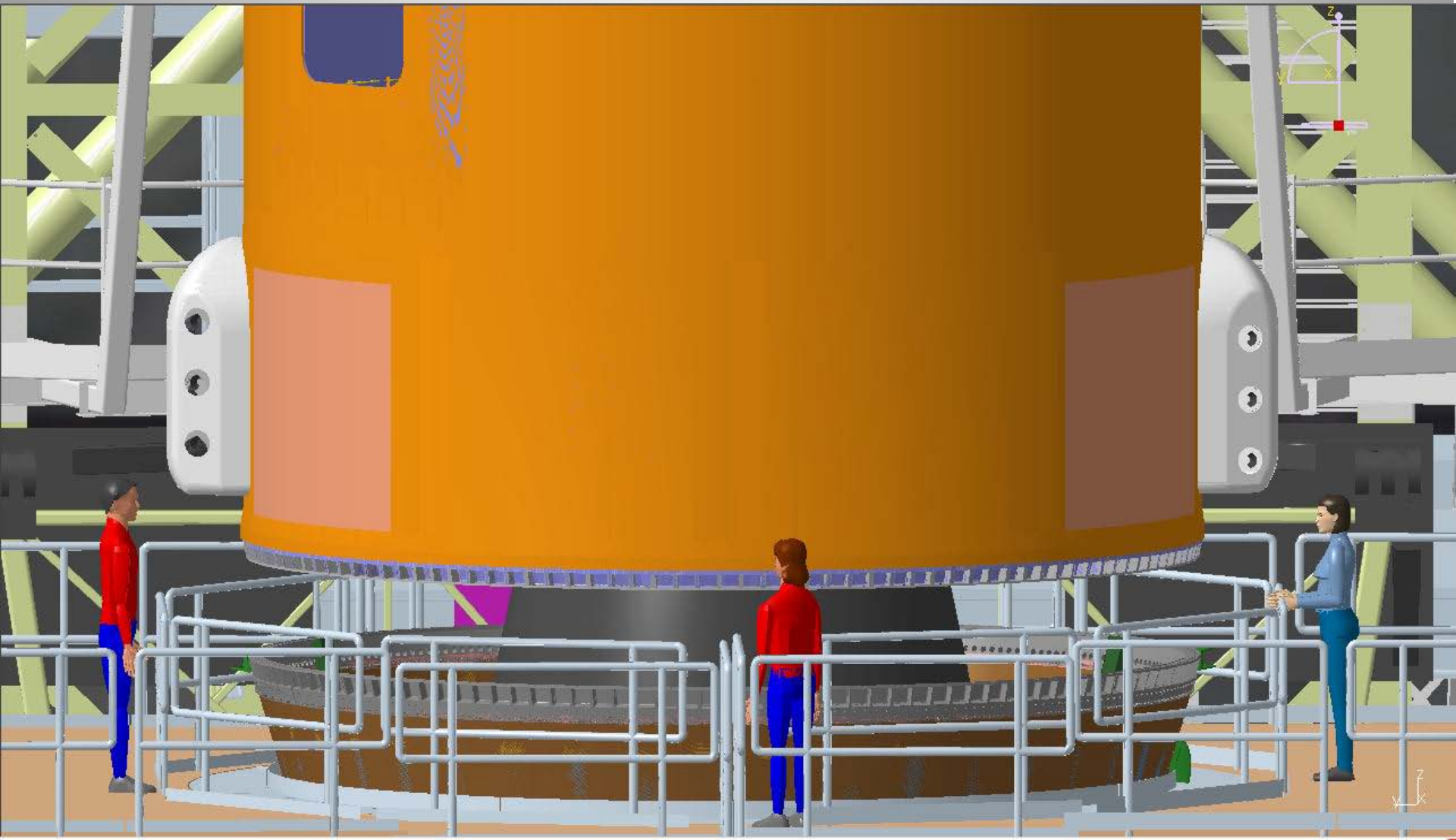
VIEW 1



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

MATE UPPER STAGE TO FIRST STAGE

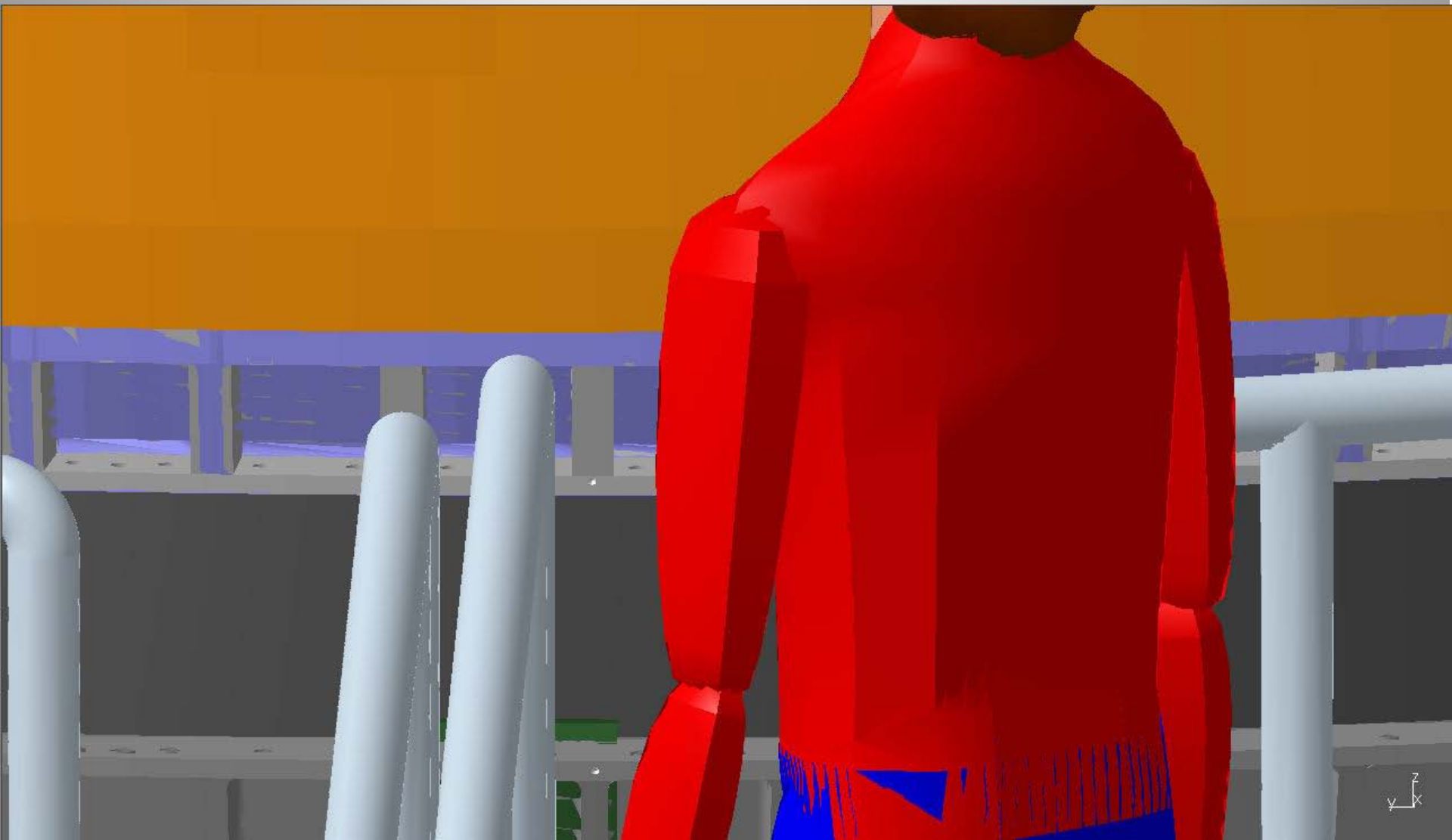
VIEW 2



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

MATE UPPER STAGE TO FIRST STAGE

VIEW 3



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

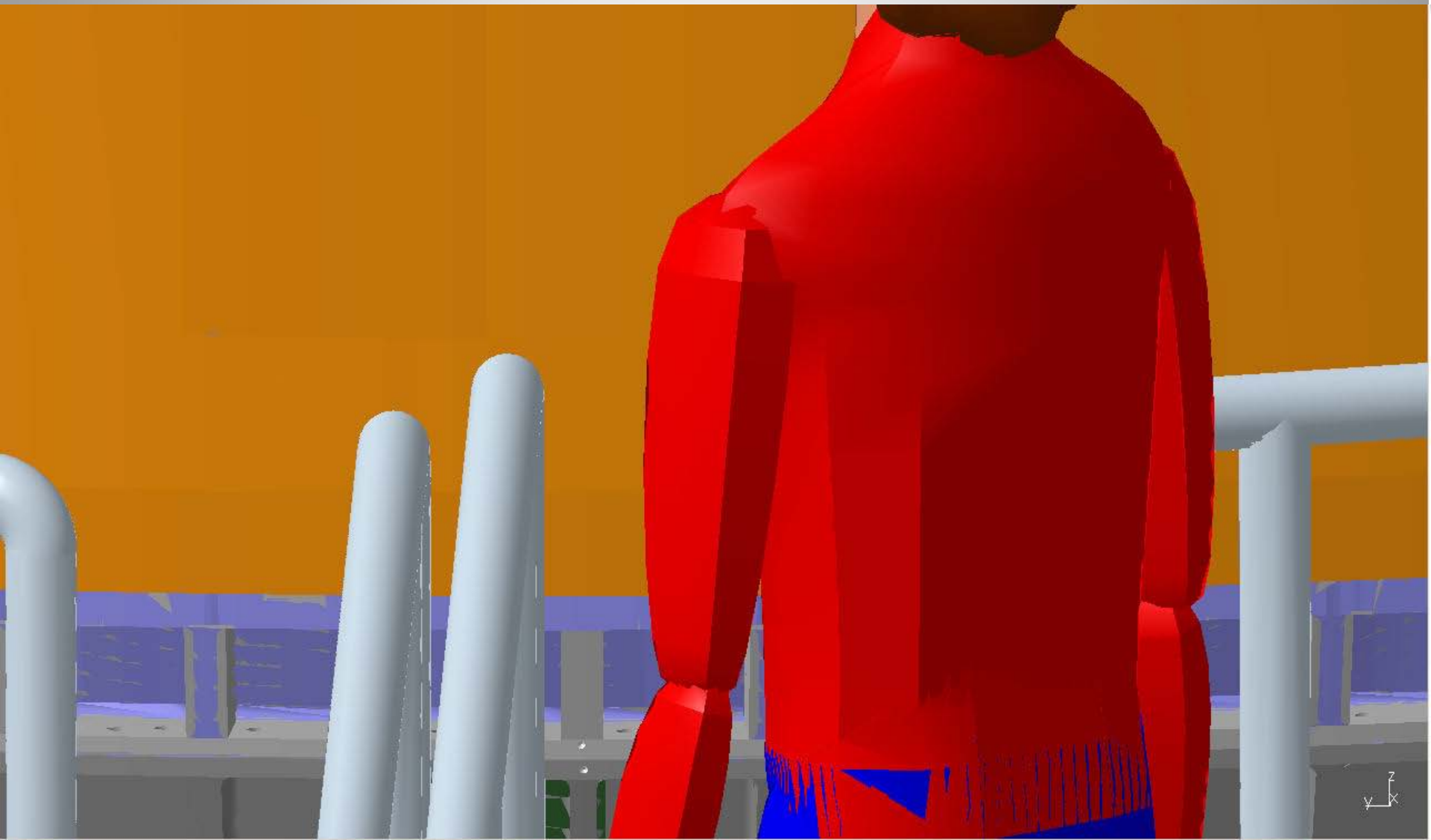
MATE UPPER STAGE TO FIRST STAGE

VIEW 4

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

MATE UPPER STAGE TO FIRST STAGE

VIEW 5

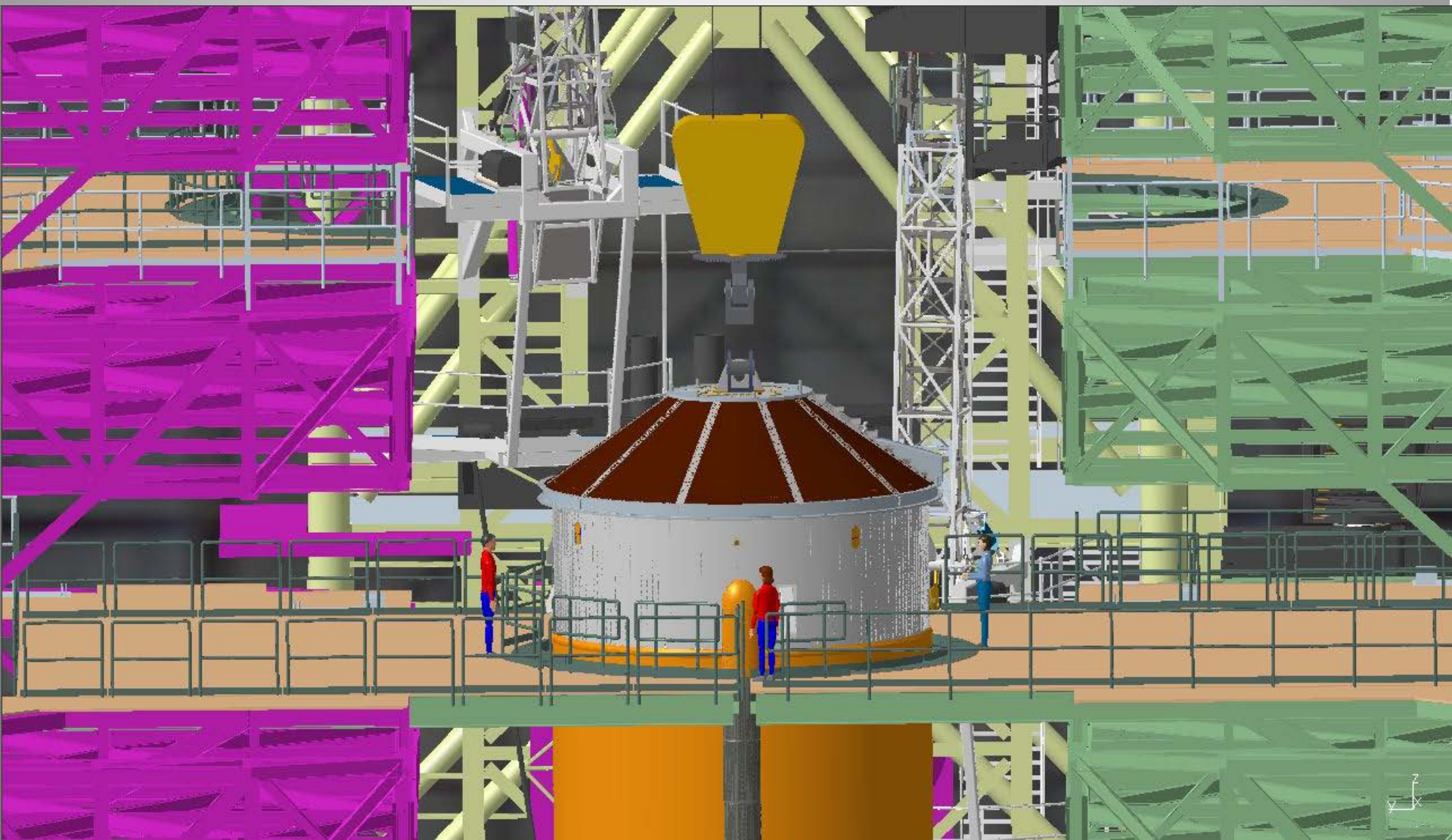


Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

MATE UPPER STAGE TO FIRST STAGE VIEW 6

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

PREPARE THE FORWARD DOME FOR REMOVAL

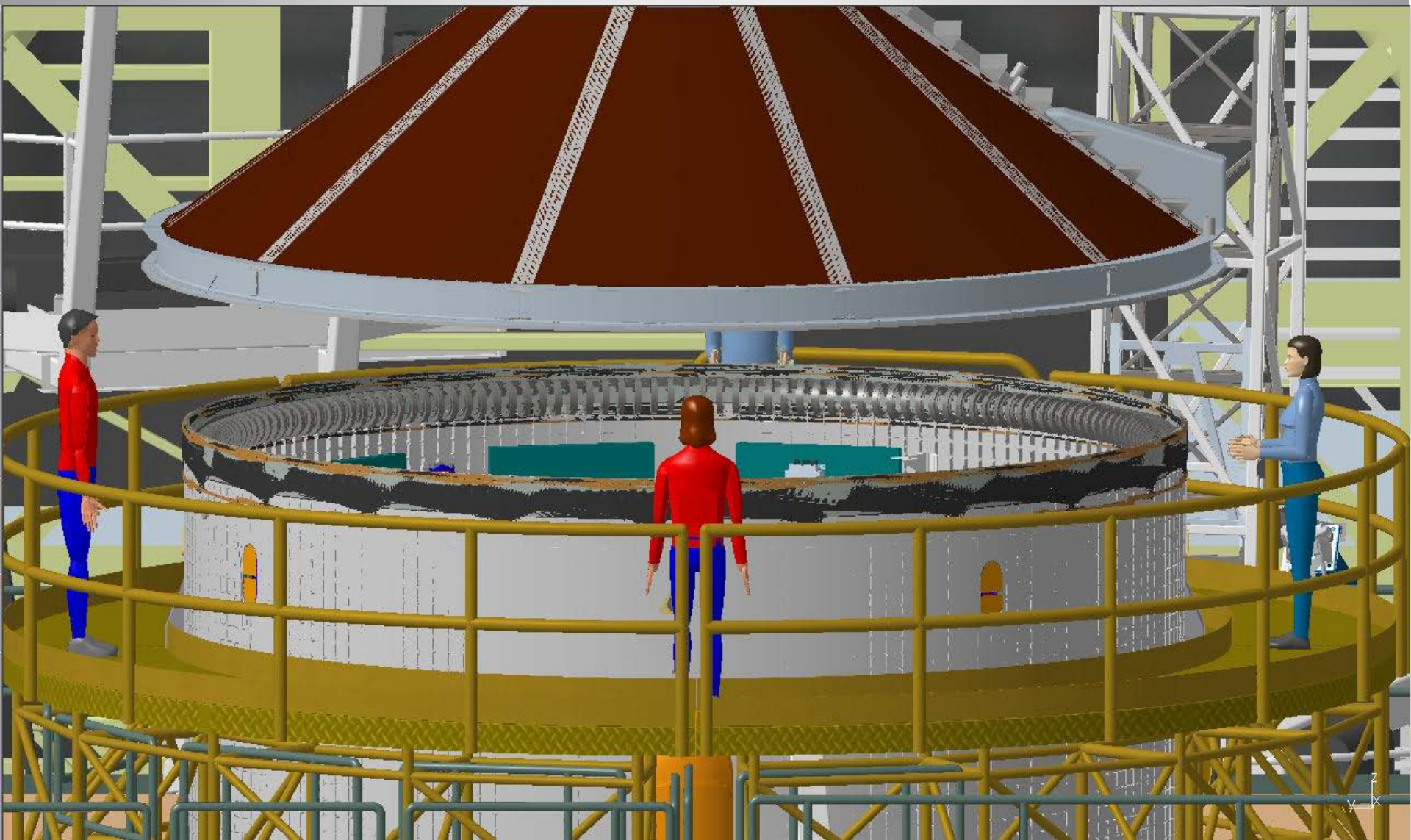


Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

UNBOLT THE FORWARD DOME FROM THE UPPER STAGE

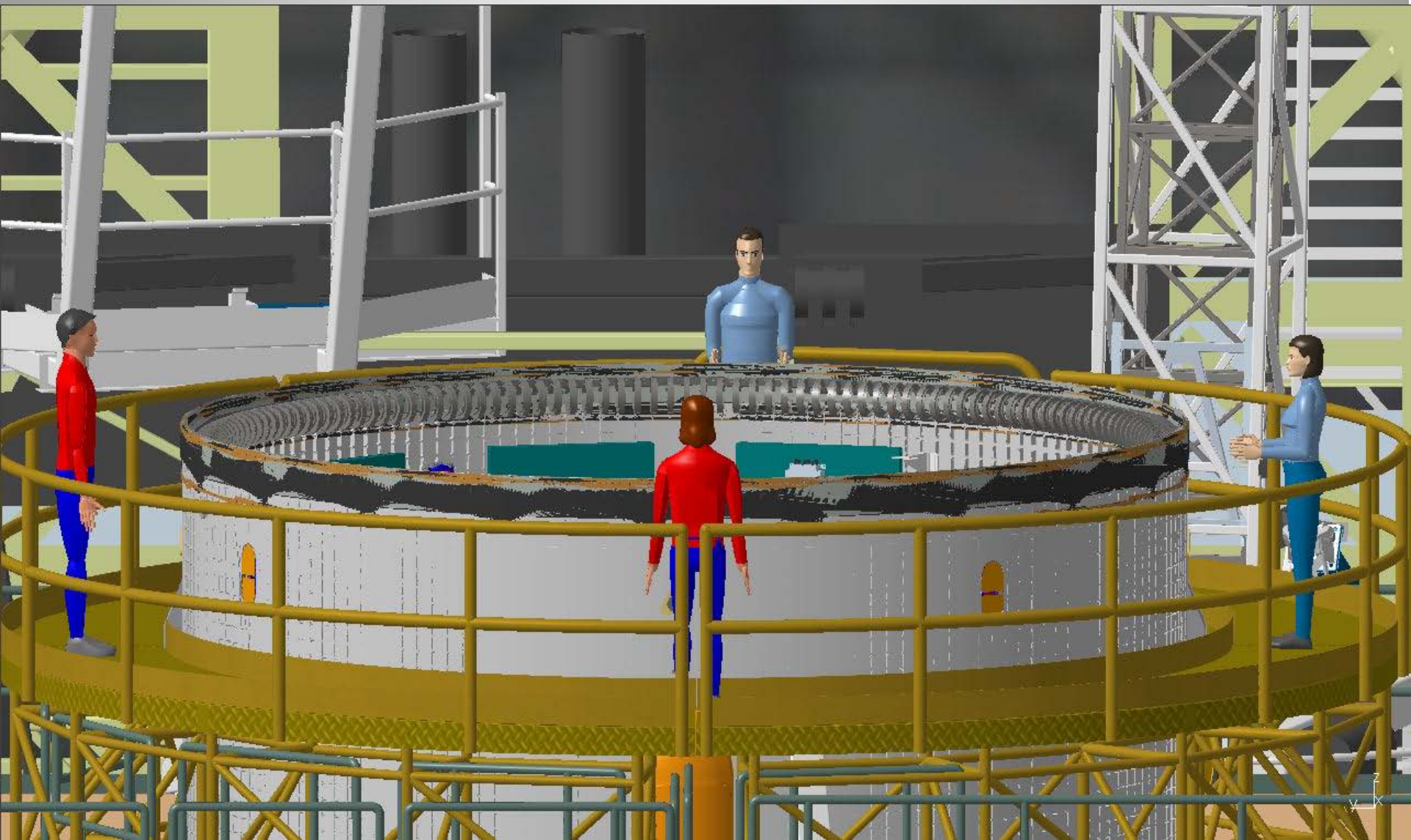
Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

REMOVAL OF THE FORWARD DOME



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

INSPECTION OF THE FORWARD DOME

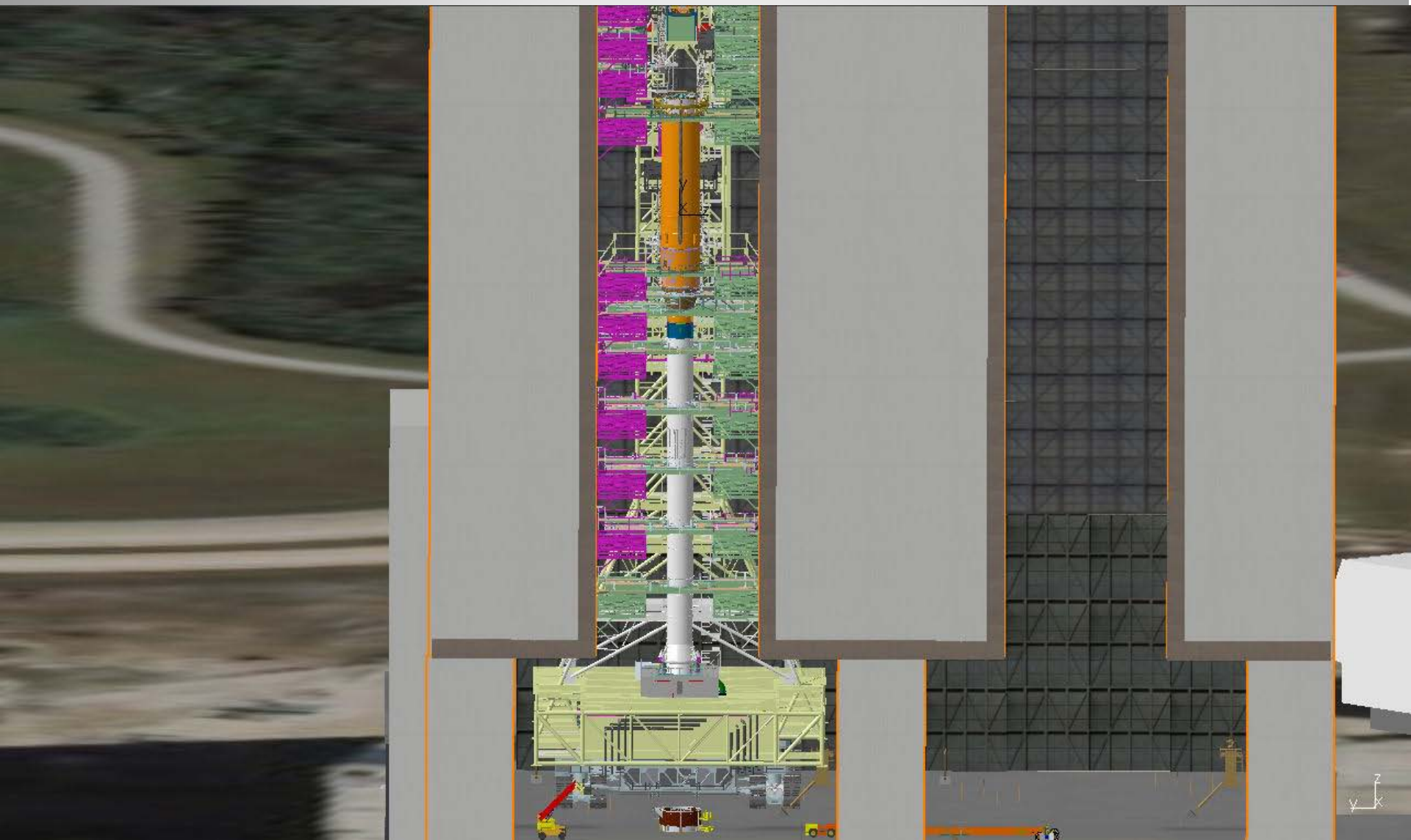


Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

UPPER STAGE MATED ON INTEGRATED STACK

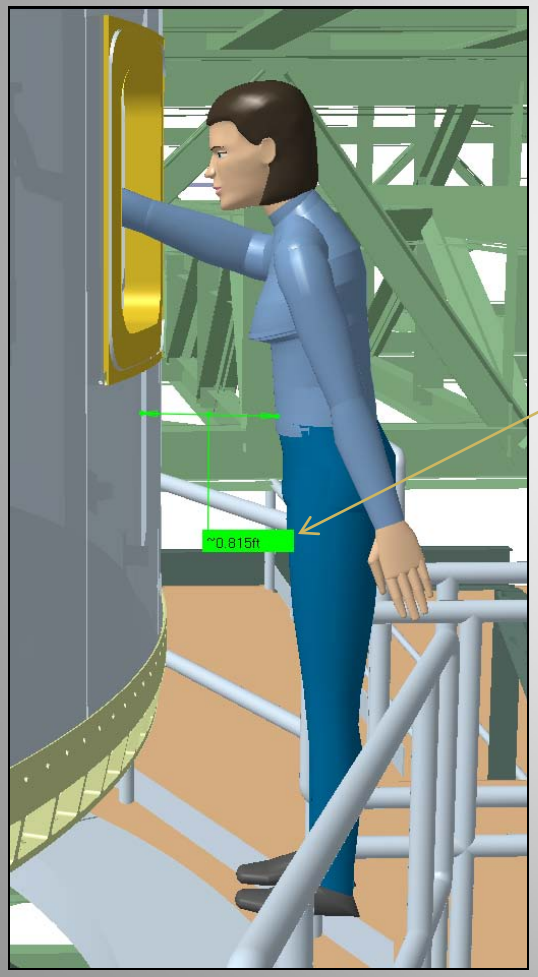
Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

UPPER STAGE MATED ON INTEGRATED STACK AND CRAWLER



Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION



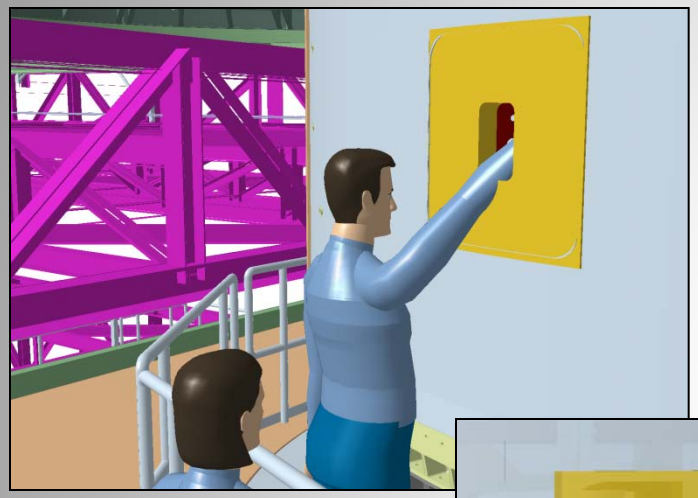
- Based on the A104 configuration, personnel will be able to get within a range of ~.305ft (3.66”) to the outer mold line (OML*) of the Crew Launch Vehicle (CLV) to access the Electrical Interface Panel via the Interstage porthole.*

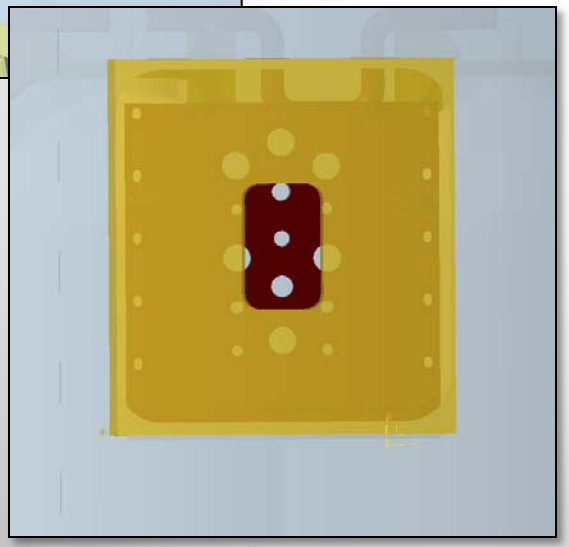
- *The analysis w*ill be conducted with both the 5th%tile American female* and 95th%tile American male* standing at a distance of .815ft (9.78”) from the OML of the vehicle.

* 1988 ANSUR

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (8” x 5” / 2” Corner Radii)





REASONING

- Clearance size was generated from the minimal clearance for tool-operated fasteners requirement of NASA-STD-3000.

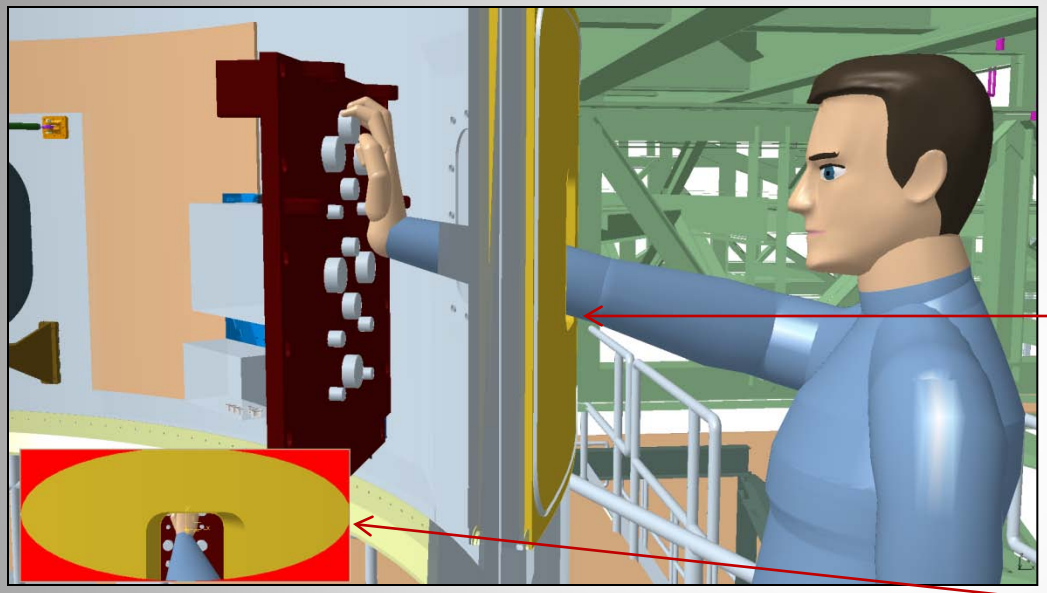
INITIAL PERCEPTION

- *Limits access to outside, upper, and lower rows of connectors*
- *Limits visual access*

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (8” x 5” / 2” Corner Radii)

95th%tile American Male

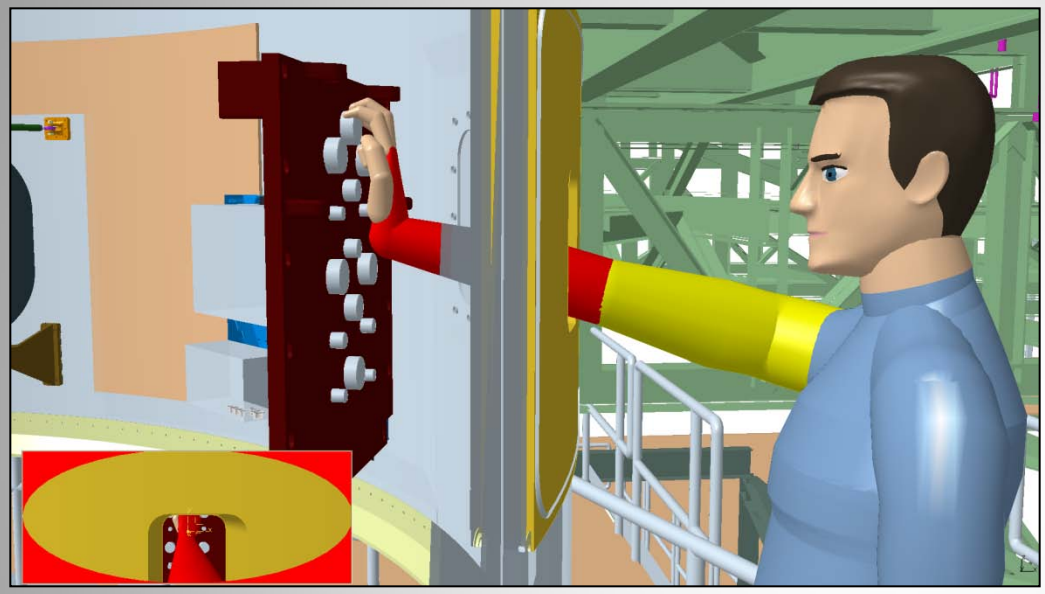


- The 8” x 5” opening does not allow physical access to all electrical panel connectors.
- The 8” x 5” opening does not allow much arm room to alter arm positions for access to lower connectors.
  (~1.2” total width clearance for male)
- The 8” x 5” opening does not allow direct line of sight visual access to all electrical panel connectors, especially with arm through porthole.
- Visual access to support strut attachments is not granted.
- Although altering the height and position of personnel would likely provide a line of sight to needed areas, adequate physical access would be denied.

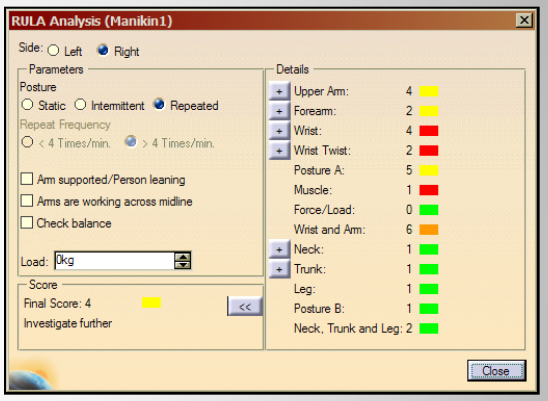
Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (RULA ANALYSIS)

95th%tile American Male



RULA ANALYSIS



- A Rapid Upper Limb Assessment (RULA)* analysis was performed; this posture generates a recommendation for further investigation for a more favorable posture

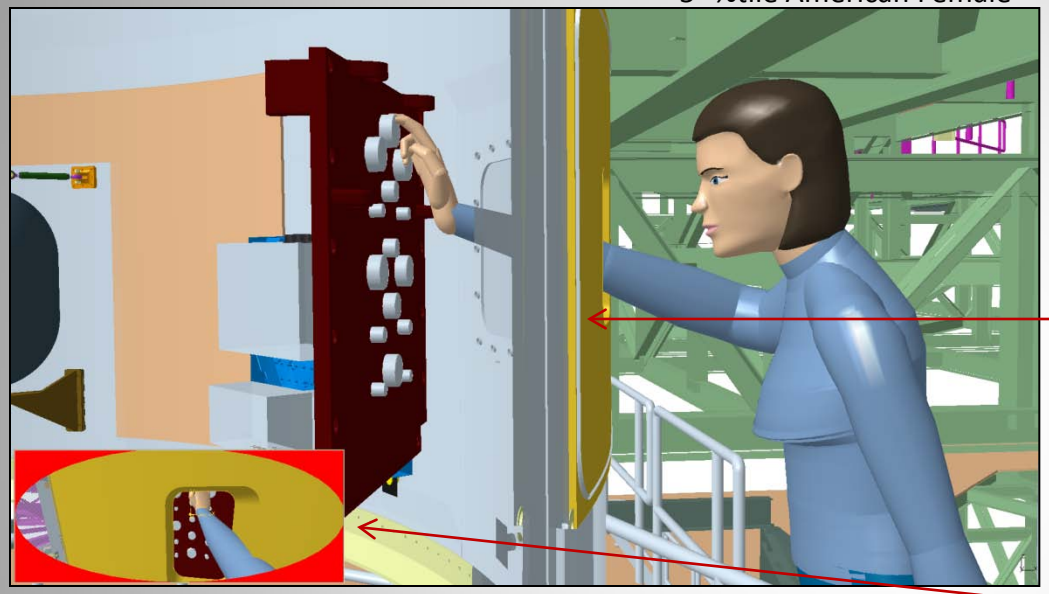
- Negatively Impacted Areas:
  - Wrist
  - Wrist and Arm

•RULA =>
Method for analyzing risk factors to the upper extremities of the human in the actual physical environment.

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (8” x 5” / 2” Corner Radii)

5th%tile American Female



- The 8” x 5” opening does not allow physical access to all electrical panel connectors. The 8” x 5” opening does not allow adequate arm room to alter arm positions for access to lower connectors.
(~1.66” total width clearance for female)

- The 8” x 5” opening does not allow direct line of sight visual access to all electrical panel connectors.

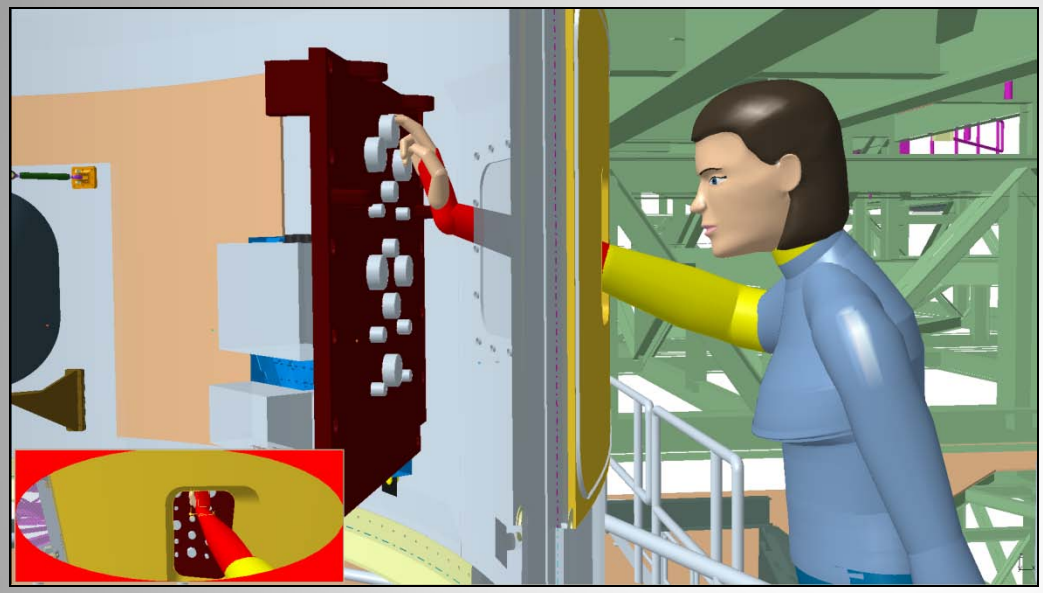
- Visual access to support strut attachments is not granted.

- Although altering the height and position of personnel would likely provide a line of sight to needed areas, adequate physical access would be denied.

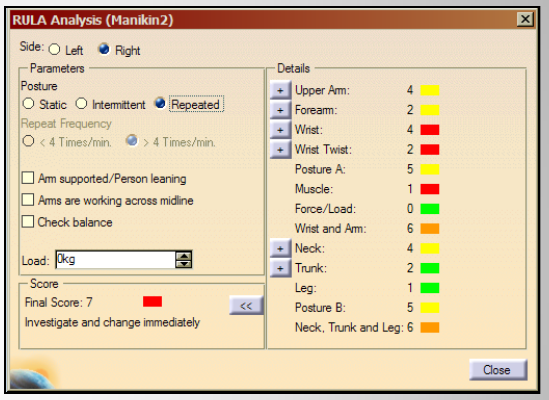
Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (RULA ANALYSIS)

5th%tile American Female



RULA ANALYSIS



- A RULA analysis was performed; this posture generates a recommendation to investigate and change immediately for a more favorable posture.

- Negatively Impacted Areas:
  - Wrist
  - Wrist and Arm
  - Neck, Trunk and Leg

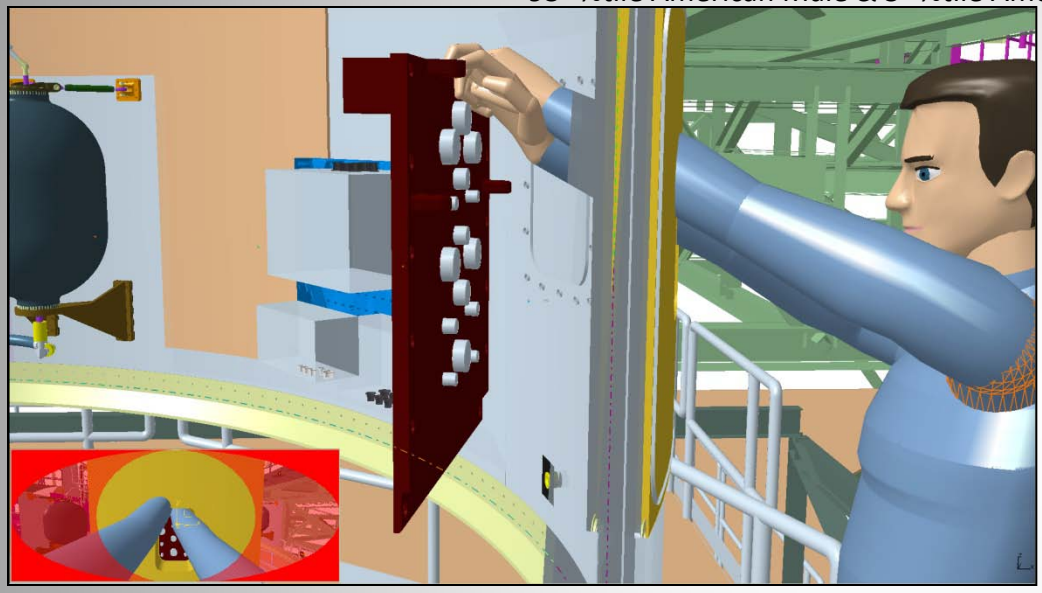
- The 5th%tile American female torso was extended ~15degs in order to reach the top connector.

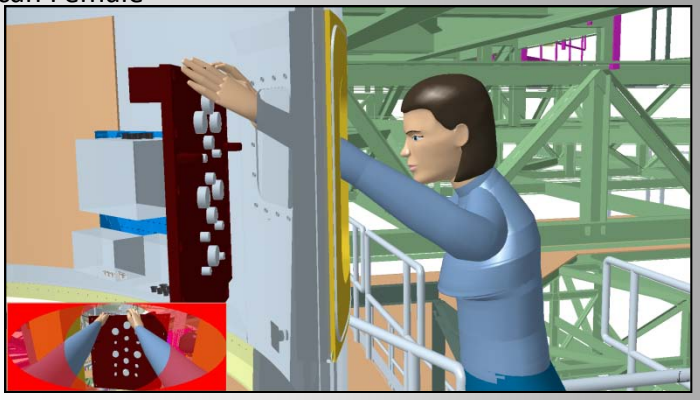
- The 5th%tile American female will be able to reach connectors and the top of electrical panel without leaning through the Interstage porthole.

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (8” x 5” Two-Handed Operation)

95th%tile American Male & 5th%tile American Female

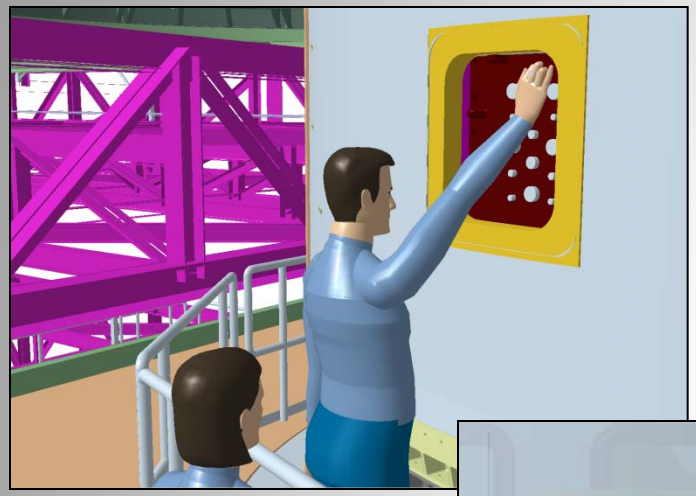




- The 8” x 5” porthole does not provide sufficient clearance to allow possible two-handed operations.
- Support structure tasks would likely be impossible.
- Both male and female personnel are able to reach the top of the electrical panel with two hands without leaning through the porthole.

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (18” x 16” / 3” Corner Radii)



REASONING

- Clearance size was taken from the Ares I Upper Stage to First Stage Interface Control Document (ICD) [CxP 72261]
- The 18” x 16” opening was used in the previous HFE analysis of the horizontal oriented electrical panel and proved to provide sufficient access to the horizontal oriented panel.
- Provides the capability to add additional connectors if needed
- Provides physical access and direct line of sight to all electrical panel connectors.

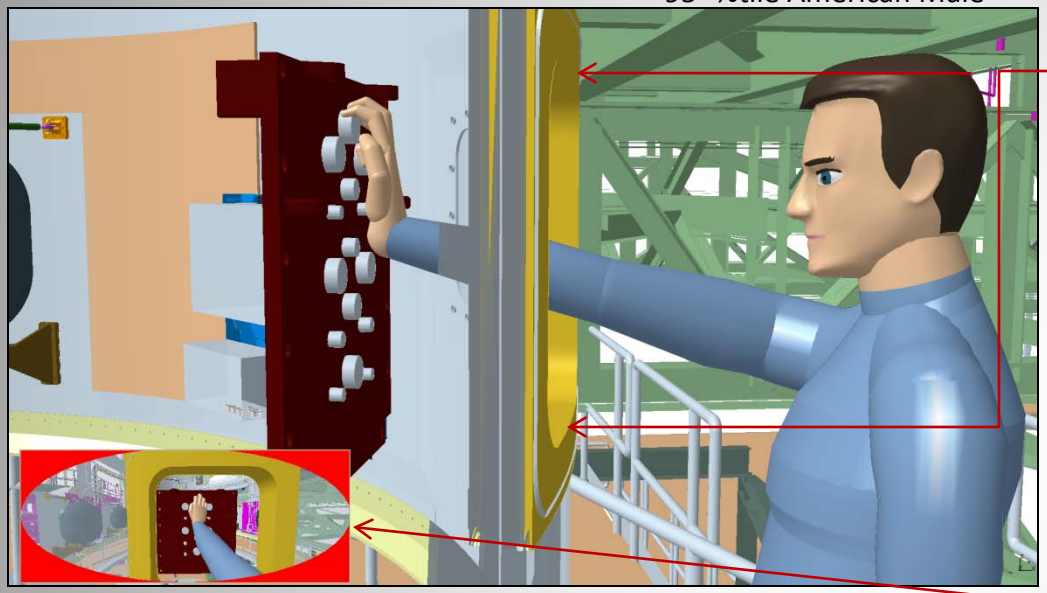
INITIAL PERCEPTION

- *Provides access to all connectors and top of electrical panel*
- *Provides ample visual access*

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (18” x 16” / 3” Corner Radii)

95th%tile American Male



- The 18” x 16” opening allows physical access to all electrical panel connectors. The 18” x 16” opening also allows sufficient arm room to alter arm positions for access to lower connectors.
  (~12.2” total width clearance for male)
  (~12.6” total width clearance for female)

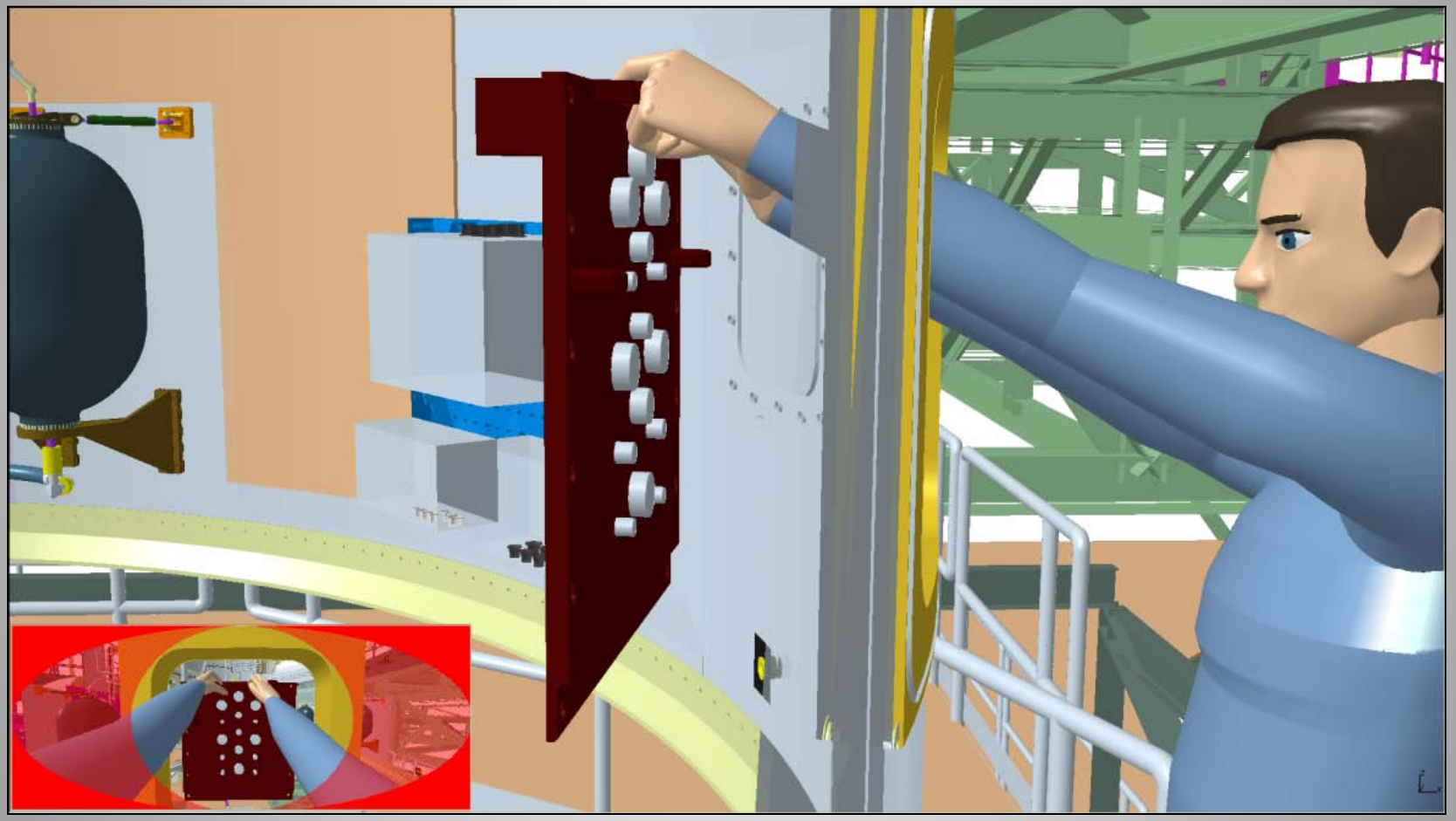
- The 18” x 16” opening allows a direct line of sight visual access to all electrical panel connectors with arm through porthole.

- Physical access and a direct line of sight to support strut attachments is granted.

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (18” x 16” Two-Handed Operation)

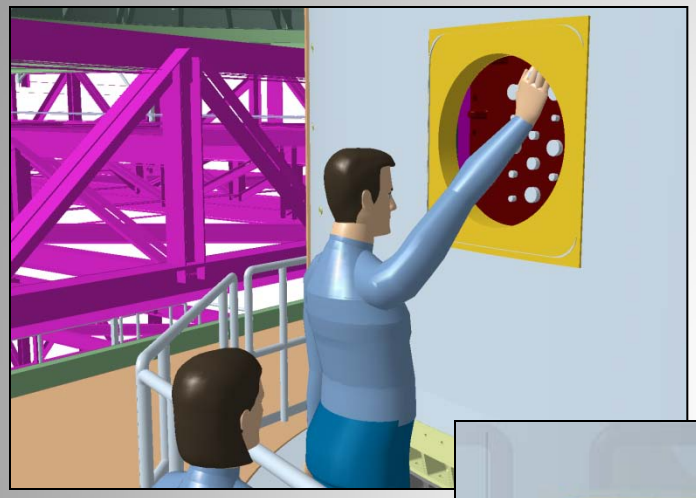
95th%tile American Male

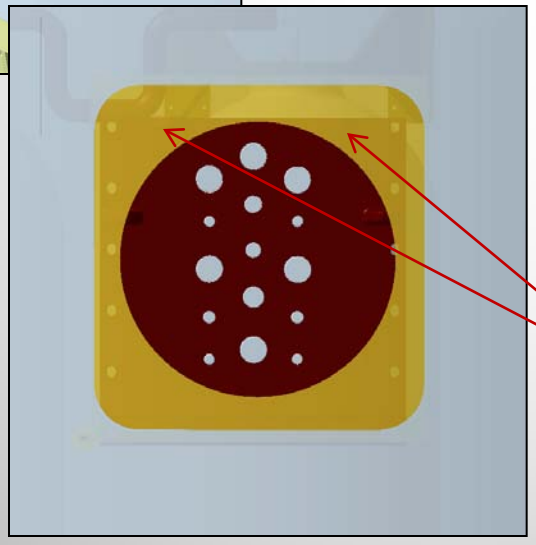


- The 18” x 16” porthole does provide sufficient clearance to allow possible two-handed operations.

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (18” Diameter)





REASONING

- Clearance size was a point of interest that incorporated the 18” clearance from the Ares I US to FS ICD [CxP 72261]; and also satisfies the desire for the porthole to be “as round as possible”

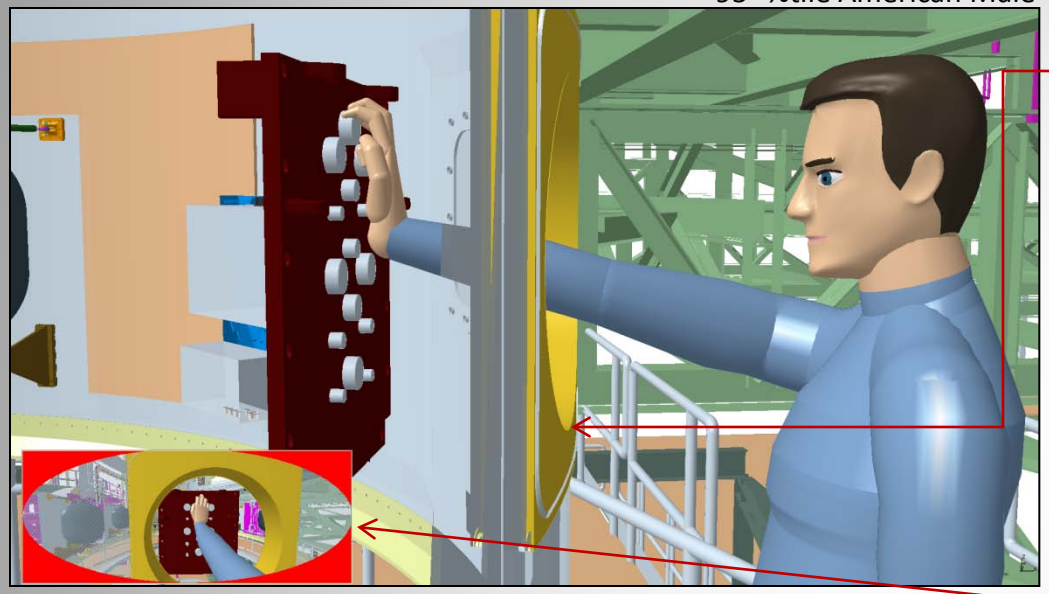
INITIAL PERCEPTION

- *Provides access to all connectors and top of electrical panel*
- *Provides ample visual access*
- *Could possibly reduce ability to access top of electrical panel for attachment of support struts, etc…*
- *Possible physical pressure point for corner connectors*

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (18” Diameter)

95th%tile American Male



- The 18” diameter opening allows physical access to all electrical panel connectors. The 18” diameter opening also allows sufficient arm room to alter arm positions for access to lower connectors.
(~14.2” total clearance for male)
(~14.66” total clearance for female)

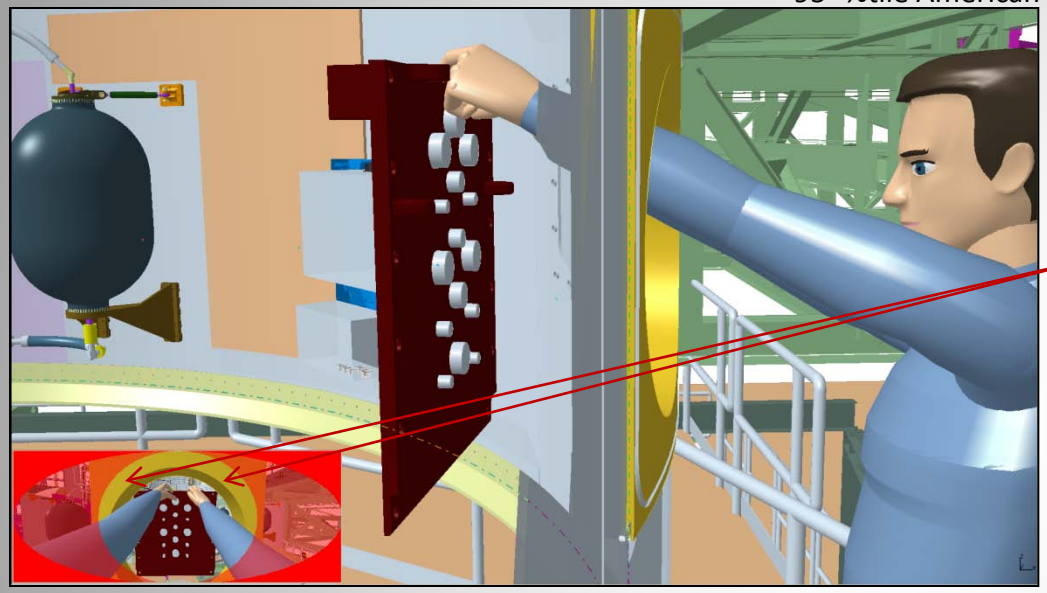
- The 18” diameter opening allows a direct line of sight visual access to all electrical panel connectors.

- Physical access and a direct line of sight to support strut attachments is granted.

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (18” Diameter Two-Handed Operation)

95th%tile American Male

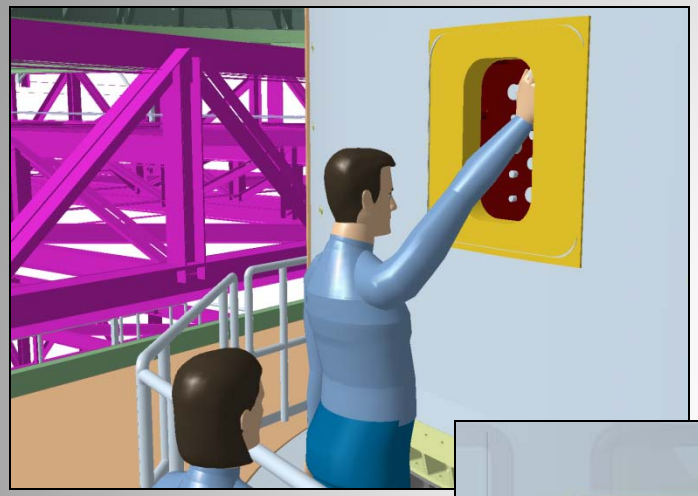


- Diameter/round shaped porthole has the potential to reduce the capability to access top of electrical panel; the lesser the diameter the less access is provided to the electrical panel.

- The 18” diameter porthole does provide sufficient clearance to allow possible two-handed operations.

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (17” x 10” / 3” Corner Radii)



REASONING

- Size was generated from the dimensions of the actual footprint of the connector layout (see slide 9) and adding an additional 1” to outside edge. The thought was that no additional connectors would be added to the layout.

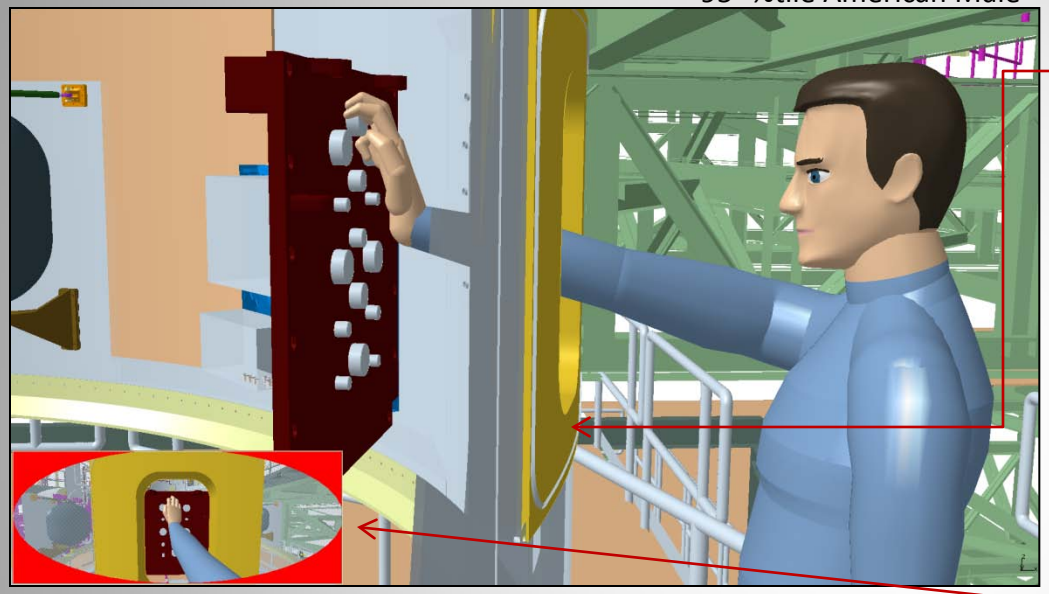
INITIAL PERCEPTION

- *Provides access to all connectors and top of electrical panel*
- *Provides visual access*

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (17” x 10” / 3” Corner Radii)

95th%tile American Male



- The 17” x 10” opening allows physical access to all electrical panel connectors. The 17” x 10” opening also allows sufficient arm room to alter arm positions for access to lower connectors.
  (~6.2” total width clearance for male)
  (~6.66” total width clearance for female)

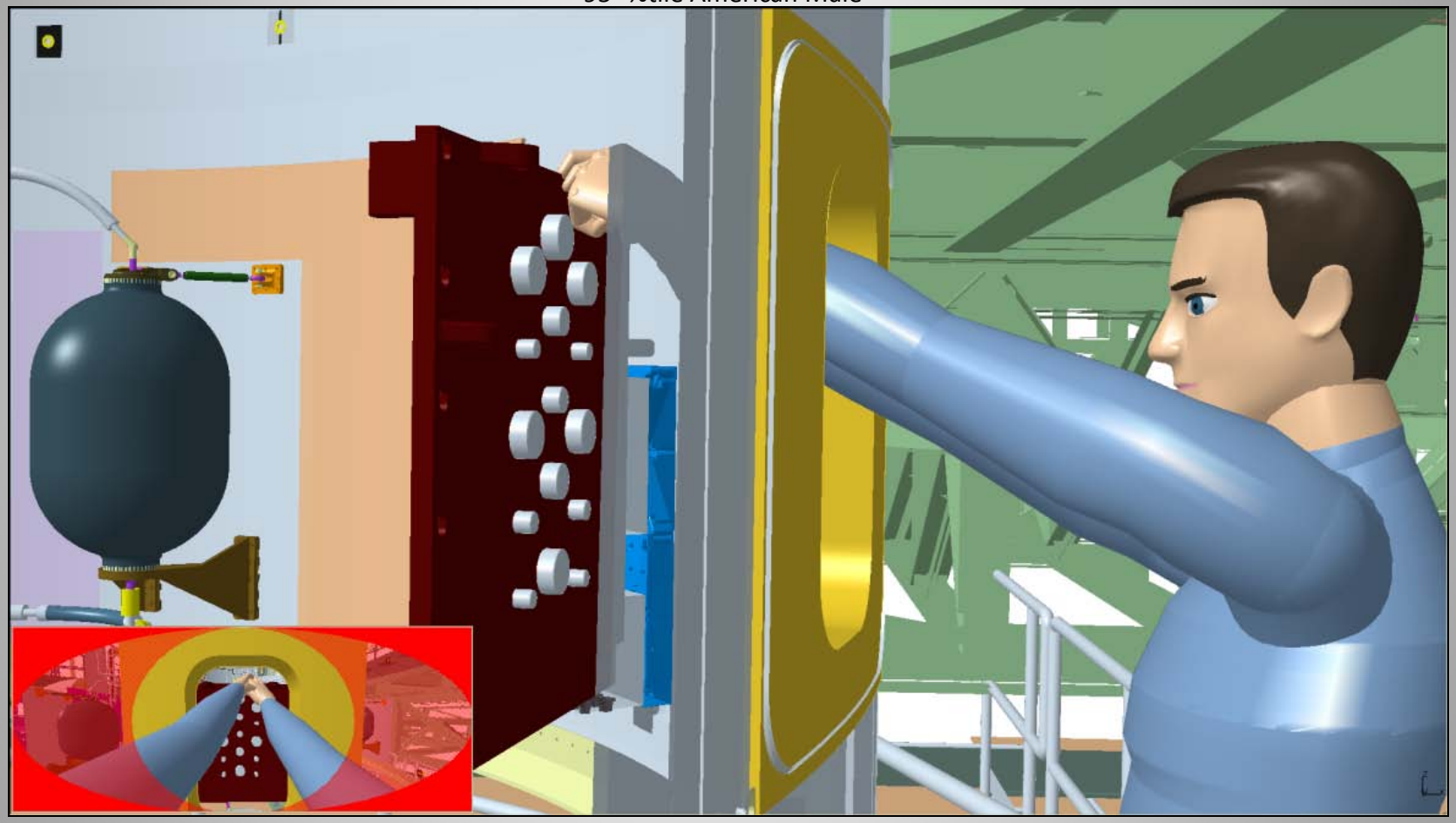
- The 17” x 10” opening allows a direct line of sight visual access to all electrical panel connectors.

- Physical access and a direct line of sight to support strut attachments is granted.

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (17” x 10” Diameter Two-Handed Operation)

95th%tile American Male

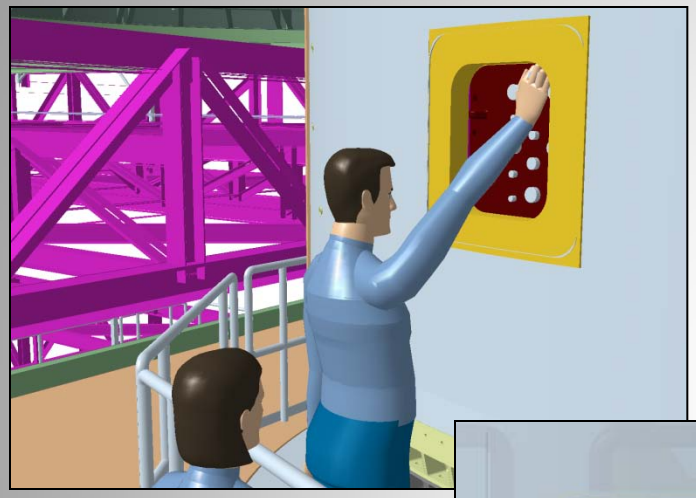


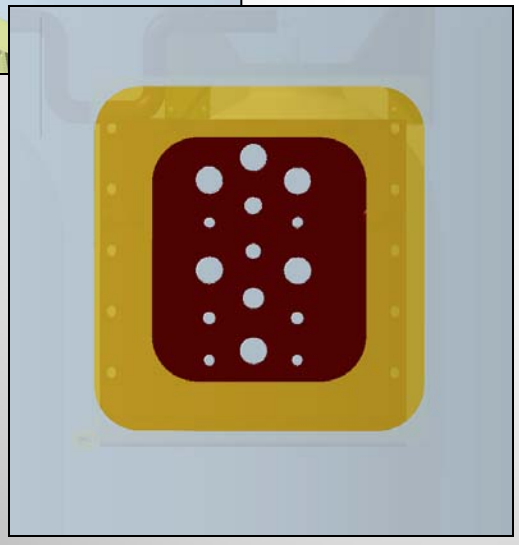
- The 17” x 10” porthole does provide sufficient clearance to allow possible two-handed operations.

- Reduction in porthole size makes capability for two-handed access and operations more cumbersome.

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (16” x 14” / 3” Corner Radii)





REASONING

- Clearance size was generated from the Ares I US FS ICD 18” x 16” dimension and reducing both the height and width by 2”.

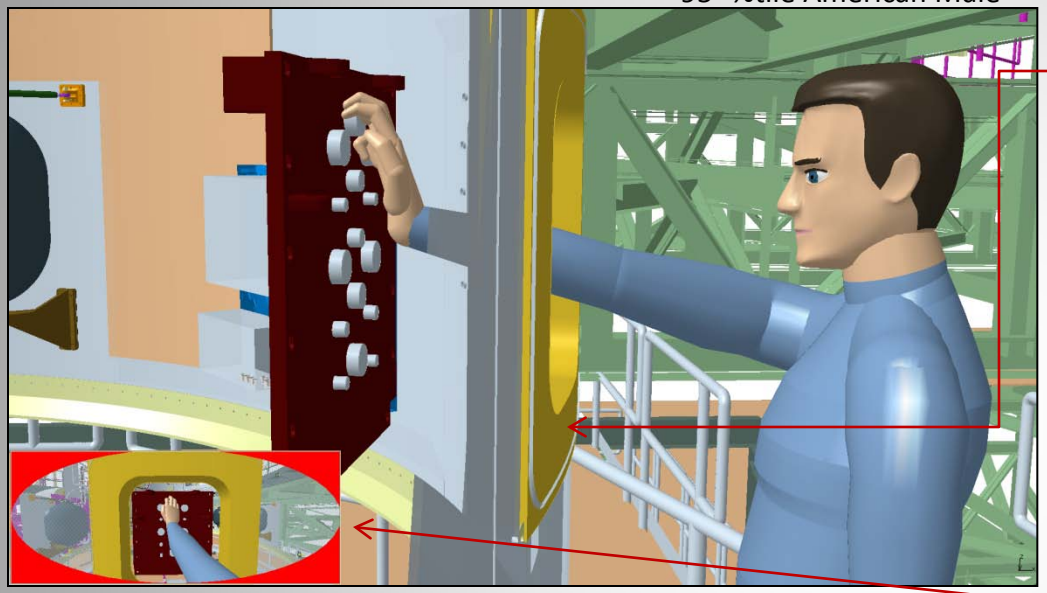
INITIAL PERCEPTION

- *Provides access to all connectors and top of electrical panel*
- *Provides visual access*

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (16” x 14” / 3” Corner Radii)

95th%tile American Male



- The 16” x 14” opening allows physical access to all electrical panel connectors. The 16” x 14” opening also allows sufficient arm room to alter arm positions for access to lower connectors. (~10.2” total width clearance for male) (~10.66” total width clearance for female)

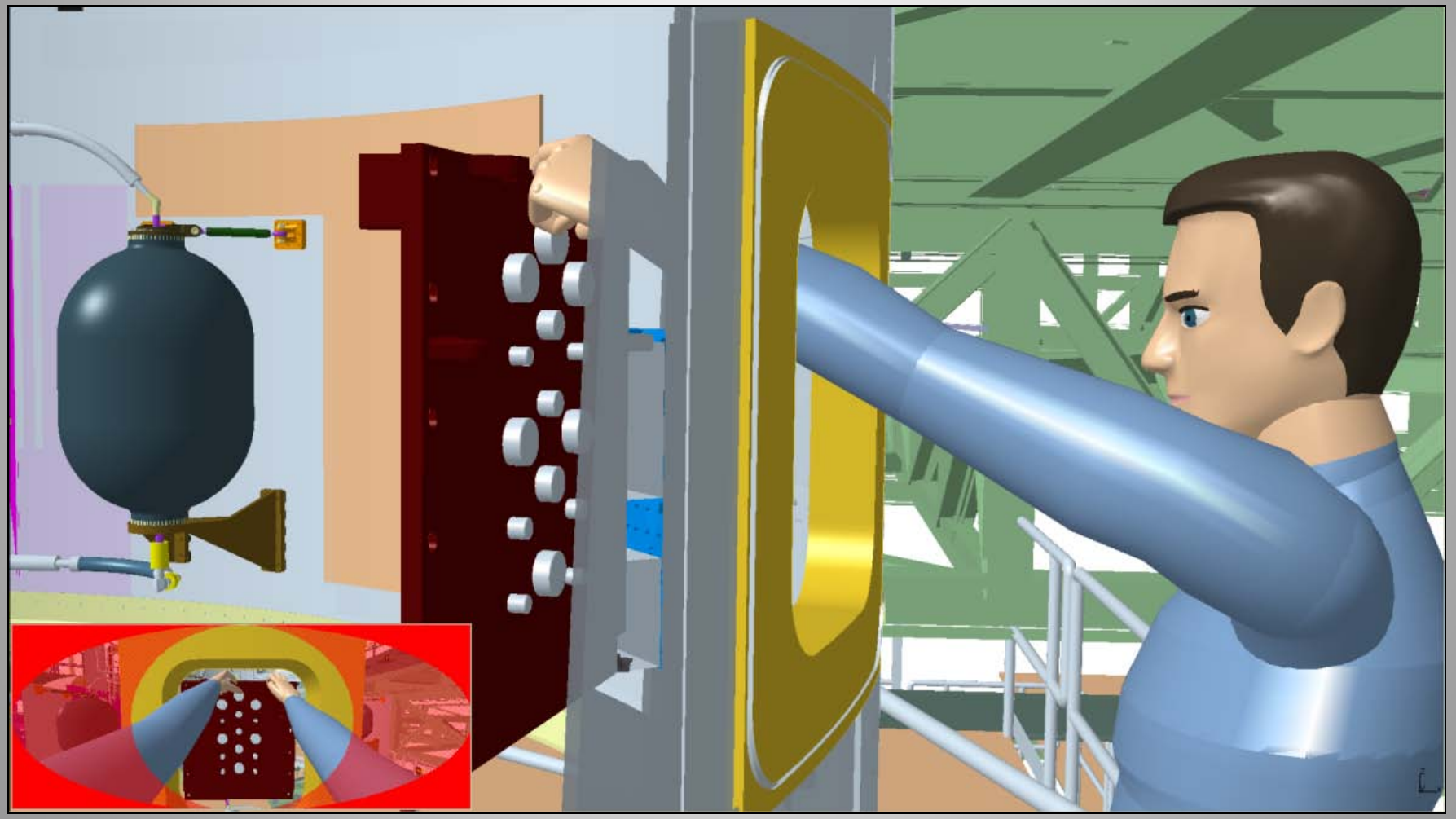
- The 16” x 14” opening allows a direct line of sight visual access to all electrical panel connectors.

- Physical access and a direct line of sight to support strut attachments is granted.

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (16” x 14” Diameter Two-Handed Operation)

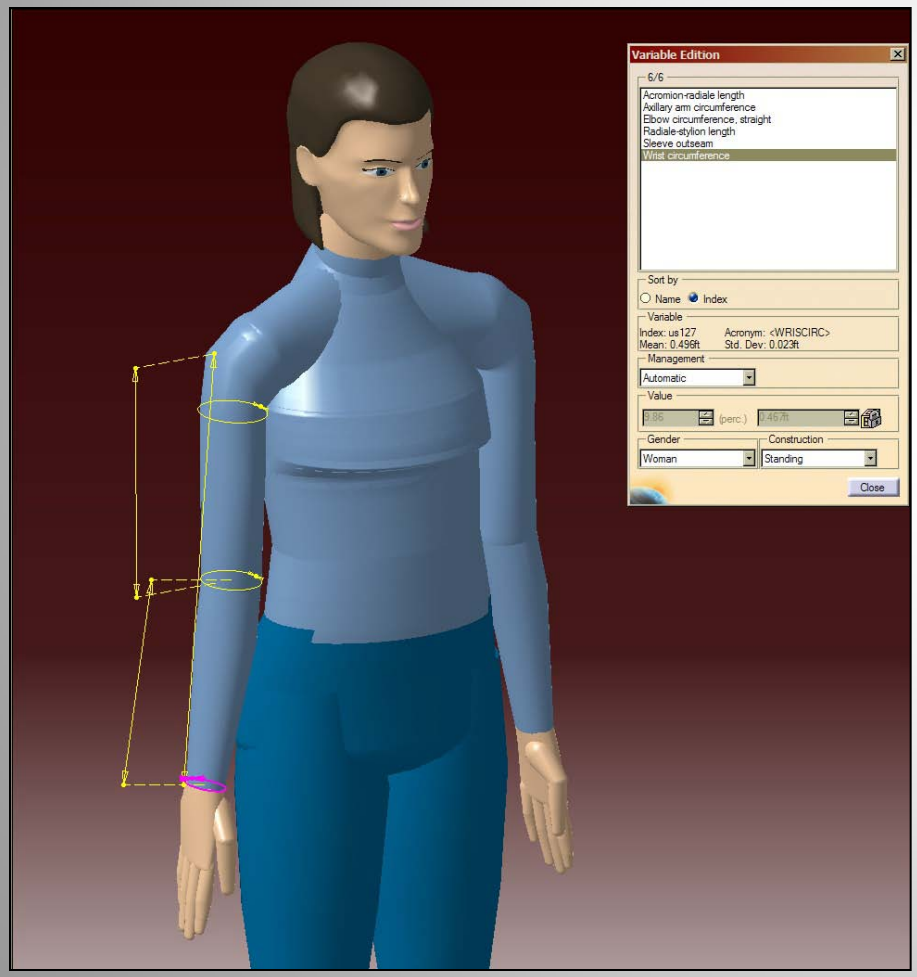
95th%tile American Male



- The 16” x 14” porthole does provide sufficient clearance to allow possible two-handed operations.

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (Human Sizing) 5th% tile American Female

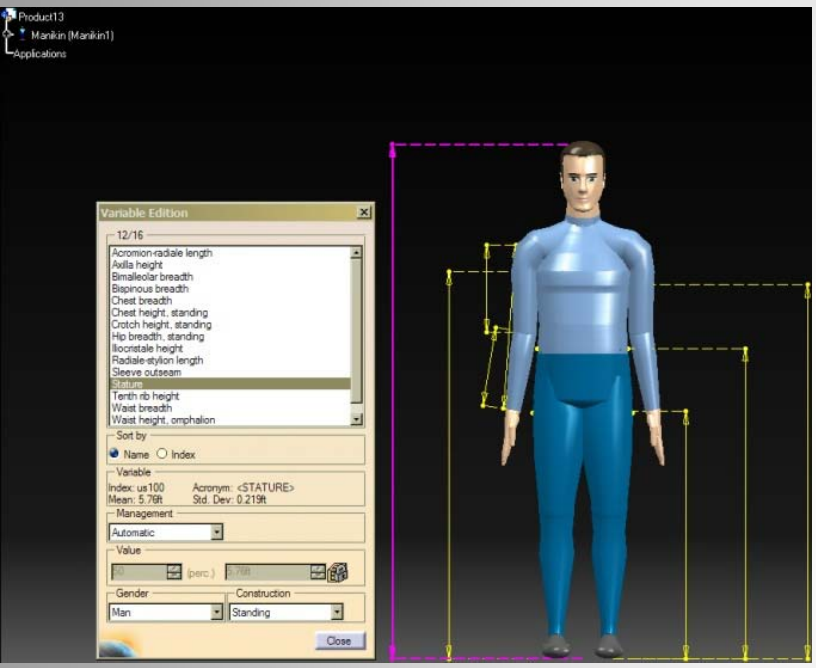


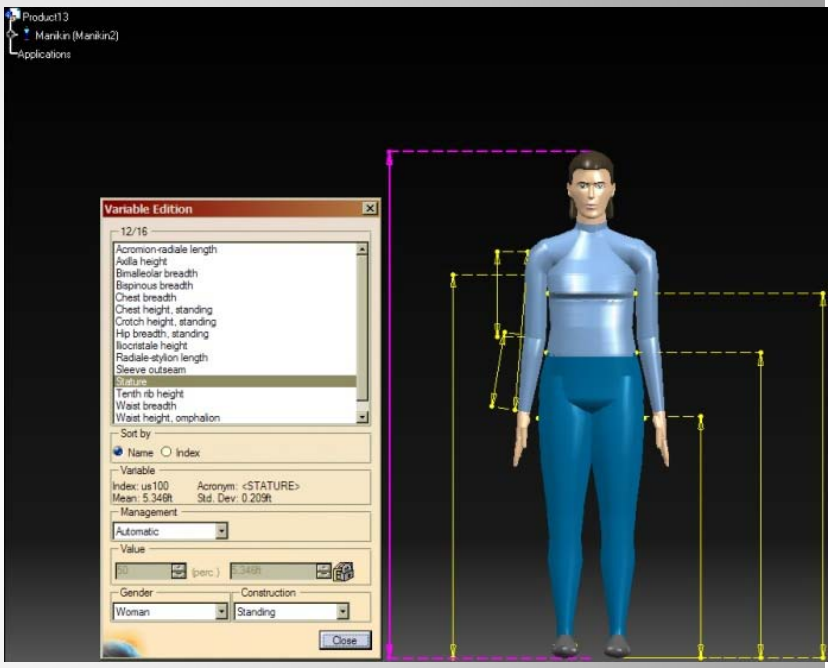
- Acromion-radiale Length = .951 ft (11.41”)
- Axillary Arm Circumference = .874ft (10.48”)
- Elbow Circumference, Straight = .723ft (8.78”)
- Radiale-stylion Length = .742ft (8.90”)
- Sleeve Outseam = 1.669ft (20.02”)
- Wrist Circumference = .467ft (5.60”)

- Diameter ~3.34”
  [will be used to approximate available clearance]

Modeling and Simulation of the ARES UPPER STAGE Transportation, Lifting, Stacking and Mating operations within the Vehicle Assembly Building at KSC

ANALYSIS DESCRIPTION (Human Sizing)





5%tile	5.4ft (5’ 4.8”)
10%tile	5.48ft (5’ 5.76”)
50%tile	5.76ft (5’ 9.12”)
90%tile	6.041ft (6’ .492”)
95%tile	6.121ft (6’ 1.452”)

5%tile	5.003ft (5’ .036”)
10%tile	5.078ft (5’ .936”)
50%tile	5.346ft (5’ 4.152”)
90%tile	5.613ft (5’ 7.356”)
95%tile	5.689ft (5” 8.268”)