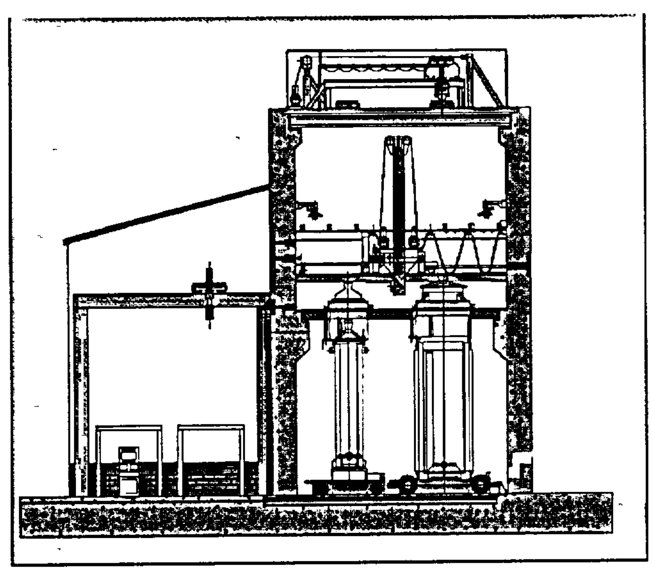
Dry Transfer System

Revision 1

Topical Safety Analysis Report

Volume II



U.S. Department of Energy
Office of Civilian Radioactive Waste Management

CHAPTER 5

OPERATION SYSTEMS

This chapter provides a description of all operations, including the systems, equipment and instrumentation and their operating characteristics for the safe transfer of fuel from one cask to another cask. Operational safety features which prevent against hazards are also presented.

5.1 Operation Description

The following sections outline the handling procedures and systems for the DTS. The handling systems have been developed to minimize the radiation dose to operators and to enable the operations involved in the transfer of irradiated fuel from the source cask to the receiving cask to be performed safely.

5.1.1 Narrative Description

This section provides a detailed description of the operations required to transfer fuel within the DTS including cask receipt, preparation, cask opening, fuel transfer, cask closure and removal. This section is focused on the major operations equipment and control system, but functions of the ancillary equipment during operations is also discussed. A brief overview of the operational sequence is presented in Section 1.3. The description is broken down into the following subsections:

Receiving Cask Receipt, Preparation, Inspection, Positioning and Mating
Source Cask Receipt, Preparation, Inspection and Positioning and Mating
Source Cask Opening
Receiving Cask Opening
Fuel Transfer
Source Cask Closing
Receiving Cask Closing
Source Cask Detachment and Removal
Receiving Cask Detachment and Removal

The words "operator interface" are used to denote the monitor and control panel in the control center which indicates the status of the equipment within the DTS. The operator interface provides information to the operator from sensors on the equipment such as limit switches, encoders and load cells.

The words "Portable Communication System" are used to denote the means used to communicate between the Preparation Area, Lower Access Area or during maintenance operations, the TCA and the Control Center. The system, as a minimum, allows audio communication.

5.1.1.1 Receiving Cask Receipt, Preparation, Inspection, Positioning and Mating

Receiving Cask Receipt

The receiving cask is transported to the DTS by a site specific method. This may be a horizontal cask transporter, a rail car, or a heavy haul trailer. Handling of the receiving cask prior to loading onto the receiving cask transfer trolley will be addressed in the site specific application. The receiving cask is positioned and loaded on the receiving cask transfer trolley to allow its entry into the Preparation Area as follows:

1. Position the receiving cask transporter (e.g. truck, rail car) in the cask loading/unloading area outside of the Preparation Area.

2. Open the roll up door to the Preparation Area. The roll up door is controlled using specific control panels inside and outside the Preparation Area.

3. Visually check that there is no obstruction on the rails.

4. Position the source cask transfer trolley at the end of the runway rails.

   The control of the source cask transfer trolley is achieved by use of a joystick on the Preparation Area control panel. The joystick has two different positions in each direction to set the current speed of the trolley motorization. The Source Cask Transfer Subsystem is energized using a push button on the control panel.

   - Activate the Preparation Area control panel.
   - Switch on Source Cask Transfer Subsystem power.
   - Move the trolley using the fast speed until it is roughly 3½ feet (1.1 m) from the end of the runway rails. Operators communicate via portable communication devices to place the trolley in the proper position.
   - End the movement using the slow speed.
   - Position the transfer trolley near the end of the runway rails.
   - Switch off Source Cask Transfer Subsystem power.

5. Position the receiving cask transfer trolley in its attachment location.

   The control of the receiving cask transfer trolley is achieved by use of a joystick on the Preparation Area control panel. The joystick has two different positions in each direction to set the current speed of the trolley motorization. The Receiving Cask Transfer Subsystem is energized using a push button on the control panel.

   - Switch on Receiving Cask Transfer Subsystem power.
   - Move the trolley using the fast speed until roughly 6 feet (2 m) from the loading area. Operators communicate via portable communication devices to place the trolley in proper position.

- End the movement using the slow speed.
- Visually check the correct positioning of the transfer trolley.
- Switch off Receiving Cask Transfer Subsystem power.
- Deactivate the Preparation Area control panel.

6. Close the roll up door to the Preparation Area.

7. Remove the trunnion tiedowns and bolts and store temporarily.

8. Load the receiving cask onto the trolley. This operation will most likely be performed using a crane, and will be addressed in the site specific applications.

9. Fasten the cask onto the trolley using the trunnion tiedowns and bolts.

The cask is now ready for entry into the Preparation Area.

Receiving Cask Entry in the Preparation Area

The receiving cask trolley is fixed in position and locked in place in the Preparation Area. This is to prevent movement of the trolley along its rails in a seismic event and also to prevent inadvertent activation of the trolley while the cask is inspected and prepared for unloading. The locking device is actuated by use of push buttons on the Preparation Area control panel. The sequence of operations is as follows:

1. Visually check the proper fixation of the receiving cask on the transfer trolley.

2. Open the roll up door.

3. Visually check that there is no obstruction on the rails.

4. Position the receiving cask transfer trolley in its preparation location.

- Activate the Preparation Area control panel.
- Switch on Receiving Cask Transfer Subsystem power.
- Move the trolley using the fast speed until it is roughly 3½ feet (1.1 m) from the end of the runway rails. Operators communicate via portable communication devices to place the trolley in the proper position."
- End the movement using the slow speed. The receiving cask transfer trolley is automatically stopped in its preparation location.
- Close the roll up door.
- Lock the transfer trolley in position.
- Correct locking of the trolley is indicated by the operator interface in the Control Center. The operator is notified that the operation is satisfactorily completed using the portable communication system.
- Switch off receiving cask transfer trolley power.

- Deactivate the Preparation Area control panel.

Receiving Cask Preparation and Inspection

The design basis receiving cask consisting of the MPC and its overpack (cask) must be prepared prior to being introduced into the Lower Access Area and receiving transferred fuel assemblies. The sequence of operations is as follows:

1. Remove the receiving cask lid.

2. Remove the canister outer lid.

3. Remove the canister inner lid.

4. Position and attach the shield plug lifting pintle.

5. Visually check receiving cask seals and surfaces for scratches or defects.

Receiving Cask Positioning in the Lower Access Area

The receiving cask is now ready for entry into the Lower Access Area. It must be placed and locked in its mating position in the Lower Access Area. A control panel in the Lower Access Area having the same functions as the Preparation Area control panel is used to control the positioning of the receiving cask trolley. The sequence of operations is as follows:

1. Open the sliding door. The sliding door is operating from a control panel on the Preparation Area wall.

2. Visually check the closed position of the two TC port covers.

3. Visually check that the two mating flanges are in upper position.

4. Visually check that there is no obstruction on the rails.

5. Position the receiving cask transfer trolley in its transfer position in the Lower Access Area.

   - Activate the Lower Access Area control panel.
   - Switch on receiving cask transfer trolley power.
   - Unlock the receiving cask transfer trolley.
   - Transfer the trolley using the fast speed until roughly 6 feet (2 m) from the transfer location.
   - End the movement using the slow speed. The receiving cask transfer trolley is automatically stopped in its transfer location.
   - Visually check the correct positioning of the transfer trolley.

6. Lock the receiving cask transfer trolley in its transfer position. The locking function is activated manually from the trolley. The completion of the operation is indicated by the operator interface in the Control Center. The locking function prevents the trolley from moving along its rails in a seismic event. The operator is notified that the operation is completed using the portable communication system.

7. Switch off receiving cask transfer trolley power.

8. Deactivate the Lower Access Area control panel.

9. Visually check the locked position of the receiving cask transfer trolley.

10. Leave the Lower Access Area.

11. Close the sliding door after verifying that all personnel have left the Lower Access Area.

Receiving Cask Mating

The receiving cask is mated with the Transfer Confinement Area prior to start of the fuel transfer. The main control panel, located in the Control Center, provides the necessary equipment to remotely control the mating operations. Mating of the receiving cask is performed without anyone in the Lower Access Area.

1. Visually check the closed position of the sliding door.

2. Mate the receiving cask with the Transfer Confinement Area.

   - Switch on Receiving Cask Mating Subsystem power.
   - Lower the mating flange. Monitor the operation with a CCTV display. A unique push button is used to request the control of the three electric jacks. The Programmable Logic Controller (PLC) controls the mating process based on height and pressure information. The operator is notified that the operation is completed by the operator interface (control panel or monitor).
   - Check the consistency of the height and load information of the three electric jacks displayed by the operator interface. Visually verify proper mating with the camera in the LAA.
   - Switch off Receiving Cask Mating Subsystem power.

5.1.1.2 Source Cask Receipt, Preparation, Inspection, Positioning and Mating

Source Cask Receipt

The source cask, which contains four spent fuel assemblies, is transported to the DTS by truck, rail or a vertical cask transporter.

It must be positioned on the source cask transfer trolley prior to entry in the Preparation Area. The method used to load the source cask onto the transfer trolley will be addressed in site specific applications. The sequence of operations is as follows:

1. Position the source cask transporter.

2. Open the roll up door.

3. Visually check that there is no obstruction on the rails.

4. Position the source cask transfer trolley in its loading position.

   - Activate the Preparation Area control panel.
   - Switch on Source Cask Transfer Subsystem power.
   - Move the trolley using the fast speed until roughly 6 feet (2 m) from the attachment location. Operators communicate via portable communication system to place the trolley in proper position.
   - End the movement using the slow speed.
   - Visually check the correct positioning of the transfer trolley.
   - Switch off Source Cask Transfer Subsystem power.
   - Deactivate the Preparation Area control panel.

5. Close the roll up door.

6. Remove the trunnion tiedowns and bolts.

7. Lift the source cask onto the trolley and replace the trunnion tiedowns and bolts.

<u>Source Cask Entry in the Preparation Area</u>

Once the source cask is fixed on its transfer trolley, it has to be positioned and locked in the Preparation Area prior to process preparation operations. The locking device is actuated by use of push buttons on the Preparation Area control panel.

1. Check the proper fixation of the source cask on the transfer trolley.

2. Open the roll up door.

3. Visually check that there is no obstruction on the rails.

4. Position the transfer trolley in its preparation location.

   - Activate the Preparation Area control panel.
   - Switch on Source Cask Transfer Subsystem power.

- Move the trolley using the fast speed until roughly 6 feet (2 m) from the preparation location.
- End the movement using the slow speed. The source cask transfer trolley is automatically stopped in its preparation location.
- Close the roll up door.

5. Lock the transfer trolley in position.

   The completion of the operation is indicated by the operator interface in the Control Center. The operator is notified that the operation is completed using the portable communication system.

6 Switch off Source Cask Transfer Subsystem power.

7. Deactivate the Preparation Area control panel.

Source Cask Preparation and Inspection

The following operations will be performed in the Preparation Area before moving the Source Cask into the Lower Access Area.

1. Vent Source Cask to portable HEPA filter.
2. Unbolt source cask lid.
3. Position and attach lid lifting pintle to the lid..
4. Clean Lid/Source Cask External Surfaces.

Source Cask Positioning in the Lower Access Area

Once prepared, the source cask has to be placed and locked in its mating position in the Lower Access Area.

1. Manually unlock and remove sliding panels from the sliding door. The sliding panels fit around the rails to reduce the amount of open area between the Preparation Area and the Lower Access Area. They are removed for trolley entrance and egress.
2. Open the sliding door.
3. Visually check the closed position of the two TC port covers.
4. Visually check that the receiving cask is mated.
5. Visually check that the source cask mating flange is in upper position.

6. Visually check that there is no obstruction on the rails.

7. Position the source cask transfer trolley in its mating position.

   - Activate the Lower Access Area control panel.
   - Switch on Source Cask Transfer Subsystem power.
   - Unlock the source cask transfer trolley.
   - Transfer the trolley using the fast speed until roughly 6 feet (2 m) from the mating location.
   - End the movement using the slow speed. The source cask transfer trolley is automatically stopped in its mating location.
   - Visually check the correct positioning of the transfer trolley.
   - Lock the source cask transfer trolley in its transfer position.
     The completion of the operation is indicated by the operator interface in the Control Center. The operator is notified that the operation is completed using the portable communication system.
   - Switch off Source Cask Transfer Subsystem power.
   - Deactivate the Lower Access Area control panel.

8. Leave the Lower Access Area.

9. Close the sliding door after verifying that all personnel have left the Lower Access Area.

10. .Lock the sliding door manually, placing the four locking pins in their locations. Place sliding panels in position for sealing the sliding door around the rails.

11. Check with the Control Center that the sliding door is locked.

Source Cask Mating

The source cask is mated with the Transfer Confinement Area prior to start of any transfer operation. The main control panel, located in the Control Center provides the necessary equipment to remotely control the mating operations.

1. Check the locked position of the sliding door.

2. Check the locked position of the source cask transfer trolley.

3. Mate the source cask with the Transfer Confinement Area as follows.

   - Switch on Source Cask Mating Subsystem power.

- Lower the mating flange. Monitor the operation with a CCTV display in the Control Center. A unique push button is used to control the three electric jacks. The PLC controls the mating process based on height and pressure information. The operator is notified that the operation is completed by the operator interface.
- Check the consistency of the height and load information of the three electric jacks displayed by the operator interface. Visually verify proper mating with the camera in the LAA.
- Switch off Source Cask Mating Subsystem power.

5.1.1.3 <u>Source Cask Opening</u>

1. Verify using the operator interface that the two upper shield ports are in the closed and locked positions.

2. Verify using the operator interface that the lid/shield plug grapple is stopped in upper Z position.

3. Position the upper crane above the source cask.

   The positioning operation is automatically stopped when the upper crane reaches the source cask position.

4. Verify using the operator interface that the upper crane is in source cask position.

5. Verify that the radiation level in roof enclosure is acceptable.

6. Unlock the source cask upper shield port.

   The operator interface displays when this operation is completed.

7. Verify using the CCTV monitor that the receiving cask TC port cover is closed.

8. Open the source cask upper shield port.

   The operation is automatically stopped when the shield port reaches the open position.

9. Lock the source cask upper shield port.

   The operator interface displays when this operation is complete.

10. Verify using the operator interface that the source cask upper shield port cover is open and locked.

11. Switch on source cask TC port cover power.

12. Open the source cask TC port cover.

    The source cask TC port cover is controlled with push buttons (open, closed) on the main control panel. Monitor the motion of the port cover with the CCTV display. The operation is automatically stopped when the TC port cover reaches the open position.

13. Verify using the CCTV monitor and the operator interface that the source cask TC port cover is in open position.

14. Verify using the operator interface that the lid/shield plug grapple is in the disengaged position.

15. Lower the lid/shield plug grapple to the overlid level.

    The operator can use a variable speed. Monitor the operation with the CCTV displays when the grapple is in the TCA. Monitor the speed, the position and the load of the system with the operator interface when visibility is lost. The operation is stopped automatically when the cables are unloaded indicating that the grapple is in contact with the overlid.

16. Verify the Z position of the grapple with the operator interface.

17. Verify using the operator interface that the cables are unloaded.

18. Grapple the source cask lid.

    The operator interface notifies the operator when the source cask lid is fully grappled.

19. Lift the lid above the TC port cover.

    Monitor the position of the lid using the CCTV display. The operation is automatically stopped when the limit position is reached.

20. Verify using the CCTV and the operator interface that the lid is above the source cask TC port cover.

21. Close the source cask TC port cover.

    Monitor visually the motion of the source cask TC port cover. The operation is automatically stopped when it reaches the closed position.

22. Verify using the CCTV and the operator interface that the source cask TC port cover is stopped in closed position.

23. Switch off source cask TC port cover power.

24. Lower the lid onto the source cask TC port cover.

The operator can only use the slow speed for this operation. Visually monitor the motion of the lid and its positioning on the port cover. The operation stops automatically when the lid seats on the TC port cover.

25. Check the Z position of the grapple with the operator interface.

26. Ensure that the cables are unloaded using the operator interface.

27. Disengage the grapple.

The operator interface indicates when the grapple is fully disengaged.

28. Lift the lid/shield plug grapple to its upper Z position.

The operator can use the variable speed. Visually monitor the motion of the grapple when it is underneath the upper plate. The operation is automatically stopped when the grapple reaches its upper Z position.

29. Verify using the operator interface the Z position of the lid/shield plug grapple.

30. Unlock the source cask upper shield port.

The operator interface displays when this operation is complete.

31. Close the source cask upper shield port.

The operation stops automatically when the upper shield port reaches the closed position.

32. Verify using the operator interface the closed position of the upper shield port.

33. Lock the source cask upper shield port.

The operator interface indicates when the operation is completed.

34. Switch off Source Cask Lid and Receiving Cask Shield Plug Handling Subsystem power.

5.1.1.4 <u>Receiving Cask Opening</u>

1. Verify using the operator interface the closed and locked position of the two uppershield ports.

2. Verify using the operator interface that the lid/shield plug grapple is stopped in upper Z position.

3. Verify using the operator interface that the HVAC Subsystem is effective by checking each room pressure.

4. Switch on the Source Cask Lid and Receiving Cask Shield Plug Subsystem power.

5. Position the upper crane above the receiving cask.

   The upper crane is controlled with a joystick on the main control panel which allows the operator to position the upper crane in the receiving or source cask position. The positioning operation automatically stops when the upper crane reaches the receiving cask position.

6. Verify using the operator interface that the upper crane is in receiving cask position.

7. Verify using the operator interface that the fuel assembly grapple is in disengaged position.

8. Verify using the operator interface that the fuel assembly hoist system is not loaded.

9. Verify that the radiation level in the Roof Enclosure Area is within acceptable limits.

10. Unlock the receiving cask upper shield port.

    The upper shield port locking devices are controlled with push buttons (lock, unlock) on the main control panel. The operator interface notifies the operator when the upper shield port is unlocked.

11. Verify that the source cask TC port cover is closed.

12. Open the receiving cask upper shield port.

    The upper shield ports are controlled with push buttons (open, close) on the main control panel. The operation stops when the shield port is in open position.

13. Lock the receiving cask upper shield port.

    The operator interface displays when this operation is complete.

14. Verify using the operator interface that the receiving cask upper shield port cover is open and locked.

15. Switch on the receiving cask TC port cover power.

16. Open the receiving cask TC port cover.

    The receiving cask TC port cover is controlled with push buttons (open, off center, closed) on the main control panel. Monitor the movement of the port cover with the CCTV display. The operation stops automatically when the TC port cover reaches the open position.

17. Verify using the CCTV and the operator interface that the receiving cask TC port cover is in open position.

18. Verify using the operator interface that the lid/shield plug grapple is in disengaged position.

19. Verify using the CCTV monitor that the fuel assembly handling crane is stopped in its parking position.

20. Lower the lid/shield plug grapple to the overlid level.

    The lid/shield plug hoist system is controlled using a joystick on the main control panel, which allows the use of variable speed in both directions. Monitor the operation with the CCTV displays when the grapple is in the TCA. Monitor the speed, the position and the load of the system with the operator interface when visibility is blocked. The operation stops automatically when the cables are unloaded so when the grapple is in contact with the overlid.

21. Check the Z position of the grapple with the operator interface.

22. Verify using the operator interface that the cables are unloaded.

23. Grapple the shield plug.

    The lid/shield plug grapple is controlled using push buttons on the main control panel (grapple, ungrapple). The PLC pilots the lower level operations and interactions between the shield plug, the overlid and the grapple. The operator interface notifies the operator when the shield plug is completely grappled.

24. Lift the shield plug above the TC port cover.

    Use the same control device as for the lowering operation. Visually monitor the position of the shield plug when it is above the mezzanine level. The operation is automatically stopped when the limit position is reached.

25. Verify using the CCTV monitor and the operator interface that the shield plug is above the receiving cask TC port cover.

26. Position the receiving cask TC port cover in the off centered position.

    Visually monitor the movement of the receiving cask TC port cover. The operation is automatically stopped when it reaches the off centered position.

27. Verify using the CCTV monitor and the operator interface that the receiving cask TC port cover is stopped in the off centered position.

28. Lower the shield plug on the receiving cask TC port cover.

    The operator uses the slow speed for this operation. The operation is automatically stopped when the shield plug is on the TC port cover.

29. Verify the correct Z- position of the grapple is displayed on the operator interface.

30. Verify that the operator interface indicates that the cables are unloaded.

31. Disengage the grapple.

    The operator interface displays the status of the grapple.

32. Lift the lid/shield plug grapple to an intermediate level (above the maximum height of the shield plug when resting on the TC port cover).

    The operator can use the high speed for this operation. Visually monitor the movement of the grapple. The operator stops the motion when he sees that there is sufficient clearance between the top of the port cover and the bottom of the shield plug.

33. Close the receiving cask TC port cover.

    Visually monitor the movement of the port cover. The operation is automatically stopped when the port cover reaches the closed position.

34. Verify using the CCTV and the operator interface that the receiving cask TC port cover is closed.

35. Switch off receiving cask TC port cover power.

36. Lift the lid/shield plug grapple to its upper Z position.

    The operator can use the variable speed. Visually monitor the movement of the grapple when it is beneath the upper plate.

The operation stops when the grapple reaches its upper Z position.

37. Check with the operator interface the Z position of the lid/shield plug grapple.

38. Unlock the receiving cask upper shield port.

    The operator interface displays when this operation is complete.

39. Close the receiving cask upper shield port.

    The operation stops when the upper shield port reaches the closed position.

40. Verify using the operator interface that the upper shield port is closed.

41. Lock the receiving cask upper shield port.

    The operator is notified by the operator interface when the operation is completed.

5.1.1.5 Fuel Transfer

Fuel transfer is remotely monitored and controlled from the Control Center. The operator uses two CCTV displays and an operator interface (the operator interface includes the monitoring display prompted by the monitoring software as well as the indication panels in the Control Center). The cameras and the lights are controlled by the operator.

1. Verify that the operator interface indicates that the two upper shield ports are locked.

2. Switch on receiving cask TC port cover power.

3. Switch on source cask TC port cover power.

4. Open the source cask TC port cover.

   This operation can be performed simultaneously with the receiving cask TC port cover opening. Visually monitor the movement of the port cover. The operation stops when the port cover reaches the open position.

5. Verify using the CCTV and the operator interface display that the source cask TC port cover is open.

6. Lock the source cask TC port cover.

   The operator interface indicates when the operation is completed. This operation can be performed simultaneously with the receiving cask TC port cover locking operation.

7. Open the receiving cask TC port cover.

   Visually monitor the movement of the port cover. The operation stops when the port cover reaches the open position.

8. Verify using the CCTV monitor and the operator interface that the receiving cask TC port cover is open.

9. Lock the receiving cask TC port cover.

   The operator operator interface indicates when the operation is completed.

10. Switch off receiving cask TC port cover power.

11. Switch off source cask TC port cover power.

12. Check with the operator interface that the fuel assembly grapple is in upper Z position.

13. Check with the CCTV that the crud catcher is in closed position.

14. Switch on power for the Fuel Assembly Handling Subsystem.

15. Position the transfer tube above a fuel assembly (in the source cask) centerline.

    The positioning is composed of three phases. The first phase is a rough positioning in X and Y directions. It can be automatically controlled using the personal computer (PC). The second phase is a fine positioning (X,Y) controlled by using a joystick for the X and Y direction movement. In manual mode, the speed is limited to the slow one (X,Y). The third phase is the positioning in Θ direction. The rotating platform is controlled with a joystick on the main control panel. Two speeds can be used for the platform rotation. The second and third phases can be performed simultaneously.

- Set the coordinates (X,Y) in the PC of the position to be reached by the transfer tube.
- Run the automatic positioning of the transfer tube. Monitor visually the operation. The operator is notified when the operation is completed.
- Verify, using the CCTV monitor and the operator interface, the rough positioning (X,Y) of the transfer tube.
- Accurately position (X,Y) the transfer tube above the fuel assembly centerline. Monitor visually the X,Y motion and position. The operator stops the movement when the proper position is reached.
- End the positioning with the Θ rotation. Monitor visually the Θ movement and position. The operator stops movement when the proper position is reached.
- Identify the fuel assembly and record.

16. Open the crud catcher.

    The crud catcher is controlled using push buttons on the main control panel. The operator is notified when the operation is completed.

17. Verify using the CCTV that the crud catcher is open.

18. Select the operating winch.

    Two winches can be used to lift the fuel assembly. One is used as a backup. The operator selects, using a switch on the main control panel, the winch to be used for the transfer process.

19. Lower the fuel assembly grapple.

    The operating winch is activated using a joystick on the main control panel which gives the operator the opportunity to use a variable speed in both directions. For a limited distance, the PLC limits the speed to the minimum slow speed. The grapple is not visible while it is in the transfer tube. Cameras on the TCA walls provide viewing of the grapple between the bottom of the transfer tube and the mezzanine plate. When the grapple is close to the fuel assembly, one camera, at least, at the bottom of the transfer tube provides viewing of the operation. The operator monitors the Z position of the grapple on the operator interface. The communication system transmits the operation sounds so the operator can detect any interference or motor failure. The operation is automatically stopped when the handling cable is unloaded.

20. Check with the operator interface that the cables are not under load.

21. Verify the Z position of the grapple using the operator interface.

22. Grapple the fuel assembly.

    The fuel assembly grapple is controlled using push buttons on the main control panel (grapple, ungrapple). The operator interface indicates that the operation is completed.

23. Lift the fuel assembly to its upper Z position.

    Use the same control and monitoring means as for the lowering operations. The operator can use the variable speed until the upper Z position. The sound of the operation is displayed in the Control Center. The operator monitors the Z position of the grapple and the cable load with the operator interface. The operation stops automatically when the grapple has reached its upper Z position.

24. Verify using the operator interface that the grapple is in its upper Z position.

25. Verify using the CCTV that the fuel assembly is retracted into the transfer tube.

26. Close the crud catcher.

    The operator interface displays that the operation is completed.

27. Verify the closed position of the crud catcher using the CCTV monitor.

28. Position the transfer tube above an empty cell centerline in the receiving cask.

29. Open the crud catcher.

30. Verify using the CCTV monitor the open position of the crud catcher.

31. Lower the fuel assembly to the bottom of the receiving cask.

32. Check with the operator interface that the cables are not under load.

33. Check with the operator interface the Z position of the grapple.

34. Ungrapple the fuel assembly.

    The fuel assembly ungrappling operation is controlled using the specific push button on the main control panel. The operator interface displays that the operation is completed.

35. Lift the fuel assembly grapple to its upper Z position.

36. Verify the Z position of the grapple using the operator interface.

37. Close the crud catcher.

38. Verify the closed position of the crud catcher using the CCTV monitor.

39. Repeat steps 15 through 38 until the source cask is empty.

40. Position the fuel assembly handling crane carriage in its parking position.

    Only gross positioning in the X and Y directions is necessary.

41. Verify the position of the fuel assembly handling crane carriage using the CCTV monitor.

42. Switch off power to the Fuel Assembly Handling Subsystem equipment.

43. Switch on receiving cask TC port cover power.

44. Switch on source cask TC port cover power.

45 Unlock the receiving cask TC port cover.

The operator is notified by the operator interface when the unlocking operation is completed.

46. Off-center the receiving cask TC port cover.

The operation is automatically stopped when the TC port cover reaches the off-centered position.

47. Verify that the receiving cask TC port cover is in the off-centered position using the CCTV monitor.

48. Unlock the source cask TC port cover.

The operator is notified when the unlocking operation is completed. This operation can be performed simultaneously with the receiving cask TC port cover unlocking.

49. Close the source cask TC port cover.

The operation is automatically stopped when the source cask TC port cover reaches the closed position. This operation can be performed simultaneously with the receiving cask TC port cover off centering operation.

50. Verify the closed position of the source cask TC port cover using the CCTV monitor.

51. Switch off receiving cask TC port cover power.

52. Switch off source cask TC port cover power.

5.1.1.6 Receiving Cask Closing

1. Verify the closed and locked position of the two upper shield ports.

2. Verify that the lid/shield plug grapple is stopped in upper Z position.

3. Verify that the receiving cask TC port cover is in the off-centered position using the CCTV monitor.

4. Check that the source cask TC port cover is closed with the CCTV.

5. Switch on the Source Cask Lid and Receiving Cask Shield Plug Subsystem power.

6. Position the upper crane above the receiving cask.

   The positioning operation is automatically stopped when the upper crane reaches the receiving cask position.

7. Verify using the operator interface that the upper crane is in receiving cask position.

8. Verify using the operator interface that the fuel assembly grapple is in disengaged position.

9. Verify using the operator interface that the fuel assembly hoist system is not loaded.

10. Verify that the radiation levels in the Roof Enclosure Area are acceptable.

11. Unlock the receiving cask upper shield port.

    The operator interface displays when the operation is completed.

12. Open the receiving cask upper shield port.

    The operation is automatically stopped when the upper shield port is in open position.

13. Lock the receiving cask upper shield port.

    The operator interface displays when this operation is complete.

14. Verify using the operator interface that the receiving cask upper shield port cover is open and locked.

15. Verify that the lid/shield plug grapple is in disengaged position using the operator interface.

16. Verify that the fuel assembly handling crane is stopped in the parking position using the CCTV monitor.

17. Lower the lid/shield plug grapple to the level of the overlid on the port cover.

    Monitor the operation with the CCTV displays. Monitor the speed, the position and the load of the system using the operator interface.
    The operation is stopped automatically when the cables are unloaded indicating that the grapple is in contact with the overlid.

18. Verify that the operator interface displays the correct Z position of the grapple.

19. Verify that the operator interface displays that the cables are unloaded.

20. Grapple the shield plug.

    The operator interface displays that the shield plug is grappled.

21. Lift the shield plug above the TC port cover.

    Visually monitor the position of the shield plug when it is visible above the mezzanine level. The operation is automatically stopped when the limit position is reached.

22. Verify that the shield plug is above the receiving cask TC port cover using the CCTV and that the correct position is displayed on the operator interface.

23. Switch on the receiving cask TC port cover power.

24. Open the receiving cask TC port cover.

    Monitor the movement of the port cover with the CCTV display. The operation is automatically stopped when the TC port cover reaches the open position.

25. Verify that the receiving cask TC port cover is in open position using the CCTV monitor and the operator interface displays that the cover is in the open position.

26. Lower the shield plug on the receiving cask.

    The operator can use only the slow speed. Visually monitor the movement of the shield plug when it is above the mezzanine plate. Monitor the Z position of the grapple and the cable load with the operator interface when it is underneath the mezzanine level. The operation is automatically stopped when the shield plug is on the TC port cover.

27. Verify that the correct Z position of the grapple is shown on the operator interface.

28. Verify that the operator interface displays that the cables are unloaded.

29. Disengage the grapple.

    The operator interface will display that the grapple is disengaged.

30. Lift the lid/shield plug grapple to an intermediate level.

    The operation does not require accuracy. The operator can use the variable speed. Monitor the grapple position and the cables load using the operator interface. Visually monitor the movement of the grapple when it is above the mezzanine level. The operator stops the movement when there is sufficient clearance beneath the grapple to close the receiving cask TC port cover.

31. Close the receiving cask TC port cover.

    Visually monitor the movement of the port cover. The operation is automatically stopped when the port cover reaches the closed position.

32. Verify that the receiving cask TC port cover is closed using the CCTV monitor and the operator interface.

33. Switch off receiving cask TC port cover power.

34. Lift the lid/shield plug grapple to its upper Z position.

    The operator can use the variable speed. Visually monitor the movement of the grapple when it is underneath the upper plate. The operation is automatically stopped when the grapple reaches its upper Z position.

35. Verify that the operator interface displays the correct Z position of the lid/shield plug grapple.

36. Unlock the receiving cask upper shield port.
    The operator interface displays when this operation is complete.

37. Close the receiving cask upper shield port.

    The operation is automatically stopped when the upper shield port reaches the closed position.

38. Verify that the operator interface displays that the receiving cask upper shield port is closed.

39. Lock the receiving cask upper shield port.

    Verify that the operator interface displays that the receiving cask upper shield port is locked.

5.1.1.7 Source Cask Closing

1. Verify that the operator interface displays that the two upper shield ports are closed and locked.

2. Verify that the operator interface displays that the lid/shield plug grapple is stopped in the upper Z position.

3. Verify that the receiving cask TC port cover is in the closed position using the CCTV monitor.

4. Verify that the source cask TC port cover is in the closed position using the CCTV monitor.

5. Position the upper crane above the source cask.

   The positioning operation is automatically stopped when the upper crane reaches the source cask position.

6. Verify that the operator interface indicates that the upper crane is positioned above the source cask.

7. Verify that the radiation levels in the Roof Enclosure Area are acceptable.

8. Unlock the source cask upper shield port.

   The operator interface displays the unlocked condition.

9. Open the source cask upper shield port.

   The operation is automatically stopped when the upper shield port is in open position.

10. Lock the source cask upper shield port.

    The operator interface displays when this operation is complete.

11. Verify using the operator interface that the source cask upper shield port cover is open and locked.

12. Verify that the operator interface displays that the lid/shield plug grapple is disengaged.

13. Lower the lid/shield plug grapple to the level of the lid on the port cover.

    Monitor the operation using the CCTV displays.
    Monitor the speed, the position and the load of the system with the operator interface.
    The operation is stopped automatically when the cables are unloaded indicating that the grapple is in contact with the overlid.

14. Verify that the correct Z position of the grapple is displayed on the operator interface.

15. Verify that the operator interface displays that the cables are unloaded.

16. Grapple the source cask lid.

The operator interface displays that the grapple is closed.

17. Lift the source cask lid above the TC port cover.

    Monitor the position of the source cask lid when it is above the mezzanine level using the CCTV monitor. The operation is automatically stopped when the limit position is reached.

18. Verify that the source cask lid is above the source cask TC port cover using the CCTV monitor and the operator interface.

19. Switch on the receiving cask TC port cover power.

20. Open the source cask TC port cover.

    Monitor the movement of the port cover using the CCTV display. The operation is automatically stopped when the TC port cover reaches the open position.

21. Verify that the source cask TC port cover is in the open position using the CCTV monitor and the operator interface.

22. Lower the source cask lid onto the source cask.

    The operator can only use the slow speed. Visually monitor the movement of the lid when it is above the mezzanine plate. Monitor the Z position of the grapple and the cable load with the operator interface when it is underneath the mezzanine level. The operation is automatically stopped when the lid is on the TC port cover.

23. Verify that the operator interface displays the correct Z position of the grapple.

24. Verify that the operator interface displays that the cables are unloaded.

25. Disengage the grapple.

    The grapple status is displayed by the operator interface.

26. Lift the lid/shield plug grapple to an intermediate level.

    The operation does not require accuracy. The operator can use the variable speed. Monitor the grapple position and the cable load using the operator interface. Visually monitor the movement of the grapple when it is above the mezzanine level. The operator stops the movement when there is sufficient clearance below the grapple to close the TC port cover.

27. Close the source cask TC port cover.

    Visually monitor the movement of the port cover. The operation is automatically stopped when the port cover reaches the closed position.

28. Verify that the source cask TC port cover is closed using the CCTV monitor and the operator interface.

29. Switch off source cask TC port cover power.

30. Lift the lid/shield plug grapple to its upper Z position.

    The operator can use the variable speed. Monitor visually the movement of the grapple when it is underneath the roof plate. The operation is automatically stopped when the grapple reaches its upper Z position.

31. Verify that the correct Z position of the lid/shield plug grapple is displayed on the operator interface.

31. Unlock the source cask upper shield port.

    The operator interface displays when this operation is complete.

33. Close the source cask upper shield port.

    The operation is automatically stopped when the upper shield port reaches the closed position.

34. Verify the closed position of the upper shield port using the operator interface.

35. Lock the source cask upper shield port.

    The locked condition is displayed on the operator interface.

36. Switch off Source Cask Lid / Receiving Cask Shield Plug Handling Subsystem power.

5.1.1.8 Source Cask Detachment and Removal

Source Cask Detachment

1. Verify using the CCTV that the two TC port covers are in the closed position.

2. Verify using the CCTV that the source and receiving casks are closed.

3. Verify using the operator interface that the sliding door is locked.

4. Disengage the source cask from the Transfer Confinement Area as follows:

- Switch on Source Cask Mating Subsystem power.
- Lift the source cask mating flange. Monitor the operation with a CCTV display. A unique push button is used to lift the three electric jacks. The operator can monitor the height of the electrical jacks. The operator stops the motion when desired according to monitoring information.
- Switch off Source Cask Mating Subsystem power.

Source Cask Removal from the Lower Access Area

1. Check the radiation level in the Lower Access Area to ensure that the casks are closed.

2. Unlock manually and raise the sliding panels on the sliding door.

3. Open the sliding door.

4. Position the source cask in the preparation location as follows:

- Activate the Lower Access Area control panel.
- Switch on Source Cask Transfer Subsystem power.
- Unlock the source cask transfer trolley.
- Transfer the trolley using the fast speed until roughly 6 feet (2 m) from the preparation location.
- End the movement using the slow speed. The source cask transfer trolley is automatically stopped in its preparation location.
- Visually check the proper positioning of the source cask transfer trolley.
- Lock the source cask transfer trolley in the preparation position.
- Switch off Source Cask Transfer Subsystem power.
- Deactivate the Lower Access Area control panel.

5. Close the sliding door.

6. Lock the sliding door manually and lower the sliding panels on the sliding door.

Source Cask Preparation for Removal

1. Decontaminate source cask using damp cloths.

2. Check surface dose rates.

3. Disengage lid lifting pintle.

4. Bolt and verify bolt torque on source cask lid.

5. Verify surface dose rates are acceptable.

Source Cask Removal From the Preparation Area

1. Open the rolling door.

2. Position the source cask transfer trolley in the loading/unloading area as follows:

   - Activate the Preparation Area control panel.
   - Unlock the source cask transfer trolley.
   - Move the source cask transfer trolley using the fast speed until roughly 6 feet (2 m) from the loading/unloading area.
   - End the positioning operation using the slow speed.
   - Visually check the proper positioning of the transfer trolley.
   - Deactivate the Preparation Area control panel.

3. Close the rolling door.

4. Unfasten source cask from the trolley.

5. Remove the source cask from the trolley.

5.1.1.9 Receiving Cask Detachment and Removal

Receiving Cask Detachment

1. Verify that the source cask is removed from the DTS.

2. Visually check the locked position of the sliding door.

3. Disengage the receiving cask from the Transfer Confinement Area.

   - Switch on Receiving Cask Mating Subsystem power.
   - Lift the receiving cask mating flange. Monitor the operation with a CCTV display. A unique push button is used to lift the three electric jacks. The operator can monitor the electrical jacks height information. The operator stops the motion when desired according to monitoring information.
   - Switch off Receiving Cask Mating Subsystem power.

Receiving Cask Removal from the Lower Access Area

1. Check the radiation level in the Lower Access Area to ensure that the sliding door can be opened safely.

2. Unlock the sliding door manually and raise the sliding panels on the sliding door.

3. Open the sliding door.

4. Position the receiving cask in the preparation location as follows:

   - Activate the Lower Access Area control panel.
   - Switch on Receiving Cask Transfer Subsystem power.
   - Unlock the receiving cask transfer trolley.
   - Transfer the trolley using the fast speed until roughly distant from 6 feet (2 m) to the preparation location.
   - End the movement using the slow speed. The receiving cask transfer trolley is automatically stopped in its preparation location.
   - Visually check the proper positioning of the receiving cask transfer trolley.
   - Lock the receiving cask transfer trolley in the preparation position.
   - Switch off Receiving Cask Transfer Subsystem power.
   - Deactivate the Lower Access Area control panel.

5. Close the sliding door.

Receiving Cask Preparation for Removal

1. Decontaminate receiving cask using damp cloths.

2. Survey receiving cask surface dose rates.

3. Disengage shield plug lifting pintle.

4. Place inner lid on receiving cask canister.

5. Install annulus welding protection.

6. Install remote welding equipment.

7. Weld the canister inner lid following approved procedures in compliance with receiving cask topical report.

8. Perform NDE on weld following approved procedures in compliance with receiving cask topical report.

9. Remove welding equipment.

10. Install inerting and drying equipment.

11. Dry and Inert receiving cask following approved procedures in compliance with receiving cask topical report.

12. Remove Drying and inerting equipment.

13. Perform a leak test of the seal weld following approved procedures in compliance with receiving cask topical report.

14. Weld valve cover plates in accordance with approved procedures in compliance with receiving cask topical report.

15. Install canister outer lid.

16. Set up remote welding equipment.

17. Weld receiving cask outer lid following approved procedures in compliance with receiving cask topical report.

18. Perform NDT on welds following approved procedures in compliance with receiving cask topical report.

19. Remove weld equipment.

20. Remove annulus weld protection.

21. Install receiving cask overpack lid.

22. Perform HP survey.

23. Bolt and torque receiving cask lid following approved procedures in compliance with receiving cask topical report.

Receiving Cask Removal from the Preparation Area

1. Verify that the source cask transfer trolley is out of the building at the far end of the rails.

2. Open the rolling door.

3. Position the receiving cask transfer trolley in the attachment location as follows:

   - Activate the Preparation Area control panel.
   - Unlock the receiving cask transfer trolley.
   - Move the receiving cask transfer trolley using the fast speed until roughly 6 feet (2 m) from the attachment location.

- End the positioning operation using the slow speed.
- Verify the proper positioning of the transfer trolley with respect to the unloading vehicle (rail car or heavy haul trailer).
- Deactivate the Preparation Area control panel.

4. Close the rolling door.

5. Unfasten the receiving cask from the trolley.

6. Remove receiving cask from the trolley.

5.1.1.10 Ancillary Activities

Radiation monitoring is performed continually within the DTS. The radiation monitoring functions are fully described in Chapter 7.

The HVAC system is fully described in Section 4.3. The HVAC System monitors interior temperatures to ensure that pressure differentials are maintained and to ensure that the DTS is operated at safe temperatures.

Periodic examinations for structural deterioration, foundation soundness and security of contents will be performed, and addressed in the site specific applications.

Waste handling is described in Chapter 6.

The main interfaces, related to safety, between the different DTS subsystems, are those involving the mechanical equipment, the Radiation Monitoring Subsystem and the HVAC Subsystem.

All these interfaces are managed by the Control Subsystem which prevents any unsafe operation which could result in an abnormal exposure for the workers (Radiation Monitoring and mechanical equipment interface), in a release of contaminated particles (HVAC and mechanical equipment interface) or in any compromise of the recovery requirements (mechanical equipment interface). These interfaces are described in subsequent sections of this Topical Report.

5.1.2 Flowsheets

The following flow charts describe the DTS operating sequence. The flow charts describe the logic of the transfer process. The operating sequence is broken into 13 macro-operations. The flow chart of macro-operations is provided in Figure 5.1-1. The anticipated time to perform each operation is also listed.

Each macro-operation is further broken into operations as shown in Figures 5.1-2 through 5.2-8. The operations are further broken down into a sequence of controls which is detailed in Appendix 5A.

The time estimates presented in Figures 5.1-1 through 5.1-7 were calculated using the design operating speeds of the equipment and the distances that the equipment must move. The operating speeds and the distances moved for the various pieces of equipment appear in Section 5.2, and are summarized below.

Equipment	Speed	Distance
Receiving Cask Transfer System	Slow 0.7 ft/min	3.5 ft
	Fast 10.0 ft/min	30 ft
Source Cask Transfer System	Slow 0.7 ft/min	3.5 ft
	Fast 10.0 ft/min	18 ft
Annular Platform (Bellows)	2 ft/min	1 ft
TC Port Covers	3 ft/min	6.6 ft
Upper Shield Port Covers	3 ft/min	2.8 ft
Upper Crane Trolley	3.3 ft/min	Varies
Upper Crane Hoist	1 ft/min to 16.4 ft/min	Varies
Fuel Assembly Bridge	0.33 ft/min to 26 ft/min	Varies
Fuel Assembly Trolley	0.33 ft/min to 20 ft/min	Varies
Rotate Platform	180 degrees/min	Varies
Fuel Hoist	0.33 ft/min to 16 ft/min	Varies

For the transfer trolleys and the port covers, operation time was calculated by dividing the distance to be moved by the speed. The bridge, trolley, and the hoist speeds are variable, and their operating speeds are determined (by the operator) by using a joy-stick. Operating times for these pieces of equipment were calculated using the distance that must be traveled and estimated average operating speeds, consistent with the equipment design, that the operator is expected to achieve. Times for grappling and ungrappling are best estimates. Testing of the demonstration system at INEEL has confirmed that the DTS can transfer a fuel assembly from the source to receiving cask in 30 minutes.

Performance of the DTS operating sequence and the macro-operations are controlled by administrative procedure.

5.1.3 Identification of Subjects for Safety Analysis

5.1.3.1 Criticality Prevention

Both the source cask and the receiving cask contain fuel baskets which have been designed to provide for criticality safety. The fuel baskets may contain both neutron poison material and flux traps to control reactivity of the fuel/basket configuration. It is assumed that criticality evaluations have been performed for both the source cask and the receiving casks through a separate licensing process(es). In these evaluations, it is further assumed that the casks are evaluated in a wet, flooded condition with optimum moderation (fresh water). This system is a dry transfer system which has only a single fuel assembly out of a cask at any one time. There are no specific methods utilized or necessary for criticality control in the Transfer System Installation because there are no conditions that could exist within the installation that are not bounded by the criticality licensing evaluations performed for the casks.

5.1.3.2 Chemical Safety

No chemicals which could give rise to a hazard are required for the function of the DTS.

5.1.3.3 Operational Shutdown Modes

The DTS can be shut down for extended or short-term periods or in the event of an emergency, such as a tornado warning. Moveable equipment associated with the DTS will not be affected by anticipated dynamic loading events since the concrete DTS structure has been designed to withstand loads due to heavy winds and snow storms. The moveable equipment will not be required to be "parked" in a designated position during any of these occasions.

All of the moveable equipment has been designed to withstand maximum loads on the system for the worst case locations of the equipment during a seismic event. In the event of an unexpected dynamic event, the entire system will be safe in any position. During non-operation times the moveable equipment will be positioned as follows:

1. The cask transfer trolleys will be locked in their respective park positions in the preparation area.
2. The cask mating subsystem will be in the raised position.
3. Both the TC port covers and the upper shield port covers will be positioned in the closed positions.
4. The shield plug/lid crane will be positioned over either the source or receiving cask with the grapple in the up position.
5. The fuel transfer crane bridge will be positioned centrally between the source and receiving cask TC port covers, the trolley will be positioned at the end of travel opposite the port openings, the rotating platform will be positioned with the hoist drums perpendicular to the trolley truck and the grapple will be fully up.

The DTS may be shut down for extended periods of time for maintenance or when there is no fuel to transfer. All fuel will be moved into the receiving cask. The normal sequence of operations will be followed until all fuel is transferred into the receiving cask, and both casks are moved out of the DTS. The time required to complete the total operating sequence is approximately ten 24 hour days. The majority of this time is required to weld the receiving cask canister lids in place. Details of the time required to perform DTS operations is provided in Table 7.4-1.

After an extended shut down, the DTS will be fully operationally tested.

The DTS may be shut down for short-term periods for repairs, equipment replacement, etc. If the repair is performed in the Preparation Area, and will take a significant period of time, the loaded casks should be moved into the Lower Access Area to minimize worker radiation exposure. If the repair must be performed in the Lower Access Area or the TCA, the casks must be closed, and moved into the Preparation Area. This requires approximately 1 hour to complete the fuel transfer operation, and one hour to install the source cask lid and receiving cask shield plug. It takes another 2 hours to remove the casks from the Lower Access Area.

Prior to entry into the Lower Access Area or the TCA for maintenance, the areas would be checked for contamination and decontaminated as necessary. Start up would occur after operational testing of the faulty equipment.

In the event of an emergency or a tornado watch, the DTS would be put into a temporary shut down condition. This would entail completing the fuel transfer of the assembly currently in transfer, installing the source cask lid and the receiving cask shield plug and closing the TC port covers and upper shield port covers. These operations take approximately 2 hours.

To start up, the cask can simply be reopened and operations be restarted.

5.1.3.4 Instrumentation

Process instrumentation and controls throughout the DTS allow the control and monitoring of the following:

- Mechanical equipment including the Cask Transfer Subsystem; the Cask Mating Subsystem; the TC Port Shield Subsystem; the MPC Shield Plug and Source Cask Lid Handling Subsystem; and the Fuel Assembly Handling Subsystem.
- The HVAC Subsystem equipment.
- The Radiation Monitoring Subsystem.

The control and monitoring of DTS mechanical equipment and HVAC Subsystem equipment is described in Section 5.2.

The control and monitoring of the Radiation Monitoring Subsystem is described in this section.

The Radiation Monitoring Subsystem includes permanently mounted area radiation detectors in the Preparation Area, in the Lower Access Area, in the Transfer Confinement Area, in the Roof Enclosure Area, and in the HVAC Subsystem.

The Radiation Monitoring Subsystem has displays at the detector location, the Preparation Area and the Control Center. Audible and visible alarms for high radiation levels, low radiation/low battery, and detector failure are also at the detector location, the Preparation Area and the Control Center.

The Radiation Monitoring Subsystem is interlocked with the sliding door. Once fuel transfer begins, the area radiation monitor within the Lower Access Area will be interlocked with the sliding door preventing the door from being opened until the radiation levels inside the Lower Access Area have fallen below a given set point. This is to prevent inadvertent access to the Lower Access Area during fuel transfer.

The roof enclosure radiation monitor is interlocked with the upper shield ports to prevent their opening in the presence of high radiation levels.

The DTS has installed radiation monitoring equipment which continuously monitors and displays the radiation dose rates. This avoids the need to have personnel routinely entering areas to obtain the data manually. This also allows the monitoring of radiation level changes throughout operations and permits prompt personnel action if alarm situations occur.

The following features are included in the system:

- Display at each detector location and remote display at the Preparation Area and the Control Center;
- Warning for Low Level Detection;
- Alarms for High Level Detection, Detector Failure, and Low Battery;
- Audible and visible alarms at each detector, the Preparation Area, and the Control Center;
- Battery backup of monitoring equipment;
- Remotely operated check source; and
- Associated electronic equipment and cabling.

The selected equipment has readout capability at the highest anticipated radiation levels and positive readout at lowest radiation levels.

Area gamma radiation monitors are mounted at several fixed locations within the DTS. The monitors are located in areas where personnel will be for periods of time during transfer operations and maintenance operations. Neutron measurements will be taken using portable instrumentation as necessary.

Two detectors are mounted in the Preparation Area, one detector is mounted in the Lower Access Area, one is mounted in the Transfer Confinement Area, one is in the Roof Enclosure Area and one is on the exhaust stack off the DTS.

To support maintenance of the detector, each is mounted at a height of 5 feet (1.5 m) from the flooring. A list of the installed radiation monitors, their locations, and effective range is presented in Table 5.1-1. The lower end range is such that the radiation levels below this point are not significant. The upper end range is above the anticipated radiation levels in the area.

The exhaust stack is equipped with a continuous air monitor. This monitor is configured to allow the electronics to be mounted remotely from the sampling/detection system. The stack monitor collects and monitors airborne particulate, iodine and noble gases.

The sample stream will be drawn from the stack using an isokinetic probe. A pump/motor assembly is present to draw the sample and produce a flow through the monitor. A rotary vane pump with a 3/4 hp (0.56 kW) motor provides a flow rate of up to 4 CFM. One inch inlet and outlet sample lines are used. A mass flow transducer with a controller integral to the monitor is used to regulate the flow.

Once the sample is drawn, particulate is collected on filter paper with a collection efficiency of 99% for particles 0.3 micron and larger. After passing through the filter paper, the sample stream is passed through the iodine and noble gas detectors.

After the sample has passed through the detectors, it is returned the exhaust stack down stream of the sample inlet point.

Table 5.1-1

Locations of Area Radiation Monitors within the DTS

Detector Location	Range
Preparation Area, Monitor #1	0.1-10,000 mrem/hr (0.001-100 mSv)
Preparation Area, Monitor #2	0.1-10,000 mrem/hr (0.001-100 mSv)
Lower Access Area	0.1-10,000 mrem/hr (0.001-100 mSv)
Transfer Confinement Area	1-100,000 mrem/hr (0.01-1,000 mSv)
Roof Enclosure Area	0.1-10,000 mrem/hr (0.001-100 mSv)
Exhaust (HEPA Filters) Stack	1-100,000 mrem/hr (0.01-1,000 mSv)

The outputs are sent through a microprocessor to the Control Center and the Preparation Area. Audible and visible alarms will be present at both the Preparation Area and the Control Center.

5.1.3.5 Maintenance Techniques

Maintenance operations are carried out on the equipment when the fuel and casks are removed from the DTS. In the TCA, maintenance operations are generally limited to change out of equipment, and minor repairs. The TCA is accessed through the Lower Access Area by way of the cask openings. Scaffolding will be available for ease of entry.

In the Lower Access Area, filter change out and maintenance on the Cask Mating Systems will be performed. Filter change out and cask mating system change out will be performed using conventional "bagging" techniques.

Upper crane and upper shield port covers will be maintained on contact in the Roof Enclosure Area. A sealed door is provided for maintenance activities in this area. Maintenance activities will not be performed in this area when fuel is being transferred or while either the source or receiving cask is open.

Maintenance on the cask trolleys and lid welding equipment will be performed in the Preparation Area when the casks are removed from the area.

Items requiring substantial maintenance or refurbishment or which are heavily contaminated will be serviced in the on-site reactor facilities.

The spare parts and component list will be provided in the site specific application.

5.1.3.6 Fuel Damage

To prevent damage to the fuel assemblies during transfer operations, the site specific application will determine the load limit during fuel assembly lifting. The limit will be based on the load carrying capacity of the fuel assembly guide tubes, taking into account the effects of service in the reactor.

Figure 5.1-1

DTS Operating Sequence
Flow Chart of Macro-Operations

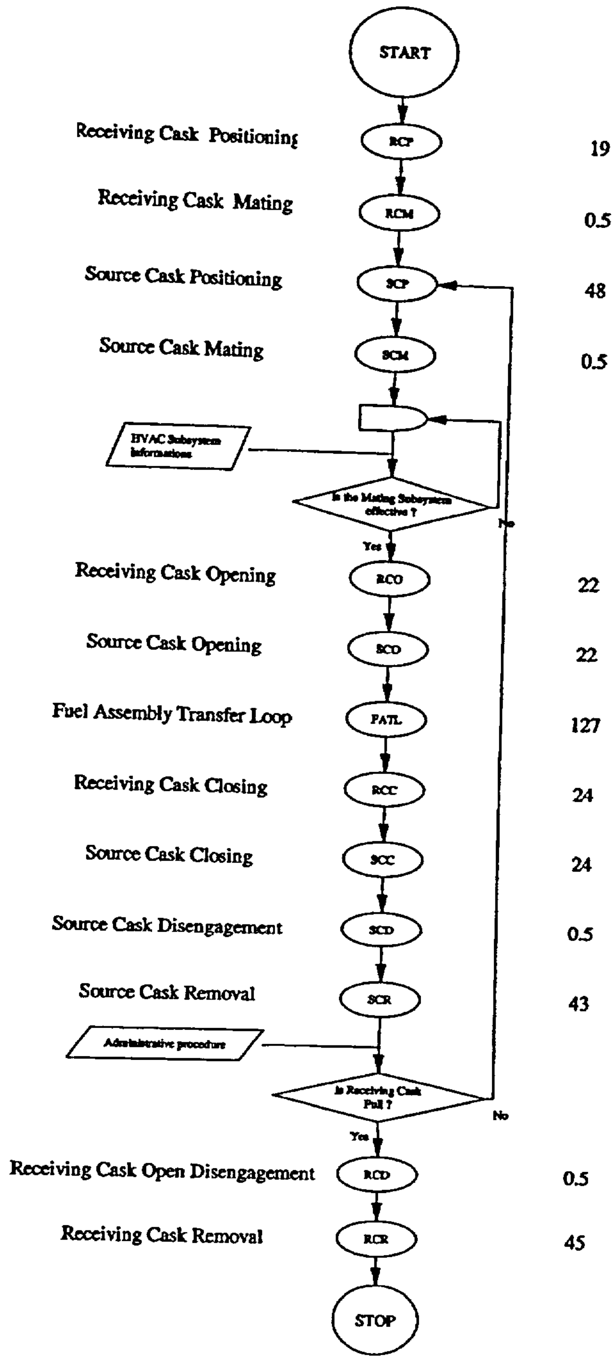


Figure 5.1-2

Positioning of Source and Receiving Casks Macro-Operation Flow Chart of Operations

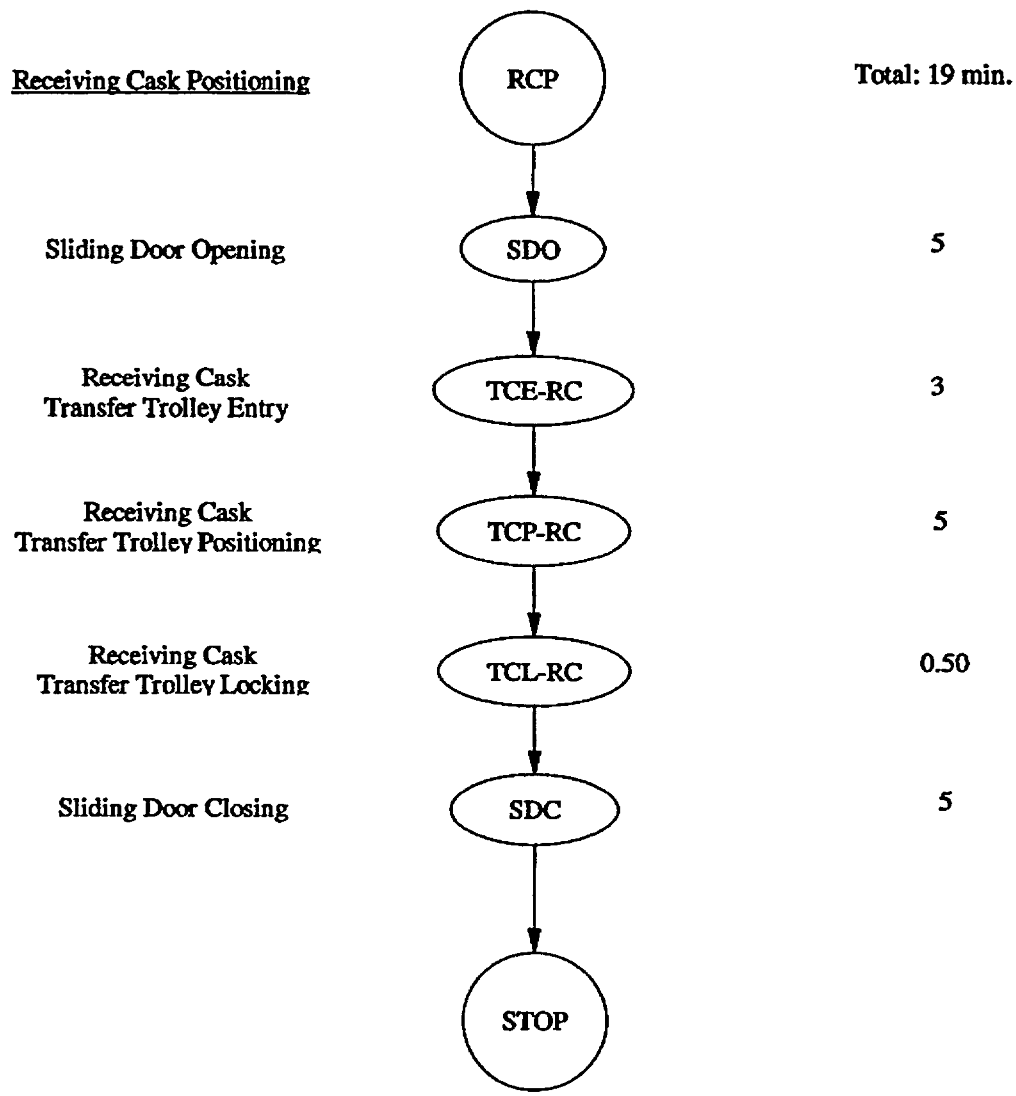


Figure 5.1-2 (Continued)

Positioning of Source and Receiving Casks Macro-Operation

Flow Chart of Operations

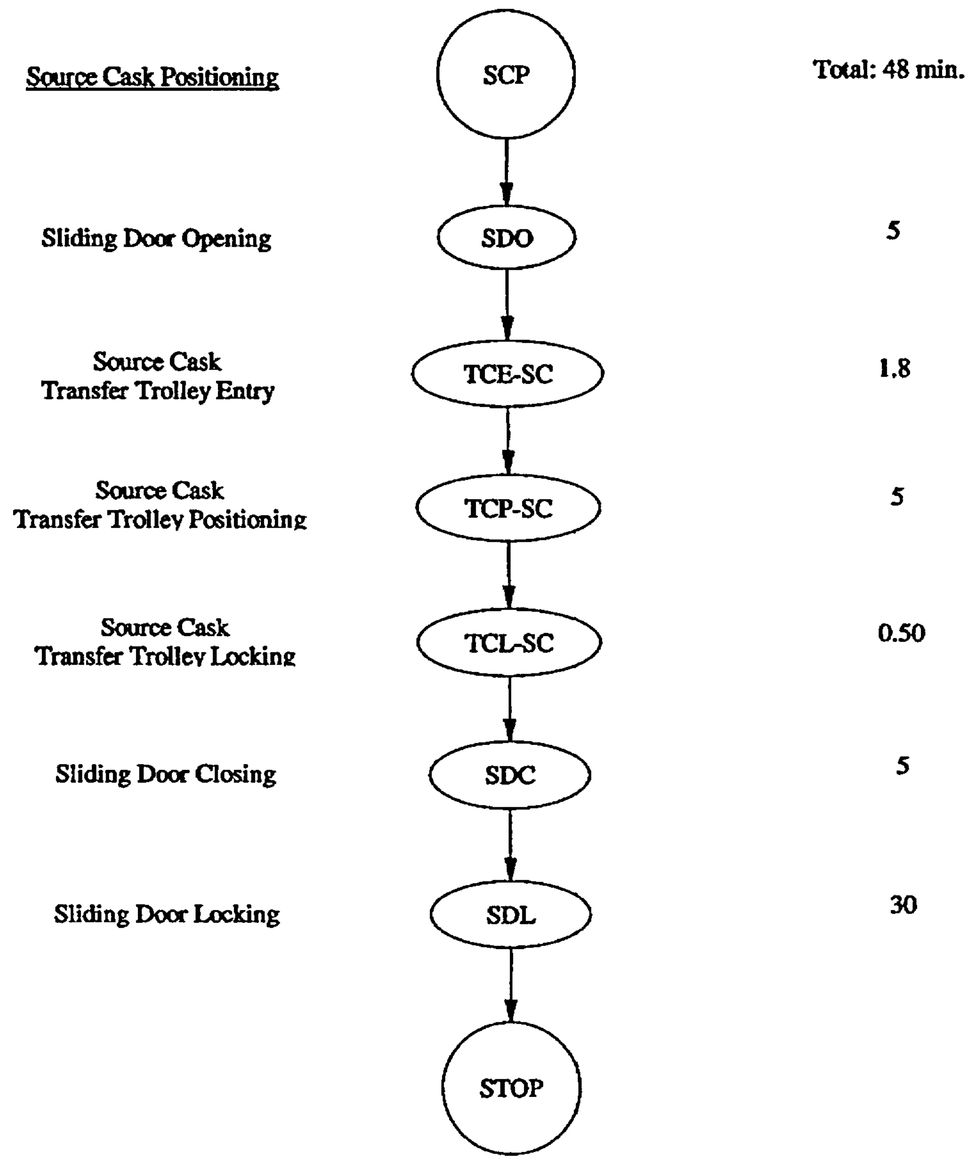


Figure 5.1-3

Opening of Source and Receiving Casks Macro-Operation
Flow Chart of Operations

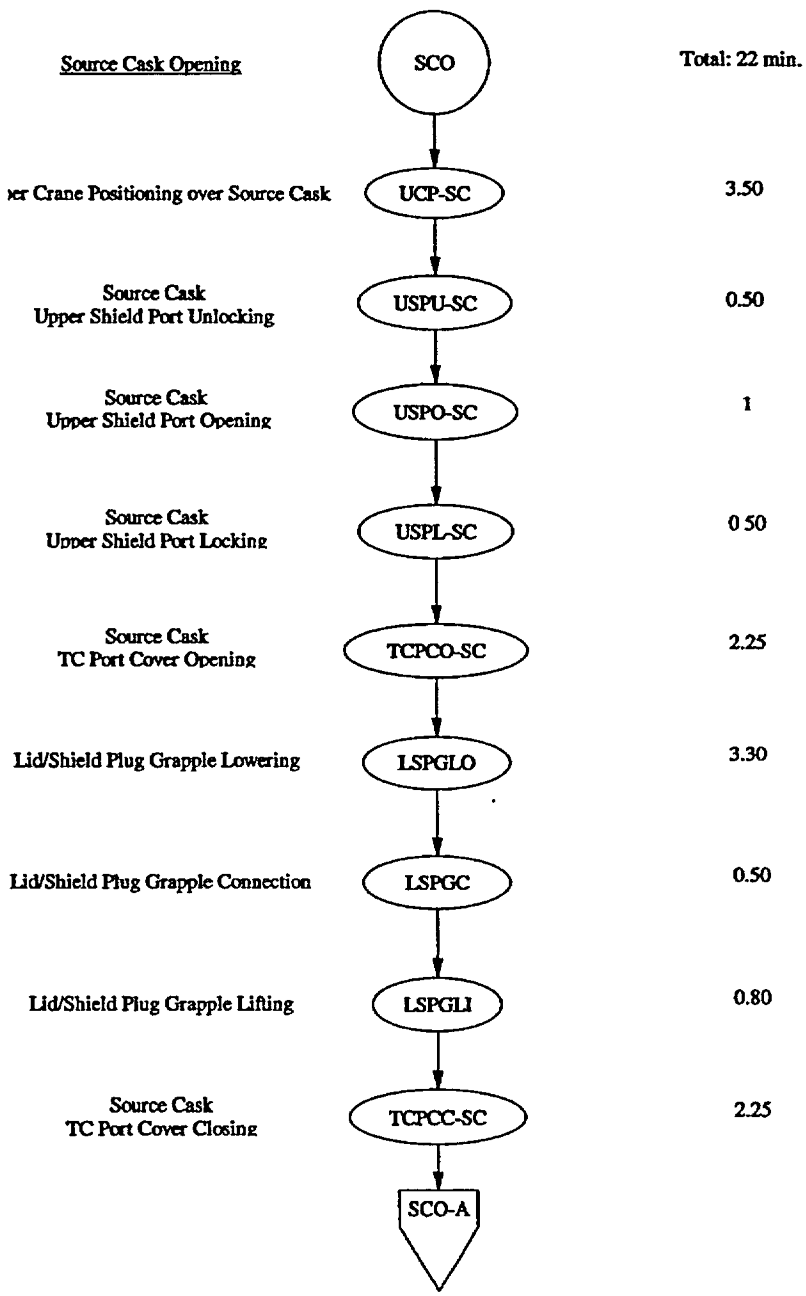


Figure 5.1-3 (Continued)

Opening of Source and Receiving Casks Macro-Operation
Flow Chart of Operations

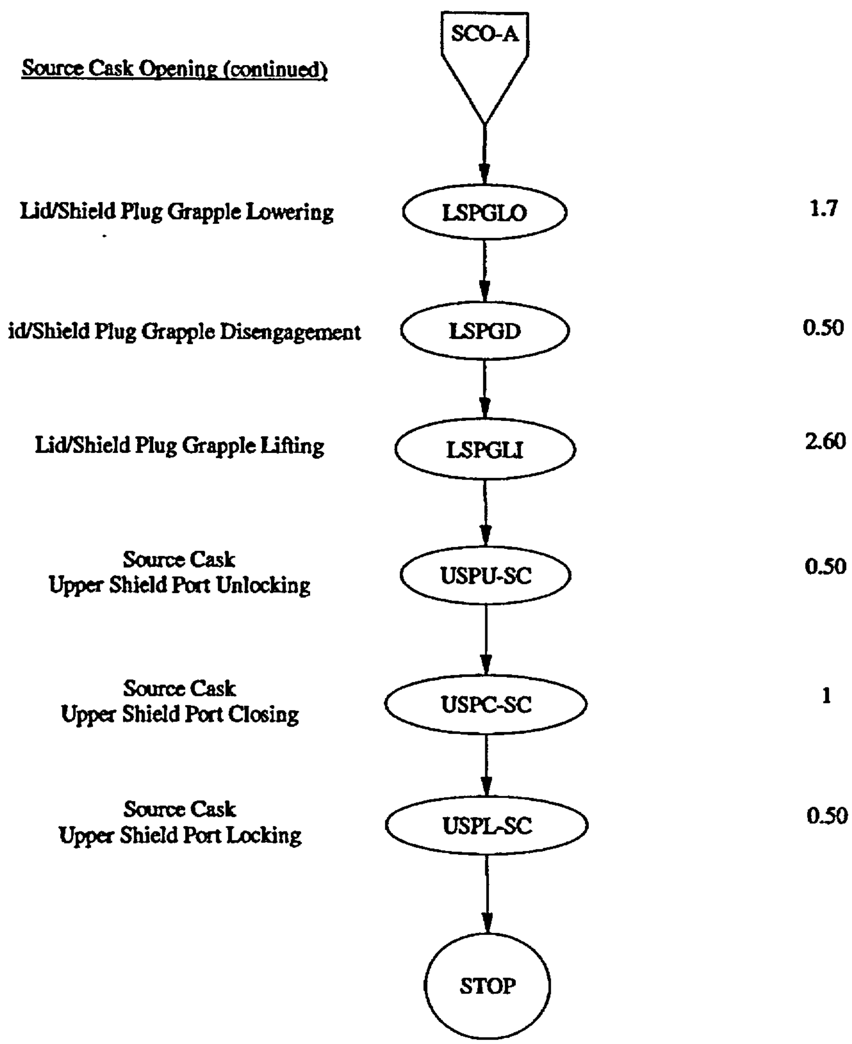


Figure 5.1-3 (Continued)

Opening of Source and Receiving Casks Macro-Operation Flow Chart of Operations

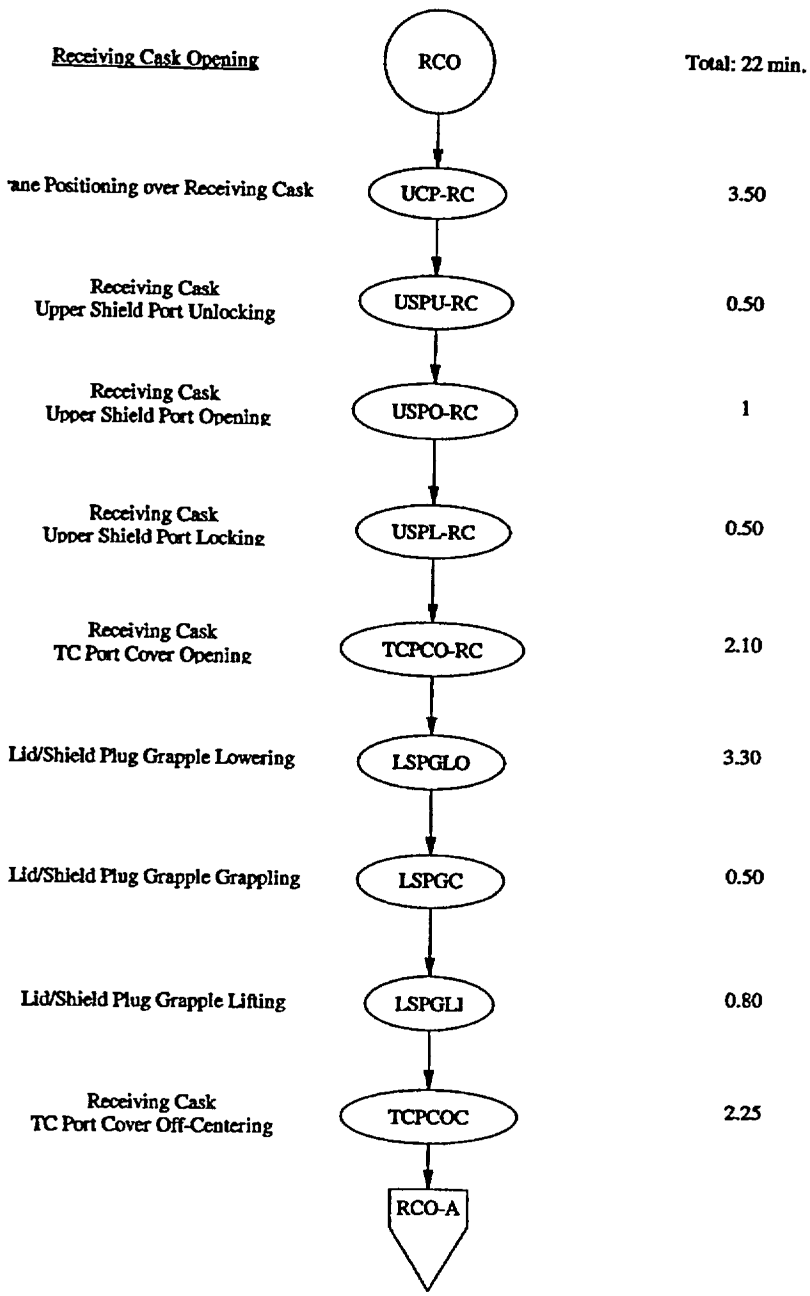


Figure 5.1-3 (Continued)

Opening of Source and Receiving Casks Macro-Operation Flow Chart of Operations

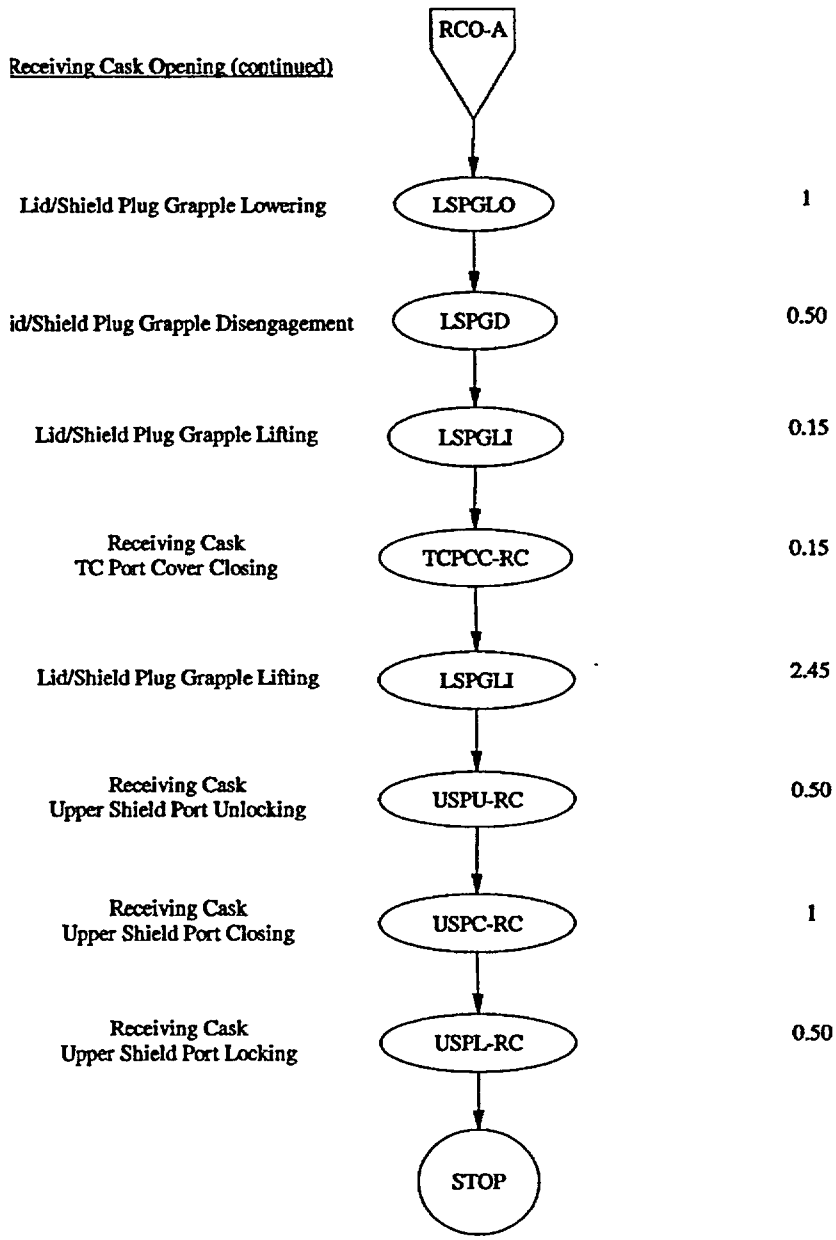


Figure 5.1-4

**Fuel Assembly Transfer Loop Macro-Operation
Flow Chart of Operations**

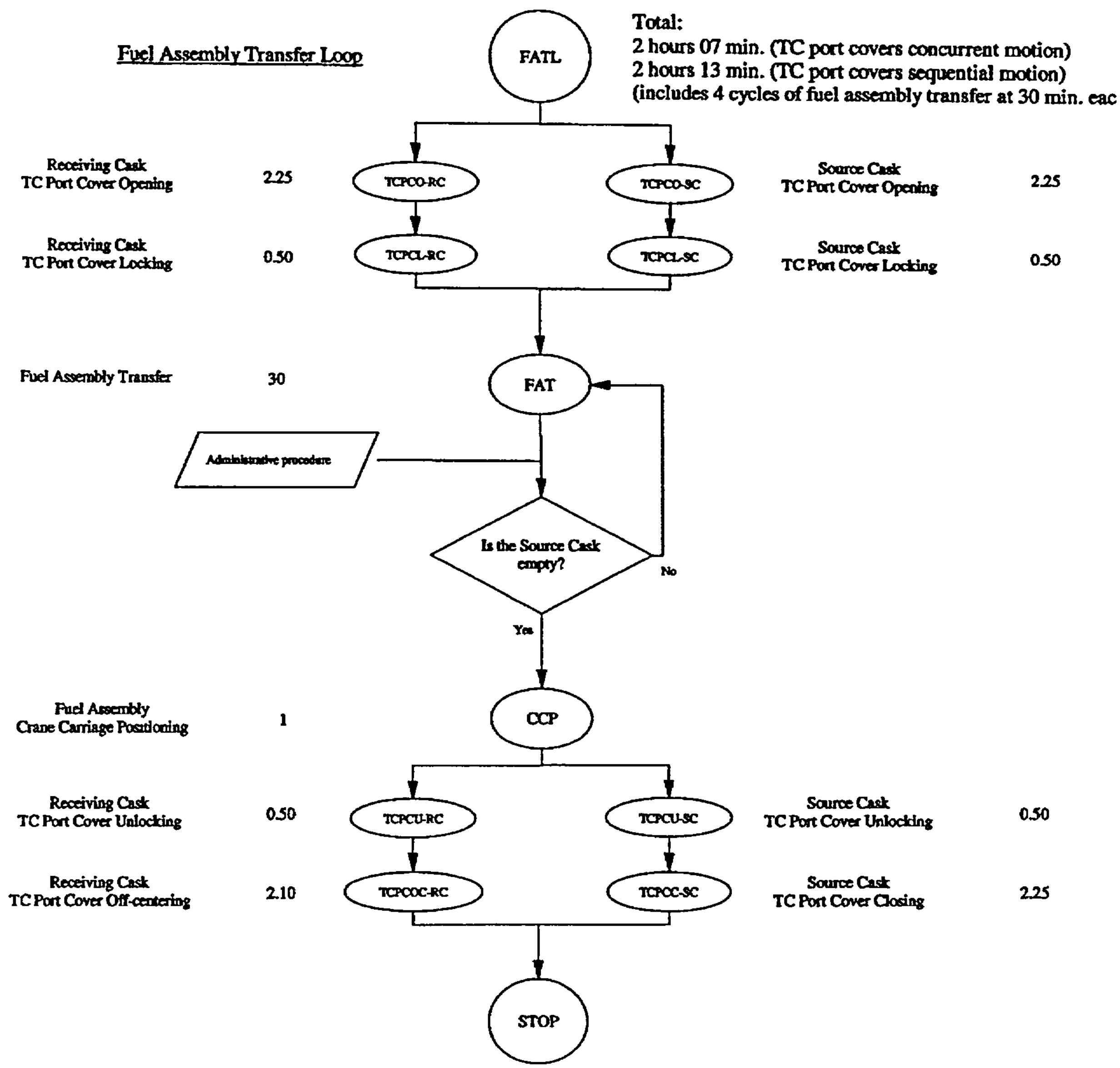


Figure 5.1-5

Fuel Assembly Transfer Macro-Operation Flow Chart of Operations

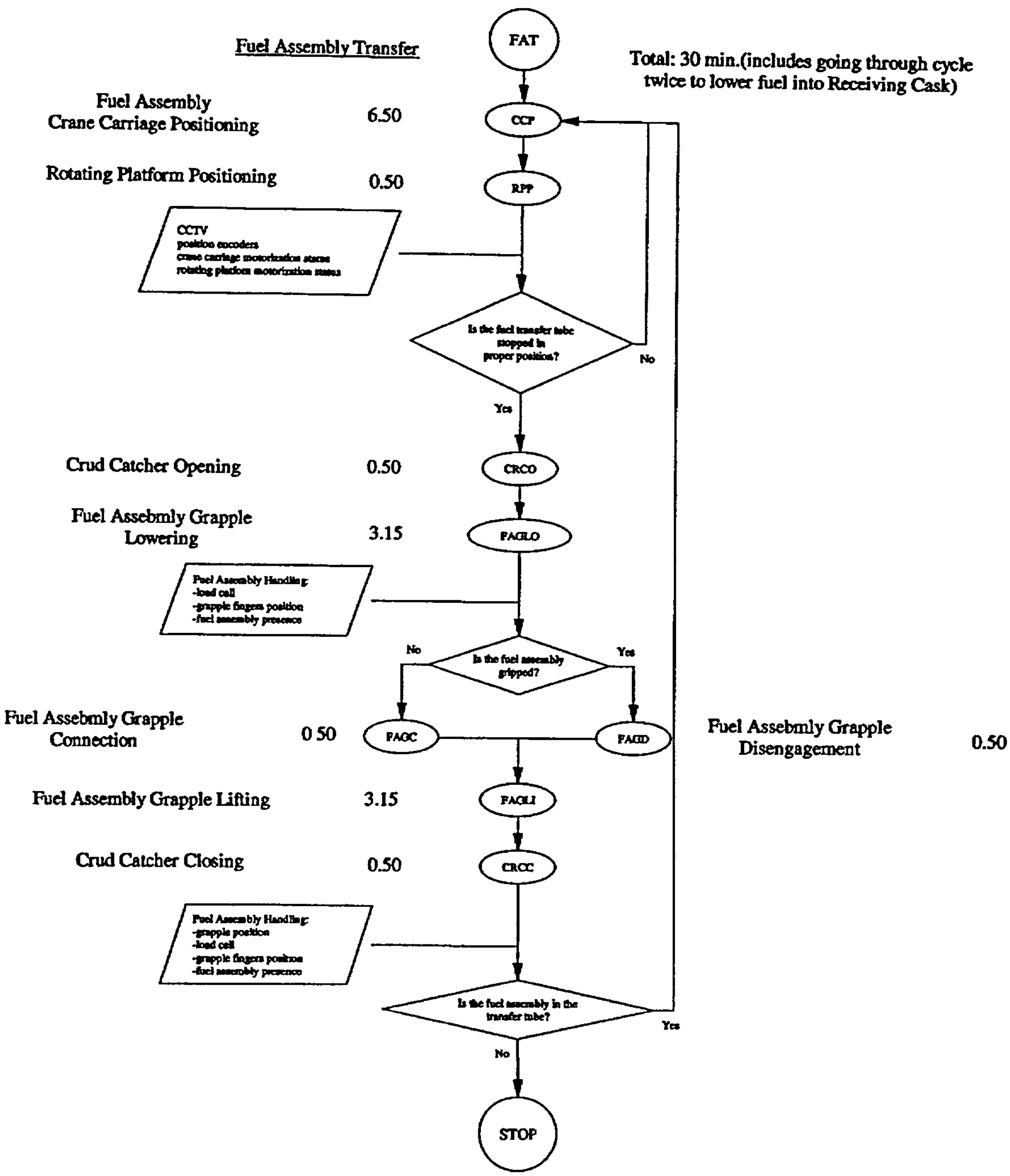


Figure 5.1-6

Closing of Source and Receiving Casks Macro-Operation
Flow Chart of Operations

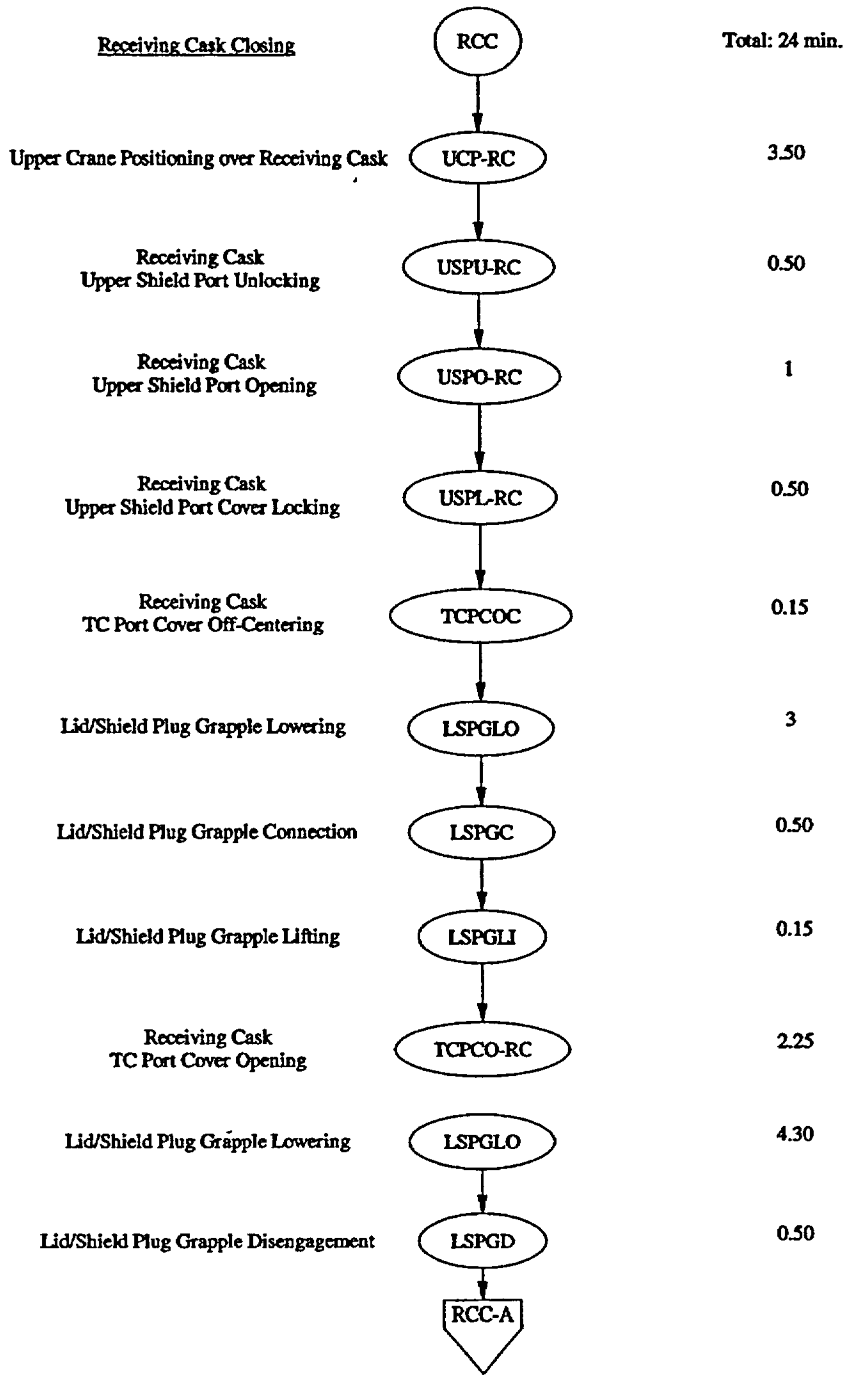


Figure 5.1-6 (Continued)

Closing of Source and Receiving Casks Macro-Operation Flow Chart of Operations

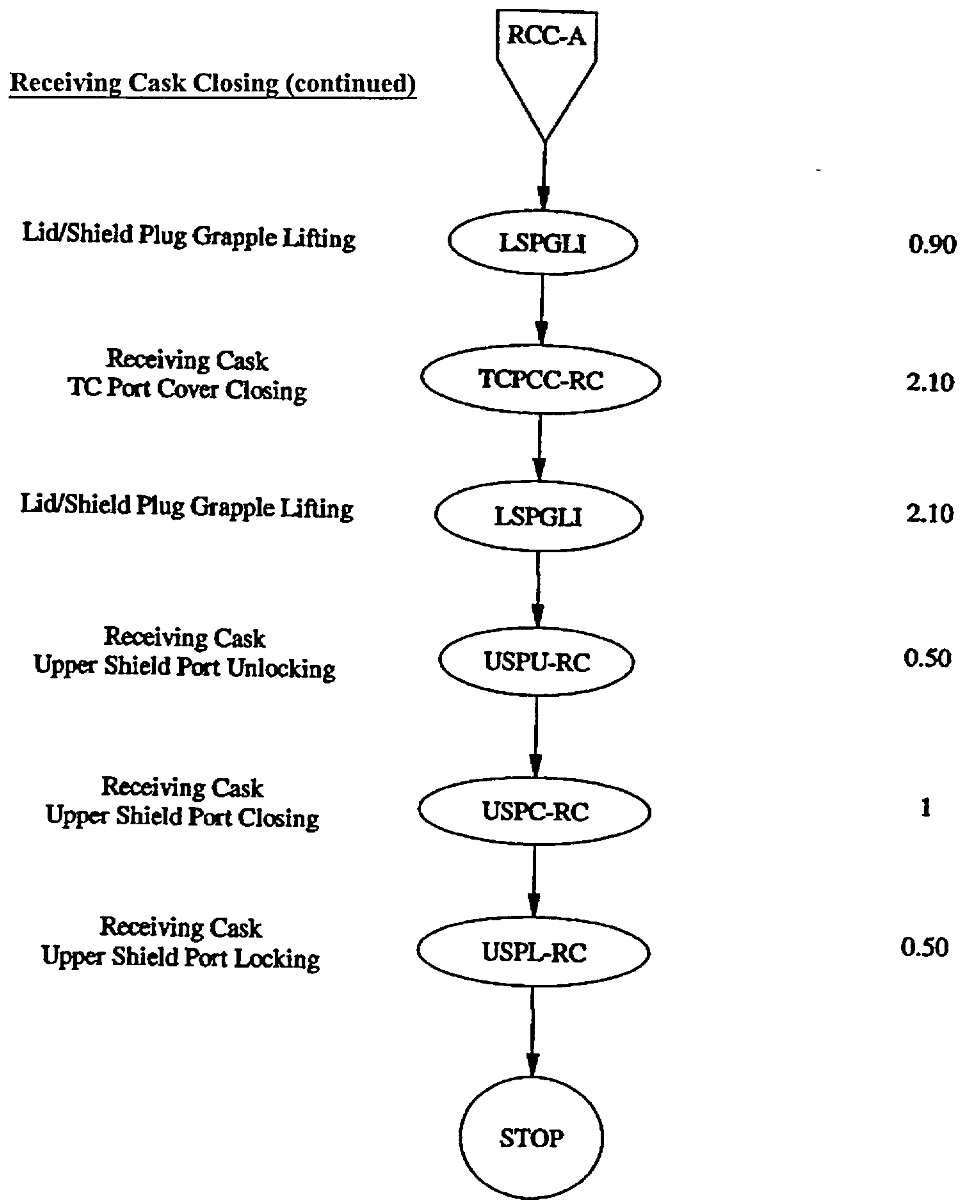


Figure 5.1-7

**Removal of Source and Receiving Casks Macro-Operation
Flow Chart of Operations**

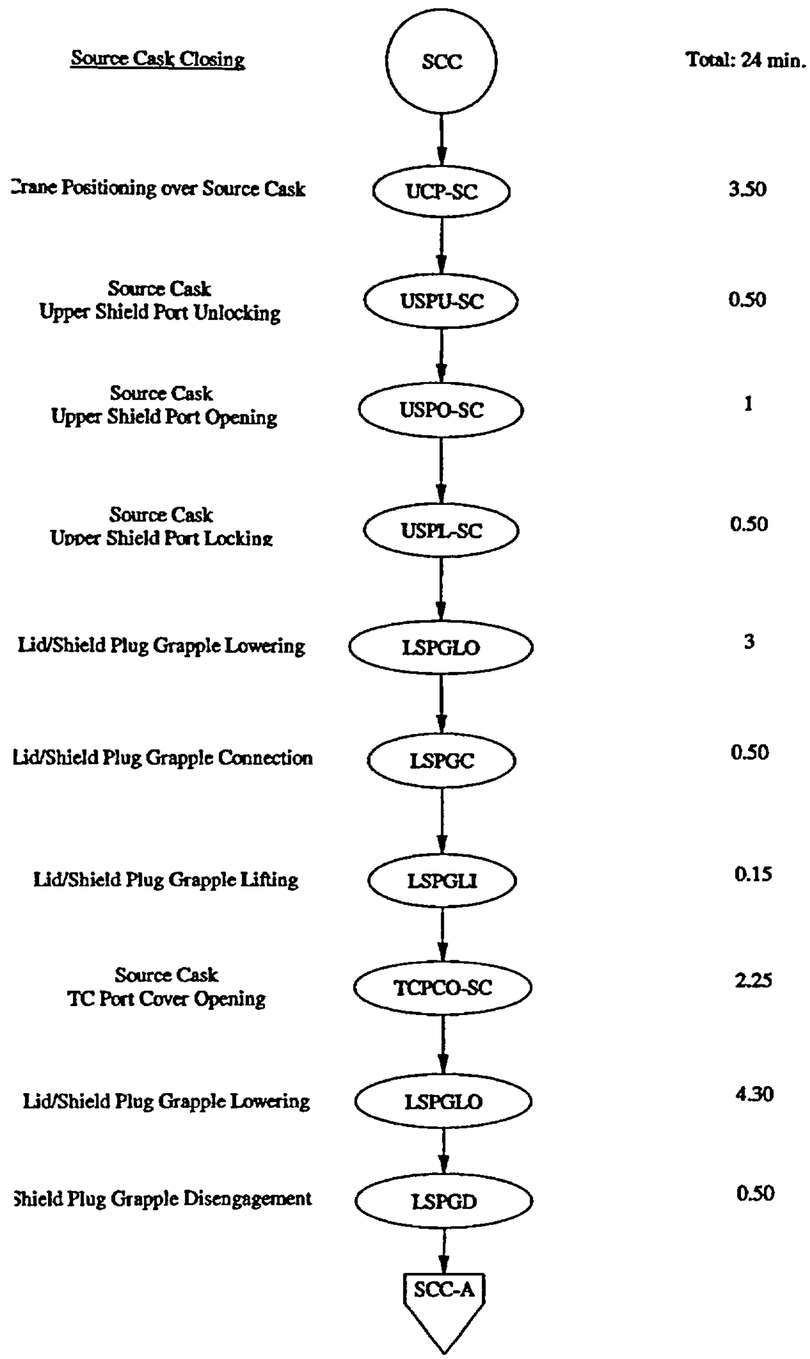


Figure 5.1-7 (Continued)

Removal of Source and Receiving Casks Macro-Operation
Flow Chart of Operations

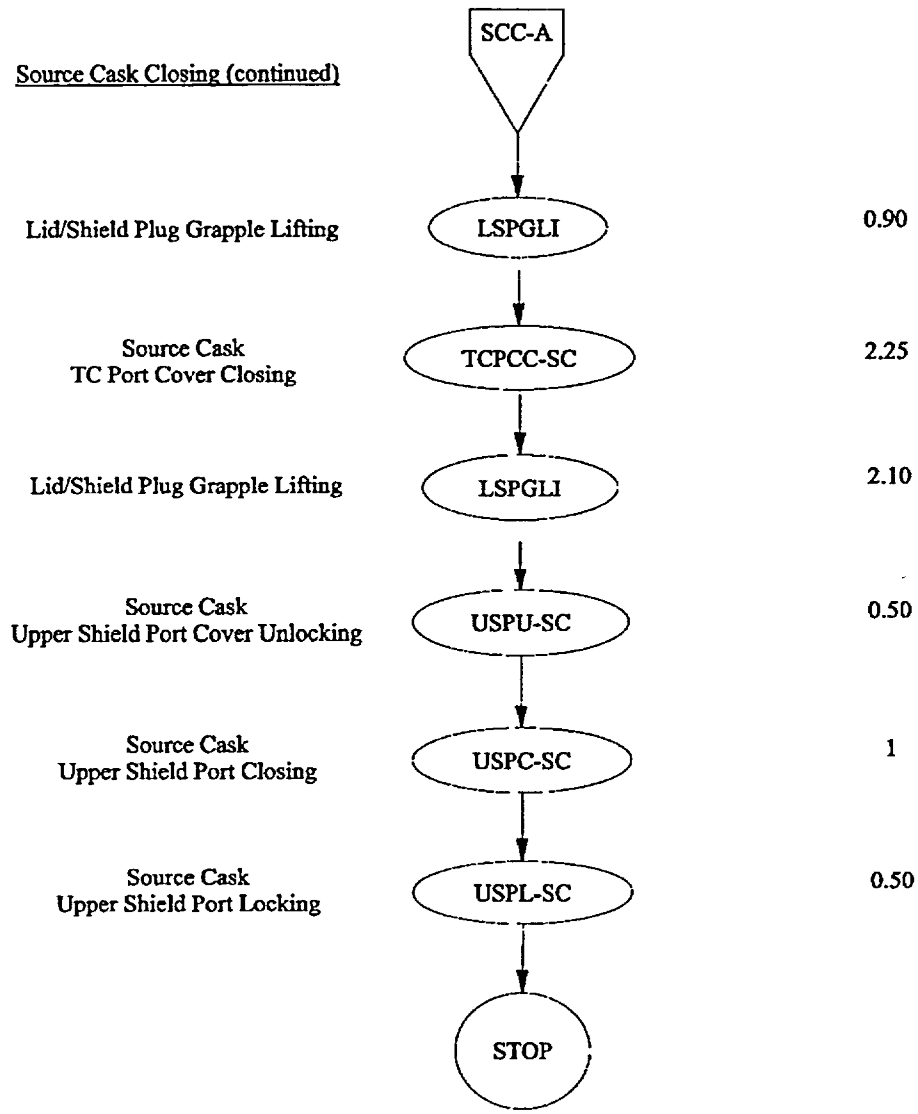


Figure 5.1-8

Removal of Source and Receiving Casks Macro-Operation

Flow Chart of Operations

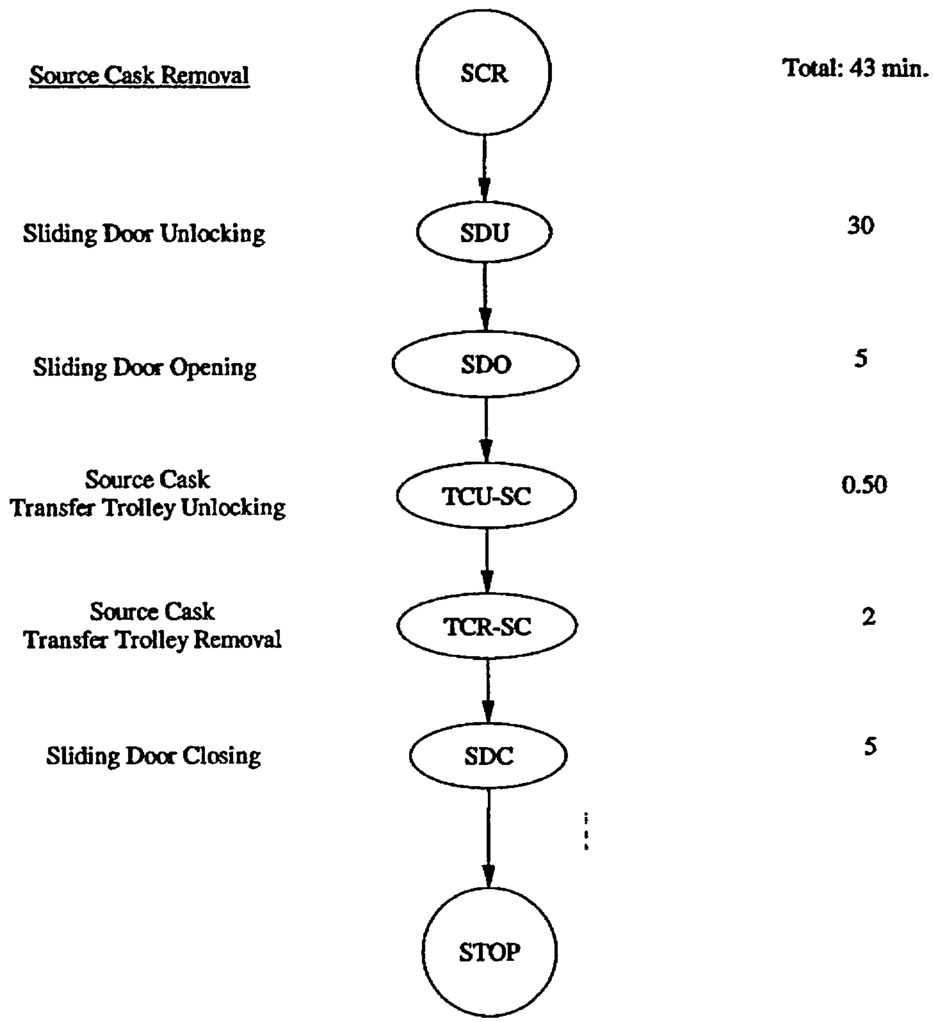
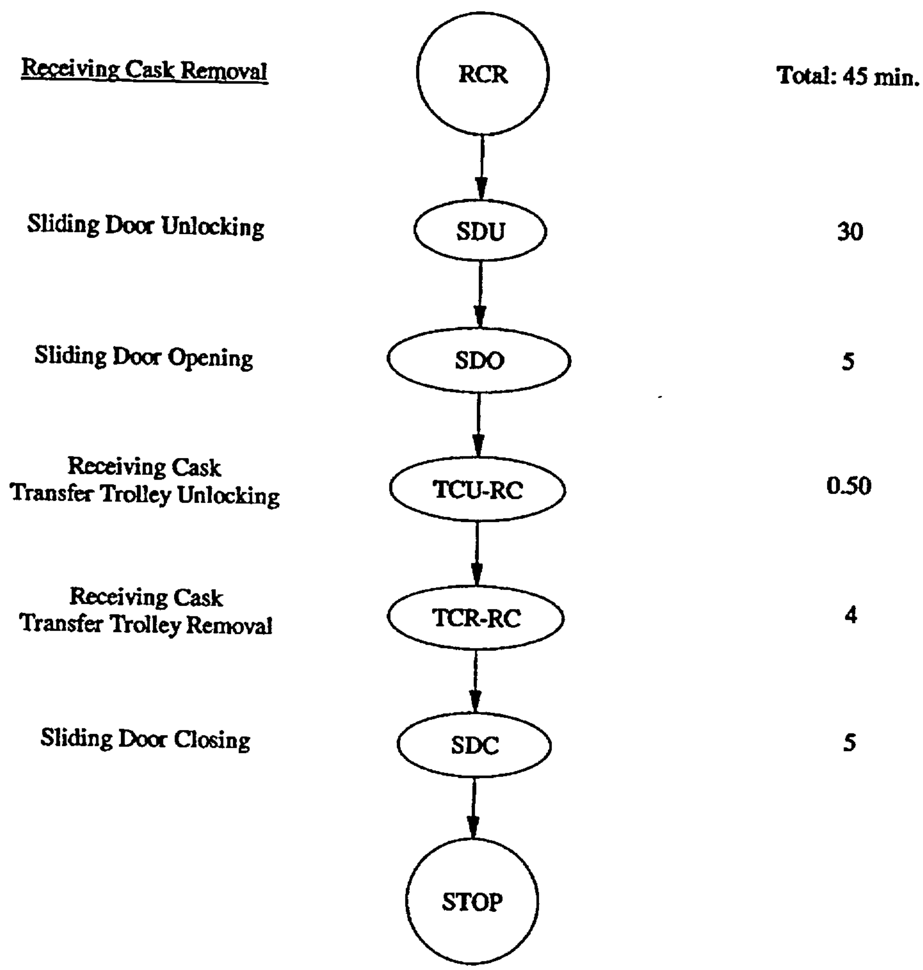


Figure 5.1-8 (continued)

Removal of Source and Receiving Casks Macro-Operation

Flow Chart of Operations



5.2 Spent Fuel Handling Systems

This section describes the functions, design bases, and the pertinent design features of the major operating equipment. Each subsection describes a specific operating subsystem. The flow diagram for the operations is presented in Chapter 1, Figures 1.3-2 through 1.3-8.

5.2.1 Receiving and Source Cask Transfer Subsystem

The Receiving and Source Cask Transfer Subsystem consists of two trolleys which are mounted on one set of rails. The rails run from outside of the DTS structure, through the Preparation Area, and into the Lower Access Area. Since there is only one set of rails, the receiving cask must enter the DTS before the source cask. The Receiving Cask Transfer Subsystem is shown on Drawing No. 3039-2, Rev. 0. The Source Cask Transfer Subsystem is shown on Drawing No. 3039-6, Rev. 0. Each trolley is motor driven and operated using identical control panels located in the Preparation Area and the Lower Access Area. The control panels are key operated such that only one panel can be operated at any time.

The Cask Transfer Subsystem supports the casks during operations within the DTS, and prevents the casks from tipping over in a seismic event.

Receiving Cask Transfer Subsystem

The Receiving Cask Transfer Subsystem is shown in Drawing No. 3039-2, Rev. 0.

The receiving cask trolley is 11.2 ft x 10.2 ft x 3.4 ft (3.4 m x 3.1 m x 1.0 m) and has a capacity of 125 tons (113 metric tons). It runs on rails 9 ft (2.75 meters) apart, and has a wheel base of 8.9 ft (2.7 m). The main components of the trolley are made from painted carbon steel. The trolley wheels are 27.6 in (700 mm) minimum diameter.

Four tapered centering guides, bolted to the top plate of the trolley, guide the cask in place during lowering. The lead angle on the centering guides allows for 4 inches (100 mm) of misalignment. These centering guides also resist the horizontal loading during a seismic event. The centering guides can be removed and repositioned for receiving casks with different dimensions.

The cask is fixed on the trolley by means of two trunnion cradles with bolted tiedown covers. These are shown in Figure 5.2-1. The trunnion cradles are bolted to the top plate of the trolley. Six 1.25 in (30 mm) dia. bolts are used to attach each tiedown cover. The trunnion cradles, together with their covers, prevent the cask from becoming disengaged during a seismic event. This analysis is presented in Appendix 8A.2. The trunnion cradles are bolted to the trolley. The tiedown covers weigh a maximum of 60 lbs (27 kg) and can be removed manually.

The trolley is driven by means of an asynchronous motor and service brake. The service brake can be manually disengaged. Only two out of four trolley wheels (one on each side) are motorized. The motor has two speeds which results in a trolley movement of 0.7 ft/min (≈ 0.2 m/min) or 10 ft/min (≈ 3 m/min). Since the motor has a frequency variable speed drive, acceleration and deceleration slopes are used to minimize stress on the motor.

The operator manually starts the trolley motion from the control panel in the Preparation Area. The trolley moves at its selected fast speed for gross positioning and the slower speed for fine positioning. Limit switches mounted on the trolley rail stop the trolley to ensure that the trolley is positioned in the correct location in the Preparation Area and the Lower Access Area.

The drive motor characteristics are listed below:

- 440 three phase V
- 60 Hz
- 20 horsepower (15 kW)

The motor produces approximately 4.5 kW of heat output while in operation.

The trolley has two braking mechanisms: a service brake and an emergency brake. The service brake is located on the motor drive shaft. The emergency brake is located on the output shaft. Both brakes engage upon loss of electrical power (and can be manually disengaged, if necessary). The emergency brake is engaged as a parking brake when the trolley is not in motion.

The receiving cask trolley is locked in place by means of a locking pin which engages with a hole in the concrete floor in the Preparation Area and in the Lower Access Area. See Figure 5.2-2 . This prevents the trolley from sliding along its rails while work is performed on the cask. This safety feature was incorporated since there are periods during receiving cask loading when the fuel is in the receiving cask with only the shield plug in place. The locks prevent damage to personnel and equipment in the event of inadvertent activation of the trolley. The locking pin is evaluated in Appendix 8A.2.

The trolley locking pin is not used during cask loading or unloading. The cask is either empty or the lids are welded and bolted closed during these operations.

Trolley guidance is made by two sets of lateral rollers on one of the two runway rails. See Figure 5.2-3. The rollers are 3.50 inches (88.9 mm) in diameter and are sized to withstand a lateral load of 24% of the vertical load. The guidance rollers are not designed to withstand the seismic event. Lateral rollers were used instead of flanged wheels to ensure accurate positioning of the trolley on its rails. The lateral rollers are evaluated for normal loads in Appendix 8A.2.

A plate mounted beneath the trolley which runs below the runway rail at each wheel location prevents the trolley from tipping over in a seismic event. This plate is defined as the "anti-taking off device" and is shown in Figure 5.2-3. The minimum thickness of the plate is 1.6 inches (40 mm), and must run beneath the rail for at least 6.3 inches (160 mm). The plate is attached to the trolley by means of four 1 inch (25 mm) diameter bolts. The anti-taking off devices are evaluated in Appendix 8A.2.

Bumper guards are located at the end of each runway rail to prevent damage to the trolley. A tow ring for attaching a pulling device (e.g., a tractor) in the event of a motor failure is mounted on one end of the trolley.

The electrical cables for the motor and sensors on the trolley are run underground. The slack in the electrical cables is taken by a winder mounted on the base of the trolley.

Due to the heavy weight of the receiving cask and trolley, and the need to prevent cask or trolley tip-over during a seismic event, a special composite runway rail was designed. The runway rail is shown in Figure 5.2-3. The composite runway provides a large bearing area for the anti-taking off device. It also provides guidance for the lateral guidance rollers.

The receiving cask transfer trolley is evaluated in Appendix 8A.2. The specified dimensions of the key components of the Receiving Cask Transfer Subsystem are presented in Table 5.2-1.

Table 5.2-1

Receiving Cask Transfer Subsystem Specified Dimensions

Part	Calculated Size
Bolts of Cradle	6 bolts 30 mm (1.2 in)
Plate of Anti-Taking Off Device	Thickness 40 mm (1.6 in)
Bolts of the Anti-Taking Off Device	4 bolts 24 mm (1 in)
Diameter of the Locking Pin	D = 120 mm (4.8 in)
Wheel Diameter	D = 700 mm (27.6 in)
Rail Width Minimum	100 mm (3.9 in)
Guidance Roller	D = 88.9 mm (3.50 in)
Rail Height Minimum	50.8 mm = (2.00 in)

Source Cask Transfer Subsystem

The Source Cask Transfer Subsystem is essentially identical to the Receiving Cask Transfer Subsystem, except for its size. It also has a spacer between the trolley base plate and the cask such that the top surface of the receiving cask and the top surface of the source cask are at the same elevation. The source cask is loaded onto its transfer trolley outside of the Preparation Area.

After the trolley is loaded, it is moved into the Preparation Area on rails. During preparation the source cask remains on the trolley and the trolley is locked by means of a jack actuated pin that penetrates into the floor of the Preparation Area.

The source cask trolley is 10.2 ft x 8.5 ft x 4.4 ft (3.1 m x 2.6 m x 1.3 m) and has a capacity of 30 tons (27.3 metric tons). It runs on rails 9 ft (2.75 meters) apart, and has a wheel base of 6.6 ft (~2 m). The main components of the trolley are made from painted carbon steel. The trolley wheels are 17.7 in (450 mm) minimum diameter.

Four tapered centering guides, bolted to the top plate of the trolley, guide the cask in place during lowering. The lead angle on the centering guides provides for 4 inches (100 mm) misalignment. These centering guides also resist the horizontal loading during the seismic event.[7] The centering guides can be removed and repositioned for source casks with different dimensions. The cask is fixed on the trolley by means of two trunnion cradles with bolted tiedown covers, similar to those used for the receiving cask. The cradles and centering guides are evaluated in Appendix 8A.2.

The trolley is driven by means of an asynchronous motor and service brake. The service brake can be manually disengaged. Only two, out of four trolley wheels (one on each side) are motorized. The motor has two speeds which results in a trolley movement of 0.7 ft/min ($\approx$ 0.2 m/min) or 10 ft./min ($\approx$ 3 m/min). Since the motor has a frequency variable speed drive, acceleration and deceleration slopes are used to minimize stress on the motor.

The operator manually starts the transfer from the control panel in the Preparation Area. The trolley is moved at its selected fast speed for gross positioning and is moved at its slow speed for fine positioning. Limit switches mounted on the trolley rail stop the trolley and ensure that it is positioned in the correct location in the Preparation Area and the Lower Access Area.

The drive motor characteristics are listed below:

- 440 three phase V;
- 60 Hz; and
- 5.4 horsepower (4 kW).

The motor produces approximately 1.2 kW of heat output while in operation.

The trolley has two braking mechanisms: a service brake and an emergency brake. The service brake is located on the motor drive shaft. The emergency brake is located on the output shaft from the gear reducer. Both brakes engage upon loss of electrical power (and if necessary, can be manually disengaged). The emergency brake is engaged as a parking brake when the trolley is not in motion.

The locking device described for the receiving cask trolley is also used for the source cask trolley. This prevents the trolley from sliding along its rails during a seismic event.

The trolley guidance device and the anti-taking off device are identical to the devices described for the receiving cask trolley, with the exception of the sizes of the components. A summary of the calculated dimensions required on the source cask trolley are presented in Table 5.2-2. The Source Cask Transfer System is evaluated in Appendix 8A.2.

Table 5.2-2

Source Cask Transfer Subsystem

Specified Dimensions

Part	**Calculated Size**
Bolts of Cradle	6 bolts 30 mm (1.2 in)
Plate of Anti-Taking Off Device	Thickness 30 mm (1.2 in)
Bolts of the Anti-Taking Off Device	4 bolts 16 mm (~0.6 in)
Diameter of the Locking Pin	D = 80 mm (3.2 in)
Wheel Diameter	D = 450 mm (17.7 in)
Rail Width Minimum	40 mm = (1.6 in)
Guidance Roller	D = 50.8 mm (2.00 in)
Rail Height Minimum	31.75 mm (1.25 in)

Cask Transfer Subsystem Sensors

Several sensors are used to ensure that the Cask Transfer Subsystem operates properly. These sensors are listed below.

- Two limit switches on each trolley (one on the front and one on the back) stop motion in the event of collision with the bumper guards. These prevent damage to equipment.
- One limit switch on the back of the receiving cask trolley stops motion in the event of a collision with the source cask.
- One limit switch at the end of the runway rails in the Lower Access Area stops motion if the trolley travels beyond a specified position. This is to prevent crashing into the wall of the Lower Access Area.
- Three limit switches mounted on the rails stop motion of the trolleys. One limit switch is at the space in the Preparation Area for locking. One limit switch is located in the Lower Access Area at the space for locking and mating of the receiving cask trolley. One limit switch is located in the Lower Access Area at the space for locking and mating of the source cask trolley.
- There are three electrical contacts which are mounted in the locking pin housing in the concrete basemat. These tell the operators that the locking pins are fully engaged. One electrical contact is located in each of the three locking locations: In the preparation area used for both casks, in the Lower Access Area in the Receiving Cask Mating Position and in the Lower Access Area in the Source Cask Mating Position.

Maintenance and Repair

Maintenance and repair operations are performed by operators working directly on the failed item. To keep dose rates as low as reasonably achievable, repairs and maintenance will be performed on the trolleys only when the casks are removed, when possible. The casks will be closed prior to any maintenance or repair on the trolleys. A tractor can be used to pull the trolleys out of the Lower Access Area and into the Preparation Area or outside the DTS in the case of a motor failure.

5.2.2 Receiving and Source Cask Mating Subsystem

The Receiving and Source Cask Mating Subsystem provides mating of the casks with the floor of the TCA to provide a confinement seal between the cask upper surface and the floor. The mating subsystem provides a physical confinement barrier with the HVAC performing a secondary confinement function to prevent gross spread of contamination from the TCA to the Lower Access Area. Backup confinement to the Receiving and Source Cask Mating Subsystem is provided by the sliding door between the Lower Access Area and the Preparation Area. The evaluation of the cask mating subsystems is presented in Appendix 8A.3.

The Receiving and Source Cask Mating Subsystem is operated remotely from the Control Center. It is designed such that personnel are not required to be present in the Lower Access Area when this operation is performed. This operation is performed remotely since there is potential contamination on the equipment, and to minimize radiatin exposure. The design incorporates several features which reduce the potential for spread of contamination.

A camera in the Lower Access Area provides partial viewing of these operations.

The motorized annular platform has a cone shaped surface machined into the inner diameter, which allows the platform to center itself over a possibly misaligned cask. The three electrical screw jacks that raise and lower the annular platform have the capability to compensate for a cask that may be misaligned up to three inches in any given direction. When the annular platform rests on top of the cask, a static seal acts as a confinement boundary between the cask and the Lower Access Area. When lowering the annular platform, all three screw jacks operate until the platform makes contact with the top of the cask. The first screw jack to make the contact stops automatically when it senses a preset load. The remaining two jacks lower until they reach their set loads. This operation assures that the annular platform is securely and properly mated with the cask.

There are two Cask Mating Subsystems, one for each cask, which are based on the same operating principles. These mating devices are shown on Drawing No. 3039-3, Rev. 0 and 3039-7, Rev. 0 Each Cask Mating Subsystem consists of an overlid with a gripping device, confinement bellows, and a motorized annular platform which supports the overlid. The overlid protects the upper surface of the cask lid from contamination. The gripping device is activated by a drive shaft which is driven by the motorized grapple of the upper crane. The confinement bellows, the annular platform and a static seal between the annular platform and the cask top surface provide the confinement barrier between the TCA and the Lower Access Area. Three electrical screw jacks enable platform lowering and lifting.

The Receiving and Source Cask Mating Subsystem is shown schematically in Figure 5.2-4.

Overlid with Gripping Device

The overlid protects the upper surface of the source cask lid (or receiving cask shield plug) from contamination during removal and storage within the TCA. A static seal at the bottom of the overlid which mates with the top edge of the source cask lid (or receiving cask shield plug) provides this function. The overlid and its gripping device is a welded structure which is made primarily of painted carbon steel.

The overlid contains a gripping device which engages the lifting pintle on the source cask lid (or receiving cask shield plug). The gripping device is operated by a drive screw activated by the motorized grapple of the upper crane. The use of the overlid and gripping device essentially keeps the source cask lid and the pintle free of radioactive contaminants. The overlid gripping device is shown in Figure 5.2-5. A brief description of how the gripping device operates follows:

Initial Condition:

The overlid is initially resting on the annular platform. The gripping fingers are open and the cam is in its lowest position. Due to the geometry of the annular platform and the overlid, the lifting pintle is aligned with the overlid. See Figure 5.2-5.

Step I:

The drive screw is activated, and the cam is lifted to its locked upper position. See Figure 5.2-6. The drive screw is engaged by the motorized grapple on the upper crane which is not shown in the Figures. At this point there is still a gap between the gripping fingers and the source cask lifting pintle.

Step II:

The drive screw continues to turn, lifting the spring plate against the internal spring. A shear pin prevents the spring plate from rotating. The internal spring prevents the spring plate from lifting until the cam is first lifted to its locked position. This last small motion compresses the static seal between the overlid and the source cask lid (or shield plug) and lifts the gripping fingers slightly, closing the gap between the pintle and the gripping fingers. A small recess in the lifting pintle ensures positive lifting, and prevents the fingers from disengaging under load. See Figure 5.2-7.

There are four gripping fingers, and in case of a failure of one finger, the others are able to support the load. The gripping device is identical for the Source Cask Mating Subsystem and the Receiving Cask Mating Subsystem. Therefore, the gripping device stresses were calculated based on the weight of lifting the receiving cask shield plug.

Above the gripping device is the lifting attachment for the overlid. This is shown in Figure 5.2-5. The overall dimensions of the overlids and loads on the gripping devices are provided in Table 5.2-3. The critical dimensions of the TC Cask Mating Subsystem are presented in Table 5.2-4 and shown in Figure 5.2-8.

Table 5.2-3

Receiving and Source Cask Mating Subsystem Overlid Dimensions and Loading

Description	US Units	Metric Units
Source Cask		
Overlid Overall Dimensions	3.3 ft dia x 2.0 ft thick	100 cm dia. x 60 cm thick
Maximum Live Load	1.7 tons	≈ 1.5 tons
Estimated Dead Load	0.88 tons	≈ 0.8 tons
Receiving Cask		
Overlid Overall Dimensions	5.6 ft dia. x 2.0 ft thick	170 cm dia. x 60 cm thick
Maximum Live Load	3.3 tons	≈ 3 tons
Estimated Dead Load	1.6 tons	≈ 1.5 tons

Table 5.2-4

TC Cask Mating Subsystem Calculated Dimensions and Stresses

Description	Size
Axis for Finger of the Overlid Diameter	1.0 in (25 mm)
Thickness of the Finger of the Overlid	2.0 in (50 mm)
Overlid Pintle Thickness	1.6 in (40 mm)
Shield Plug Pintle Thickness	2.0 in (50 mm)

Confinement Bellows

The confinement bellows form the confinement boundary between the TCA mezzanine plate and the cask. They are mounted onto the bottom face of the mezzanine plate and to the top of the annular platform (Figure 5.2-9). Table 5.2-5 presents the confinement bellow characteristics.

Table 5.2-5

Confinement Bellows Characteristics

Characteristic	US Units	Metric Units
Inside Diameter Source Cask Mating Subsystem	4.3 ft	≈ 1.3 m
Inside Diameter Receiving Cask Mating Subsystem	6.6 ft	≈ 2 m
Height, h (Compressed)	1.6 ft	≈ 0.5 m
Thickness	0.1 in	≈ 2 mm
Allowable Deflection Δ	0.3 ft	≈ 0.1 m
Allowable Stretch δ	0.8 ft	≈ 0.25 m
Material	Silicon Coated Polyester Fabric	
Minimum Operating Temperature	40°F	≈ 4°C
Maximum Operating Temperature	240°F	≈ 115°C
Minimum Integrated Dose Design Value	10^7 rad	

Motorized Annular Platform

Three electrical jacks mounted on the bottom of the mezzanine plate are used to stretch the confinement bellows and lower and lift the annular platform. The annular platform supports the overlid, and contains a static seal which is used to mate with the top surface of the cask. The static seal and the confinement bellows provide the confinement boundary between the TCA mezzanine plate and the cask.

The electrical jacks are mounted on spherical bearings which enable the platform lowering and lifting. The jacks operate independently and allow angular and axial misalignment between the real and theoretical cask position. Identical jacks are used for both mating subsystems. The jacks have the following estimated characteristics:

Table 5.2-6 Jack Characteristics

Characteristic	US Units	Metric Units
Force	4500 lbs	2000 daN
Power Requirement	1.6 hp	1.2 kW
Speed	2 ft/min	0.6 m/min
Stroke	1 ft	0.30 m

The annular platforms are made from stainless steel. The annular platform for the receiving cask mating subsystem weighs approximately 1.1 tons (1.0 metric tons). The annular platform for the Source Cask Mating Subsystem weighs approximately 0.66 tons (0.6 metric tons).

Guides on the annular platform are used to ensure proper alignment. These guides fit over the outside diameter of the cask.

The sequence of operations of the motorized annular platforms is as follows:

The platform is lowered, roughly horizontally, by the three jacks operating together until contact is made with the cask. Lowering of the platform continues by the three jacks operating together until one jack reaches its set contact load. The contact load automatically stops movement of the individual jack. The remaining jacks continue to lower the platform until they reach their set contact load. The three jacks are again operated together a last time to ensure that all three have reached their contact load. The platform is raised using the three jacks operating together until they reach their upper position.

Sensors

The load on each jack is measured to ensure proper engagement of the subsystem with the cask. The vertical position of each jack is also measured by a potentiometer which provides backup information regarding proper mating.

A rod which runs through the drive shaft of the gripping device actuates sensors in the grapple of the upper crane regarding positive engagement and disengagement of the gripping device.

Cask Misalignment

Depending on the fabrication tolerances of the trolley, the surface on which the bottom of the cask rests may not be parallel to the rails. Also, the fabrication of the cask will allow a tolerance on the perpendicularity of the cask with respect to its bottom. Based on the stack-up of these tolerances, the top of the cask may be misaligned from the theoretical, ideal centerline. The cask mating subsystem is designed to accommodate variations and misalignment that may occur between the cask and the mating subsystem. The bellows for instance have an allowable deflection of 3.6 inches in any direction as stated in Table 5.2-5. The inflatable seals also accommodate some misalignment. The lid/shield plug is considerably smaller than the hole in the mezzanine plate which allows misalignment without sacrificing the ability to lift the lid/shield plug along with the overlid.

Maintenance

Cask Mating System maintenance is done by operators working directly on the failed item. Maintenance is only performed when the casks and fuel assemblies have been removed from the TCA and Lower Access Area. The confinement bellows and seals are expected to be replaced after about 100 days of operation. The bellows and the lower annual platform are bagged in plastic. While still covered with the plastic, the bellows are unbolted from the lower annular platform and are allowed to drop into a plastic confinement bag. The contaminated bellows are disposed of appropriately. A clean set of bellows are placed in a clean plastic confinement bag and are brought back to the lower annular platform and bolted, while still covered with the plastic.

5.2.3 Receiving and Source Cask Transfer Confinement Port Cover Handling Subsystem

The receiving and source cask TC port covers are rail mounted trolleys activated by electrical screw jacks. One port cover is positioned above each cask opening in the mezzanine floor. The openings allow access into the casks from the TCA for the lid and shield plug grapple and the fuel assembly grapple. The receiving and source cask TC port covers are shown on Drawing No. 3039-8, Rev. 0. A guidance device is mounted on each TC port cover, which allows the source cask lid (or receiving cask shield plug) to be accurately positioned on the port cover during fuel transfer operations.

The TC port covers are operated remotely from the Control Center.

The source cask TC port cover has two positions: open and closed. The receiving cask TC port cover has three positions: open, closed and off-centered. The off-centered position is the position in which the shield plug is lowered or lifted off the receiving cask TC port cover. Both port covers move only in the Y - direction.

The main components of the TC port covers are:

- Two motorized port covers and
- Two sets of runway rails.

Each port cover has four wheels (two on each side) which run on the rails. The port cover is guided on the rails by four sets of lateral rollers as shown in Figure 5.2-10 The shape of the runway rail prevents the port cover from becoming disengaged from the rails due to a seismic event.

A locking pin which penetrates into a hole in the mezzanine plate prevents the port cover from accidental forward or backward movement when fuel is being transferred. This prevents the port cover from hitting into the fuel assembly transfer tube if it becomes disengaged or accidentally closed while fuel is being transferred. The locking pin is jack operated and can be accessed through a penetration in the wall of the DTS for manual operation in the event of an equipment failure. The source cask TC port cover locking pin is 2 inches (50 mm) in diameter and the receiving cask TC port cover locking pin is 1.6 in (40 mm) in diameter.

The TC port covers are actuated by electrical screw jacks. The motors for the jacks are located outside of the TCA, allowing easy replacement in case of a failure. The jack is able to move the port cover with an average travel length of 6.6 feet ($\approx$ 2 m). The jacks run on 440 3 phase voltage. 1.7 hP (1.3 kW) are required for the source cask TC port cover and 2.7 hP (2 kW) are required for the receiving cask TC port cover. Both jacks run at a speed of 3 ft/min (0.9 m/min).

The jacks will be shielded from the weather.

The main structural components are made from painted carbon steel. The paint will meet the requirements of Category A - Service Level 1 coatings as defined in ASME-NOG-1.

The main characteristics of the source and receiving cask TC port covers are presented in Tables 5.2-7 and 5.2-8.

Table 5.2-7

Source Cask TC Port Cover Characteristics

Characteristic	US Units	Metric Units
Overall Dimensions	5.2 ft x 4.9 ft x 5.9 in	≈ 1.6 m x 1.5 m x 0.15 m
Length of Runway	12.8 ft.	≈ 3.9 m
Span	5 ft	≈ 1.5 m
Wheel Base	5.3 ft	≈ 1.6 m
Maximum Live Load	2.5 tons	≈ 2.3 tons
Dead Load	≈ 1.7 tons	≈ 1.5 tons

Table 5.2-8

Receiving Cask TC Port Cover Characteristics

Characteristic	US Units	Metric Units
Overall Dimensions	6.6 ft x 6.6 ft x 5.9 in	≈ 2 m x 2 m x 0.15 m
Length of Runway	13.6 ft.	≈ 4.2 m
Span	6.9 ft	≈ 2.1 m
Wheel Base	5.6 ft	≈ 1.7 m
Maximum Live Load	5 tons	≈ 4.5 tons
Dead Load	≈ 2.8 tons	≈ 2.5 tons

Sensors

Limit switches mounted on the rails at each of the set locations (open and closed for the source cask TC port cover and open, closed and off-centered for the receiving cask TC port cover) automatically stop movement. Additional limit switches at each end of the runway rails prevent over travel. Electrical contacts in the mezzanine plate and in the jacks indicate whether the lock is engaged or disengaged.

Maintenance and Repair

Maintenance is performed directly on the failed item after removal of the fuel and casks from the DTS. Maintenance on the jacks can be performed at any time since they are housed outside of the confinement area.

5.2.4 Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem

The Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem consists of two different parts. The first part is the Upper Shield Port Covers which is the equipment which controls the opening and closing of the upper shield port covers on the roof of the TCA (In the Roof Enclosure Area). The second is the Upper Crane which is housed in the Roof Enclosure Area. The Upper Crane is used to lift and lower the receiving cask shield plug and the source cask lid. The Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem is evaluated in Appendix 8A.4.

5.2.4.1 Receiving and Source Cask Upper Shield Port Covers

The upper shield port covers are rail mounted trolleys activated by electrical screw jacks. They provide shielding over the openings in the roof plate. One upper shield port cover is positioned above each opening in the roof plate (above each cask). The two upper shield port covers are identical. The openings allow access into the TCA from the Roof Enclosure Area for the lid and shield plug grapple. The upper shield port covers are shown on Drawing No. 3039-4, Rev. 0. The upper shield port covers are operated from the Control Center.

The upper shield port covers operate on the same principle as the TC port covers and also provide shielding. The covers are seven inch (178 mm) thick painted carbon steel.

Both upper shield port covers move in the Y - direction and have two fixed positions: open and closed.

The main components of the upper shield port covers are:

- Two motorized port covers and
- Two sets of runway rails.

Each upper shield port cover has four wheels (two on each side) which run on the rails. The upper shield port cover is guided by four sets of lateral rollers as shown in Figure 5.2-11. The shape of the runway rail prevents the upper shield port cover from becoming disengaged from the rails due to a seismic event.

A one-inch (24 mm) diameter locking pin which penetrates into a hole in the upper plate prevents the upper shield port cover from accidental forward or backward movement when it is in the open and closed positions. This prevents the upper shield port cover from opening due to a seismic event that would result in inadequate shielding at the roof. The locking pin is jack operated and can be manually activated in the event of an equipment failure.

The upper shield port covers are actuated by electrical screw jacks. The jacks are located in the Roof Enclosure Area, allowing easy replacement in case of a failure. Each jack is able to move the port cover with an average travel length of 2.8 feet (≈ 85 cm). The jacks run on 440 3 phase voltage. 0.4 hP (0.3 kW) are required for movement of each upper shield port cover. Both jacks run at a speed of 3 ft/min (0.9 m/min).

The main structural components are made from painted carbon steel. The paint will meet the requirements of Category A - Service Level 1 coatings as defined in ASME-NOG-1. The main characteristics of the upper shield port cover are presented below.

Upper Shield Port Cover Characteristics

Characteristic	US Units	Metric Units
Overall Dimensions	31.5 in x 38 in x 7 in	≈ 0.8 m x 1 m x 0.18 m
Length of Runway	7.5 ft.	≈ 2.3 m
Span	2.9 ft	≈ 0.9 m
Wheel Base	2.6 ft	≈ 0.8 m
Weight	1.4 tons	≈ 1.3 tons

Upper Shield Port Covers Sensors

Limit switches mounted on the rails at each of the set locations (Open and Closed) automatically stop movement. Additional limit switches at each end of the runway rails prevent over travel. Electrical contacts in the upper plate and in the jacks indicate whether the locks are engaged or disengaged.

Maintenance and Repair

Maintenance is performed directly on the failed item, after the fuel is returned to the casks and the casks are closed. Maintenance can be performed in the roof enclosure area for short periods of time, in the event of an emergency while fuel is in the TCA, following special procedures.

5.2.4.2 Upper Crane

The upper crane removes the shield plug from the empty receiving cask, places it in its storage position on the TC port cover and replaces it in the receiving cask upon completion of fuel transfer. The upper crane also removes the lid from the source cask, places it in storage, and installs it onto the source cask when unloading is completed.

The upper crane is shown on Drawing No. 3039-4, Rev. 0. It consists of a motorized trolley suspended on rails, a hoist and a motorized grapple. It is a Type 1 crane as designated in ASME NOG-1. The trolley moves between two fixed positions: directly above the source cask and directly above the receiving cask. The upper crane is housed within the Roof Enclosure Area. When the TC port cover and upper shield port cover are opened, the hoist lowers the grapple through the opening of the roof plate and the TC mezzanine floor. The grapple engages with a lifting pintle on the source cask lid or receiving cask shield plug. The lid (or shield plug) is then raised above the top of the TC port cover. While the lid (or shield plug) is suspended, the TC port cover is moved underneath the lid (or shield plug). The lid (or shield plug) is then lowered onto the TC port cover for temporary storage. Note that the upper crane is never moved laterally while under load.

During fuel transfer, the upper crane is not operated, and is shielded by the roof plate and upper shield port covers.

The protective cover protects the crane from environmental loads (wind and snow and tornado missiles).

Motor Driven Trolley

The trolley is motorized and moves along the X-axis on rails. The trolley is 4.3 ft x 4.6 ft x 2.8 ft (1.3 m x 1.4 m x 0.85 m) and has a capacity of 6.1 tons (5.5 metric tons). It runs on rails 3.9 ft (1.2 meters) apart, and has a wheel base of 2.6 ft (0.8 m). The main components of the trolley are made from painted carbon steel. The trolley positioning accuracy is at least ± 0.4 inches (± 1 cm).

The trolley is driven by means of an asynchronous motor and service brake. Two trolley wheels are motorized. The trolley has a speed of 3.3 ft/min (≈ 1 m/min).

The operator indicates which position the trolley should be in (above source cask or above receiving cask) and the trolley moves to the desired position. Limit switches mounted on the rail stop motion and ensure that the trolley is positioned in the correct location.

The drive motor characteristics are listed below:

- 440 three phase V,
- 60 Hz, and
- 2.7 horsepower (2 kW).

The motor produces approximately 0.6 kW of heat output while in operation.

The trolley has two braking mechanisms: a service brake and an emergency brake. The service brake is located on the motor drive shaft. The emergency brake is located on the output shaft.

Both brakes engage upon loss of electrical power (and can be manually disengaged, if necessary). The service brake is engaged as a parking brake when the trolley is not in motion.

Trolley guidance is made by two sets of lateral rollers on one of the two runway rails. See Figure 5.2-12. The rollers are 2.00 inches (50.8 mm) in diameter and are sized to withstand a lateral load of 24% of the vertical load. The guidance rollers are not designed to withstand the seismic event.

A plate mounted beneath the trolley which runs below the runway rail at each wheel location prevents the trolley from tipping over in a seismic event. This plate is defined as the "Anti-taking off Device", and is shown in Figure 5.2-12. The minimum thickness of the plate is 0.8 inches (20 mm), and must run beneath the rail for at least 5.5 inches (140 mm). The plate is attached to the trolley by means of four 5/8 inch (16 mm) diameter bolts. It is sized to take the vertical static and seismic loads.

The anti-derailing devices are sized to withstand the lateral loads on the trolley due to static and seismic loading. See Figure 5.2-13.

The trolley has a hoist ring for attaching a winch and an auxiliary motor to move the trolley in the event of malfunction. The winch and auxiliary motor would be set on the top of the upper plate prior to maintenance intervention.

A summary of the calculated dimensions required for the upper crane trolley are presented in Table 5.2-9.

Wiring for equipment mounted on the trolley is guided on rails mounted adjacent to the trolley rails.

Table 5.2-9

Upper Crane Trolley Calculated Dimensions

Part	Calculated Size
Plate of Anti-Taking Off Device	Thickness 20 mm (0.8 in)
Bolts of the Anti-Taking Off Device	4 bolts 16 mm (5/8 in)
Wheel Diameter	D = 139 mm (5.5 in)
Rail Width Minimum	37 mm (1.45 in)
Guidance Roller	D = 50.8 mm (2.0 in)

Upper Crane Hoist

The hoist motorization is shown schematically in Figure 5.2-14. The hoist is designed to lift and lower the overlid (described in the Cask Mating Subsystem Section) with the receiving cask shield plug or the source cask lid. The hoist consists of two cables, 1 cable drum, a compensator and a series of pulleys. The reeving system is divided into two separate load paths so that either path will support the load and maintain vertical alignment in the event of cable breakage or failure in the cable system.

The cable drum is mounted on the upper plate of the DTS. Each cable runs from the cable drum, around a pulley mounted on the crane support structure (pulleys #1 and #8), around a pulley on the trolley (pulleys #2 and #9), down and around a pulley on the grapple device (pulleys #3 and #10), up and around pulleys on the trolley (pulleys #4 and #5 and #11) down again around a pulley on the grapple (pulleys #6 and #12), up to a pulley on the trolley (pulleys #7 and #13) to the compensator. The kinematic chain is shown in Figure 5.2-15. The compensator is used to balance the load, taking up the slack in the cables. It is also used in the event of a cable break to alert the operator.

The hoist has an asynchronous motor, reduction gear, emergency brake and service brake. The service brake is housed within the motor, but can be manually disengaged. The emergency brake is housed on the drum, and is activated in the event of a malfunction of the service brake as indicated by overtravel or overspeed indications or in the event of a loss of power.

The hoist has a variable speed drive which results in lift speeds from 1 ft/min (0.3 m/min) to 16.4 ft/min (5 m/min). Using a frequency variable speed drive, acceleration and deceleration slopes are utilized to avoid load oscillation.

Each cable is capable of safely lifting the entire load and keeping the load balanced. The cable is made from 0.48 inch (12 mm) 6 x 37 wire rope.

Lid/Shield Plug Grapple

The motorized grapple is used to grip the overlid and to activate the overlid gripping device to engage the receiving cask shield plug or source cask lid. The grapple is shown in Figures 5.2-16 and 5.2-17. The overlid gripping is accomplished by means of four fingers which are activated by an electrical screw jack. The four fingers engage with the pintle on the overlid. The jack moves a shaft with a cam shaped base up and down. In the full up position, the grapple fingers are disengaged. In the full down position, the grapple fingers are fully engaged.

The grapple can be disengaged manually in the event of a jack malfunction, by means of a long handled pole which can be installed through a penetration in the wall of the DTS, or by means of a long handled tool lowered down through the roof plate opening. If the grapple fails to engage properly, it will be moved back up to the roof enclosure area and inspected.

The overlid gripping device is activated by means of an electrical motor and gear train. The motor and gears turn the drive shaft which activates the gripping device.

A winder for the electrical cables used for sensors and equipment on the grapple is mounted on the trolley.

Upper Crane Sensors

There are four limit switches which stop motion of the trolley, all mounted on the trolley rails. Switches stop motion at the correct location above the source cask and the receiving cask. A switch at each end of one of the rails also stops motion. These limit switches would only be activated in the event of a failure of one of the other switches or the service brake.

The hoist has several sensors, as required by NOG-1 for a Type 1 crane. A wire potentiometer mounted on the trolley provides information regarding the absolute positioning of the grapple. This information is used to control the speed of the grapple, and to stop the grapple in the following positions:

First High Limit	The lid and overlid are lifted above the TC port cover
Second High Limit	The grapple is in the upper position above the roof plate
First Low Limit	The lid and overlid are seated on the TC port cover
Second Low Limit	The lid or shield plug is seated in the cask

Note that the low limits are different for the source cask lid and the receiving cask shield plug.

An electrical switch mounted on the trolley is used to stop motion in the event of an overtravel in the high direction (The grapple has gone beyond the second high limit). An electrical switch mounted on the cable drum is used to stop motion in the event of an overtravel in the low direction. An electrical switch on the cable drum is used to stop motion in the event of the hoist speed exceeding its maximum speed.

Two electrical switches (one for each cable) mounted on the drum are used to detect improper threading of the hoist rope in the hoist drum grooves. Actuation of this switch shall result in removal of power from all crane drive motors and setting of the emergency brakes. Actuation of the limit switch prevents further hoisting or lowering. When this occurs, an operator knowledgeable in the hoist control system shall determine and correct the cause of the tripping of the limit switch. That operator shall direct the lowering of the load.

Two electrical switches mounted on the compensator are used to stop motion in the event of an unbalanced load. These switches will be activated in the event of a cable break, or a failure in one of the load paths.

A load cell is mounted on the grapple. If the reading from the load cell is abnormally high or abnormally low during lifting or lowering under load, motion will be stopped.

A rod mounted on the overlid gripping device connects to a positioning device within the grapple. This sensor provides information regarding the status of the overlid gripping device fingers. There are three positions which are used to control the overlid gripping device: fingers open, fingers closed, and fingers gripped.

An electrical contact on the grapple provides information regarding the status of the grapple fingers. There are two positions of the grapple fingers: open and closed.

Upper Crane Maintenance and Repairs

Maintenance on parts of the upper crane is performed by operators directly on the failed item after the grapple has been moved into the Roof Enclosure Area. Maintenance and repairs would normally be done after the fuel and casks have been removed from the DTS. However, if necessary, limited repairs can be performed on the upper crane if the upper shield port covers are closed and locked.

In the event of a malfunction, equipment can be manually activated to ensure that the source cask lid and receiving cask shield plug can be reinstalled in the casks.

All equipment and sensors will be tested prior to use.

Inspection and testing before operation and during storage will be performed following the equipment supplier's recommendations and handling equipment rules and regulations.

5.2.5 Fuel Assembly Handling Subsystem

The Fuel Assembly Handling Subsystem is an NOG-1, Type 1 gantry crane. The gantry crane consists of:

- A bridge supporting a trolley with two girders and end ties running on rails (X-direction);
- A motor driven trolley supporting a rotating platform and running on bridge girders (Y-Direction);
- A rotating platform supporting the Z-direction hoists and allowing correct orientation of the transfer tube above the cask basket cell (Θ-Direction);
- A transfer tube which encloses and protects the fuel assembly during lateral movement;
- A spent fuel assembly grapple; and
- A crud catcher at the bottom of the transfer tube which minimizes the spread of contamination in the TCA.

Two cameras and associated lighting are mounted at the base of the transfer tube. These cameras are used to verify identification of each fuel assembly and ensure that the fuel is properly lifted and lowered into the fuel assembly compartment.

The Fuel Assembly Handling Subsystem is shown on Drawing No. 3039-9 and shown schematically in Figure 5.2-18.

The Fuel Assembly Handling Subsystem grapple attaches to a fuel assembly in the source cask, lifts it vertically (in Z direction) into the transfer tube, translates it laterally (both in X and Y directions), and rotates about the fuel assembly centerline to position it directly above the opening in the fuel cell of the receiving cask. The fuel assembly is then lowered and released. Since the subsystem has a full range of motion in the X, Y, Z and Θ directions it is adaptable to any two vertical loading/unloading casks.

Handling loads in a PWR fuel assembly are transmitted through the guide tubes. Stresses that are sufficient to break the guide tubes could result in dropping of a fuel assembly. During lifting the load is limited, by means of the load cell in the fuel assembly hoist system, to the safe load the fuel assembly guide tubes can withstand. Also, the hoist uses acceleration and deceleration slopes that minimize acceleration loads on the fuel assemblies. The limits will be determined as part of the site-specific application.

It is to be noted that damaged fuel assemblies will not be accepted into the DTS. Spent fuel will be visually inspected as it is removed from the spent fuel pool at the applicable site. Any damaged fuel will be rejected for dry transfer and returned to the pool. If it is believed that the fuel is damaged during transit from the site to the DTS, it will not be accepted for transfer in the DTS. If fuel is to be transferred at the DTS from a dry storage cask, it is the responsibility of the host utility to ensure that the fuel is undamaged prior to acceptance at the DTS.

The fuel handling crane has been analyzed for static (dead and live loads) and seismic loads. The seismic loads are analyzed with and without the rated load. The fuel handling crane is evaluated in Appendix 8A.5.

Fuel Assembly Handling Bridge

The fuel handling bridge consists of a welded structure of two girders and two end ties mounted on rails. Each bridge rail is simply supported on the concrete structure. The rails are W 12 x 96 beams reinforced by two plates on the outside. KS22-A45 runway rails are mounted on the beams, and clamped in place by steel shapes bolted to the main beams.

The bridge allows movement in the X-direction for nearly the full width of the TCA. This allows the fuel transfer tube to be positioned over any fuel assembly location in either the source cask or the receiving cask. The X-direction movement is approximately 18 feet (≈ 5.5 m). The average bridge travel is 16 feet (≈ 5 m).

The bridge has the following characteristics:

Overall Dimensions	9 ft x 16 ft x 2 ft (2.8 m x 5 m x 0.6 m)
Wheel Base	7.9 ft (≈ 2.4 m)
Span	15.4 ft (≈ 4.7 m)
Maximum Bridge Live Load	6.6 tons (≈ 6 metric tons)
Bridge Dead Load	5 tons (≈ 4.5 metric tons)
Positioning Accuracy	± 1/8 inch (± 3 mm)

The bridge is guided by two sets of lateral rollers on one of the runway rails as shown in Figure 5.2-19. The rollers are 2.00 inches (50.8 mm) in diameter and are sized to withstand a lateral load of 24% of the dead and live loads on the bridge. The guidance rollers are not designed to withstand the seismic event.

An anti-derailing device and an anti-taking off device are used to prevent the bridge from becoming disengaged during a seismic event. There are four anti-derailing devices bolted to the underside of the bridge. These act as bumpers which take the lateral loadings during a seismic event. See Figure 5.2-20.

The anti-taking off device is a plate mounted beneath the bridge which runs below the top flange of the structural beam. See Figure 5.2-20.

The plate is sized to withstand the vertical loading due to a seismic event, and prevent the bridge from becoming disengaged from its rails. The minimum thickness of the plate is 1.2 inches (30 mm) and must run beneath the beam flange for at least 5.5 inches (140 mm). The plate is attached to the bridge by four 5/8 inch (16 mm) diameter bolts.

The bridge is made up of two kinds of beams: W 12 x 8 x 0.5 beams which span the rails and W 14 x 82 beams which run above the rails. The beams are reinforced by two plates on the sides. A schematic of the bridge is shown in Figure 5.2-22.

The bridge is driven by means of an asynchronous motor and brake. The drive is a "A-1" Drive as defined in ASME NOG-1. The brake can be manually disengaged. One axle is motorized. Two bridge speeds are used: a slow speed of 0.33 ft/min (≈ 0.1 m/min) and a higher speed 26 ft/min (≈ 8 m/min). Since the motor has a frequency variable speed drive, acceleration and deceleration slopes are used to minimize stress on the motor and to avoid load oscillation.

The bridge is operated semi-automatically. The destination position is input into a PC in the Control Center. The operator then initiates the movement by inputting a command into the PC. When the programmed position is reached, movement stops. Fine positioning is performed using a joystick with the aid of a video camera mounted on the fuel transfer tube. Fine positioning is performed at the slow speed. A stop button on the control panel can be used to stop movement at any time. The operator views the TCA and the fuel cell location on monitors in the Control Center during this operation.

The drive motor characteristics are listed below:

- 440 three phase V
- 60 Hz
- 2 horsepower (1.5 kW)

The motor produces approximately 0.5 kW of heat output while in operation.

The bridge has two braking mechanisms: a service brake and an emergency brake. The service brake is located on the motor drive shaft. The emergency brake is located on the output shaft. Both brakes engage upon loss of electrical power. The service brake is engaged as a parking brake when the bridge is not in motion. The emergency brake is activated in the following events:

- A sensor such as an overtravel limit switch is activated;
- The operator pushes the emergency brake button; or
- Loss of Power.

Cable guides run along each side of the bridge. One is used for the primary power supply to the fuel hoist and grapple. The other is used for emergency power supply to the fuel hoist and grapple. Cable separation has been provided for safety purposes to keep the hoist systems independent and redundant.

Fuel Assembly Handling Trolley

The fuel assembly handling trolley is supported on rails bolted to the fuel assembly handling bridge. Four bumper guards, one at the end of each rail, can stop the trolley in the event of a malfunction. The trolley is shown schematically in Figure 5.2-23. The rails are W 12 x 96 beams reinforced by two plates on the outside. KS22-A45 runway rails are mounted on the beams, and clamped in place by steel shapes bolted to the structural beams.

The trolley allows movement in the Y - direction and allows the fuel transfer tube to be positioned over any fuel assembly location in either the source cask or the receiving cask.
The trolley has the following characteristics:

Overall Dimension	6.6 ft x 9.2 ft x 1.2 ft (2 m x 2.8 m x 0.4 m)
Wheel Base	7.9 ft (≈ 2.4 m)
Span	5.6 ft (≈ 1.7 m)
Maximum Trolley Live Load	4.9 tons (≈ 4.5 metric tons)
Trolley Dead Load	1.7 tons (≈ 1.5 metric tons)
Positioning Accuracy	± 1/8 inch (± 3 mm)

The trolley is guided by two sets of lateral rollers on one of the runway rails as shown in Figure 5.2-24. The rollers are 2.00 inches (50.8 mm) in diameter and are sized to withstand a lateral load of 24% of the dead and live loads on the bridge. The guidance rollers are not designed to withstand the seismic event.

An anti-derailing device and an anti-taking off device are used to prevent the trolley from becoming disengaged during a seismic event. There are four anti-derailing devices bolted to the underside of the trolley. These act as bumpers which take the lateral loadings during a seismic event. The anti-derailing device is shown in Figure 5.2-25.

The anti-taking off device is a plate mounted beneath the bridge which runs below the top flange of the supporting bridge beam. The plate is sized to withstand the vertical loading due to a seismic event, and prevent the trolley from becoming disengaged. The minimum thickness of the plate is 1.2 inches (30 mm) and must run beneath the beam flange for at least 5.5 inches (140 mm). The plate is attached to the bridge by 4 5/8 inch (16 mm) diameter bolts.

The trolley is made from a frame of W12 x 12 x 0.5 beams bolted to a flat plate.

The trolley is driven by means of an asynchronous motor and brake. The drive is an "A-1A" Drive as defined in ASME NOG-1. The brake can be manually disengaged. One axle is motorized. The motor has a variable speed which results in a trolley movement of 0.33 ft/min (≈ 0.1 m/min) at slow speed and 20 ft/min (≈ 6 m/min). Since the motor has a frequency variable speed drive, acceleration and deceleration slopes are used to minimize stress on the motor and to avoid load oscillation.

The trolley is operated semi-automatically. The destination position is input into a PC in the Control Center. The operator then initiates the movement by inputting a command into the PC. When the programmed position is reached, movement stops. Fine positioning is performed using a joystick with the aid of a video camera mounted on the fuel transfer tube. Fine positioning is performed at the slow speed. A stop button on the control panel can be used to stop movement at any time. The operator views the TCA and the fuel cell location on monitors in the Control Center during this operation.

The drive motor characteristics are listed below:

- 440 three phase V
- 60 Hz
- 1.2 horsepower (0.9 kW)

The motor produces approximately 0.3 kW of heat output while in operation.

The trolley has two braking mechanisms: a service brake and an emergency brake. The service brake is located on the motor drive shaft. The emergency brake is located on the output shaft. Both brakes engage upon loss of electrical power. The service brake is engaged as a parking brake when the bridge is not in motion. The emergency brake is activated in the following events:

- A sensor such as an overtravel limit switch is activated;
- The operator pushes the emergency brake button; or
- Loss of Power.

Endless Chain Subsystem

The endless chain system provides a means of moving the bridge or the trolley in an emergency situation in the event of motor or power failure.

The endless chain mechanism for the bridge or trolley retrieval is comprised of a heavy duty chain, reeved over two free wheeling sprockets mounted at the ends of one of the two bridge or trolley rails, with the ends of the chain connected to the bridge or trolley frame. The sprocket in line with a wall penetration contains a shaft extension, with a male hex adapter attached to it. Under normal operation, the chain moves with the bridge or trolley without affecting their operation. Under emergency conditions, long handled tools inserted through penetrations are used to turn the endless chain shaft extensions that move the bridge or the trolley.

Rotating Platform

The rotating platform is a welded mechanical structure which supports the transfer tube and the hoist motorization. The rotating platform is shown schematically in Figure 5.2-26 .

The rotating platform has overall dimensions of 5.6 ft in diameter by 3.3 ft high ($\approx$ 1.7 m diameter by 1 m high). The maximum live load on the rotating platform is 3.8 tons (3.4 metric tons). The dead load of the rotating platform is 1.6 tons (1.4 metric tons).

The rotating platform is driven by means of an asynchronous geared motor and brake, mounted on the trolley. The brake can be manually disengaged. The rotating platform can be positioned within $\pm 1°$.

The motor has a variable speed set to operate at two speeds: high and low. The slow speed is 10°/min and the high speed is 180°/min. Acceleration and deceleration slopes are utilized to avoid load oscillation. The operator controls the rotation through the use of a joystick in the Control Center, choosing a direction (clockwise or counter-clockwise) and the speed. Motion stops when the joystick is released.

The drive motor characteristics are listed below:

- 440 three phase V
- 60 Hz
- 0.9 horsepower (0.7 kW)

The motor produces approximately 0.2 kW of heat output while in operation.

The rotating platform has two braking mechanisms: a service brake and an emergency brake. Both brakes engage upon loss of electrical power (and manually disengaged if necessary). The service brake is engaged as a parking brake when the rotating platform is not in motion. The emergency brake is activated in the following events:

- A sensor such as an overtravel limit switch is activated;
- The operator pushes the emergency brake button; or
- Loss of Power.

The rotating platform is supported by ball bearings. A toothed wheel located at the upper edge of the platform engages with a ring gear on the rotating platform. In the event of a malfunction, a rod through a wall penetration can be used to manually drive the gearing system.

An anti-taking off device is used to ensure that the rotating platform does not become disengaged from the trolley in a seismic event. The anti-taking off device is a brace mounted to the trolley which extends over the top of the rotating platform.

Fuel Assembly Transfer Tube and Hoisting System

The transfer tube is an approximately 3/4 inch thick (20mm) carbon steel tube that is mounted to the rotating platform. The fuel assembly grapple lifts the fuel into the transfer tube to fully enclose the fuel assembly during lateral transfer and rotation.

The bottom of the transfer tube incorporates the crud catcher that opens during lifting operations and closes during lateral transfer and rotation.

Automatic positioning of the fuel transfer subsystem will help position the transfer tube approximately over the location of the fuel assembly that is to be transferred. The operator then accurately positions the transfer tube with the joystick. The operator relies on the CCTV to accurately position the transfer tube. The variation in the information received from the cameras compared to the actual location is extremely minute. Because the operator has ultimate control of aligning the transfer tube with the centerline of the fuel assembly, the tolerance differences in the casks will not affect the functionality of the fuel transfer subsystem.

The relatively tight clearance between the grapple and fuel assembly and the round section transfer tube ID (approximately .25 to .5 inch, depending on the fuel and available nominal tube dimensions) prevents the fuel assembly from swinging excessively while in horizontal transit, minimizing the possibility of assembly damage.

A generous conical lead-in will be built into the bottom of the transfer tube. This lead-in ensures that the fuel assembly spacer grids will not snag on any protrusions or sharp edges. If some swinging occurs while the fuel assembly is being lifted, the lead-in will assist in centering the fuel assembly into the transfer tube.

The single failure proof hoisting system incorporates two hoists as shown in Figure 5.2-27. The two hoists are mounted on the rotating platform opposite each other, on either side of the transfer tube. Each hoist has its own wire rope which runs over a sheave mounted on the top of the transfer tube, down around one sheave, on the grapple load block and then up to dead end at a connection at the top of the transfer tube. Each wire rope has a factor of safety of 10 on breaking strength based on two-part reaving with the full critical load. The two sheaves on the grapple load block are mounted one above the other, and are oriented at ninety degrees to each other to provide a balanced load configuration. Simultaneous operation of the two hoists allows the grapple to be lifted or lowered.

The hoists are operated by variable speed vector frequency drives with one drive acting as the master and the second as the slave to equalize the lifting torque in each hoist. Separate power lines (one for each motor) supply power to each of the hoists. The motors are identical and designed to operate at a lifting speed range of 0.33 ft/min (~0.1 m/min) or 16 ft/min (~5 m/min). Acceleration and deceleration slopes are used to avoid load oscillation and impact loads.

The hoist is operated by means of a joystick in the Control Center with slow speed elevation zones controlled by the CPU. This ensure safes operation in critical zones such as initial insertion into a cask cell location prior to setting the assembly down, and on initial entry into the transfer tube.

The power supply system has the following characteristics:

- 480 VAC

- 60 Hz/3 Phase
- 3 HP (2.2 kW)'

The motor produces approximately 0.7 kW of heat output while in operation.

Each hoist has a service brake at the input shaft to the gearbox and each brake is rated to hold the entire load providing a single-failure proof braking system. Both brakes act as parking brakes when the hoist is not in motion and both brakes act as emergency brakes that engage upon loss of electrical power.

Both hoists are stopped and both the brakes are engaged in the following events:

- An over travel limit, overload, or over speed indication is detected by the sensor;
- The operator pushes the emergency brake button; or
- Loss of Power to either hoist.

In case of failure of one hoist motor, the other hoist can be made to complete the fuel transfer by bypassing the control system drive master/slave logic.

Dual load cells are mounted at the top of the transfer tube supporting the load bar, at the dead end of the hoist cables, to sense the grapple load. If the grapple is sensed to be overloaded or under-loaded, the fuel assembly may be stuck in the cask, and the hoist system will stop in order to prevent damage of the fuel assembly, cask, and hoisting equipment and/or the inadvertent release of the fuel.

Control interlocks are provided such that the fuel assembly grapple must be fully raised and the crud catcher closed before the fuel transfer crane can move horizontally, thus precluding the possibility of damaging the fuel while it is engaged within both the cask cell and the transfer tube. Furthermore, sensors in the grapple prevent operation of the hoist in the event that the fuel assembly is not properly grappled.

Fuel Assembly Grapple

The fuel assembly grapple shown on the drawings is based on engaging a 15 x 15 B&W PWR fuel assembly. However the basic principles in the design of this grapple can be used for other types of fuel. Since PWR and BWR nozzles are different, two different gripping devices would be used. The BWR fuel would be gripped from the outside, while the PWR fuel is gripped internally.

The PWR grapple consists of a mechanical structure supporting the gripping device. Dual load path gripping fingers with passive mechanical interlocks under load ensure that the load cannot be dropped.

The grapple has two independent actuating mechanisms. One electrical jack (connected to the primary power line) is used during normal operating conditions.

Two additional electrical jacks (connected to the secondary power line) are used in the event of a failure in the primary electrical jack. The grapple design is shown in Figure 5.2-28. Alternate designs utilizing other redundant actuation means (e.g.: use of solenoid actuators) and mechanisms which provide the same level of safety features may be incorporated into the final detail design of the grapple.

Crud Catcher

The crud catcher is at the bottom of the transfer tube. It covers the bottom of the fuel assembly when it is fully retracted into the transfer tube, and minimizes the spread of radioactive particulate during fuel transfer. During lateral movement and rotation of the fuel assembly, the crud catcher is closed.

The crud catcher is operated by an electric screw jack located at the top of the transfer tube. A wire rope system connects the electric jack to the crud catcher. A load sensitive latch is placed in line with the wire rope and is designed to slip to allow enough travel in the rope to open the crud catcher if the system is overloaded. The crud catcher is shown in Figure 5.2-29.

In the event that the crud catcher malfunctions and does not open, the weight of the fuel assembly or unloaded grapple is used to force the break away latch to allow the crud catcher to open. As this breakaway load is only approximately 50-75 pounds, it will not impose any damage to the fuel assembly or grapple.

Fuel Assembly Handling Subsystem Sensors

There are two limit switches which stop motion at the end of the bridge runway rails. A synchroresolver provides the operator with absolute positioning information on the bridge.

Similarly, there are two limit switches which stop motion at the end of the trolley rails. A synchroresolver provides the operator with absolute positioning information on the trolley.

The rotating platform is also equipped with a synchroresolver which provides the operator with the rotational position of the fuel transfer tube.

The hoist has several sensors, as required by NOG-1 for a Type 1 crane. A wire potentiometer mounted on the top of the transfer tube provides information regarding the absolute positioning of the grapple. This information is used to control the speed of the grapple, and to stop the grapple in the following positions:

First High Limit	Fuel grapple is in the maximum operating position
First Low Limit	The fuel grapple is below a set position where only slow speed can be used.
Second Low Limit	The fuel grapple is in the engagement or disengagement position in the source cask.

Third Low Limit — The fuel grapple is in the engagement or disengagement position in the receiving cask.

An electrical switch mounted on the top of the transfer tube is used to stop motion in the event of an overtravel in the high direction (The grapple has gone beyond the first high limit). An electrical switch mounted on each cable drum is used to stop motion in the event of an overtravel in the low direction. An electrical switch on the cable drum is used to stop motion in the event of the hoist speed exceeding its maximum speed.

Two electrical switches (one for each drum) are used to detect improper threading of the hoist rope in the hoist drum grooves. Actuation of this switch shall result in removal of power from all crane drive motors and setting of the brakes. Actuation of the limit switch prevents further hoisting or lowering. When this occurs, a person knowledgeable in the hoist control system shall determine and correct the cause of the tripping of the limit switch. That person shall direct the lowering of the load.

A load cell is mounted on the hoist system. If while lifting a fuel assembly, the reading from the load cell reaches the limit determined per Section 5.1.3.6, motion will be stopped. If the reading from the load cell is abnormally low while lowering a fuel assembly, motion will also be stopped.

A limit switch on the grapple indicates that the fuel assembly is present under the grapple, and stops motion.

A limit switch on the grapple provides information regarding the status of the grapple fingers. There are two positions used to operate the grapple: open and closed.

<u>Fuel Assembly Handling Subsystem Maintenance and Repairs</u>

Maintenance on parts of the Fuel Handling Subsystem is done by operators directly on the failed item after the fuel and casks have been removed from the DTS.

In the event of a malfunction, all equipment is backed up by completely redundant systems or can be manually activated to ensure that the fuel assembly can be reinstalled in a cask.

Equipment and sensors will be tested prior to use. Inspection and testing before operation and during storage will be performed following the equipment supplier's recommendations and handling equipment rules and regulations.

Normal maintenance of the equipment would include cleaning/replenishment of the lubricants as required. The typical lubricants that have been identified for use with the DTS equipment are advertised as radiation resistant to 10^7-10^8 rads. Estimates of the dose rates around a bare fuel assembly are on the order of 10^4 rad/hr.

Thus, attention to the condition of the lubricants would be recommended after several thousand hours of operation time (considering the actual time equipment is exposed to a bare fuel assembly). Lubricant "inspection" will be included as part of the normal maintenance program.

5.2.6 Off-Normal Retrieval Methods

Handling subsystems in high radiation areas are provided with alternate means of operation, manual and powered, in the event of a component failure. This section defines the alternate operating means, and the projected tooling required to perform the operations, as well as the approximate times required to complete the tasks. Times given do not take into consideration setup times involved with staging of tools, removal of penetration covers or movement of other equipment obstructing the use of the tools for the specific applications.

5.2.6.1 Receiving and Source Cask Mating Subsystem

The cask mating subsystems include overlids at each port which incorporate gripping devices to engage the source cask lid and receiving cask shield plug for lifting with the upper crane. The gripping devices are actuated by the motorized grapple of the upper crane. In the event that an overlid gripping device can not be made to disengage from the lid or plug by the motorized grapple, the motorized grapple will be fully raised and moved out of the way and the gripping device will be manually actuated by engaging the vertical spline of its drive screw with a long pole tool inserted through the open upper shield port cover directly above. The tool consists simply of a long pole with an end socket designed to engage the shaft spline and a suitable crank handle at the other end.

Once the end socket of the tool is engaged on the shaft spline, full disengagement of the fingers can be accomplished in approximately 1 minute.

All other cask mating subsystem components can be repaired on contact once the cask lid and shield plug are installed.

5.2.6.2 Receiving and Source Cask TC Port Cover Handling Subsystem

The TC port covers are rail mounted trolleys which allow access into the casks from the TCA. The TC port covers are opened and closed by means of electric motor driven screw jacks. A locking pin engages a hole in the mezzanine plate to lock the cover in the open position. Postulated failure modes are the main screw jack or motor failing or locking pin screw jack failing. Refer to Figure 1.2-8 in Chapter 1.

Main Screw Jack Failure

The main screw jack and motor are located outside of the DTS at mezzanine level, shielded from the weather. In the event of motor failure, the screw jack shaft may be turned manually or by other powered means and/or the drive motor can be readily removed and replaced.

The screw jack connection to the TC port cover is made via an extension rod through the concrete penetration such that, when the cover is fully retracted (open), the screw jack can be physically disconnected from the extension rod for easy replacement from outside containment.

In the event that the screw jack fails with the screw extended (i.e. port cover in other than the fully open condition) such that the extension rod connection is not accessible, the screw jack can be disconnected from the outside frame and forcefully pulled out to fully open the cover, allowing its replacement.

Time required to complete this task will vary depending on the location of the TC port cover, and the means by which the failure is resolved. Extending or retracting the jackscrew by turning the output shaft will take approximately 4 minutes by a power assisted tool (i.e. electric drill motor). The screw jack connection to the extension rod can be released instantaneously since it can be reached easily. Time required to forcefully pull the screw jack varies depending on the means to produce the force required to push/pull.

Locking Pin Screw Jack Failure

The locking pin screw jack is mounted on the TC port cover centered on the front side (opposite the port cover operating jack connection). A hex shaft extension on the jack aligns horizontally with a penetration in the DTS wall, for manual operation of the jack, in the event of motor failure. This is accomplished by inserting a long pole crank with a female hex socket at its end through the penetration to engage and turn the manual hex drive. In the event lock-up failure of the screw jack, preventing its turning, the locking pin/jack assembly can be disengaged from the port cover. This can be accomplished by pulling a pin with a hook at the end of the extension pole and then lifting the assembly out of the engaging hole using a pry bar attachment at the end of the pole.

The locking pin screw jack can be manually engaged via a long pole crank in approximately 1 minute. Disengaging and removing the locking pin assembly can be accomplished in 5 minutes.

5.2.6.3 Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem

Upper Shield Port Covers

The upper shield port covers operate in the same manner as the TC port covers. A main screw jack pushes and pulls the cover and a locking pin screw jack locks the cover in the closed position. Since this equipment is located in the Roof Enclosure Area, it can be manually operated by turning the screw jack shafts or otherwise repaired on contact by entering the area.

Times required to repair or replace the upper shield port cover screw jacks are of the same magnitude as those postulated for the TC port covers in Section 5.2.6.2.

Upper Crane

The upper crane hoist incorporates a manual crank device for emergency retrieval in the event of crane failure.

This operation is performed by first releasing the primary and secondary brakes and then rotating the output shaft by means of a power tool (i.e. electric drill motor) or a manual crank tool. Since this equipment is located in the Roof Enclosure Area manual retrieval and or repair operations will be performed directly.

The time to fully retract or lower the upper crane hoist is 16 minutes with the power-assisted tool. The time to place a lid/shield plug onto the cask from a TC port cover is 10 minutes and (not including TC port cover positioning times).

Lid/Shield Plug Grapple

Should the motorized grapple fingers not properly engage when attempting to grapple the overlid, the grapple will be completely raised, inspected and repaired in the roof enclosure area with the TC port covers and upper shield port covers closed.

In the event that the grapple does not disengage from the overlid, manual disengagement may be performed in one of two ways. If the other lid or plug is already in place in the other cask, the overlid with lid or plug will be placed back in the cask and the manual disengagement may be made directly since both casks will be closed. If this is not the case, the overlid with lid or shield plug will be raised and placed on the TC port covers so that the grapple manual actuation hex drive is accessible through a penetration in the DTS side wall. Referring to Figure 5.2-16 and Figure 1.2-11 in Chapter 1, the manual activation device consists of a screw jack with a hex input shaft which, when manually turned will raise or lower the failed electric screw jack to in turn raise or lower the grapple finger actuating cam. The same tool that is used for the locking pin jack screw on the port covers is used for this application.

The screw jack operated manually will take approximately 1 minute to fully engage or retract the grapple fingers.

5.2.6.4 Fuel Assembly Handling Subsystem

Fuel Assembly Handling Subsystem horizontal emergency retrieval motions (bridge, trolley and rotating platform) may be remotely performed in three different ways. This can be accomplished, by a) using the endless chain system described in Section 5.2.5 (Revised per NRC RAI 5-6), or b) by using a remote long handled tool designed to turn the motor shaft extensions, after releasing the mechanical brakes, or c) by forcefully moving the bridge or trolley and engaging a pole into hooks provided on the frames and pulling or pushing in the desired direction.

Hoisting retrieval motion may be performed first by operating the second hoist, if operable, and secondly by turning the motor shaft manually.

Using the endless chain system in a retrieval operation, the bridge or trolley drive motor brake must first be released to allow rolling motion of the bridge or trolley, by means of a long pole tool with a hook end to pull the brake release lever.
Note that in case of the trolley, the bridge must first be positioned in line with a containment wall penetration. An extension rod tool with a hex socket at one end and a crank at the other is then inserted through the appropriate penetration in line with the sprocket shaft and the shaft engaged. The tool is then turned in the appropriate direction to move the bridge or trolley.

Remote tools will be designed for use through a number of penetrations through the concrete containment walls located at strategic locations to perform the desired motions in the event that the endless chain system cannot be used. The tools will be comprised of long poles with hook and hex socket end effectors in combination with cranks or drill drivers outside the penetration. For ease of remote tool engagement, tool end effectors and equipment shaft extensions will incorporate generous lead-ins and suitable pole guides will be provided were possible to guide and support the poles. At penetration locations where projected radiation doses will be extremely high (i.e., where penetration is in direct "shine" of a suspend fuel assembly and precludes direct manual manipulation of retrieval tools), special tool supports, insertion and manipulation devices will be required outside the containment wall, allowing indirect manipulation.

If recovery operations must be performed with a fuel assembly suspended on the Fuel Assembly Handling Subsystem, the reach-rod ports will be utilized. The dose rate at the inside of the wall has been calculated to be on the order of 3,000 Rem/hr. An estimate of the dose rate at the outside of the reach-rod port can be made based on the methodology in Chapter 8 of the Engineering Compendium on Radiation Shielding (1968). For the approximately 1 ft diameter port in the three foot thick wall, the dose at the outside of the port would be approximately 0.01 of the inside dose rate or about 30 to 40 Rem/hr. However, for many of the reach-rod ports, equipment partially blocks the line-of –site to the port that reduces the estimated dose.

Before allowing personnel to perform reach-rod operations, temporary shielding such as lead bags would be placed into the port and other temporary shielding placed outside the port to significantly lower the dose rate. The specific design of the temporary shielding would be site specific and very dependent on the dry-run/training program that would be performed for recovery operations.

Manipulations with the reach-rod will use the CCTC system to align the tools. The four wall mounted cameras capable of remotely zooming and rotating, will allow accurate alignment of the tools using a remote monitor located at the reach port. The use of the remote TV monitor will require only the operator's hands to be in the port while his body is beside the port, essentially shielded by the wall and any temporary shielding. Thus, the majority of personnel dose will be extremity dose because personnel will not need to work directly in line with the port.

Because of the remote operation CCTV system with pan, tilt and zoom features, virtually all areas in the TCA can be covered.

Also, personnel training is of major importance in any operation that involves potentially high dose rates. Prior to operation of the DTS, training at the site will be conducted using the reach-rod ports.

The various manipulations will be performed in a non-radioactive environment to access the suitability of the equipment and to formalize and refine actual procedures that will be utilized if and when emergency operations are required. Ancillary tooling/fixtures and temporary shielding will also be defined during this training program.

Operational exposure due to emergency operations will be minimized by utilizing temporary shielding, the CCTV system for tool alignment and manipulation, and personnel training to minimize operational time. It is likely that an extremity dose rate as high as 10 to 20 Rem/hr could be at the reach-rod port but personnel whole body exposure would be significantly less than the extremity exposure. A minimum number of personnel are needed to perform the reach-rod operations and in fact only one person would be manipulating the reach rod with his/her hand in direct site of the port. It is anticipated at a total exposure time on the order of 1 hour could be required to perform the necessary operations. This could produce an extremity exposure of 10 to 20 Rem but a whole body dose several orders of magnitude less. However, it is anticipated that through proper training and the use of temporary shielding, the personnel exposure would be significantly less than that postulated above.

Remote tool design is not included in this report and will be developed as part of the detailed design of the DTS equipment.

Emergency retrieval motions will be performed generally as follows:

<u>Bridge</u>

By utilizing the endless chain system, the full travel of the bridge would require approximately 7 minutes. If additional force or mechanical advantage is required to rotate the endless chain system, a suitable crank end with a reduction gearbox or other suitable means can be built into the retrieval tool. Adding mechanical advantage would increase the operation time to 18 minutes. The bridge endless chain system will be operated with a short tool since the driven sprocket remains stationary and is located close to a wall and will align with a penetration in the DTS.

The bridge motor will always be aligned with a penetration in one of the end walls. In the event that the endless chain system fails, a long pole with a hex socket and hook end effector, will be inserted through the penetration to reach the motor. Utilizing the hook, the motor brake will be released by engaging and pulling on the brake release lever ring. The hex end effector will then be engaged to the hex end motor shaft extension and the motor shaft rotated in the desired direction by means of a power assisted tool.

A guide support will be provided on the crane to support and guide the pole into position. Due to gear ratios, turning load is minimal and well within manual operation. The bridge can be traversed to its extents of travel in approximately 5 minutes by a power-assisted tool.

Trolley

By utilizing the endless chain system, the full travel of the trolley would require approximately 3 minutes. If additional force or mechanical advantage is required to rotate the endless chain system, a suitable crank end with a reduction gearbox or other suitable means can be built into the retrieval tool. Adding mechanical advantage would increase the operation time to 7 minutes. The trolley endless chain system will require a long tool able to reach the limits of bridge travel since the trolley position changes depending on the position of the bridge. Similar tools in varied lengths or a telescoping shaft can be designed for this purpose.

In the event that the endless chain system cannot be used, the trolley motor will be required to be aligned with a containment side wall penetration by first moving the bridge. Manual motor driving operations will then be the same as for the bridge. The trolley can be traversed to its extents of travel in approximately 3 minutes by a power-assisted tool.

Rotating Platform

The rotating platform motor will be required to be aligned with a containment side wall penetration by first moving the bridge. Manual motor driving operations will then be the same as for the bridge. The rotating platform can be rotated at a rate of 20 degrees per minute by a power assisted tool.

In the event of a locked brake or gearbox, the rotating platform may be forcefully rotated by simply hooking onto any suitable part of the platform frame (special hook points will be provided to align with containment penetrations) with a long pole hook and/or cable and pulling or pushing in the desired direction. This is possible by the incorporation of a slip clutch or overload coupling in the final drive shaft which is pre-adjusted to allow slip free normal operation yet allowing platform rotation with a nominal (~200 lbs) force at the platform periphery. The possibility of the platform bearing ring gear jamming with the pinion drive gear due to a broken tooth is deemed not credible by the extreme conservatism in the gear sizing.

Hoist

Primary hoisting motion retrieval will be by means of the redundant hoist which is powered through a secondary power feed cable which should be available in the event of failure of the other hoist or power cable.

The failed hoist gearbox brake must first be released by first rotating the platform to align the brake with a containment penetration and then utilizing a long pole/hook tool (note that the hoist load will be maintained by the brake of the good hoist). The platform can then be rotated back into position to lower the fuel with the good hoist.

A jammed failed hoist brake or gearbox will require cutting that hoist's cable with a special tool (hydraulic) cutter end effector prior to operation of the good hoist.

In the event of power failure to both hoists, one hoist motor may be manually operated by releasing the brake and turning the brake hex drive shaft projection, with a long pole tool. This will first require rotating the platform to align the brake shaft with a containment penetration. Turning the motor shaft can be accomplished by a power-assisted tool with a hex socket to mate with the male hex drive extension on the output shaft. Full travel of the hoist would require approximately 13 minutes with the power-assisted tool.

If the fuel is already within a cask cell, rotation of the platform will not affect lowering of the fuel due to cable flexibility. In the event that the fuel is above the cask cell, a second pole and hook will be required to be inserted through another penetration to hook and rotate the fuel assembly into correct orientation. This will require extreme precautions due to the direct shine of the fuel through the penetration.

Crud Catcher

The crud catcher is at the bottom of the transfer tube. It covers the bottom of the fuel assembly when it is fully retracted into the transfer tube, and minimizes the spread of radioactive particulate during fuel transfer. During lateral movement and rotation of the fuel assembly, the crud catcher is closed. The crud catcher is operated by an electric screw jack located at the top of the transfer tube. A cable system connects the electric jack to the crud catcher. A load sensitive latch is placed in line of the cable and is designed to slip to allow enough travel in the cable to open the crud catcher if the system is overloaded.

In the event that the crud catcher does not open, the weight of the fuel assembly or unloaded grapple is used to force the break away latch to allow the crud catcher to open. As this breakaway load is only approximately 50-75 lbs, it will not impose any damage to the fuel assembly or grapple.

Figure5.2-29 shows a the crud catcher configuration. In this configuration, a clamshell arrangement is used in which a wire rope connects the clamshells to an electric screw jack at the top of the transfer tube. Locating the motor at the top of the tube reduces its radiation exposure, as a fuel assembly is raised or lowered into or out of the tube, from that which would be received at the bottom of the transfer tube. The clam shell design reduces the space required at the end of the transfer tube for the crud catcher.

The crud catcher is intended to catch only small, lightweight, particles that may contaminate the outside surfaces of the fuel and that could fall off the fuel as it is moved. It is not intended to support heavy loads. As the crud catcher is only opened when the transfer tube is over a receiving or source cask, any particles that are caught will fall into one of the two casks. As shown in the figure, a "breakaway latch" is incorporated into the actuating wire rope to allow the crud catcher to open in the event of a motor failure. If the fuel is lowered while the crud catcher is closed, pressure is applied to the crud catcher by the bottom fuel nozzle and slowly

builds until, at 50 to 75 pounds, the "breakaway latch" allows the crud catcher doors to fall open.

As the weight of a fuel assembly is well in excess of 1,000 pounds and the fuel is self-supporting when stored supported by its bottom nozzle, the maximum opening force of 75 pounds applied by the fuel bottom nozzle will not have any effect on the nozzle. The fuel rods, support tubes and spacer grids never come in contact with the crud catcher and are, therefore, not affected.

The crud catcher clamshell doors are to include counter weights, such that in the event the "breakaway latch" is actuated, the doors will drop into the full open position and will not close on or contact the fuel assembly.

The revised crud catcher design will not allow inadvertent closure of the crud catcher doors once the "breakaway latch" has been activated until the latch is reset. This is accomplished because activation of the "breakaway latch" increases the effective length of the crud catcher activating cables, without breaking the cables. Resetting the latch will require manual entry into the fuel transfer area.

5.2.6.5 Operator Training

Operators will be trained and tested in accordance with the technical training program as described in Section 9.3 (refer to the response to RAI 9-3). Training will include a description of the tools, a video showing use of the tools and mock-up training if deemed necessary. Each training program will require the operator to pass a written, computer based, oral or practical examination.

Figure 5.2-1

Cask Transfer Subsystem Trunnion Cradles

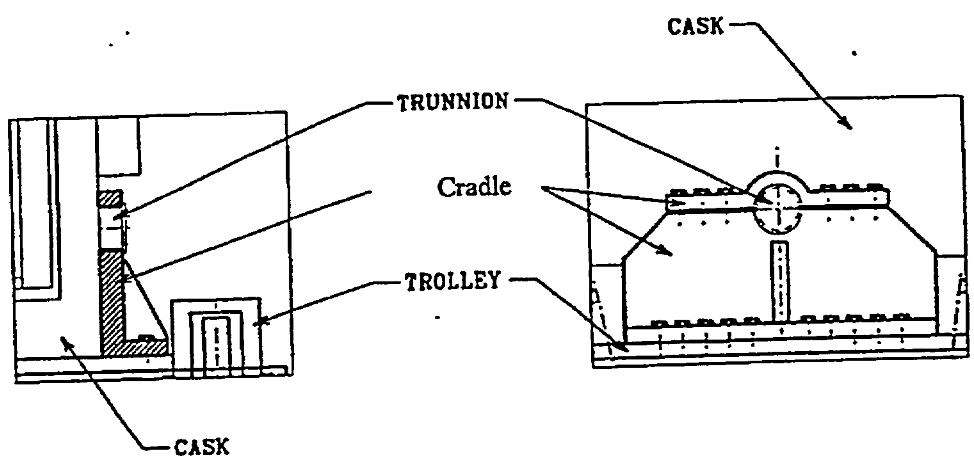


Figure 5.2-2

Cask Transfer Subsystem Locking Pin

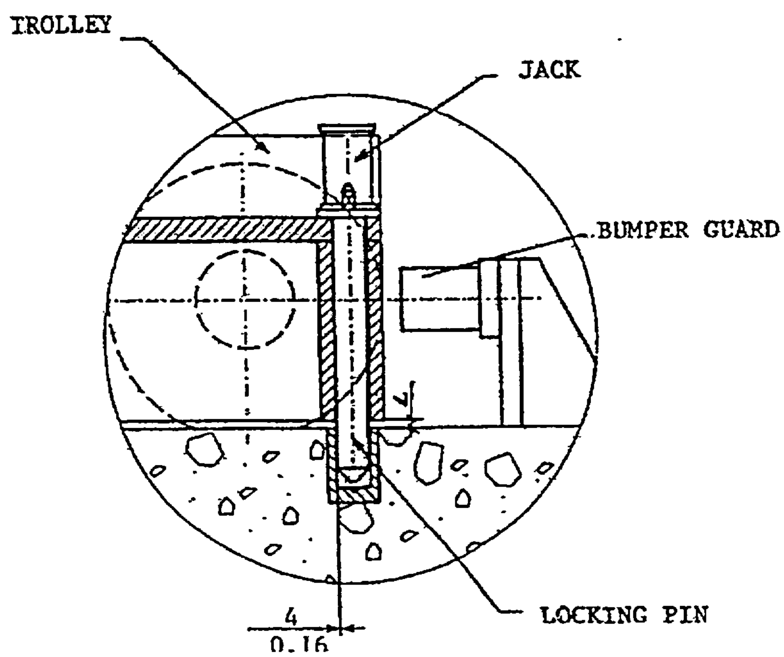


Figure 5.2-3

Cask Transfer Subsystem Trolley Guidance and Anti-Taking Off Device

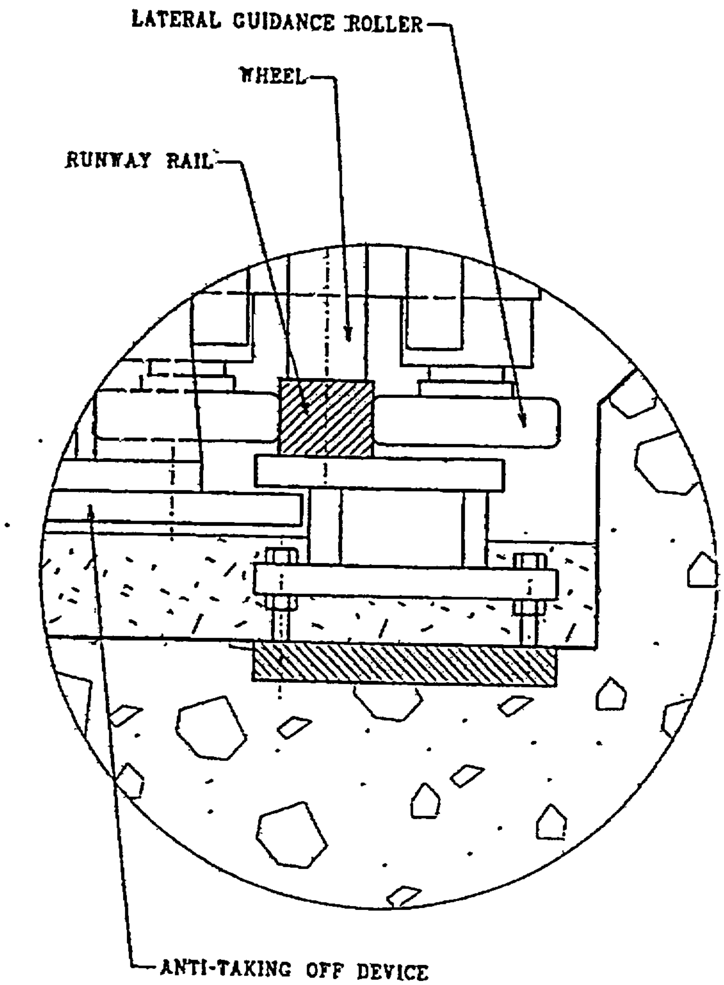


Figure 5.2-4

Receiving and Source Cask Mating Subsystem

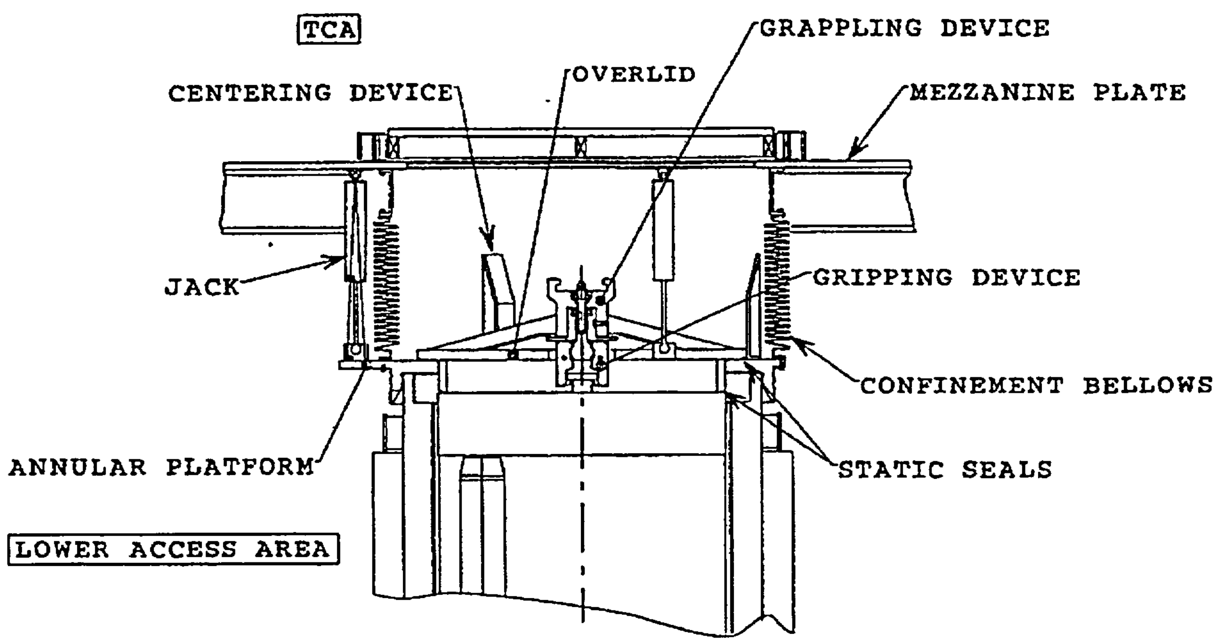


Figure 5.2-5

Gripping Device - Initial Open Position

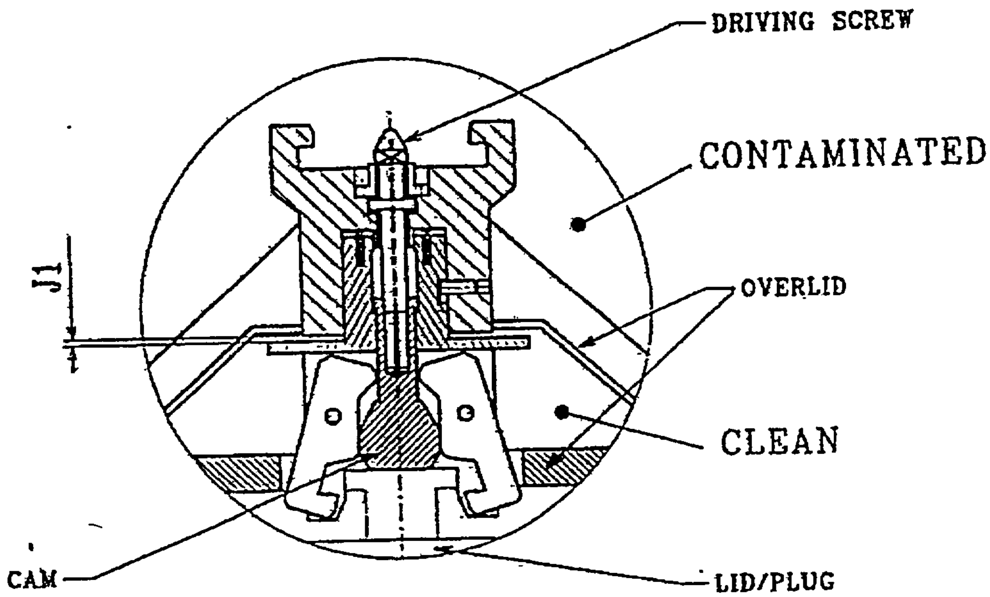


Figure 5.2-6

Gripping Device - Intermediate Position

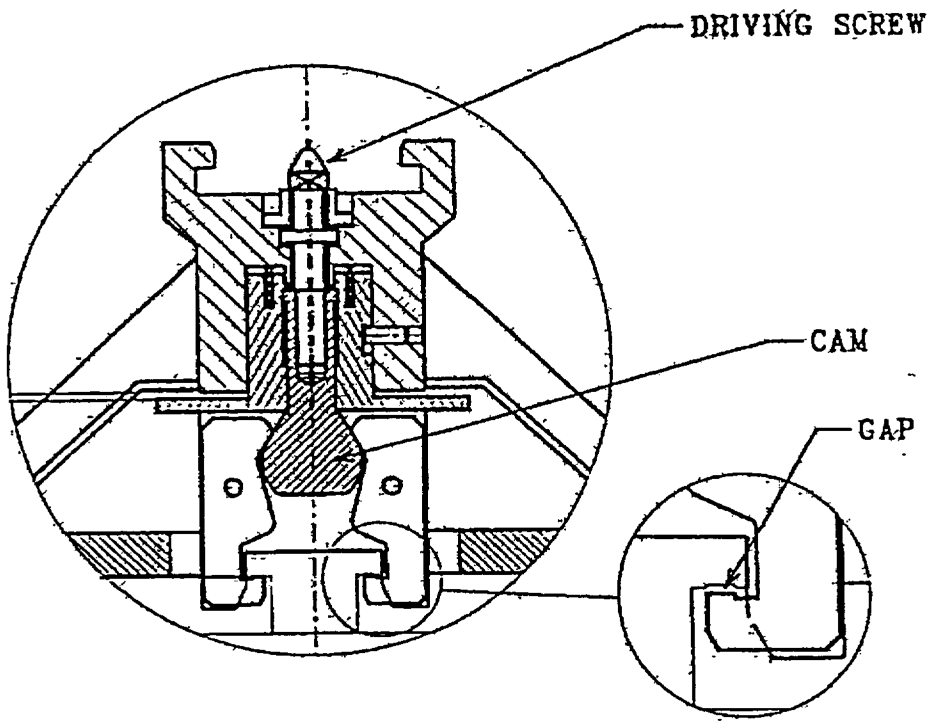


Figure 5.2-7

Gripping Device - Final Engaged Position

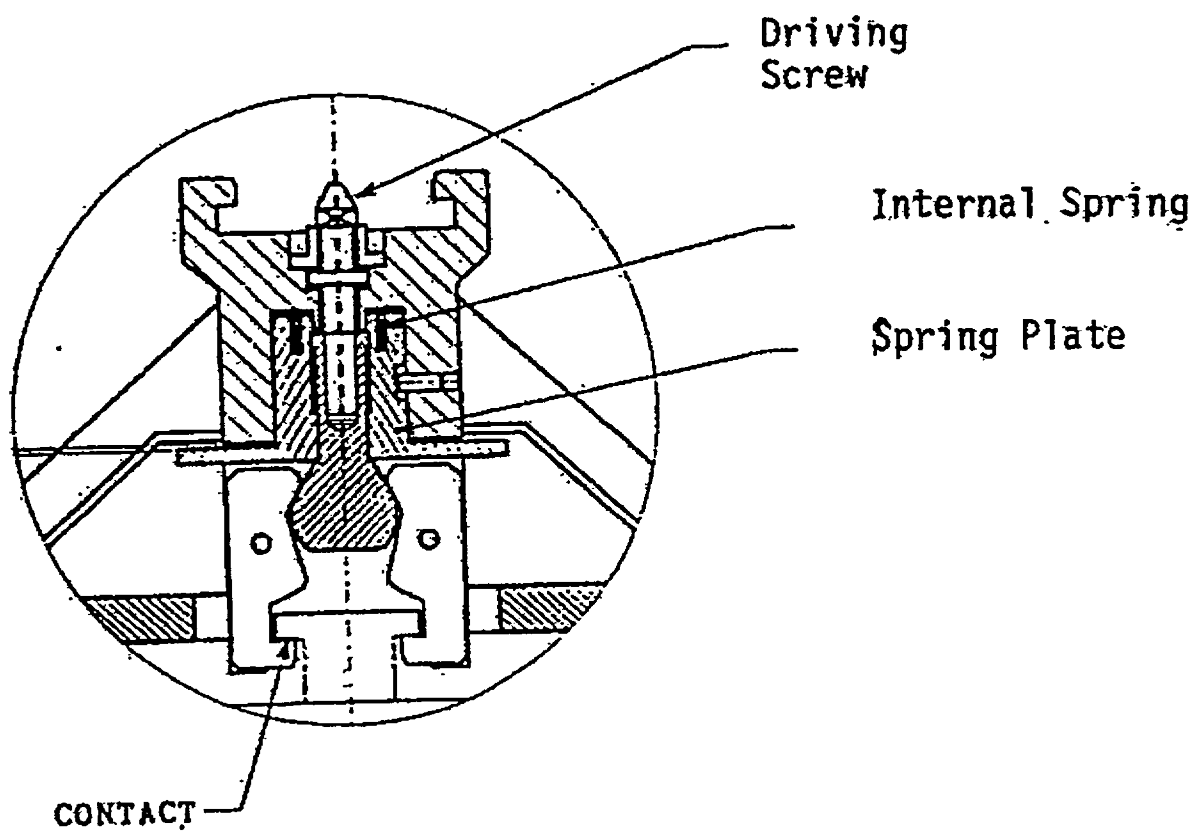


Figure 5.2-8

Dimensions of Gripping Device

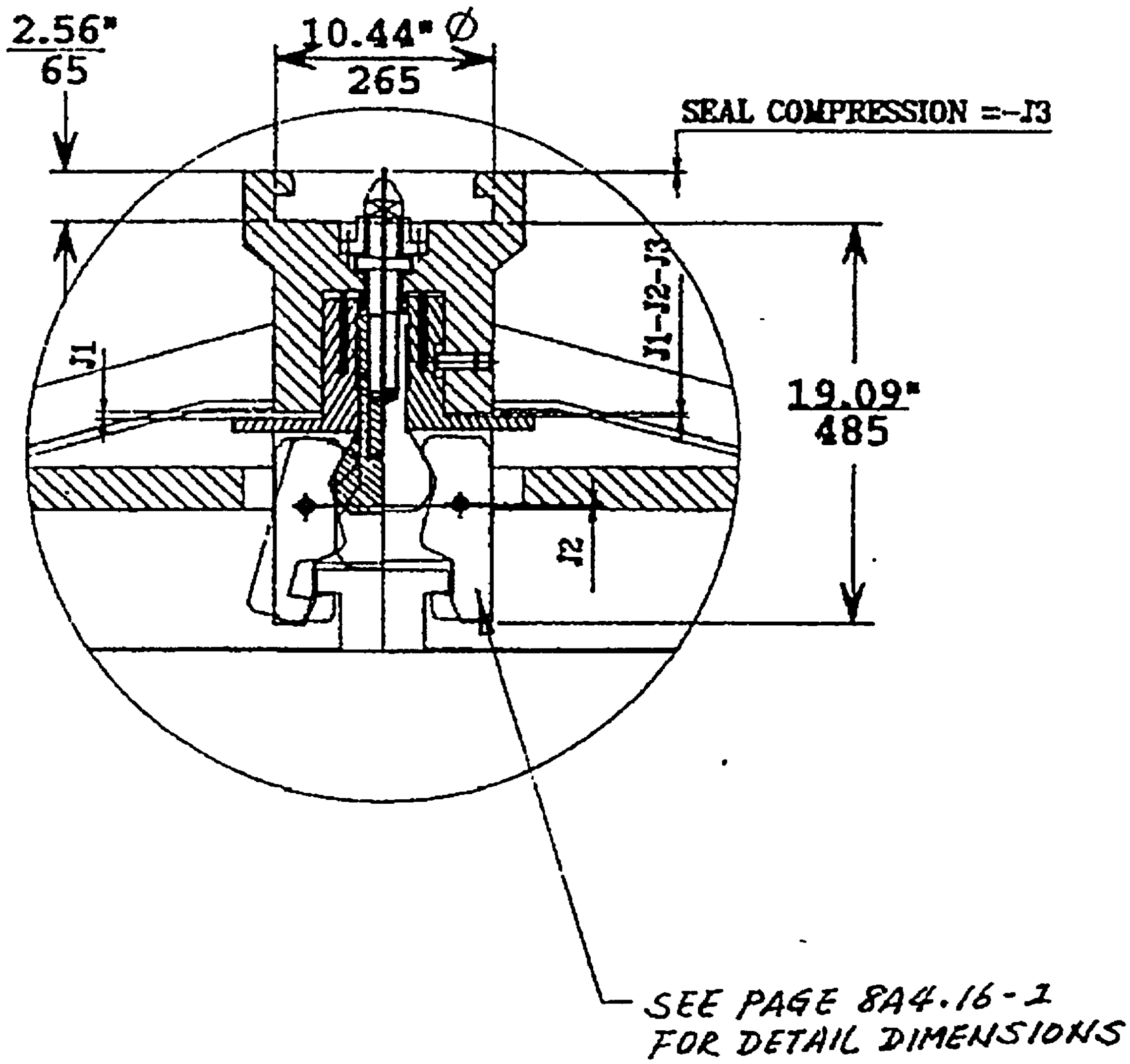


Figure 5.2-9

Confinement Bellows Schematic

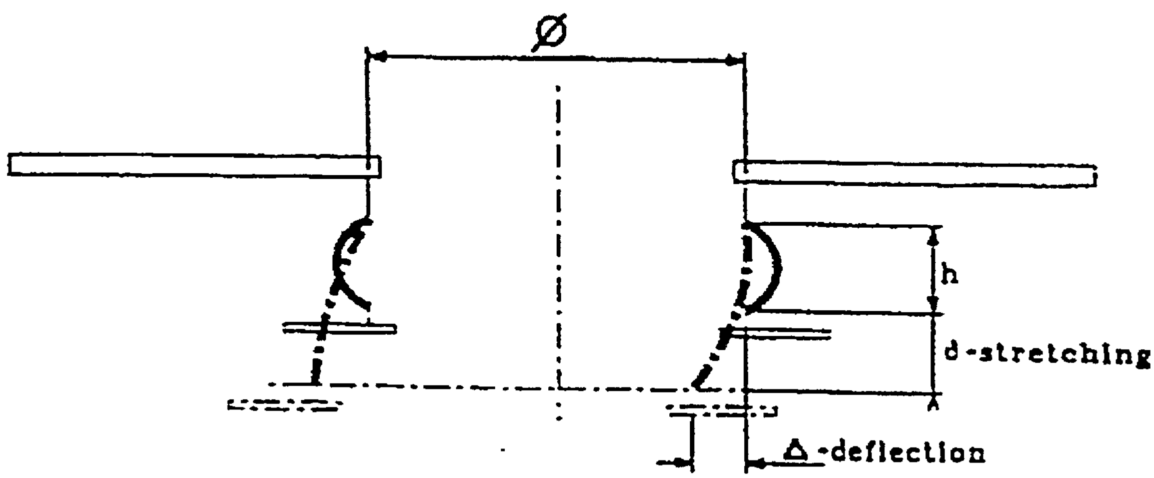


Figure 5.2-10

TC Port Cover Rails

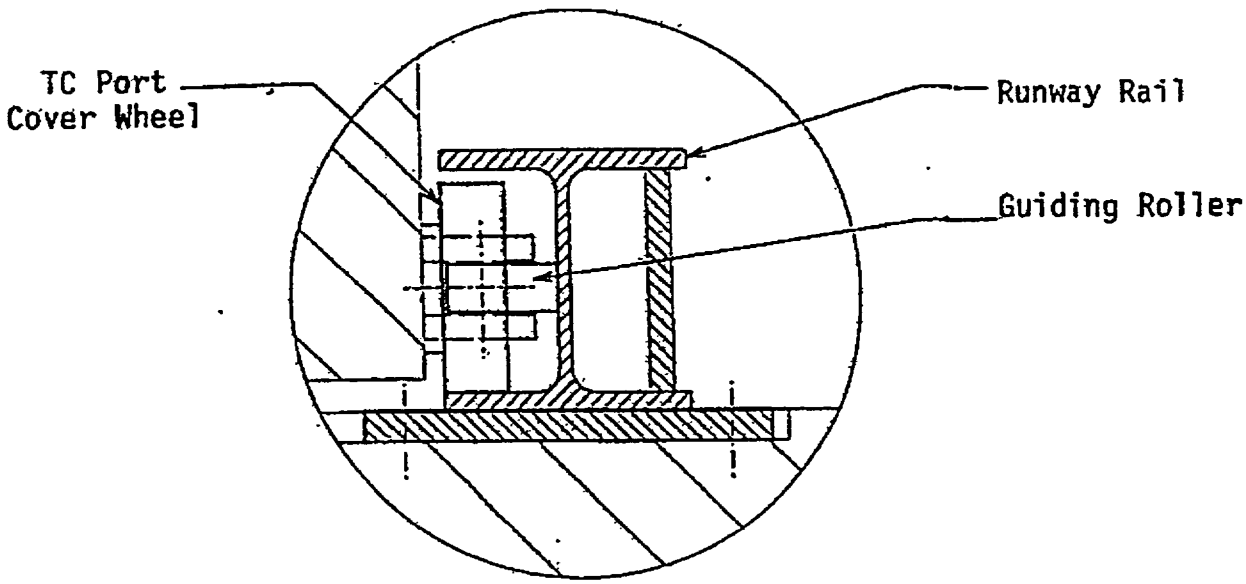


Figure 5.2-11

Upper Shield Port Cover Rails

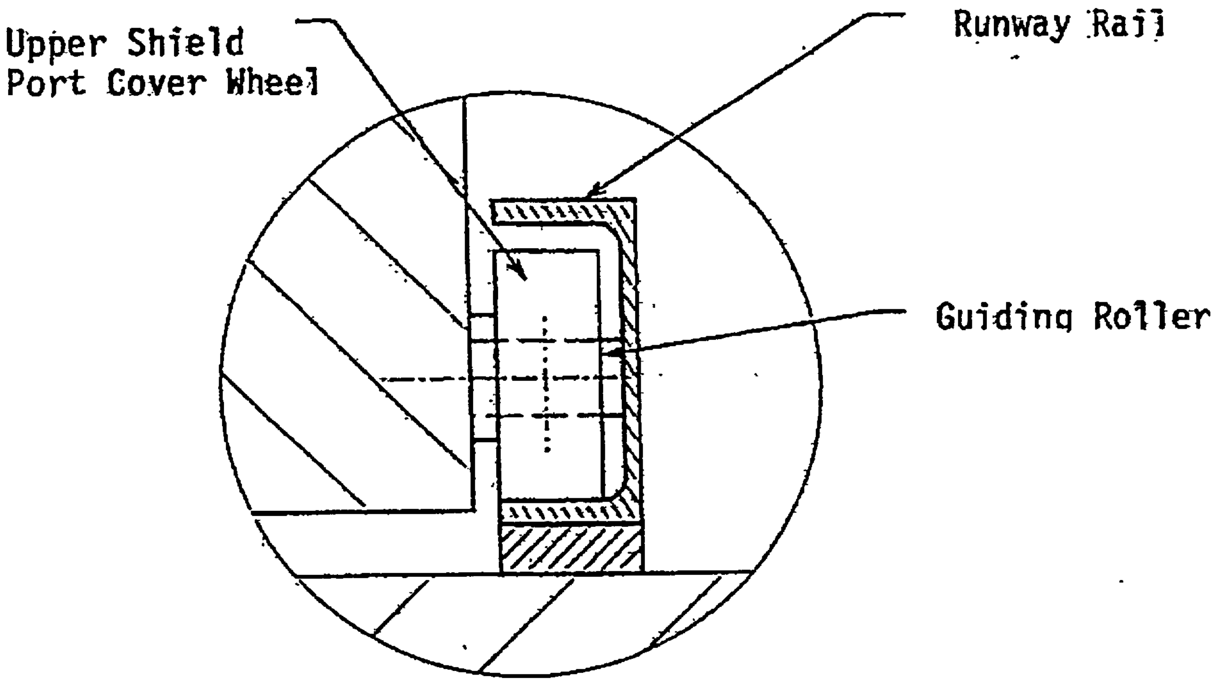


Figure 5.2-12

Upper Crane Trolley Rails

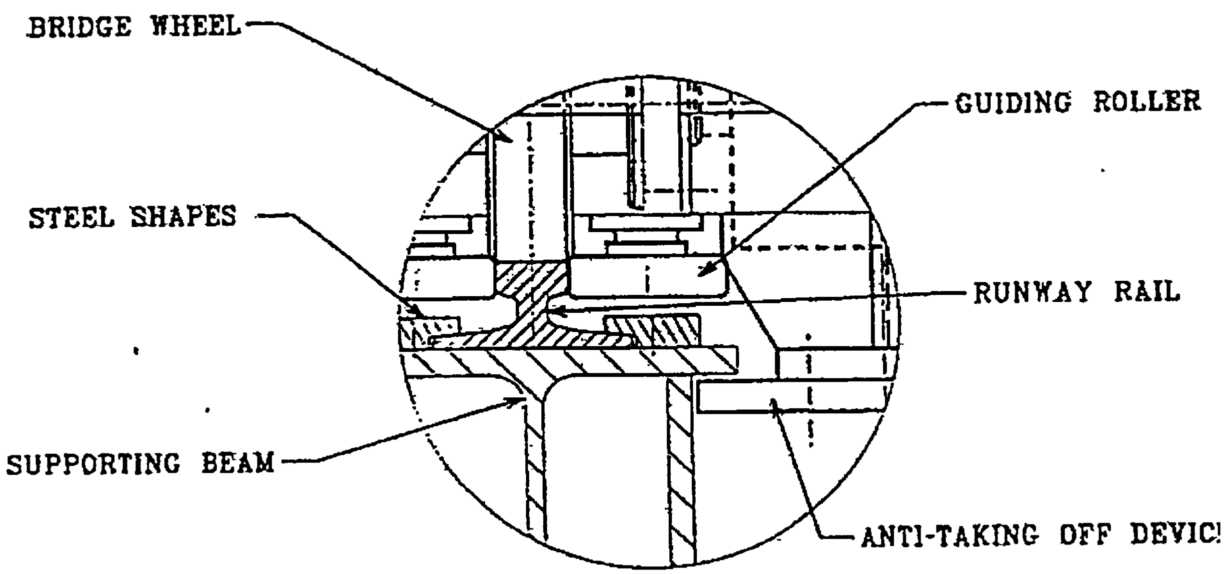


Figure 5.2-13

Upper Crane Trolley Anti-Derailing Device

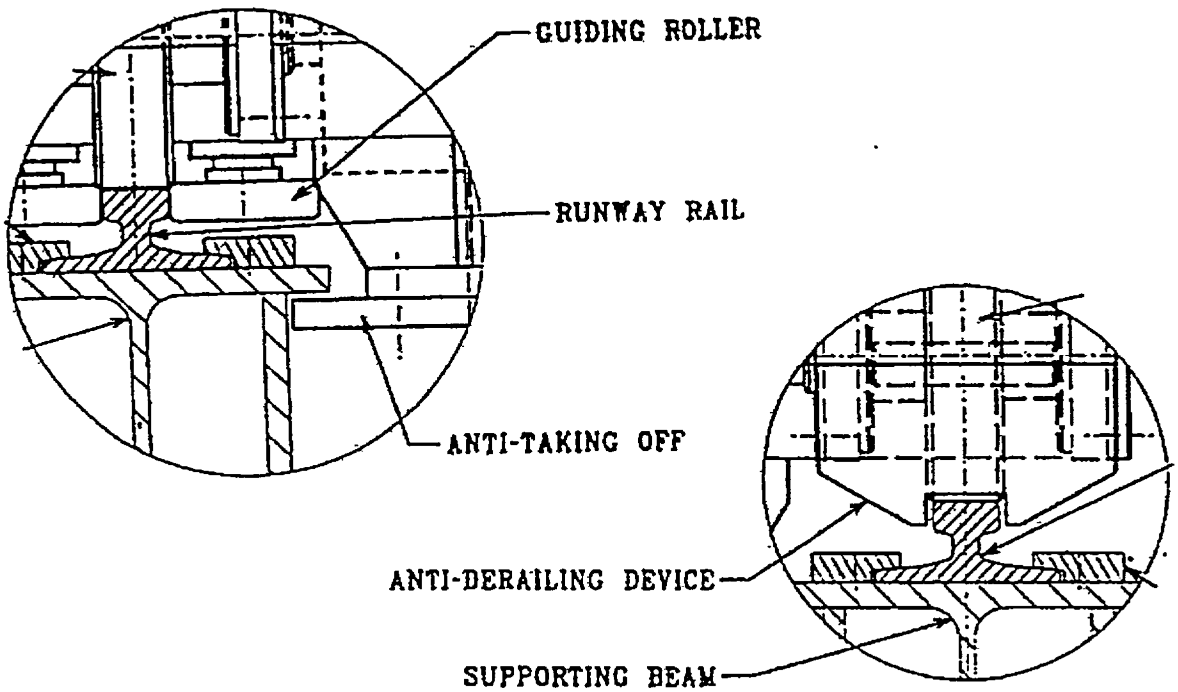


Figure 5.2-14

Upper Crane Hoist Motorization

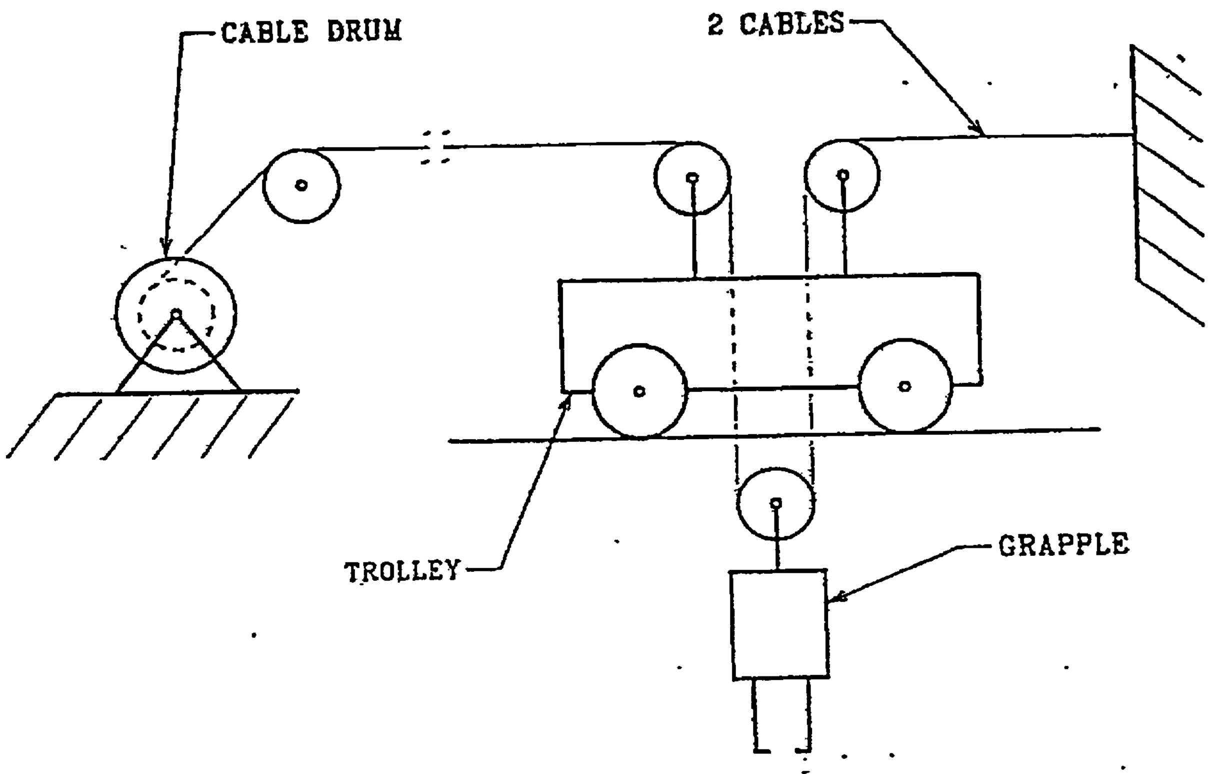


Figure 5.2-15

Upper Crane Kinematic Chain

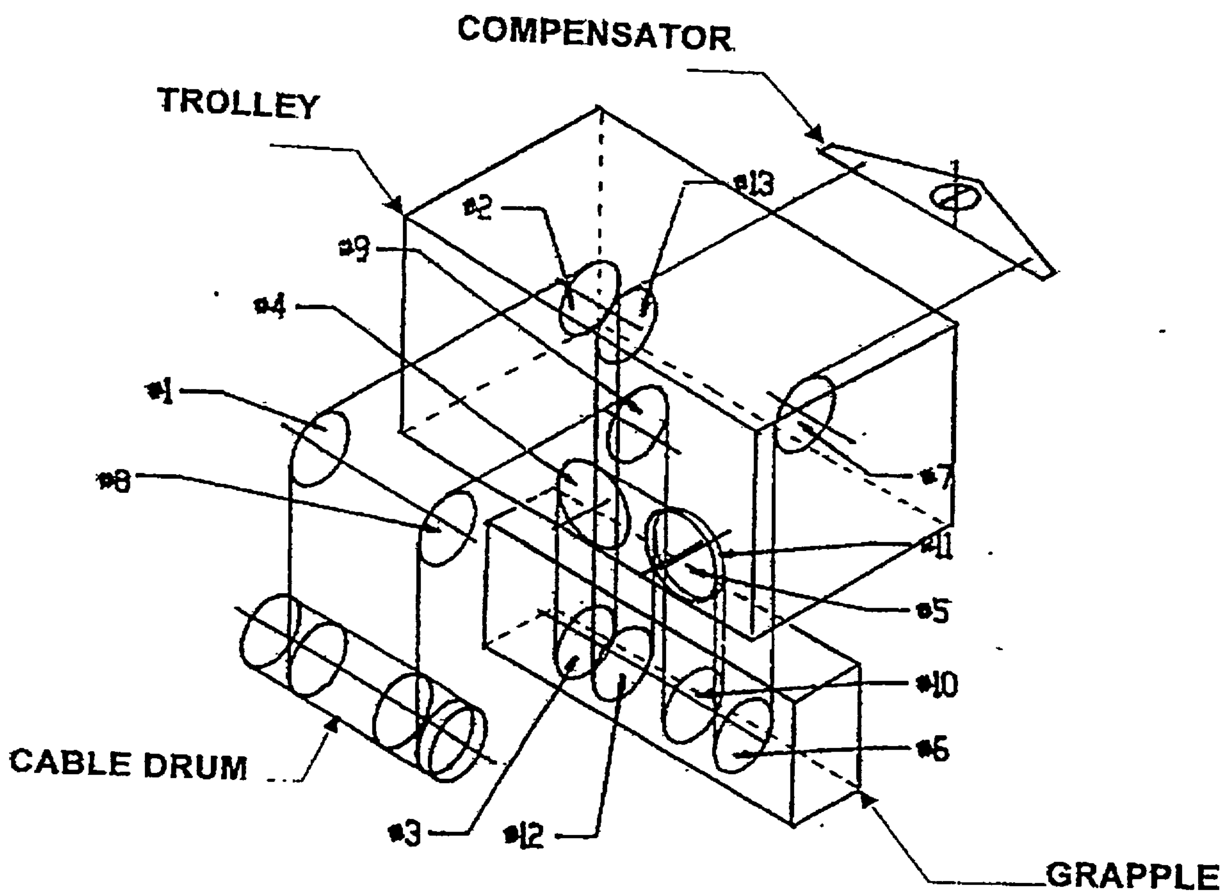


Figure 5.2-16

Upper Crane Motorized Grapple Showing Jacking Mechanism

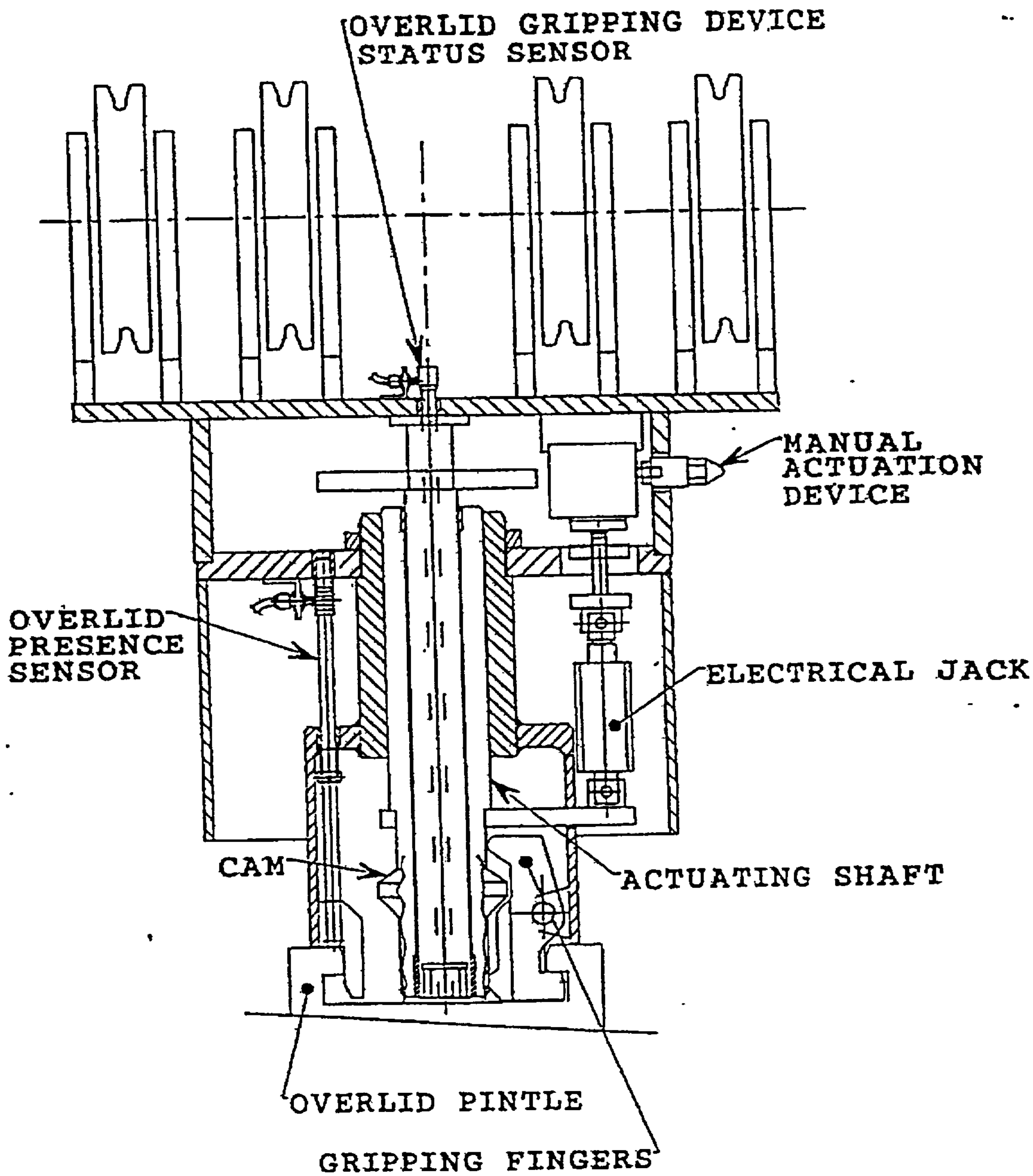


Figure 5.2-17

Upper Crane Motorized Grapple Showing Overlid Gripping Device Activation

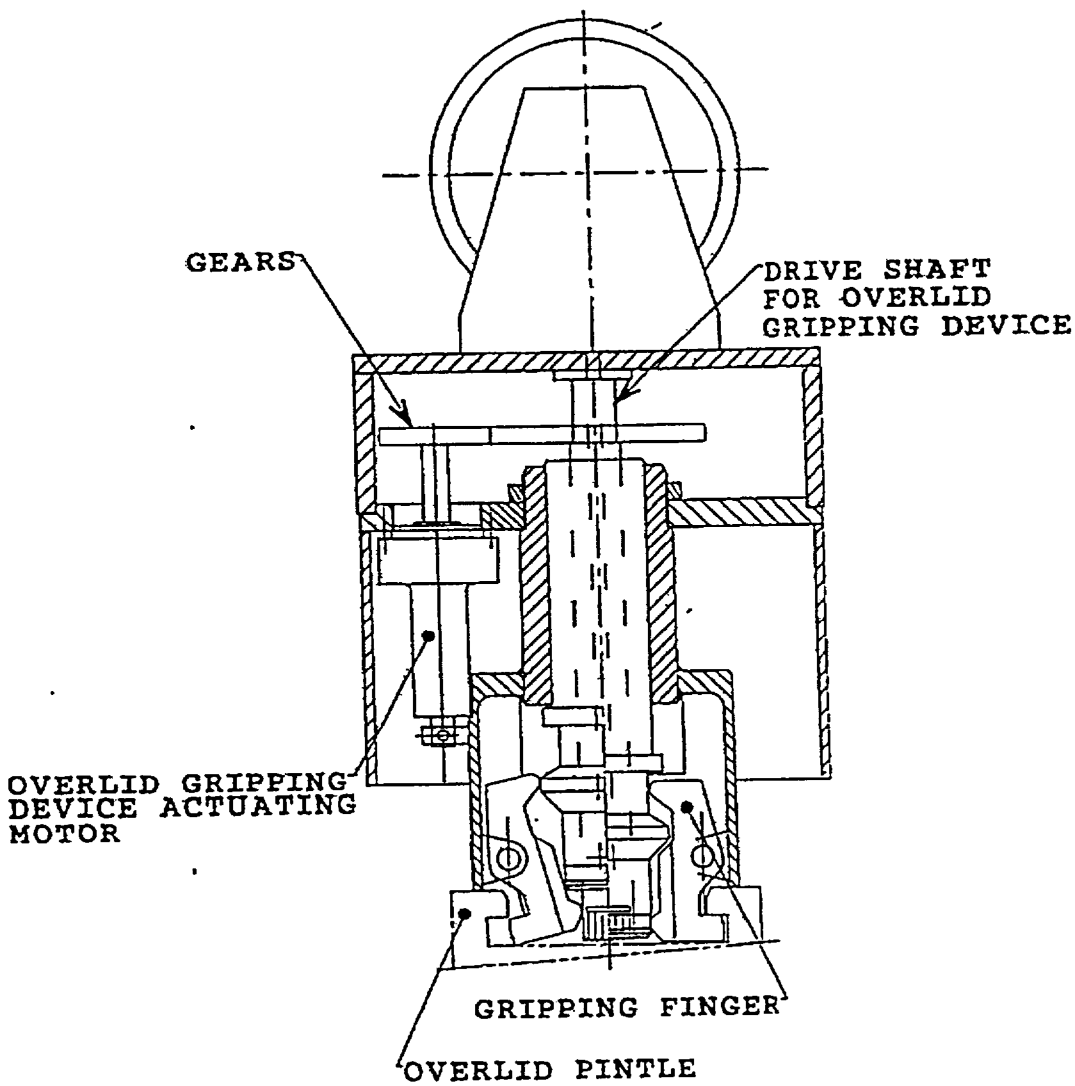
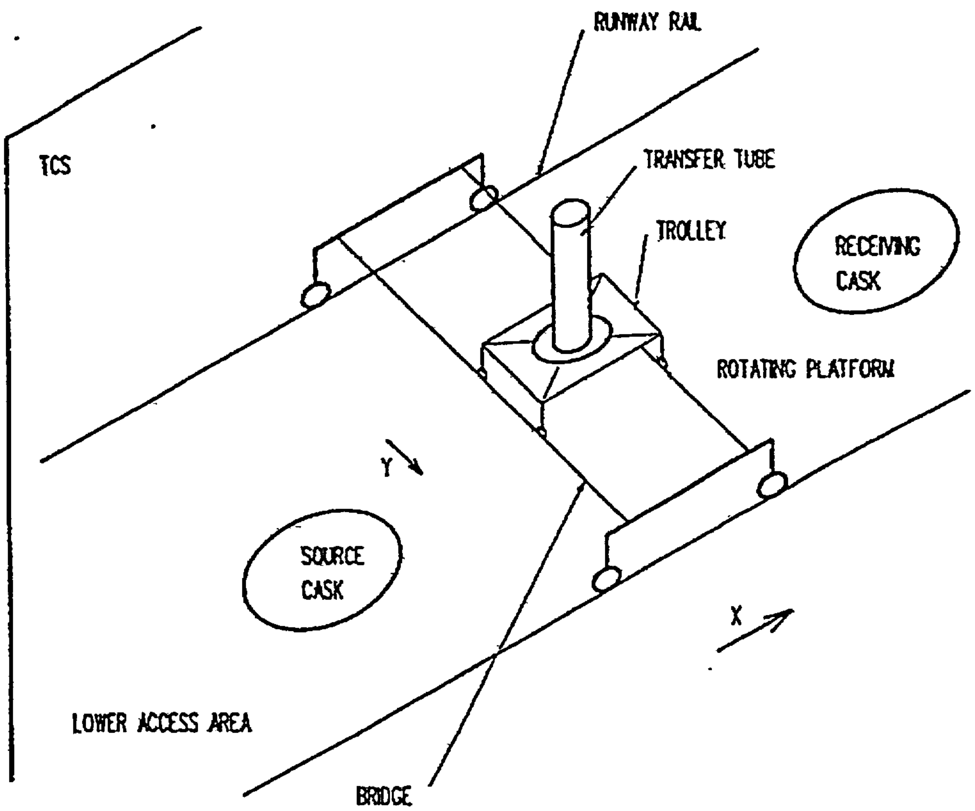


Figure 5.2-18

Fuel Assembly Handling Subsystem



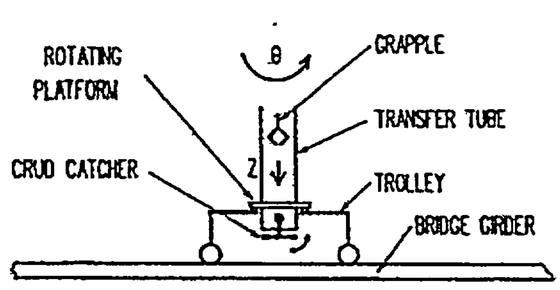


Figure 5.2-19

Fuel Handling Bridge Rail

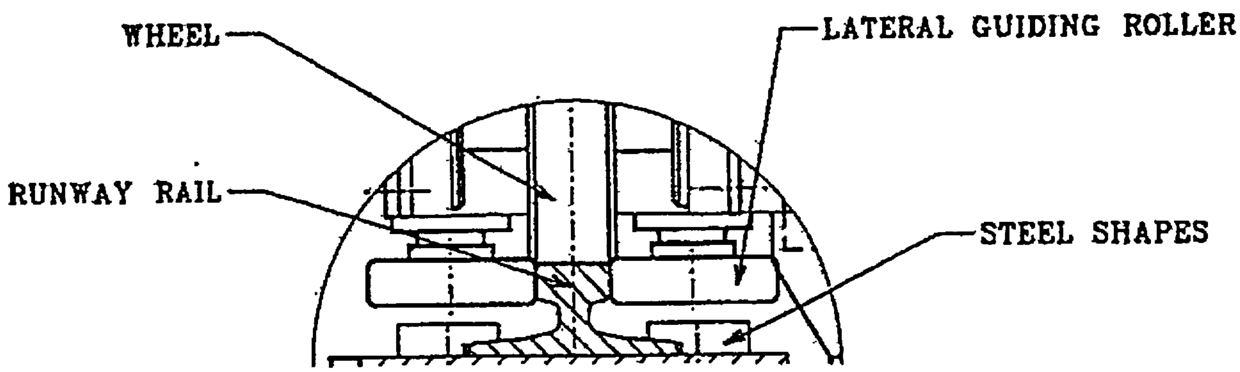


Figure 5.2-20

Fuel Handling Bridge Anti-Derailing Device

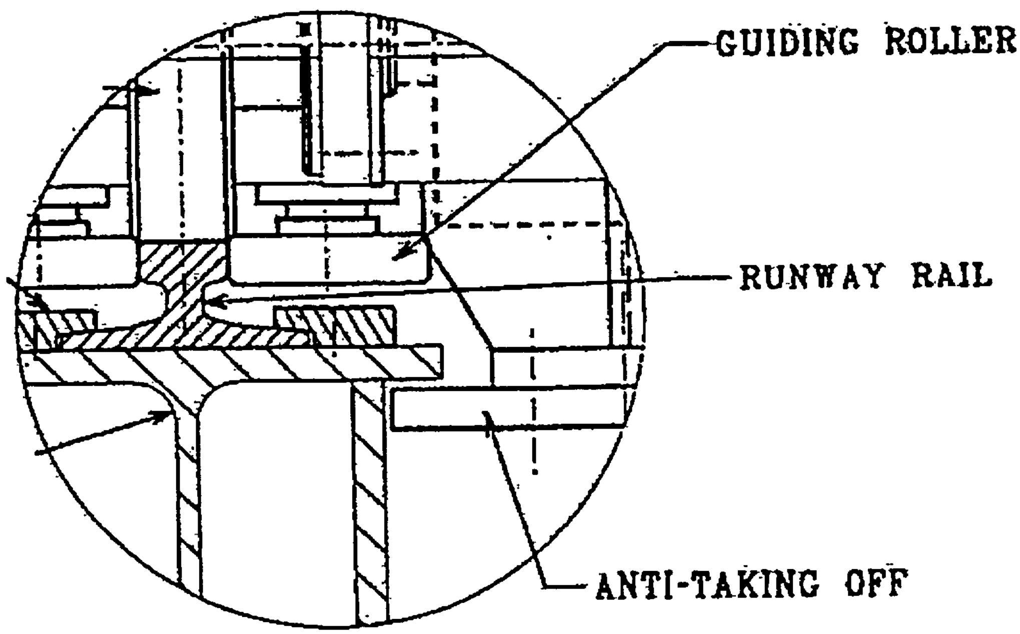


Figure 5.2-21

Fuel Handling Bridge Anti-Taking Off Device

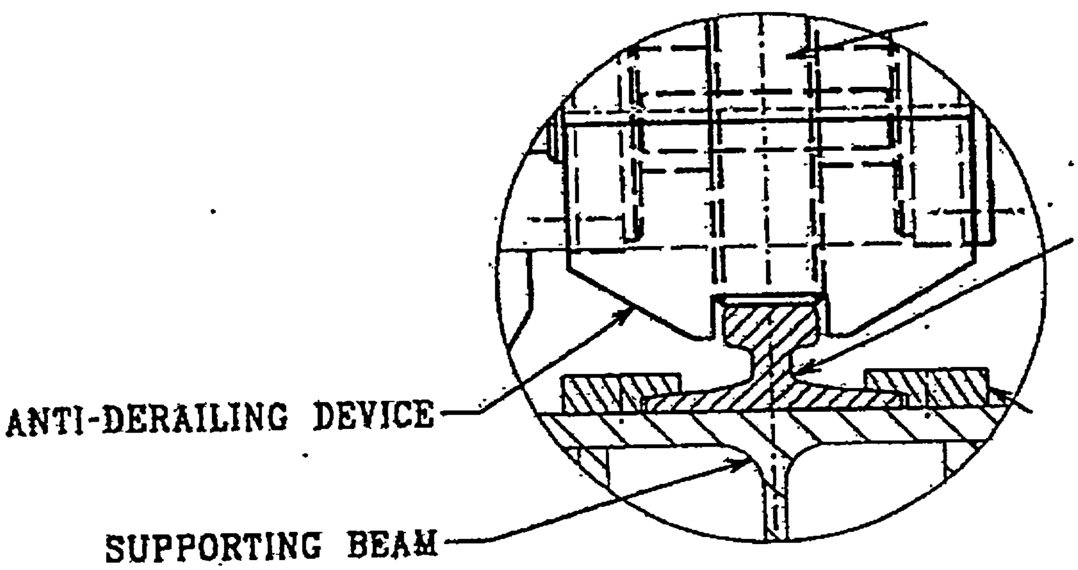


Figure 5.2-22

Schematic of Fuel Handling Bridge

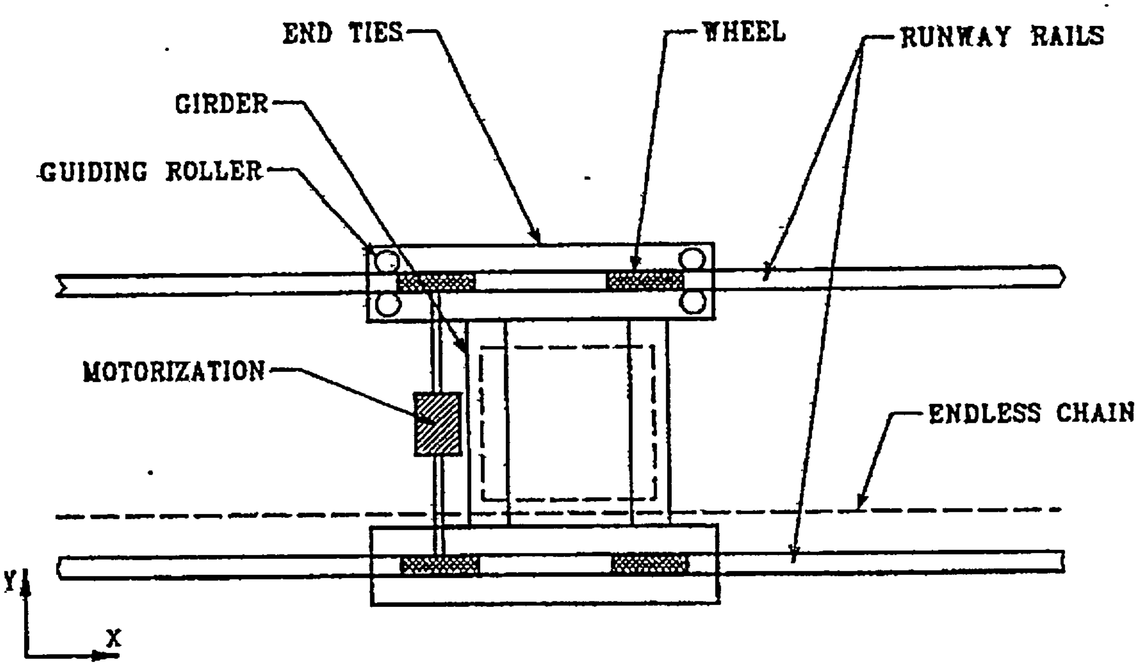


Figure 5.2-23

Fuel Assembly Handling Trolley

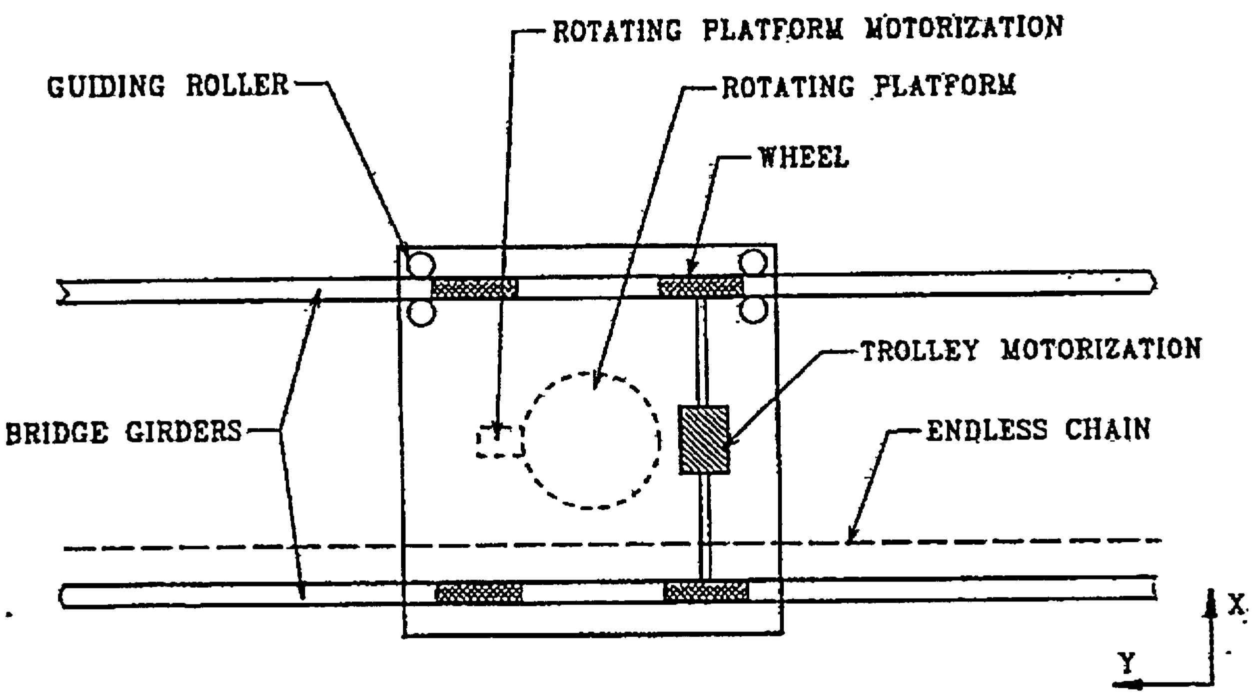


Figure 5.2-24

Fuel Assembly Handling Trolley Rail

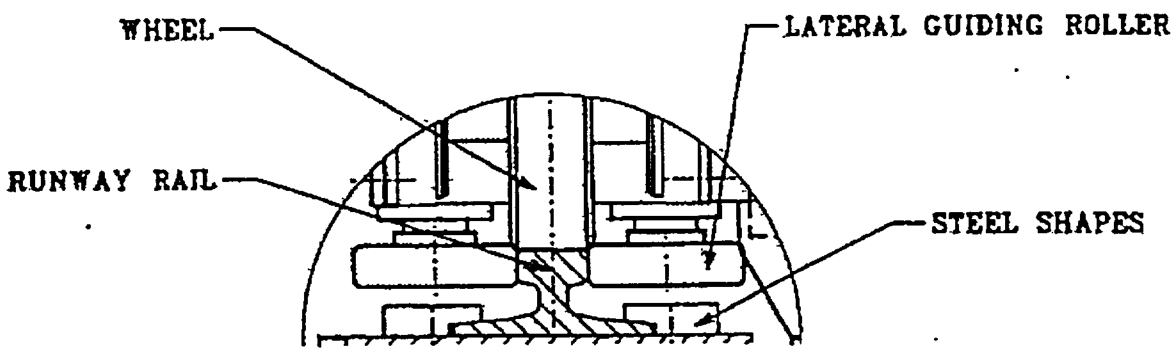


Figure 5.2-25

Fuel Assembly Handling Trolley Anti-Derailing Device

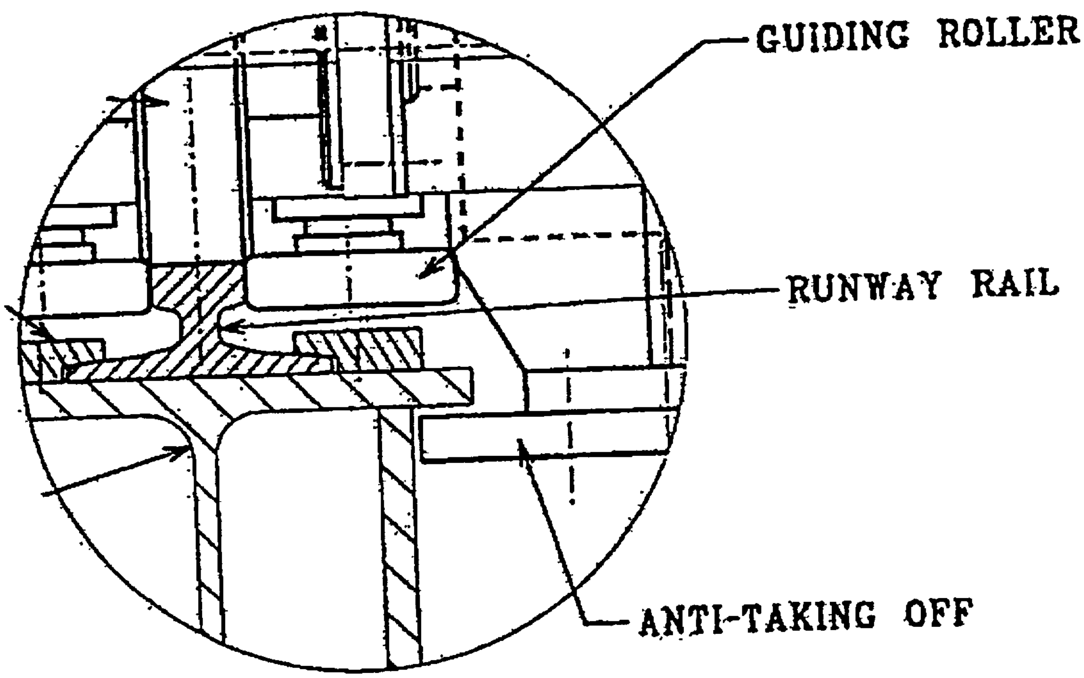


Figure 5.2-26

Rotating Platform Schematic

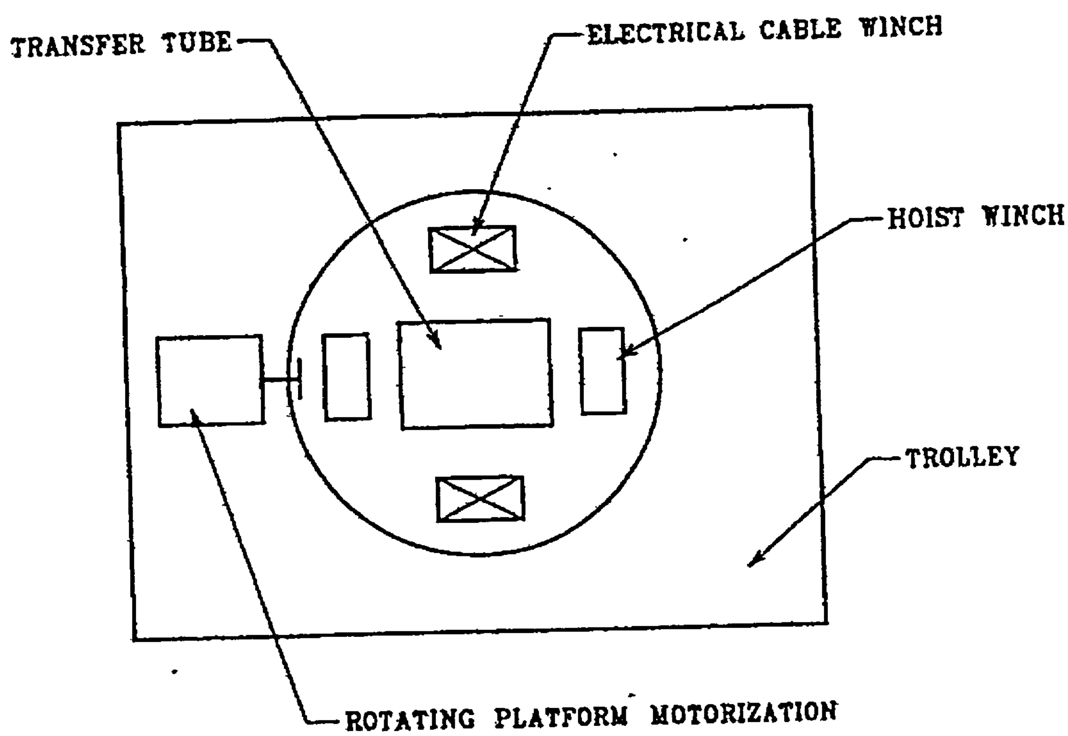


Figure 5.2-27

Fuel Assembly Hoisting System

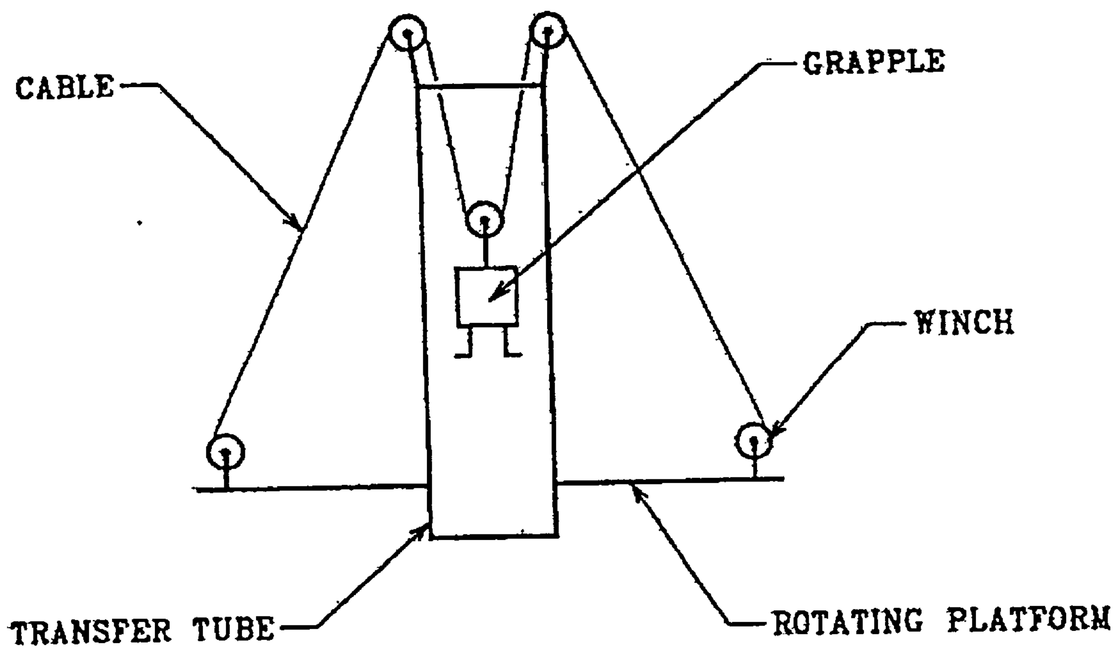


Figure 5.2-28

Fuel Handling Grapple

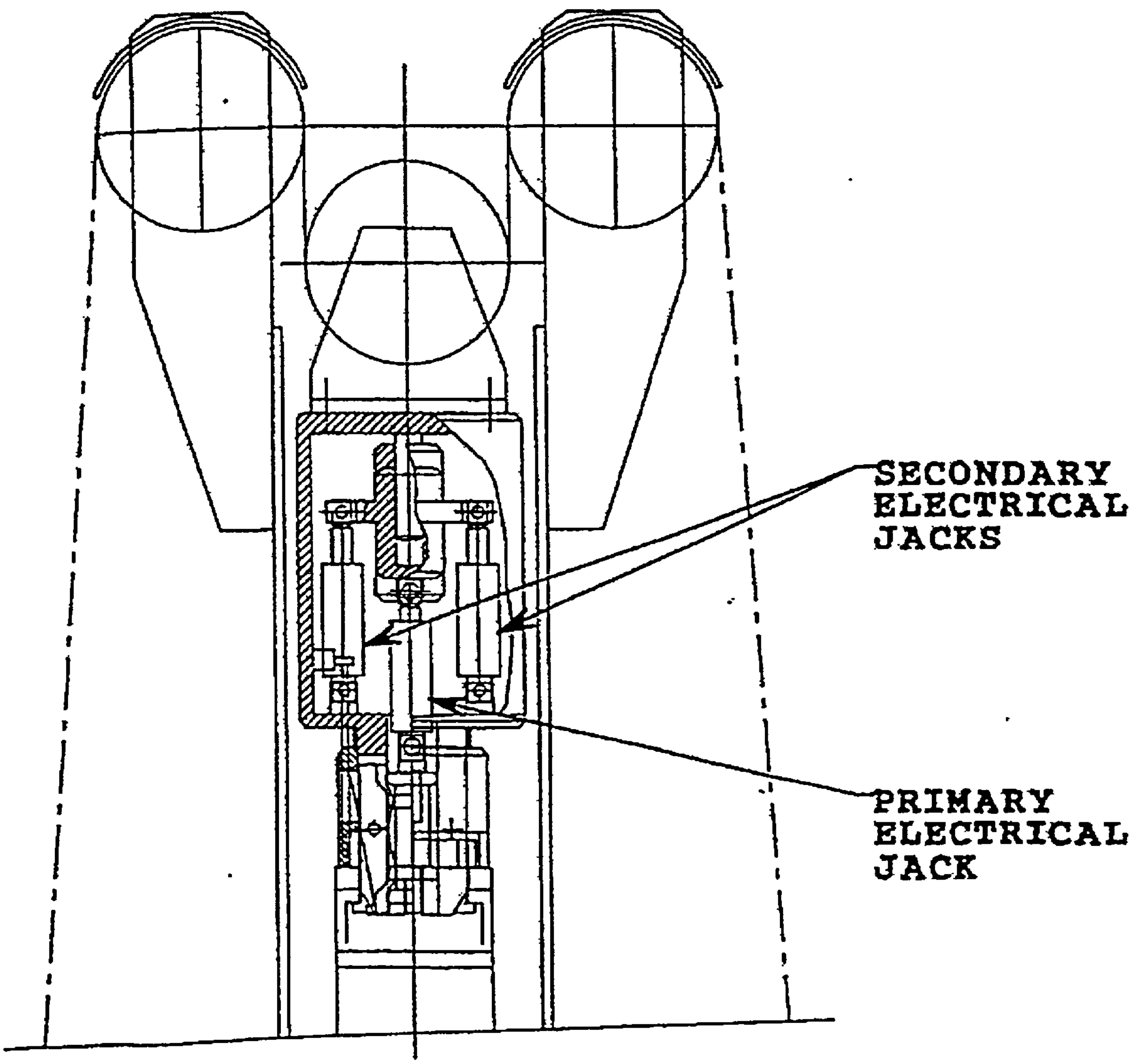
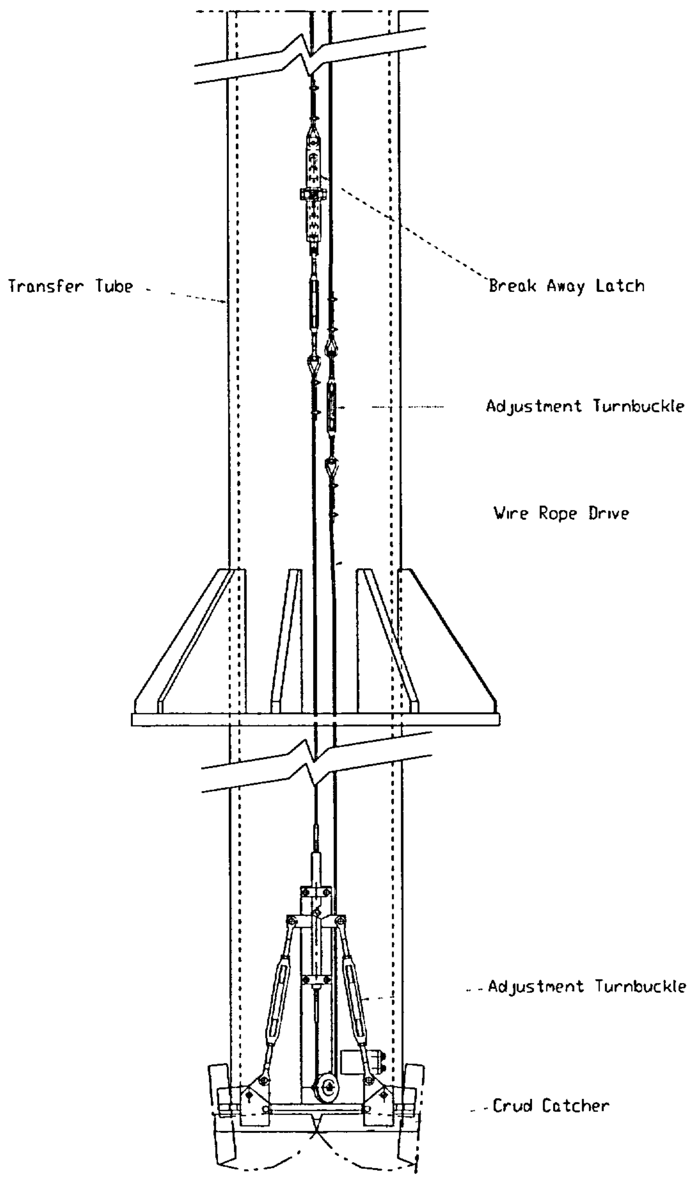


Figure 5.2-29

Crud Catcher



5.3 Other Operating Systems

5.3.1 HVAC Subsystem

The HVAC Subsystem is fully described in Section 4.3.1.

5.3.2 Welding Subsystem

The welding subsystem for welding the lids and shield plug will be adopted from the Department of Energy, based on the work performed on the Multi-Purpose Canister (MPC) program. This equipment will be fully described in the site specific applications.

5.3.3 Inerting Subsystem

The receiving cask will be inerted prior to final closure. The equipment required to perform the inerting will be adopted from the Department of Energy, based on the work performed on the MPC program. This equipment will be fully described in the site specific applications.

5.4 Operation Support Systems

5.4.1 Instrumentation and Control Systems

This section described the instrumentation and control features associated with operation control, monitors and alarms, and the relationship of one to the other. The details of the operational control system is provided in Appendix 5A.

Section 5.4.1.1 describes the structure of the Control System. Section 5.4.1.2 describes the control of the Cask Transfer Subsystem. Section 5.4.1.3 describes the control of the Cask Mating Subsystem. Section 5.4.1.4 describes the control of the Lid/Shield Plug Handling Subsystem. Section 5.4.1.5 describes the control of the Fuel Handling Subsystem.

5.4.1.1 Control System Structure

This section presents the structure of the Control System and describes the control and monitoring equipment used by the operator to safely conduct a fuel transfer cycle. The Control System does not perform any actions to recover from or mitigate the consequences of an accident. It does not, therefore, perform any "safety functions". The control system is used only as an operator interface to the equipment, to record fuel movements and to verify interlock conditions. In the event of a hardware/software failure all fuel movement will be stopped until repairs are made. The Instrumentation and Control Structural Diagram, Figure 5.4-1, provides a schematic view of the Control Subsystem structure. The operator/machine interfaces for the control and monitoring of equipment are located in three areas:

- the Control Center, located in a trailer outside of the DTS building;
- the Preparation Area; and
- the Lower Access Area.

The operations which are locally controlled and monitored in the Preparation Area are:

- the receiving and source cask transfer (including trolley entry, positioning, removal, locking, and unlocking);
- the rolling door and the sliding door (including rolling door opening and closing, sliding door opening, locking, unlocking and closing operations); and
- the receiving cask lids removal and replacement.

A panel indicating the radiation levels from each of the area radiation monitors in the DTS is present in the Preparation Area.

The operations in the Lower Access Area which are locally controlled and monitored are the receiving and source cask transfer (including transfer trolleys entry, positioning, removal, locking, and unlocking).

The radiation monitor in the Lower Access Area displays the radiation level in this area.

The operations which are remotely controlled and monitored in the Control Center are:

- the receiving and source cask mating;
- the receiving and source cask transfer confinement port cover opening/closing;
- the receiving cask shield plug and source cask lid removal and replacement: including upper shield ports opening and closing, upper crane positioning, grapple lowering and lifting; and
- the fuel assembly transferring.

The HVAC subsystem is controlled and monitored in the Control Center. A panel displaying the radiation levels from each of the radiation monitors in the DTS is provided in the Control Center, as well.

The instrumentation and monitors in the Control Center are described in Section 5.5. The instrumentation and monitoring equipment outside of the Control Center is described in the following sections.

The main control panel and the personal computer (PC) are linked to two Programmable Logic Controllers (PLC's) and to the Radiation Monitoring equipment. One PLC controls all the mechanical equipment, while the other controls the sliding door and the HVAC equipment.

When a control is requested, the PLC checks that all conditions are met for the operation to be performed, and that the interface between the Power Subsystem and the equipment is established. In the other direction, the sensors provide information to the PLC on the status and position of the equipment, and the PLC transmits this information to the PC to prompt the supervisor and to update the knowledge of the process in the instruction guide software and to the other PLC if the information constitutes an interface (as the mating status for example).

The second PLC regulates the HVAC equipment and triggers alarms when necessary.

The support of communication between the PC and the PLC's is a local network.

All alarms are, as much as possible, directly activated by the equipment which detects the problem. Therefore, the equipment, the instrumentation, the PLC and the PC are all linked to the alarm system.

Transition Conditions

Safe Operation of the DTS is provided by visual surveillance of all fuel transfer operations within the TCS. The Control System provides a backup to the visual surveillance to ensure that operator error does not result in an operation which is out of sequence or which could harm the equipment. Adherence to the operating sequence is achieved through administrative procedure.

The safety of the complete transfer cycle depends on the control of each operation.

The safety criteria is based on maintaining the integrity of the fuel assemblies, preventing damage to the source cask lid and receiving cask shield plug which would prevent proper closure, keeping radiation exposure to a minimum and ensuring that there is a means to recover from any failure of equipment. The primary means of safe operation is through visual confirmation of all operations and relies upon the operator following written procedures. However, the control system is equipped with an interlock system that prevents operations from being activated, if the prerequisite conditions are not achieved. The control system automatically checks the initial conditions and prevents operations from occurring which could result in improper operation of the DTS. Alarms are also used to alert the operator of off-normal conditions.

The results of operations or equipment status are used as conditions to allow the initiation of subsequent operations.

A transition condition can be necessary to process consecutive operations. The first validation, the administrative control and the interlocks (if applicable) guarantee the validation for the consecutive operations.

Each transition is classified in accordance to its importance:

- If the transition condition is only necessary for the operating process, it is classified as Operating.
- If the transition condition is important for confirming a safe status it is classified as Safety.

The means used to validate a transition condition depends on its level of importance. Most mechanical operations are monitored using the CCTV Subsystem. For operations that are important with respect to the operating sequence, the administrative control, the viewing provided by the CCTV Subsystem and the indications provided by the mechanical equipment (motorization status and device position) are sufficient to validate a transition. Operations that are important to safety are validated by the means described above and are also validated using interlocks between the equipment. These interlocks are managed by the PLC's.

Interlocks

All interlocks are implemented in software except over travel interlocks. Limit switches that prevent over travel, including over travel of the bridge, trolley, rotate platform and hoist, are wired directly to the associated motor control center and interrupt power to the associated motor if they are activated. Table 5.4-1 provides a list of the interlocks used to control operations.

Bypasses

In the case of a sensor-default, an accidental or equipment failure condition, the interlocks may prevent the initiation of related operations. To continue operating or to recover to a safe condition, the interlocks may need to be deactivated.

This deactivation or shunt is regulated (usage of passwords or keys) to prevent unauthorized or untrained personnel from performing the operation. Two different levels are implemented:

- Administrator level
- Operator level

Design and operation

Figure 5.4-1, Instrumentation and Controls Structural Diagram, shows all the major components of the control system. Controls for the Cask Transfer Subsystem and the Lower Access Area Shielding Door are located locally to these items and operate the associated motors directly. All other equipment is operated from controls located in a trailer external to the transfer building. Central to the operation of the controls in the remaining subsystems, is a PLC which implements majority of the operational logic, and whose internal software also contains all of the interlocks. As shown by the diagram, inputs to the PLC include position resolvers for the bridge, trolley and hoist, load cells and various limit switches.

The operator commands for fuel movement operations can be input to the PLC using a PC based computer running a commercially available Man Machine Interface (MMI) program. In addition to providing the operator interface, the PC will record all machine movements and alarm conditions. The PC and MMI program will be chosen to properly handle time and date functions over the expected life of the facility. The PLC will not be used for any time or date functions. It should be noted that operator controls, consisting of lights and switches directly connected to the PLC, could be used in place of the PC if the automatic recording functions and a graphical operator interface are not desired by a specific installation.

The PLC and the power distribution panels are located in a protected area within the transfer system building. The PC interface to the PLC is located in a trailer external to the building. Cables connect the equipment located in the trailer, with the PLC and the site power through connectors external to the DTS. These connectors will be selected to allow easy replacement, if necessary. No active electronic components, except for load cell pre-amplifiers, are located within the radiation areas of the DTS building. There are no emergency events that require response by the control system. In the event of a control system malfunction due to failure of a component outside the fuel transfer area, all fuel movement activities will be stopped until repairs are made. Each site will be responsible for having the appropriate kind and quantity of spare parts and special tools to make the repairs. Functional redundancy has been provided for components inside the radiation area. That is, two hoists have been supplied, the grapple is provided with two actuators and the CCTV system allows viewing equipment positions as a check on resolver accuracy. In addition, limit switches provide a backup to prevent over travel of the bridge, trolley, hoist and rotate platform. Wiring inside the radiation areas to the hoist motors and grapple actuators will be kept physically separated. Access ports allow the bridge, trolley, and rotating platforms to be moved using long handled tools in the event of motor failure on one of these components. In the event of a failure of a component inside the radiation area, fuel in transfer will be placed in a cask, the cask covers will be replaced and repairs will be made.

All control logic, except for over travel conditions, is performed by the PLC. The PLC programming will include validity checks to assure operator commands received from the PC are valid, thereby providing protection against failure of the PC MMI programming in addition to operator errors. To protect against failures of the PLC, over travel limit switches are wired to bypass the PLC and directly cut off power to the associated motors. In addition, the operator is provided with an "Emergency Stop" switch that he can use to cut off power to all motors in the event a PLC failure causes unexpected motion.

Table 5.4-1

Interlocks

Interlock Acronym	Source equipment	Sensor	Interlocked Equipment	Prevention description
I-CRC	Crud catcher	YL 119A YL 119B	Fuel assembly handling crane carriage (bridge and trolley)	Any motion of the fuel assembly handling crane carriage if the crud catcher is not in closed position
			Rotating platform	Any motion of the rotating platform if the crud catcher is not in closed position
			Fuel assembly handling hoist system	Lowering of the fuel assembly grapple if the crud catcher is not opened
I-FAHCC	Fuel assembly handling crane carriage (bridge and trolley)	No transmitter	Receiving and Source Casks TC port covers and locking devices	Unlocking and closing of any TC port cover if the fuel assembly handling crane carriage is in motion.
			Crud catcher	Opening of the crud catcher if the fuel assembly handling crane carriage is in motion.
			Fuel assembly handling hoist system	Lowering of the fuel assembly grapple if the fuel assembly handling crane carriage is in motion.
I-FAHG	Fuel assembly handling grapple	YL 116B YL 116A YLS 117	Fuel assembly handling hoist system	Lifting of the fuel assembly grapple if it is not totally connected or disconnected
			Receiving and Source Casks TC port covers and locking devices	Unlocking and closing of any TC port cover if the fuel assembly grapple is engaged
			Receiving and Source Cask upper shield ports and locking devices	Unlocking and opening of any upper shield port if the fuel assembly grapple is engaged

Table 5.4-1 (Continued)

Interlocks

Interlock Acronym	Source equipment	Sensor	Interlocked Equipment	Prevention description
I-FAHHAP	Fuel assembly handling hoist system	ZIT 109	Fuel assembly handling grapple	Disconnecting the fuel assembly if the fuel assembly grapple is not in a proper position
I-FAHHLC	Fuel assembly handling hoist system	WIT 115	Fuel assembly handling grapple	Disconnecting the fuel assembly if the hoist is loaded
			Receiving and Source Casks upper shield ports and locking devices	Unlocking and opening of any upper shield port if the fuel assembly handling hoist is loaded
			Receiving and Source Casks TC port covers and locking devices	Unlocking and closing of any TC port cover if the fuel assembly handling hoist is loaded
I-FAHHUP	Fuel assembly handling hoist system	ZSH 109	Fuel assembly handling crane carriage (bridge and trolley)	Any motion of the fuel assembly handling crane carriage if the fuel assembly grapple is not in its upper z position
			Rotating platform	Any motion of the rotating platform if the fuel assembly grapple is not in its upper z position
			Crud catcher	Closing of the crud catcher if the fuel assembly grapple is not in its upper z position
I-FAHPP	Fuel assembly handling crane carriage (bridge and trolley)	ZIT 101 ZIT 104	Lid/shield plug handling hoist system	Lowering and lifting of the lid/shield plug grapple if the crane carriage is not stopped in parking position

Table 5.4-1 (Continued)

Interlocks

Interlock Acronym	Source equipment	Sensor	Interlocked Equipment	Prevention description
I-LSPHAP	Lid/shield plug handling hoist system	ZIT 307	Lid/shield plug grapple	Disconnecting of the lid/shield plug if the grapple is not in the proper position
			Receiving and Source Casks TC port covers	Closing of any TC port cover if the lid/shield plug handling hoist system is not above the position of the shield plug overlid on the TC port cover level
I-LSPHGP	Lid/shield plug handling grapple	YL 311A YL 311B YLS 310 ZL 315A ZL 315B	Lid/shield plug handling hoist system	Lifting of the lid/shield plug handling grapple if the grapple is not totally connected or disconnected (including overlid)
I-LSPHLC	Lid/shield plug handling load cell	WIT 309	Lid/shield plug handling grapple	Disconnecting the lid/shield plug if the cables are loaded
I-LSPHUP	Lid/shield plug handling hoist system	ZLL 307	Receiving and Source Casks upper shield ports	Closing of any upper shield port if the lid/shield plug grapple is not stopped in its upper z position
			Upper crane	Any motion of the upper crane if the lid/shield plug grapple is not stopped in its upper z position
I-RM-UL	Radiation monitoring at the upper level	RAH 905	Receiving and Source Casks upper shield ports and locking devices	Unlocking and opening of any upper shield port if the radiation level is too high
I-RM-SD	Radiation monitoring Lower Access Area	RAH 903	Sliding door	Opening of the sliding door in case of high radiation levels in the Lower Access Area

Table 5.4-1 (Continued)

Interlocks

Interlock Acronym	Source equipment	Sensor	Interlocked Equipment	Prevention description
I-RP	Rotating platform	No transmitter	Fuel assembly handling hoist system	Lowering of the fuel assembly grapple if the rotating platform is not stopped
I-RP	Rotating Platform	None	Crud catcher	Opening of the crud catcher if the rotating platform is not stopped
I-SDLD	Sliding door locking device	YL 801A YL 801B YL 801C YL 801D	Receiving and Source Casks TC port covers	Opening of any TC port cover if the sliding door is not locked in closed position
I-TCPC-RC-C	Receiving Cask TC port cover	ZS 317B	Source Cask upper shield port	Opening of the Source Cask upper shield port if the Receiving Cask TC port cover is not in the closed or off centered position
I-TCPC-RC-C	Receiving Cask TC port cover	ZS 317B	Source Cask upper shield port	Opening of the Source Cask upper shield port if the Receiving Cask TC port cover is not in the closed or off centered position
I-TCPC-RC-O	Receiving Cask TC port cover	ZS 317A	Receiving Cask TC port cover locking device	Locking of the Receiving Cask TC port cover if the port cover is not in open position
I-TCPCLD-RC	Receiving Cask TC port cover locking device	YL 318A YL 318B	Fuel assembly handling crane carriage (bridge and trolley)	Any motion of the fuel assembly handling crane carriage if the Receiving Cask TC port cover is not locked in opened position

Table 5.4-1(Continued)

Interlocks

Interlock Acronym	Source equipment	Sensor	Interlocked Equipment	Prevention description
I-TCPC-RC-OC	Receiving Cask TC port cover	ZS 317C	Source Cask upper shield port	Opening of the Source Cask upper shield port if the Receiving Cask TC port cover is not in closed or off centered position
I-TCPC-SC-CSource Cask TC port cover	ZS 315B	Receiving Cask upper shield port	Opening of the Receiving Cask upper shield port if the source cask TC port cover is not in closed position	
I-TCPC-SC-OI-TCPC-SC-O	Source Cask TC port cover	ZS 315A	Source Cask TC port cover locking device	Locking of the source cask TC port cover if the port cover is not in open position
I-TCPCLD-SC	Source Cask TC port cover locking device	YL 316A YL 316B	Fuel assembly handling crane carriage (bridge and trolley)	Any motion of the fuel assembly handling crane carriage if the Source Cask TC port cover is not locked in open position
I-TTLD-RC	Transfer trolley for the Receiving Cask locking device	YL 405C	Receiving Cask mating flange electric jacks	
I-TTLD-SC	Transfer trolley for the Source Cask Locking Device	YL 404C	Source Cask Mating flange electric jacks	Lowering of the source cask mating flange if the source cask transfer trolley locking device is not in locked position

Table 5.4-1 (Continued)

Interlocks

Interlock Acronym	Source equipment	Sensor	Interlocked Equipment	Prevention description
I-USP-RC-C	Receiving cask upper shield port	ZS 302B	Upper Crane	Any motion of the upper crane if the receiving cask upper shield port is not in closed position
			receiving cask upper shield port locking device	Locking of the receiving cask upper shield port if it is not in open or closed position
			source cask upper shield port	Opening of the source cask upper shield port if the receiving cask is not in closed position
I-USP-SC-C	Source cask upper shield port	ZS 301B	upper crane	Any motion of the upper crane if the source cask upper shield port is not in closed position
			source cask upper shield port locking	locking of the source cask upper shield port if it is not in open or closed position
			receiving cask upper shield port	opening of the receiving cask upper shield port if the source cask upper shield port is not closed
I-USPLD-RC	receiving cask upper shield port locking device	YL 313A YL 313B	Fuel assembly handling crane carriage (bridge and trolley)	Any motion of the fuel assembly handling crane carriage if the receiving cask upper shield port is not locked in closed position
			Source cask TC port cover	Opening of the source cask TC port cover if the receiving cask upper shield port is not locked (in closed position)
			Upper Crane Grapple	Any motion of the upper crane grapple if the receiving cask upper shield port is not locked in the open position

Table 5.4-1 (Continued)

Interlocks

Interlock Acronym	Source equipment	Sensor	Interlocked Equipment	Prevention description
I-USPLD-SC	Source Cask upper shield port locking device	YL 312A YL 312B	Fuel assembly handling crane carriage (bridge and trolley)	Any motion of the fuel assembly handling crane carriage if the Source Cask upper shield port is not locked in closed position
			Receiving Cask TC port cover	Opening of the Receiving Cask TC port cover if the Source Cask upper shield port is not locked (in closed position)
			Upper Crane Grapple	Any motion of the upper crane grapple if the source cask upper shield port is not locked in the open position

One unique administrator is able to associate users, passwords and the bypasses that they can use. The operators are able to use the bypasses defined by the administrator.
Any transition between process operations being interlocked has the possibility to be bypassed, in order to allow recovery to a safe condition and testing of the equipment.

During integration, the following tests are implemented:

- all the software (for PC and PLC) unit level are tested to verify correct execution of software elements,
- interfaces are tested to verify that software units execute together as expected,
- computer software configurations are tested to verify the execution of the software as a unit,
- system-level is tested to verify the softwares' performance within the overall system,
- system is tested to verify that the software will not cause an abnormal condition or event under abnormal circumstances, such as unexpected input values.

Similar tests are performed on the Control Subsystem at the supplier's office using input/output simulators before integration.

Maintenance requirements of the Control System shall be provided as part of the site specific applications.

5.4.1.2 Cask Transfer Subsystem

The Casks Transfer Subsystem permits entry of the source and receiving casks into the Lower Access Area and supports and positions (X direction) them accurately beneath the Mating Subsystem. The equipment that supports the cask is composed of two motor driven trolleys on rails and locking devices. The Source and Receiving Cask subparts of the Subsystem are identical in regard to the control and monitoring of the operations. The Subsystem is described in Section 5.2.1.

The two transfer trolleys are locally controlled by the operator using the Preparation Area or the Lower Access Area control panel. The operator controls the entry, positioning and removal operations by setting the direction and the speed of the trolleys' motorization. The trolleys stop when they reach a specific position in these areas. They are locally monitored by the operator. Only the indications on locking positions are provided in the Control Center.

Between the cask positioning and removal macro-operations of a source cask, no operator will be present in the Lower Access Area. The access to the Lower Access Areas is regulated by the Radiation Monitoring Subsystem (interlocked with the sliding door of the Structural Subsystem).
The transfer trolleys can only be unlocked locally, which guarantees that a cask will always be closed (lid/shield plug on) when its transfer trolley is unlocked. There is no interlock on this equipment.

Redundant instrumentation is not necessary for the control of the trolleys since they can be accessed for maintenance if required.

Redundant instrumentation is provided to ensure that the casks won't get damaged by a crash into a wall in the Lower Access Area, into the sliding door or due to a collision between the two casks as described below:

- limit switches located on the runway rails stop the trolleys in position,
- limit switches located on the runway rails stop the trolleys in case of an over-travel,
- electrical switches stop the trolleys upon detection of a collision with bumper guards,
- electrical switch stops source cask motion upon detection of a collision with the receiving cask.

In the Preparation Area, the source and receiving casks are stopped by the preparation position limit switch (one position for the two casks) and, by the collision detectors in the event of over-travel. In the Lower Access Area, when the casks are being positioned, the receiving cask can be stopped by its transfer position limit switch, by the over-travel electrical switch or by the collision with bumper guards detector while the source cask can be stopped by its transfer position limit switch, or by the collision with the receiving cask detector.

Redundant instrumentation is not necessary for proper position detection because the accuracy required is only to ensure that the transfer trolley can be locked.

Locking is performed locally and will be verified visually by the operator.

The collision and over-travel detectors generate alarms which are audible and visible in the Preparation Area, in the Lower Access Area and in the Control Center.

Table 5.4-2 lists the necessary instrumentation for the Casks Transfer Subsystem.

TABLE 5.4-2
Casks Transfer Subsystem Instrumentation

Equipment	Data	Sensor type	Action	Reference
Source cask trolley	Collision with bumper guard	Electrical switch	Stop motion	YAS 401A YAS 401B
Receiving cask trolley	Collision with bumper guard	Electrical switch	Stop motion	YAS 402A YAS 402C
	Collision with source cask trolley	Electrical switch	Stop motion	YAS 402B
Runway rails	Over travel	Electrical switch	Stop motion	ZASH 403D
	Preparation position	Electrical switch	Stop motion	ZS 403B
	Source cask loading position	Electrical switch	Stop motion	ZS 403C
	Receiving cask loading position	Electrical switch	Stop motion	ZS 403D
Ground	Locking at preparation position / Source cask	Electrical contact	----	YL 404B
	Locking at preparation position / Receiving cask	Electrical contact	----	YL 405B
	Locking at loading position / Source cask	Electrical contact	----	YL 404C
	Locking at loading position / Receiving cask	Electrical contact	----	YL 405C

5.4.1.3 Transfer Confinement Cask Mating Subsystem

The Transfer Confinement Casks Mating Subsystem provides the mating and disengagement of the source and receiving casks with the floor of the TCA. The Subsystem is divided into two functionnally identical parts, each one using three electric jacks attached to the mating flange, guiding its movement to make it fit around the cask. The mating flange provides a seal through the use of confinement bellows and static seals. Each subpart uses an overlid which permits the gripping and removal of the Source Cask lid/ Receiving Cask shield plug when activated by the lid/shield plug handling grapple. This subsystem is fully described in Section 5.2.2.

The two parts of the Subsystem are identical in regard to the control and monitoring of the operations.

The operations are remotely controlled. A camera provides viewing of the movement of the two mating flanges motion and z position. The operator controls the mating and disengagement operations. The electric jacks are operated simultaneously by a PLC.

Mating operations:

Once actuated, the jacks lower the platform until it makes contact with the top of the cask. Each of the three electric jacks individually and automatically stops when the contact load is reached. When the three jacks are stopped, the same procedure is repeated to ensure that the contact with the cask is perfect. The completion of the operation is displayed by the supervisor.

Disengagement operations:

The three jacks are actuated together. The operator has to stop motion when the platform reaches the mezzanine level.

The vertical position of each jack and the correct completion of the mating operation is displayed in the Control Center (in case of any load sensor failure).

The mating flange lowering operation is interlocked with the locking devices of the Cask Transfer Subsystem (interlock on one cask) to prevènt any mating flange lowering if the corresponding Casks Transfer Subsystem's trolley is not locked. This ensures that the trolleys are locked in place before the casks are opened.

The proper positioning of the jacks is controlled by a PLC using the electric jack's pressure and vertical position information.

The mating status is transmitted to the PLC managing the HVAC Subsystem. This information is required to enable the system to properly regulate the HVAC process.

Redundant instrumentation is not provided for the control of the mating flanges because the source and receiving casks are closed (lid/shield plug on) during the mating and disengagement operations, permitting removal and repair of defective instrumentation.

Redundancy is provided for each jack's proper positioning detection.

Table 5.4-3 lists the necessary instrumentation for the TC Casks Mating Subsystem.

TABLE 5.4-3
Transfer Confinement Casks Mating Subsystem Instrumentation

Equipment	Data	Sensor type	Action	Reference
TC Source cask mating subsystem	Vertical position	Potentiometer	----	ZIT 208A ZIT 208B ZIT 208C
	Pressure operated by jack	Force (or load) sensor	Stop jack lowering	WSH 209A WSH 209B WSH 209C
TC Receiving cask mating subsystem	Vertical position	Potentiometer	----	ZIT 203A ZIT 203B ZIT 203C
	Pressure operated by jack	Force (or load) sensor	Stop jack lowering	WSH 204A WSH 204B WSH 204C

5.4.1.4 <u>Transfer Confinement Port/Shield Handling Subsystem</u>

The Transfer Confinement Port/Shield Handling Subsystem consists of two port covers that have a locking device. They support the source cask lid and receiving cask shield plug when the casks are opened. The ports and the locking devices are actuated by electric jacks. This subsystem is described in Section 5.2.3.

There are slight differences in the control and monitoring of the two port covers, because the receiving cask shield plug needs to be off centered on the TC port cover (one more specific position).

Cameras in the TCA provide viewing of the movement and position of the TC port covers. Both TC port covers and their locking devices are remotely controlled. The locking devices are only used in the open position, prior to transfer of any fuel assembly. Both TC port covers use a finite number of positions and need accurate positioning. The operator activates a TC port cover setting the position to be reached. The TC port cover is automatically stopped when the position is reached. The operator activates a locking device by setting the desired locking position. When the locking operation is completed, the information is transmitted to the supervisor which displays it.

The position and motorization status of the TC port covers and locking devices are displayed in the Control Center.

The following interlocks will be implemented:

- Interlock the TC port covers with the Source Cask Lid and Receiving Cask Shield Plug Handling Subsystem hoist. This prevents any TC port cover from closing if the lid / shield plug grapple is not stopped above the TC port cover (with lid/shield plug on), thus preventing a potential collision of the equipment.

- Interlock the TC port covers with the upper shield ports. This prevents any TC port cover from opening if the diagonal upper shield port is not closed, thus ensuring proper shielding to the roof enclosure area at all times.

- Interlock the TC port covers and their locking devices with the Fuel Assembly Handling Subsystem crane carriage. It shall prevent any TC port cover unlocking and closing or off-centering if the crane carriage of the Fuel Assembly Handling Subsystem is not stopped in the x and y directions or if fuel is being transferred. This prevents a potential collision of equipment.

- Interlock the TC port covers with the Structural Subsystem. It shall prevent opening of any TC port cover if the sliding door of the Structural Subsystem is not locked (in closed position). This ensures that the radiation levels in the Preparation Area will be acceptable during fuel transfer.

- Interlock each TC port cover with its locking device. It shall prevent locking if the TC port cover is not in the opened position.

The PLC shall memorize the TC port covers' movements as well as those of the lid/shield plug grapple in order to know (logically) if the lid/shield plug is present on the port cover. This information shall be used to prevent any TC port cover opening when the relative upper shield port is opened if the lid/shield plug hoist is not handling the lid/shield plug and if the cask is not closed.

The interlocks on the TC port covers and their locking device prevent:

- any damage to the fuel assembly during a transfer due to an inadvertent TC port cover closure (seismic event or human error).

- high radiation levels at the upper plate level during the opening or closing of a cask due to a wrong synchronisation between the TC and upper shield ports and the lid/shield plug handling hoist system.

- high radiation levels at the sliding door level in case of a seismic event.

- compromise of recovery requirements (port cover stuck)

Redundant instrumentation is not provided for the control of the TC port covers and their locking devices, since manual backup equipment is provided for the locking devices and the port covers drives are outside the TCA. Two different instrumentation are used to detect the locked and unlocked positions of the TC port covers.

Redundant instrumentation is not provided for the TC port covers position detection because the CCTV Subsystem provides viewing of this equipment and the verification of the alignment with references on the mezzanine is included in the operation validation.

The TC port covers implement a locking pin to ensure that the cover stays open while lifting the lid/shield plugs from the casks and during fuel transfer between the casks. The pin has been designed to withstand a seismic event so that in the event that an earthquake occurs during a fuel transfer, the TC port covers will not close due to the locking pin failing.

Control system interlocks will not allow an operator to inadvertently close the TC port covers without a number of conditions being confirmed by the system as being appropriate for closing the covers. As indicated in the flow charts in pages 45 and 46 in Appendix 5A, the TC port covers cannot be unlocked unless the interlocks sense the following three conditions are fulfilled. The tree conditions are: 1) the fuel handling crane carriage is stopped in the x and y directions, 2) the crane carriage is in the parked position, and 3) a fuel assembly is not currently being transferred. All conditions must be met for the jack screw to withdraw the locking pin, enabling the cover to close.

Table 5.4-4 lists the necessary instrumentation for the TC Port Shield Subsystem.

Table 5.4-4

TC Port Shield Subsystem Instrumentation

Equipment	Data	Sensor type	Action	Reference
Receiving cask TC port cover	Open position	Electrical switch	Stop motion	ZS 317A
	Closed position	Electrical switch	Stop motion	ZS 317B
	Off centered position	Electrical switch	Stop motion	ZS 317C
	Over travel	Electrical switch	Stop motion	ZASH 317A ZASH 317B
	Locked (in open position)	Electrical contact	----	YL 318A
	Unlocked (in open position)	Electrical contact	----	YL 318B
Source cask TC port cover	Open position	Electrical switch	Stop motion	ZS 315A
	Closed position	Electrical switch	Stop motion	ZS 315B
	Over travel	Electrical switch	Stop motion	ZASH 315A ZASH 315B
	Locked (in open position)	Electrical contact	----	YL 316A
	Unlocked	Electrical contact	----	YL 316B

5.4.1.5 Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem

The Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem consists of a motor driven trolley which utilizes a motorized grapple attached to a hoist system and two shield ports actuated by electric jacks. The subsystem is housed on the roof of the Transfer Confinement building and the shield ports provide access to the Transfer Confinement Area for the grapple. The motorized grapple is capable of grappling the overlid in order to grip the receiving cask shield plug or the source cask lid. This subassembly is described in Section 5.2.4.

The function of the Control Subsystem is to allow:

- the upper crane to be properly positioned above the Source or Receiving Cask
- the upper shield ports to be opened, closed and locked in closed position
- the lid/shield plug grapple to be lowered and lifted

- the lid/shield plug grapple to connect and disengage the overlids, and to activate the source cask lid or the receiving cask shield plug connection and disengagement.

Cameras are used to visually monitor the operations which occur in the Transfer Confinement Area, but not in the Roof Enclosure Area. Monitoring and control are in the Control Center.

Control and Monitoring of the Upper Crane

The upper crane is a motor driven trolley which positions the handling equipment over the source cask lid or receiving cask shield plug.

The operation consists of positioning of the upper crane in the source cask or receiving cask position. There is a finite number of positions and accurate positioning over the source cask lid or the receiving cask shield plug is required. The operator activates the upper crane motion setting the position to be reached. The upper crane is automatically stopped when the position is reached. There is no CCTV monitoring of the upper crane motion or position.

The position of the trolley and its motorization status are displayed in the Control Center.

The following interlocks will be implemented:

- Interlock the upper crane with the hoist system. It will prevent any motion of the upper crane if the lid / shield plug handling grapple is not stopped in its upper z position.

- Interlock the upper crane with the upper shield ports. It will prevent any motion of the upper crane if both upper shield ports are not stopped in the closed position.

The interlocks prevent any inadvertent motion of the trolley during handling, because that could cause:

- pendulum movement of the lid/shield plug (which can cause high dose rates)
- damage to the lid/shield plug
- damage to the fuel assembly transfer tube
- damage to the confinement bellows

Redundant instrumentation is not required for the control of the upper crane since the Roof Enclosure Area housing the upper crane drive is shielded.

Redundant instrumentation is provided to prevent any damage to the trolley: limit switches corresponding to the source and receiving positions and overtravel detectors on each side of the runway rails stop the trolley motion when activated.

Redundant instrumentation is not required for the upper crane position detection because a mispositioning will prevent other operations to be processed (grapple connection). This does not have an impact on safety.

Table 5.4-5 lists the instrumentation for the Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem trolley.

Control and Monitoring of the Upper Shield Ports

The upper shield ports provide shielding between the TCA and the Roof Enclosure Area. They permit lid/shield plug grapple access to the TCA allowing lid/shield plug removal and replacement on the casks. They consist of trolleys with a locking device. The equipment is actuated by electric jacks.

Both upper shield ports and their locking devices are remotely controlled. The locking devices are only used in the closed position. The operator activates an upper shield port or its locking device setting the position to be reached. The upper shield ports are automatically stopped when the position is reached. When the operation is completed, the information is transmitted to the supervisor which displays it.

The position and motorization status of the upper shield ports and locking devices are displayed in the Control Center.

The following interlocks will be implemented:

- Interlock the upper shield ports with the lid/shield plug handling hoist system. This will prevent closing of the upper shield ports if the lid / shield plug grapple is not in the upper z position and if the hoist is loaded.

- Interlock the upper shield ports and the TC port covers. This will prevent opening of any upper shield port if the opposite TC port cover is not closed (or off centered).

- Interlock the upper shield ports and their locking device with the fuel assembly handling hoist system. This will prevent unlocking and opening of the upper shield ports if a fuel assembly is being transferred.

- Interlock the upper shield ports and their locking device with the radiation monitoring subsystem. This will prevent unlocking and opening of an upper shield port if the radiation at the level of the roof enclosure is too high.

- Interlock the receiving and source casks upper shield ports. This will prevent the opening of an upper shield port if the other is not closed.

- Interlock each upper shield port with its locking device. This will prevent locking if the upper shield port is not in the closed position.

The interlocks prevent:

- any damage to the lid/shield plug and the fuel assembly transfer tube due to the closure of an upper shield port on the lid/shield plug handling cables.
- abnormal high radiation levels on the top of the building due to incorrect synchronisation of the upper shield ports with the TC port covers
- abnormal high radiation levels on the top of the building due to a seismic event during a fuel assembly transfer.

In the event of malfunction, the instrumentation for the upper shield ports and their locking devices can be replaced, since they are located in the shielded Roof Enclosure Area.

Two different sensors are provided to detect the locked and unlocked position of the upper shield ports prior to initiating the transfer process.

Redundant instrumentation is provided to prevent any damage to the upper shield ports: limit switches corresponding to the open and closed positions and overtravel detectors on each side of the two sets of runway rails stop the trolley motion when activated.

Table 5.4-5 lists the required instrumentation for the Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem upper shield ports.

Control and Monitoring of the Hoist System

The motorized hoist system lowers and lifts the grapple by means of two cables. Cable breaking is detected by a compensator. Its motorization is located inside the Roof Enclosure Area.

The hoist system of the lid/shield plug handling system is remotely activated by the operator, setting the direction of the hoist motorization and using a variable speed. The viewing of the system is provided in the Transfer Confinement Area only.

Lowering:

The motion is automatically stopped when the cables are underloaded.

Lifting:

The motion is automatically stopped when the grapple reaches the upper position and the safety position above the TC port cover when the cables are loaded.

The motion and the direction of the hoist system are indicated in the Control Center, as well as the grapple z position. The speed is variable but is automatically lowered to its minimum when a limit distance from the target is reached.

The following interlocks will be implemented:

- Interlock the hoist with the cable load monitoring device and the grapple position monitoring device. This will prevent the lifting of the grapple over the limit position if the cables are loaded.

- Interlock the hoist with the fuel assembly handling crane carriage. This will prevent lowering and lifting if the crane is not stopped in parking position.

- Interlock the hoist with the lid/shield plug grapple. This will prevent lifting if the grapple is not totally disengaged from the overlid or if both grapple and overlid are not totally engaged.

- Interlock of the hoist system with the upper shield ports. It will prevent any motion of the hoist if either the receiving or source cask upper shield port cover (depending on what position the upper crane trolley is at) is not stopped and locked in its open position.

The interlock with the lid/shield plug grapple ensures that the source cask lid or the receiving cask shield plug won't be dropped during lifting due to an incomplete engagement or disengagement of the grapple.

The interlock with the position of the crane carriage ensures that the lid/shield plug can't collide with the crane bridge which could damage it and compromise recovery requirements.

The control of the winch motor is not redundant since it is located in the Roof Enclosure Area and is accessible for repair in case of a malfunction.

The instrumentation includes all the sensors required by NOG-1.

The overload limit is adapted to the weight to be handled and so, this limit depends on the upper crane position. The overload, underrun, overrun, overspeed, abnormal drum rope level wind and cable breaking are abnormal situations and their detection generates an alarm and automatically stops motion.

Redundancy is provided to detect the proper positioning of the grapple relative to the lid/shield plug. The underload is a normal situation, its detection automatically stops motion. The z position of the grapple is then verified to validate the positioning operation.

In addition, the lid/shield plug grapple design includes a sensor to detect the overlid presence.

Table 5.4-5 lists the necessary instrumentation for the Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem hoist.

Control and Monitoring of the Lid/Shield Plug Grapple

The grapple is motorized and can grapple or disengage the source or receiving cask overlid that can grip or disengage the source cask lid or receiving cask shield plug.

The concerned operations are the connection and disconnection of the lid/shield plug grapple with the source cask lid or receiving cask shield plug. The operator activates the grappling operation by setting the desired status (connected/disconnected). The operation is automatically stopped when the desired status is reached, and this information is displayed by the supervisor. The remote viewing of the operation by CCTV is possible when it occurs above the mezzanine level.

The following interlock will be implemented:

Interlock the grapple with the hoist system. This interlock prevents the disengagement of the overlid if the cables are loaded and if the grapple is not in its proper z position. It prevents the dropping of the lid/shield plug and uses redundant information: load and z position.

No redundant sensors are necessary for the control of the grapple since a manual backup is provided to disengage it in case of a malfunction.

Redundant sensors are provided to detect the position of the grapple fingers. The overlid presence detector provides an additional level of redundancy to the proper positionig of the grapple on the overlid. The overlid fingers position detection uses three different sensors activated by a unique mechanical device.

Table 5.4-5 lists the instrumentation for the Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem grapple.

Table 5.4-5

Source Cask Lid and Receiving Cask Shield Plug Handling Subsystem Instrumentation

Equipment	Data	Sensor type	Action	Reference
Trolley (x)	Position above source cask	Electrical switch	Stop motion	ZS 303A
	Position above receiving cask	Electrical switch	Stop motion	ZS 303B
	Over travel	Electrical switch	Stop motion	ZASH 303A ZASH 303B
Upper shield ports (x2)	Open position	Electrical switch	Stop motion	ZS 301A ZS 302A
	Closed position	Electrical switch	Stop motion	ZS 301B ZS 302B
	Over travel	Electrical switch	Stop motion	ZASH 301A ZASH 301B ZASH 302A ZASH 302B
	Locked (in closed position)	Electrical contact	----	YL 312A YL 312B
	Unlocked	Electrical contact	----	YL 312B YL 313B

Table 5.4-5 (Continued)

Source Cask Lid and Receiving Cask Shield Plug Handling Subsystem Instrumentation

Equipment	Data	Sensor type	Action	Reference
Hoist motorization	Absolute lifting positioning	Wire potentiometer	----	ZIT 307
	First high limit	Form ZIT 307	----	ZLH 307
	Second high limit	Form ZIT 307	Stop motion	ZSHH 307
	Overtravel (final high limit)	Position selector	Stop motion	ZASH 314
	First low limit	Form ZIT 307	----	ZLL 307
	Overtravel (final low limit)	Position selector	Stop motion	ZASL 306
	Hoist overspeed limits	Electrical switch	Stop motion	SASH 305
	Hoist drum rope level winds limits	Electrical switch	Stop motion	ZS 308A ZS 308B
	Unbalanced load limits	Electrical switch	Stop motion	CS 304A CS 304B
	Weight of live load	Load cell	----	WIT 309
	Abnormal high weight of live load	From WIT 309	Stop motion	WASL 309 WASH 309
Lid/shield plug grapple	Grapple fingers open	Electrical contact	----	YL 311A
	Grapple fingers closed	Electrical contact	----	YL 311B
	Overlid presence	Electrical switch	Stop motion	YLS 310
	Overlid fingers open	Position detector	----	ZL 315A
	Overlid fingers closed	Position detector	----	ZL 315B
	Overlid fingers gripped	Position detector	----	ZL 315C

5.4.1.6 Fuel Assembly Handling Subsystem

The Fuel Assembly Handling Subsystem consists of a crane carriage which supports a rotating platform and a transfer tube fitted with a hoist system (including two motorized winches), a motorized grapple and a crud catcher. This subsystem is described in Section 5.2.5.

The functions of the Control Subsystem for this subsystem are to allow:

- positioning of the fuel transfer tube in the x, y and Θ directions.
- the hoist system to lower / lift the grapple.
- the grapple to connect / disengage the fuel assembly.
- the crud catcher to be opened / closed.

Monitoring and control are performed in the Control Center. Cameras are available to visually monitor the position and motion of the crane carriage, the rotating platform, and the crud catcher. Other cameras are available to visually monitor the positioning of the fuel transfer tube above a cell, the state of the grapple connection and the introduction of a fuel assembly in a cell.

Control and Monitoring of the Crane Carriage

The crane carriage consists of a motorized bridge (X direction) which supports a motorized trolley (Y direction) which supports a motorized rotating platform (Θ). It can reach three types of positions:

- Over the source cask : over a fuel assembly centerline (or an empty cell in case of design event IV to replace a fuel in the source cask if necessary).
- Over the receiving cask : over an empty cell.
- In a "parking position" before opening or closing the source and receiving casks.

The motion is "strongly" computer assisted. To position the crane carriage of the Fuel Assembly Handling Subsystem, the operator sets the coordinates of the position (X,Y) to be reached. After motion request, the bridge and the trolley are automatically positioned by the PLC using concurrent X and Y movement. The PLC limits the use of the speeds to the slow one during fine positioning.

The position is rough and the operator has to finish the positioning of the transfer tube controlling directly the X, Y and Θ motions. Fine tuning permits the operator to make the crane carriage reach the exact position over a fuel assembly (or empty cell) centerline.

The operator is helped by the CCTV Subsystem which provides two cameras (one only may be used depending on the position) fitted at the bottom of the transfer tube, the view of a complete cell.

The current (X,Y) position and the motorizations states are displayed in the Control Center.

The following interlocks will be implemented:

- Interlock the crane carriage (bridge and trolley) with the hoist system.This will prevent motion of the crane carriage if the fuel assembly grapple is not in its upper z position.
- Interlock the crane carriage (bridge and trolley) with the crud catcher. This will prevent motion of the crane carriage if the crud catcher is not closed.
- Interlock the crane carriage (bridge and trolley) with the upper shield ports. This will prevent motion of the crane carriage if the two upper shield ports are not locked (in closed position).
- Interlock the crane carriage (bridge and trolley) with the TC port covers. This will prevent motion of the crane carriage if the two TC port covers are not locked (in open position).

The interlocks prevent the crane carriage from moving during fuel assembly lifting/lowering operations. They guarantee that:

- if fuel is in the transfer tube, the crud catcher can minimize the spread of contamination and the fuel is fully retracted into the transfer tube during motion.
- if fuel is being lowered or lifted, the crane carriage won't move which could damage the fuel assembly and compromise recovery requirements.
- shielding to the roof of the DTS building during normal operating conditions or in case of a seismic event.
- the fuel transfer can't occur if the TC port covers are unlocked. If a seismic event occurs during a fuel transfer, the TC port covers will not collide with the fuel assembly.
- the safety of the source cask lid or receiving cask shield plug lifting won't be compromised by a collision with the fuel assembly handling crane

Redundant instrumentation is not required to control the crane carriage, since manual backup is provided.

The positioning of the crane carriage uses position encoders. Limit switches on each end of the runway rails detect over-travels and stop the X and Y motions when activated.

Redundant instrumentation is not required for the proper positioning of the crane carriage as the CCTV Subsystem provides the viewing of a cell.

Table 5.4-6 lists the instrumentation for the Fuel Assembly Handling Subsystem crane carriage.

Control and Monitoring of the Rotating Platform

The rotating platform is motor driven, it supports the hoist motorization and can rotate around its centerline to allow the proper positioning of the fuel transfer tube above a fuel assembly centerline or an empty cell.

The operator remotely controls the θ motion of the rotating platform, chooses the direction (clockwise, counter clockwise) and the speed. The CCTV provides the viewing of the empty cell or of the fuel assembly.

The position (θ) of the rotating platform and the motorization status is displayed in the Control Center.

The following interlocks will be implemented:

- Interlock the rotating platform with the hoist system. This will prevent any rotation of the platform if the assembly grapple is not in upper z position.
- Interlock the rotating platform with the crud catcher. This will prevent any rotation of the platform if the crud catcher is not closed.

The interlocks prevent the rotating platform from moving during a fuel assembly lifting or lowering operation which could damage the fuel assembly and compromise recovery requirements.

A manual backup can rotate the platform in case of a malfunction, so redundant instrumentation is not required. The position encoder and the CCTV Subsystem provide sufficient information to properly position the rotating platform.

The trolley and bridge position indicators are to be accurate to +/- 1/8 inch and the rotating platform position to +/- 1^0.

Table 5.4-6 lists the instrumentation for the Fuel Handling Subsystem rotating platform.

Control and Monitoring of the Crud Catcher

The crud catcher is a trapdoor actuated by an electric jack, which covers the bottom of the fuel assembly when it is fully retracted into the transfer tube. It minimizes the spread of radioactive particulate during the fuel transfer.

The crud catcher is remotely controlled. The operator sets the position he wants to reach (open/closed). When the electric jack is in the desired position, the completion of the operation and the position are displayed by the supervisor. The CCTV Subsystem provides viewing of this equipment.

Monitoring and control of the crud catcher are performed in the Control Center.

The following interlocks will be implemented:

- Interlock the crud catcher with the crane carriage (bridge and trolley) motorizations. This will prevent the crud catcher opening if the crane carriage is not stopped in x and y directions.
- Interlock the crud catcher with the rotating platform. This will prevent the crud catcher opening if the rotating platform is in motion.
- Interlock the crud catcher with the fuel assembly handling hoist system. This will prevent the crud catcher closure if the grapple is not in the upper z position.

The interlocks prevent crud catcher opening during fuel transfer tube positioning. They also ensure that if a fuel assembly is present in the transfer tube during positioning, it is fully retracted into it.

The interlock with the hoist system ensures that the crud catcher can't damage the fuel assembly during closure.

Redundant instrumentation is not required for the control of the crud catcher since a manual backup is provided.

Two different sensors are used to detect the open and closed positions of the crud catcher. This allows easy detection of the failure of a sensor which could have an impact on the interlocks. The CCTV provides an additional means for validation.

Table 5.4-6 lists the instrumentation for the Fuel Assembly Handling Subsystem crud catcher.

Control and Monitoring of the Hoist System

The hoist system consists of a cable with two motorized winches.

Only one winch is controlled at a time. The operator selects the current winch, and activates it for lowering and lifting operations.

Lowering:

The speed of each winch is variable. The lowering operation is automatically stopped when the cables are underloaded.

Lifting:

The operator uses the variable speed and the operation is automatically stopped when the grapple is in the upper position, or when the load reaches the limit determined per Section 5.1.3.6.

During operations, the operator can monitor the z position of the grapple. The CCTV Subsystem provides the viewing of the top of the fuel assembly in the cask or of the top of an empty cell. The operator can monitor the entry of the fuel assembly in an empty cell.

The two motorized winches can not operate simultaneously and use the two different power supply channels. The speed is variable and is controlled by the operator. However the slow speed is automatically selected below a limit z position of the grapple.

The following interlocks will be implemented:

- Interlock the hoist system with the crud catcher. This will prevent lowering of the grapple if the crud catcher is closed.
- Interlock the hoist system with the fuel assembly grapple. This will prevent lifting if the grapple is not totally engaged or disengaged.
- Interlock the hoist system with the crane carriage and the rotating platform. This will prevent lowering if the crane carriage and the rotating platform are not stopped.
- Interlock of the hoist system with the upper shield ports. It will prevent any motion of the hoist if either the receiving or source cask upper shield port cover (depending on what position the upper crane trolley is at) is not stopped and locked in its open position.

These interlocks prevent:

- the fuel assembly from getting stuck in the transfer tube; and
- dropping of a fuel assembly due to an improper gripping.

Redundant motorization, on two different power channels are provided.

The instrumentation includes all the sensors required by NOG-1.

Redundancy is provided to detect the proper positioning of the grapple relative to the fuel assembly. The underload is a normal situation, its detection automatically stops motion. The z position of the grapple is then verified to validate the positioning operation
In addition to that, the fuel assembly grapple design includes a fuel assembly presence detector. The overrun/underrun, overload, overspeed and abnormal drum rope level winds situations are abnormal, their detection generates an alarm and automatically stops motion.

Table 5.4-6 lists the instrumentation for the Fuel Assembly Handling Subsystem hoist.

Control and monitoring of the grapple

The motorized grapple is used to connect and disengage the spent fuel assembly. There are three motors, one for normal operating conditions and the two others for backup.

The operator selects the normal or backup equipment using a switch on the main control panel, and activates it by setting the desired status (connected/disconnected). The operation is automatically stopped when the desired status is reached and this information is displayed by the supervisor. The CCTV Subsystem provides viewing of the status of the connection (mechanical flags).

The backup equipment will only be used to disengage the grapple.

All the indications on connection and motorization status are displayed in the Control Center.

The following interlock will be implemented:

Interlock the grapple with the hoist system. This will prevent the disengagement of the fuel assembly if the cable is loaded and if the grapple is not stopped in a proper position.

The interlock with the hoist system ensures that the spent fuel can't be dropped due to an operator error.

The grapple motorization is redundant. The two backup motors shall be on the secondary power channel.

Two different sensors are used to detect the position of the grapple fingers.

Table 5.4-6 lists the instrumentation for the Fuel Assembly Handling grapple.

Table 5.4-6

Fuel Assembly Handling Subsystem Instrumentation

Equipment	Data	Sensor type	Action	Reference
Bridge (x)	Absolute traveling positioning	Synchroresolver	----	ZIT 101
	Over travel	Electrical switch	Stop motion	ZASH 102A ZASH 102B
Trolley (y)	Absolute traversing positioning	Synchroresolver	----	ZIT 104
	Over travel	Electrical switch	Stop motion	ZASH 105A ZASH 105B
Rotating platform	Absoulte rotating positioning	Synchroresolver	----	ZIT 107
Crud catcher	Open position	Electrical contact	----	YL 119A
	Closed position	Electrical contact	----	YL 119B
Hoist motorization	Absolute lifting positioning	Wire potentiometer	----	ZIT 109
	First high limit	from ZIT 109	Stop motion	ZSH 109
	Final overtravel high limit	Electrical switch	Stop motion	ZASH 118
	First low limit	from ZIT 109	----	ZSLL 109
	Final overtravel low limit	Electrical switch	Stop motion	ZASL 110
	Hoist overspeed limits	Electrical switch	Stop motion	SASH 111 SASH 112
	Hoist drum rope level winds	Electrical switch	Stop motion	ZS 113 ZS 114
	Weight of live load	Load cell	----	WIT 115
	Limit weights	from WIT 115	Stop motion	WASH 115 WASL 115

Table 5.4-6 (Continued)

Fuel Assembly Handling Subsystem Instrumentation

Equipment	Data	Sensor Type	Action	Reference
Grapple Grapple	Grapple fingers closed	Electrical switch	----	YL 116B
	Grapple fingers open	Electrical switch	----	YL 116A
	fuel assembly presence	Electrical switch	Stop motion	YLS 117

Security-Related Information Figure Withheld Under 10 CFR 2.390.

FIGURE 5.4-1A
INSTRUMENTATION AND CONTROLS
STRUCTURAL DIAGRAM
5-9

Security-Related Information Figure Withheld Under 10 CFR 2.390.

FIGURE 5.4-1B
INSTRUMENTATION AND CONTROLS
STRUCTURAL DIAGRAM
5-10

Security-Related Information Figure Withheld Under 10 CFR 2.390.

FIGURE 5.4–1C
INSTRUMENTATION AND CONTROLS
STRUCTURAL DIAGRAM
5–11

Security-Related Information Figure Withheld Under 10 CFR 2.390.

FIGURE 5.4–1D
INSTRUMENTATION AND CONTROLS
STRUCTURAL DIAGRAM
5–12

Security-Related Information Figure Withheld Under 10 CFR 2.390.

FIGURE 5.4-1E
INSTRUMENTATION AND CONTROLS
STRUCTURAL DIAGRAM
5-13

Security-Related Information Figure Withheld Under 10 CFR 2.390.

FIGURE 5.4-1F
INSTRUMENTATION AND CONTROLS
STRUCTURAL DIAGRAM
5-14

5.5 Control Room and Control Areas

5.5.1 Control Location and Operations

As shown in the Instrumentation and Control Structure Diagram (Figure 5.4-1), the human/machine interfaces for the control and monitoring of the equipment are located in three areas:

- the Control Center which is located on a trailer outside the DTS building,
- the Preparation Area, and
- the Lower Access Area.

The locally controlled and monitored operations are those involving:

- the Casks Transfer Subsystem (transfer trolleys entry/positioning/removal and locking/unlocking operations),
- the Structural Subsystem (roll-up and sliding doors opening/closing operations)., and the receiving cask lid removal and replacement.

All the other operating subsystems are remotely controlled and monitored from the Control Center.

5.5.2 Local Control and Monitoring Under Normal Conditions

Two identical control panels are located in the Lower Access Area and in the Preparation Area to control the Cask Transfer Subsystem during normal operating conditions. A unique key activates the control panel, in order to give control to an authorized operator.

The control of the sliding door is performed using specific control panels in the Lower Access Area and in the Preparation Area. The control of the roll-up door is performed using specific control panels outside of the building and in the Preparation Area.

5.5.3 Remote Control and Monitoring Under Normal Conditions

The following instrumentation is provided to remotely control and monitor operations during normal conditions:

- a video system (2 CCTV displays, Intensity Control Units and Camera Control Units),
- one main control panel,
- a personal computer,
- a monitoring display, and
- an audio system.

Two CCTV displays provide viewing of the Lower Access Area, of the Transfer Confinement Area and of the upper part of the casks' baskets. They permit the operator to validate operations and transition conditions and to position the fuel assembly transfer tube above a fuel cell, to check the entry of a fuel assembly in a cask and to detect physical equipment problems, abnormal process conditions or the initiation of a fire. They also provide viewing of the Preparation Area (for security reasons) and of the welding process.

The control trailer would have a separate control console for the CCTV and associated lighting. The CCTV control console will consist of a VCR, a color monitor, and a pan/tilt controller for each camera. These controller units will have near and far sight focus, wide angle-telephoto zoom, Iris open/close, and shutter open/off controls, which control the cameras as well as the associated lights.

All CCTV controls will be mounted in a standard rack, with a 120 V ac feed to supply the strips in the cabinet. All control leads will be supplied with standard BNC connectors. All components of the CCTV control system will be off the shelf items, and are easily replaceable.

In the event of a total distruction of the control trailer, no fuel assembly movement will be attempted until there is visual reference. After the disaster, the CCTV feed lines from the facility would need new BNC end fittings, and then they can be plugged into a new controller console.

No special design features have been incorporated into the DTS to protect the control trailer from a potential tornado, since the trailer is considered to be 'Not Important to Safety'. However, the trailer may be protected from the tornado if the utility deems it financially advantageous to save it. The details on where it will be moved to, for shelter, will be up to the utility and will be site-specific.

There is no intention to insert fuel assemblies into a cask without visual reference. As shown in Figure 1.2-14 there are four cameras mounted in the Transfer Confinement Area, CCTV1 through CCTV4, a camera located in the Lower Access Area, CCTV5, and two cameras mounted on the transfer tube, CCTV6 and CCTV7. Each camera is provided with a co-located lighting assembly. The two cameras mounted on the transfer tube are the most critical for final alignment of the fuel assembly as it is inserted into a cask. The wiring to these cameras is to be installed such that they are placed on opposite sides of the transfer tube. Separation will be maintained between the wiring to cameras CCTV6 and CCTV7 and the associated lights, from the top of the transfer tube. The wiring will exit the confinement building via two separate penetration areas with the wiring to the associated hoists, which is also to be separated.

In the event of a failure of TV equipment external to the confinement building, which makes viewing of the transfer process impossible, transfer operations will be suspended and repairs made to the equipment. Although only required in an event of two-or-more camera failures, the building emergency access ports provide locations from which a camera can be inserted, if required.

The main control panel permits the operator to control every remote operation by use of push buttons and joysticks, and to control the power of each equipment group (locking device and motorization for example). It includes a general emergency push button that de-energizes all the mechanical equipment when activated and generates alarms.

The personal computer enables the operator to set the coordinates of the target position of the fuel assembly transfer tube prior to activate its positioning. It also houses the monitoring software (supervisor) which displays all the necessary monitoring information to safely control the operations as:

- Mechanical equipment: equipment status and positions, etc,
- HVAC: temperature and pressure in each area, equipment status,
- Radiation Monitoring: radiation level in the different areas.

The audio system provides an additional monitoring means for the operations that occur in the Transfer Confinement Area.

The Control Subsystem is considered "fail safe" which means that the failure of a control system component or failure of the control system software will not result in damage to the fuel and/or result in a radiation dose that exceeds regulatory limits. The DTS control system is not relied upon to initiate or control any protective actions. Except for redundant load cell pre-amplifiers, there are no active control system components in the Transfer Confinement Area or the Lower Access Area. If a failure occurs in the control system, fuel transfer operations will be suspended until repairs can be made. Fuel transfer operations can be suspended at any time without causing fuel damage. It will be the responsibility of the site organization to have readily available spare parts either on site or by means of a service agreement with an outside source. Potential control system hardware and software failures are discussed in more detail below.

Failure of the PLC

A failure of the PLC can result from any of the following:

CPU or Memory Failure

The PLC will be monitored by a watch dog timer circuit. The watch dog timer is to be independent of the main processor CPU and memory. In the event the watch dog timer determines the program execution has stopped, it will shutdown the PLC and leave all outputs in the OFF state. This is a safe condition as it results in no motor operation. The watch dog timer circuit is in turn to be monitored by the PLC. The operator will be alerted to an error with the watch dog timer. Memory failures are addressed in response to question 5-7

Output Module Failure

Relay contact and/or solid state outputs will be used to switch equipment ON or OFF. It is possible for the PLC outputs to fail in the ON or OFF state. The control

circuits will be arranged such that the action that results from switching each output is monitored by an input to the PLC. For example, all contactors will be provided with an auxiliary contact that closes when the contactor is energized. The PLC software will monitor the auxiliary contact to verify that the contactor is in the proper state. A discrepancy indicates a malfunction.

Additionally, position information from resolvers provides confirmation that motors are moving in the correct direction and at the correct speed. A discrepancy will provide information to indicate a control failure. Also, the PWR grapple consists of a mechanical structure that supports the gripping device. Dual load path gripping fingers, with passive mechanical interlocks under load, ensure that the load can not be dropped.

The PLC software will alert the operator to any detected malfunctions and remove power from all motors.

Input Module Failure

PLC input modules are used to sense the status of PLC outputs (as explained above) sense the status of limit switches, monitor motor drive operation and to read position information from resolvers. A discrepancy between the state of a PLC output and the input used to verify it, can be detected and the operator will be alerted. There is no backup to inputs from limit switches which are provided as a backup to travel limits established by resolver based position information, as these inputs are part of a back up system themselves. Operating procedures will prevent the operator from lifting a fuel element if the input from the grapple closed limit switch fails in the on condition or off condition as he will not see the grapple position change. Similarly by procedure failure of the input from the grapple open limit switch will not allow another fuel element to be lifted. It will not, however, prevent releasing a fuel assembly. Proper release can be verified by monitoring the CCTV cameras and by observing hoist load and hoist elevation. The system can be operated without position information from the resolvers using the CCTV system. This allows returning all fuel to a storage cask prior to making repairs to the resolver input modules.

Software Failure

Fuel transfer operations are to be performed primarily as a manual operation. The operator is to monitor system parameters (i.e. equipment positions) visually using the CCTV system. The software is, therefore, a backup that prevents operator error. However, in the worst case scenario, a software failure can be postulated to request uncontrolled movement. During fuel movements the Sliding Door to the Lower Access Area is manually locked closed, power to the Cask Transfer Subsystem is turned off, and the TC port covers are locked open. Thus these pieces of equipment will not inadvertently move. The bridge, trolley and rotate platform speeds are relatively slow. The operator has been provided with an

Emergency Stop button that removes all power to motors independent of the computer control system. It is the operator's responsibility to stop motion if one of the remaining motors moves uncontrollably. If the operator fails to act, the motors will be stopped by their respective travel limit switches, which are wired to disconnect the power from the motor drive. The structural design is adequate to allow the bridge, trolley and rotate platform to run into the end of travel stops at full speed with no mechanical damage to the equipment.

PC Monitoring System PC Failure

The PC Monitoring System records information on fuel movements and provides the interface for operator input to the control system to request fuel movements. The PC Monitoring System does not perform any control logic operations. Failure of the system will prevent continued operation until it is repaired. As stated above, it will be the responsibility of the site to have the means to quickly repair the system.

Failure of a Position Sensor

Resolvers are used to measure the position of the bridge, trolley and hoist elevation. The resolvers are to be tied directly to PLC input modules that perform verification that the input lines have not opened and that the resolvers have not shorted or opened internally. These are the most likely failure modes. In addition, movement of the equipment is visually monitored by the operator, using the CCTV equipment. Improper position information will be observable by the operator. Fuel movement can be performed, without information from the control system, using the CCTV system. All fuel will be placed in the casks and the cask covers installed to allow equipment repair if a resolver fails.

Failure of a Limit Switch

All limit switches will be tested prior to each cask unloading to assure correct operation. Limit switches used to verify a condition, such as "Grapple Fingers Closed", will be wired to close when the condition is true. Limit switches used to test for a limit, such as "Bridge Travel Limit" will be wired to open when the limit condition is true. This wiring provides the greatest protection against a failure of wiring to the limit switch. However, as explained above under failure of an input module, travel limit switches are provided as a backup to the resolver based position limits, and operation is possible with failure of the grapple limit switches.

Most processes using limit switches are monitored using CCTV, and faults will be detected while viewing the process. The processes not monitored by CCTV include a redundant sensor (in addition to the limit switch), and in the event of inconsistent information between the switch and the sensor, the PLC will trigger an alarm.

Failure of Load Monitor

Two load cells and monitors are used. The PLC software will perform cross checks to identify a failure in one of the systems. If a failure occurs, an alarm will sound indicating a load cell failure, and any grappled fuel will be placed in a cask and further fuel transfer will be suspended until repairs are made.

Software Failure

The fuel transfer operation is performed as a manual operation with the operator initiating each step according to detailed operating procedures. During fuel transfer the operator is assigned responsibility to monitor equipment positions and hoist loads. In this respect the PLC software is used as a back up to assure the operator is following the procedures correctly. Therefore, software failure should not be considered to occur coincident with an operator error. However, for design purposes an "Emergency Stop" has been supplied that the operator can use to disconnect power to all motors. As all motions are slow, sufficient time exists for the operator to respond should a software failure cause unanticipated motion.

The status of all bypassed interlocks will be continuously displayed to the operator using the PC monitoring system display and/or by a dedicated operator alarm status panel, as determined by the final site specific control system design. Under normal operating conditions no interlocks will be bypassed and the operator is able to continuously verify this using the interlock status display.

To prevent the inadvertent bypassing of an interlock, administrative procedures will be developed on a site-specific basis to control bypassing interlocks. The procedures will require the use of a control switch key and/or passwords, entered via the PC monitoring system, to bypass an interlock. Bypassing an interlock will only be allowed for equipment testing purposes, when fuel is not being transferred, or to recover from an unanticipated event. In the latter case operations will be limited to those required to place all fuel in the storage casks so that recovery actions can be taken. The PC monitoring system will record the time at which any bypass is implemented and the operator that bypassed the interlock.

5.5.4 Local Control Under Off-Normal conditions

During off-normal conditions, the local operations can only be processed if:

- there is no fuel being transferred,
- if the two casks are closed,
- if the radiation level is under the admissible limit.

The local operations affected by off-normal conditions are the unlocking and removal of

the transfer trolleys. The unlocking operation can be processed manually. The transfer trolleys can be removed using a prime mover. In case of a complete loss of the Control System, the disengagement of the casks (remote operation under normal conditions) with the mezzanine floor can be operated locally, taking all the necessary precautions.

5.5.5 Remote Control Under Off-Normal Conditions

Most equipment has a manual backup or is accessible for repair and so can be controlled under any condition. The equipment which do not have manual backup and are not accessible for repairs include:

- the fuel assembly grapple
- the fuel assembly hoists

Selectors on the main control panel allows the operator to switch the current hoist and to use the backup motorizations of the grapple in case of a motorization or power supply failure. For both systems, the main motorization and its backup are on the two different power supply channels and don't share any control or power wire.

Failure of monitoring and control system (design event II)

In the case of a loss of the remote control of this equipment (fuel assembly hoist and grapple), the system is designed to fail safe (brakes engage upon loss of electrical power, grapple fingers opening mechanically impossible). Two different PLC's manage the HVAC and the mechanical equipment. So, a failure of the control of the fuel assembly hoist or grapple doesn't necessarily implicate a failure of the control of the HVAC System. In the case where the failure of the Control Subsystem is due to a failure upstream of the PLC, the HVAC can be switched to a "manual mode" where the speed of the exhaust fan is set by the operator as well as the activity of the cooling system. In these conditions, the Control System can be repaired without time restrictions.

Tornado missiles, hurricanes and high winds (design event IV)

In the case of a tornado warning or watch, the installation is placed in a safe condition (fuel replaced in the casks and casks closed). The Control Center may be disconnected from the DTS and moved to a sheltered area. The HVAC system can be controlled manually. No remote control is required during this temporary shutdown period. If a tornado hits, and depending on the damage caused to the Preparation Area and to the HVAC exhaust fans, two solutions can be chosen:

- either the Control System and the HVAC can be repaired and the casks can be reopened or the transfer can be completed,
- or the casks need to be inerted and removed from the DTS.

In the worst case, the Preparation Area is lost and the receiving cask overpack lid is damaged or lost which prevents the cask from being inerted. The utility may wish to keep a backup overpack lid for this reason. The damages caused to the Preparation Area (housing the PLC's) and to the HVAC can be fixed without time restrictions.

Seismic event (design event IV)

In the case of a seismic event, the Control System can be lost. Monitoring means such as periscopes or fiberscopes may need to be introduced in the TCA to monitor the operations. Special toolswcould be required to lower the spent fuel in a cask and disengage it.

Fire and explosion (design event IV)

In the case of a fire of a fuel assembly hoist or grapple motorization, the fire suppression system and the separation of electrical wiring guarantee that the redundant motorization will not be affected.

In the case of a fire in the Preparation Area, the control cabinets house temperature monitoring sensors which are linked to the PLC's. In case of abnormal high temperatures, the PLC places the equipment in a safe condition and shuts down. After the fire, the control system can be reset to place the installation in a shut down condition, until an assessment of the damage and/or repairs are made.

If the Control Center is removed from service, the Radiation Monitoring, which has its own power supply backup (batteries), still displays the radiation levels in each area, in the Preparation Area.

5.6 Analytical Sampling

Section 7.3.4 describes the sampling which will be performed to ensure that operations are within prescribed radiological limits.

5.7 Preventive Maintenance.

Preventive maintenance is performed on all components of the DTS system to prevent any unexpected system, equipment, or component malfunction. The following preventive maintenance requirements, for each subsystem, are in addition to the maintenance requirements outlined in Chapter 5. Scheduled maintenance will be performed, as a minimum, in 100-day cycles (i.e. after 10 receiving cask loading, each loading lasting10 days).

A log will be maintained, to record past maintenance on the system, and to report any problems that might have existed.

Pintle Grappling Device in Preparation Area:

1. Lubricate bearings, shaft couplings, pillow blocks, and drive gearboxes. Inspect drive gearboxes and motor seals for oil leakage.
2. Check wheels and guide rollers for excessive wear.
3. Inspect the motors, gearboxes, drive shafts, cable drums, and bumpers for damage or excessive wear.
4. Lubricate and inspect cables.
5. Inspect electric cables for fraying or brittle insulation.
6. Inspect the runway rails for excessive wear and alignment.
7. Spot check bolted connections for tightness.
8. Inspect pendant cables and controls for any physical damage.
9. Perform operational tests of all functions.

Cask Transfer Subsystem (Receiving and Source Casks):

1. Lubricate bearings, shaft couplings, pillow blocks, drive gearbox and locking pin screw jack. Inspect drive gearbox and motor seals for oil leakage.
2. Check wheels and guide rollers for excessive wear.
3. Inspect the motors, gearbox, trunnion cradles, centering guides, drive shaft, axles, bumpers and locking pin mechanism for damage or excessive wear.
4. Inspect brakes for mechanical damage, misalignment and ease of manual override operation. Measure the thickness of the friction discs and the air gap around the brake pot.
5. Inspect the limit switches for operation, set-points, tight connections and wear or pitting.
6. Inspect the electric cable for fraying or brittle insulation.
7. Inspect the trolley rails for excessive wear and alignment.
8. Spot check bolted connections for tightness.
9. Inspect pendant cables and controls for any physical damage.
10. Perform operational tests of all functions.

TC and Upper Shield Port Covers:

1. Lubricate bearings, and locking pin screw jack.
2. Check the wheels and guide rollers for excessive wear.
3. Inspect the screw jack motor, drive shaft, axles, bumpers and locking pin mechanism for damage or excessive wear.
4. Inspect the limit switches for operation, set-points, tight connections and wear or pitting.
5. Spot check bolted connections for tightness.
6. Perform operational tests of all functions.

Cask Mating Subsystem (Receiving and Source Casks):

1. Lubricate bearings.
2. Replace confinement bellows every 100 days of operation as stated on page 5.2-13 of the TSAR and other equipment subject to radiation damage per recommended schedule (to be developed based on detailed design and exposure rates).
3. Inspect the electric jacks for damage or excessive wear.
4. Inspect receiving cask plug overlid and source cask overlid grapple finger mechanism by manually rotating engagement shaft.
5. Spot check bolted connections for tightness.
6. Perform operational tests of all functions.

Receiving Cask Plug and Source Cask Lid Crane Subsystem:

1. Lubricate bearings, shaft couplings, pillow blocks and drive gearboxes. Inspect drive gearboxes and motor seals for oil leakage.
2. Check wheels and guide rollers for excessive wear.
3. Inspect the motors, gearboxes, drive shafts, cable drums and sheaves, compensator and bumpers for damage or excessive wear.
4. Lubricate and inspect cables.
5. Inspect grapple for damage and proper finger adjustment.
6. Inspect brakes for mechanical damage, misalignment and ease of manual override operation. Measure the thickness of the friction discs and the air gap around the brake pot.
7. Inspect the limit switches for operation, setpoints, tight connections and wear or pitting.
8. Inspect electric cables for fraying or brittle insulation.
9. Inspect the runway rails for excessive wear and alignment.
10. Spot check bolted connections for tightness.
11. Check and adjust load cell calibration by suspending a known load on the grapple. Under normal circumstances, the load cell requires no adjustment.
12. Perform operational tests of all functions.

Fuel Assembly Transfer Subsystem:

1. Lubricate bearings, shaft couplings, pillow blocks and drive gearboxes. Inspect drive gearboxes and motor seals for oil leakage.
2. Check wheels and guide rollers for excessive wear.
3. Inspect the motors, gearboxes, drive shafts, cable drums and sheaves and bumpers for damage or excessive wear.
4. Lubricate and inspect cables.
5. Inspect grapple for damage and proper finger adjustment.
6. Inspect brakes for mechanical damage, misalignment and ease of manual override operation. Measure the thickness of the friction discs and the air gap around the brake pot.
7. Inspect the limit switches for operation, setpoints, tight connections and wear or pitting.
8. Inspect electric cables for fraying or brittle insulation.
9. Inspect the runway rails for excessive wear and alignment.
10. Spot check bolted connections for tightness.
11. Check and adjust load cell calibration by suspending a known load on the grapple.
12. Check the crud catcher for damage and proper adjustment.
13. Inspect the endless chain system and lubricate the chain, drive gearbox and bearings.
14. Replace equipment subject to radiation damage per recommended schedule (to be developed based on detailed design and exposure rates).

Sliding Door:

1. Lubricate worm screws and brackets.
2. Check wheels for excessive wear.
3. Inspect the motor and drive shaft for damage or excessive wear.
4. Spot check bolted connections for tightness.
5. Inspect the four locking pins and the two sliding panels.
6. Perform operational tests of all functions.

HVAC System:

1. Monitor and replace the four particulate filters, as necessary.
2. Inspect condition of all damper motors.
3. Perform maintenance on the exhaust fans, condensing units and air handling units as required by the manufacturer.
4. Inspect outdoor exhaust stack to ensure it is securely fixed to the exterior DTS wall and repair any damage from weather conditions.

Control Panels:

1. Open electrical panel and clean as necessary using lint free rags and vacuum.
2. Ensure all components and connections are tight.
3. Inspect flexible conduit for cuts, tears or other damage.
4. Check conductors and components for discoloration and overheating.
5. Exercise contactors by manually pushing armatures several times and verify smooth operation.
6. Verify ribbon cables are undamaged.
7. Verify that filters are clean and clean as necessary with compressed air.
8. Visually inspect relays to verify that they are tightly seated into relay socket.

Routine maintenance of the controls is expected to be minimal, consisting of periodic inspections and calibration checks. Detailed maintenance requirements will be developed using the manufacturer's recommendations for specific equipment used in the control system. The effect of radiation on components is considered. Total dose to control system components located in the fuel transfer area (resolvers, load cells and limit switches) will be monitored. A site-specific plan will be developed for replacement of these items, based on total integrated dose, to prevent equipment failure during fuel movement.