Appendix 5A Technical Report for the Control Subsystem

This appendix provides details for the design of the monitoring and control equipment (both hardware and software) of the Dry Transfer System. The Control Subsystem covers the logic of the two first levels providing macro-operation and operation sequences, origin and usage of information for verification of conditions.

5A.1 DEFINITIONS

5A.1.1 Introduction

As specified in the referenced document 8.1, the purpose of the Control Subsystem is:

- to allow the control and monitoring of the mechanical equipment including the following subsystems:
  - Cask Transfer Subsystem
  - Transfer Confinement Mating Subsystem
  - Transfer Confinement Port Shield Subsystem
  - MPC Shield Plug and Source Cask Lid Handling Subsystem
  - Fuel Assembly Handling Subsystem
- to allow the control and monitoring of the HVAC Subsystem equipment
- to allow the monitoring of the Radiation Monitoring Subsystem
- to manage the interfaces and interlocks, internal and external to the equipment and subsystems.
- to allow communication between the DTS and the Control Center

5A.1.2 Scope

This report covers the design of the monitoring and control equipment (both hardware and software) of the DTS. The monitoring and control system includes the control panels, equipment used to process information from the sensors on the operating equipment, HVAC system, sliding and roll up doors, Radiation Monitoring equipment, the alarm systems. The sensors and cables for equipment are considered part of the equipment.

The DTS transfer cycle operations can be broken down into three levels:

- Macro-operation level: Opening of a cask...
- Operation level: opening of a port cover, lowering of a grapple...
- Micro-operation level: brake activation, speed regulation...

The Control Subsystem covers the logic of the two first levels providing macro-operation and operation sequences, origin and usage of information for the verification of the conditions to allow each operation processing. These levels have been analyzed for a safe control and monitoring of the operations during normal operating conditions. For the off-normal operating conditions, this document identifies the different alarm levels, their causes and consequences.

Numerous flow charts are provided in this Appendix to assist in understanding the Control System. The following Flow Chart Table is provided as supplementary information to the logic flow charts presented throughout this appendix.

Table 5A-1
FLOW CHARTS

Procedure	Meaning	Page
Legend		15
Complete transfer operations		16
CCP	Crane Carriage Positioning	90
CRCC	Crud Catcher Closing	99
CRCO	Crud Catcher Opening	98
FAGC	Fuel Assembly Grapple Connecting	109
FAGD	Fuel Assembly Grapple Disconnecting	110
FAGLI	Fuel Assembly Grapple Lifting	105
FAGLO	Fuel Assembly Grapple Lowering	103
FAT	Fuel Assembly Transfer	24
FATL	Fuel Assembly Transfer Loop	23
LSPGC	Lid/Shield Plug Grapple Connecting	84
LSPGD	Lid/Shield Plug Grapple Disconnecting	85
LSPGLI	Lid/Shield Plug Grapple Lifting	80
LSPGLO	Lid/Shield Plug Grapple Lowering	76
MFLI-RC	Receiving Cask Mating Flange Lifting	39
MFLI-SC	Source Cask Mating Flange Lifting	40
MFLO-RC	Receiving Cask Mating Flange Lowering	37
MFLO-SC	Source Cask Mating Flange Lowering	38
RCC	Receiving Cask Closing	21
RCD	Receiving Cask Disengagement - see MFLI-RC	
RCM	Receiving Cask Mating - see MFLO-RC	
RCO	Receiving Cask Opening	19
RCP	Receiving Cask Positioning	17
RCR	Receiving Cask Removal	18

FLOW CHARTS (Continued)

Procedure	Meaning	Page
RPP	Rotating Platform Positioning	94
SCC	Source Cask Closing	21
SCD	Source Cask Disengagement - see MFLI-SC	
SCM	Source Cask Mating - see MFLO-SC	
SCO	Source Cask Opening	19
SCP	Source Cask Positioning	17
SCR	Source Cask Removal	18
SDC	Sliding Door Closing	115
SDO	Sliding Door Opening	114
TCE-RC	Transfer Cask Entering - Receiving Cask	28
TCE-SC	Transfer Cask Entering - Source Cask	29
TCL-RC	Transfer Cask Locking - Receiving Cask	31
TCL-SC	Transfer Cask Locking - Source Cask	31
TCP-RC	Transfer Cask Positioning - Receiving Cask	30
TCP-SC	Transfer Cask Positioning - Source Cask	30
TCPCC-RC	TC Port Cover Closing - Receiving Cask	49
TCPCC-SC	TC Port Cover Closing - Source Cask	50
TCPCL-RC	TC Port Cover Locking - Receiving Cask	52
TCPCL-SC	TC Port Cover Locking - Source Cask	53
TCPCO-RC	TC Port Cover Opening - Receiving Cask	47
TCPCO-SC	TC Port Cover Opening - Source Cask	48
TCPCOC	TC Port Cover Off Centering	51
TCPCU-RC	TC Port Cover Unlocking - Receiving Cask	45
TCPCU-SC	TC Port Cover Unlocking - Source Cask	46
TCR-RC	Transfer Cask Removal - Receiving Cask	33
TCR-SC	Transfer Cask Removal - Source Cask	33

FLOW CHARTS (Continued)

Procedure	Meaning	Page
TCU-RC	Transfer Cask Unlocking - Receiving Cask	32
TCU-SC	Transfer Cask Unlocking - Source Cask	32
UCP-RC	Upper Crane Positioning above the Receiving Cask	58
UCP-SC	Upper Crane Positioning above the Source Cask	59
USPC-RC	Receiving Cask Upper Shield Port Closing	70
USPC-SC	Source Cask Upper Shield Port Closing	71
USPL-RC	Receiving Cask Upper Shield Port Locking	66
USPL-SC	Source Cask Upper Shield Port Locking	67
USPO-RC	Receiving Cask Upper Shield Port Opening	68
USPO-SC	Source Cask Upper Shield Port Opening	69
USPU-RC	Receiving Cask Upper Shield Port Unlocking	64
USPU-SC	Source Cask Upper Shield Port Unlocking	65

5A.2 STRUCTURE

5A.2.1 Introduction

This section presents the structure of the Control Subsystem. It describes the human/machine interfaces which are the control and monitoring equipment used by the operator to safely perform a transfer cycle. It shows the different levels in which information is processed, the type of equipment used to process the information and the communication links between the equipment.

The Instrumentation and Control Structural Diagram (see Appendix A) provides a schematic view of the Control Subsystem structure.

5A.2.2 Human/Machine interface locations

As shown in the structural diagram, the human/machine interfaces for the control and monitoring of the equipment are located in three areas:

- the Control Center which is located in a trailer outside the DTS building
- the Preparation Area
- the Lower Access Area

The locally controlled and monitored operations are those involving:

- the Cask Transfer Subsystem (transfer trolleys entry/positioning/removal and locking/unlocking operations)
- the Structural Subsystem (sliding door opening/closing operations)

During all the other operations, workers are not in the DTS building and means are provided to safely control and monitor the operations remotely from the Control Center.

5A.2.3 Local control and monitoring means

Two identical control panels are located in the Lower Access Area and in the Preparation Area (referenced document 1.9) to control the Cask Transfer Subsystem during normal operating conditions. A unique key activates the control panel, in order to give the control to a unique operator. Entry, positioning and removal of the receiving and source casks transfer trolleys are controlled by these panels.

The control of the sliding door is performed using specific control panels located in the Lower Access Area and in the Preparation Area.

Communication means are provided to enable communication between the Control Center and the Preparation Area or the Lower Access Area.

5A.2.4 Remote control and monitoring means

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) (referenced document 1.6)
- one main control panel (referenced document 1.8)
- a personal computer (PC)
- a monitoring display
- an audio system

The operating cycle is completely controlled by the operator. Each operation is controlled independently and there is no automatic sequence. The main control panel permits the operator to control every remote operation by use of pushbuttons and joysticks and to control the power of each equipment group (locking device and motorization for example).

A monitoring display animated by a monitoring software (supervisor) provides a schematic representation of all the equipment status, motions and positions which are necessary to monitor the process and validate operations in order to safely control the process. It provides information for the monitoring of the HVAC Subsystem and the Radiation Monitoring Subsystem too. In addition, an Instruction Guide listing the steps to be completed by the operator is displayed, based on the monitoring information.

Two CCTV displays provide viewing of the Lower Access Area, of the Transfer Confinement Area and of the upper part of the cask baskets. They permit the operator to validate different operations and transition conditions, and also to help him to position the transfer tube above a cell, to check the correct entry of a fuel assembly in a cask and to detect either physical problems on equipment or abnormal process conditions.

The computer also enables the operator to set the coordinates of the target position of the fuel transfer tube to activate its automatic positioning (see Section 5.2.5).

The audio system provides another monitoring means for the operations which occur in the Transfer Confinement Area.

5A.2.5 Between control request and operation processing

The control panel and the PC are linked to two Programmable Logic Controllers (PLC). One PLC controls all the mechanical equipment, while the other controls the sliding door and the HVAC equipment. The PLC controlling the sliding door is linked to the Radiation Monitoring equipment. The PLCs and the PC are linked by a local network.

When a control is requested (control panel), the PLC checks all the safety conditions allowing the operation processing, and the request is transmitted to the electronic cabinets which manage the interface between the Power Subsystem and the equipment. In the other direction, the sensors provide information to the PLC on the different status and positions of the equipment, which transmits it to the PC to animate the supervisor and to update the process data of the instruction guide software.

Concerning the HVAC equipment, the PLC task is esssentially a regulation and alarms task (see Section 5.4).

Concerning the Radiation Monitoring equipment, the PLC task is essentially to check values and transmit them to the supervisor.

5A.2.6 Alarms

The alarms are always directly activated by the detecting equipment. So, the equipment, the instrumentation, the PLC and the PC are linked to the alarm system.

5A.3 ANALYSIS OF THE TRANSITION CONDITIONS

5A.3.1 Introduction

As specified in the Referenced Document 1.1, a function of the Control Subsystem is to prevent unsafe control of the transfer operations. The compliance with the operating sequence is achieved through the administrative procedure; there is no automatic checking of the sequence.

The safety of the complete operating 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 safe control of an operation is achieved by the automatic checking of the iniation conditions which are important to safety. During an operation process, safety is guaranteed by the design of the alarms and by the design of each equipment.

5A.3.2 Nomenclature

All the operation (or macro-operation) results or equipment status are used as conditions to allow the initiation of other operations (or macro-operations). These conditions are identified throughout this document using their acronym.

The condition's acronym, in the case of an operation result, is based on the operation's acronym (cf Referenced Document 1.1) that achieves the condition, using the extension "x" for executed.

Example : Condition : Source Cask Trolley locked
Operation : TCL-*SC*
Condition's acronym : TCL-*SC*-x

The table 5A-2 lists all the equipment status acronyms, linking the equipment, its status, the operations that can influence it and the acronym.

Table 5A-2
Equipment Status Acronyms

Equipment	Status	Operation	Acronym
TC Cask Mating Subsystem	in upper position	MFLO MFLI	MF-up
Mating Flange	in proper mated position	MFLO MFLI	MF-mp
Source Cask Lid / Receiving Cask Shield Plug Grapple	in upper position	LSPGLO LSPGLI	LSPG-up
	above TC port cover	LSPGLO LSPGLI SCLLI SCLLO SPLI SPLO	LSPG-p1
	at the TC port cover level (MPC shield plug or source cask lid on the TC port cover) Note: These levels are not the same for the Source and the Receiving Casks	LSPGLO LSPGLI SCLLO SCLLI SPLO SPLI	LSPG-p2
	at the cask level Note: These levels are not the same for the Source and the Receiving Casks	LSPGLO LSPGLI SCLLO SCLLI SPLO SPLI	LSPG-p3
	in gripping position	SCLG SCLGD SPG SPGD	LSPG-g

Table 5A-2 (Continued)
Equipment Status Acronyms

Equipment	Status	Operation	Acronym
Source Cask Lid / Receiving Cask Shield Plug Grapple (continued)	in disengaged position	SCLG SCLGD SPG SPGD	LSPG-d
Source Cask Lid / Receiving Cask Shield Plug Handling Subsystem handling cables	not loaded	SCLLO SCLLI SPLO SPLI	LSPHC-nl
Fuel Assembly Handling Subsystem Grapple	in upper z position	FAGLO FAGLI FALO FALI	FAG-up
	in gripping / disengagement z position	FAGLO FALO	FAG-p
	fingers in disengaged position	FAGC FAGD	FAG-d
Fuel Assembly Handling Subsystem handling cable	not loaded	FAGLO FAGLI FALO FALI	FAHC-nl

5A.3.3 Analysis

This section presents the results of the analysis of the transition conditions. The Table 5A-3 shows the conditions which are necessary to pass from the operating process step n to n+1. These conditions are classified as internal if the device or system at their source is a part of the same subsystem as the operation to process. Otherwise, they are classified as external. This classification permits one to see the interactions between the different Subsystems.

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. The Column '↓' provides the index of the last operation depending on this transition (without discontinuity).

Each transition is classified in the Column O/S according to its importance to safety :

- if the transition condition is only necessary for the operating process, it is classified as Operating (O).
- if the transition condition is important to safety, it is classified as Safety (S).

This table doesn't show the operating sequence (cf Referenced Document 1.1) but only the transitions. When extensions exist for an operation that are not specified with the name of the operation to process, it means that the transition is available for a same system (usually Source or Receiving Cask) whatever it is. This table doesn't show the transitions which occur during the processing of two identical macro-operations (for example, the entering and mating of the source and receiving casks).

Table 5A-3
Transition Conditions

#	Operation to Process	Internal Transition Conditions	↓ #	OS	External Transition Conditions	↓ #	OS
0	TCE	TCU-x	0	0	TCSPC-*(RC & SC)*-x MF-up SDO-x	9 1 3	O O O
1	TCP	TCE-x	1	O			
2	TCL	TCP-x	2	O			
3	SDC						
4	SDL	SDC-x		O			
5	MFLO				TCL-x SDL-x	55 53	SO
6	UCP	USPC-*(RC & SC)*-x LSPG-up	6 9	O S	Mating successful	52	S
7	USPU	UCP-x	19	S	Radiation level low FAHC-nl	8 22	SS
8	USPO	USPU-x	8	O			
9	TCSPO				USPO-x SDL-x	19	O S
10	LSPGLO				TCSPO-*(RC & SC)*-x CCP-*PP*-x	13 21	OS
11	SPGC / SCLGC	LSPG-p3 LSPHC-nl	11 11	O O			
12	SPLI/SCLLI	LSPG-g	15	S			
13	TCSPOC / TCSPC				LSPG-p1	13	S
14	SPLO / SCLLO				TCSPOC-x / TCSPC-*SC*-x	17 17	O O
15	SPGD / SCLGD	LSPG-p2 LSPHC-nl	15 15	S S			
16	LSPGLI	LSPG-d	16	S			
17	TCSPC				LSPG-p1	17	O
18	LSPGLI	TCSPC-x	21	O			
19	USPC	LSPG-up	19	O			

Table 5A-3 (Continued)
Transition Conditions

#	Operation to Process	Internal Transition Conditions	↓ #	OS	External Transition Conditions	↓ #	OS
20	USPL	USPC-x	40	S			
21	TCSPO-*(RC & SC)*-x				USPL-*(RC & SC)*-x	40	S
22	TCSPL- *(RC & SC)*	TCSPO-*(RC & SC)*-x	22	O			
23	CCP-*SC* & RPP	CRCC-x FAG-up FAG-d	23 24 25	S S O	TCSPL-*(RC & SC)*-x	36	S
24	CRCO	CCP-*SC*-x & RPP-x	28 28	S S			
25	FAGLO	CRCO-x	27	S			
26	FAGC	FAG-p	26	O			
27	FALI	FAGC-x	31	S	-		
28	CRCC-*SC*	FAG-up	30	S			
29	CCP-*RC* & RPP	CRCC-x	30	S			
30	CRCO	CCP-RC-x & RPP-x	34 34	S S			
31	FALO	CRCO-x	33	S			
32	FAGD	FAG-p FAHC-nl	32 37	S S			
33	FAGLI	FAG-d	37	S			
34	CRCC	FAG-up	37	S			
35	CCP-*PP*	CRCC-x	35	O			
36	TCSPU- *(RC & SC)*				CCP-PP-x	50	S
37	TCSPC-*SC* & TCSPOC	TCSPU-*(RC & SC)*-x	37	O			

**Table 5A-3 (Continued)
Transition Conditions**

#	Operation to Process	Internal Transition Conditions	↓ #	OS	External Transition Conditions	↓ #	OS
38	UCP	USPC-*(RC & SC)*-x LSPG-up	38 40	O S	TCSPC-*SC*-x TCSPOC-x	42 42	S S
39	USPU	UCP-x	50	S	Radiation level low	40	S
40	USPO	USPU-x	40	O			
41	LSPGLO	USPO-x	50	S			
42	SPGC / SCLGC	LSPG-p2	42	O			
43	SPLI / SCLLI	LSPG-g	46	S			
44	TCSPO				LSPG-p1	44	S
45	SPLO / SCLLO				TCSPO-*(RC & SC)*-x	48	S
46	SPGD / SCLGD	LSPG-p3 LSPHC-nl	46 46	S S			
47	LSPGLI	LSPG-d	47	S			
48	TCSPC				LSPG-p1	49	O
49	LSPGLI	TCSPC-x	55	O			
50	USPC	LSPG-up	50	O			
51	USPL	USPC-x	51	O			
52	MFLI						
53	SDU				MF-up Radiation level nil	56 54	O S
54	SDO	SDU-x	54	O			
55	TCU				SDO-x	56	O
56	TCR	TCU-x	56	O			

5A.3.4 Transition validation

The means used to validate the transition conditions depend on their level of importance to safety. Most mechanical operations are monitored using the CCTV Subsystem. For the operations which are not important to safety but important with respect to the operation sequence (O), the administrative control, the viewing provided by the CCTV Subsystem and the indications provided by the mechanical equipment (motorization status, device position, ...) are sufficient to validate a transition. Concerning operations which are important to safety (S), this validation means is necessary but not sufficient. These transitions are validated using interlocks between the equipment. These interlocks are managed by the PLCs.

5A.4 CONTROL AND MONITORING OF THE EQUIPMENT UNDER NORMAL OPERATING CONDITIONS

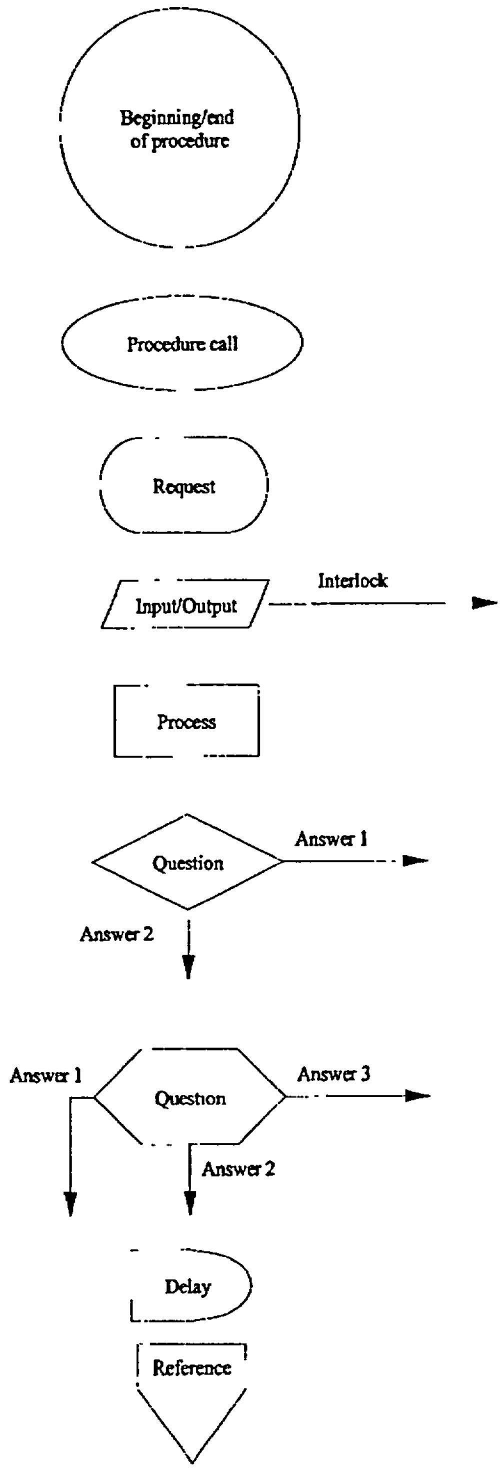
5A.4.1 Introduction

The following flow charts describe the operating sequence, providing the high level procedures call sequence. The acronyms used for the procedure calls are listed in the flow chart table of contents. The flow charts describing the low level procedures (control of one single operation) are provided in each subsection.

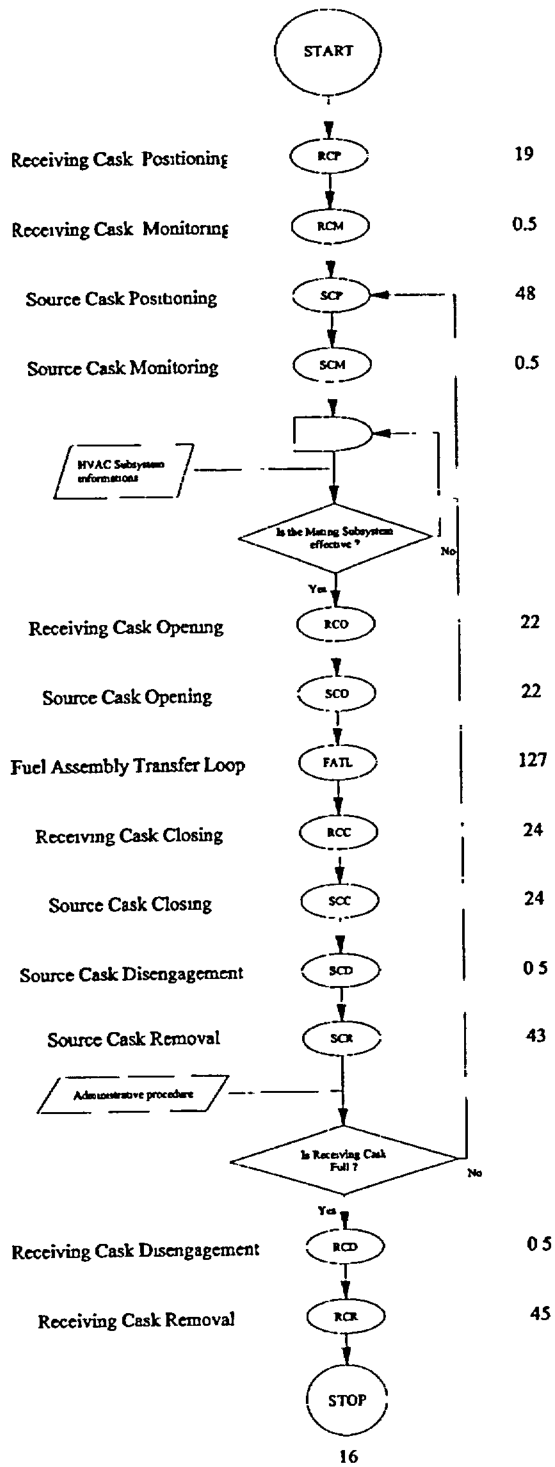
This section provides for all equipment:

- a brief description of the equipment
- a brief description of the operating principle
- the functional requirements for the control, monitoring and alarms
- the transition condition validation requirements including internal and external interlocking requirements, based on the previous analysis of the transitions
- the instrumentation requirements
- the flow charts for the control system

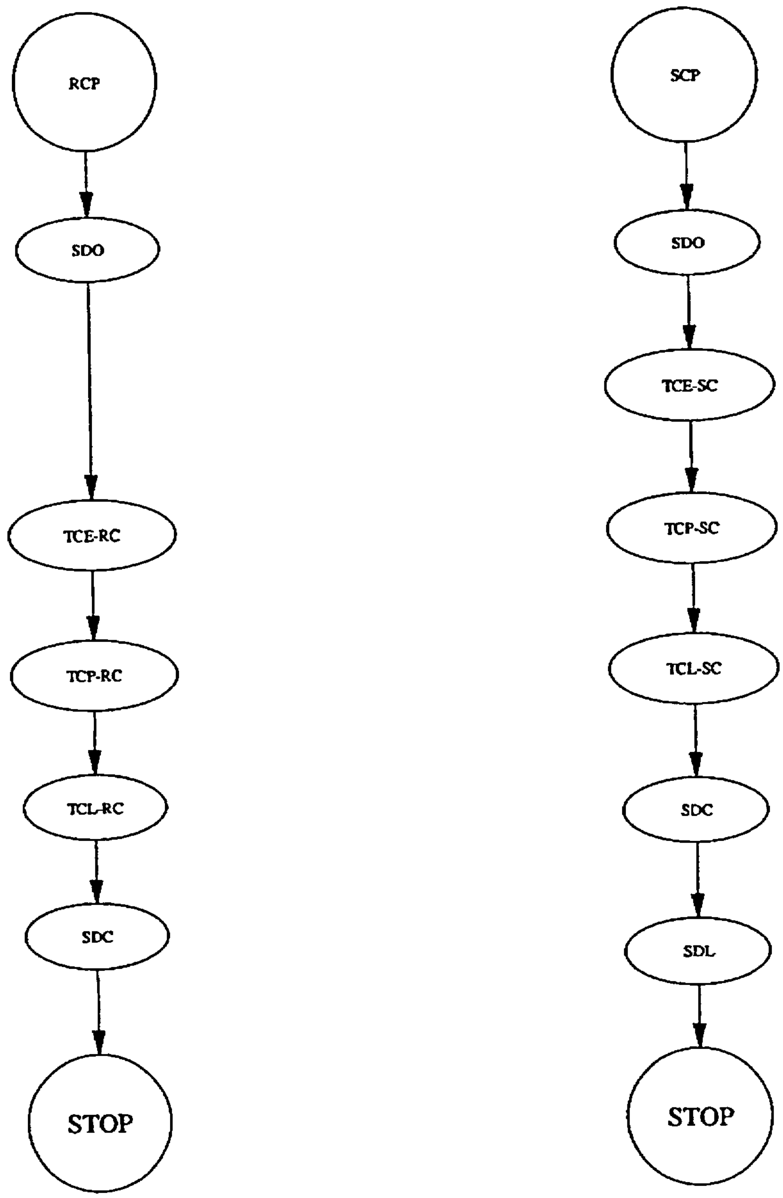
FLOW CHART LEGEND



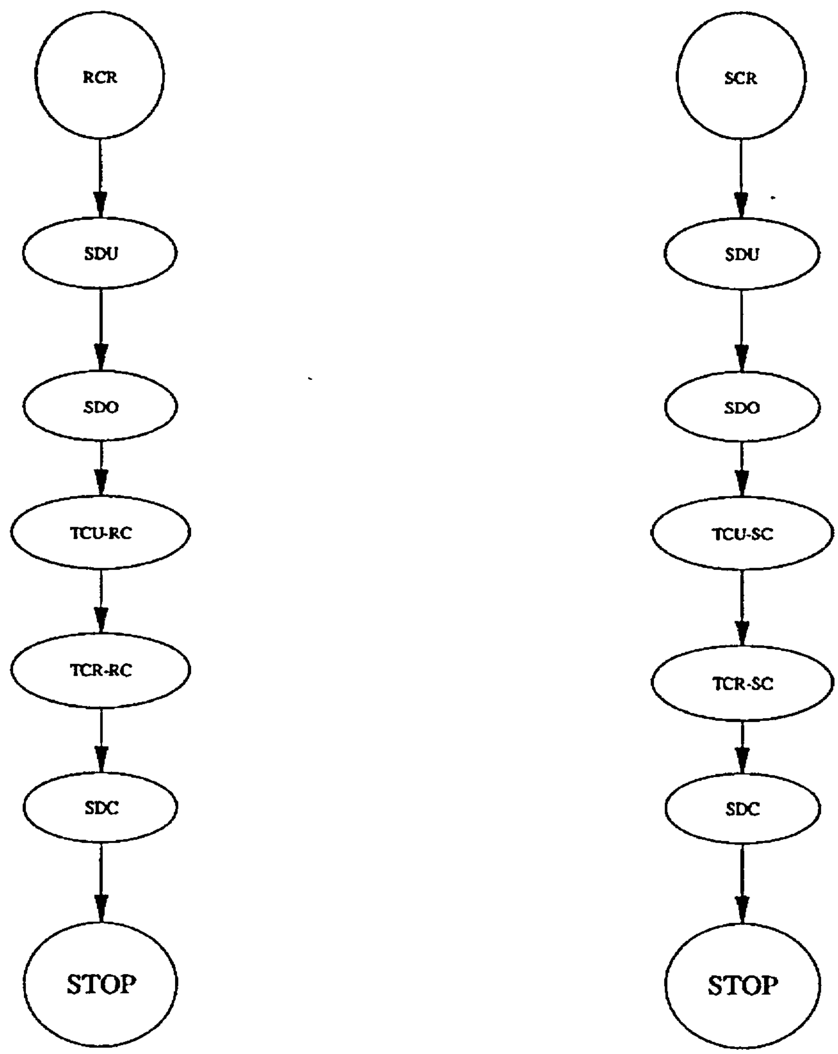
COMPLETE TRANSFER OPERATIONS



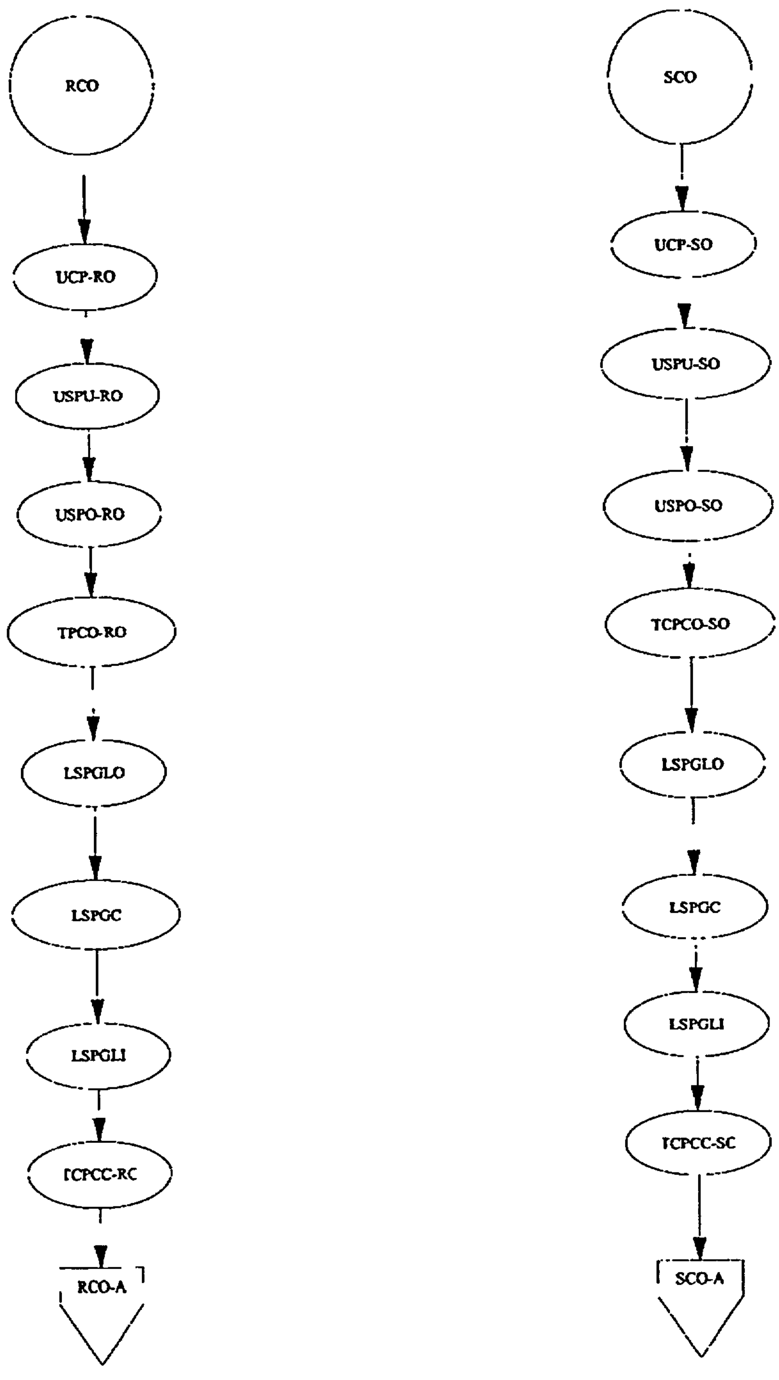
Source and Receiving Casks Positioning



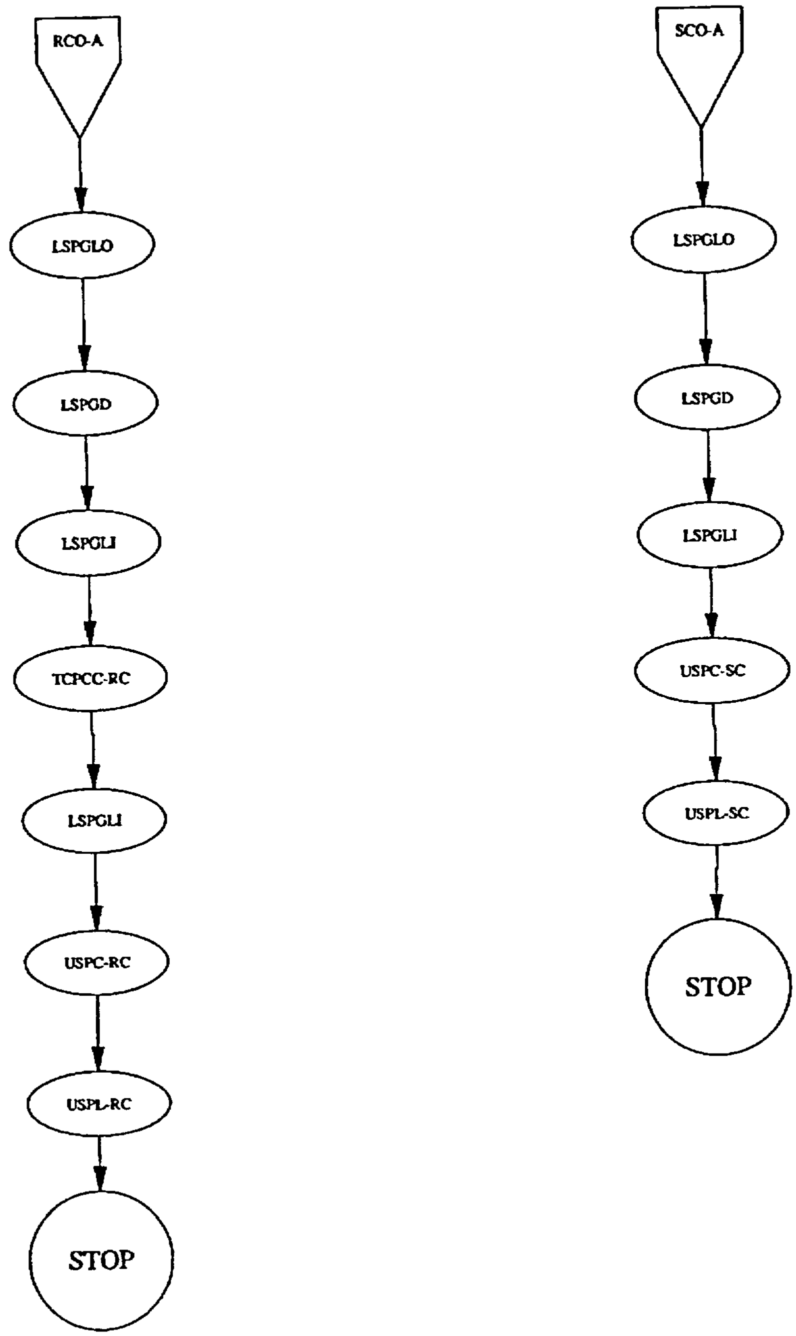
Source and Receiving Casks Removal



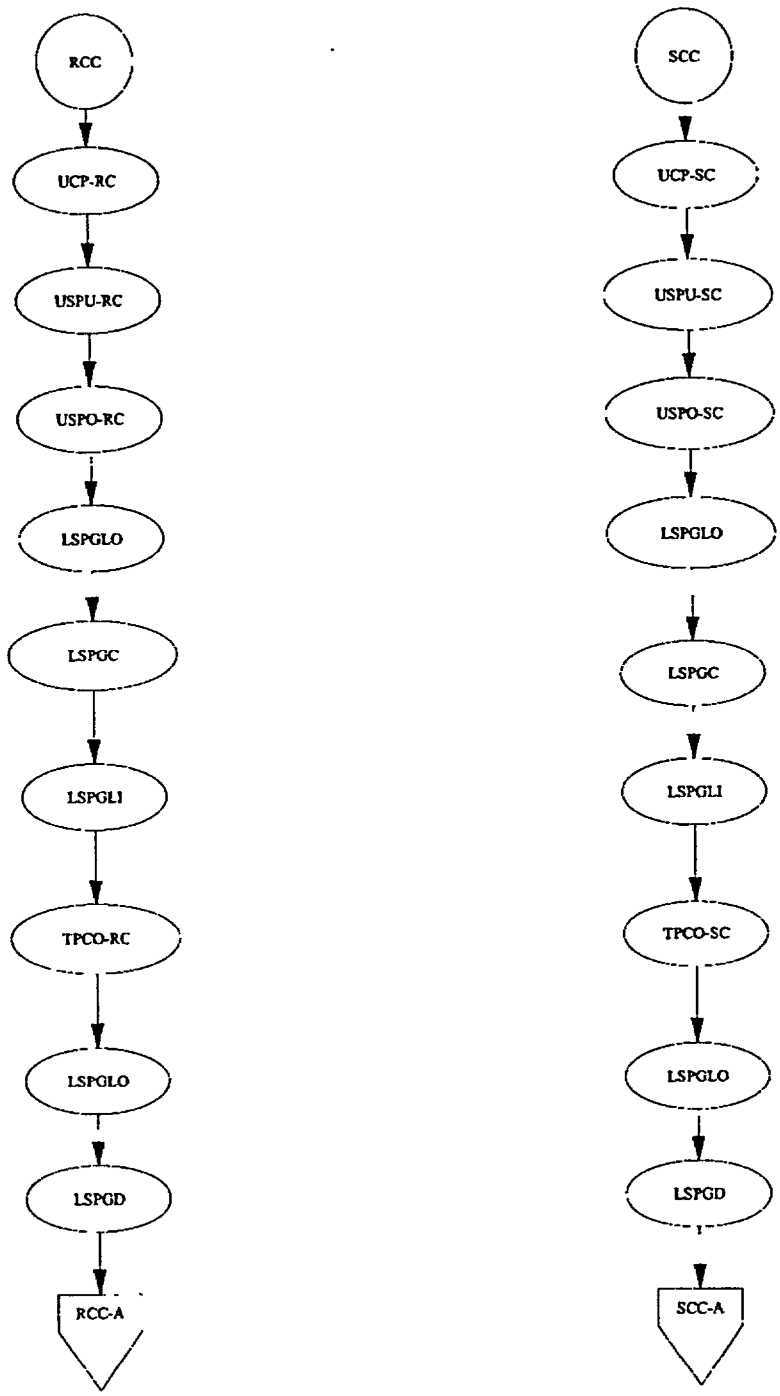
Source and Receiving Casks Opening



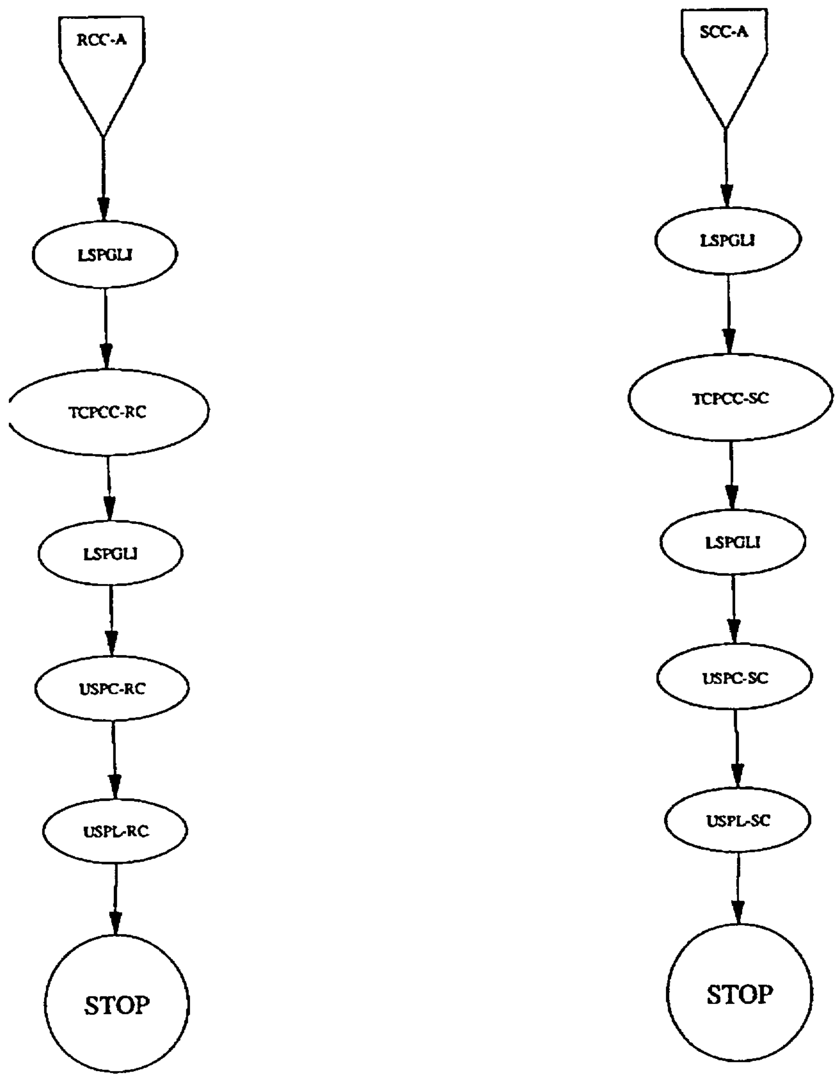
Source and Receiving Casks Opening (continued)



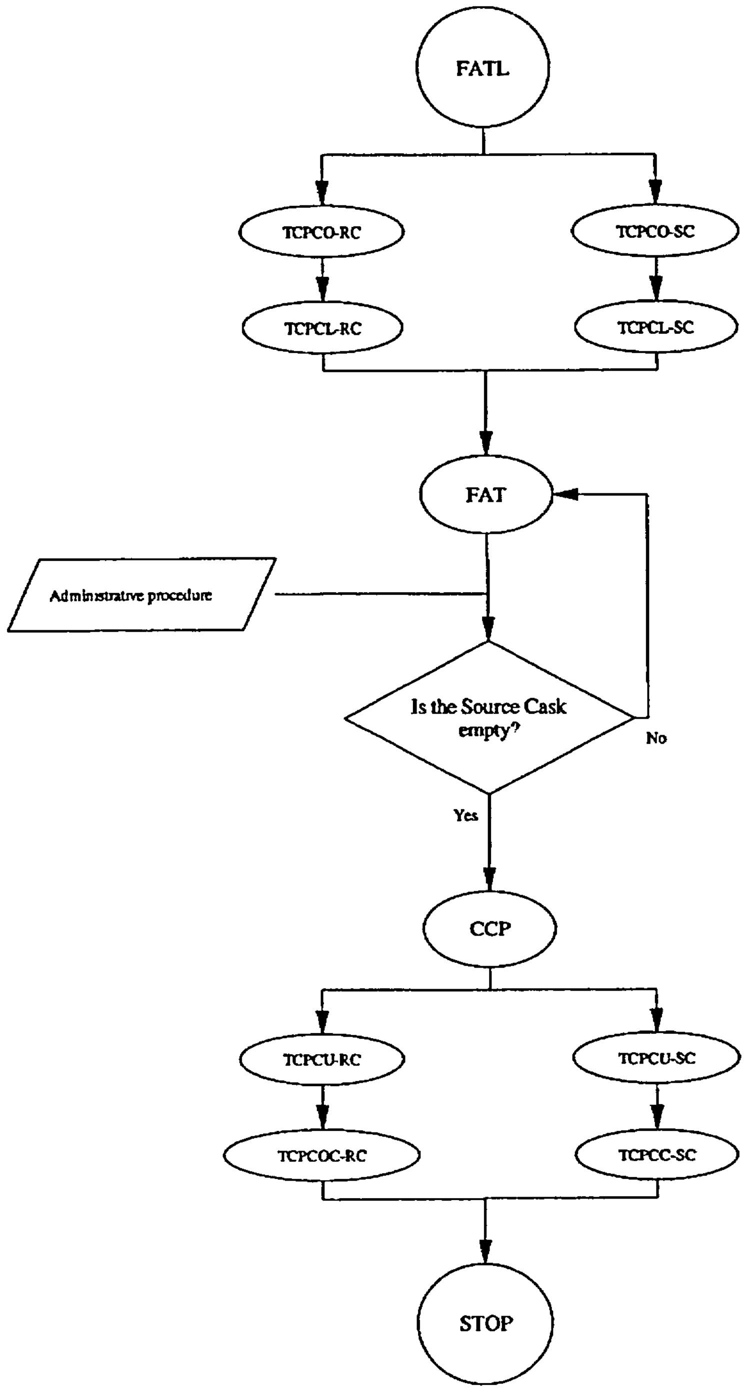
Source and Receiving Casks Closing



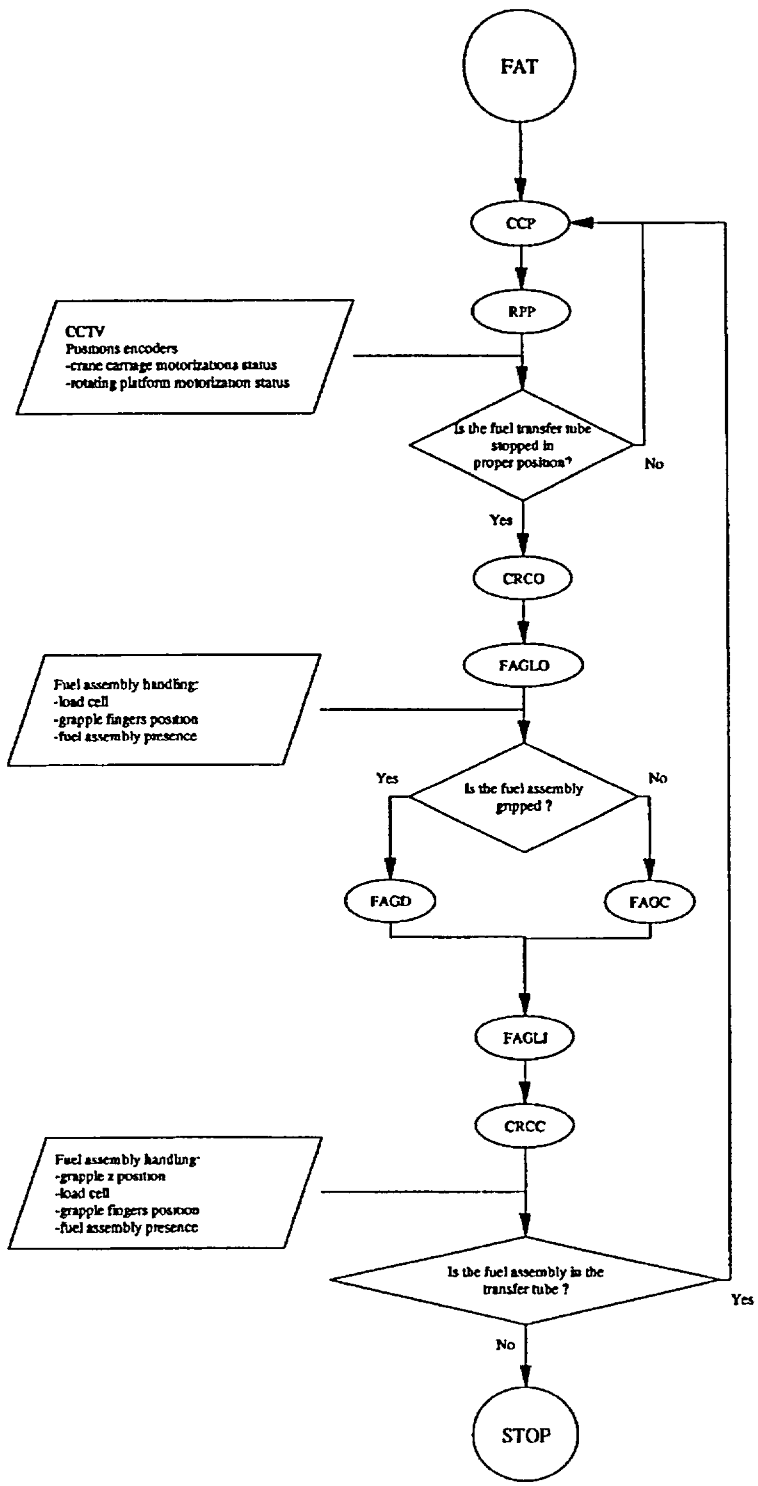
Source and Receiving Casks Closing (continued)



Fuel Assembly Transfer Loop



Fuel Assembly Transfer



5A.4.2 Control and monitoring of the mechanical equipment

5A.4.2.1 Control and monitoring of the Cask Transfer Subsystem

A. Description

The Cask 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 (cf Referenced Document 8.2). The Source and Receiving Casks subparts of the Subsystem are identical in regard to the control and monitoring of the operations.

B. Operating principle

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.

C. Control and monitoring requirements

The Control Subsystem for each subpart of the Cask Transfer Subsystem shall :

- Locally control the motorization (run/direction/stop/2 speeds).
- Detect the proper positions of the trolley (stop motion).
- Detect an overrun (alarm + stop motion).
- Detect a collision with a bumper guard (alarm + stop motion).
- Detect a collision between the two trolleys (alarm + stop motion).
- Locally control the locking device (lock/unlock/stop).
- Monitor the position of the locking device (locked/unlocked/undefined).

Only indications on locking positions shall be indicated in the Control Center. The proper positions correspond to the preparation position in the Preparation Area and to the loading/unloading positions in the Lower Access Area. The preparation position is the same for the two trolleys while the other positions are trolley dependent.

D. Transition conditions validation requirements

Rationale:

The control of the motorization is local. 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 shall 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.

Dependent equipment:

TC Cask Mating Subsystem - mating flanges

E. Instrumentation requirements

Redundant instrumentation is not necessary for the control of the trolleys since a recovery system is provided.

Table 5A-4 lists the necessary instrumentation for the Cask Transfer Subsystem.

F. Flow charts

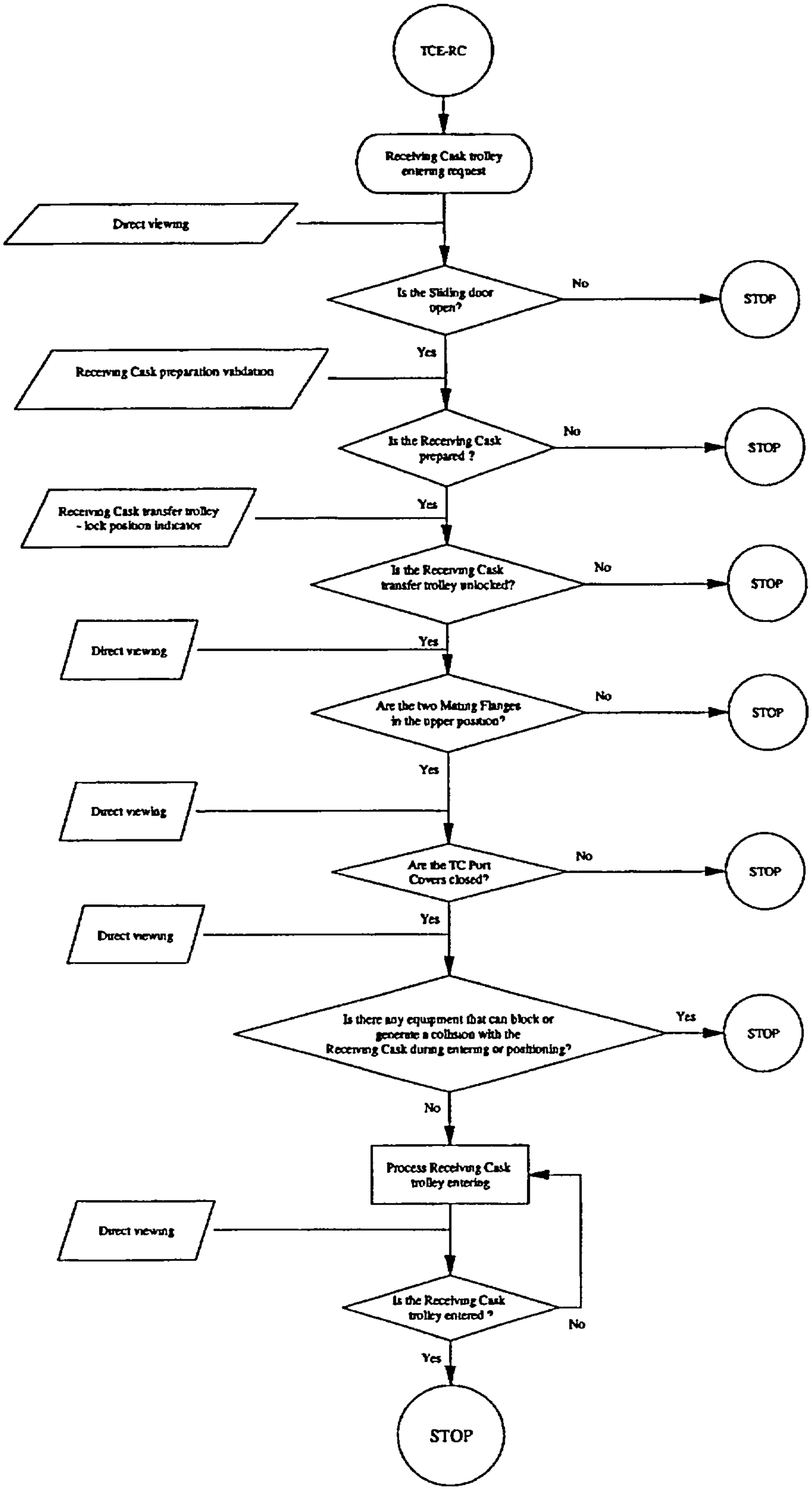
The flow charts describe the control for the following operations:

- Entry in the Lower Access Area of a cask on its transfer trolley (receiving and source casks)
- Positioning of a cask in its transfer position (receiving and source casks)
- Removal of a cask after transfer (receiving and source casks)
- Locking of a transfer trolley in the transfer position (receiving and source casks)
- Unlocking of a transfer trolley (receiving and source casks)

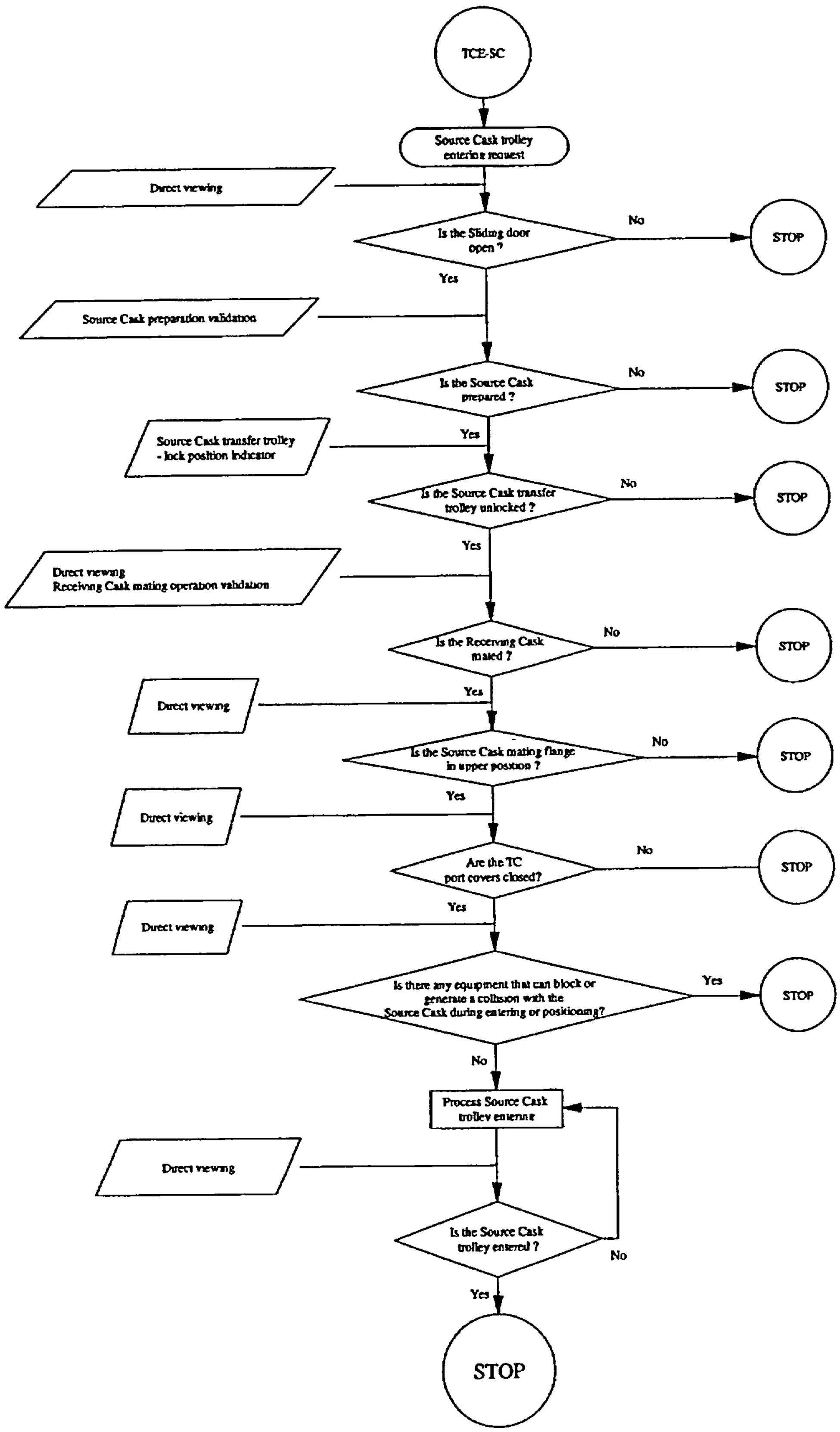
Table 5A-4
Cask Transfer Subsystem Instrumentation

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	Electrical contact	----	YL 404B YL 405B
	Locking at loading position / Source cask	Electrical contact	----	YL 404C
	Locking at loading position / Receiving cask	Electrical contact	----	YL 405C

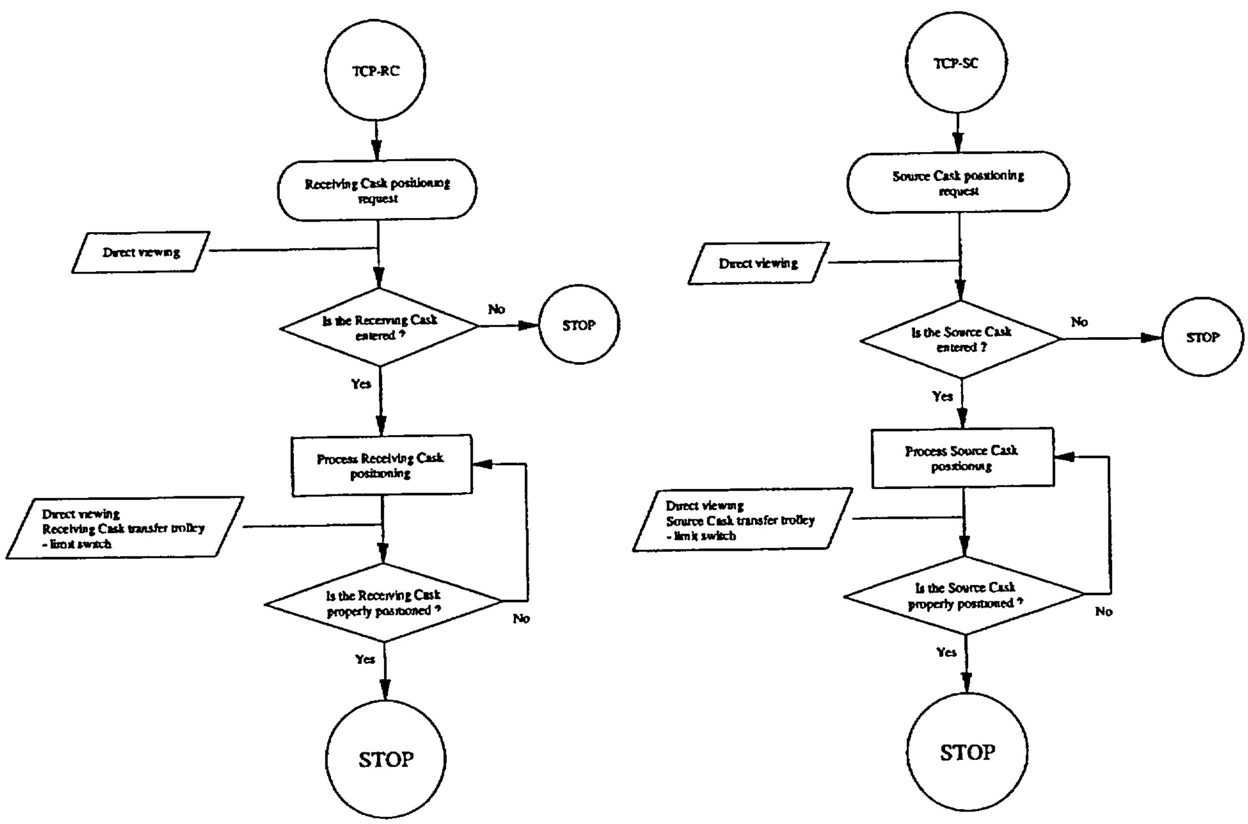
Transfer Cask Entering - Receiving Cask



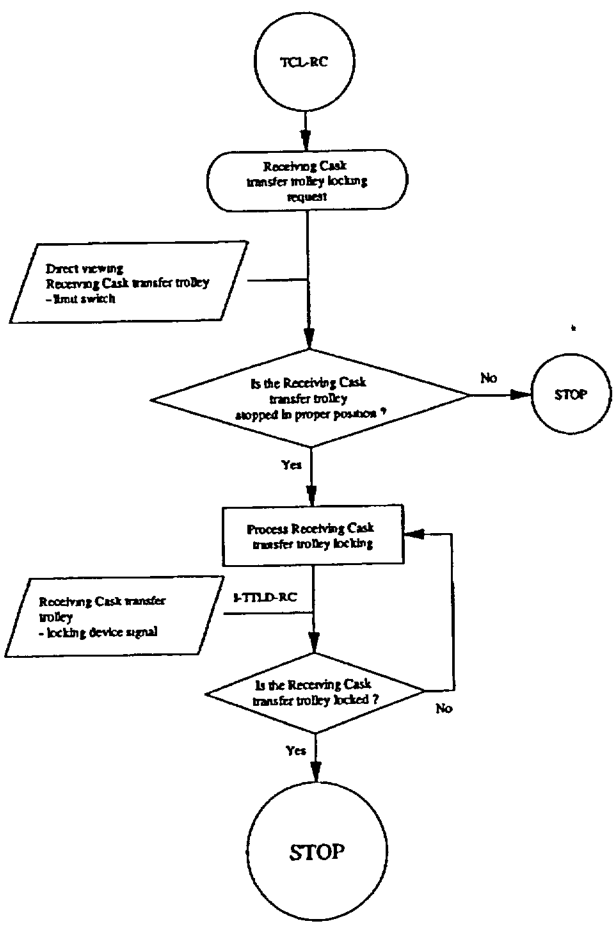
Transfer Cask Entering - Source Cask

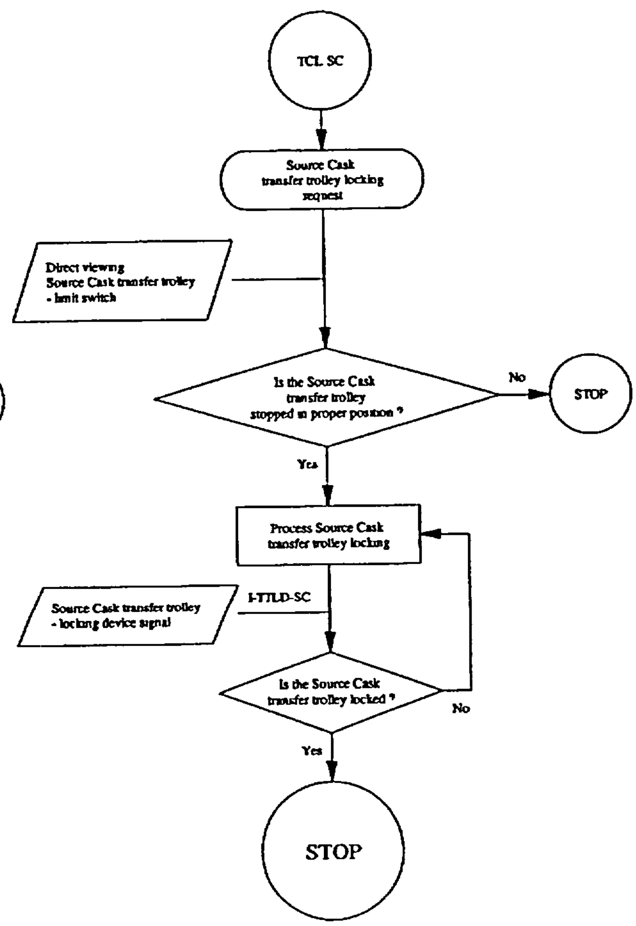


Transfer Cask Positioning - Receiving and Source Casks

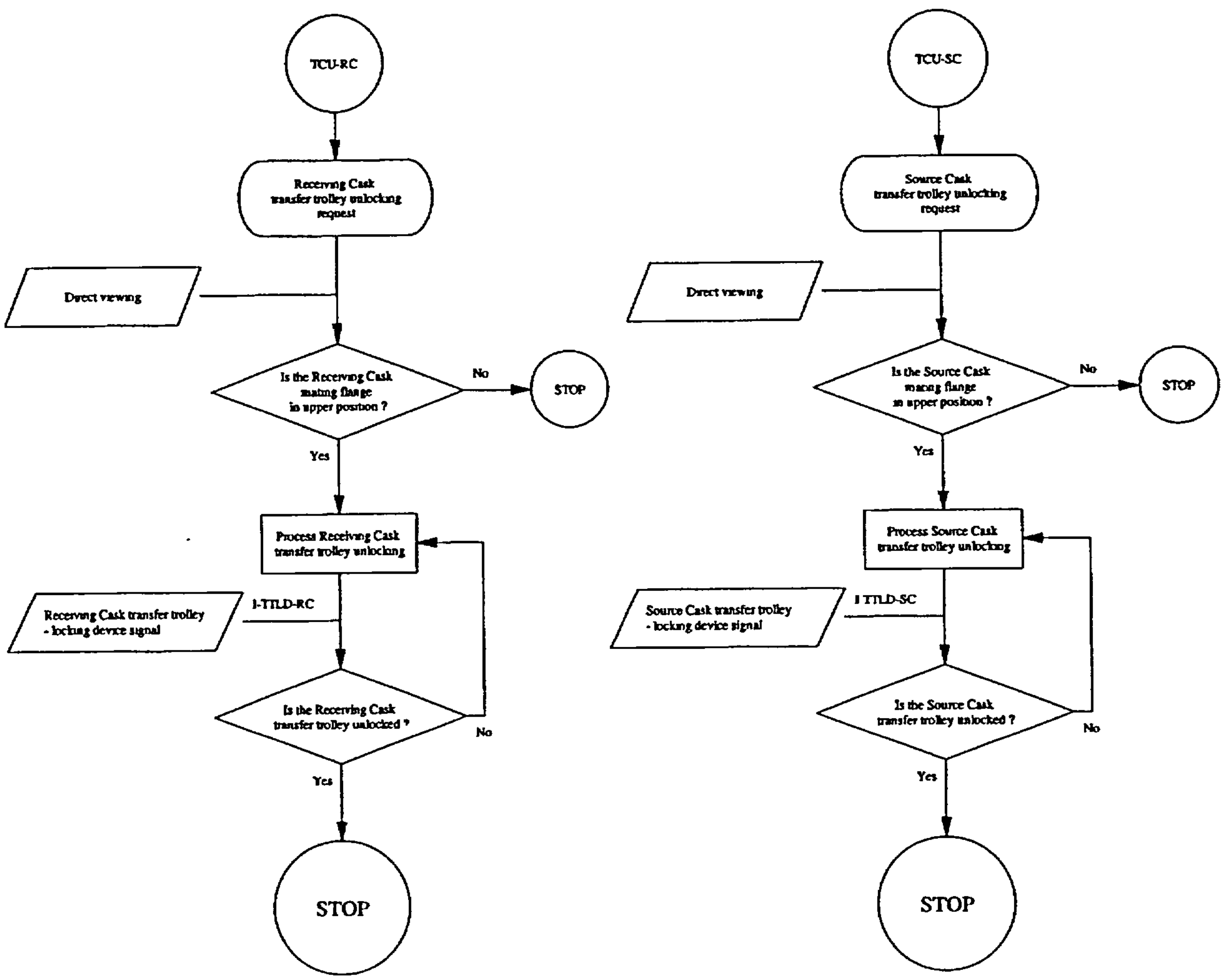


Transfer Cask Locking - Receiving and Source Casks

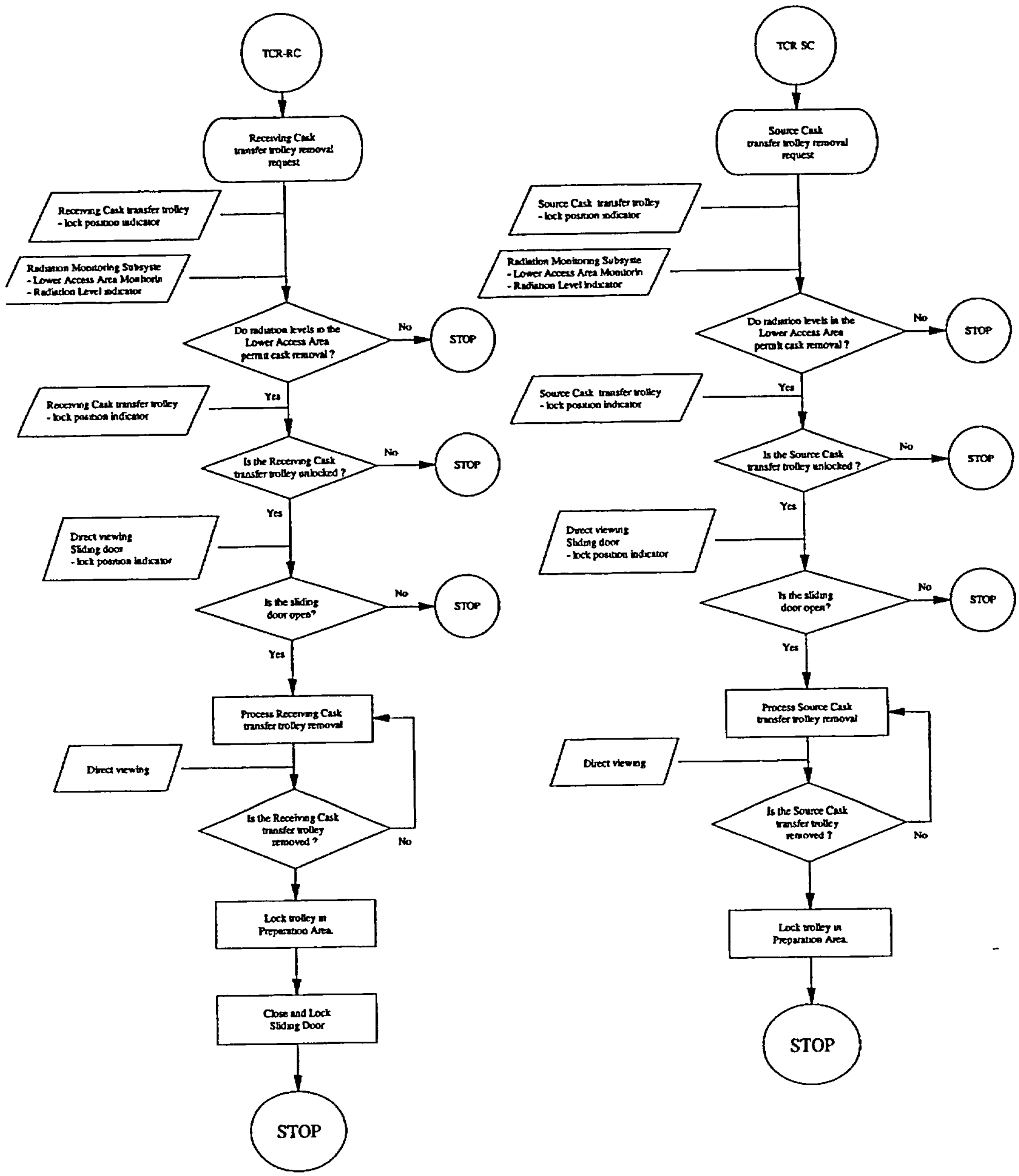




Transfer Cask Unlocking - Receiving and Source Casks



Transfer Cask Removal- Receiving and Source Casks



5A.4.2.2 Control and monitoring of the Transfer Confinement Cask Mating Subsystem

A. Description

The Transfer Confinement (TC) Cask Mating Subsystem provides the mating and disengagement of the source and receiving casks with the floor of the TC Area (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 (cf Referenced Document 8.3).

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

B Operating principle

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

C Control and monitoring requirements

The Control Subsystem, for each part of the TC Cask Mating Subsystem, shall:

- Control the movement of the mating flange (lower/lift/stop).
- Monitor the mating status (mated/disengaged).
- Monitor the vertical position of each jack.

The proper positioning of the jacks is controlled by a PLC using the electric jack's pressure and vertical position information. 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 status is transmitted to the PLC managing the HVAC Subsystem. This information is required to enable the system to properly regulate the HVAC process (see Section 5A.4.4).

D. Transition conditions validation requirements

Requirement:

Interlock the mating flange motion with the locking devices of the Cask Transfer Subsystem. It shall prevent any mating flange lowering if the corresponding Cask Transfer Subsystem trolley is not locked (interlock on one cask).

Rationale:

The interlock is justified by the importance of safely of locking the trolleys in place before starting any cask opening operation.

Dependent equipment:

The TC Cask Mating Subsystem status is never used for interlocks.

E. Instrumentation requirements

Redundant instrumentation is not necessary 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 the defective instrumentation.

Table 5A-5 lists the necessary instrumentation for the TC Casks Mating Subsystem.

F. Flow charts

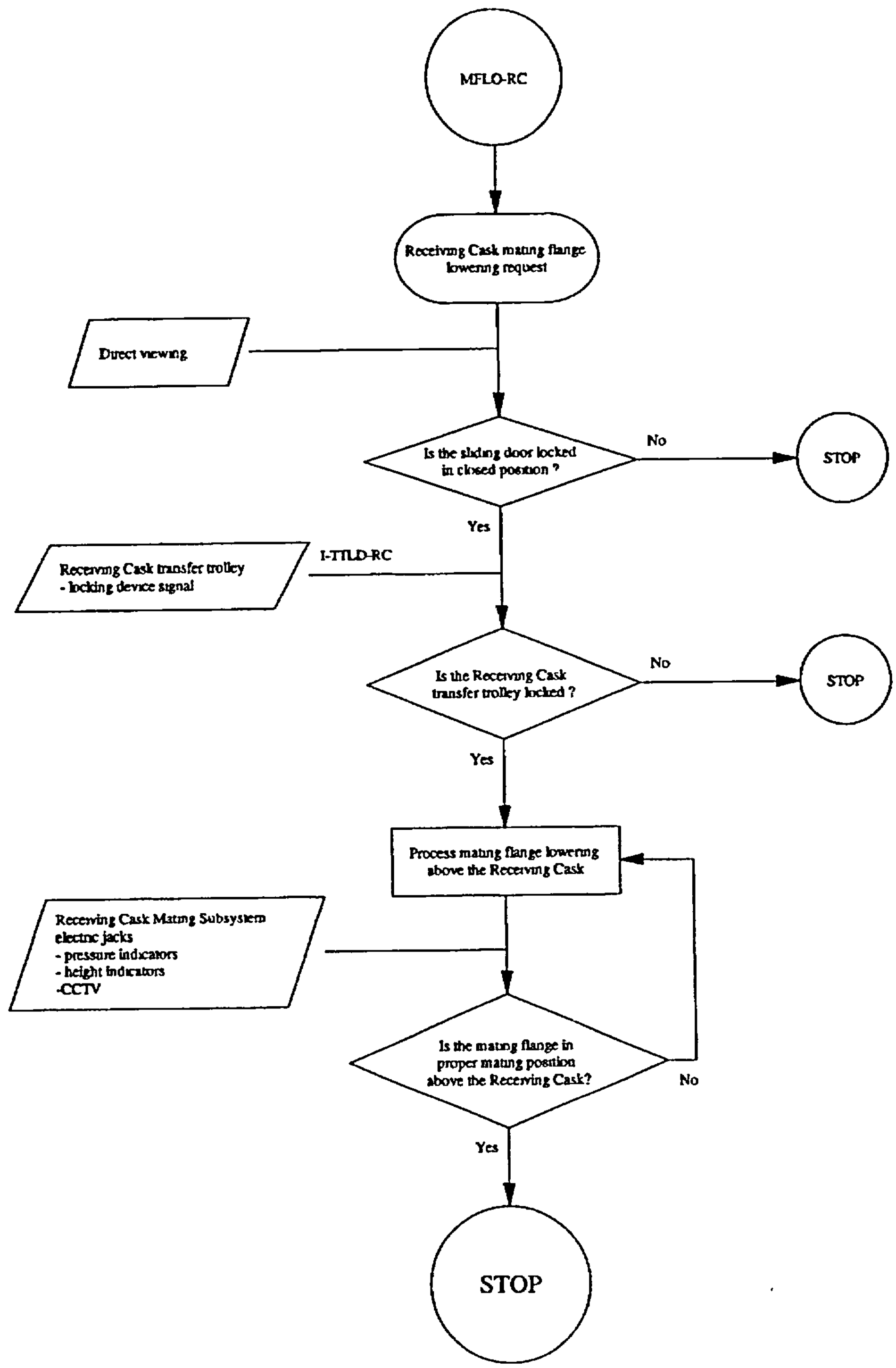
The flow charts describe the control of the following operations:

- Lowering of a mating flange (receiving and source casks)
- Lifting of a mating flange (receiving and source casks)

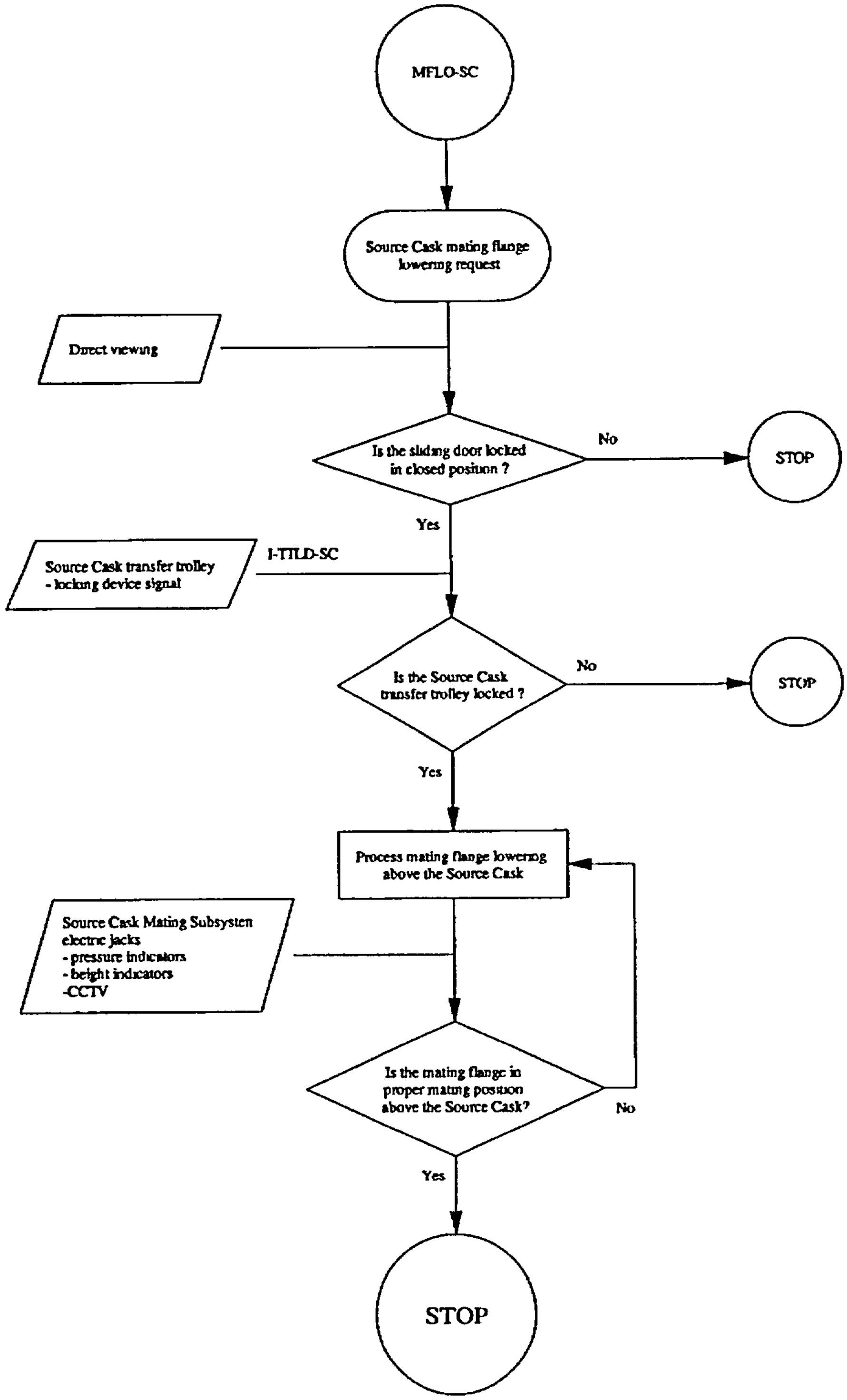
Table 5A-5
TC Casks Mating Subsystem Instrumentation

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

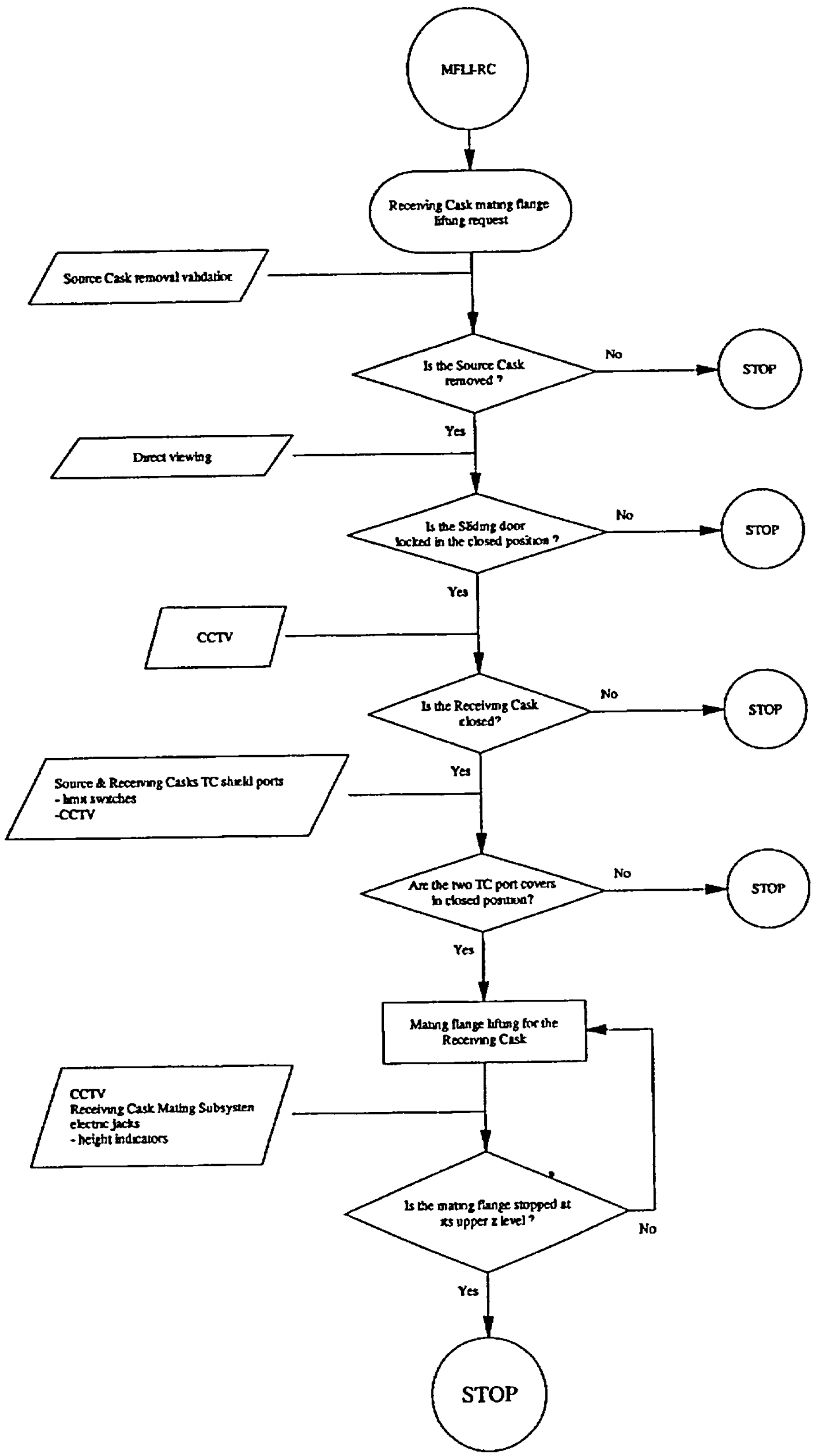
Receiving Cask Mating Flange Lowering



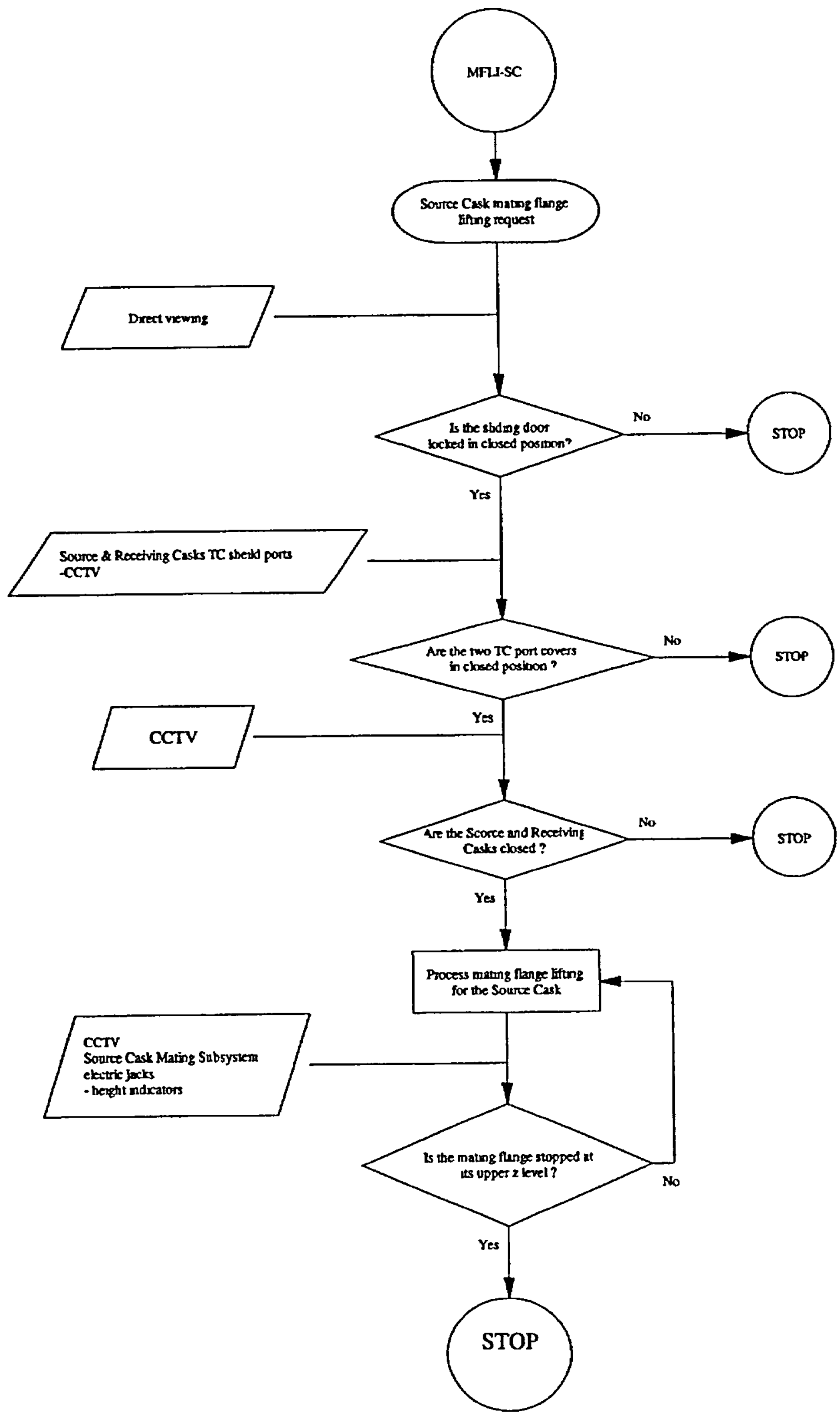
Source Cask Mating Flange Lowering



Receiving Cask Mating Flange Lifting



Source Cask Mating Flange Lifting



5A.4.2.3 Control and monitoring of the Transfer Confinement Port/Shield Handling Subsystem

A. Description

The Transfer Confinement Port/Shield Handling Subsystem consists of two port covers that have a locking device (cf Referenced Document 8.4). 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.

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).

B Operating principle

Cameras in the TCA provide viewing of the motion 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.

C. Control and monitoring requirements

The Control Subsystem shall:

- Control the movement of the motorized TC port covers (open/close/off center (receiving cask)/stop).
- Detect an overrun (alarm + stop motion).
- Detect the proper position of the TC port covers (stop motion).
- Monitor the TC port covers positions (open/closed/off centered (receiving cask)/undefined).
- Control the TC port covers locking devices (lock/unlock/stop).
- Monitor the lock positions (locked/unlocked/undefined).

All the TC port covers and locking devices' positions are displayed in the Control Center. The overrun detectors are on each side of the runway rails and automatically stop motion when activated.

D. Transition conditions validation requirements

Requirements:

The following interlocks shall be implemented:

- Interlock the TC port covers with the Source Cask Lid and Receiving Cask Shield Plug Handling Subsystem hoist. It shall prevent any TC port cover closing if the lid / shield plug grapple is not stopped above the TC port cover (with lid/shield plug on).

- Interlock the TC port covers with the upper shield ports. It shall prevent any TC port cover opening if the diagonal upper shield port is not closed.

- 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.

- 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).

- 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.

Rationale:

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)

Dependent equipment:
Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem - upper shield ports, grapple
Fuel Assembly Handling Subsystem - crane carriage

E. Instrumentation requirements

Redundant instrumentation is not necessary 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 motorizations are outside the building. Two different instrumentations are necessary to detect the locked and unlocked positions of the TC port covers.

Table 5A-6 lists the necessary instrumentation for the TC Port Shield Subsystem.

F. Flow charts

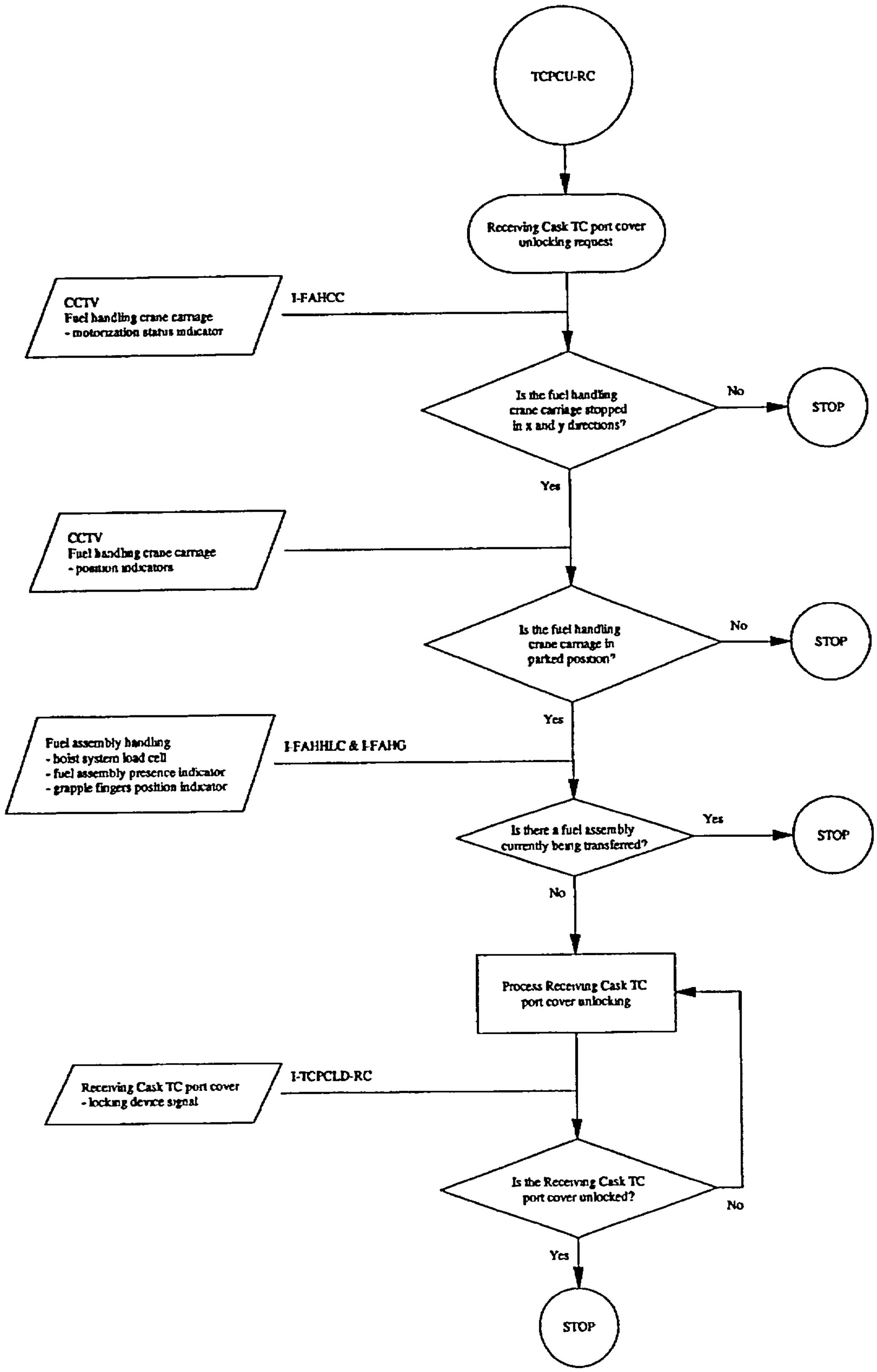
The flow charts describe the control of the following operations:

- TC port cover opening (receiving and source casks)
- TC port cover closing (receiving and source casks)
- TC port cover off centering (receiving cask)
- TC port cover locking (receiving and source casks)
- TC port cover unlocking (receiving and source casks)

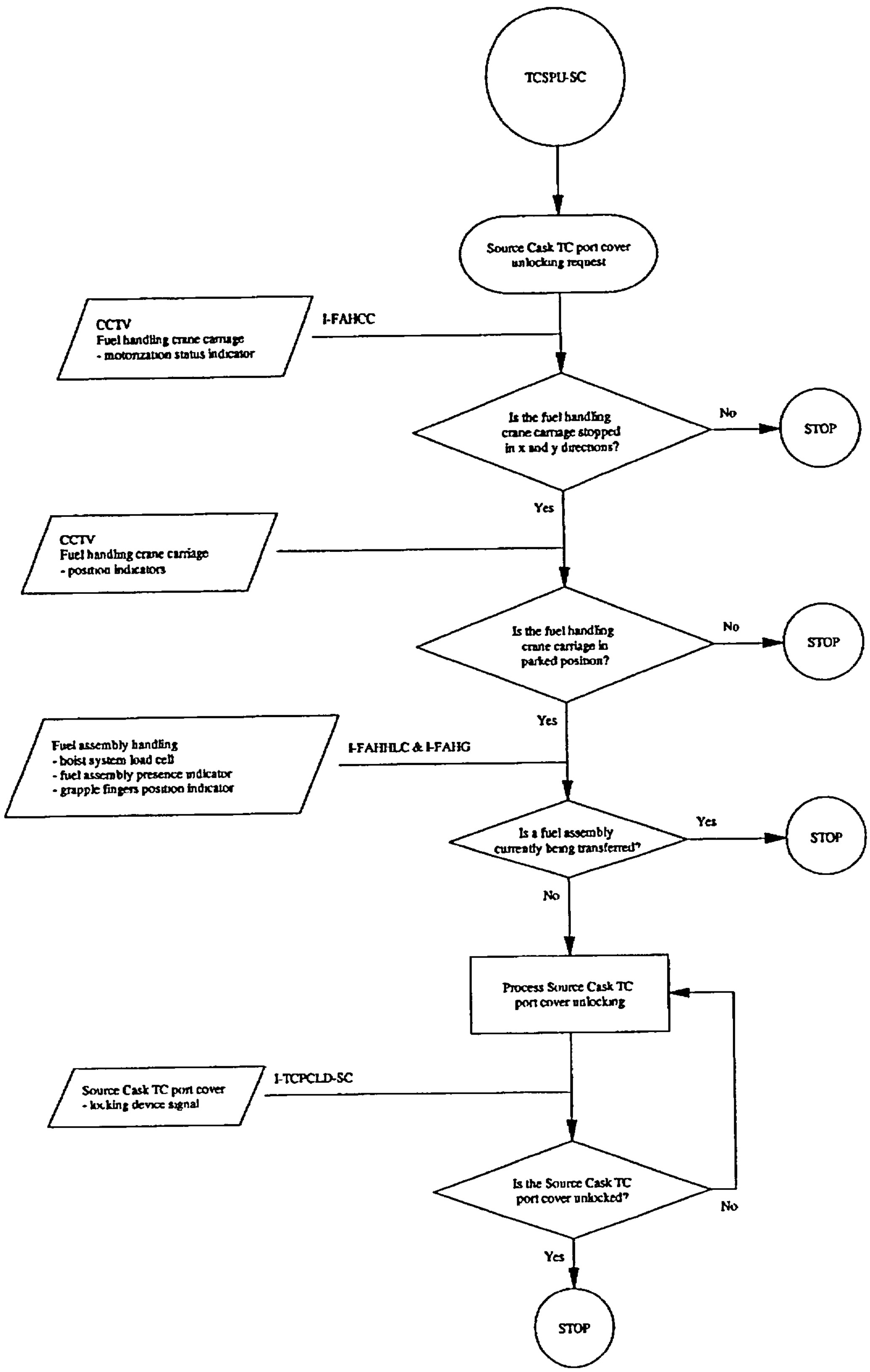
Table 5A-6
TC Port Shield Subsystem Instrumentation

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

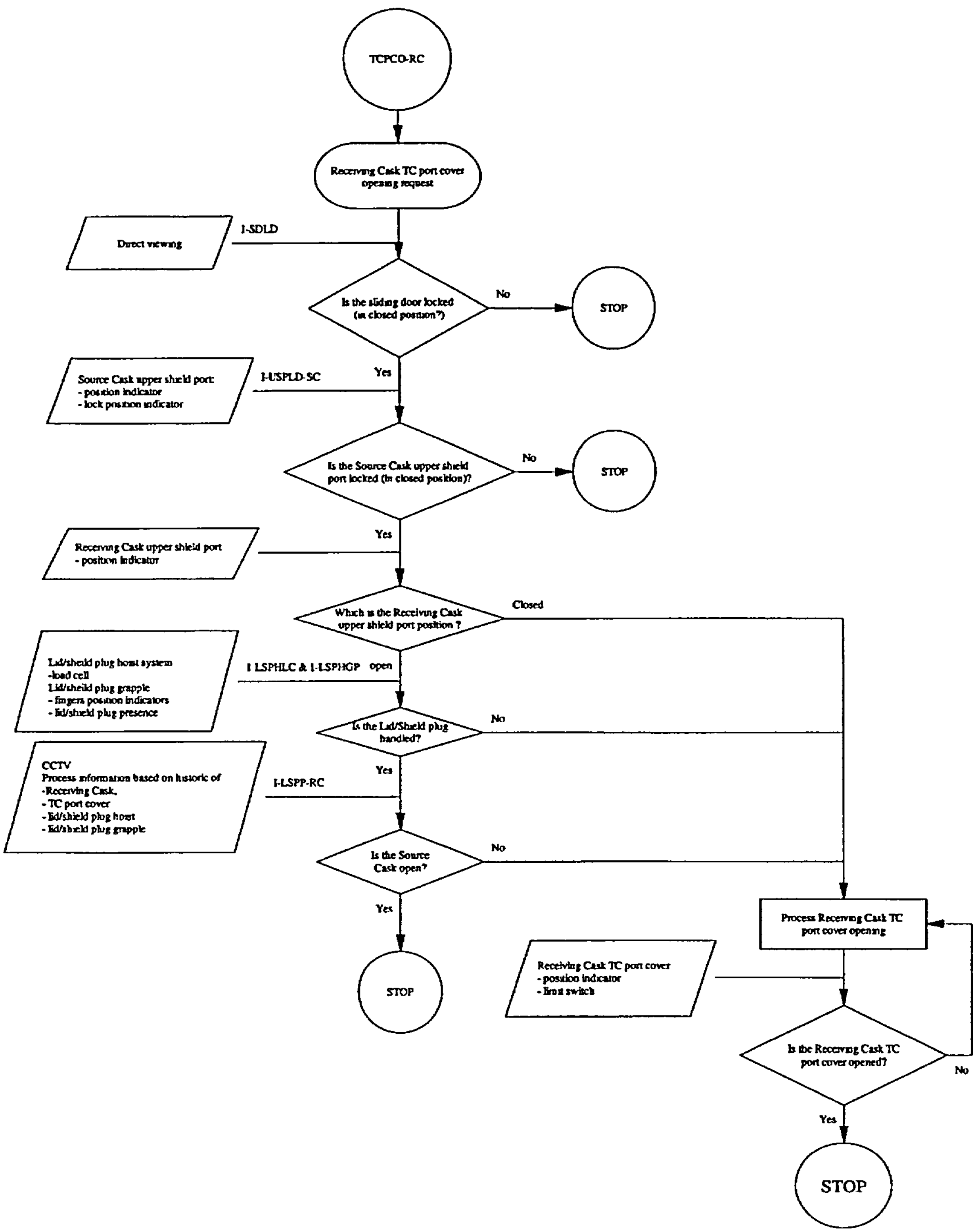
Receiving Cask TC Port Cover Unlocking



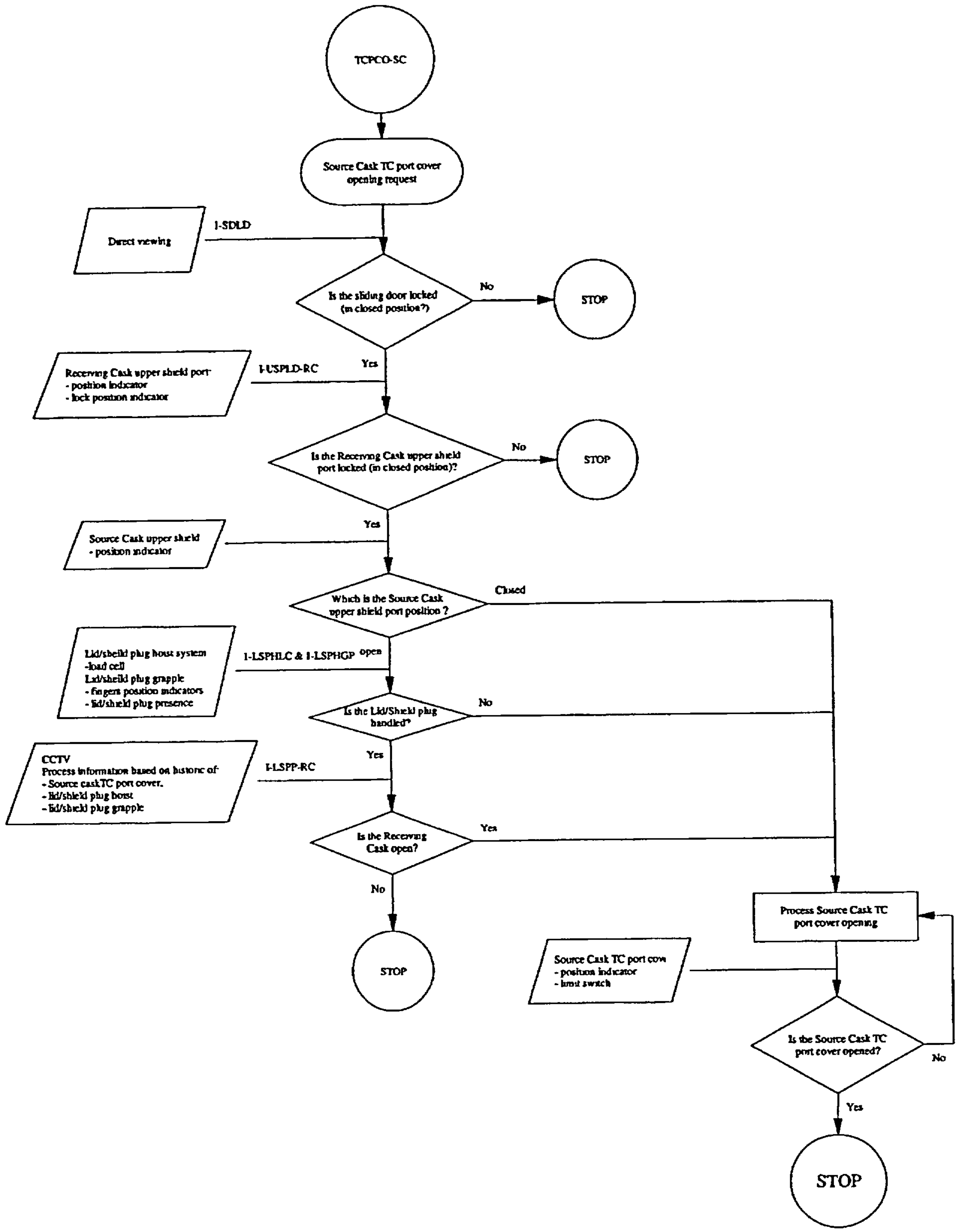
Source Cask TC Port Cover Unlocking



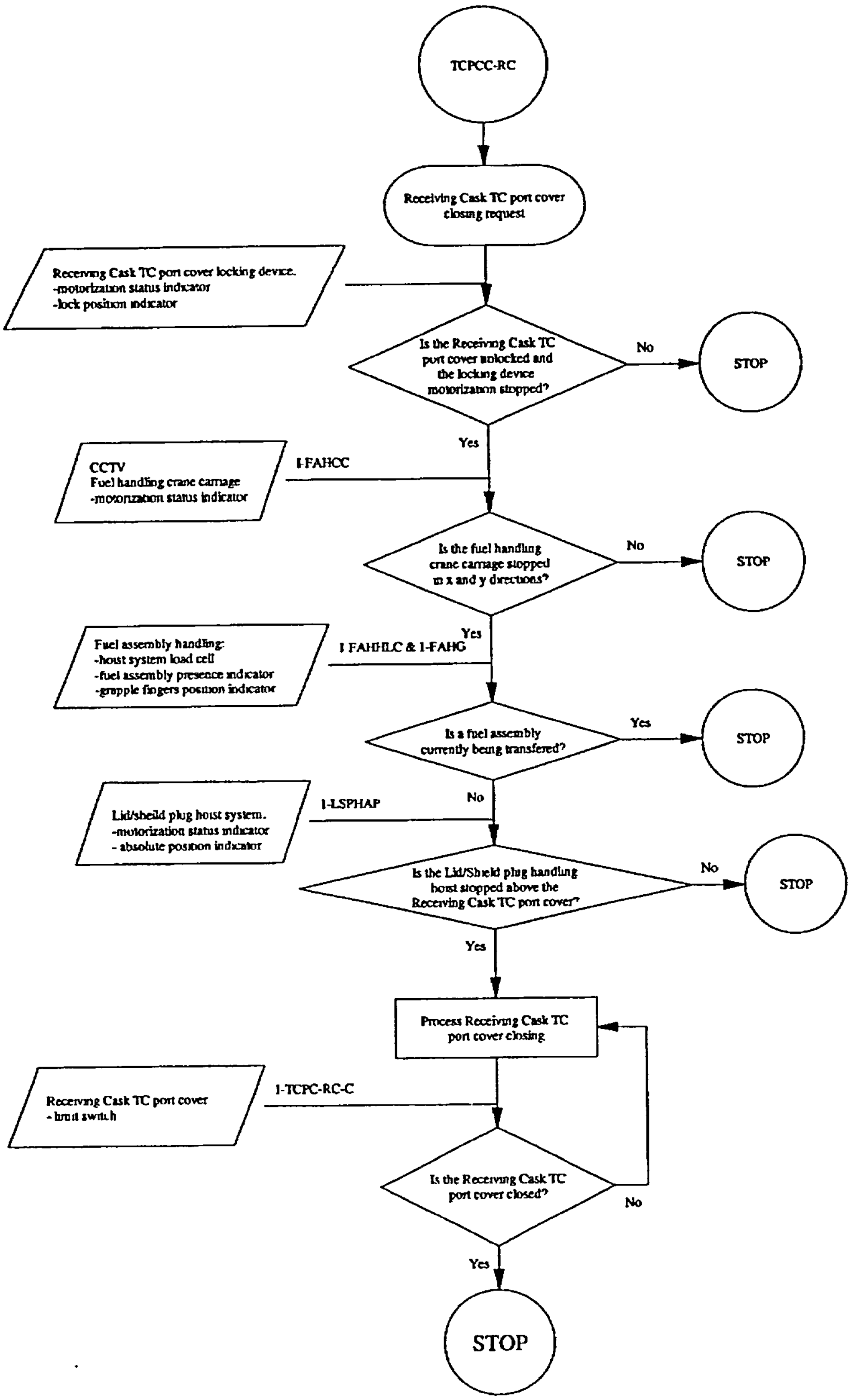
Receiving Cask TC Port Cover Opening



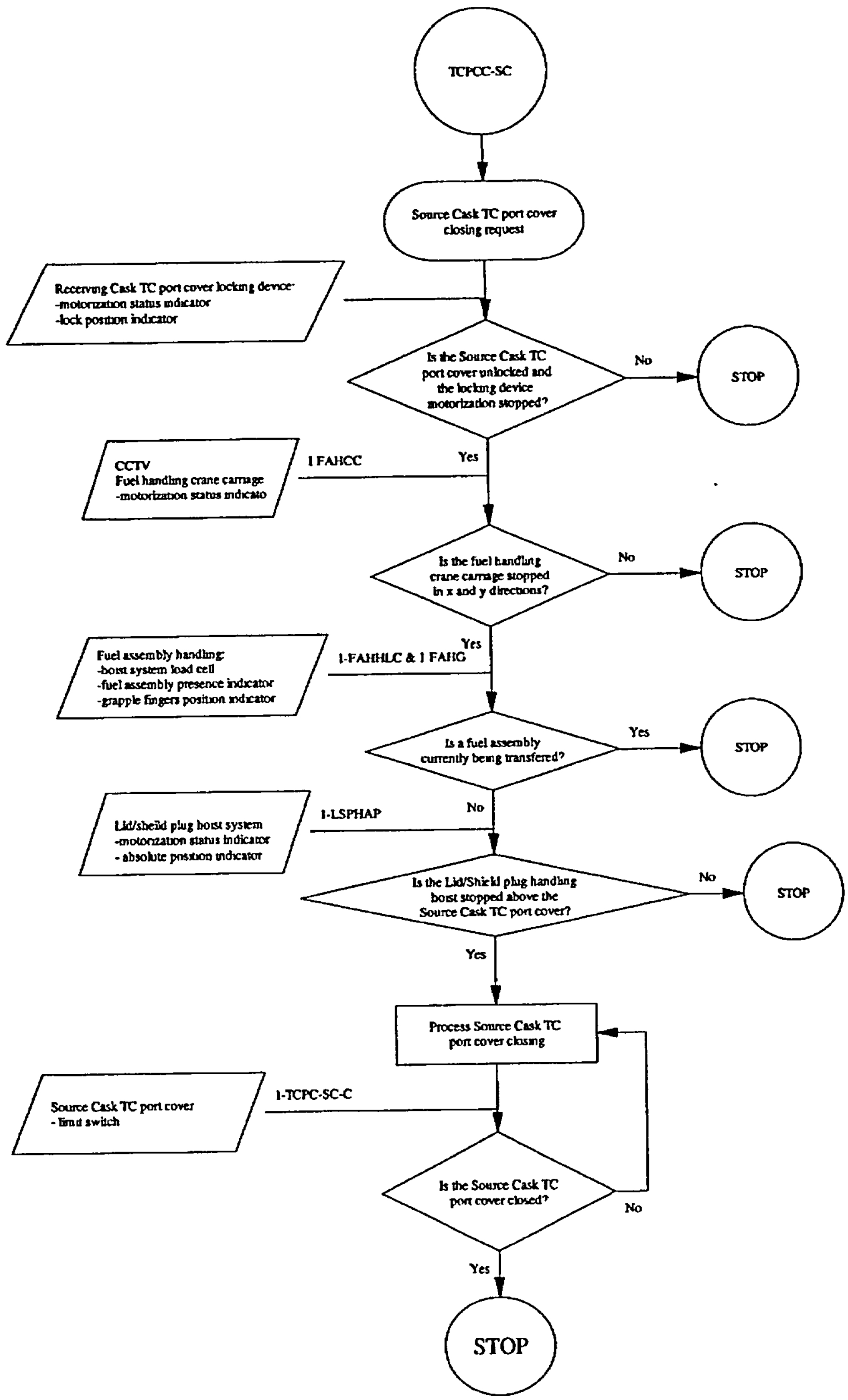
Source Cask TC Port Cover Opening



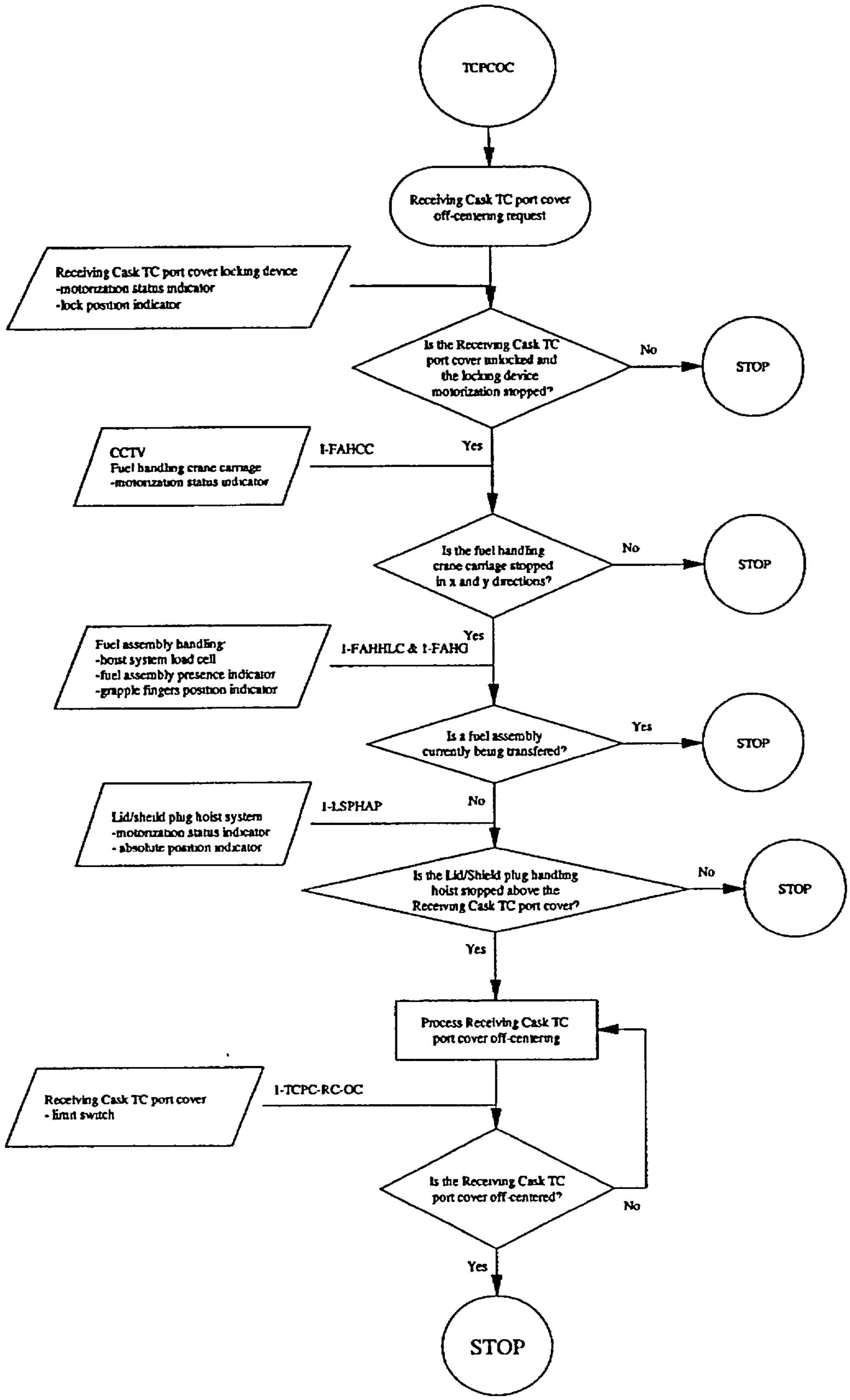
Receiving Cask TC Port Cover Closing



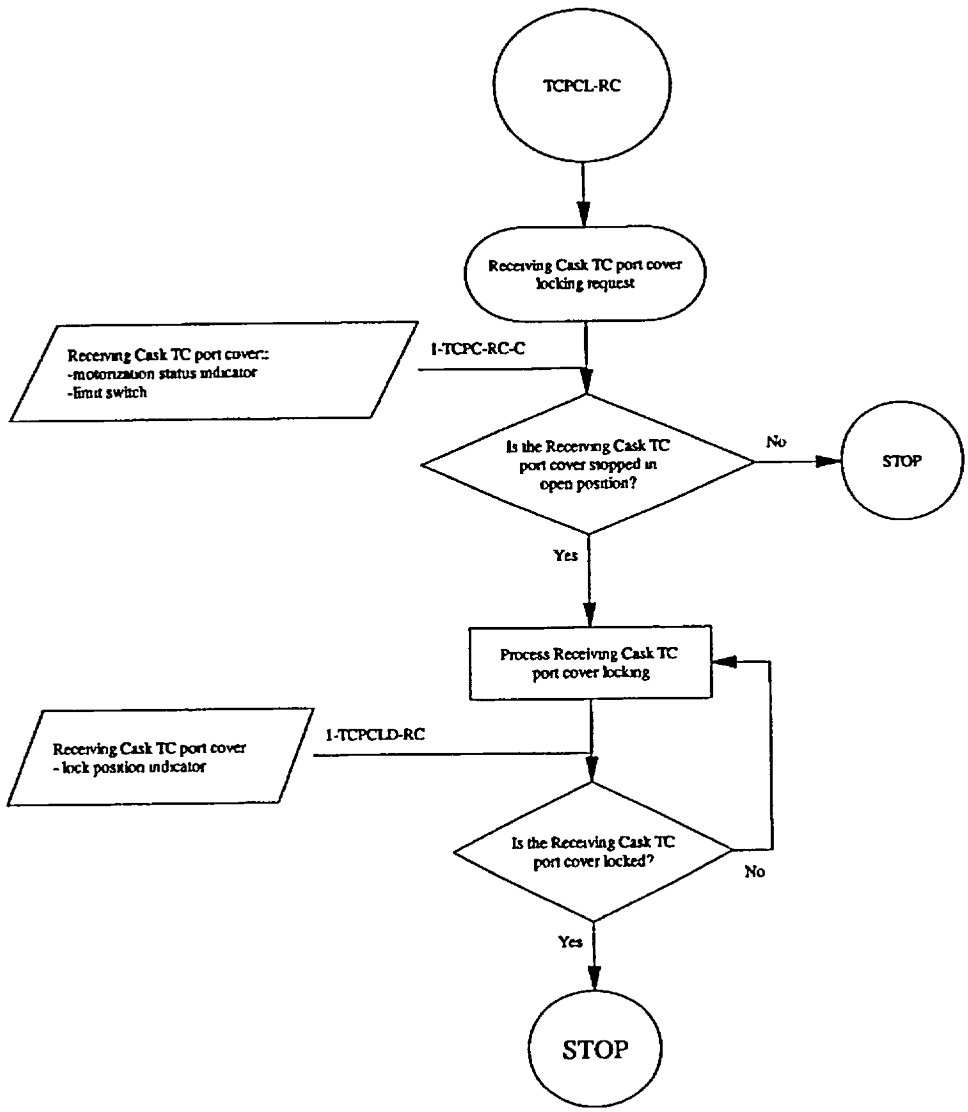
Scource Cask TC Port Cover Closing



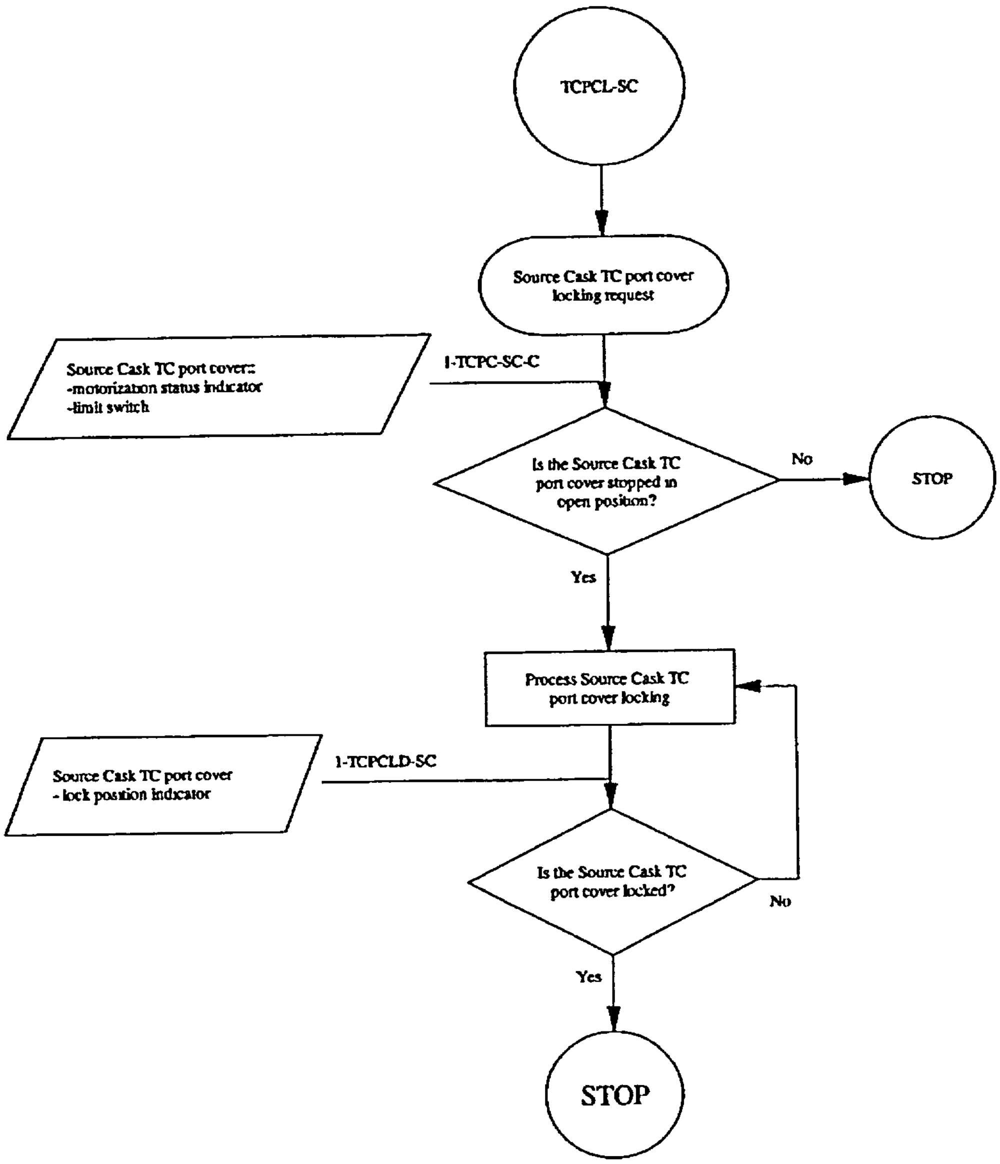
Receiving Cask TC Port Cover Off-centering



Receiving Cask TC Port Cover Locking



Source Cask TC Port Cover Locking



5A.4.2.4 Control and monitoring of the Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem

A. Description

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 (cf Applicable Document 8.4).

B. General requirement

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 grapple and disengage the overlids, and to activate the source cask lid or the receiving cask shield plug gripping and disengagement.

Cameras are only available to visually monitor the operations which occur in the Transfer Confinement Area. Monitoring and control are in the Control center.

5A.4.2.5 Control and monitoring of the upper crane

A. Description

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

B. Operating principle

The operation consists of positioning of the upper crane in the source cask or receiving cask position. There is a finite number of positions therefore, 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.

C. Control and monitoring requirements

The Control Subsystem shall:

- Control the upper crane motion (run/direction/stop).
- Detect an overrun (alarm + stop motion).
- Detect the proper positions of the trolley (stop motion).

- Monitor the position of the trolley (Receiving Cask/Source Cask/Undefined).

The overrun detectors are on each side of the runway rails and automatically stop motion when activated. The position of the trolley is displayed in the Control Center.

D. Transition conditions validation requirements

Requirement:
The following interlocks shall be implemented:

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

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

- pendulum movement of the lid / shield plug (=> probable high dose rates)
- damage to the lid / shield plug
- damage to the confinement bellows

Dependent equipment:
Lid/shield plug handling - hoist system

E. Instrumentation requirements

Redundant instrumentation is not necessary for the control of the upper crane since the motorization is in a shielded area (roof enclosure) and since the crane includes a recovery system.

Table 5A-7 lists the necessary instrumentation for the Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem trolley.

F. Flow charts

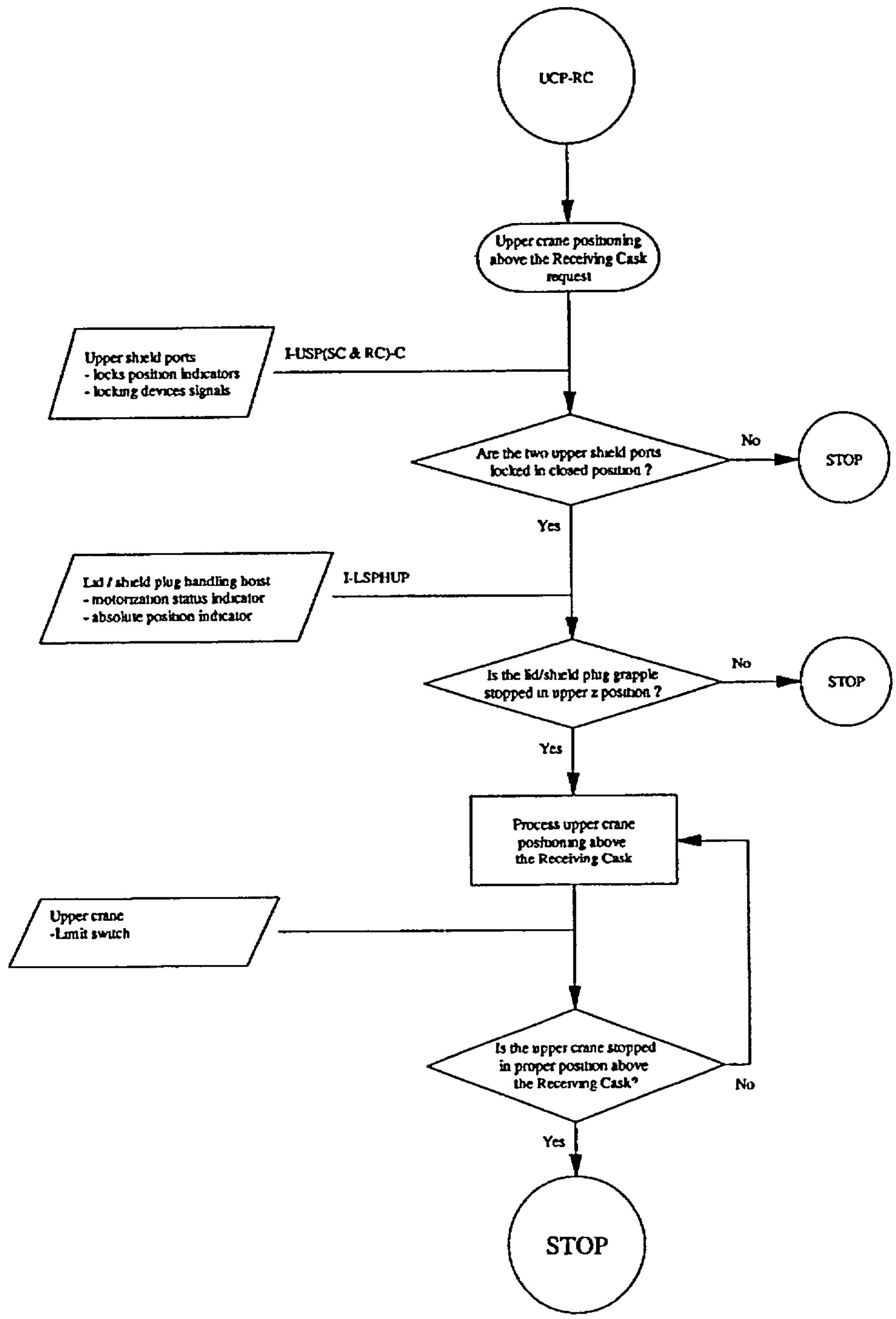
The flow charts describe the control of the following operations:

- Upper crane positioning above source cask
- Upper crane positioning above receiving cask

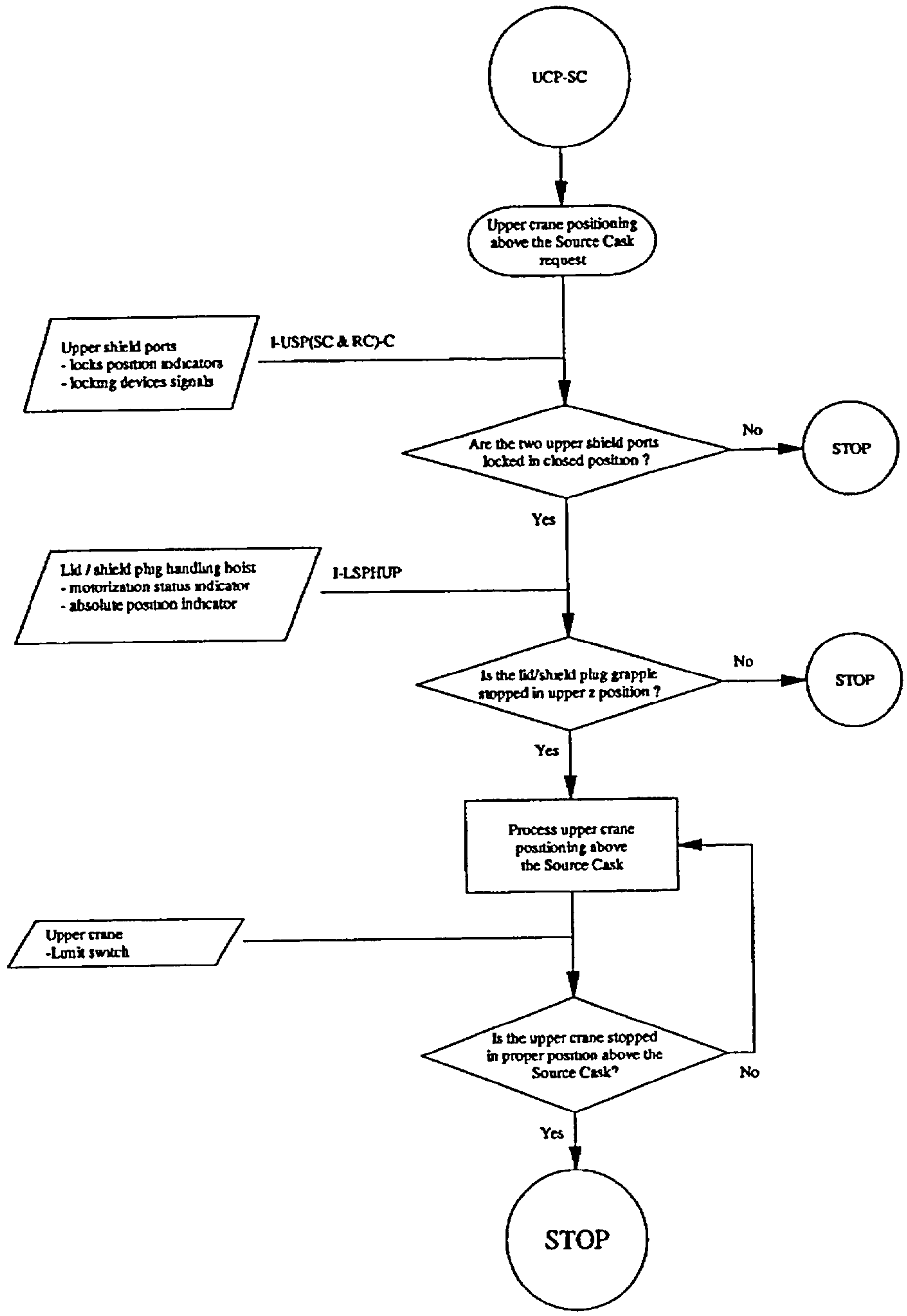
Table 5A-7
Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem Trolley Instrumentation

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 Crane Positioning
above the Receiving Cask



Upper Crane Positioning above the Source Cask



5A.4.2.6 Control and monitoring of the upper shield ports

A. Description

The upper shield ports provide shielding between the TCA and the 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.

B. Operating principle

There is no viewing of the upper shield port motion or position. 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.

C. Control and monitoring requirements

The Control Subsystem shall:

- Control the movement of the upper shield ports (open/close/stop).
- Detect an overrun. (alarm + stop motion).
- Detect the upper shield ports proper positions (stop motion).
- Monitor the upper shield ports position (open/closed/undefined).
- Control the locking device (lock/unlock/stop).
- Monitor the locked positions (locked/unlocked/undefined).

The overrun detectors are on each side of the runway rails and automatically stop motion when activated. The position of the upper shield ports and of their locking device is displayed in the Control Center.

D. Transition conditions validation requirements

Requirements:
The following interlocks shall be implemented:

- Interlock the upper shield ports with the lid/shield plug handling hoist system. It shall 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. It shall 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. It shall 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. It shall 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. It shall prevent the opening of an upper shield port if the other is not closed.

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

Rationale:
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.

Dependent equipment:
Source Cask Lid/ Receiving Cask Shield Plug Handling Subsystem - upper crane
Fuel Assembly Handling Subsystem - crane carriage

E. Instrumentation requirements

Instrumentation which controls the motion of the upper shield ports and the locking devices is not redundant since in the event of malfunction, the shield port motorizations are outside the building (on the roof) and, for the locking devices, they are only used when the upper shield ports are in closed position. Two different instrumentations are necessary to detect the locked and unlocked position of the upper shield ports.

Table 5A-8 lists the necessary instrumentation for the Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem upper shield ports.

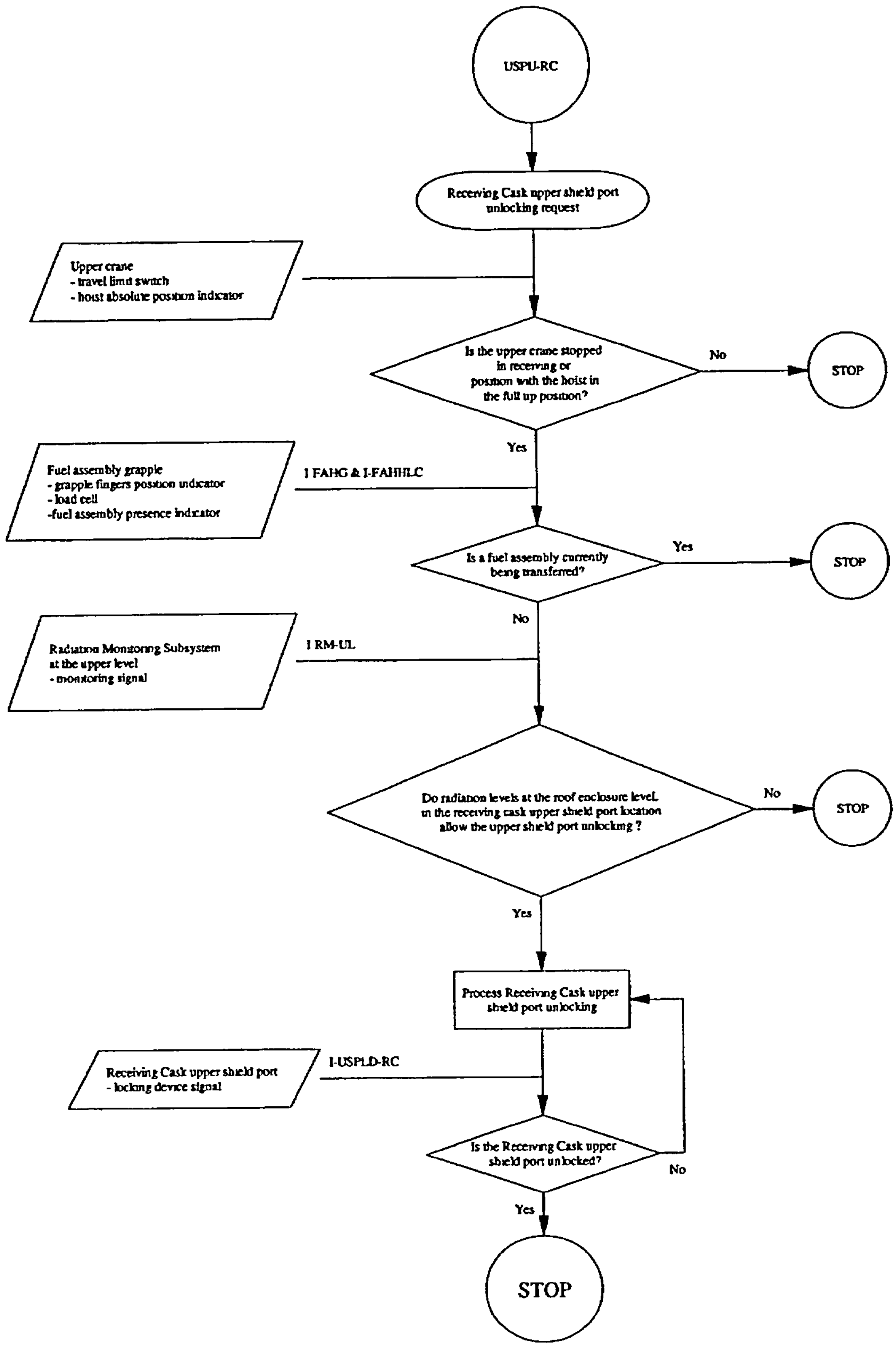
F. Flow charts

The flow charts describe the control of the following operations:
- Upper shield port opening (receiving and source cask)
- Upper shield port closing (receiving and source cask)
- Upper shield port locking (receiving and source cask)
- Upper shield port unlocking (receiving and source cask)

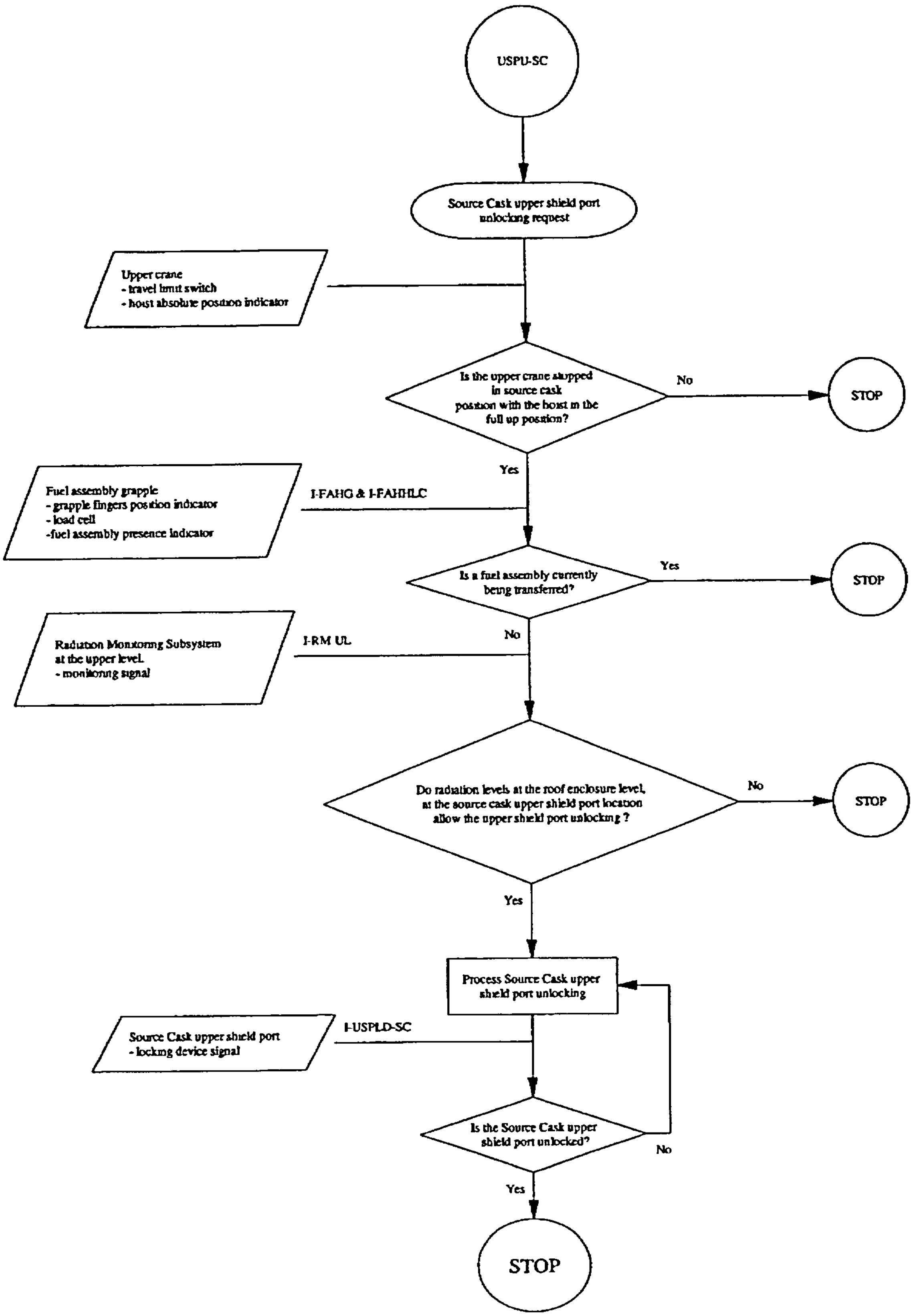
Table 5A-8
Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem upper shield ports instrumentation

Equipment	Data	Sensor type	Action	Reference
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 313A
	Unlocked	Electrical contact	----	YL 312B YL 313B

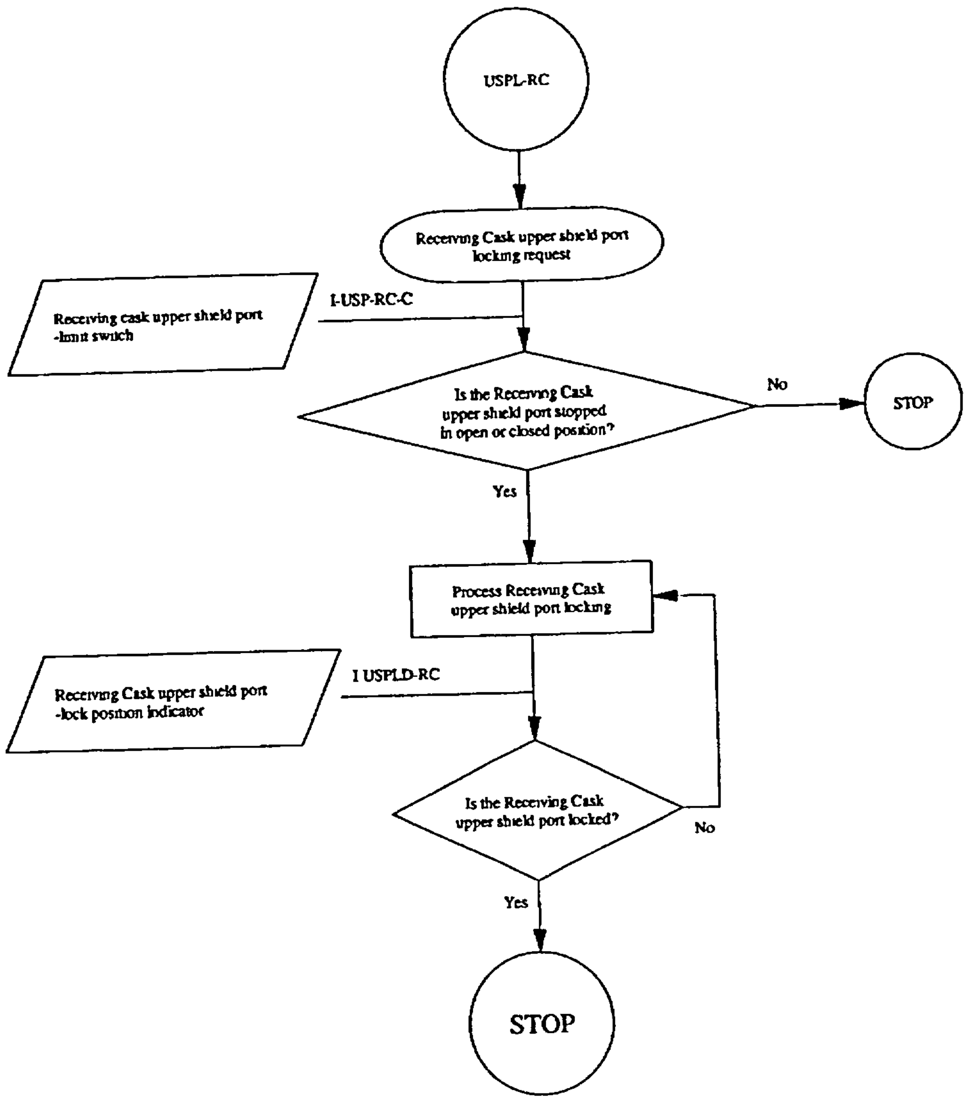
Receiving Cask Upper Shield Port Unlocking



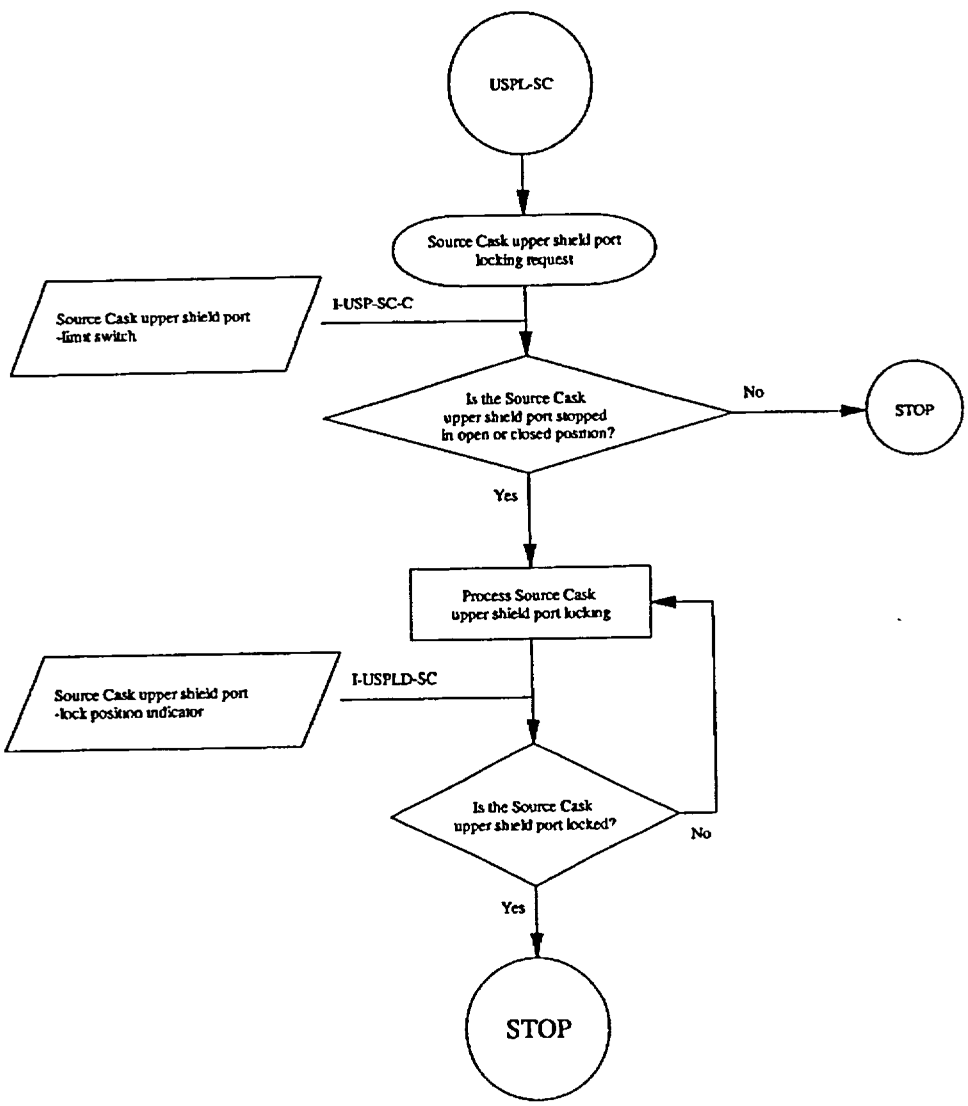
Source Cask Upper Shield Port Unlocking



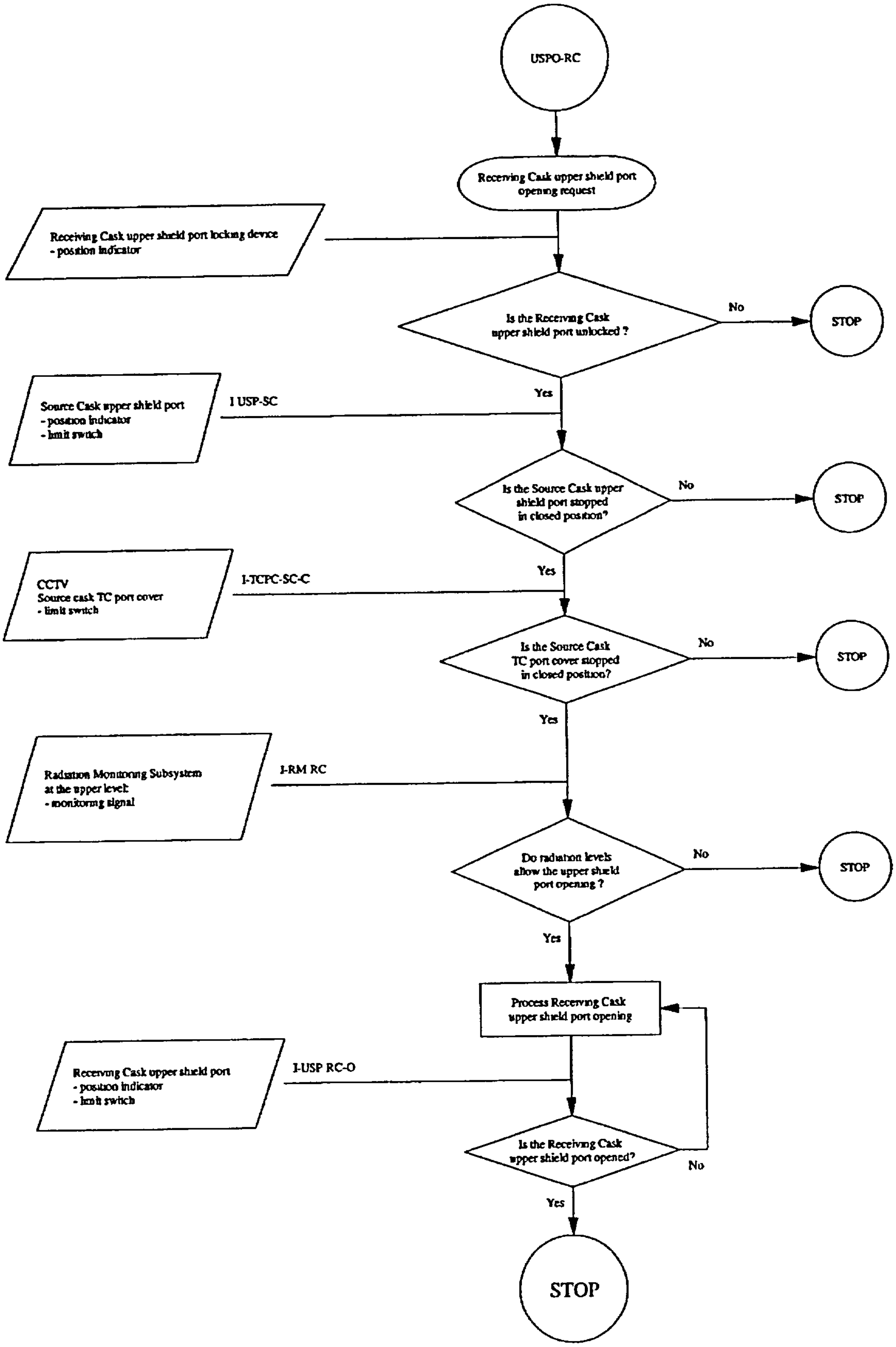
Receiving Cask Upper Shield Port Locking



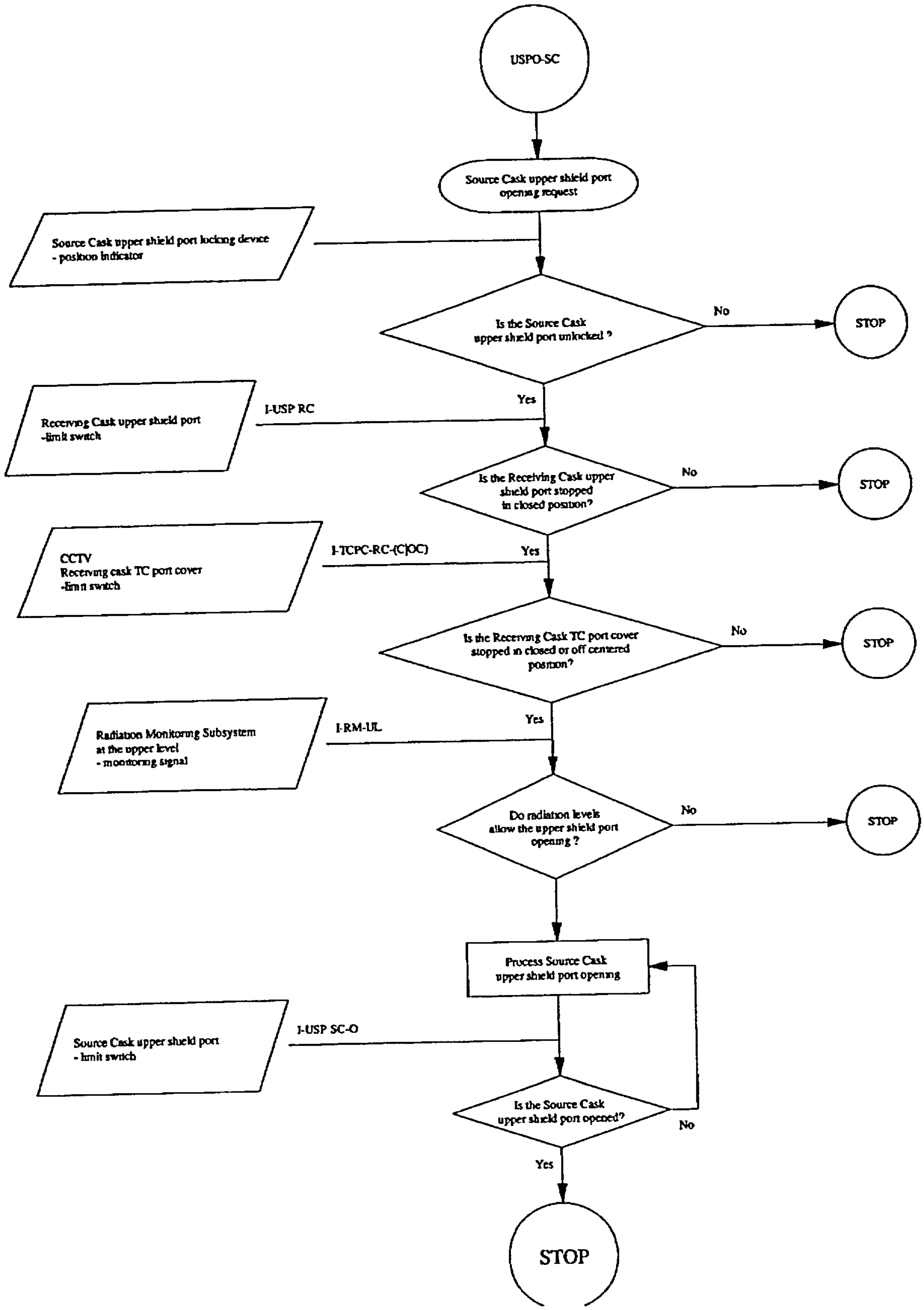
Source Cask Upper Shield Port Locking



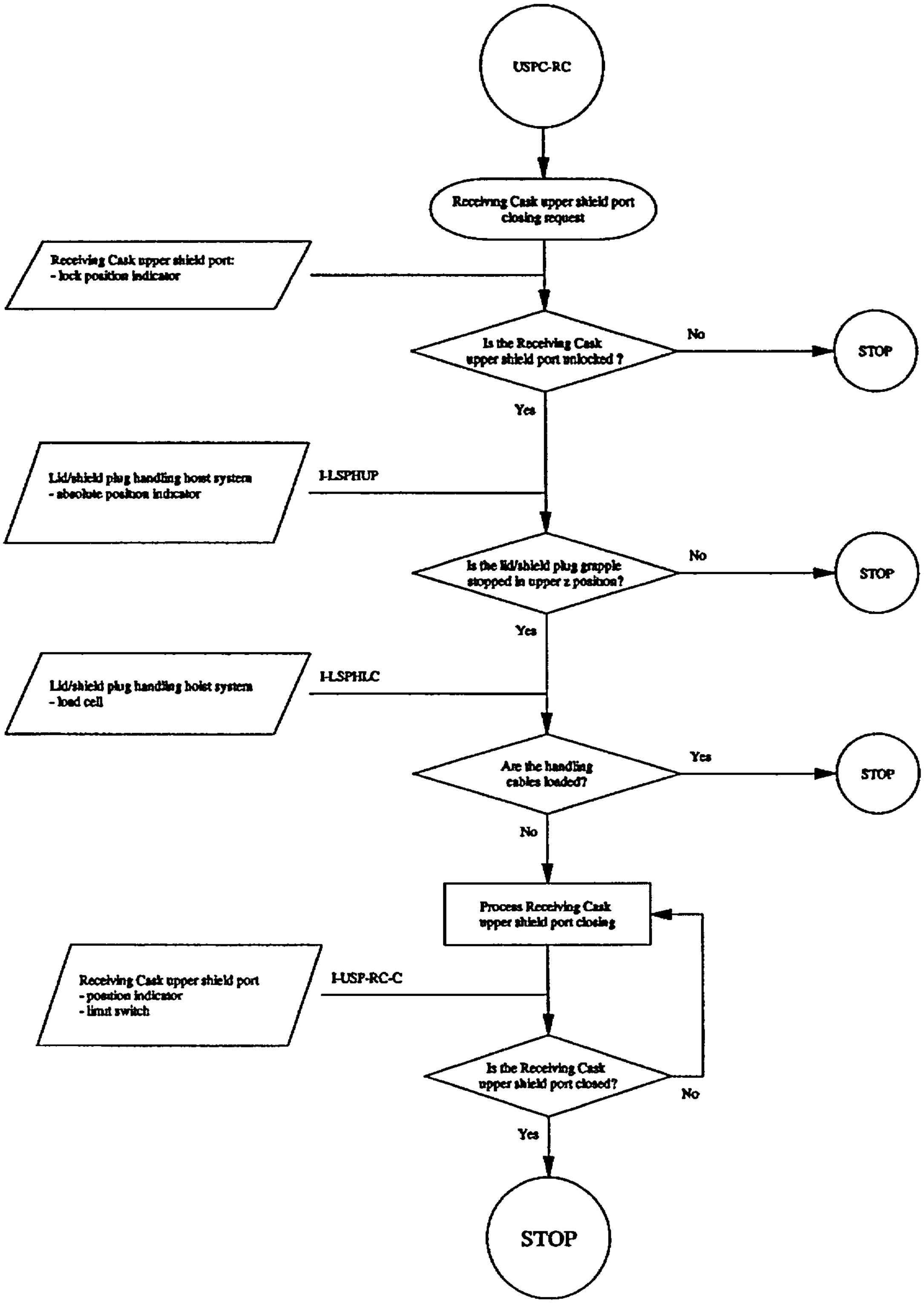
Receiving Cask Upper Shield Port Opening



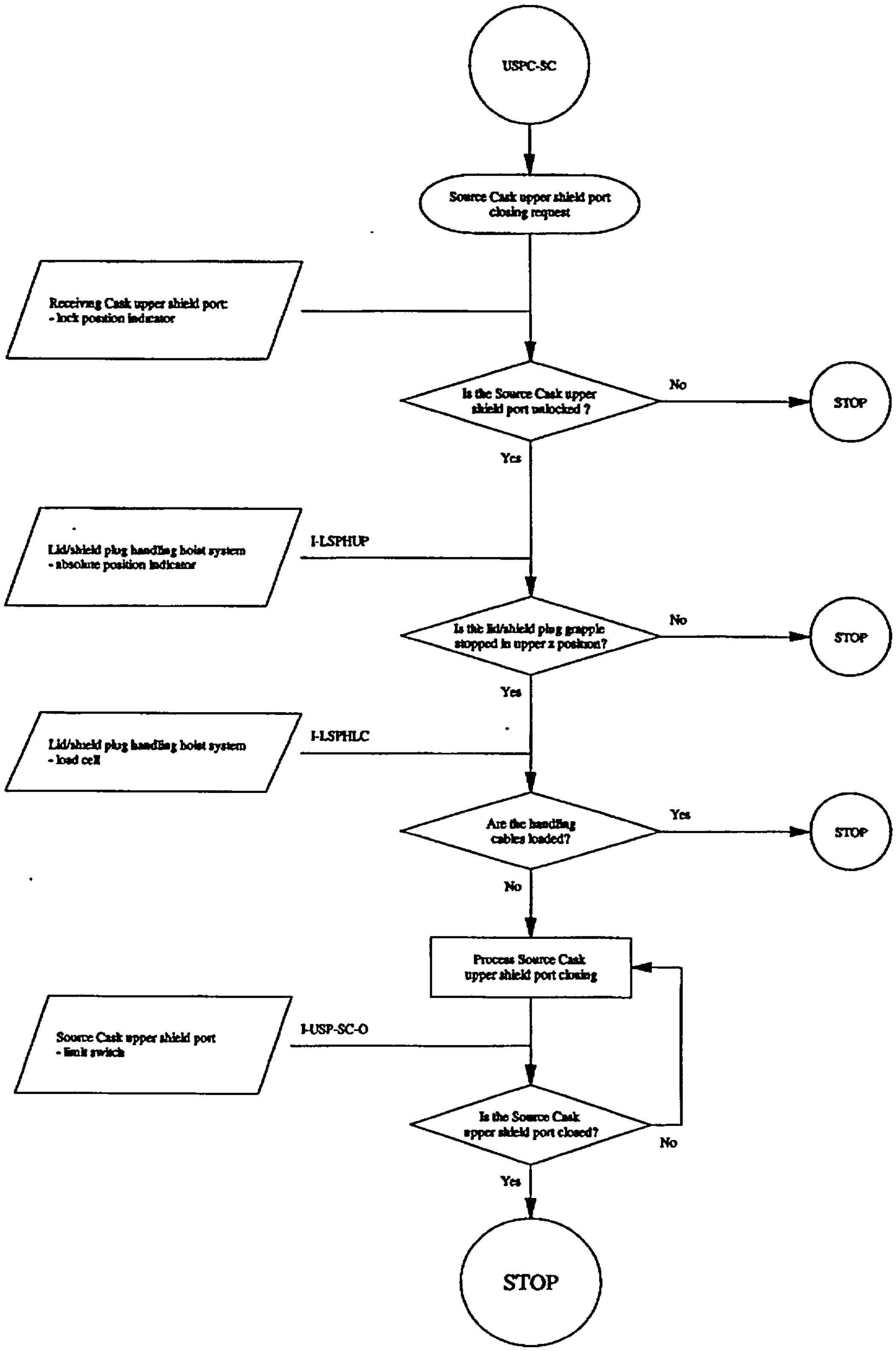
Source Cask Upper Shield Port Opening



Receiving Cask Upper Shield Port Closing



Source Cask Upper Shield Port Closing



5A.4.2.7 Control and monitoring of the hoist system

A. Description

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 outside of the TCA.

B. Operating principle

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 Confinemnt 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.

C. Control and monitoring requirements

The Control Subsystem shall:

- Control the hoist (lower / lift / stop / variable speed).
- Monitor its status (lowering / lifting / stopped).
- Detect an overload (alarm + stop motion).
- Detect an overrun/underrun (alarm + stop motion).
- Detect breaking of a cable (alarm + stop motion).
- Detect an overspeed (alarm + stop motion).
- Detect an abnormal drum rope level wind (alarm + stop motion).
- Monitor the grapple z position.
- Detect an underload (stop motion).

The motion and the direction of the hoist system are indicated in the Control Center, as well as the grapple z 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. The underload is a normal situation, its detection automatically stops motion. The overload limit is adapted to the weight to be handled and so, this limit depends on the upper crane position. The speed is variable but is automatically lowered to its minimum when a limit distance from the target is reached.

D. Transition conditions validation requirements

Requirements:
The following interlocks shall be implemented:

- Interlock the hoist with the cable load monitoring device and the grapple position monitoring device. It shall 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. It shall prevent lowering and lifting if the crane is not stopped in parking position.

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

Rationale:

The mechanical resistance of the mezzanine between the TC area and the Lower Access Area is not designed to withstand the dropping of the lid/shield plug above a limit distance. In addition, the radiation levels at the upper level depend on the z position of the lid/shield plug.

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.

Dependent equipment:

TC port covers
Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem - upper crane, upper shield ports, grapple

E. Instrumentation requirements

The control of the winch motor is not redundant since it is located in an uncontaminated and shielded area.

Table 5A-9 lists the necessary instrumentation for the Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem hoist.

F. Flow charts

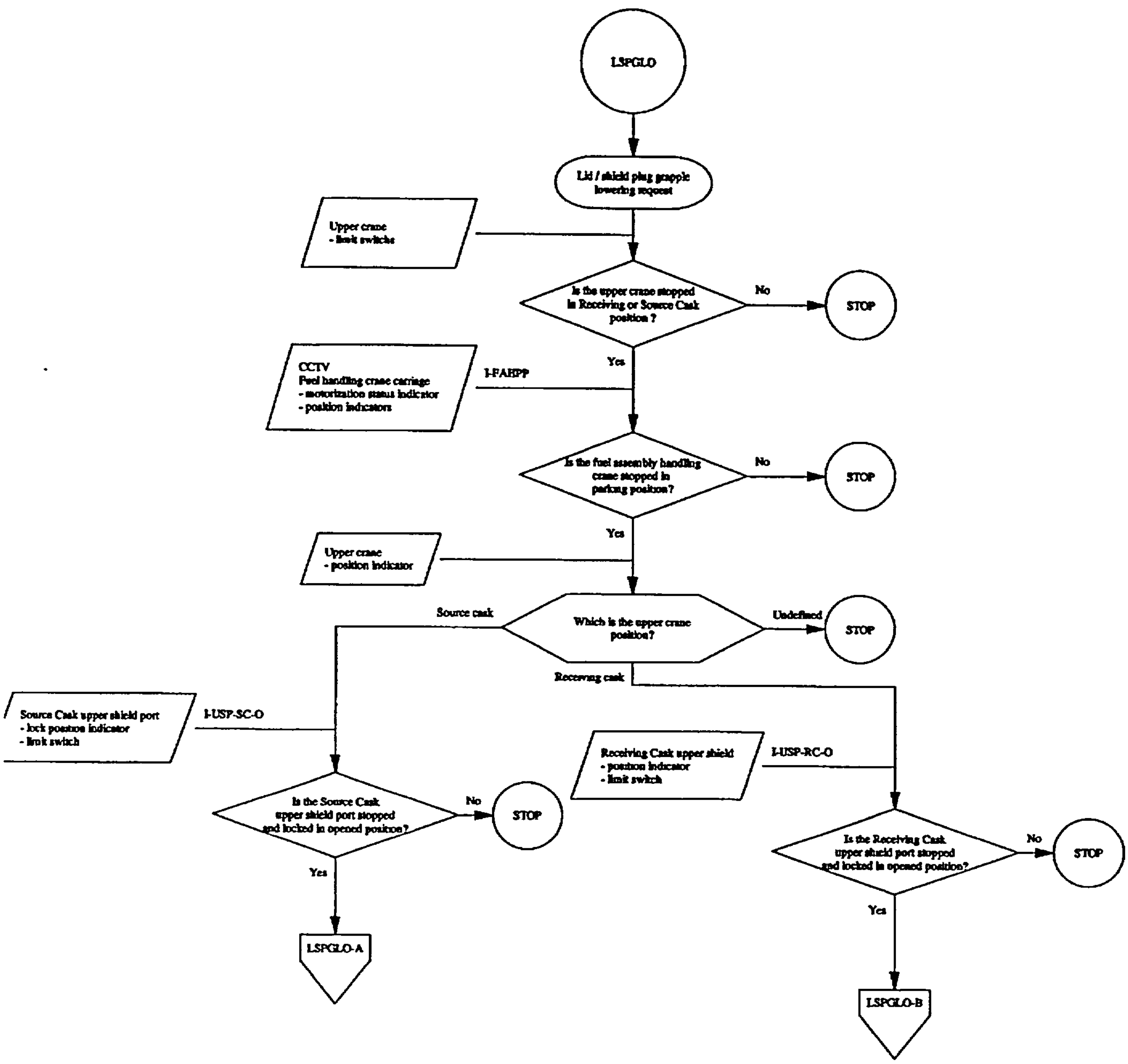
The flow charts describe the control of the following operations:

- Source Cask lid / Receiving Cask shield plug grapple lowering
- Source Cask lid / Receiving Cask shield plug grapple lifting

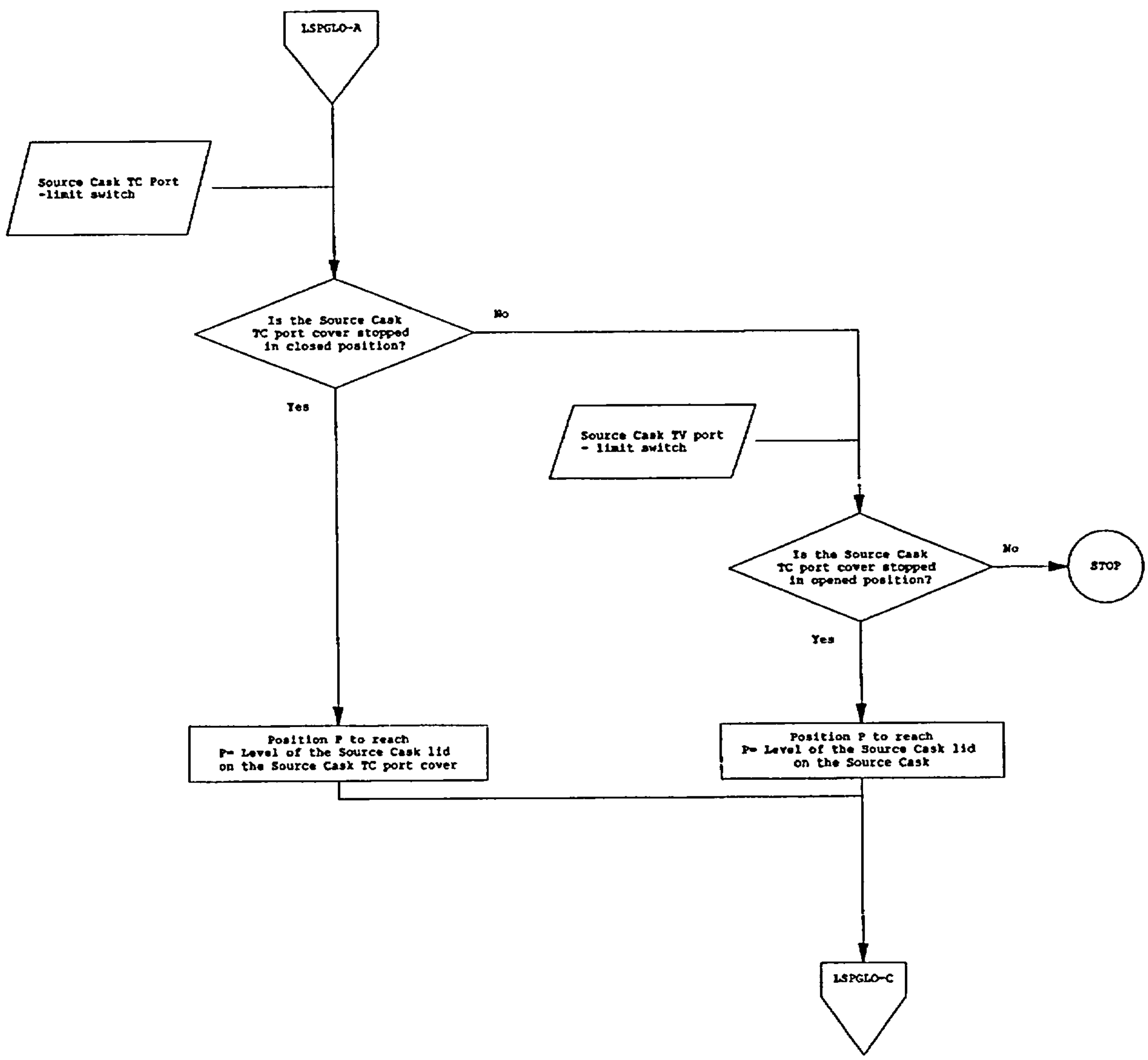
Table 5A-9
Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem Hoist Instrumentation.

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

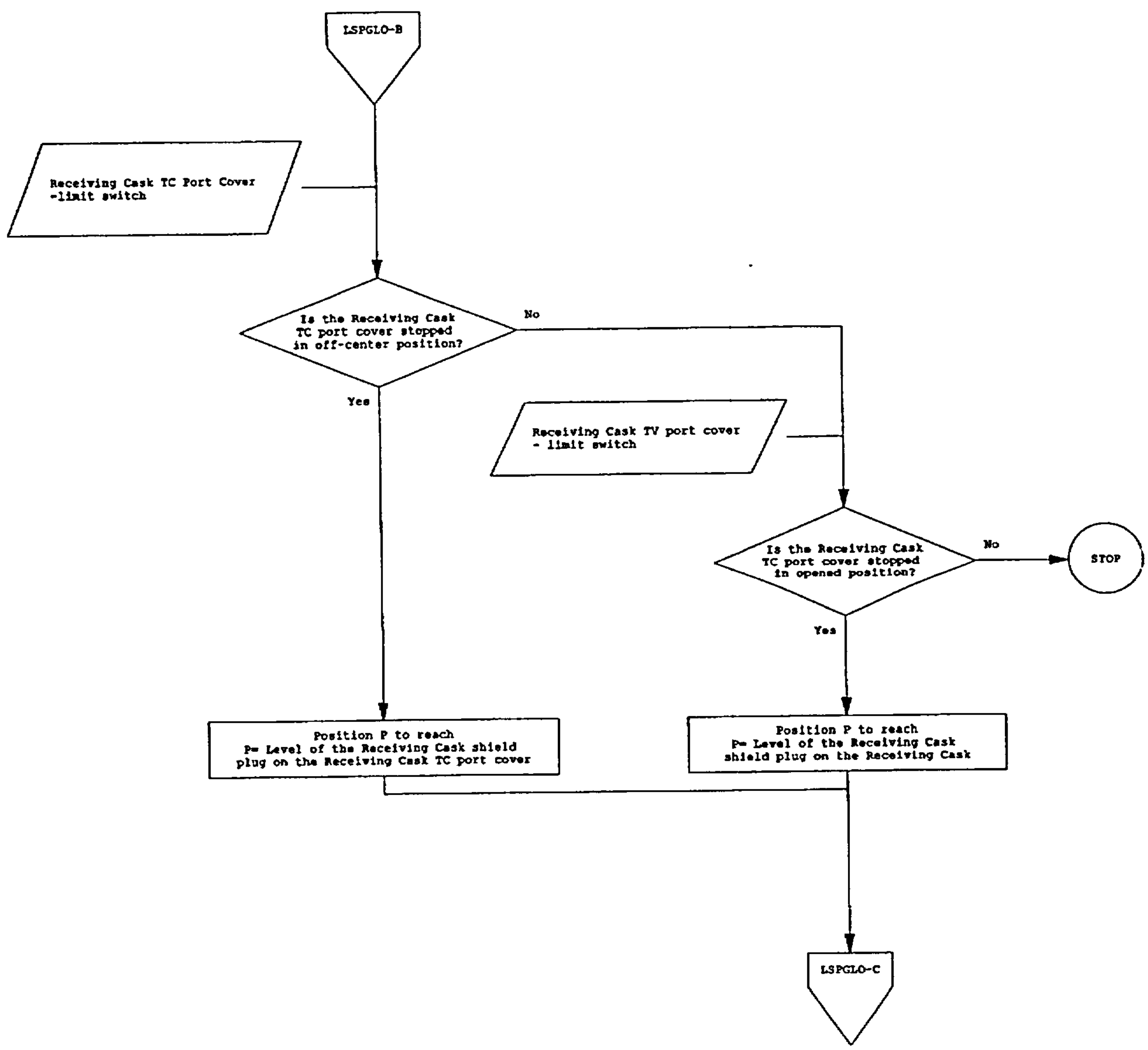
Source Cask Lid / Receiving Cask Shield Plug Grapple Lowering



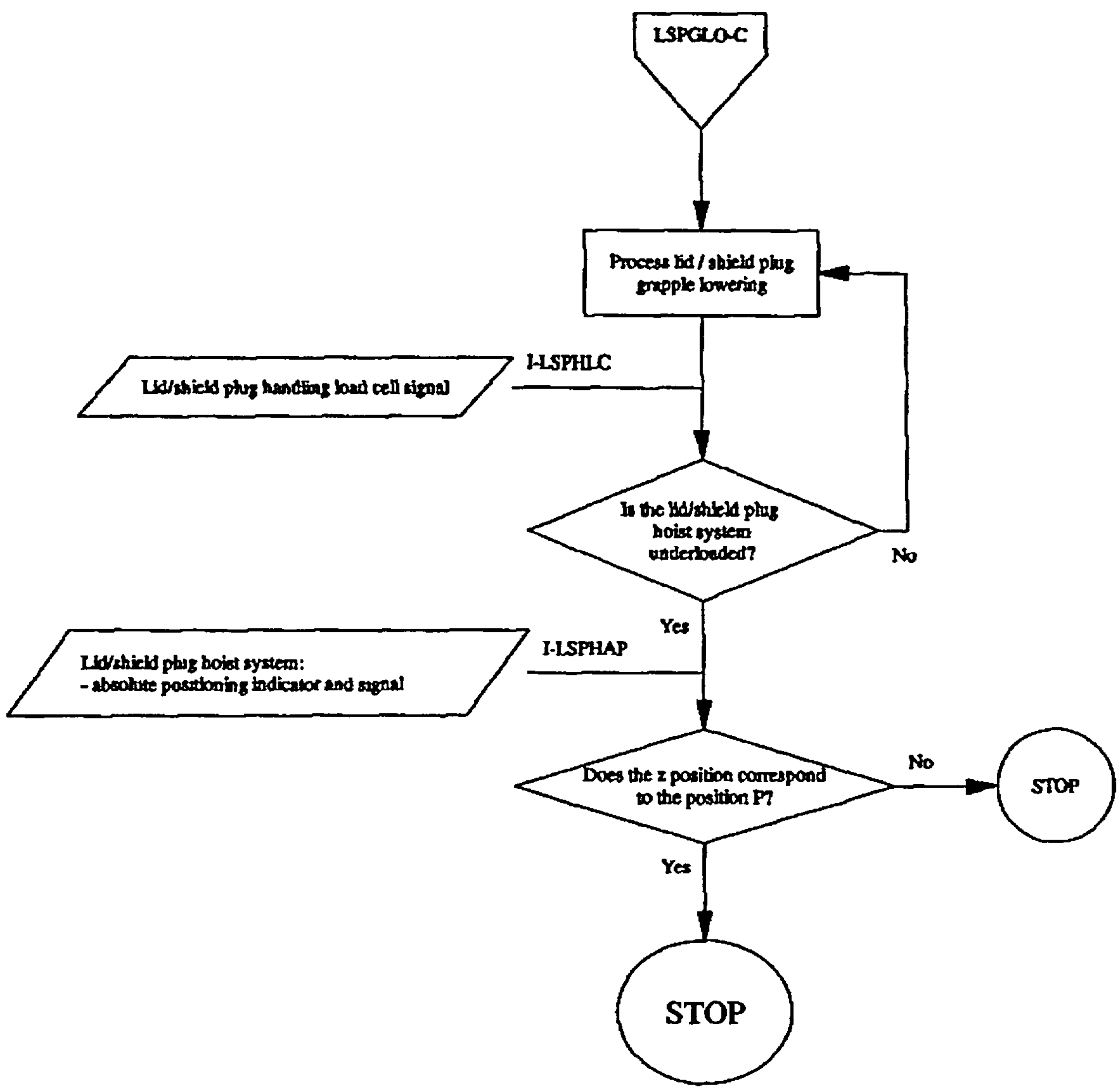
Source Cask Lid / Receiving Cask Shield Plug
Grapple Lowering (continued)



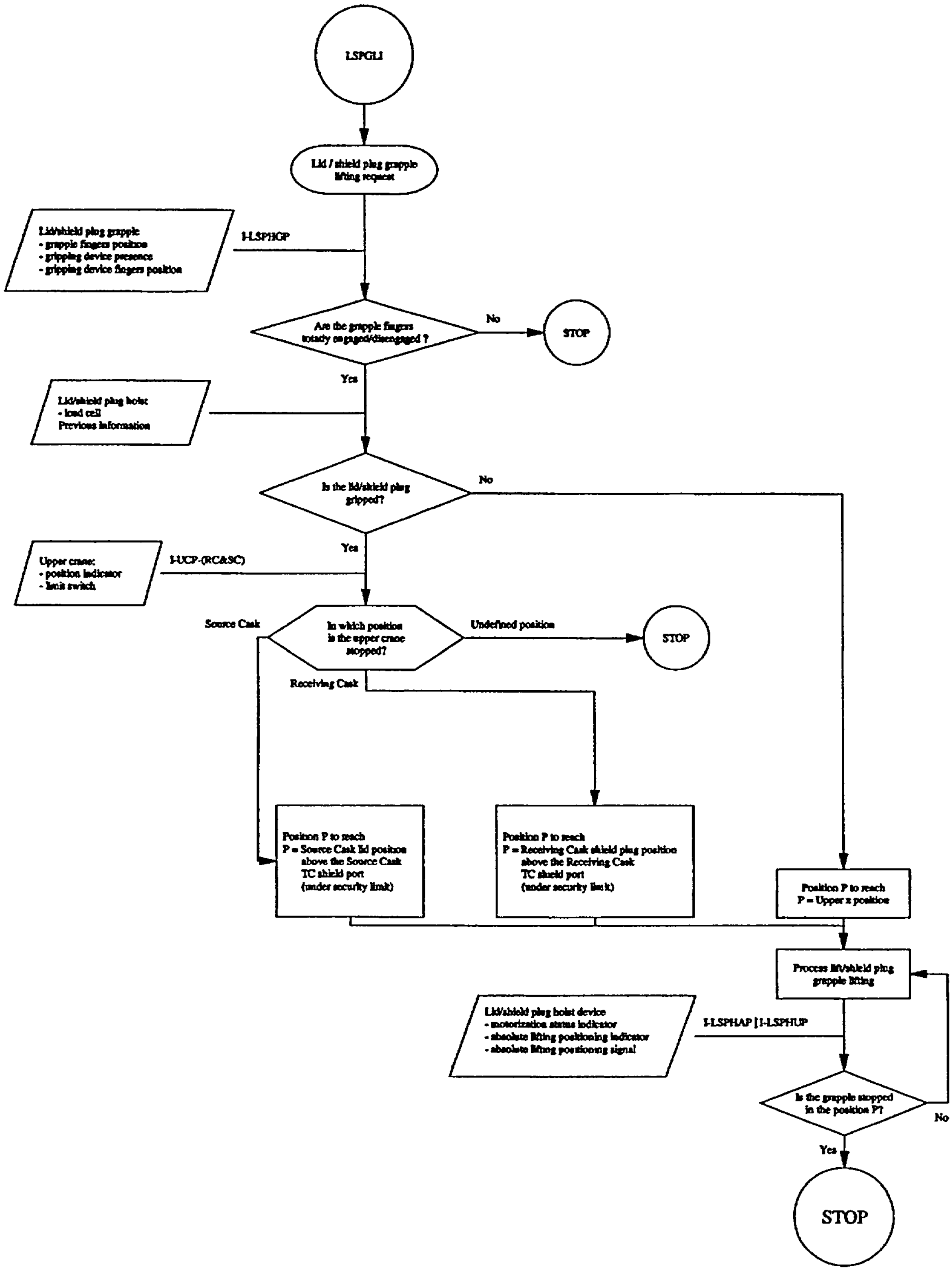
Source Cask Lid / Receiving Cask Shield Plug Grapple Lowering (continued)



Source Cask Lid /Receiving Cask Shield Plate
Grapple Lowering (continued)



Source Cask Lid / Receiving Cask Shield Plug Grapple Lifting



5A.4.2.8 Control and monitoring of the lid / shield plug grapple

A. Description

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.

B. Operating principle

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.

C. Control and monitoring requirements

The Control Subsystem shall:

- Control the motorized grapple (grapple/disengage/stop).
- Monitor the grapple fingers' position (open/closed/undefined).
- Monitor the presence of the overlid.
- Monitor the gripping device fingers' position (open/closed/unknown).
- Detect the gripping of overlid fingers (alarm + stop motion).

The system is independent of the object to grapple because of the overlids' design.

D. Transition conditions validation requirements

Interlock requirements:
The following interlock shall be implemented:

Interlock the grapple with the hoist system. It shall prevent the disengagement of the overlid if the cables are loaded and if the grapple is not in its proper z position.

Rationale:

The interlock prevents the dropping of the lid/shield plug and uses redundant information: load and z position.

Dependent equipment:

Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem - hoist system

E. Instrumentation requirements

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

Table 5A-10 lists the necessary instrumentation for the Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem grapple.

F. Flow charts

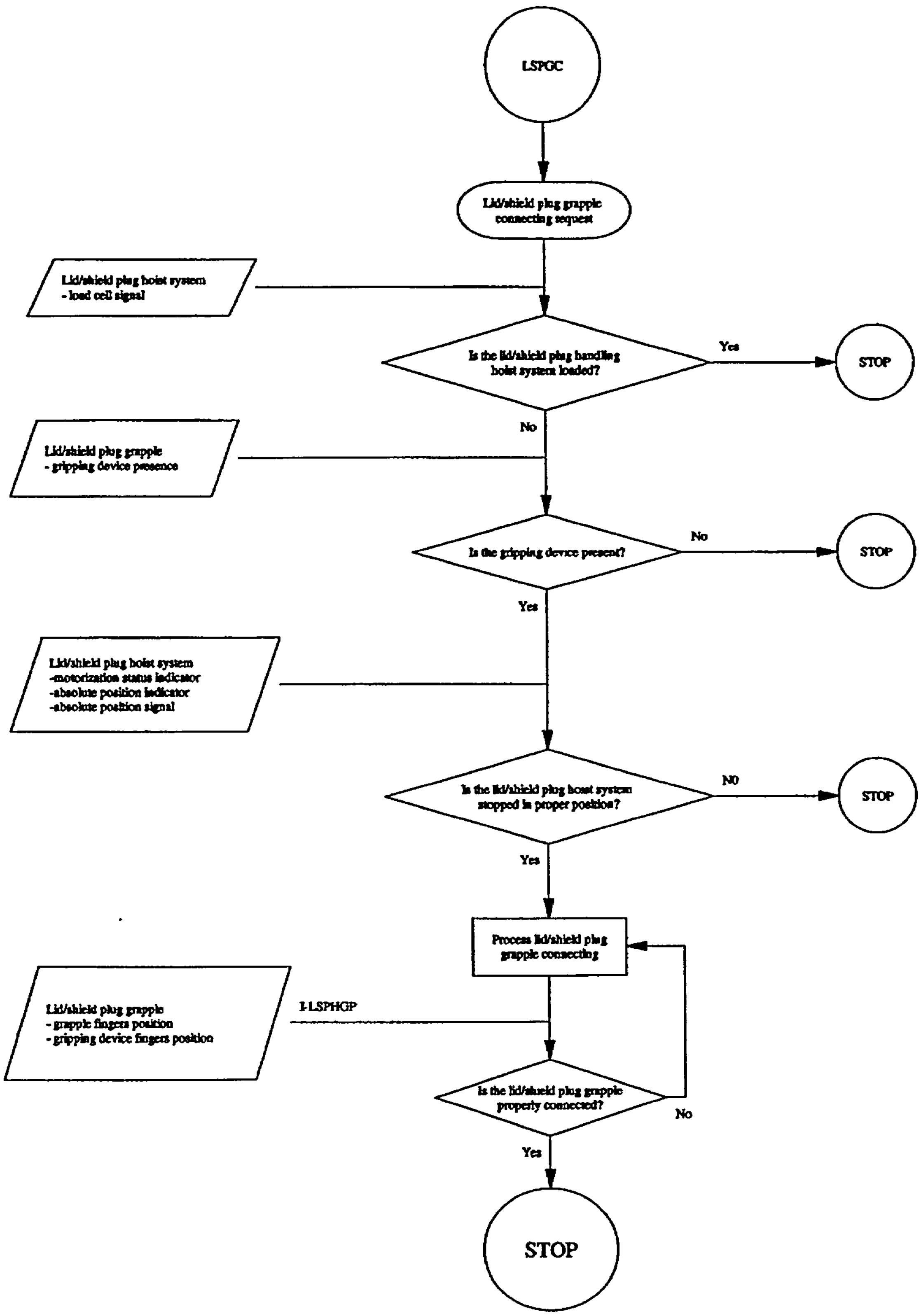
The flow charts describe the control of the following operations:

- Lid/shield plug grapple connection
- Lid/shield plug grapple disengagement

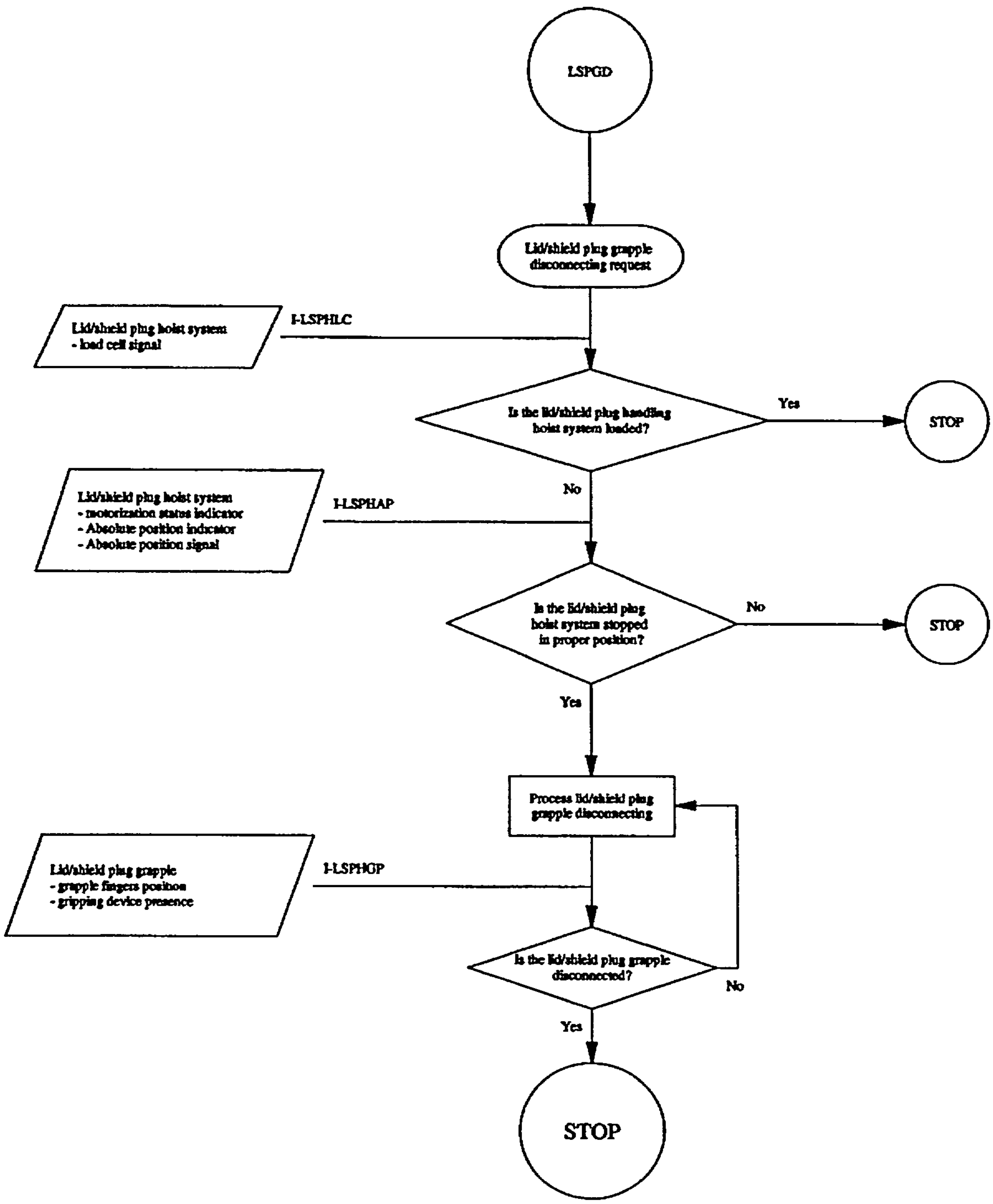
Table 5A-10
Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem Grapple Instrumentation

Equipment	Data	Sensor type	Action	Reference
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

Lid/Shield Plug Grapple Connecting



Lid/Shield Plug Grapple Disconnecting



5A.4.2.9 Control and monitoring of the Fuel Assembly Handling Subsystem

A. Description

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 (see Applicable Document 8.5).

B. General requirement

The Control Subsystem allows:

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

Monitoring and control are 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 and the introduction of a fuel assembly in a cell.

5A.4.2.10 Control and monitoring of the crane carriage

A. Description

The crane carriage consists of a motorized bridge (x direction) which supports a motorized trolley (y direction) which supports a motorized rotating platform. 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.

B. Operating principle

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 movements (adapted speed, brakes...).

The position is rough and the operator has to finish the positioning of the transfer tube controlling 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.

C. Control and monitoring requirements

The Control Subsystem shall:

- Control crane carriage x direction motorization (mode / direction / run / stop / 2 speeds)
- Control crane carriage y direction motorization (mode / direction / run / stop / 2 speeds).
- Monitor the status (mode/running/stopped), and the current speed in the x direction.
- Monitor the status (mode/running/stopped), the current speed in the y direction.
- Detect an overrun in x and y directions (alarm + stop x and y motions).
- Monitor the x and y positions

Four overrun devices (one at each runway rail end of the two rails) which automatically stop motion (in both x and y directions) are provided. The PLC limits the use of the speeds to the slow one during the fine positioning.

D. Transition conditions validation requirements

Requirements:
The following interlocks shall be implemented:

- Interlock the crane carriage (bridge and trolley) with the hoist system. It shall 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. It shall 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. It shall 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. It shall prevent motion of the crane carriage if the two TC port covers are not locked (in open position).

Rationale:
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

Dependent equipment:

TC port covers locking devices
Source Cask Lid/ Receiving Cask Shield Plug Handling Subsystem - hoist system
Fuel Assembly Handling Subsystem - crud catcher, hoist system

E. Instrumentation requirements

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

Table 5A-11 lists the necessary instrumentation for the Fuel Assembly Handling Subsystem crane carriage.

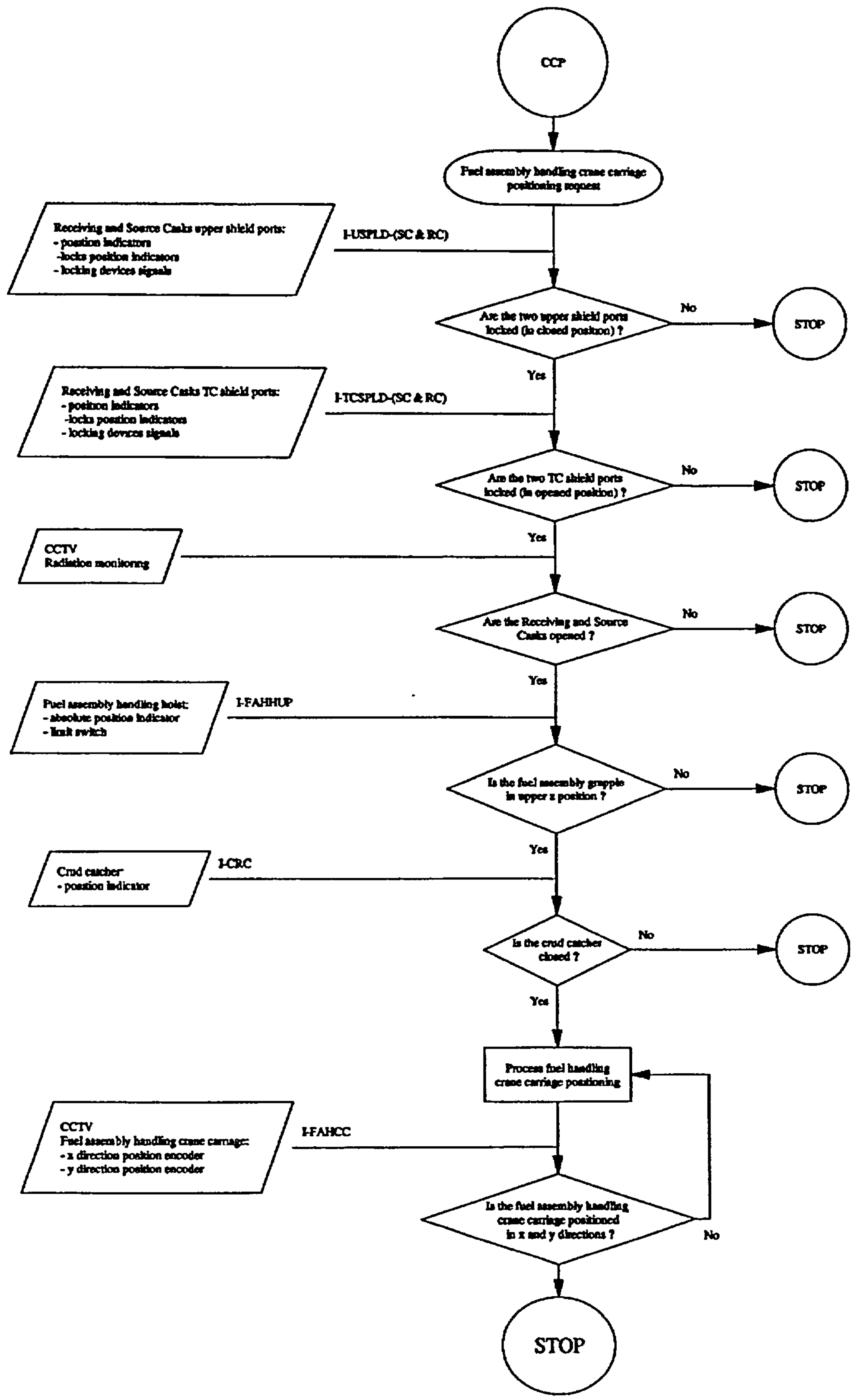
F. Flow charts

The flow chart describes the control of the crane carriage (bridge and trolley).

Table 5A-11
Fuel Assembly Handling Subsystem
Crane Carriage 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

Fuel Assembly Handling Crane Carriage Positioning



5A.4.2.11 Control and monitoring of the rotating platform

A. Description

The rotating platform is motor driven, it supports the hoist motorization and can rotate ± 180 degrees around its centerline to allow the proper positioning of the fuel transfer tube above a fuel assembly centerline or an empty cell.

B. Operating principle

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 centerline.

C. Control and monitoring requirements

The Control Subsystem shall:

- Control the motorization of the rotating platform (run clockwise/counter-clockwise/stop/ 2 speed).
- Monitor the rotating platform orientation.

Monitoring, control and indications are in the Control center.

D. Transition conditions validation requirements

Requirements:
The following interlocks shall be implemented:

- Interlock the rotating platform with the hoist system. It shall prevent any rotation of the platform if the assembly grapple is not in upper z position.

- Interlock the rotating platform with the crud catcher. It shall prevent any rotation of the platform if the crud catcher is not closed.

Rationale:
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.

Dependent equipment:
Fuel Assembly Handling Subsystem - hoist system, crud catcher

E. Instrumentation requirements

No instrumentation has to be redundant for this scope.

Table 5A-12 lists the necessary instrumentation for the Fuel Handling Subsystem rotating platform.

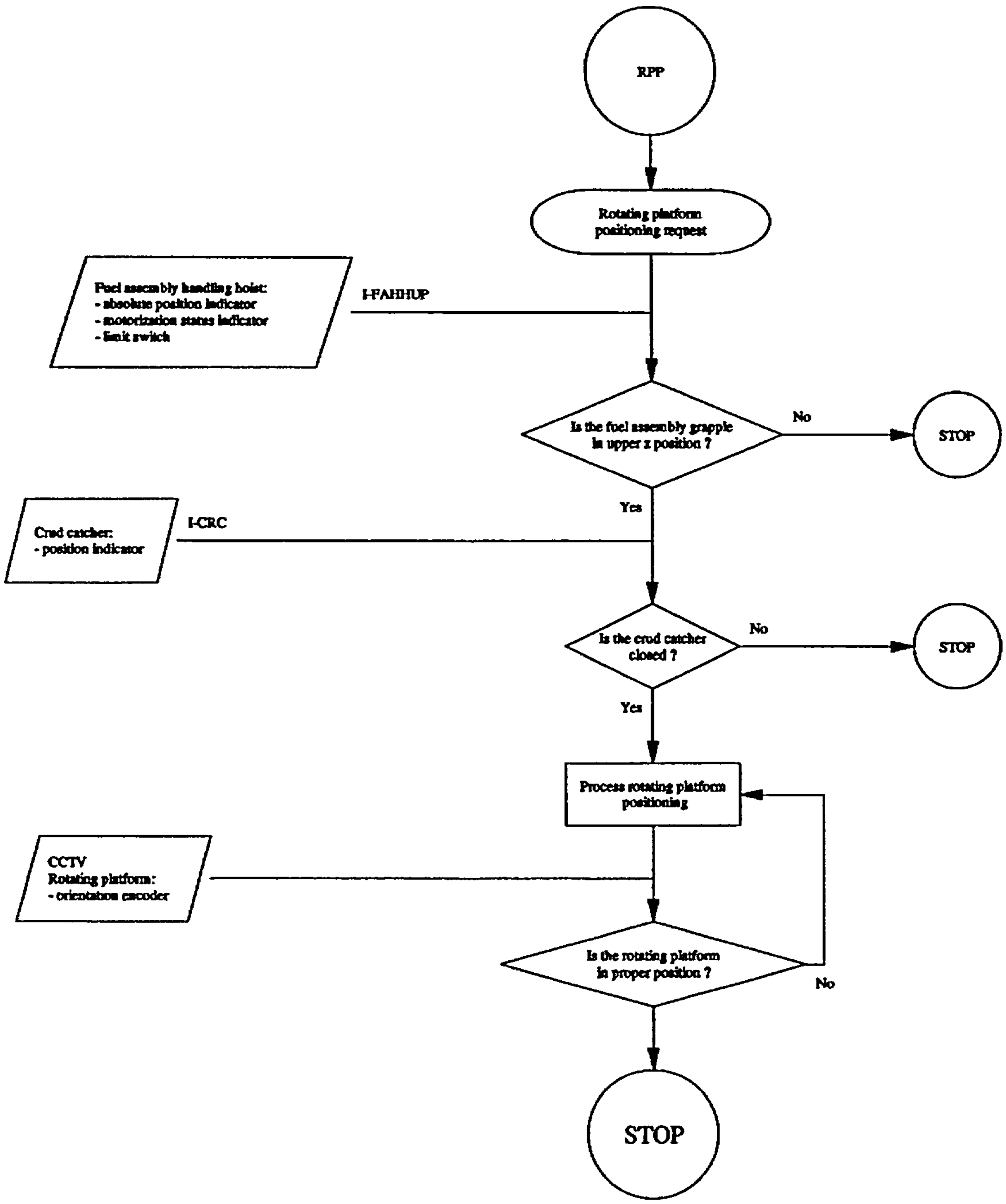
F Flow charts

The flow chart describes the control of the rotating platform positioning.

Table 5A-12
Fuel Handling Subsystem
Rotating Platform Instrumentation

Equipment	Data	Sensor type	Action	Reference
Rotating platform	Absoulte rotating positioning	Synchroresolver	----	ZIT 107

Rotating Platform Positioning



5A.4.2.12 Control and monitoring of the crud catcher

A. Description

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.

B. Operating principle

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 is displayed by the supervisor. The CCTV Subsystem provides viewing of this equipment.

C. Control and monitoring requirements

The Control Subsystem shall:

- Control the crud catcher motorization (open/close/stop).
- Monitor the device position (open/closed/undefined).

Monitoring and control are in the Control Center.

D. Transition conditions validation requirements

Requirements:
The following interlocks shall be implemented:

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

Rationale:

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 guarantees that the crud catcher can't damage the fuel assembly during closure.

Dependent equipment:

Fuel Assembly Handling Subsystem - crane carriage, rotating platform, hoist system

E. Instrumentation requirements

Table 5A-13 lists the necessary instrumentation for the Fuel Assembly Handling Subsystem crud catcher.

F. Flow charts

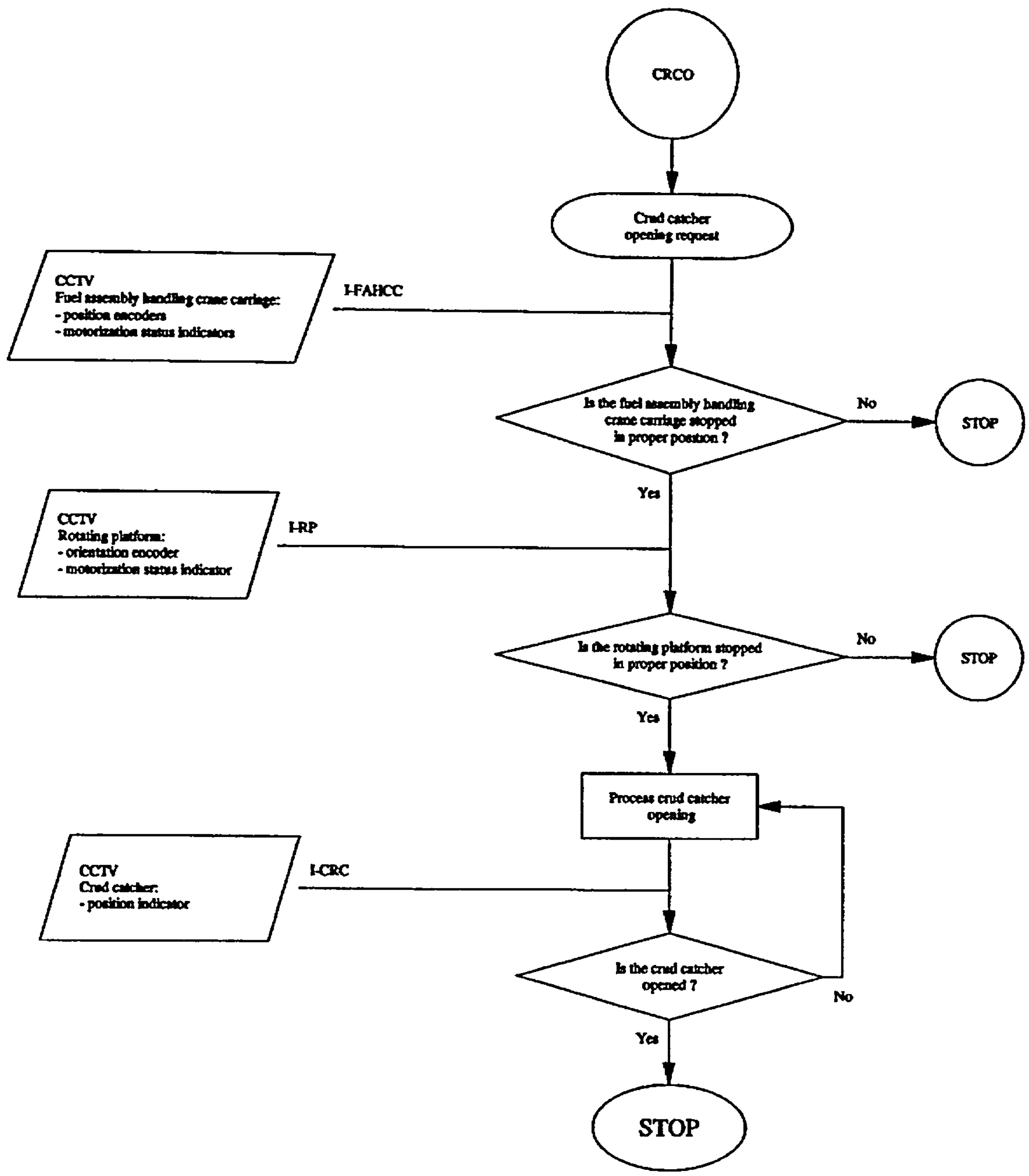
The flow charts describe the control of the following operations:

- Crud catcher opening
- Crud catcher closing

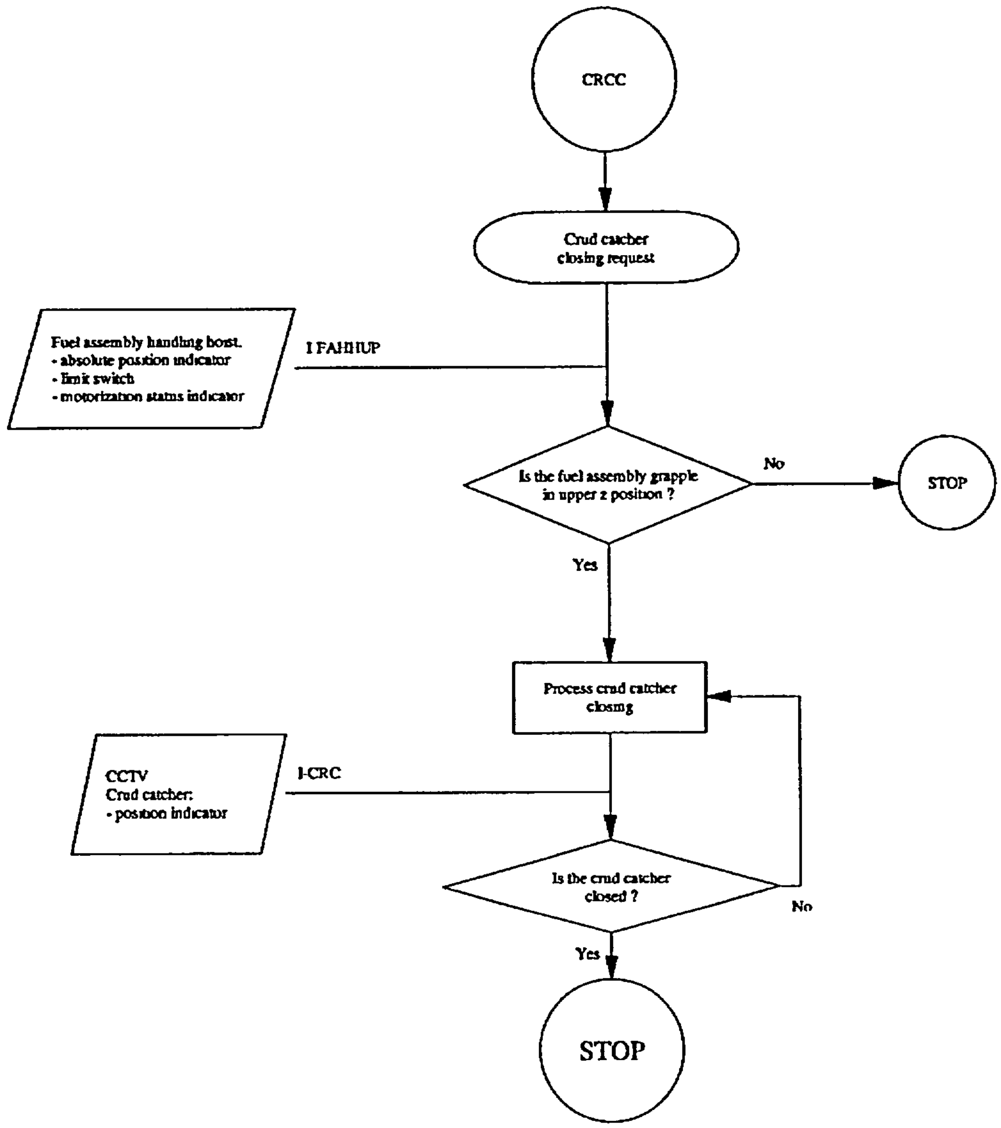
Table 5A-13
Fuel Assembly Handling Subsystem
Crud Catcher Instrumentation

Equipment	Data	Sensor type	Action	Reference
Crud catcher	Open position	Electrical contact	----	YL 119A
	Closed position	Electrical contact	----	YL 119B

Crud Catcher Opening



Crud Catcher Closing



5A.4.2.13 Control and monitoring of the hoist system

A. Description

The hoist system consists of a cable with two motorized winches.

B. Operating principle

Only one winch can be 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.

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.

C. Control and monitoring requirements

The Control Subsystem shall:

- Allow the selection of the current winch
- Control the current motorized winch (lower / lift / stop / speed).
- Monitor the current motorization status (lowering / lifting / stopped), and the current speed.
- Detect an overrun (lowest grapple position)/underrun (highest grapple position) (alarm + stop motion).
- Detect an overload (alarm + stop motion).
- Detect an overspeed (alarm + stop motion).
- Detect an abnormal drum rope level wind (alarm + stop motion).
- Detect an underload (stop motion).
- Monitor the length of the unreeled cable.

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 overrun/underrun, overload, overspeed and abnormal drum rope level winds situations are abnormal, their detection generates an alarm and automatically stops motion. The underload is a normal situation.

D. Transition conditions validation requirements

Requirements:
The following interlocks shall be implemented:

- Interlock the hoist system with the crud catcher. It shall prevent lowering of the grapple if the crud catcher is closed.

- Interlock the hoist system with the fuel assembly grapple. It shall prevent lifting if the grapple is not totally engaged or disengaged.

- Interlock the hoist system with the crane carriage and the rotating platform. It shall prevent lowering if the crane carriage and the rotating platform are not stopped.

Rationale:
The interlocks prevent:

- the fuel assembly from getting stuck in the transfer tube
- dropping of a fuel assembly due to an improper gripping

Depending equipment:
Fuel Assembly Handling Subsystem - crud catcher, grapple, crane carriage, rotating platform

E. Instrumentation requirements

Redundant motorization, on two different power channels are provided.

Table 5A-14 lists the necessary instrumentation for the Fuel Assembly Handling Subsystem hoist.

F. Flow charts

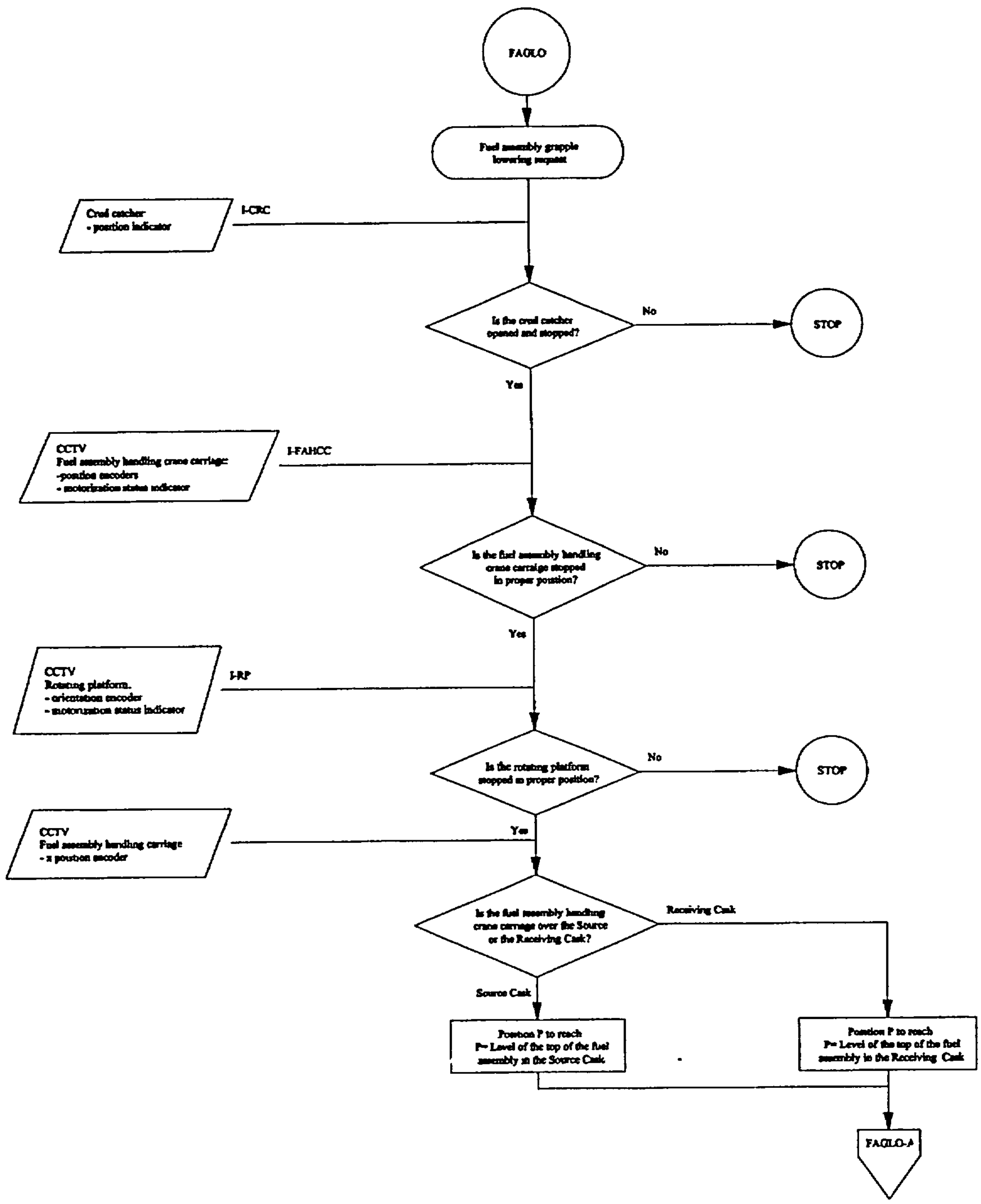
The flow charts describe the following operations:

- Fuel assembly grapple lowering
- Fuel assembly grapple lifting

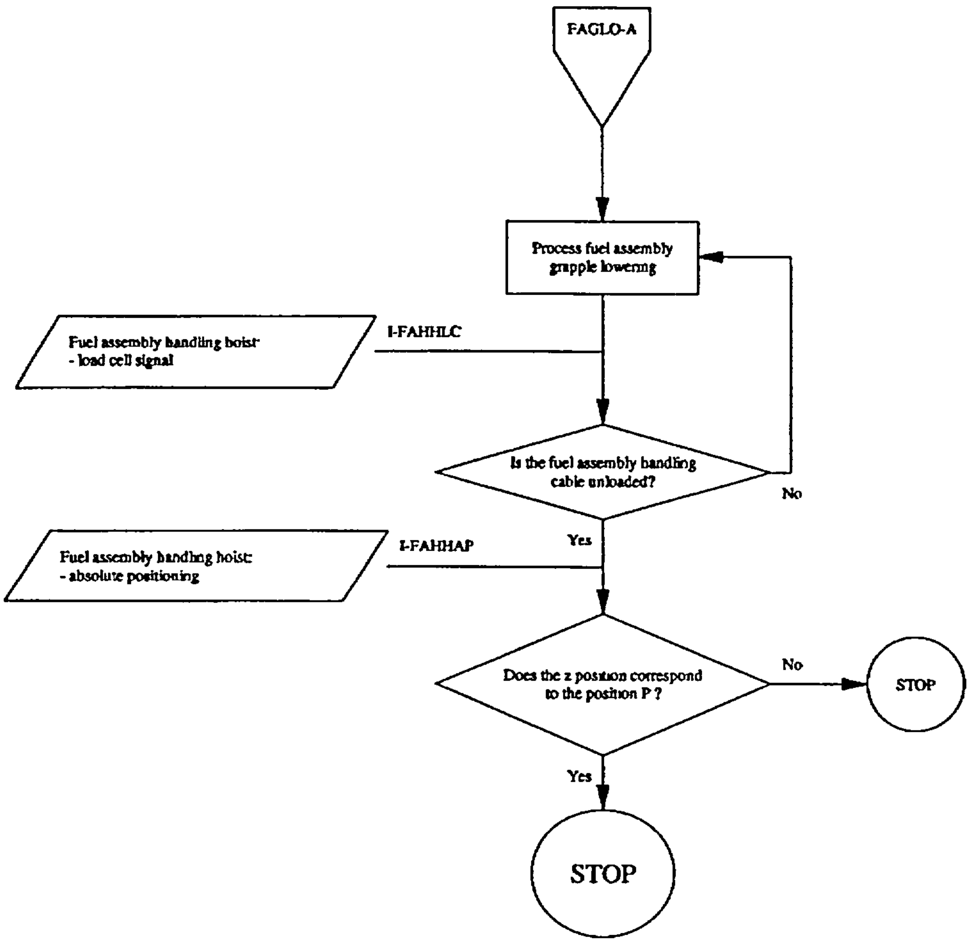
Table 5A-14
Fuel Assembly Handling Subsystem
Hoist System Instrumentation

Equipment	Data	Sensor type	Action	Reference
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

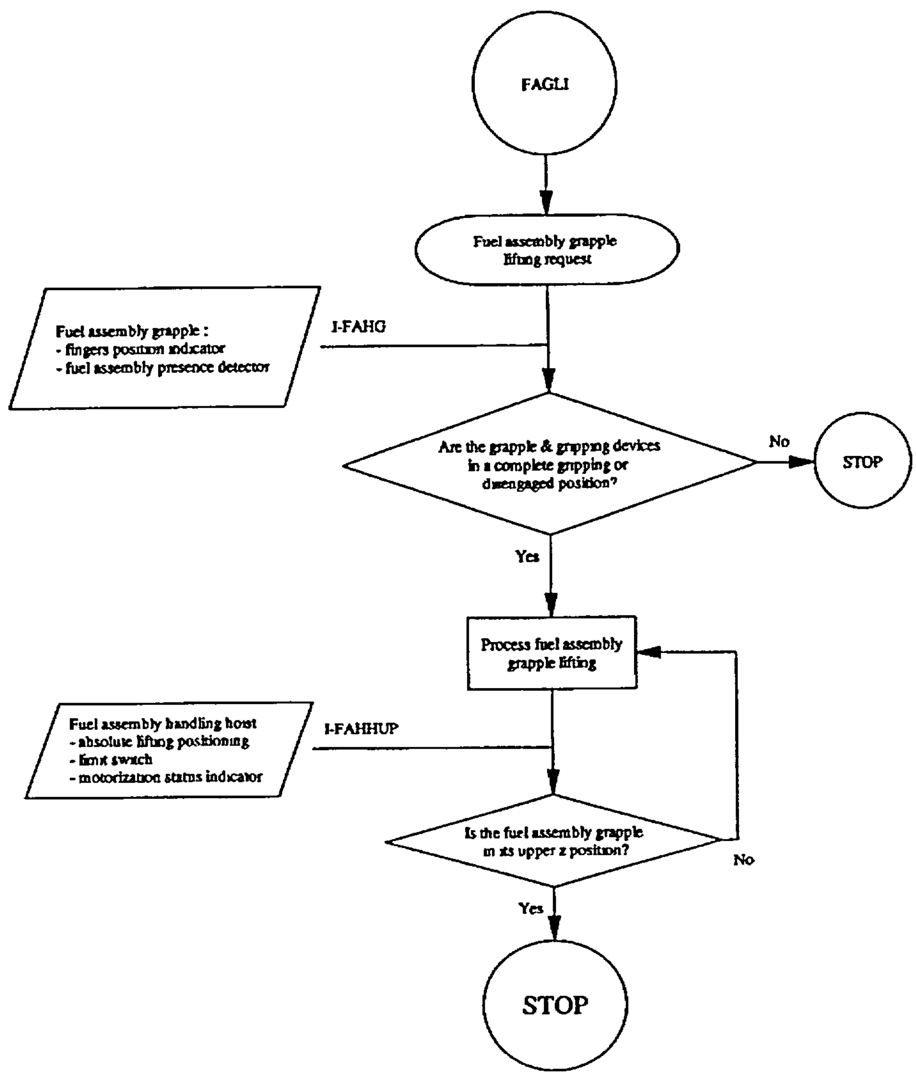
Fuel Assembly Grapple Lowering



Fuel Assembly Grapple Lowering (continued)



Fuel Assembly Grapple Lifting



5A.4.2.14 Control and monitoring of the grapple

A. Description

The motorized grapple shall be able to grip and disengage the spent fuel assembly. There are three motors, one for normal operating conditions and the two others for backup.

B. Operating principle

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 operation.

C. Control and monitoring requirements

The Control Subsystem shall:

- Select the current grappling equipment (normal/backup).
- Control the motorized grapple (grapple/disengage/stop).
- Monitor the grapple status (grappling/disengaged/undefined).
- Monitor the grapple fingers position (open/closed/undefined).
- Detect the fuel assembly presence.

All the indications are displayed in the Control Center. The two backup motors shall be on the secondary power channel. The backup equipment shall only be used to disengage the grapple.

D. Transition conditions validation requirements

Requirements:
The following interlock shall be implemented:

Interlock the grapple with the hoist system. It shall prevent the disengagement of the fuel assembly if the cable is loaded and if the grapple is not stopped in a proper position.

Rationale:

The interlock with the hoist system guarantees that the spent fuel can't be dropped due to an operator error.

Dependent equipment:

Fuel Assembly Handling Subsystem - winches
TC port covers and locking devices
Source cask lid/receiving cask shield plug handling subsystem - upper shield ports and locking devices.

E. Instrumentation requirements

The grapple motorization is redundant.

Table 5A-15 lists the necessary instrumentation for the Fuel Assembly Handling grapple.

F. Flow Sheets

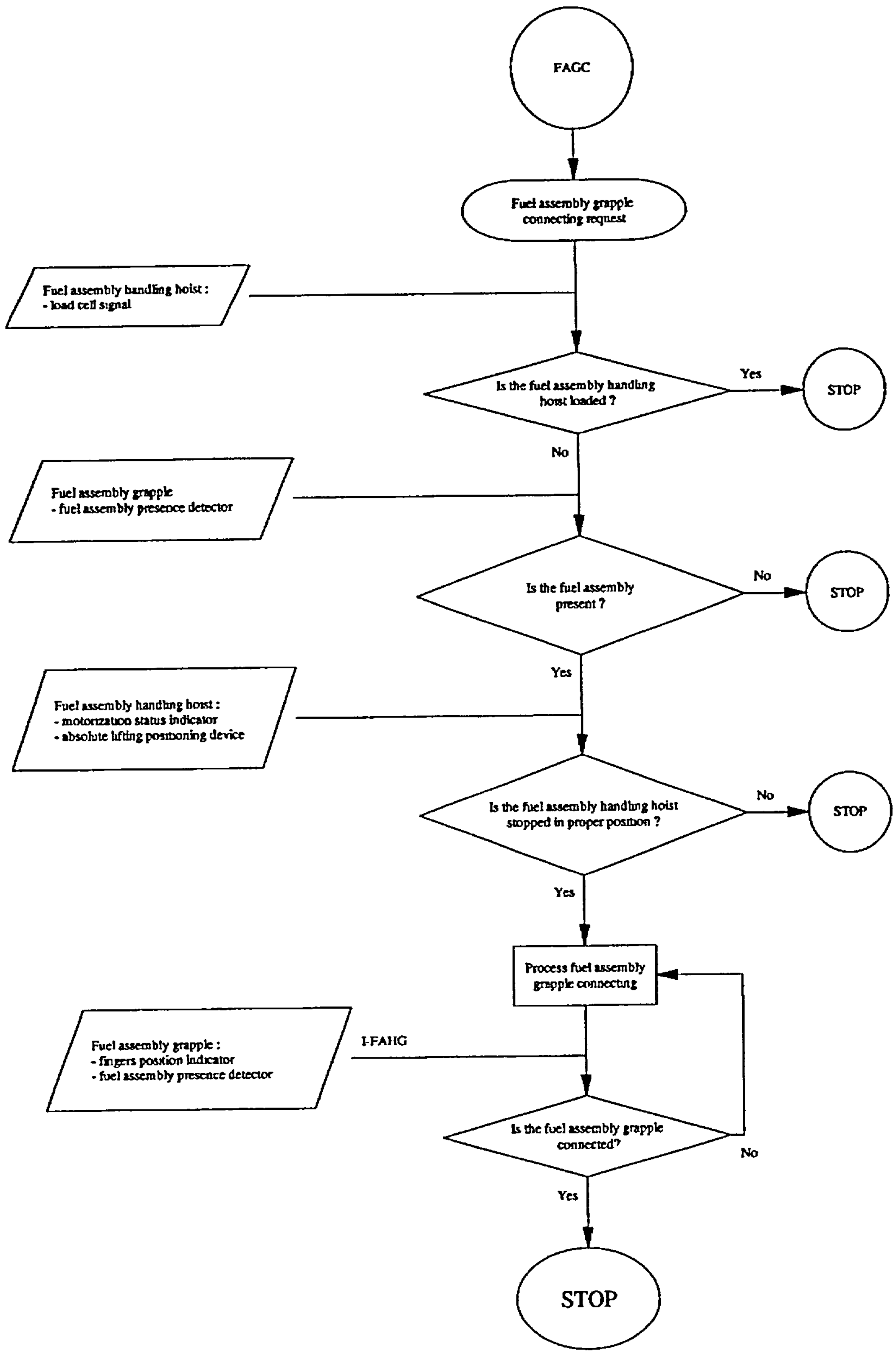
The flow charts describe the following operations:

- Fuel assembly grapple connecting
- Fuel assembly grapple disconnecting

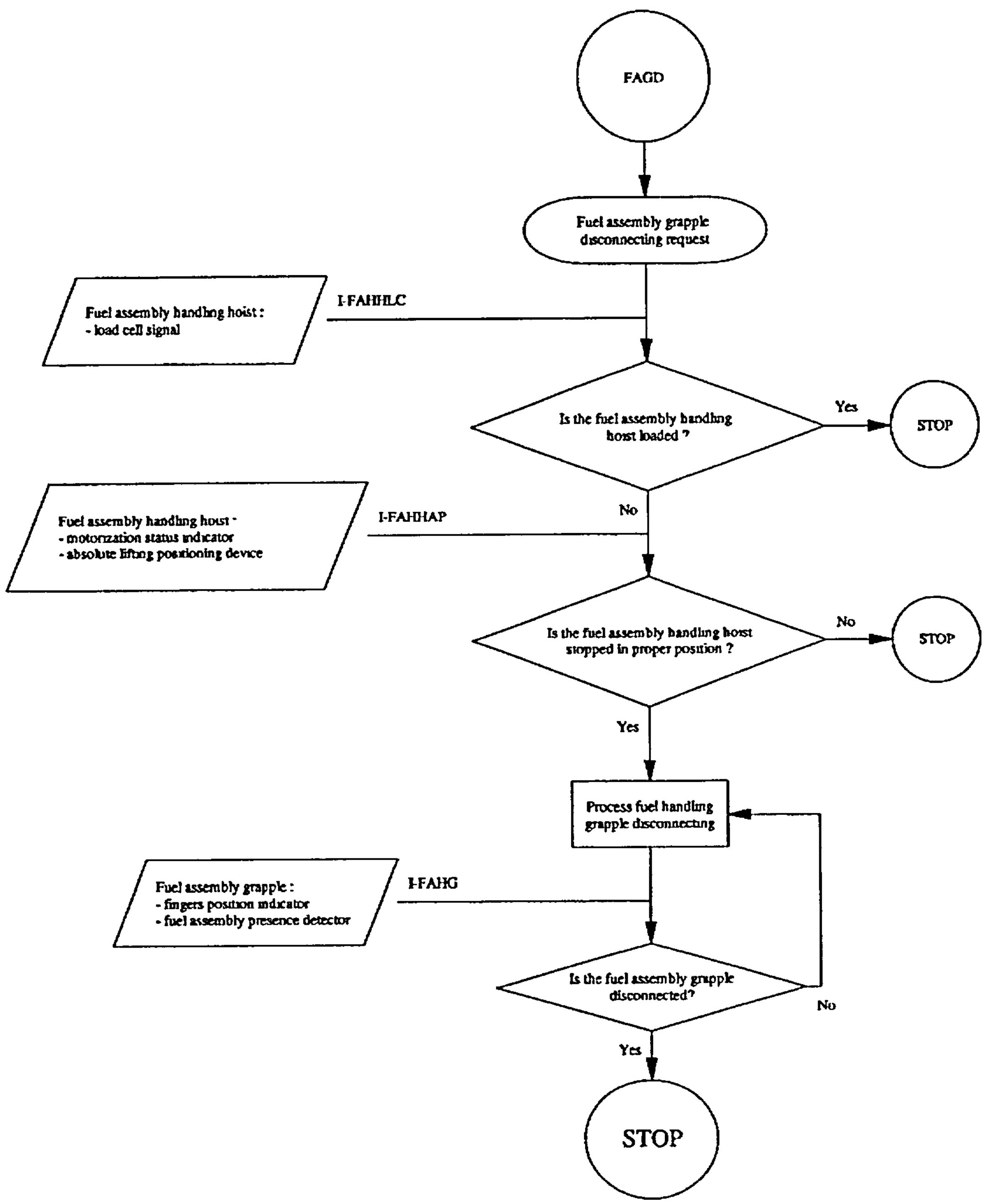
Table 5A-15
Fuel Assembly Handling
Grapple Instrumentation

Equipment	Data	Sensor type	Action	Reference
Grapple	Grapple fingers closed	Electrical switch	----	YL 116B
	Grapple fingers open	Electrical switch	----	YL 116A
	fuel assembly presence	Electrical switch	Stop motion	YLS 117

Fuel Assembly Grapple Connecting



Fuel Assembly Grapple Disconnecting



5A.4.3 Control and monitoring of the Structural Subsystem's doors

5A.4.3.1 Description

The Structural Subsystem includes two motorized doors:

- a rollup door that permits entry and removal of the source and receiving casks in the Preparation Area.
- a sliding door that permits entry and removal of the source and receiving casks between the Preparation Area and the Lower Access Area.

The sliding door provides confinement of the Lower Access Area during operations (except casks transfer operations). Four locking devices guarantee that the sliding door remains closed in case of a seismic event. These locking devices are manually operated.

5A.4.3.2 Operating principles

The sliding door is locally operated, and visually monitored, either from the Lower Access Area or from the Preparation Area.

The rolling door is locally operated, and visually monitored, either from outside the DTS or from the Preparation Area.

5A.4.3.3 Control and monitoring requirements

The Control Subsystem shall:

- Control the sliding door motorization (open/close).
- Monitor the locked positions of the locking pins (locked/unlocked).
- Detect the closed position of the sliding door.
- Detect the closed position of the rollup door.

Control and monitoring of the sliding door shall be in the Preparation Area and in the Lower Access Area.

The detection of the doors' positions is used by the PLC for HVAC regulation (see Section 5A.4.4).

5A4..3.4 Transition conditions validation requirements

Requirements:
The following interlocks shall be implemented:

Interlock the sliding door with the Radiation Monitoring Subsystem. It shall prevent opening of the sliding door if the radiation level is not acceptable.

Dependent equipment:

TC port covers

5A.4.3.5 Instrumentation requirements

Table 5A-16 lists the necessary instrumentation for the Structural Subsystem sliding door.

5A.4.3.6 Flow charts

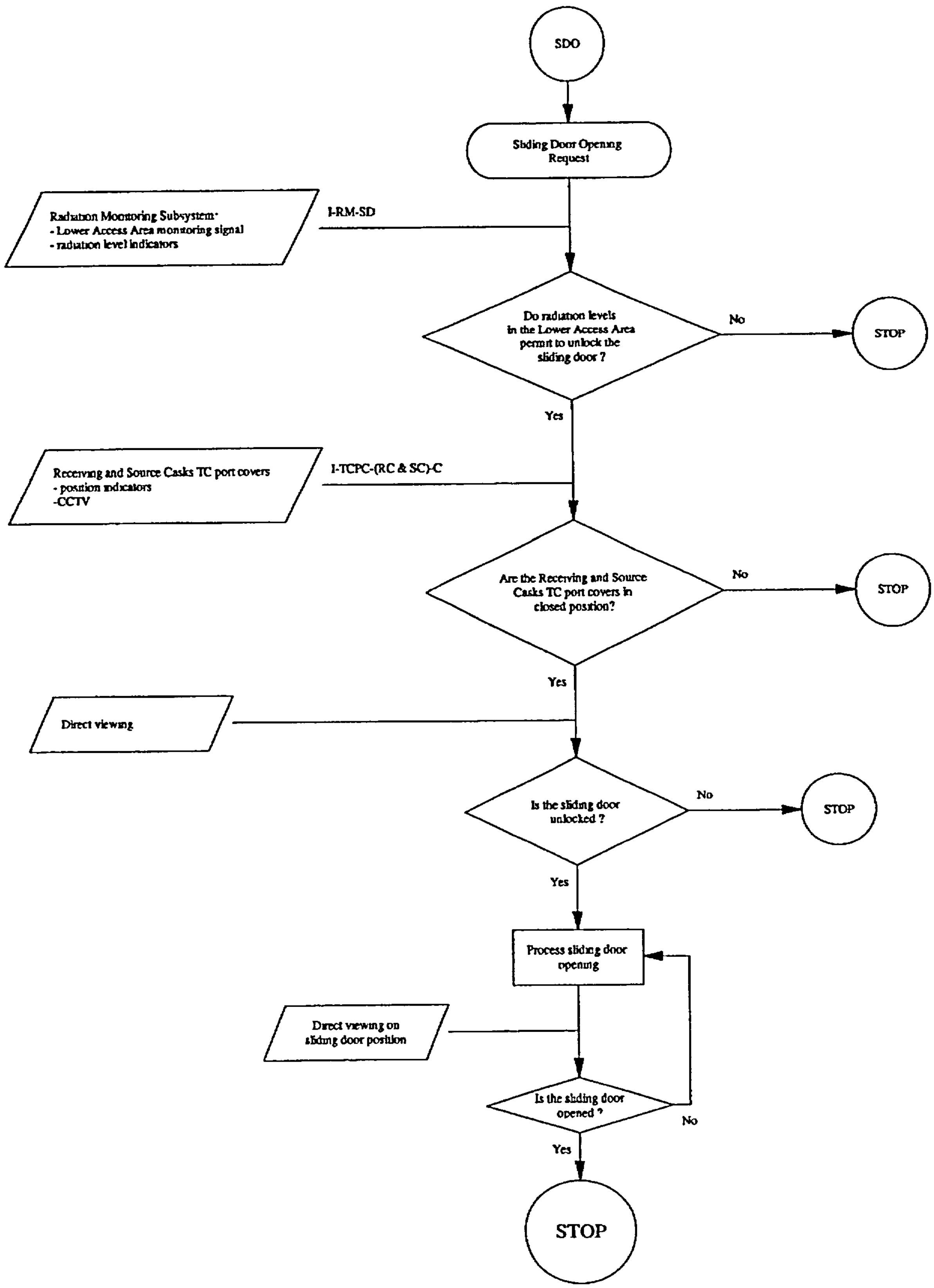
The flow charts describe the control of the following operations:

- Sliding door opening
- Sliding door closing

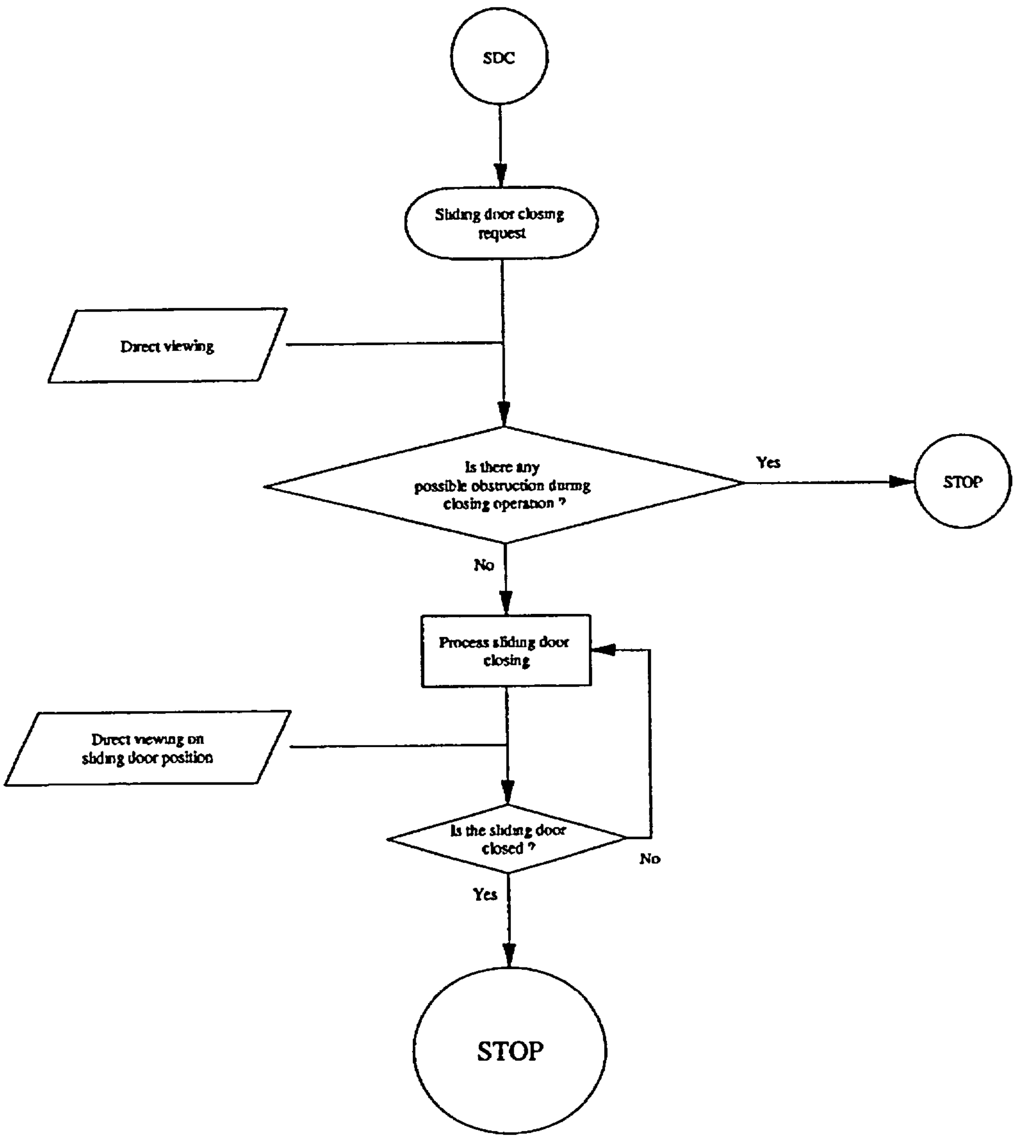
Table 5A-16
Structural Subsystem
Sliding door Instrumentation

Equipment	Data	Sensor type	Action	Reference
Sliding door	Locking pin in position	Electrical contact	----	YL 801A YL 801B YL 801C YL 801D
	Closed position	Electrical switch	Stop motion	ZS 802
Rollup door	Closed position	Electrical switch	Stop motion	ZS 803

Sliding Door Opening



Sliding Door Closing



5A.4..4 Interfaces with the HVAC Subsystem

5A.4.4.1 Functional Description

The HVAC Subsystem is designed to provide an additional level of confinement of radioactive material associated with the transfer of spent fuel assemblies, to direct air flow from areas of low levels of potential contamination to areas of higher levels of potential contamination, and to control the temperatures of the spent fuel, fuel transfer equipment, the DTS structure and associated components. All three areas of the DTS, i.e., the Preparation Area, the Lower Access Area and the TCA are served by the HVAC Subsystem.

The HVAC Subsystem performs its confinement function by maintaining negative pressures in various areas relative to atmospheric pressure. By establishing pressure differentials, air flow direction is maintained from the ambient into the Preparation Area through the Lower Access Area to the TCA. The air is exhausted through HEPA filter banks up a stack. Redundant components such as exhaust fans and HEPA filters have been incorporated into the design to minimize the potential for failure of the confinement function during normal operating conditions. Motorized dampers can isolate a HEPA filter bank for replacement of the filter.

The temperature in each area of the DTS is maintained with a combination of air conditioning and heating units. The air in the Roof Enclosure Area is also maintained by a separate air conditioning/heat pump unit.

The control schematics of the HVAC Subsystem are provided in the Referenced Document 5A.7-7.

5A.4.4.2 Monitoring and alarms of the HVAC Subsystem

The equipment is controlled by the PLC which is specific to the HVAC Subsystem, the Radiation Monitoring Subsystem and the sliding door. The supervisor displays the HVAC Subsystem information such as:

- the temperature in each area
- the pressure in each area
- the equipment status

A. Pressure monitoring

The pressure information in each area is used to validate the proper functioning of the HVAC Subsystem, prior to initiating the cask opening process. The pressure in each area is based on pressure differentials between:

- the outside and the Preparation Area
- the Preparation Area and the Lower Access Area
- the Lower Access Area and the Transfer Confinement Area
- the Transfer Confinement Area and the outside

The failure of a pressure sensor is automatically detected by periodically verifying the consistency between all the pressure information. This generates an alarm which is activated by the PLC which uses the pressure differential information to regulate the system.

B. Temperature monitoring

Temperature information in each area is provided by sensors at each Air Handling Unit duct entrance. One temperature sensor in the ductwork before the exhaust fans, outside the DTS, provides the temperature of the exhausted air. The failure of a temperature sensor can result in an air overheating or overcooling. Alarms are generated when the signal from any sensor strays from within a given range. A failure of the Preparation Area cooling/heating system is detected by the Lower Access Area cooling/heating system. A failure of the Lower Access Area cooling/heating system is detected by the TCA cooling/heating system. A failure of the TCA cooling/heating system is detected by the temperature sensor outside the building. These failures generate alarms that the supervisor displays.

C. Equipment status monitoring

The status (on/off) of the two exhaust fans is displayed by the supervisor. The information is provided by the pressure differential switch in the exhaust fan. The speed of the operating exhaust fan is also monitored.

The dampers' position and motion, the cooling, heating or dehumidification systems' activities are not monitored.

D. HEPA filters alarms

Pressure differential sensors which measure the pressure differential accross each HEPA filter are linked to the PLC which generates alarms in the case of abnormally low (broken filter) or high (filter full) pressure differential.

5A.4.4.3 <u>Control of the HVAC Subsystem</u>

A. Pressure control

Motorized dampers between the Preparation Area and the Lower Access Area and between the Lower Access Area and the TCA are controlled by the PLC as well as variable speed exhaust fans (lead and backup).

At system start-up, all dampers between areas are closed. The lead exhaust fan isolation control damper will open and the fan will ramp up via its variable frequency drive to a speed which will maintain the static pressure setpoint for the TCA as sensed by the TCA static pressure sensor.

After an adjustable delay period, the damper between the Lower Access Area and the TCA will come under control of the Lower Access Area static pressure sensor and will modulate to maintain Lower Access Area static setpoint.
After a second similar delay, the damper between the Preparation Area and the Lower Access Area will come under control of the Preparation Area static pressure sensor and will modulate to maintain the Preparation Area static setpoint. As each of these dampers comes on line, the exhaust fan speed will increase as required to maintain the TCA static setpoint. The static pressure control will only operate when the source and receiving casks are mated to the TCA, and the DTS sliding door and Preparation Area doors are closed. The system will react to changes in the infiltration of air into the DTS by speeding up or slowing down the fan and opening or closing dampers as necessary to maintain pressure differential setpoints. This is the typical operating mode during which the transfer of fuel will occur.

When the Preparation Area door (rollup door) is opened, the air curtain units will be energized via door mounted end switch to help prevent the influx of dust and insects. When the Preparation Area door is closed, these units will automatically be turned off.

In the event that the PLC senses a failure of the lead exhaust fan (absence of pressure differential), an alarm will be generated, the lead fan isolation damper will close, the standby fan isolation damper will open, and the startup sequence will continue as described above. In the event that a failure is sensed during normal operation (for example, a fan belt breaks) the lead fan isolation damper and the two transfer dampers will close, the standby fan isolation damper will open, and the startup sequence will continue as described above. The control dampers in the Lower Access Area and the TCA are designed to fail in the open position to allow the airflow through these areas to continue in the proper direction in the event of a loss of control of any damper. The control damper in the duct between the Preparation Area and the Lower Access Area is designed to fail in the closed position.

Four motorized dampers, on each side of the two sets of HEPA filters are used to isolate the HEPA filters in order to replace them. These dampers can be remotely opened or closed by the operator using bypasses. Two dampers (one on each side of the HEPA filters) are activated at the same time. When these dampers close, the absence of pressure differential accross the corresponding HEPA filters validates the closure of the dampers.

Normal operations of the DTS cycle have an influence on the control of the HVAC exhaust fan speed and dampers' control. When the source or receiving casks are being moved in or out of the DTS, the ventilation system air flow will be controlled to prevent high air flow rates within the TCA and increase the risk of the generating airborne contamination. Information that the Cask Mating Subsystem has been disengaged or the DTS sliding door has been opened, will be used by the PLC to override the fan/damper components from trying to re-establishing the pressure setpoints.

Once both casks are mated and the doors are closed, the PLC restarts the regulation process.

B. Temperature control

The cooling, heating and dehumidification devices are self-controlled. These devices only interface with the Control Subsystem providing temperature monitoring and alarms.

5A.4.5 Interface with the Radiation Monitoring Subsystem

5A.4.5.1 Monitoring requirements

Gamma area radiation monitors are located in the Preparation Area, in the Lower Access Area, in the Transfer Confinement Area and in the roof enclosure. Their values are interpreted by the PLC managing the HVAC Subsystem and the sliding door. All the values are transmitted to the PC to allow a remote monitoring of the radiation levels in the different areas and a periodical storage if necessary. Some values are used by the PLC for the interlocks with the sliding door. Some others are transmitted to the PLC for the mechanical equipment and for the interlocks with the upper shield ports.

5A.4.5.2 Interlocking requirements

The Lower Access Area monitor is interlocked with the sliding door in order to prevent the opening of the sliding door in case of high radiation levels.

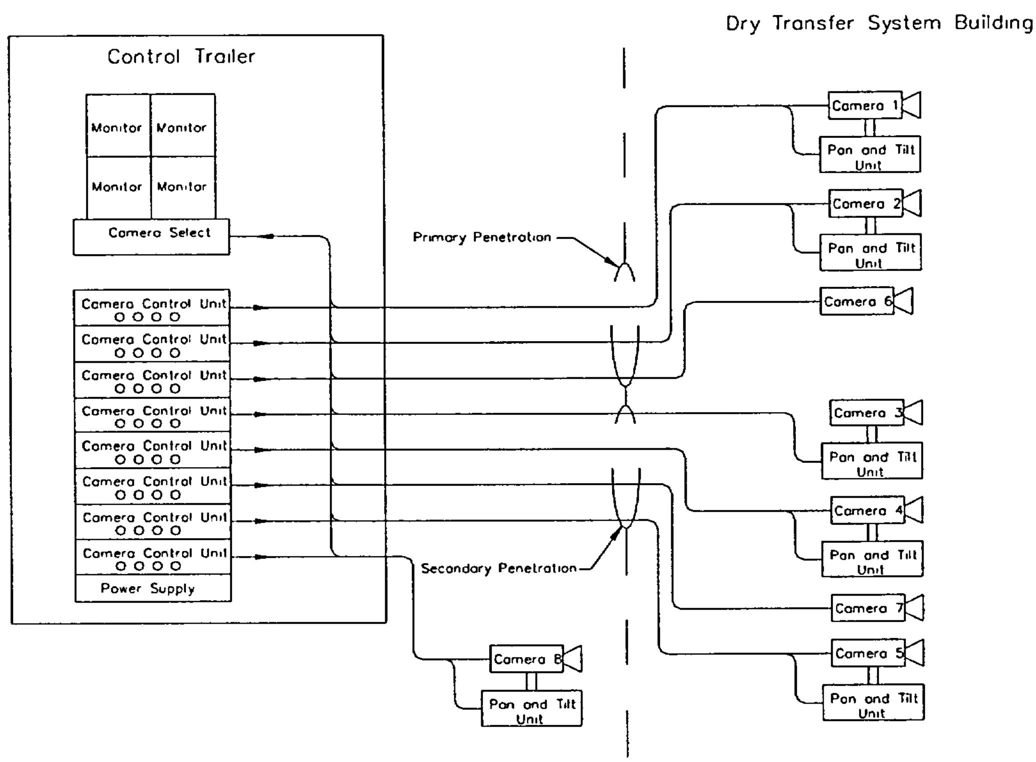
The roof enclosure monitor is interlocked with the upper shield ports to prevent their opening in case of high radiation levels.

5A.4.6 Interfaces with the CCTV and Lighting Subsystems

5A.4.6.1 Description

The CCTV Subsystem provides viewing of the mechanical equipment located in the Transfer Confinement Subsystem and in the Lower Access Area during operations. It is used as a validation means for most of the transition conditions. It is also used for various other functions such as equipment inspection and fuel assembly identification.

The CCTV subsystem uses commercially available equipment to monitor the operation of the Dry Fuel Transfer System. Radiation resistant TV cameras are mounted in the transfer building. The locations of these cameras are shown in Drawing 3039-13. CCTV1, CCTV2, CCTV3 and CCTV4 are wall mounted and provide views of the Transfer Containment Area. CCTV5 is wall mounted and provides a view of the Lower Access Area. CCTV6 and CCTV7 are mounted on the Fuel Assembly Handling Subsystem Transfer Tube and provide views of the fuel handling grapple. CCTV8 provides a view of the Preparation Area. Drawing 3039-9 presents a close up view of the mounting of CCTV6 and CCTV7. The figure below presents a block diagram of the CCTV equipment and component interconnections.



The wall-mounted cameras are mounted on pan and tilt assemblies. All cameras have remote zoom and focus capability. The cameras operate from a low voltage power supply. The power supplies and camera controls, including focus, zoom, pan and tilt, are located in the control trailer.

The cameras operate completely independently of the other DTS subsystems. There are no hardware or software interfaces between the CCTV and other DTS subsystems.

Except for using radiation resistant cameras, the CCTV subsystem uses standard, industrial surveillance equipment with standard components. The cameras and the camera controls are stand-alone units, and do not share any equipment with or interface with other DTS subsystems. The camera view is selected by the operator to monitor the fuel transfer operations, manually. No software is used for controlling the cameras.

The CCTV system is supplied by site power, which is fed to the control trailer. This power Is supplied to all trailer located equipment. This is only one electrical interface between the CCTV system and other DTS subsystems. The CCTV system uses independent cables to connect the trailer mounted controls to each camera. No logical functions are performed by the CCTV system.

Maintenance requirements of the CCTV system are limited to cleaning the housings and camera windows and periodic inspections of the system cables and connectors. Radiation exposure records will be maintained for the cameras mounted in the TCA and the Lower Access Area, to facilitate camera replacement before camera dose limits are reached.

Cameras in the Transfer Confinement Area are used to verify all fuel transfer operations and therefore, are important to the safe operation of the Dry Transfer System. Redundant cameras have been installed in the Transfer Containment Area and on the Fuel Transfer Tube to permit completion of a fuel movement operation with the failure of a single camera. Separation is maintained for all camera system wiring in the DTS Transfer Containment Area. Wiring to the two Transfer Tube mounted cameras is run on opposing sides of the transfer tube and then via separate cable penetration areas to the outside of the Transfer Confinement Area. In the event of a camera failure in the Transfer Confinement Area, the movement of any fuel element will be completed using the cameras that remain functional, the cask lids will be placed on the casks and the camera repaired. In the event of a failure of CCTV equipment external to the Transfer Confinement Area, fuel movement will be interrupted and the equipment will be repaired immediately. It will be the responsibility of the site to maintain parts and equipment to permit immediate repairs.

Redundant cameras are not provided in the Lower Access Area and the Preparation Area, since views of these areas are not needed to perform fuel transfer operations.

It is intended that the CCTV equipment will use standard commercial grade power supplies. The power supplies are located in the control trailer and operate at normal ambient temperatures. There is no special support equipment.

The site specific design documents will consist of wiring diagrams and equipment location specifications as required by the specific CCTV equipment that is to be installed.

The site organization will also prepare maintenance and repair procedures to implement maintenance functions required by the selected CCTV equipment.

The CCTV and Lighting System are designated "important to safety" (see Subsection 5A.2.4). The cameras, cables, and lights, within the TCA will be designed, fabricated, and tested, to ensure that they will survive the normal and accident conditions. There are two cameras with the associated lighting positioned on the fuel handling equipment. There are six cameras with their lights mounted on the walls of the DTS. All of the cameras and the lights will be seismically mounted. The cables for each camera with its light will be independent, to prevent a single event from rendering all cameras inoperable.

Specifications for the CCTV System are provided in Subsection 5A.4.6.5. The cameras and the lighting will be replaced during scheduled maintenance based on the expected radiation doses.

Hence the CCTV and Lighting System will survive the design basis accident events. As stated above, a fuel assembly will not be manipulated when there is a loss of power.

Each following subsection details the CCTV interface with the concerned mechanical equipment, operations and transition conditions.

5A.4.6.2 Interfaces with the Transfer Confinement Cask Mating Subsystem

The CCTV Subsystem provides a side viewing of the two bellows and the mating platform during the mating and disengagement operations from the top of a cask to the mezzanine. The transition condition which is partially validated by the CCTV Subsystem is the disengagement of the mating flanges. The mating position can't be validated using the CCTV Subsystem because of the accuracy required for this operation. The transition validation means are described in Section 5A.4.2.2.

5A.4.6.3 Interfaces with the Transfer Confinement Port/Shield Subsystem

The CCTV Subsystem provides viewing of the two TC port covers during the closing, opening and off centering operations.

The different positions of the TC port covers are indicated by lines on the mezzanine. The position transitions are partially validated by the alignment of these lines with the TC port covers.

The locking operations can't be validated using the CCTV Subsystem as there is no visibility of the involved equipment. The transition validation means are described in Section 5A.4.2.3.

5A.4.6.4 Interfaces with the Source Cask Lid and Receiving Cask Shield Plug Handling Subsystem

The CCTV Subsystem provides viewing in the TCA only for this subsystem.
The operations involving the upper shield ports and the upper crane can't be monitored with the CCTV Subsystem.

The motion of the grapple, its position above the mezzanine level and its connection with the source cask lid or receiving cask shield plug can be monitored but not validated with the CCTV Subsystem.

5A.4.6.5 Interfaces with the Fuel Assembly Handling Subsystem

Cameras on the walls provide viewing of the following equipment:

- the crane carriage during positioning
- the rotating platform during positioning
- the crud catcher during opening and closing operations

The crud catcher position can be partially validated with this equipment.

Cameras on the bottom of the transfer tube provide viewing of the top of the baskets of the source and receiving casks. They permit the operator to:

- position the transfer tube above a fuel assembly centerline or an empty cell
- identify the fuel assemblies
- monitor the entrance of the fuel assembly in the basket
- monitor the position of the grapple around the basket level
- monitor the connection status between the grapple and the fuel assembly

The proper position of the transfer tube is validated using this equipment. The proper position of the grapple and its connection status can't be validated using the CCTV Subsystem.

5A.4.7 Transition conditions validation synthesis

5A.4.7.1 Viewing and instrumentation requirements for transition conditions validation

Based on Sections 5A.4.2 and 5A.4.6 information, this section provides a synthesis of the different instrumentation requirements necessary to validate the transition conditions.

Table 5A-17 lists these requirements for each transition condition validation.

Table 5A-17
Viewing and means requirement for transition conditions validation

Legend

- N: Nothing
- D: Direct viewing
- C: CCTV
- S: Single means
- R: Redundant or two different means

Data	Transition Condition	Viewing N/D/C	Means N/S/R
Position of the sliding door	SDO-x	D	N
	SDC-x		
Lock position of the sliding door	SDL-x	D	S
	SDU-x		
Position of the casks transfer trolleys	TCE-x	D	S
	TCR-x		
	TCP-x		
Lock position of the transfer trolley	TCL-x	N	S
	TCU-x		
Position of the Mating flange	MF-up	C	S
	MF-mp	N	R

Table 5A-17 (Continued)
Viewing and means requirement for transition conditions validation

Data	Transition Condition	Viewing N/D/C	Means N/S/R
Position of the TC port cover	TCSPO-x	C	S
	TCSPC-x		
	TCSPOC-x		
Lock position of the TC port cover	TCSPL-x	N	R
	TCSPU-x		
Position of the upper crane	UCP-x	N	S
Position of the upper shield port	USPO-x	N	S
	USPC-x		
Lock position of the upper shield port	USPL-x	N	R
	USPU-x		
z position of the lid / shield plug grapple	LSPG-up	N	S
	LSPG-p1		
	LSPG-p2		
	LSPG-p3		
Lid/shield plug grapple connection status	LSPG-c	N	R
	LSPG-d		
Lid / shield plug handling cable load	LSPHC-lz	N	S
Position of the crane carriage	CCP-x	C	S
Position of the rotating platform	RPP-x	C	S
Position of the crud catcher	CRCO-x	C	S
	CRCC-x		

Table 5A-17 (Continued)
Viewing and means requirement for transition conditions validation

Data	Transition Condition	Viewing N/D/C	Means N/S/R
z position of the fuel assembly grapple	FAG-up	N	S
	FAG-p	N	
Fuel assembly grapple connection status	FAGD-x	N	R
	FAGC-x		
Fuel assembly handling cable load	FAHC-lz	N	S

5A.4.7.2 Interlock synthesis

Based on Section 5A.4.2, 5A.4.3 and 5A.4.4, Table 5A-18 provides a synthesis of all the interlocks used to safely control the process. The table lists, for each interlock, the instrumentation which is the source of the information, the affected equipment and a brief description of the interlock. The interlock acronyms are those which are used in the flow charts.

Table 5A-18
Interlock Synthesis

Interlock Acronym	Source equipment	Signal transmitters	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
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

Table 5A-18 (Continued)
Interlock Synthesis

Interlock Acronym	Source equipment	Signal transmitters	Interlocked equipment	Prevention description
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
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)

Table 5A-18 (Continued)
Interlock Synthesis

Interlock Acronym	Source equipment	Signal transmitters	Interlocked equipment	Prevention description
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
I-RP	Rotating platform	No transmitter	Fuel assembly handling hoist system	Lowering of the fuel assembly grapple if the rotating platform is not stopped
			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-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

Table 5A-18 (Continued)
Interlock Synthesis

Interlock Acronym	Source equipment	Signal transmitters	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-C	Source 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-O	Source Cask TC port cover	ZS 315A	Source Cask TC port cover locking device	Locking oif the Source 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
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 opened position
I-TTLD-RC	Transfer trolley for the Receiving Cask locking device	YL 405C	Receiving Cask mating flange electric jacks	Lowering of the Receiving Cask mating flange if the Receiving Cask transfer trolley locking device is not in locked position
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
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 closed position
			Source Cask upper shield port	Opening of the Source Cask upper shield port if the Receiving Cask upper shield port 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 device	Locking of the Source Cask upper shield port if it is not in 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

Table 5A-18 (Continued)
Interlock Synthesis

Interlock Acronym	Source equipment	Signal transmitters	Interlocked equipment	Prevention description
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)
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)

5A.4.8 Design Requirements and Specifications

The final control system design specifications will be generated to meet the requirements of the specific site. Design specification documents will include the following:

Dry Transfer System Controls Procurement Specification – This specification will be generated by the site organization. It will define the specific requirements for the design, fabrication and testing of the Dry Transfer System control system. The specification will include environmental requirements (temperature, humidity and radiation levels), power available at the site and functional requirements for the control system as defined by the TSAR, including hardware control logic and interlocks. It will also impose by reference the applicable industry codes and standards. Specific codes and standards to be included, as a minimum, in the procurement specification requirements are identified below.

Software Requirements Specification - This specification will be generated by the site organization. It will define the functional requirements of the PLC and PC software, i.e. software logic functions as described by the TSAR and other site specific requirements, operator interface to the software, performance requirements and implementation language.

Software Verification and Validation Plan – This document will be generated by the site organization. The plan will define requirements to demonstrate that the software meets the requirements of the Software Requirements Specification.

Control System Functional Test Requirements – The site organization will generate this document. The test plan will define functional test requirements. Testing will demonstrate proper operation of software and hardware as a system and will include a testing matrix with sensors faulted to demonstrate proper software operation.

Control System Documentation – The fabricator will supply complete documentation of the control system. Documentation is to include:

Engineering Drawings including:

Block Diagram
Schematics
Control System Arrangement Drawings
Wiring Diagrams
Panel Layout Drawings
Bill of Materials

Functional Test Results

QA Records

Operating Instructions and Procedures

The applicable codes and standards, and a summary of requirements from the system requirements specification document are as follows:

Dry Transfer System Controls Procurement Specification

This specification will define site specific environmental requirements, temperatures and humidity, radiation levels and available electric power. In addition to meeting the functional requirements as specified by the TSAR the specification will incorporate by reference requirements of the following codes and standards:

NFPA No. 70, - "National Electric Code", - provides guidance to the safe installation of electrical wiring and equipment.

IEEE Std 383-1974, "IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations" – defines requirements for cables, including fire resistance qualification. All cables inside the DTS are to meet the fire resistance requirements of this standard.

IEEE Std 1050-1996, "IEEE Guide for Instrumentation Control Equipment Grounding in Generating Stations" – Provides recommended practices for grounding and noise-minimization techniques for instrumentation and control systems to minimize emissions and susceptibility to EMI/RFI and power surges.

NFPA Std 78, "Lightning Protection Code" – defines lightning protection requirements that should be addressed for electromagnetic compatibility.

IEEE C62.41-1991, "Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits" – Provides guidance for the selection of voltage and current surge test criteria for evaluating surge withstand capability of equipment connected to low-voltage AC power circuits. This specification will aid in the selection of computer equipment.

MIL-STD-461D, "Requirements for the Control of Electromagnetic Interference Emissions and Susceptibility" – Provides test criteria in regard to EMI/RFI effects on instrumentation and controls used in nuclear power plants.

Software Requirements Specification

This specification will be the basis for software development. It will be written in accordance with the requirements of the following industry standard:

IEEE Std 830-1993, "IEEE Recommended Practice for Software Requirements Specifications – provides an approach for preparation of software requirements specifications.

Control System Functional Test Requirements

Testing will be performed to demonstrate the functionality of the complete system. Testing will include verification of each operator input and sensor.

Control System Documentation

Specific performance requirements for the CCTV system are specified below, which will be included in the DTS TSAR Rev. 1. Also, administrative procedures will be in place preventing any welding activity within DTS, during the fuel transfer. This is necessary to prevent any electromagnetic interference/radio-frequency interference.

Operating Conditions

All the components of the CCTV Subsystem and of the Lighting Subsystems located inside the DTS shall be able to withstand the following normal operating conditions, according to their location:

Temperature:

- Maximum operating temperature: 130^0 F
- Minimum operating temperature: 40^0 F
- Typical range of normal temperatures: 70^0 F- 80^0 F

All the components shall withstand these temperatures without any cooling system unless otherwise noted.

Radiation:

The minimum total absorbed dose that the equipment shall be able to receive without requiring any maintenance shall permit the equipment to withstand the operating periods. The specific dose rates and total absorbed dose that the equipment shall withstand will be specified for each particular equipment set.

Pressure:

- Transfer Confinement Subsystem: 1 in H_2O less than ambient
- Lower Access Area: 0.5 in H_2O less than ambient
- Preparation Area: 0.25 in H_2O less than ambient

Humidity:

A non-condensing atmosphere is maintained in the DTS. Humidity will be maintained between 0% and 50%.

Technical Requirements

Basic Requirements

All the cameras shall have a horizontal resolution greater than or equal to 500 TV lines, a motorized focus and an automatic iris.

The lenses exposed to radiation shall be non-browning lenses if standard quartz lenses can not permit to withstand the operating periods. The radiation sensitive parts of the equipment shall be easily dismountable and decontaminated.

Each set of equipment, including camera, viewing head, specific lighting, lens, connector and pan and tilt positioning system (if applicable) shall fit and operate within a 20 inch cube, unless otherwise noted.

The lighting devices for CCTV shall provide sufficient illumination permitting the CCTV Subsystem to monitor the operations. Each camera shall be associated with a proper lighting device. These devices will only be used during operations.

The lighting devices for general purpose will be located in the Preparation Area, the Lower Access Area and the Transfer Confinement Area and shall provide an average illumination greater than or equal to 100 lux in their area in order to perform simple visual tasks on contact.

Preparation Area

Radiation requirements

The equipment shall withstand the radiation through the sliding door during fuel assembly lifting and lowering operations and through the DTS walls during fuel assembly transfer.

CCTV and associated lighting equipment

There is no need for any CCTV equipment in this area, all the operations being performed on contact.

Lighting equipment for general purpose

The lighting devices located in the Preparation Area will be used during the preparation, entrance and removal operations of the Source and Receiving Casks. It shall be tolerant to the following levels:

- Maximum dose rate: 200 mrads/hr
- Total absorbed dose: 100 rads

Lower Access Area

Radiation requirements

The equipment located in the Lower Access Area shall withstand the radiation emitted during the fuel assembly lifting and lowering operations and the radiation through the mezzanine plate during fuel assembly transfers.

CCTV and associated lighting equipment

The operations to be monitored or to be validated using the CCTV Subsystem in the Lower Access Area are related to the Cask Mating Subsystem. A single camera shall be procured. It shall be mounted with its associated lighting equipment on a pan and tilt positioning system for horizontal and vertical rotation. The camera and the lighting equipment are CCTV5 and LTG5.

The equipment shall be tolerant to the following radiation levels:

- Maximum dose rate: 1.5×10^4 rads/hr
- Total absorbed dose : 10^7 rads

The equipment shall be able to meet the following viewing requirements:

Rotation:	horizontal	$> 120^0$
	vertical	$> 100^0$
Viewing angles:	horizontal	$> 45^0$
	vertical	$> 35^0$
Minimum distance from target:		60 in
Maximum distance form target:		13 ft

Lighting equipment for general purpose

The equipment will be used during the entrance and removal operations of the Source and Receiving Casks. It shall be tolerant to the following radiation levels:

- Maximum dose rate: 10^3 rads/hr
- Total absorbed dose: 10^6 rads

Transfer Confinement Area

Radiation requirements

The equipment located in the Transfer Confinement Area shall withstand the radiation emitted by the casks (opened), those emitted during the fuel assembly lifting, lowering and transfer operations.

CCTV and associated lighting equipment

Fuel Assembly Viewing and fine positioning of the Fuel Assembly Handling Subsystem

Two cameras and two lighting devices shall be fitted in shielding boxes at the end of the transfer tube. They shall be operated to monitor the positioning of the transfer tube above a fuel assembly or an empty cell centerline and the lifting or lowering of the fuel assembly. This equipment will only be used for these operations (including fuel assembly identification) and will be shielded while other operations are being performed.

The equipment shall be tolerant to the following radiation levels :
- Total absorbed dose: $> 10^8$ rads
- Maximum dose rate : $> 1.5 \times 10^5$ rads/hr.

The cameras and the associated lighting devices shall be fitted in a fixed orientation, without any rotating device. The positioning of the transfer tube requires the viewing of a complete target cell. In addition, the identification of the fuel assemblies requires a clear legibility of half inch letters located on the top of each fuel assembly on a stainless steel surface. The cameras and the associated lighting devices are CCTV6, CCTV7, LTG6 and LTG7.

The cameras shall be able to meet the following viewing requirements:

Minimum horizontal viewing angle for positioning:	35^0
Minimum vertical viewing angle for positioning:	15^0
Minimum distance from target:	89 in
Maximum distance from target:	93 in

The picture displayed for the fuel assembly identification shall be equivalent to the target.

The specific lighting equipment shall permit the CCTV system to have a depth field greater than or equal to 8". Fans or static heat exchanger can be used to cool the lighting equipment if necessary. Direction of air flow, if applicable, requires approval by purchaser.

Each camera and lighting device shall fit and operate within the specified dimensions: 8 in x 8 in x 17 in.

Other operations

Four cameras shall be mounted on the walls of the Transfer Confinement Subsystem to monitor and validate operations of the TC Port/Shield Handling Subsystem, MPC Shield Plug and Source Cask Lid Handling Subsystem and Fuel Assembly Handling Subsystem.

This equipment shall be tolerant to the following radiation levels:

- Dose rate: $> 1.5 \times 10^4$ rads/hr
- Total absorbed dose: $> 10^7$ rads

The four cameras and their associated lighting devices are referenced as CCTV1, CCTV2, CCTV3, CCTV4, LTG1, LTG2, LTG3 and LTG4 in the Applicable Document 2.4. The cameras shall have zoom functions and be mounted with their associated lighting devices on remotely controlled pan and tilt positioning systems.

The equipment shall be able to meet the following viewing requirements:

Rotation:	horizontal	$> 180^0$
	vertical	$> 160^0$
Viewing angles:	horizontal	$7^0 < \theta < 39^0$
	vertical	$6^0 < f(\theta) < 30^0$
Minimum distance from target:		30 in
Maximum distance from target:		15 ft.

Lighting equipment for general purpose

The equipment in this area shall be tolerant to the following radiation levels:

- Dose rate: 1.5×10^4 rads/hr
- Total absorbed dose: 10^7 rads

Remote Control

The cameras shall be linked to remote camera control units (CCU) by means of connectors and single cables which provide all the necessary power, control and signal functions. The lighting for CCTV shall be linked to a remote Intensity Control Unit (ICU). Connectors and cables which are located in the DTS shall be compatible with the same operating conditions as the mated equipment. The distance between the cameras or the specific lighting devices and the CCU shall be less than 300 feet. As much as possible, the CCU shall house the electronic equipment. The CCU shall be fully compatible with American Video Standards and shall provide full remote control (focus, zoom). Two black and white displays and a quad switcher shall permit visualization of all the views by switching input. The pan and tilt positioning systems shall be remotely controlled.

5A.5 CONTROL AND MONITORING OF THE EQUIPMENT UNDER OFF NORMAL OPERATING CONDITIONS

5A.5.1 Alarms, Warnings and Emergencies

5A.5.1.1 Principles

Alarm panels including buzzers and lights are located in the Control Center and in each area of the building (and outside for radiation alarms). Each alarm is audible, at least, in the Control Center. The only automatic action that can have an alarm is to stop the failing equipment. Emergency pushbuttons are available in all the DTS areas and in the Control Center. They deenergize the equipment and activate the alarms. The main alarm sources which are the HVAC Subsystem, the mechanical equipment and the Radiation Monitoring Subsystem are easily distinguishable. Depending on their classification, different procedures are necessary to resume the process.

5A.5.1.2 Classification

A. Radiation alarms and warnings

Warnings:

The warnings of the radiation monitoring system inform the operating staff that high radioactivity levels are detected. This information is used by the PLC controlling the mechanical equipment to interlock the sliding door and the upper shield ports. Each radiation monitor has two levels of warnings activated according to the radiation level detected. These warnings are displayed locally and remotely.

Alarms:

Alarms are generated when the self checking of a radiation monitor has detected a failure or when the batteries are low. These alarms are displayed by the monitoring system which indicates the involved monitor and the alarm cause. The alarm is released after operator identification to ensure that someone has been notified of the failure.

B. Mechanical equipment alarms

The alarms generated by the mechanical equipment can be broken down into two categories:

Defaults:

The defaults correspond to mechanical or electrical functioning defaults which can show the loss of redundancy (overtravel) or of incorrect functioning. The concerned operation is always stopped under these circumstances. No operation can be initiated before alarm deactivation which requires password entry and so involves responsibility levels.

The defaults are generated by the overtravel, overload, collision detectors, etc.

The PLC detects all the inconsistencies between information as for example: TC port cover in opened and closed position. These inconsistencies show the failure of instrumentation and are considered as defaults. The release of the alarm may not always be sufficient to resume the operations, if conditions not valid anymore are used for interlocks. In this case, the use of bypasses is necessary.

Incidents:

It corresponds to a non-compliance with the procedure or to an external factor. These alarms are detected by operation time-out managed by the PLC on all the mechanical equipment. Alarm release requires operator identification. The resumption of the operations shall not require any particular administrative procedure, since safety is not compromised. The monitoring system shall display a way to recover normal conditions.

For locally controlled operations, the operators are alarmed in the Preparation Area and in the Lower Access Area.

Alarms are always displayed by the monitoring system and the two failure levels are easily distinguishable.

C. HVAC alarms and warnings

Three alarm levels are considered for the HVAC Subsystem:

High level alarms:

It corresponds to the loss of the double confinement provided by this system or abnormal high temperature in any area. It is detected by the absence of pressure differential at the level of the two outside blowers. The alarms are audible and visible in the building and in the Control Center. The monitoring system provides sufficient means to understand the localisation of the failing equipment (temperature monitoring in each room displayed, blower activity and pressure differential displayed). The deactivation of alarms requires bypasses. The operations are not affected by this alarm, allowing a fast recovery to a safe condition.

Low level alarms:

The loss of redundancy on the blowers detected by the absence of pressure differential, the loss of any Fan Coil Unit (FCU) detected by the absence of pressure differential with a local temperature above the FCU initiation level, the malfunctioning of a damper (detected by the equipment) generate this alarm which is only audible and visible in the Control Center. If during the transfer operations, the HVAC is not able to maintain the pressure differential between the three areas, this alarm is generated. The activation of the detection automatically starts when the two casks are mated and automatically deactivated when the first operation after transfer is initiated (lifting of a mating flange). The deactivation of the alarms requires operator identification.

Warnings:

The need for HEPA filter maintenance detected by an abnormal low or high pressure differential accross the filter warns the operator.

5A.5.2 Control and monitoring

The TC port covers and upper shield ports are actuated by electric jacks. The motorization is outside the DTS and can be replaced easily.

The fuel assembly handling winches are redundant. The fuel assembly grapple has three electric jacks, one for normal operating conditions and the two others, on the secondary power supply channel, for backup during off normal operating conditions.

The lid/shield plug handling hoist motorization is located in an uncontaminated and shielded area and so can be replaced easily. The lid/shield plug grapple can be disengaged manually from the overlid.

Also, it is possible to confirm positively that the grapple has properly engaged the plug or source the cask lid lifting pintle even without visual means. Because, the overlid has a set of fingers that are used to engage the pintle on the cask. The Shield Plug Handling System Grapple Assembly has a mechanism to operate the overlid fingers and has its own grapple that is used to attach to the overlid. Referring to Drawings 3039-3 and 3039-7 of the TSAR, the overlid is supported by the cask mating system when a cask is not in place, with its pintle fingers open. After a cask is located under the cask mating system, the overlid is lowered as the cask mating system is lowered and takes its final position with its open pintle fingers placed around the cask pintle. This process is monitored using the four wall mounted cameras in the Transfer Containment Area, CCTV1 through CCTV4. See Drawing 3039-14. If the overlid does not lower properly, this is observable using the TV cameras.

After the overlid is in place, the Shield Plug Handling System Grapple is used to lift both the overlid and cask lid as a unit. To accomplish this, the Shield Plug Handling System Grapple is first lowered onto the overlid. Prior to lowering limit switch YL 311A is checked to verify that the overlid grapple fingers are open. Lowering is stopped when the hoist becomes unloaded as indicated by the hoist load instrumentation, WT 309. Proper placement of the grapple on the overlid is indicated by activation of the Overlid Present limit switch, YLS 310. The Overlid Presence Sensor is shown in TSAR Figure 5.2-16. The elevation of the hoist, as indicated by ZIT 307, is then compared to the expected hoist elevation. See page 79 of TSAR, Section 5A. Any deviation in elevation indicates that the overlid is not in the correct position and is cause to stop the operation and investigate the problem. The position of the overlid pintle fingers can also be verified as open at this time by limit switch ZL 315A which is activated by a rod in the center of the grapple assembly. This rod is also shown in TSAR Figure 5.2-16.

If the above conditions are satisfactory, the overlid pintle fingers are closed and the overlid is grappled. Limit switch ZL 315B indicates closing of the pintle fingers on the pintle. Limit switch YL 311B indicates that the overlid grapple fingers are closed.

The hoist is then used to lift the combination of the overlid and cask lid. As a final check, the hoist load is monitored and compared to the expected weight of the combined overlid and cask cover while the cask cover is lifted.

It should be noted that the overlid pintle fingers are normally activated only prior to the transfer of fuel from the source cask to the receiving cask, or after all the fuel has been transferred. By removing the source cask cover last, prior to a transfer operation, and replacing the receiving cask cover first, at the end of a transfer operation, the overlid pintle fingers are never actuated while fuel is exposed. It is, therefore, possible to enter the Transfer Confinement Area in the event of a problem activating the pintle fingers. Also, in the event of a problem operating the Shield Plug Handling System Grapple Assembly, the grapple can be raised over the upper shield and repaired with the Upper Shield Port Covers closed.

In the case of loss of the CCTV Subsystem (seismic event), penetrations in the DTS structure for manual backup can be used to introduce fiberscopes, borescopes... The lid/shield plug handling subsystem can be used to introduce viewing equipment in the TCA.

5A.6 FAILURE MODE AND EFFECT ANALYSIS

5A.6.1 Introduction

The DTS is designed such that a single failure of a component will not result in unacceptable high radiation levels outside the DTS, in any damage to a fuel assembly, in any damage to the lid or the shield plug and in compromising the recovery requirements.

This section presents the potential failures of the Control Subsystem, describing the failures types, effects, detection means and provisions used to compensate the failures. Only single failures are considered in this analysis.

The section is divided in three parts:

- evaluation of the general failures (PLC, network communication...)
- description and evaluation of instrumentation failure impact on operations
- description and evaluation of instrumentation failure impact on interlocks

5A.6.2 Failure analysis

5A.6.2.1 General Failures analysis

The general failures of the Control Subsystem are those which are not specific to an operating component, either because the responses to the failures are the same for all the equipment or because they can have influence on the general control and monitoring of the process.

A watch dog detects the failure of the PLC's CPU, based on internal clock checking, and automatically stops all the equipment in the activity by resetting all its outputs.

A coupler's failure, a network disconnection of the PLC, a network failure between the PLC and the monitoring PC or between the main control panel and the PLC are detected and the equipment is automatically stopped. A failure of the link between the PLC and the electronic cabinets results in a deenergization of the controlled equipment which activates the emergency brakes. A loss of control (wire disconnection/breaking) between the electronic cabinets and the equipment has the same effect.

A loss of power directly stops the operating equipment. The PLCs and the PC are supplied by an independent backup and then keep their historic information (process, positions...), and update the equipment status (stopped).

5A.6.2.2 Sensor failure analysis

The failure of sensors result in absence of detection or erroneous information. The PLC will then have an information which is not updated and which validity is either undetermined or erroneous. The information inconsistencies are not considered in the sensors failures analysis as they are detected by the PLC which generates an alarm, stops the equipment and requires operator identification to resume the operations.

Table 5A-19 lists all the sensor failures which can have an effect on safety. For each type of failure, the possible effect on the current operation involving the use of the failing sensor is described, the means provided to detect the failure and the compensating provisions.

5A.6.2.3 Interlock failure analysis

The interlock failure analysis describes for each interlock, the instrumentation failures which can affect its function, its possible effect, the means provided to detect it and the compensating provisions. The erroneous information which generates a control request refusal can be bypassed to resume the operations.

Table 5A-20 lists all the interlocks and their failure analyses.

5A.6.2.4 PLC Memory failure analysis

In general, a PLC consists of a central processing unit that executes a program stored in memory and uses additional memory to store intermediate calculation results, to store temporary data, such as user input set points, and to control I/O interfaces. The memory used to store the program does not normally change once the program has been installed and tested. The content of other memory is changed many times as the program executes. Two types of memory are used in PLCs, volatile and non-volatile. Volatile memory requires constant power to maintain its contents. Non-volatile maintains its contents even if power is removed. As a final selection of equipment for the control system, including the PLC, has not been made, the specific causes of possible memory loss and its effects will need to be addressed more completely in the final site-specific design. However, it is recognized that there is a slight chance that the PLC memory can become corrupted. Possible causes of memory corruption or loss are:

1. Loss of power
2. Environmental damage
3. Electrical noise
4. Static electricity
5. Memory Integrated Circuit failure
6. Failure of memory support chips

The following precautions will be taken in developing the final control system design and in the selection of a specific PLC, which makes the possibility of undetected memory corruption or loss non-existent.

1. The PLC will be chosen to operate at the temperature and humidity extremes expected where installed in the Dry Transfer System building.
2. The PLC program will be stored in an UV erasable EPROM. This type of memory is non-volatile and can only be changed by removing the memory module from the PLC and exposing the EPROM to ultra violet light.
3. The PLC chosen will perform a memory Cyclic Redundancy Check (CRC) self check of the program. This check will be performed both at start up and at periodic intervals during operation. A CRC failure will indicate memory corruption and will result in an immediate shutdown of the PLC and opening of all outputs.
4. The control system configuration will include a watch dog timer that will shut down the PLC in the event the control program stops execution. The watch dog timer will be either integral with the PLC or a separate unit. In either case it will not share the memory and main processor used by the PLC.
5. If a PLC is chosen that down loads information to memory in I/O modules, the PLC must perform periodic checks to insure valid information is stored in the I/O modules.
6. If a PLC is chosen that uses a battery to store operating information while power is removed, a means will be provided to alert the operator to low battery status via an alarm. This alarm shall be visible in the control trailer.
7. Instrumentation will be installed using proper grounding techniquePower to the PLC will be provided via a battery backed non-interruptible power supply to prevent unexpected power interruption. The power supply will be sized to allow adequate time to shutdown the PLC if main power can not be restored.
8. The PLC and operator interface will be programmed such that equipment set points displayed to the operator are continuously updated by reading and displaying the values stored in the PLC. This makes any changes visible to the operator.

Should a memory failure occur, the result will be a memory reload from the EPROM, with a shutdown of the PLC and an alarm to the operator. There are no time critical operations while moving fuel in the DTS and the PLC is not used to perform any safety mitigating actions.
Fuel movement can be interrupted in the event of memory failure and resumption delayed until after repairs are completed.

Table 5A-19
Sensor failure analysis

Data provided by sensor	Failure	Possible Failure effect	Failure Detection	Compensating Provisions Remarks
Transfer trolley position limit switches	No position detection	Transfer trolley not stopped in position. Collision between casks	Visual	Overtravel limit switches and collision detectors stop motion
Transfer trolley lock position	Erroneous lock position information	Erroneous validation of a safety condition		Operation performed on contact
Electric jack vertical position	Erroneous value	Loss of mating operation validation means	CCTV	Electrical jack vertical position and load information used to operate and validate the mating operation, controlled by the PLC.
Electric jack load sensor	Higher than actual load reading	Jacks stopped before reaching proper mating position. Mating ineffective.	CCTV Vertical position indicators	
	Lower than actual load reaading	Final mating phase never happens as a jack never reaches its mating pressure. Jacks overloaded.	Alarm	Time out on mating operation generates alarm.
TC port covers position limit switches	No position detection	TC port cover motion not stopped in proper position	CCTV Alarm	Overtravel electrical switches on each side of the runway rails stop motion.
	Erroneous detected closed or off centered position information	Lid/shield plug can be left in an unsafe position on the port cover and this position not being predictible, closing operations may be compromised.	CCTV	Marks on the mezzanine show the proper positions of the TC port covers. Centering guides on port covers prevent improper positioning of the lid/shield plug on the port cover.
	Erroneous detected open position information	Locking operation can be processed in an improper position.	Alarm	Time out on locking operation generates alarm.
TC port covers lock position	Erroneous locked position information	Erroneous validation of a safety condition (see interlocks)	Alarm	PLC checks consistency with pin unlocked position. Range of time to process the operation (minima and maxima) controlled by the PLC

Table 5A-19 (Continued)
Sensor failure analysis

Data provided by sensor	Failure	Possible Failure effect	Failure Detection	Compensating Provisions Remarks
Upper crane trolley position (X motion)	No position detection	Trolley motion not stopped	Alarm	Overtravel electrical switches on each side of the runway rails stop motion.
	Erroneous position detection	Erroneous validation can make the gripping of the lid/shield plug impossible or can cause damage of the grapple on the upper plate.	Alarm	Underload detection stops motion. Range of time to process the operation controlled by the PLC, generates alarm
Upper shield ports position (opened/closed)	No position detection	Upper shield port motion not stopped.	Alarm	Overtravel electrical switches on each side of the runway rails stop motion.
	Erroneous detected closed position	Erroneous validation makes that locking operation can be processed in an improper position.	Alarm	Range of time to process the operation controlled by the PLC, generates alarm.
	Erroneous detected open position	Erroneous validation can cause damage to lid/shield plug grapple on upper shield port.	Alarm	Underload detection stops motion. Range of time to process operation controlled by the PLC, generates alarm
Upper shield ports locking position	Erroneous locked position	Erroneous validation of a safety condition (see interlocks).	Alarm	PLC checks consistency with pin unlocked position. Range of time to process the operation controlled by the PLC.
Lid/shield plug hoist z position	Erroneous z position	Damage to the lid/shield plug or to the cask due to excessive lowering. Unsafe lifting due to excessive lifting Dropping due to collision with upper plate.	Alarm CCTV	Overtravel electrical switch stops motion and generates alarmn Overload stops motion and generates alarm.
Lid/shield plug grapple status	Erroneous closed fingers position	Unsafe lifting due to incorrect grappling.	Alarm	Range of time to process operation controlled by the PLC, generates alarm
	No position detection	Jack can be damaged and ungrappling compromised	Alarm	Jack is stopped by hard stops and then shutdown after short time
	Erroneous overlid closed fingers position	Unsafe lifting due to incorrect gripping.	Alarm	Operation stopped by load

Table 5A-19 (Continued)
Sensor failure analysis

Data provided by sensor	Failure	Possible Failure effect	Failure Detection	Compensating Provisions Remarks
Fuel assembly crane carriage x and y positions	Erroneous x,y position	Damage to the transfer tube, to the crud catcher and to the lid/shield plug due to excessive crane carriage movement. Can make the FA stuck in the transfer tube.	Alarm CCTV	Overtravel electrical switches stop motion in x and y directions and generate alarms.
Crud catcher position	Erroneous position detection	Crud catcher stopped in an undefined position	CCTV	
	No position detection	Operation never ends	Alarm	Time out on operation generates alarm
FA grapple z position	Erroneous z position	No detection of first high and low limits. Damage to the FA. Excessive lifting.	CCTV Alarm	Overtravels electrical switches stop motion and generate alarms. Underload stops motion
FA grapple status	No grapple fingers detection	Operation never ends. Damage to the jacks	Alarm	Time out on operation generates alarm Operation stopped by load
	Erroneous closed fingers detection	Grapple fingers closed in an undefined position Safe lifting of FA compromised.		Operation stopped by load.
	Erroneous FA presence detection	Grapple positioning not validated		Grapple doesn't engage FA

Table 5A-20
Interlock failure analysis

Interlock	Failure	Possible Failure effect	Failure Detection	Compensating Provisions Remarks
I-CRC	Erroneous crud catcher closed position information	FA crud spreading during motion. FA damaged or stuck due to motion or platform rotation if not fully retracted into transfer tube.	CCTV	Transfer tube positioning (x,y,θ) interlocked with the grapple upper z position.
	Erroneous crud catcher open position information	Lowering of the FA onto the crud catcher. Damage to the FA. Stuck FA in the transfer tube because of crud catcher stuck in closed position	CCTV Unexpected loss of load	Loss of load stops motion. Crud catcher position validated visually before lowering FA.
I-FAHG	Erroneous FA gripping information	Unsafe lifting of FA. High radiation levels at upper level due to possible unlocking and opening of the upper shield ports	Alarm	Open and closed grapple fingers position sensors Redundancy on proper gripping information Upper shield ports interlocked with load cell and radiation monitoring.
I-FAHHAP	Erroneous z position information of the FA hoist system	Damage to FA due to disconnection above the proper position	CCTV Alarm due to inconsistency between load and position	Redundancy on FA disconnection based on underload situation Mechanical design of grapple prevents its opening when loaded.
I-FAHHLC	Erroneous underload information	Damage to FA due to disconnection above the proper position High radiation levels at the upper level due to upper shield port opening FA stuck in the transfer tube because of damage to transfer tube due to collision with TC port cover.	CCTV Alarm due to inconsistency between position and load	FA disconnection interlocked with position encoder. Mechanical design of grapple prevents its opening when loaded. Upper shield port interlocked with gripping status and radiation monitoring device. TC port cover closing interlocked with gripping status
I-FAHHUP	Erroneous upper position information	Damage to FA due to crane motion or platform rotation with FA not fully retracted into the transfer tube. Damage to FA and crud catcher due to crud catcher closure on FA.	CCTV	Crane carriage and rotating platform motion interlocked with crud catcher position. Visual verification prior to closing crud catcher.
I-FAHPP	Erroneous x,y position information	Damage to the lid/shield plug Dropping of the lid/shield plug, gripping of thegrapple	CCTV	Visual verification prior to lift the lid/shield plug. Minimum speed imposed by PLC under the safety level

Table 5A-20 (Continued)
Interlock failure analysis

Interlock	Failure	Possible Failure effect	Failure Detection	Compensating Provisions Remarks
I-LSPHAP	Erroneous z position information of the lid/shield plug hoist system	Damage to the lid/shield plug due to disconnection of the lid/shield plug above the proper position	CCTV Alarm due to inconsistency between load and position	Lid/shield plug disconnection interlocked with load cell (underload situation)
		Lid/shield dropping or damage due to closure of TC port cover on the handling cables	CCTV	The grapple position is visible and has to be validated before closing a TC port cover.
I-LSPHGP	Erroneous gripping status	Unsafe lifting and dropping of the lid/shield plug	Alarm due to inconsistency between gripping information	Open and closed grapple fingers position sensors Redundancy on proper overlid gripping Open and closed overlid fingers position Overlid fingers gripping detection
I-LSPHLC	Erroneous underload information	Damage to lid/shield plug due to dropping of the lid/shield plug above the proper position	CCTV Inconsistency between load and position	Redundancy on lid/shield plug disconnection based on z position.
I-LSPHUP	Erroneous upper position information	Dropping of the lid/shield plug due to closure of an upper shield port on the handling cables.	CCTV	Upper shield ports closure interlocked with gripping status.
		Unsafe handling of the lid/shield plug due to upper crane motion.		Upper crane motion interlocked with upper shield ports closed position.
I-RM-UL	Erroneous dose rate	High dose rate at the upper level due to upper shield port unlocking and opening during FA transfer or with cask and TC port cover open.	CCTV Radiation monitoring alarms Inconsistency between radiation monitoring devices	Radiation monitoring equipment alarms on failure. Upper shield port unlocking and opening interlocked with TC port covers positions, FA grapple and load cell status.
I-RM-SD	Erroneous dose rate	High dose rate at the sliding door level.	Inconsistency with Preparation Area radiation monitoring	Radiation monitoring equipment alarms on failure. Sliding door opening requires severe administrative procedure
I-SDLD	Erroneous sliding door locked position	High dose rates in case of a seismic event due to sliding door opening	Direct viewing	Operating procedure. Operation performed on contact.

Table 5A-20 (Continued)
Interlock failure analysis

Interlock	Failure	Possible Failure effect	Failure Detection	Compensating Provisions Remarks
I-TCPC-RC-C I-TCPC-RC-OC I-TCPC-SC-C	Erroneous TC port cover closed position	High dose rates at the upper level due to upper source cask opening with TC port cover not closed or off-centered	CCTV	Upper shield port opening interlocked with radiation monitoring
I-TCPCLD-RC I-TCPCLD-SC	Erroneous TC port cover lock position	Unsafe FA transfer with TC port cover unlocked which could damage the FA in case of a seismic event Collision between source cask lid or receiving cask shield plug and FA crane carriage.	Alarm	Unlocked position information provided by jack. Locking operation validated with time information.
I-TTLD-RC I-TTLD-SC	Erroneous cask transfer trolley lock position	Transfer trolley can be projectile in case of a seismic event. Damage to FA in case of transfer.	Visual	Operating procedure. Operation performed on contact.
I-UC-SC I-UC-RC	Erroneous upper crane position	Cask opening or closing impossible Damage to the lid/shield plug grapple onto the upper plate.	Alarm Unexpected loss of load or unconsistency between load and position.	Time information is used to validate the upper crane positioning information.
I-USP-RC-C I-USP-SC-C	Erroneous upper shield port position	Dropping of the lid/shied plug or unsafe lifting due to upper crane motion. High dose rates at the upper level during opening/closing of the opposite cask.		Upper crane motion interlocked with upper z grapple position. Upper shield port opening interlocked with radiation monitoring
I-USPLD-RC I-USPLD-SC	Erroneous upper shield port lock position	High dose rates at the upper level during FA transfer in case of a seismic event.		Unlocked position information provided by jack. Locking operation validated with time information.

5A.7 REFERENCES

5A.7-1 E-13679, Design Criteria for the Control Subsystem of the Dry Transfer System, Rev. 0.

5A.7-2 Operating Instructions, Cask Transfer Subsystem Specifications (Final Design), NF00321 22 0004, Rev. A.

5A.7-3 Operating Instructions, TC Cask Mating Subsystem Specifications (Final Design), NF 00321 22 0002, Rev. A.

5A.7-4 Operating Instructions, Transfer Confinement Port/Shield & Lid/Shield Plug Handling Subsystem (Final Design), NF 00321 22 0003, Rev. A.

5A.7-5 Operating Instructions, Fuel Assembly Handling Subsystem Specifications (Final Design), NF 00321 22 0001, Rev. A.

5A.7-6 Procurement Specification for the Closed Circuit Television and Lighting Subsystems of the DTS, E-13738, Rev. 0.

5A.7-7 Transnuclear Design Drawing No. 3039-13, Dry Transfer System HVAC Subsystem Control Schematics

5A.7-8 Transnuclear Design Drawing TN 1051-42, Dry Transfer System Main Control Panel

5A.7-9 Transnuclear Design Drawing TN 1051-43, Dry Transfer System Preparation Area and Lower Access Area Control Panels

5A.7-10 Transnuclear Design Drawing No. 3039-14, Dry Transfer System CCTV & Lighting Subsystems

Notes: See Referenced Document 5A.7-1 for additional references.