AD/RHIC/RD–73
AMENDED

RHIC PROJECT

Brookhaven National Laboratory

FMEA RHIC Cryogenics

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F.M.E.A.
R.H.I.C. CRYOGENICS

1.0 INTRODUCTION

1.1 GENERAL

The object of a Failure Mode and Effect Analysis is to identify all the postulated modes of failure, within a system or sub-system design, so that the resultant effects can be eliminated at the earliest possible time. The system must remain safe for all reasonable postulated equipment failures or operator errors. The analysis shall be used to assess existing high risk items and the systems or sub-systems, in the design stage. The analysis will then provide us with the information needed to minimize hazardous effects due to component failure. The end result of an F.M.E.A. is increased reliability and safety.

1.2 OUTLINE

To provide assurance that all of the subsystems of the RHIC cryogenic system were covered, the analysis was carried out in concert with the design effort when possible.

1.2.1 The cognizant engineer (CE) involved in the design of their respective subsystem or component have considered the potential failure modes and their effects on the subsystem or component.

1.2.2 The failure of a component of a subsystem, causing a complete failure of the subsystem, would be viewed upon as a component failure of the system. For example, a vacuum failure of one of the valve boxes would be viewed as a failure of the valve box for the system FMEA.

1.2.3 This F.M.E.A. will review the failure modes and effects of a component failure in subsystems, and in addition will study the effect of total failure modes, of the subsystems, and their effect on the Cryogenic system as a whole.

1.2.4 The FMEA is primarily component orientated. Each component of the system should be reviewed in each possible failed state, for each mode of operation, to evaluate its possible safety consequences to the system. When the FMEA is applied to a process, with different modes of operation, the steps or operating procedures have been carefully formulated or reviewed. In addition a safety analysis work sheet, with operating mode indicated, is used as a record of the specific failures. The work sheets will include information on system or subsystem modes in order to evaluate the components effect as a function of mode. The work sheets will contain specific information as follows:

1.2.4.1 The description of failure.
1.2.4.2 Mode or phase.
1.2.4.3 Cause(s) of failure.
1.2.4.4 The effect of this failure on the system.
1.2.4.5 Assignment of risk assessment values for severity and probability.
1.2.4.6 Recommended corrective action.
1.2.4.7 Effect of the recommended action

2.0 SCOPE

2.1 GENERAL

2.1.1 This FMEA is intended to cover the RHIC cryogenic distribution system and components.

2.2 SYSTEMS AND COMPONENTS FOR ANALYSIS

2.2.1 The broad categories that will be included in this study are as follows:

2.2.1.1 The cold helium distribution system associated with the ring magnets (valve boxes, transfer lines, etc.)

2.3 COMPONENTS REVIEWED

2.3.1 Types of components that are covered in this study include: valves, relief valves, sensors, filters, switches, gauges, interlocks, etc.

2.4 SYSTEMS OR SUBSYSTEMS NOT COVERED

2.4.1 Systems that are not a direct part of the Cryogenic System, i.e. magnet power supplies, quench protection devices, etc. will be subjected to an F.M.E.A., by others. The F.M.E.A. of these "other" systems is outside the scope of this F.M.E.A.

3.0 PROCEDURE

3.1 INTRODUCTION

3.1.1 To properly prepare an F.M.E.A. that includes the effects on the process and the potential hazards to personnel, we must systematically identify and analyze all of the possible faults.

3.2 GENERAL PROCEDURE FOR ANALYSIS

3.2.1 Identify the major systems and subsystems that in an event of failure will greatly affect the operation of the cryogenic system or could present a hazardous situation to personnel.

3.2.2 Meet with cognizant personnel, to discuss potential failure modes of equipment and systems. Compile this information (see appendix).

3.2.3 Review or establish operating procedures so that mode dependency can be established.

3.2.4 Study and list each component, in the analysis work sheets, and enter all required information. See appendix.

3.3 DETAILED PROCEDURE FOR ANALYSIS

3.3.1 As the analysis of systems differ, in that some are operational mode dependant, the detailed method is contained as a cover sheet with the analysis work sheets.

FMEA FOR THE VALVE BOXES

To apply an FMEA, to the valve boxes and magnet strings, a detailed study of the valve box P&ID's and the development of detailed operating procedures was completed. The operating procedures covered the various modes of operation, **A to G**, below. The development of the procedures was the first exercise verifying the capability of the valve box P&ID's. Some modifications, noted below, were made before the actual FMEA. The modes studied for the analysis of the valve box and magnet strings are as follows:

A) *Normal* full-ring operation.

B) ***Warm-up*** of the sextant at ***5:00*** including: isolation, reestablishment of heat shield flow to other sextants, liquid and gas recovery via CR line, reestablishment of helium coolant to other sextants (circulator off, refrigerator supply to magnet loop to recooler JT valves to return), circulation of warm helium from compressor discharge.

Note: Isolation of lead flow problem

C) ***Warm-up*** of the ***7:00*** sextant including: the same as 5:00

Note: proposed modification to the 8:00 and the 10:00 P&IDs, thus allowing operation the same as 5:00. Relocate the S to M bypass line between the isolation valves in the supply and magnet lines. This allows the reestablishment of the helium coolant (in any direction), via the refrigerator supply directed to the magnet loop, in the counter clockwise direction through the magnet loop. The helium coolant then enters the supply header and feeds the recooler JT valves, with final passage to return.

D) ***Warm-up*** of the ***9:00*** sextant including: isolation, reestablishment of heat shield flow to other sextants except 7:00, liquid and gas recovery via CR line, reestablishment of helium coolant to other sextants except 7:00 (circulator off, refrigerator supply to magnet loop to recooler JT valves to return); ***7:00 sextant, magnet and heat shield, will be vented periodically via H4806A and H4810A/H4811A.***

Note: warm helium for final warmup step is circulated through the cold sextant at 7:00, with subsequent increase in conductive heat load to the 7:00 cold mass. An alternate scheme is a remote helium circulation pump. This would require warm tap points at individual valve boxes.

Note: Modification of P&ID .....86 (6:00 valve box) as follows: move the tap from H4639A to zone E6 or E7. See page 15 of notes.

E) ***Cooldown*** of the ***"first" loop***(1/2 ring).

F) ***Cooldown*** of the entire machine.

G) ***Recool*** the ***5:00*** sextant with all others cold.

The following analysis work sheets cover the valve boxes and magnet strings for the modes of operation referenced above.

Failure Mode Effects Analysis

System: RHIC Cryogenic System
Operation Mode: Normal Operations

Date: Tuesday, August 30, 1994

Item: 1 **Failure:** Open

Failure Effect: Contaminants may cause valves downstream of affected filter to leak.

Failure Detection: Minor helium leak. Minor increase in refrigerator output.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4862H	B	8	FILTER H 10
F6851H	Y	8	FILTER H 10
F5051H	B	10	FILTER H 12
F7051H	Y	10	FILTER H 12
F4029H	B	12	FILTER H 2
F6054H	Y	12	FILTER H 2
F4251H	B	2	FILTER H 4
F6256H	Y	2	FILTER H 4
F4469H	B	4	FILTER H 6
F6425H	Y	4	FILTER H 6
F4611H	B	6	FILTER H 8
F6748H	Y	6	FILTER H 8

Item: 1 **Failure:** Clogged

Failure Effect: No flow. Heat shield temperature increase with magnet temperature rise and subsequent magnet quench. Lines protected by relief valves. Pump & Purge will minimize condensibles.

Failure Detection: Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4862H	B	8	FILTER H 10
F6851H	Y	8	FILTER H 10
F5051H	B	10	FILTER H 12
F7051H	Y	10	FILTER H 12
F4029H	B	12	FILTER H 2
F6054H	Y	12	FILTER H 2
F4251H	B	2	FILTER H 4
F6256H	Y	2	FILTER H 4
F4469H	B	4	FILTER H 6
F6425H	Y	4	FILTER H 6
F4611H	B	6	FILTER H 8
F6748H	Y	6	FILTER H 8

Item: 2

Failure: Open

Failure Effect: Contaminants may cause valves downstream of affected filter to leak. Short/open on Magnet electrical circuits. Circulator failure.

Failure Detection: Minor helium leak. Minor increase in refrigerator output.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4860H	B	8	FILTER M 10
F6849H	Y	8	FILTER M 10
F5049H	B	10	FILTER M 12
F7049H	Y	10	FILTER M 12
F4027H	B	12	FILTER M 2
F6052H	Y	12	FILTER M 2
F4249H	B	2	FILTER M 4
F6254H	Y	2	FILTER M 4
F4467H	B	4	FILTER M 6
F6423H	Y	4	FILTER M 6
F4609H	B	6	FILTER M 8
F6746H	Y	6	FILTER M 8

Item: 2

Failure: Clogged

Failure Effect: No flow. Magnet temperature rise and subsequent magnet quench. Lines protected by relief valves. Pump & Purge will minimize condensibles.

Failure Detection: Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4860H	B	8	FILTER M 10
F6849H	Y	8	FILTER M 10
F5049H	B	10	FILTER M 12
F7049H	Y	10	FILTER M 12
F4027H	B	12	FILTER M 2
F6052H	Y	12	FILTER M 2
F4249H	B	2	FILTER M 4
F6254H	Y	2	FILTER M 4
F4467H	B	4	FILTER M 6
F6423H	Y	4	FILTER M 6
F4609H	B	6	FILTER M 8
F6746H	Y	6	FILTER M 8

Item: 3

Failure: Open

Failure Effect: Contaminants may cause valves downstream of affected filter to leak.

Failure Detection: Minor helium leak. Minor increase in refrigerator output.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4864H	B	8	FILTER R 10
F6853H	Y	8	FILTER R 10
F5053H	B	10	FILTER R 12
F7053H	Y	10	FILTER R 12
F4032H	B	12	FILTER R 2
F6056H	Y	12	FILTER R 2
F4253H	B	2	FILTER R 4
F6258H	Y	2	FILTER R 4
F4471H	B	4	FILTER R 6
F6427H	Y	4	FILTER R 6
F4613H	B	6	FILTER R 8
F6750H	Y	6	FILTER R 8

Item: 3

Failure: Clogged

Failure Effect: No flow. Recooler temperature increase with Magnet temperature rise and subsequent magnet quench. Lines protected by relief valves. Pump & Purge will minimize condensibles.

Failure Detection: Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4864H	B	8	FILTER R 10
F6853H	Y	8	FILTER R 10
F5053H	B	10	FILTER R 12
F7053H	Y	10	FILTER R 12
F4032H	B	12	FILTER R 2
F6056H	Y	12	FILTER R 2
F4253H	B	2	FILTER R 4
F6258H	Y	2	FILTER R 4
F4471H	B	4	FILTER R 6
F6427H	Y	4	FILTER R 6
F4613H	B	6	FILTER R 8
F6750H	Y	6	FILTER R 8

Item: 4

Failure: Open

Failure Effect: Contaminants may cause valves downstream of affected filter to leak.

Failure Detection: Minor helium leak. Minor increase in refrigerator output.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4861H	B	8	FILTER S 10
F6850H	Y	8	FILTER S 10
F5050H	B	10	FILTER S 12
F7050H	Y	10	FILTER S 12
F4028H	B	12	FILTER S 2
F6053H	Y	12	FILTER S 2
F4250H	B	2	FILTER S 4
F6255H	Y	2	FILTER S 4
F4468H	B	4	FILTER S 6
F6424H	Y	4	FILTER S 6
F4610H	B	6	FILTER S 8
F6747H	Y	6	FILTER S 8

Item: 4

Failure: Clogged

Failure Effect: No flow. Recooler level declines with Magnet temperature rise and subsequent magnet quench. Lines protected by relief valves. Pump & Purge will minimize condensibles.

Failure Detection: Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4861H	B	8	FILTER S 10
F6850H	Y	8	FILTER S 10
F5050H	B	10	FILTER S 12
F7050H	Y	10	FILTER S 12
F4028H	B	12	FILTER S 2
F6053H	Y	12	FILTER S 2
F4250H	B	2	FILTER S 4
F6255H	Y	2	FILTER S 4
F4468H	B	4	FILTER S 6
F6424H	Y	4	FILTER S 6
F4610H	B	6	FILTER S 8
F6747H	Y	6	FILTER S 8

Item: 5

Failure: Clogged

Failure Effect: No impact. Utility line not used during normal operations.

Failure Detection: None.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4863H	B	8	FILTER U 10
F6852H	Y	8	FILTER U 10
F5052H	B	10	FILTER U 12
F7052H	Y	10	FILTER U 12
F4031H	B	12	FILTER U 2
F6257H	Y	2	FILTER U 2
F6055H	Y	12	FILTER U 2
F4252H	B	2	FILTER U 4
F4470H	B	4	FILTER U 6
F6426H	Y	4	FILTER U 6
F4612H	B	6	FILTER U 8
F6749H	Y	6	FILTER U 8

Item: 5

Failure: Open

Failure Effect: Contaminants may cause valves downstream of affected filter to leak.

Failure Detection: None.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4863H	B	8	FILTER U 10
F6852H	Y	8	FILTER U 10
F5052H	B	10	FILTER U 12
F7052H	Y	10	FILTER U 12
F4031H	B	12	FILTER U 2
F6257H	Y	2	FILTER U 2
F6055H	Y	12	FILTER U 2
F4252H	B	2	FILTER U 4
F4470H	B	4	FILTER U 6
F6426H	Y	4	FILTER U 6
F4612H	B	6	FILTER U 8
F6749H	Y	6	FILTER U 8

Item: 6 **Failure:** Open

Failure Effect: Contaminants may cause valves downstream of affected filter to leak.

Failure Detection: Minor helium leak. Minor increase in refrigerator output.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4035H	B	12	FILTER H 10
F6059H	Y	12	FILTER H 10
F4256H	B	2	FILTER H 12
F6261H	Y	2	FILTER H 12
F4474H	B	4	FILTER H 2
F6430H	Y	4	FILTER H 2
F4616H	B	6	FILTER H 4
F6753H	Y	6	FILTER H 4
F4867H	B	8	FILTER H 6
F6856H	Y	8	FILTER H 6
F5056H	B	10	FILTER H 8
F7056H	Y	10	FILTER H 8

Item: 6 **Failure:** Clogged

Failure Effect: No flow. Heat shield temperature increase with magnet temperature rise and subsequent magnet quench. Lines protected by relief valves. Pump & Purge will minimize condensibles.

Failure Detection: Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4035H	B	12	FILTER H 10
F6059H	Y	12	FILTER H 10
F4256H	B	2	FILTER H 12
F6261H	Y	2	FILTER H 12
F4474H	B	4	FILTER H 2
F6430H	Y	4	FILTER H 2
F4616H	B	6	FILTER H 4
F6753H	Y	6	FILTER H 4
F4867H	B	8	FILTER H 6
F6856H	Y	8	FILTER H 6
F5056H	B	10	FILTER H 8
F7056H	Y	10	FILTER H 8

Item: 7

Failure: Open

Failure Effect: Contaminants may cause valves downstream of affected filter to leak. Short/open on Magnet electrical circuits. Circulator failure.

Failure Detection: Minor helium leak. Minor increase in refrigerator output.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4614H	B	6	FILTER M 4
F6751H	Y	6	FILTER M 4

Item: 7

Failure: Clogged

Failure Effect: No flow. Magnet temperature rise and subsequent magnet quench. Lines protected by relief valves. Pump & Purge will minimize condensibles.

Failure Detection: Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4614H	B	6	FILTER M 4
F6751H	Y	6	FILTER M 4

Item: 8

Failure: Open

Failure Effect: Contaminants may cause valves downstream of affected filter to leak.

Failure Detection: Minor helium leak. Minor increase in refrigerator output.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4037H	B	12	FILTER R 10
F6061H	Y	12	FILTER R 10
F4258H	B	2	FILTER R 12
F6263H	Y	2	FILTER R 12
F4476H	B	4	FILTER R 2
F6432H	Y	4	FILTER R 2
F4618H	B	6	FILTER R 4
F6755H	Y	6	FILTER R 4
F4869H	B	8	FILTER R 6
F6858H	Y	8	FILTER R 6
F5058H	B	10	FILTER R 8
F7058H	Y	10	FILTER R 8

Item: 8

Failure: Clogged

Failure Effect: No flow. Recooler temperature increase with magnet temperature rise and subsequent magnet quench. Lines protected by relief valves. Pump & Purge will minimize condensibles.

Failure Detection: Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4037H	B	12	FILTER R 10
F6061H	Y	12	FILTER R 10
F4258H	B	2	FILTER R 12
F6263H	Y	2	FILTER R 12
F4476H	B	4	FILTER R 2
F6432H	Y	4	FILTER R 2
F4618H	B	6	FILTER R 4
F6755H	Y	6	FILTER R 4
F4869H	B	8	FILTER R 6
F6858H	Y	8	FILTER R 6
F5058H	B	10	FILTER R 8
F7058H	Y	10	FILTER R 8

Item: 9 **Failure:** Open

Failure Effect: Contaminants may cause valves downstream of affected filter to leak.

Failure Detection: Minor helium leak. Minor increase in refrigerator output.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4034H	B	12	FILTER S 10
F6058H	Y	12	FILTER S 10
F4255H	B	2	FILTER S 12
F6260H	Y	2	FILTER S 12
F4473H	B	4	FILTER S 2
F6429H	Y	4	FILTER S 2
F4615H	B	6	FILTER S 4
F6752H	Y	6	FILTER S 4
F4866H	B	8	FILTER S 6
F6855H	Y	8	FILTER S 6
F5055H	B	10	FILTER S 8
F7055H	Y	10	FILTER S 8

Item: 9 **Failure:** Clogged

Failure Effect: No flow. Recooler level declines with Magnet temperature rise and subsequent magnet quench. Lines protected by relief valves. Pump & Purge will minimize condensibles.

Failure Detection: Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4034H	B	12	FILTER S 10
F6058H	Y	12	FILTER S 10
F4255H	B	2	FILTER S 12
F6260H	Y	2	FILTER S 12
F4473H	B	4	FILTER S 2
F6429H	Y	4	FILTER S 2
F4615H	B	6	FILTER S 4
F6752H	Y	6	FILTER S 4
F4866H	B	8	FILTER S 6
F6855H	Y	8	FILTER S 6
F5055H	B	10	FILTER S 8
F7055H	Y	10	FILTER S 8

Item: 10 **Failure:** Open

Failure Effect: Contaminants may cause valves downstream of affected filter to leak.

Failure Detection: Minor helium leak. Minor increase in refrigerator output.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4036H	B	12	FILTER U 10
F6262H	Y	2	FILTER U 10
F6060H	Y	12	FILTER U 10
F4257H	B	2	FILTER U 12
F4475H	B	4	FILTER U 2
F6431H	Y	4	FILTER U 2
F4617H	B	6	FILTER U 4
F6754H	Y	6	FILTER U 4
F4868H	B	8	FILTER U 6
F6857H	Y	8	FILTER U 6
F5057H	B	10	FILTER U 8
F7057H	Y	10	FILTER U 8

Item: 10 **Failure:** Clogged

Failure Effect: No impact. Utility line not used during normal operations.

Failure Detection: None.

Affected Components:

Valve #	Ring	Box	Nomenclature
F4036H	B	12	FILTER U 10
F6262H	Y	2	FILTER U 10
F6060H	Y	12	FILTER U 10
F4257H	B	2	FILTER U 12
F4475H	B	4	FILTER U 2
F6431H	Y	4	FILTER U 2
F4617H	B	6	FILTER U 4
F6754H	Y	6	FILTER U 4
F4868H	B	8	FILTER U 6
F6857H	Y	8	FILTER U 6
F5057H	B	10	FILTER U 8
F7057H	Y	10	FILTER U 8

Valve #	Ring	Box	Nomenclature
FE4477H	B	4	FLOW CONTROL ELEME
FE5076H	B	10	FLOW CONTROL ELEME
FE7072H	Y	10	FLOW CONTROL ELEME
FE4470H	B	4	FLOW CONTROL ELEME
FE5071H	B	10	FLOW CONTROL ELEME
FE7073H	Y	10	FLOW CONTROL ELEME
FE4476H	B	4	FLOW CONTROL ELEME
FE5075H	B	10	FLOW CONTROL ELEME
FE7071H	Y	10	FLOW CONTROL ELEME
FE4475H	B	4	FLOW CONTROL ELEME
FE5074H	B	10	FLOW CONTROL ELEME
FE7070H	Y	10	FLOW CONTROL ELEME
FE4474H	B	4	FLOW CONTROL ELEME
FE5073H	B	10	FLOW CONTROL ELEME
FE7069H	Y	10	FLOW CONTROL ELEME
FE4473H	B	4	FLOW CONTROL ELEME
FE5072H	B	10	FLOW CONTROL ELEME
FE7068H	Y	10	FLOW CONTROL ELEME
FE4472H	B	4	FLOW CONTROL ELEME
FE5069H	B	10	FLOW CONTROL ELEME
FE7066H	Y	10	FLOW CONTROL ELEME
FE4471H	B	4	FLOW CONTROL ELEME
FE5068H	B	10	FLOW CONTROL ELEME
FE7065H	Y	10	FLOW CONTROL ELEME
FE4465H	B	4	FLOW CONTROL ELEME
FE7060H	Y	10	FLOW CONTROL ELEME
SPARE3	B	4	FLOW CONTROL ELEME
FE5052H	B	10	FLOW CONTROL ELEME
SPARE12	Y	10	FLOW CONTROL ELEME
FE5063H	B	10	FLOW CONTROL ELEME
FE5064H	B	10	FLOW CONTROL ELEME
FE4469H	B	4	FLOW CONTROL ELEME
FE7064H	Y	10	FLOW CONTROL ELEME
FE4468H	B	4	FLOW CONTROL ELEME
FE5070H	B	10	FLOW CONTROL ELEME
FE7063H	Y	10	FLOW CONTROL ELEME
FE4467H	B	4	FLOW CONTROL ELEME
FE5055H	B	10	FLOW CONTROL ELEME
FE7062H	Y	10	FLOW CONTROL ELEME
FE4466H	B	4	FLOW CONTROL ELEME
FE5054H	B	10	FLOW CONTROL ELEME
FE7061H	Y	10	FLOW CONTROL ELEME

Valve #	Ring	Box	Nomenclature
FE4867H	B	8	FLOW CONTROL ELEME
FE4092H	B	12	FLOW CONTROL ELEME
FE6259H	Y	2	FLOW CONTROL ELEME
FE6471H	Y	4	FLOW CONTROL ELEME
FE4014H	Y	6	FLOW CONTROL ELEME
FE6865H	Y	8	FLOW CONTROL ELEME
FE6064H	Y	12	FLOW CONTROL ELEME
FE4266H	B	2	FLOW CONTROL ELEME
FE4080H	B	6	FLOW CONTROL ELEME
FE4866H	B	8	FLOW CONTROL ELEME
FE4091H	B	12	FLOW CONTROL ELEME
FE6258H	Y	2	FLOW CONTROL ELEME
FE6470H	Y	4	FLOW CONTROL ELEME
FE4013H	Y	6	FLOW CONTROL ELEME
FE6864H	Y	8	FLOW CONTROL ELEME
FE6063H	Y	12	FLOW CONTROL ELEME
FE4265H	B	2	FLOW CONTROL ELEME
FE4012H	B	6	FLOW CONTROL ELEME
FE4865H	B	8	FLOW CONTROL ELEME
FE4079H	B	12	FLOW CONTROL ELEME
FE6257H	Y	2	FLOW CONTROL ELEME
FE6469H	Y	4	FLOW CONTROL ELEME
FE4003H	Y	6	FLOW CONTROL ELEME
FE6863H	Y	8	FLOW CONTROL ELEME
FE6062H	Y	12	FLOW CONTROL ELEME
FE4264H	B	2	FLOW CONTROL ELEME
FE4009H	B	6	FLOW CONTROL ELEME
FE4864H	B	8	FLOW CONTROL ELEME
FE4078H	B	12	FLOW CONTROL ELEME
FE6256H	Y	2	FLOW CONTROL ELEME
FE6468H	Y	4	FLOW CONTROL ELEME
FE4002H	Y	6	FLOW CONTROL ELEME
FE6862H	Y	8	FLOW CONTROL ELEME
FE6061H	Y	12	FLOW CONTROL ELEME
FE4263H	B	2	FLOW CONTROL ELEME
FE4008H	B	6	FLOW CONTROL ELEME
FE4863H	B	8	FLOW CONTROL ELEME
FE4077H	B	12	FLOW CONTROL ELEME
FE6255H	Y	2	FLOW CONTROL ELEME
FE6467H	Y	4	FLOW CONTROL ELEME
FE4001H	Y	6	FLOW CONTROL ELEME
FE6861H	Y	8	FLOW CONTROL ELEME
FE6060H	Y	12	FLOW CONTROL ELEME
FE4262H	B	2	FLOW CONTROL ELEME
FE4007H	B	6	FLOW CONTROL ELEME
FE4862H	B	8	FLOW CONTROL ELEME
FE4076H	B	12	FLOW CONTROL ELEME
FE6254H	Y	2	FLOW CONTROL ELEME
FE6466H	Y	4	FLOW CONTROL ELEME
FE4000H	Y	6	FLOW CONTROL ELEME
FE6860H	Y	8	FLOW CONTROL ELEME
FE6059H	Y	12	FLOW CONTROL ELEME

Item: 11

Failure: N/A

Failure Effect: No longer a separate component. Integrated with lead control.

Failure Detection:

Affected Components:

Valve #	Ring	Box	Nomenclature
FE5053H	B	10	FLOW CONTROL ELEME
FE4270H	B	2	FLOW CONTROL ELEME
FE4084H	B	6	FLOW CONTROL ELEME
FE4870H	B	8	FLOW CONTROL ELEME
FE4095H	B	12	FLOW CONTROL ELEME
FE6261H	Y	2	FLOW CONTROL ELEME
FE6474H	Y	4	FLOW CONTROL ELEME
FE4016H	Y	6	FLOW CONTROL ELEME
FE6867H	Y	8	FLOW CONTROL ELEME
FE6066H	Y	12	FLOW CONTROL ELEME
FE4261H	B	2	FLOW CONTROL ELEME
FE4006H	B	6	FLOW CONTROL ELEME
FE4861H	B	8	FLOW CONTROL ELEME
FE4075H	B	12	FLOW CONTROL ELEME
FE6262H	Y	2	FLOW CONTROL ELEME
FE6465H	Y	4	FLOW CONTROL ELEME
FE4017H	Y	6	FLOW CONTROL ELEME
FE6868H	Y	8	FLOW CONTROL ELEME
FE6067H	Y	12	FLOW CONTROL ELEME
FE4260H	B	2	FLOW CONTROL ELEME
FE4005H	B	6	FLOW CONTROL ELEME
FE4860H	B	8	FLOW CONTROL ELEME
FE4074H	B	12	FLOW CONTROL ELEME
SPARE17	Y	2	FLOW CONTROL ELEME
FE6475H	Y	4	FLOW CONTROL ELEME
SPARE1	Y	6	FLOW CONTROL ELEME
SPARE18	Y	8	FLOW CONTROL ELEME
SPARE11	Y	12	FLOW CONTROL ELEME
FE4269H	B	2	FLOW CONTROL ELEME
FE4083H	B	6	FLOW CONTROL ELEME
FE4869H	B	8	FLOW CONTROL ELEME
FE4094H	B	12	FLOW CONTROL ELEME
FE6260H	Y	2	FLOW CONTROL ELEME
FE6473H	Y	4	FLOW CONTROL ELEME
FE4015H	Y	6	FLOW CONTROL ELEME
FE6866H	Y	8	FLOW CONTROL ELEME
FE6065H	Y	12	FLOW CONTROL ELEME
FE4268H	B	2	FLOW CONTROL ELEME
FE4082H	B	6	FLOW CONTROL ELEME
FE4868H	B	8	FLOW CONTROL ELEME
FE4093H	B	12	FLOW CONTROL ELEME
FE6472H	Y	4	FLOW CONTROL ELEME
FE4267H	B	2	FLOW CONTROL ELEME
FE4081H	B	6	FLOW CONTROL ELEME

Valve #	Ring	Box	Nomenclature
H5049E	B	10	LEAD CONTROL B8
H5057E	B	10	LEAD CONTROL B9
H6264E	Y	2	LEAD CONTROL 1
H6629E	Y	6	LEAD CONTROL 1
H6870E	Y	8	LEAD CONTROL 1
H6076E	Y	12	LEAD CONTROL 1
H6294E	Y	2	LEAD CONTROL 10
H6631E	Y	6	LEAD CONTROL 10
H6871E	Y	8	LEAD CONTROL 10
H6077E	Y	12	LEAD CONTROL 10
SPARE15	Y	2	LEAD CONTROL 11
SPARE14	Y	6	LEAD CONTROL 11
SPARE10	Y	8	LEAD CONTROL 11
SPARE13	Y	12	LEAD CONTROL 11
H6263E	Y	2	LEAD CONTROL 2
H6628E	Y	6	LEAD CONTROL 2
H6869E	Y	8	LEAD CONTROL 2
H6075E	Y	12	LEAD CONTROL 2
H6262E	Y	2	LEAD CONTROL 4
H6627E	Y	6	LEAD CONTROL 4
H6868E	Y	8	LEAD CONTROL 4
H6074E	Y	12	LEAD CONTROL 4
H6261E	Y	2	LEAD CONTROL 5
H6626E	Y	6	LEAD CONTROL 5
H6867E	Y	8	LEAD CONTROL 5
H6073E	Y	12	LEAD CONTROL 5
H6232E	Y	2	LEAD CONTROL 6
H6619E	Y	6	LEAD CONTROL 6
H6858E	Y	8	LEAD CONTROL 6
H6049E	Y	12	LEAD CONTROL 6
H6231E	Y	2	LEAD CONTROL 7
H6618E	Y	6	LEAD CONTROL 7
H6857E	Y	8	LEAD CONTROL 7
H6048E	Y	12	LEAD CONTROL 7
H6229E	Y	2	LEAD CONTROL 8
H6614E	Y	6	LEAD CONTROL 8
H6856E	Y	8	LEAD CONTROL 8
H6047E	Y	12	LEAD CONTROL 8
H6228E	Y	2	LEAD CONTROL 9
H6613E	Y	6	LEAD CONTROL 9
H6855E	Y	8	LEAD CONTROL 9
H6046E	Y	12	LEAD CONTROL 9

Item: 12

Failure: None

Failure Effect: Shaped pipe. Has no normally anticipated failure modes.

Failure Detection:

Affected Components:

Valve #	Ring	Box	Nomenclature
FE4011H	B	6	VENTURI FLOW 200 g/s
FE4010H	Y	6	VENTURI FLOW 200 g/s

Item: 13

Failure: Closed

Failure Effect: No lead cooling. Power supply shutdown by voltage monitoring circuit.

Failure Detection: Power supply shutdown or elevated lead current.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4265E	B	2	LEAD CONTROL 1
H4552E	B	6	LEAD CONTROL 1
H4866E	B	8	LEAD CONTROL 1
H4079E	B	12	LEAD CONTROL 1
H6473E	Y	4	LEAD CONTROL 1
H4256E	B	2	LEAD CONTROL 10
H4514E	B	6	LEAD CONTROL 10
H4856E	B	8	LEAD CONTROL 10
H4065E	B	12	LEAD CONTROL 10
H6453E	Y	4	LEAD CONTROL 10
H4255E	B	2	LEAD CONTROL 11
H4513E	B	6	LEAD CONTROL 11
H4855E	B	8	LEAD CONTROL 11
H4064E	B	12	LEAD CONTROL 11
H6474E	Y	4	LEAD CONTROL 11
H4264E	B	2	LEAD CONTROL 2
H4551E	B	6	LEAD CONTROL 2
H4865E	B	8	LEAD CONTROL 2
H4078E	B	12	LEAD CONTROL 2
H6472E	Y	4	LEAD CONTROL 2
H4263E	B	2	LEAD CONTROL 3
H4550E	B	6	LEAD CONTROL 3
H4864E	B	8	LEAD CONTROL 3
H4077E	B	12	LEAD CONTROL 3
H6460E	Y	4	LEAD CONTROL 3
H4262E	B	2	LEAD CONTROL 4
H4549E	B	6	LEAD CONTROL 4
H4863E	B	8	LEAD CONTROL 4
H4076E	B	12	LEAD CONTROL 4
H6459E	Y	4	LEAD CONTROL 4
H4261E	B	2	LEAD CONTROL 5
H4548E	B	6	LEAD CONTROL 5
H4862E	B	8	LEAD CONTROL 5
H4075E	B	12	LEAD CONTROL 5
H6458E	Y	4	LEAD CONTROL 5
H4260E	B	2	LEAD CONTROL 6
H4547E	B	6	LEAD CONTROL 6
H4860E	B	8	LEAD CONTROL 6
H4074E	B	12	LEAD CONTROL 6
H6457E	Y	4	LEAD CONTROL 6
H4259E	B	2	LEAD CONTROL 7
H4523E	B	6	LEAD CONTROL 7
H4859E	B	8	LEAD CONTROL 7

Item: 13 **Failure:** Closed

Failure Effect: No lead cooling. Power supply shutdown by voltage monitoring circuit.

Failure Detection: Power supply shutdown or elevated lead current.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4265E	B	2	LEAD CONTROL 1
H4552E	B	6	LEAD CONTROL 1
H4866E	B	8	LEAD CONTROL 1
H4079E	B	12	LEAD CONTROL 1
H6473E	Y	4	LEAD CONTROL 1
H4256E	B	2	LEAD CONTROL 10
H4514E	B	6	LEAD CONTROL 10
H4856E	B	8	LEAD CONTROL 10
H4065E	B	12	LEAD CONTROL 10
H6453E	Y	4	LEAD CONTROL 10
H4255E	B	2	LEAD CONTROL 11
H4513E	B	6	LEAD CONTROL 11
H4855E	B	8	LEAD CONTROL 11
H4064E	B	12	LEAD CONTROL 11
H6474E	Y	4	LEAD CONTROL 11
H4264E	B	2	LEAD CONTROL 2
H4551E	B	6	LEAD CONTROL 2
H4865E	B	8	LEAD CONTROL 2
H4078E	B	12	LEAD CONTROL 2
H6472E	Y	4	LEAD CONTROL 2
H4263E	B	2	LEAD CONTROL 3
H4550E	B	6	LEAD CONTROL 3
H4864E	B	8	LEAD CONTROL 3
H4077E	B	12	LEAD CONTROL 3
H6460E	Y	4	LEAD CONTROL 3
H4262E	B	2	LEAD CONTROL 4
H4549E	B	6	LEAD CONTROL 4
H4863E	B	8	LEAD CONTROL 4
H4076E	B	12	LEAD CONTROL 4
H6459E	Y	4	LEAD CONTROL 4
H4261E	B	2	LEAD CONTROL 5
H4548E	B	6	LEAD CONTROL 5
H4862E	B	8	LEAD CONTROL 5
H4075E	B	12	LEAD CONTROL 5
H6458E	Y	4	LEAD CONTROL 5
H4260E	B	2	LEAD CONTROL 6
H4547E	B	6	LEAD CONTROL 6
H4860E	B	8	LEAD CONTROL 6
H4074E	B	12	LEAD CONTROL 6
H6457E	Y	4	LEAD CONTROL 6
H4259E	B	2	LEAD CONTROL 7
H4523E	B	6	LEAD CONTROL 7
H4859E	B	8	LEAD CONTROL 7

Valve #	Ring	Box	Nomenclature
H4068E	B	12	LEAD CONTROL 7
H6456E	Y	4	LEAD CONTROL 7
H4258E	B	2	LEAD CONTROL 8
H4519E	B	6	LEAD CONTROL 8
H4858E	B	8	LEAD CONTROL 8
H4067E	B	12	LEAD CONTROL 8
H6455E	Y	4	LEAD CONTROL 8
H4257E	B	2	LEAD CONTROL 9
H4518E	B	6	LEAD CONTROL 9
H4857E	B	8	LEAD CONTROL 9
H4066E	B	12	LEAD CONTROL 9
H6454E	Y	4	LEAD CONTROL 9
H4469E	B	4	LEAD CONTROL A1
H5153E	B	10	LEAD CONTROL A1
H7075E	Y	10	LEAD CONTROL A1
H4460E	B	4	LEAD CONTROL A11
H5051E	B	10	LEAD CONTROL A11
H7087E	Y	10	LEAD CONTROL A11
H4468E	B	4	LEAD CONTROL A2
H5152E	B	10	LEAD CONTROL A2
H7074E	Y	10	LEAD CONTROL A2
H4467E	B	4	LEAD CONTROL A4
H5151E	B	10	LEAD CONTROL A4
H7073E	Y	10	LEAD CONTROL A4
H4466E	B	4	LEAD CONTROL A5
H5150E	B	10	LEAD CONTROL A5
H7072E	Y	10	LEAD CONTROL A5
H4465E	B	4	LEAD CONTROL A6
H5149E	B	10	LEAD CONTROL A6
H7071E	Y	10	LEAD CONTROL A6
H4462E	B	4	LEAD CONTROL A8
H5053E	B	10	LEAD CONTROL A8
H7061E	Y	10	LEAD CONTROL A8
H4461E	B	4	LEAD CONTROL A9
H5052E	B	10	LEAD CONTROL A9
H7060E	Y	10	LEAD CONTROL A9
H4455E	B	4	LEAD CONTROL B10
H7055E	Y	10	LEAD CONTROL B10
SPARE16	B	4	LEAD CONTROL B11
SPARE2	Y	10	LEAD CONTROL B11
H4459E	B	4	LEAD CONTROL B6
H7059E	Y	10	LEAD CONTROL B6
H4458E	B	4	LEAD CONTROL B7
H7058E	Y	10	LEAD CONTROL B7
H4457E	B	4	LEAD CONTROL B8
H7057E	Y	10	LEAD CONTROL B8
H4456E	B	4	LEAD CONTROL B9
H7056E	Y	10	LEAD CONTROL B9
H5056E	B	10	LEAD CONTROL B10
H5055E	B	10	LEAD CONTROL B11
H5058E	B	10	LEAD CONTROL B2
H5059E	B	10	LEAD CONTROL B4

Valve #	Ring	Box	Nomenclature
H5050E	B	10	LEAD CONTROL B7
H5049E	B	10	LEAD CONTROL B8
H5057E	B	10	LEAD CONTROL B9
H6264E	Y	2	LEAD CONTROL 1
H6629E	Y	6	LEAD CONTROL 1
H6870E	Y	8	LEAD CONTROL 1
H6076E	Y	12	LEAD CONTROL 1
H6294E	Y	2	LEAD CONTROL 10
H6631E	Y	6	LEAD CONTROL 10
H6871E	Y	8	LEAD CONTROL 10
H6077E	Y	12	LEAD CONTROL 10
SPARE15	Y	2	LEAD CONTROL 11
SPARE14	Y	6	LEAD CONTROL 11
SPARE10	Y	8	LEAD CONTROL 11
SPARE13	Y	12	LEAD CONTROL 11
H6263E	Y	2	LEAD CONTROL 2
H6628E	Y	6	LEAD CONTROL 2
H6869E	Y	8	LEAD CONTROL 2
H6075E	Y	12	LEAD CONTROL 2
H6262E	Y	2	LEAD CONTROL 4
H6627E	Y	6	LEAD CONTROL 4
H6868E	Y	8	LEAD CONTROL 4
H6074E	Y	12	LEAD CONTROL 4
H6261E	Y	2	LEAD CONTROL 5
H6626E	Y	6	LEAD CONTROL 5
H6867E	Y	8	LEAD CONTROL 5
H6073E	Y	12	LEAD CONTROL 5
H6232E	Y	2	LEAD CONTROL 6
H6619E	Y	6	LEAD CONTROL 6
H6858E	Y	8	LEAD CONTROL 6
H6049E	Y	12	LEAD CONTROL 6
H6231E	Y	2	LEAD CONTROL 7
H6618E	Y	6	LEAD CONTROL 7
H6857E	Y	8	LEAD CONTROL 7
H6048E	Y	12	LEAD CONTROL 7
H6229E	Y	2	LEAD CONTROL 8
H6614E	Y	6	LEAD CONTROL 8
H6856E	Y	8	LEAD CONTROL 8
H6047E	Y	12	LEAD CONTROL 8
H6228E	Y	2	LEAD CONTROL 9
H6613E	Y	6	LEAD CONTROL 9
H6855E	Y	8	LEAD CONTROL 9
H6046E	Y	12	LEAD CONTROL 9

Item: 14

Failure: Open

Failure Effect: Minor increase in refrigerator heat load.

Failure Detection: Minor helium leak. Minor increase in refrigerator output.

Affected Components:

Valve #	Ring	Box	Nomenclature
H3088R	Y	6	CIRCULATOR C3018 RE
H3090R	B	6	CIRCULATOR C3019 RE
H4012R	B	12	RELIEF H4000A~H4007
H4018R	B	12	RELIEF H4005A~H4001
H4055R	B	12	RELIEF H4010A~H4011
H4056R	B	12	RELIEF H4015A~H4016
H4054R	B	12	RELIEF H4020A~H4021
H4053R	B	12	RELIEF H4035A~H4039
H4207R	B	2	RELIEF H4205M~H4200
H4246R	B	2	RELIEF H4210A~H4211
H4247R	B	2	RELIEF H4215A~H4216
H4249R	B	2	RELIEF H4218M~H4201
H4248R	B	2	RELIEF H4220A~H4221
H4419R	B	4	RELIEF H4405M~H4401
H4413R	B	4	RELIEF H4407M~H4400
H4447R	B	4	RELIEF H4410A~H4411
H4446R	B	4	RELIEF H4415A~H4416
H4448R	B	4	RELIEF H4420A~H4421
H6471R	B	6	RELIEF H4500A~H6733
H3232R	B	6	RELIEF H4501A~H4534
H3096R	B	6	RELIEF H4502A~H4510
H3094R	B	6	RELIEF H4503A~H4603
H3097R	B	6	RELIEF H4504A~H4604
H3110R	B	6	RELIEF H4510A~H4511
H3111R	B	6	RELIEF H4515A~H4516
H3093R	B	6	RELIEF H4516A~H4616
H3113R	B	6	RELIEF H4520A~H4521
H3095R	B	6	RELIEF H4534M~H4614
H3231R	B	6	RELIEF H4536A~H4636
H3235R	B	6	RELIEF H4600A~H4618
H6813R	B	6	RELIEF H4601A~H4614
H3091R	B	6	RELIEF H4602A~H4645
H3112R	B	6	RELIEF H4615A~H4616
H3109R	B	6	RELIEF H4620A~H4621
H3092R	B	6	RELIEF H4641A~H4500
H4807R	B	8	RELIEF H4800A~H4831
H4847R	B	8	RELIEF H4801A~H4805
H4832R	B	8	RELIEF H4810A~H4811
H4848R	B	8	RELIEF H4815A~H4816
H4846R	B	8	RELIEF H4820A~H4821
H5047R	B	10	RELIEF H5010A~H5011
H5048R	B	10	RELIEF H5015A~H5016
H5046R	B	10	RELIEF H5020A~H5021
H5032R	B	10	RELIEF H5283M~H5001

Valve #	Ring	Box	Nomenclature
H5282R	B	10	RELIEF H5284M~H5000
H6029R	Y	12	RELIEF H6000A~H6056
H6054R	Y	12	RELIEF H6001A~H6055
H6072R	Y	12	RELIEF H6007A~H6070
H6045R	Y	12	RELIEF H6010A~H6011
H6044R	Y	12	RELIEF H6015A~H6016
H6058R	Y	12	RELIEF H6020A~H6021
H6247R	Y	2	RELIEF H6210A~H6211
H6246R	Y	2	RELIEF H6215A~H6216
H6248R	Y	2	RELIEF H6220A~H6221
H6258R	Y	2	RELIEF H6253M~H6200
H6255R	Y	2	RELIEF H6254M~H6201
H6413R	Y	4	RELIEF H6400A~H6405
H6444R	Y	4	RELIEF H6401A~H6426
H6443R	Y	4	RELIEF H6410A~H6411
H6442R	Y	4	RELIEF H6415A~H6416
H6423R	Y	4	RELIEF H6420A~H6421
H6642R	Y	6	RELIEF H6600A~H6623
H6805R	Y	6	RELIEF H6601A~H6609
H3082R	Y	6	RELIEF H6602A~H6610
H3080R	Y	6	RELIEF H6603A~H6703
H3081R	Y	6	RELIEF H6604A~H6704
H3079R	Y	6	RELIEF H6609M~H6705
H3105R	Y	6	RELIEF H6610A~H6611
H3106R	Y	6	RELIEF H6615A~H6616
H3078R	Y	6	RELIEF H6616A~H6716
H3108R	Y	6	RELIEF H6620A~H6621
H3114R	Y	6	RELIEF H6636A~H6736
H6807R	Y	6	RELIEF H6700A~H6707
H3115R	Y	6	RELIEF H6701A~H6705
H3076R	Y	6	RELIEF H6702A~H6745
H3107R	Y	6	RELIEF H6715A~H6716
H3104R	Y	6	RELIEF H6720A~H6721
H3077R	Y	6	RELIEF H6740A~H6600
H6863R	Y	8	RELIEF H6800A~H6859
H6864R	Y	8	RELIEF H6801A~H6860
H6847R	Y	8	RELIEF H6810A~H6811
H6848R	Y	8	RELIEF H6815A~H6816
H6846R	Y	8	RELIEF H6820A~H6821
H7065R	Y	10	RELIEF H7000A~H7067
H7068R	Y	10	RELIEF H7001A~H7066
H7047R	Y	10	RELIEF H7010A~H7011
H7048R	Y	10	RELIEF H7015A~H7016
H7046R	Y	10	RELIEF H7020A~H7021

Failure Mode Effects Analysis

System: RHIC Cryogenic System **Date:** Tuesday, August 30, 1994

Operation Mode: Normal Operations

Item: 14 **Failure:** Closed

Failure Effect: Line bursts, with loss of insulating vacuum (internal line) or pressure indicator failure (external line).

Failure Detection: Elevated pressure/temperature. Temperature indicators and Magnet quench. Detectable only with individual test.

Affected Components:

Valve #	Ring	Box	Nomenclature
H3088R	Y	6	CIRCULATOR C3018 RE
H3090R	B	6	CIRCULATOR C3019 RE
H4012R	B	12	RELIEF H4000A~H4007
H4018R	B	12	RELIEF H4005A~H4001
H4055R	B	12	RELIEF H4010A~H4011
H4056R	B	12	RELIEF H4015A~H4016
H4054R	B	12	RELIEF H4020A~H4021
H4053R	B	12	RELIEF H4035A~H4039
H4207R	B	2	RELIEF H4205M~H4200
H4246R	B	2	RELIEF H4210A~H4211
H4247R	B	2	RELIEF H4215A~H4216
H4249R	B	2	RELIEF H4218M~H4201
H4248R	B	2	RELIEF H4220A~H4221
H4419R	B	4	RELIEF H4405M~H4401
H4413R	B	4	RELIEF H4407M~H4400
H4447R	B	4	RELIEF H4410A~H4411
H4446R	B	4	RELIEF H4415A~H4416
H4448R	B	4	RELIEF H4420A~H4421
H6471R	B	6	RELIEF H4500A~H6733
H3232R	B	6	RELIEF H4501A~H4534
H3096R	B	6	RELIEF H4502A~H4510
H3094R	B	6	RELIEF H4503A~H4603
H3097R	B	6	RELIEF H4504A~H4604
H3110R	B	6	RELIEF H4510A~H4511
H3111R	B	6	RELIEF H4515A~H4516
H3093R	B	6	RELIEF H4516A~H4616
H3113R	B	6	RELIEF H4520A~H4521
H3095R	B	6	RELIEF H4534M~H4614
H3231R	B	6	RELIEF H4536A~H4636
H3235R	B	6	RELIEF H4600A~H4618
H6813R	B	6	RELIEF H4601A~H4614
H3091R	B	6	RELIEF H4602A~H4645
H3112R	B	6	RELIEF H4615A~H4616
H3109R	B	6	RELIEF H4620A~H4621
H3092R	B	6	RELIEF H4641A~H4500
H4807R	B	8	RELIEF H4800A~H4831
H4847R	B	8	RELIEF H4801A~H4805
H4832R	B	8	RELIEF H4810A~H4811
H4848R	B	8	RELIEF H4815A~H4816
H4846R	B	8	RELIEF H4820A~H4821
H5047R	B	10	RELIEF H5010A~H5011
H5048R	B	10	RELIEF H5015A~H5016

Valve #	Ring	Box	Nomenclature
H5046R	B	10	RELIEF H5020A~H5021
H5032R	B	10	RELIEF H5283M~H5001
H5282R	B	10	RELIEF H5284M~H5000
H6029R	Y	12	RELIEF H6000A~H6056
H6054R	Y	12	RELIEF H6001A~H6055
H6072R	Y	12	RELIEF H6007A~H6070
H6045R	Y	12	RELIEF H6010A~H6011
H6044R	Y	12	RELIEF H6015A~H6016
H6058R	Y	12	RELIEF H6020A~H6021
H6247R	Y	2	RELIEF H6210A~H6211
H6246R	Y	2	RELIEF H6215A~H6216
H6248R	Y	2	RELIEF H6220A~H6221
H6258R	Y	2	RELIEF H6253M~H6200
H6255R	Y	2	RELIEF H6254M~H6201
H6413R	Y	4	RELIEF H6400A~H6405
H6444R	Y	4	RELIEF H6401A~H6426
H6443R	Y	4	RELIEF H6410A~H6411
H6442R	Y	4	RELIEF H6415A~H6416
H6423R	Y	4	RELIEF H6420A~H6421
H6642R	Y	6	RELIEF H6600A~H6623
H6805R	Y	6	RELIEF H6601A~H6609
H3082R	Y	6	RELIEF H6602A~H6610
H3080R	Y	6	RELIEF H6603A~H6703
H3081R	Y	6	RELIEF H6604A~H6704
H3079R	Y	6	RELIEF H6609M~H6705
H3105R	Y	6	RELIEF H6610A~H6611
H3106R	Y	6	RELIEF H6615A~H6616
H3078R	Y	6	RELIEF H6616A~H6716
H3108R	Y	6	RELIEF H6620A~H6621
H3114R	Y	6	RELIEF H6636A~H6736
H6807R	Y	6	RELIEF H6700A~H6707
H3115R	Y	6	RELIEF H6701A~H6705
H3076R	Y	6	RELIEF H6702A~H6745
H3107R	Y	6	RELIEF H6715A~H6716
H3104R	Y	6	RELIEF H6720A~H6721
H3077R	Y	6	RELIEF H6740A~H6600
H6863R	Y	8	RELIEF H6800A~H6859
H6864R	Y	8	RELIEF H6801A~H6860
H6847R	Y	8	RELIEF H6810A~H6811
H6848R	Y	8	RELIEF H6815A~H6816
H6846R	Y	8	RELIEF H6820A~H6821
H7065R	Y	10	RELIEF H7000A~H7067
H7068R	Y	10	RELIEF H7001A~H7066
H7047R	Y	10	RELIEF H7010A~H7011
H7048R	Y	10	RELIEF H7015A~H7016
H7046R	Y	10	RELIEF H7020A~H7021

Failure Mode Effects Analysis

System: RHIC Cryogenic System **Date:** Tuesday, August 30, 1994

Operation Mode: Normal Operations

Item: 15 **Failure:** Closed

Failure Effect: No impact. Relief on opposite end of magnet string is adequate

Failure Detection: Detectable only with individual test.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4838R	B	8	RELIEF LINE H 10
H6838R	Y	8	RELIEF LINE H 10
H4057R	B	12	RELIEF LINE H 10
H6041R	Y	12	RELIEF LINE H 10
H4243R	B	2	RELIEF LINE H 12
H6243R	Y	2	RELIEF LINE H 12
H5038R	B	10	RELIEF LINE H 12
H7038R	Y	10	RELIEF LINE H 12
H4443R	B	4	RELIEF LINE H 2
H6034R	Y	12	RELIEF LINE H 2
H6439R	Y	4	RELIEF LINE H 2
H4045R	B	12	RELIEF LINE H 2
H4238R	B	2	RELIEF LINE H 4
H6238R	Y	2	RELIEF LINE H 4
H3099R	B	6	RELIEF LINE H 4
H3085R	Y	6	RELIEF LINE H 4
H4438R	B	4	RELIEF LINE H 6
H6434R	Y	4	RELIEF LINE H 6
H4843R	B	8	RELIEF LINE H 6
H6843R	Y	8	RELIEF LINE H 6
H6748R	Y	6	RELIEF LINE H 8
H5043R	B	10	RELIEF LINE H 8
H7043R	Y	10	RELIEF LINE H 8
H4611R	B	6	RELIEF LINE H 8
H4836R	B	8	RELIEF LINE M 10
H6836R	Y	8	RELIEF LINE M 10
H4048R	B	12	RELIEF LINE M 10
H6039R	Y	12	RELIEF LINE M 10
H6241R	Y	2	RELIEF LINE M 12
H5036R	B	10	RELIEF LINE M 12
H4241R	B	2	RELIEF LINE M 12
H7036R	Y	10	RELIEF LINE M 12
H6032R	Y	12	RELIEF LINE M 2
H4441R	B	4	RELIEF LINE M 2
H6437R	Y	4	RELIEF LINE M 2
H4043R	B	12	RELIEF LINE M 2
H3098R	B	6	RELIEF LINE M 4
H3083R	Y	6	RELIEF LINE M 4
H4236R	B	2	RELIEF LINE M 4
H6236R	Y	2	RELIEF LINE M 4
H4436R	B	4	RELIEF LINE M 6
H6432R	Y	4	RELIEF LINE M 6
H4841R	B	8	RELIEF LINE M 6

Valve #	Ring	Box	Nomenclature
H6841R	Y	8	RELIEF LINE M 6
H4609R	B	6	RELIEF LINE M 8
H6746R	Y	6	RELIEF LINE M 8
H5041R	B	10	RELIEF LINE M 8
H7041R	Y	10	RELIEF LINE M 8
H4052R	B	12	RELIEF LINE R 10
H6840R	Y	8	RELIEF LINE R 10
H4840R	B	8	RELIEF LINE R 10
H6043R	Y	12	RELIEF LINE R 10
H4245R	B	2	RELIEF LINE R 12
H6245R	Y	2	RELIEF LINE R 12
H5040R	B	10	RELIEF LINE R 12
H7040R	Y	10	RELIEF LINE R 12
H4047R	B	12	RELIEF LINE R 2
H6038R	Y	12	RELIEF LINE R 2
H6441R	Y	4	RELIEF LINE R 2
H4445R	B	4	RELIEF LINE R 2
H6240R	Y	2	RELIEF LINE R 4
H3102R	B	6	RELIEF LINE R 4
H3087R	Y	6	RELIEF LINE R 4
H4240R	B	2	RELIEF LINE R 4
H4440R	B	4	RELIEF LINE R 6
H6845R	Y	8	RELIEF LINE R 6
H6436R	Y	4	RELIEF LINE R 6
H4845R	B	8	RELIEF LINE R 6
H4613R	B	6	RELIEF LINE R 8
H6750R	Y	6	RELIEF LINE R 8
H5045R	B	10	RELIEF LINE R 8
H7045R	Y	10	RELIEF LINE R 8
H4837R	B	8	RELIEF LINE S 10
H6837R	Y	8	RELIEF LINE S 10
H4049R	B	12	RELIEF LINE S 10
H6040R	Y	12	RELIEF LINE S 10
H4242R	B	2	RELIEF LINE S 12
H7037R	Y	10	RELIEF LINE S 12
H5037R	B	10	RELIEF LINE S 12
H6242R	Y	2	RELIEF LINE S 12
H4442R	B	4	RELIEF LINE S 2
H6438R	Y	4	RELIEF LINE S 2
H4044R	B	12	RELIEF LINE S 2
H6033R	Y	12	RELIEF LINE S 2
H3100R	B	6	RELIEF LINE S 4
H3084R	Y	6	RELIEF LINE S 4
H6237R	Y	2	RELIEF LINE S 4
H4237R	B	2	RELIEF LINE S 4
H6433R	Y	4	RELIEF LINE S 6
H4842R	B	8	RELIEF LINE S 6
H6842R	Y	8	RELIEF LINE S 6
H4437R	B	4	RELIEF LINE S 6
H4610R	B	6	RELIEF LINE S 8
H7042R	Y	10	RELIEF LINE S 8
H6747R	Y	6	RELIEF LINE S 8

Item: 15

Failure: Open

Failure Effect: Flow through Vent to atmosphere. Unacceptable leak, with depletion of helium inventory.

Failure Detection: Elevated temperature/low pressure. Frosted valve.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4838R	B	8	RELIEF LINE H 10
H6838R	Y	8	RELIEF LINE H 10
H4057R	B	12	RELIEF LINE H 10
H6041R	Y	12	RELIEF LINE H 10
H4243R	B	2	RELIEF LINE H 12
H6243R	Y	2	RELIEF LINE H 12
H5038R	B	10	RELIEF LINE H 12
H7038R	Y	10	RELIEF LINE H 12
H4443R	B	4	RELIEF LINE H 2
H6034R	Y	12	RELIEF LINE H 2
H6439R	Y	4	RELIEF LINE H 2
H4045R	B	12	RELIEF LINE H 2
H4238R	B	2	RELIEF LINE H 4
H6238R	Y	2	RELIEF LINE H 4
H3099R	B	6	RELIEF LINE H 4
H3085R	Y	6	RELIEF LINE H 4
H4438R	B	4	RELIEF LINE H 6
H6434R	Y	4	RELIEF LINE H 6
H4843R	B	8	RELIEF LINE H 6
H6843R	Y	8	RELIEF LINE H 6
H6748R	Y	6	RELIEF LINE H 8
H5043R	B	10	RELIEF LINE H 8
H7043R	Y	10	RELIEF LINE H 8
H4611R	B	6	RELIEF LINE H 8
H4836R	B	8	RELIEF LINE M 10
H6836R	Y	8	RELIEF LINE M 10
H4048R	B	12	RELIEF LINE M 10
H6039R	Y	12	RELIEF LINE M 10
H6241R	Y	2	RELIEF LINE M 12
H5036R	B	10	RELIEF LINE M 12
H4241R	B	2	RELIEF LINE M 12
H7036R	Y	10	RELIEF LINE M 12
H6032R	Y	12	RELIEF LINE M 2
H4441R	B	4	RELIEF LINE M 2
H6437R	Y	4	RELIEF LINE M 2
H4043R	B	12	RELIEF LINE M 2
H3098R	B	6	RELIEF LINE M 4
H3083R	Y	6	RELIEF LINE M 4
H4236R	B	2	RELIEF LINE M 4
H6236R	Y	2	RELIEF LINE M 4
H4436R	B	4	RELIEF LINE M 6
H6432R	Y	4	RELIEF LINE M 6
H4841R	B	8	RELIEF LINE M 6

Valve #	Ring	Box	Nomenclature
H6841R	Y	8	RELIEF LINE M 6
H4609R	B	6	RELIEF LINE M 8
H6746R	Y	6	RELIEF LINE M 8
H5041R	B	10	RELIEF LINE M 8
H7041R	Y	10	RELIEF LINE M 8
H4052R	B	12	RELIEF LINE R 10
H6840R	Y	8	RELIEF LINE R 10
H4840R	B	8	RELIEF LINE R 10
H6043R	Y	12	RELIEF LINE R 10
H4245R	B	2	RELIEF LINE R 12
H6245R	Y	2	RELIEF LINE R 12
H5040R	B	10	RELIEF LINE R 12
H7040R	Y	10	RELIEF LINE R 12
H4047R	B	12	RELIEF LINE R 2
H6038R	Y	12	RELIEF LINE R 2
H6441R	Y	4	RELIEF LINE R 2
H4445R	B	4	RELIEF LINE R 2
H6240R	Y	2	RELIEF LINE R 4
H3102R	B	6	RELIEF LINE R 4
H3087R	Y	6	RELIEF LINE R 4
H4240R	B	2	RELIEF LINE R 4
H4440R	B	4	RELIEF LINE R 6
H6845R	Y	8	RELIEF LINE R 6
H6436R	Y	4	RELIEF LINE R 6
H4845R	B	8	RELIEF LINE R 6
H4613R	B	6	RELIEF LINE R 8
H6750R	Y	6	RELIEF LINE R 8
H5045R	B	10	RELIEF LINE R 8
H7045R	Y	10	RELIEF LINE R 8
H4837R	B	8	RELIEF LINE S 10
H6837R	Y	8	RELIEF LINE S 10
H4049R	B	12	RELIEF LINE S 10
H6040R	Y	12	RELIEF LINE S 10
H4242R	B	2	RELIEF LINE S 12
H7037R	Y	10	RELIEF LINE S 12
H5037R	B	10	RELIEF LINE S 12
H6242R	Y	2	RELIEF LINE S 12
H4442R	B	4	RELIEF LINE S 2
H6438R	Y	4	RELIEF LINE S 2
H4044R	B	12	RELIEF LINE S 2
H6033R	Y	12	RELIEF LINE S 2
H3100R	B	6	RELIEF LINE S 4
H3084R	Y	6	RELIEF LINE S 4
H6237R	Y	2	RELIEF LINE S 4
H4237R	B	2	RELIEF LINE S 4
H6433R	Y	4	RELIEF LINE S 6
H4842R	B	8	RELIEF LINE S 6
H6842R	Y	8	RELIEF LINE S 6
H4437R	B	4	RELIEF LINE S 6
H4610R	B	6	RELIEF LINE S 8
H7042R	Y	10	RELIEF LINE S 8
H6747R	Y	6	RELIEF LINE S 8

Valve #	Ring	Box	Nomenclature
H5042R	B	10	RELIEF LINE S 8
H4839R	B	8	RELIEF LINE U 10
H6839R	Y	8	RELIEF LINE U 10
H4051R	B	12	RELIEF LINE U 10
H6042R	Y	12	RELIEF LINE U 10
H4244R	B	2	RELIEF LINE U 12
H6244R	Y	2	RELIEF LINE U 12
H5039R	B	10	RELIEF LINE U 12
H7039R	Y	10	RELIEF LINE U 12
H6440R	Y	4	RELIEF LINE U 2
H4046R	B	12	RELIEF LINE U 2
H6035R	Y	12	RELIEF LINE U 2
H4444R	B	4	RELIEF LINE U 2
H4239R	B	2	RELIEF LINE U 4
H6239R	Y	2	RELIEF LINE U 4
H3103R	B	6	RELIEF LINE U 4
H3086R	Y	6	RELIEF LINE U 4
H4439R	B	4	RELIEF LINE U 6
H6435R	Y	4	RELIEF LINE U 6
H4844R	B	8	RELIEF LINE U 6
H6844R	Y	8	RELIEF LINE U 6
H7044R	Y	10	RELIEF LINE U 8
H4612R	B	6	RELIEF LINE U 8
H6749R	Y	6	RELIEF LINE U 8
H5044R	B	10	RELIEF LINE U 8

Valve #	Ring	Box	Nomenclature
H5042R	B	10	RELIEF LINE S 8
H4839R	B	8	RELIEF LINE U 10
H6839R	Y	8	RELIEF LINE U 10
H4051R	B	12	RELIEF LINE U 10
H6042R	Y	12	RELIEF LINE U 10
H4244R	B	2	RELIEF LINE U 12
H6244R	Y	2	RELIEF LINE U 12
H5039R	B	10	RELIEF LINE U 12
H7039R	Y	10	RELIEF LINE U 12
H6440R	Y	4	RELIEF LINE U 2
H4046R	B	12	RELIEF LINE U 2
H6035R	Y	12	RELIEF LINE U 2
H4444R	B	4	RELIEF LINE U 2
H4239R	B	2	RELIEF LINE U 4
H6239R	Y	2	RELIEF LINE U 4
H3103R	B	6	RELIEF LINE U 4
H3086R	Y	6	RELIEF LINE U 4
H4439R	B	4	RELIEF LINE U 6
H6435R	Y	4	RELIEF LINE U 6
H4844R	B	8	RELIEF LINE U 6
H6844R	Y	8	RELIEF LINE U 6
H7044R	Y	10	RELIEF LINE U 8
H4612R	B	6	RELIEF LINE U 8
H6749R	Y	6	RELIEF LINE U 8
H5044R	B	10	RELIEF LINE U 8

Item: 16 **Failure:** Open

Failure Effect: No impact. Headers open to warm Return. Vent checkvalve prevents flow.

Failure Detection: Detectable only with individual test.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6723R	Y	6	VENT RELIEF 8
H6827R	Y	8	VENT RELIEF 10
H4827R	B	8	VENT RELIEF 10
H5027R	B	10	VENT RELIEF 12
H7027R	Y	10	VENT RELIEF 12
H4061R	B	12	VENT RELIEF 2
H6051R	Y	12	VENT RELIEF 2
H4227R	B	2	VENT RELIEF 4
H6227R	Y	2	VENT RELIEF 4
H4427R	B	4	VENT RELIEF 6
H6452R	Y	4	VENT RELIEF 6
H4623R	B	6	VENT RELIEF 8

Failure Mode Effects Analysis

System: RHIC Cryogenic System
Operation Mode: Normal Operations

Item: 16

Failure: Closed

Failure Effect: No impact. Headers open to Return.

Failure Detection: Detectable only with individual test.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6723R	Y	6	VENT RELIEF 8
H6827R	Y	8	VENT RELIEF 10
H4827R	B	8	VENT RELIEF 10
H5027R	B	10	VENT RELIEF 12
H7027R	Y	10	VENT RELIEF 12
H4061R	B	12	VENT RELIEF 2
H6051R	Y	12	VENT RELIEF 2
H4227R	B	2	VENT RELIEF 4
H6227R	Y	2	VENT RELIEF 4
H4427R	B	4	VENT RELIEF 6
H6452R	Y	4	VENT RELIEF 6
H4623R	B	6	VENT RELIEF 8

Failure Mode Effects Analysis

System: RHIC Cryogenic System
Operation Mode: Normal Operations

Date: Tuesday, August 30, 1994

Item: 17

Failure: Full Scale High

Failure Effect: No impact. Instrumentation only with redundant sensors.

Failure Detection: Temperature indication unreasonably high.

Affected Components:

Valve #	Ring	Box	Nomenclature
TI4266H	B	2	CALIBRATED SENSOR H
TI4262H	B	2	CALIBRATED SENSOR H
TI4268H	B	2	CALIBRATED SENSOR R
TI4264H	B	2	CALIBRATED SENSOR R
TI4265H	B	2	CALIBRATED SENSOR S
TI4261H	B	2	CALIBRATED SENSOR S
TI4267H	B	2	CALIBRATED SENSOR U
TI4263H	B	2	CALIBRATED SENSOR U
TI4253H	B	2	CALIBRATED SNSR REC
TI4254H	B	2	CALIBRATED SNSR REC
TI4255H	B	2	SNSR RECLR LIQUID LI4
TI4476H	B	4	CALIBRATED SENSOR H
TI4472H	B	4	CALIBRATED SENSOR H
TI4478H	B	4	CALIBRATED SENSOR R
TI4474H	B	4	CALIBRATED SENSOR R
TI4475H	B	4	CALIBRATED SENSOR S
TI4471H	B	4	CALIBRATED SENSOR S
TI4477H	B	4	CALIBRATED SENSOR U
TI4473H	B	4	CALIBRATED SENSOR U
TI4464H	B	4	CALIBRATED SNSR REC
TI4454H	B	4	CALIBRATED SNSR REC
TI4470H	B	4	SNSR RECLR LIQUID LI4
TI4605H	B	6	CALIBRATED SENSOR H
TI4601H	B	6	CALIBRATED SENSOR H
TI4607H	B	6	CALIBRATED SENSOR R
TI4603H	B	6	CALIBRATED SENSOR R
TI4604H	B	6	CALIBRATED SENSOR S
TI4600H	B	6	CALIBRATED SENSOR S
TI4606H	B	6	CALIBRATED SENSOR U
TI4602H	B	6	CALIBRATED SENSOR U
TI3710H	B	6	CALIBRATED SNSR CIR
TI3711H	B	6	CALIBRATED SNSR CIR
TI3709H	B	6	CALIBRATED SNSR L. P.
TI3712H	B	6	CALIBRATED SNSR REC
TI3714H	B	6	CALIBRATED SNSR REC
TI4002H	B	6	SNSR RECLR LIQUID LI4
TI4862H	B	8	CALIBRATED SENSOR H
TI4866H	B	8	CALIBRATED SENSOR H
TI4864H	B	8	CALIBRATED SENSOR R
TI4868H	B	8	CALIBRATED SENSOR R
TI4861H	B	8	CALIBRATED SENSOR S
TI4865H	B	8	CALIBRATED SENSOR S
TI4863H	B	8	CALIBRATED SENSOR U

Valve #	Ring	Box	Nomenclature
TI4853H	B	8	CALIBRATED SNSR REC
TI4854H	B	8	CALIBRATED SNSR REC
TI4855H	B	8	SNSR RECLR LIQUID LI4
TI5094H	B	10	CALIBRATED SENSOR H
TI5098H	B	10	CALIBRATED SENSOR H
TI5096H	B	10	CALIBRATED SENSOR R
TI5100H	B	10	CALIBRATED SENSOR R
TI5093H	B	10	CALIBRATED SENSOR S
TI5097H	B	10	CALIBRATED SENSOR S
TI5095H	B	10	CALIBRATED SENSOR U
TI5099H	B	10	CALIBRATED SENSOR U
TI5053H	B	10	CALIBRATED SNSR REC
TI5054H	B	10	CALIBRATED SNSR REC
TI5087H	B	10	SNSR RECLR LIQUID LI5
TI4057H	B	12	CALIBRATED SENSOR H
TI4040H	B	12	CALIBRATED SENSOR H
TI4059H	B	12	CALIBRATED SENSOR R
TI4042H	B	12	CALIBRATED SENSOR R
TI4056H	B	12	CALIBRATED SENSOR S
TI4039H	B	12	CALIBRATED SENSOR S
TI4058H	B	12	CALIBRATED SENSOR U
TI4041H	B	12	CALIBRATED SENSOR U
TI4080H	B	12	CALIBRATED SNSR REC
TI4081H	B	12	CALIBRATED SNSR REC
TI4014H	B	12	SNSR RECLR LIQUID LI4
TI6264H	Y	2	CALIBRATED SENSOR H
TI6260H	Y	2	CALIBRATED SENSOR H
TI6266H	Y	2	CALIBRATED SENSOR R
TI6262H	Y	2	CALIBRATED SENSOR R
TI6263H	Y	2	CALIBRATED SENSOR S
TI6259H	Y	2	CALIBRATED SENSOR S
TI6265H	Y	2	CALIBRATED SENSOR U
TI6261H	Y	2	CALIBRATED SENSOR U
TI6251H	Y	2	CALIBRATED SNSR REC
TI6252H	Y	2	CALIBRATED SNSR REC
TI6258H	Y	2	SNSR RECLR LIQUID LI6
TI6488H	Y	4	CALIBRATED SENSOR H
TI6484H	Y	4	CALIBRATED SENSOR H
TI6490H	Y	4	CALIBRATED SENSOR R
TI6486H	Y	4	CALIBRATED SENSOR R
TI6487H	Y	4	CALIBRATED SENSOR S
TI6483H	Y	4	CALIBRATED SENSOR S
TI6489H	Y	4	CALIBRATED SENSOR U
TI6485H	Y	4	CALIBRATED SENSOR U
TI6475H	Y	4	CALIBRATED SNSR REC
TI6476H	Y	4	CALIBRATED SNSR REC
TI6477H	Y	4	SNSR RECLR LIQUID LI6
TI6705H	Y	6	CALIBRATED SENSOR H
TI6701H	Y	6	CALIBRATED SENSOR H
TI6707H	Y	6	CALIBRATED SENSOR R
TI6703H	Y	6	CALIBRATED SENSOR R
TI6704H	Y	6	CALIBRATED SENSOR S

Failure Mode Effects Analysis

System: RHIC Cryogenic System **Date:** Tuesday, August 30, 1994

Operation Mode: Normal Operations

Valve #	Ring	Box	Nomenclature
TI6700H	Y	6	CALIBRATED SENSOR S
TI6706H	Y	6	CALIBRATED SENSOR U
TI6702H	Y	6	CALIBRATED SENSOR U
TI3706H	Y	6	CALIBRATED SNSR CIR
TI3707H	Y	6	CALIBRATED SNSR CIR
TI3705H	Y	6	CALIBRATED SNSR L. P.
TI3708H	Y	6	CALIBRATED SNSR REC
TI3713H	Y	6	CALIBRATED SNSR REC
TI6605H	Y	6	SNSR RECLR LIQUID LI4
TI6862H	Y	8	CALIBRATED SENSOR H
TI6866H	Y	8	CALIBRATED SENSOR H
TI6864H	Y	8	CALIBRATED SENSOR R
TI6868H	Y	8	CALIBRATED SENSOR R
TI6861H	Y	8	CALIBRATED SENSOR S
TI6865H	Y	8	CALIBRATED SENSOR S
TI6863H	Y	8	CALIBRATED SENSOR U
TI6867H	Y	8	CALIBRATED SENSOR U
TI6853H	Y	8	CALIBRATED SNSR REC
TI6854H	Y	8	CALIBRATED SNSR REC
TI6860H	Y	8	SNSR RECLR LIQUID LI6
TI7062H	Y	10	CALIBRATED SENSOR H
TI7066H	Y	10	CALIBRATED SENSOR H
TI7064H	Y	10	CALIBRATED SENSOR R
TI7068H	Y	10	CALIBRATED SENSOR R
TI7061H	Y	10	CALIBRATED SENSOR S
TI7065H	Y	10	CALIBRATED SENSOR S
TI7063H	Y	10	CALIBRATED SENSOR U
TI7067H	Y	10	CALIBRATED SENSOR U
TI7053H	Y	10	CALIBRATED SNSR REC
TI7054H	Y	10	CALIBRATED SNSR REC
TI7055H	Y	10	SNSR RECLR LIQUID LI7
TI6064H	Y	12	CALIBRATED SENSOR H
TI6068H	Y	12	CALIBRATED SENSOR H
TI6066H	Y	12	CALIBRATED SENSOR R
TI6070H	Y	12	CALIBRATED SENSOR R
TI6063H	Y	12	CALIBRATED SENSOR S
TI6067H	Y	12	CALIBRATED SENSOR S
TI6065H	Y	12	CALIBRATED SENSOR U
TI6069H	Y	12	CALIBRATED SENSOR U
TI6055H	Y	12	CALIBRATED SNSR REC
TI6056H	Y	12	CALIBRATED SNSR REC
TI6057H	Y	12	SNSR RECLR LIQUID LI6

Item: 17 Failure: Full Scale Low

Failure Effect: No impact. Instrumentation only with redundant sensors.

Failure Detection: Zero temperature indication.

Affected Components:

Valve #	Ring	Box	Nomenclature
TI4266H	B	2	CALIBRATED SENSOR H
TI4262H	B	2	CALIBRATED SENSOR H
TI4268H	B	2	CALIBRATED SENSOR R
TI4264H	B	2	CALIBRATED SENSOR R
TI4265H	B	2	CALIBRATED SENSOR S
TI4261H	B	2	CALIBRATED SENSOR S
TI4267H	B	2	CALIBRATED SENSOR U
TI4263H	B	2	CALIBRATED SENSOR U
TI4253H	B	2	CALIBRATED SNSR REC
TI4254H	B	2	CALIBRATED SNSR REC
TI4255H	B	2	SNSR RECLR LIQUID LI4
TI4476H	B	4	CALIBRATED SENSOR H
TI4472H	B	4	CALIBRATED SENSOR H
TI4478H	B	4	CALIBRATED SENSOR R
TI4474H	B	4	CALIBRATED SENSOR R
TI4475H	B	4	CALIBRATED SENSOR S
TI4471H	B	4	CALIBRATED SENSOR S
TI4477H	B	4	CALIBRATED SENSOR U
TI4473H	B	4	CALIBRATED SENSOR U
TI4464H	B	4	CALIBRATED SNSR REC
TI4454H	B	4	CALIBRATED SNSR REC
TI4470H	B	4	SNSR RECLR LIQUID LI4
TI4605H	B	6	CALIBRATED SENSOR H
TI4601H	B	6	CALIBRATED SENSOR H
TI4607H	B	6	CALIBRATED SENSOR R
TI4603H	B	6	CALIBRATED SENSOR R
TI4604H	B	6	CALIBRATED SENSOR S
TI4600H	B	6	CALIBRATED SENSOR S
TI4606H	B	6	CALIBRATED SENSOR U
TI4602H	B	6	CALIBRATED SENSOR U
TI3710H	B	6	CALIBRATED SNSR CIR
TI3711H	B	6	CALIBRATED SNSR CIR
TI3709H	B	6	CALIBRATED SNSR L. P.
TI3712H	B	6	CALIBRATED SNSR REC
TI3714H	B	6	CALIBRATED SNSR REC
TI4002H	B	6	SNSR RECLR LIQUID LI4
TI4862H	B	8	CALIBRATED SENSOR H
TI4866H	B	8	CALIBRATED SENSOR H
TI4864H	B	8	CALIBRATED SENSOR R
TI4868H	B	8	CALIBRATED SENSOR R
TI4861H	B	8	CALIBRATED SENSOR S
TI4865H	B	8	CALIBRATED SENSOR S
TI4863H	B	8	CALIBRATED SENSOR U
TI4867H	B	8	CALIBRATED SENSOR U

Failure Mode Effects Analysis

System: RHIC Cryogenic System

Operation Mode: Normal Operations

Date: Tuesday, August 30, 1994

Valve #	Ring	Box	Nomenclature
TI4853H	B	8	CALIBRATED SNSR REC
TI4854H	B	8	CALIBRATED SNSR REC
TI4855H	B	8	SNSR RECLR LIQUID LI4
TI5094H	B	10	CALIBRATED SENSOR H
TI5098H	B	10	CALIBRATED SENSOR H
TI5096H	B	10	CALIBRATED SENSOR R
TI5100H	B	10	CALIBRATED SENSOR R
TI5093H	B	10	CALIBRATED SENSOR S
TI5097H	B	10	CALIBRATED SENSOR S
TI5095H	B	10	CALIBRATED SENSOR U
TI5099H	B	10	CALIBRATED SENSOR U
TI5053H	B	10	CALIBRATED SNSR REC
TI5054H	B	10	CALIBRATED SNSR REC
TI5087H	B	10	SNSR RECLR LIQUID LI5
TI4057H	B	12	CALIBRATED SENSOR H
TI4040H	B	12	CALIBRATED SENSOR H
TI4059H	B	12	CALIBRATED SENSOR R
TI4042H	B	12	CALIBRATED SENSOR R
TI4056H	B	12	CALIBRATED SENSOR S
TI4039H	B	12	CALIBRATED SENSOR S
TI4058H	B	12	CALIBRATED SENSOR U
TI4041H	B	12	CALIBRATED SENSOR U
TI4080H	B	12	CALIBRATED SNSR REC
TI4081H	B	12	CALIBRATED SNSR REC
TI4014H	B	12	SNSR RECLR LIQUID LI4
TI6264H	Y	2	CALIBRATED SENSOR H
TI6260H	Y	2	CALIBRATED SENSOR H
TI6266H	Y	2	CALIBRATED SENSOR R
TI6262H	Y	2	CALIBRATED SENSOR R
TI6263H	Y	2	CALIBRATED SENSOR S
TI6259H	Y	2	CALIBRATED SENSOR S
TI6265H	Y	2	CALIBRATED SENSOR U
TI6261H	Y	2	CALIBRATED SENSOR U
TI6251H	Y	2	CALIBRATED SNSR REC
TI6252H	Y	2	CALIBRATED SNSR REC
TI6258H	Y	2	SNSR RECLR LIQUID LI6
TI6488H	Y	4	CALIBRATED SENSOR H
TI6484H	Y	4	CALIBRATED SENSOR H
TI6490H	Y	4	CALIBRATED SENSOR R
TI6486H	Y	4	CALIBRATED SENSOR R
TI6487H	Y	4	CALIBRATED SENSOR S
TI6483H	Y	4	CALIBRATED SENSOR S
TI6489H	Y	4	CALIBRATED SENSOR U
TI6485H	Y	4	CALIBRATED SENSOR U
TI6475H	Y	4	CALIBRATED SNSR REC
TI6476H	Y	4	CALIBRATED SNSR REC
TI6477H	Y	4	SNSR RECLR LIQUID LI6
TI6705H	Y	6	CALIBRATED SENSOR H
TI6701H	Y	6	CALIBRATED SENSOR H
TI6707H	Y	6	CALIBRATED SENSOR R
TI6703H	Y	6	CALIBRATED SENSOR R
TI6704H	Y	6	CALIBRATED SENSOR S

Valve #	Ring	Box	Nomenclature
TI6700H	Y	6	CALIBRATED SENSOR S
TI6706H	Y	6	CALIBRATED SENSOR U
TI6702H	Y	6	CALIBRATED SENSOR U
TI3706H	Y	6	CALIBRATED SNSR CIR
TI3707H	Y	6	CALIBRATED SNSR CIR
TI3705H	Y	6	CALIBRATED SNSR L. P.
TI3708H	Y	6	CALIBRATED SNSR REC
TI3713H	Y	6	CALIBRATED SNSR REC
TI6605H	Y	6	SNSR RECLR LIQUID LI4
TI6862H	Y	8	CALIBRATED SENSOR H
TI6866H	Y	8	CALIBRATED SENSOR H
TI6864H	Y	8	CALIBRATED SENSOR R
TI6868H	Y	8	CALIBRATED SENSOR R
TI6861H	Y	8	CALIBRATED SENSOR S
TI6865H	Y	8	CALIBRATED SENSOR S
TI6863H	Y	8	CALIBRATED SENSOR U
TI6867H	Y	8	CALIBRATED SENSOR U
TI6853H	Y	8	CALIBRATED SNSR REC
TI6854H	Y	8	CALIBRATED SNSR REC
TI6860H	Y	8	SNSR RECLR LIQUID LI6
TI7062H	Y	10	CALIBRATED SENSOR H
TI7066H	Y	10	CALIBRATED SENSOR H
TI7064H	Y	10	CALIBRATED SENSOR R
TI7068H	Y	10	CALIBRATED SENSOR R
TI7061H	Y	10	CALIBRATED SENSOR S
TI7065H	Y	10	CALIBRATED SENSOR S
TI7063H	Y	10	CALIBRATED SENSOR U
TI7067H	Y	10	CALIBRATED SENSOR U
TI7053H	Y	10	CALIBRATED SNSR REC
TI7054H	Y	10	CALIBRATED SNSR REC
TI7055H	Y	10	SNSR RECLR LIQUID LI7
TI6064H	Y	12	CALIBRATED SENSOR H
TI6068H	Y	12	CALIBRATED SENSOR H
TI6066H	Y	12	CALIBRATED SENSOR R
TI6070H	Y	12	CALIBRATED SENSOR R
TI6063H	Y	12	CALIBRATED SENSOR S
TI6067H	Y	12	CALIBRATED SENSOR S
TI6065H	Y	12	CALIBRATED SENSOR U
TI6069H	Y	12	CALIBRATED SENSOR U
TI6055H	Y	12	CALIBRATED SNSR REC
TI6056H	Y	12	CALIBRATED SNSR REC
TI6057H	Y	12	SNSR RECLR LIQUID LI6

Failure Mode Effects Analysis

System: RHIC Cryogenic System
Operation Mode: Normal Operations

Item: 18

Failure: Open

Failure Effect: Not evaluated. Sensor not defined.

Failure Detection: Not evaluated. Sensor not defined.

Affected Components:

Valve #	Ring	Box	Nomenclature
PI3741H	Y	6	PRESSURE INDICATOR
PI3744H	B	6	PRESSURE INDICATOR
PI3714H	Y	6	PRESSURE INDICATOR
PI3716H	B	6	PRESSURE INDICATOR
PI3715H	Y	6	PRESSURE INDICATOR
PI3717H	B	6	PRESSURE INDICATOR
PI3720H	B	6	PRESSURE INDICATOR
PI3725H	B	4	PRESSURE INDICATOR
PI3730H	B	10	PRESSURE INDICATOR
PI3735H	B	2	PRESSURE INDICATOR
PI3748H	B	8	PRESSURE INDICATOR
PI3753H	Y	2	PRESSURE INDICATOR
PI4065H	B	12	PRESSURE INDICATOR
PI6059H	Y	6	PRESSURE INDICATOR
PI6064H	Y	12	PRESSURE INDICATOR
PI6428H	Y	4	PRESSURE INDICATOR
PI6856H	Y	8	PRESSURE INDICATOR
PI7056H	Y	10	PRESSURE INDICATOR
PI4849H	B	8	PRESSURE INDICATOR
PI6849H	Y	8	PRESSURE INDICATOR
PI4060H	B	12	PRESSURE INDICATOR
PI6055H	Y	12	PRESSURE INDICATOR
PI5049H	B	10	PRESSURE INDICATOR
PI7049H	Y	10	PRESSURE INDICATOR
PI4252H	B	2	PRESSURE INDICATOR
PI6251H	Y	2	PRESSURE INDICATOR
PI4058H	B	12	PRESSURE INDICATOR
PI6053H	Y	12	PRESSURE INDICATOR
PI4452H	B	4	PRESSURE INDICATOR
PI6425H	Y	4	PRESSURE INDICATOR
PI4249H	B	2	PRESSURE INDICATOR
PI6249H	Y	2	PRESSURE INDICATOR
PI3708H	Y	6	PRESSURE INDICATOR
PI3713H	B	6	PRESSURE INDICATOR
PI4450H	B	4	PRESSURE INDICATOR
PI6418H	Y	4	PRESSURE INDICATOR
PI4853H	B	8	PRESSURE INDICATOR
PI6851H	Y	8	PRESSURE INDICATOR
PI3704H	Y	6	PRESSURE INDICATOR
PI3709H	B	6	PRESSURE INDICATOR
PI5062H	B	10	PRESSURE INDICATOR
PI7051H	Y	10	PRESSURE INDICATOR
PI3707H	Y	6	PRESSURE INDICATOR

Failure Mode Effects Analysis

System: RHIC Cryogenic System **Date:** Tuesday, August 30, 1994

Operation Mode: Normal Operations

Valve #	Ring	Box	Nomenclature
PI4850H	B	8	PRESSURE INDICATOR
PI6850H	Y	8	PRESSURE INDICATOR
PI4063H	B	12	PRESSURE INDICATOR
PI6062H	Y	12	PRESSURE INDICATOR
PI5051H	B	10	PRESSURE INDICATOR
PI7050H	Y	10	PRESSURE INDICATOR
PI3733H	B	2	PRESSURE INDICATOR
PI3751H	Y	2	PRESSURE INDICATOR
PI4059H	B	12	PRESSURE INDICATOR
PI6054H	Y	12	PRESSURE INDICATOR
PI3723H	B	4	PRESSURE INDICATOR
PI6426H	Y	4	PRESSURE INDICATOR
PI4251H	B	2	PRESSURE INDICATOR
PI6250H	Y	2	PRESSURE INDICATOR
PI3718H	B	6	PRESSURE INDICATOR
PI6057H	Y	6	PRESSURE INDICATOR
PI4451H	B	4	PRESSURE INDICATOR
PI6424H	Y	4	PRESSURE INDICATOR
PI3746H	B	8	PRESSURE INDICATOR
PI6854H	Y	8	PRESSURE INDICATOR
PI3728H	B	10	PRESSURE INDICATOR
PI7054H	Y	10	PRESSURE INDICATOR
PI3738H	Y	6	PRESSURE INDICATOR
PI3742H	B	6	PRESSURE INDICATOR
PI3722H	B	6	PRESSURE INDICATOR
PI3727H	B	4	PRESSURE INDICATOR
PI3732H	B	10	PRESSURE INDICATOR
PI3737H	B	2	PRESSURE INDICATOR
PI3750H	B	8	PRESSURE INDICATOR
PI3755H	Y	2	PRESSURE INDICATOR
PI4067H	B	12	PRESSURE INDICATOR
PI6061H	Y	6	PRESSURE INDICATOR
PI6066H	Y	12	PRESSURE INDICATOR
PI6430H	Y	4	PRESSURE INDICATOR
PI6858H	Y	8	PRESSURE INDICATOR
PI7058H	Y	10	PRESSURE INDICATOR
PI4851H	B	8	PRESSURE INDICATOR
PI6853H	Y	8	PRESSURE INDICATOR
PI4064H	B	12	PRESSURE INDICATOR
PI6063H	Y	12	PRESSURE INDICATOR
PI5050H	B	10	PRESSURE INDICATOR
PI7053H	Y	10	PRESSURE INDICATOR
PI3734H	B	2	PRESSURE INDICATOR
PI3752H	Y	2	PRESSURE INDICATOR
PI4062H	B	12	PRESSURE INDICATOR
PI6073H	Y	12	PRESSURE INDICATOR
PI3724H	B	4	PRESSURE INDICATOR
PI6427H	Y	4	PRESSURE INDICATOR
PI4253H	B	2	PRESSURE INDICATOR
PI6252H	Y	2	PRESSURE INDICATOR
PI3719H	B	6	PRESSURE INDICATOR
PI6058H	Y	6	PRESSURE INDICATOR

Valve #	Ring	Box	Nomenclature
PI4453H	B	4	PRESSURE INDICATOR
PI6423H	Y	4	PRESSURE INDICATOR
PI3747H	B	8	PRESSURE INDICATOR
PI6855H	Y	8	PRESSURE INDICATOR
PI3739H	Y	6	PRESSURE INDICATOR
PI3745H	B	6	PRESSURE INDICATOR
PI3729H	B	10	PRESSURE INDICATOR
PI7055H	Y	10	PRESSURE INDICATOR
PI3706H	Y	6	PRESSURE INDICATOR
PI3711H	B	6	PRESSURE INDICATOR
PI3705H	Y	6	PRESSURE INDICATOR
PI3710H	B	6	PRESSURE INDICATOR
PI3740H	Y	6	PRESSURE INDICATOR
PI3743H	B	6	PRESSURE INDICATOR
PI4250H	B	2	PRESSURE INDICATOR
PI4449H	B	4	PRESSURE INDICATOR
PI4852H	B	8	PRESSURE INDICATOR
PI5063H	B	10	PRESSURE INDICATOR
PI6248H	Y	2	PRESSURE INDICATOR
PI6413H	Y	4	PRESSURE INDICATOR
PI6852H	Y	8	PRESSURE INDICATOR
PI7052H	Y	10	PRESSURE INDICATOR
PI4061H	B	12	PRESSURE INDICATOR
PI6056H	Y	12	PRESSURE INDICATOR
PI4057H	B	12	PRESSURE INDICATOR
PI6052H	Y	12	PRESSURE INDICATOR
PI3721H	B	6	PRESSURE INDICATOR
PI3726H	B	4	PRESSURE INDICATOR
PI3731H	B	10	PRESSURE INDICATOR
PI3736H	B	2	PRESSURE INDICATOR
PI3749H	B	8	PRESSURE INDICATOR
PI3754H	Y	2	PRESSURE INDICATOR
PI4066H	B	12	PRESSURE INDICATOR
PI6060H	Y	6	PRESSURE INDICATOR
PI6065H	Y	12	PRESSURE INDICATOR
PI6429H	Y	4	PRESSURE INDICATOR
PI6857H	Y	8	PRESSURE INDICATOR
PI7057H	Y	10	PRESSURE INDICATOR

Item: 18 **Failure:** Closed

Failure Effect: Not evaluated. Sensor not defined.

Failure Detection: Not evaluated. Sensor not defined.

Affected Components:

Valve #	Ring	Box	Nomenclature
PI3741H	Y	6	PRESSURE INDICATOR
PI3744H	B	6	PRESSURE INDICATOR
PI3714H	Y	6	PRESSURE INDICATOR
PI3716H	B	6	PRESSURE INDICATOR
PI3715H	Y	6	PRESSURE INDICATOR
PI3717H	B	6	PRESSURE INDICATOR
PI3720H	B	6	PRESSURE INDICATOR
PI3725H	B	4	PRESSURE INDICATOR
PI3730H	B	10	PRESSURE INDICATOR
PI3735H	B	2	PRESSURE INDICATOR
PI3748H	B	8	PRESSURE INDICATOR
PI3753H	Y	2	PRESSURE INDICATOR
PI4065H	B	12	PRESSURE INDICATOR
PI6059H	Y	6	PRESSURE INDICATOR
PI6064H	Y	12	PRESSURE INDICATOR
PI6428H	Y	4	PRESSURE INDICATOR
PI6856H	Y	8	PRESSURE INDICATOR
PI7056H	Y	10	PRESSURE INDICATOR
PI4849H	B	8	PRESSURE INDICATOR
PI6849H	Y	8	PRESSURE INDICATOR
PI4060H	B	12	PRESSURE INDICATOR
PI6055H	Y	12	PRESSURE INDICATOR
PI5049H	B	10	PRESSURE INDICATOR
PI7049H	Y	10	PRESSURE INDICATOR
PI4252H	B	2	PRESSURE INDICATOR
PI6251H	Y	2	PRESSURE INDICATOR
PI4058H	B	12	PRESSURE INDICATOR
PI6053H	Y	12	PRESSURE INDICATOR
PI4452H	B	4	PRESSURE INDICATOR
PI6425H	Y	4	PRESSURE INDICATOR
PI4249H	B	2	PRESSURE INDICATOR
PI6249H	Y	2	PRESSURE INDICATOR
PI3708H	Y	6	PRESSURE INDICATOR
PI3713H	B	6	PRESSURE INDICATOR
PI4450H	B	4	PRESSURE INDICATOR
PI6418H	Y	4	PRESSURE INDICATOR
PI4853H	B	8	PRESSURE INDICATOR
PI6851H	Y	8	PRESSURE INDICATOR
PI3704H	Y	6	PRESSURE INDICATOR
PI3709H	B	6	PRESSURE INDICATOR
PI5062H	B	10	PRESSURE INDICATOR
PI7051H	Y	10	PRESSURE INDICATOR
PI3707H	Y	6	PRESSURE INDICATOR
PI3712H	B	6	PRESSURE INDICATOR

Valve #	Ring	Box	Nomenclature
PI4850H	B	8	PRESSURE INDICATOR
PI6850H	Y	8	PRESSURE INDICATOR
PI4063H	B	12	PRESSURE INDICATOR
PI6062H	Y	12	PRESSURE INDICATOR
PI5051H	B	10	PRESSURE INDICATOR
PI7050H	Y	10	PRESSURE INDICATOR
PI3733H	B	2	PRESSURE INDICATOR
PI3751H	Y	2	PRESSURE INDICATOR
PI4059H	B	12	PRESSURE INDICATOR
PI6054H	Y	12	PRESSURE INDICATOR
PI3723H	B	4	PRESSURE INDICATOR
PI6426H	Y	4	PRESSURE INDICATOR
PI4251H	B	2	PRESSURE INDICATOR
PI6250H	Y	2	PRESSURE INDICATOR
PI3718H	B	6	PRESSURE INDICATOR
PI6057H	Y	6	PRESSURE INDICATOR
PI4451H	B	4	PRESSURE INDICATOR
PI6424H	Y	4	PRESSURE INDICATOR
PI3746H	B	8	PRESSURE INDICATOR
PI6854H	Y	8	PRESSURE INDICATOR
PI3728H	B	10	PRESSURE INDICATOR
PI7054H	Y	10	PRESSURE INDICATOR
PI3738H	Y	6	PRESSURE INDICATOR
PI3742H	B	6	PRESSURE INDICATOR
PI3722H	B	6	PRESSURE INDICATOR
PI3727H	B	4	PRESSURE INDICATOR
PI3732H	B	10	PRESSURE INDICATOR
PI3737H	B	2	PRESSURE INDICATOR
PI3750H	B	8	PRESSURE INDICATOR
PI3755H	Y	2	PRESSURE INDICATOR
PI4067H	B	12	PRESSURE INDICATOR
PI6061H	Y	6	PRESSURE INDICATOR
PI6066H	Y	12	PRESSURE INDICATOR
PI6430H	Y	4	PRESSURE INDICATOR
PI6858H	Y	8	PRESSURE INDICATOR
PI7058H	Y	10	PRESSURE INDICATOR
PI4851H	B	8	PRESSURE INDICATOR
PI6853H	Y	8	PRESSURE INDICATOR
PI4064H	B	12	PRESSURE INDICATOR
PI6063H	Y	12	PRESSURE INDICATOR
PI5050H	B	10	PRESSURE INDICATOR
PI7053H	Y	10	PRESSURE INDICATOR
PI3734H	B	2	PRESSURE INDICATOR
PI3752H	Y	2	PRESSURE INDICATOR
PI4062H	B	12	PRESSURE INDICATOR
PI6073H	Y	12	PRESSURE INDICATOR
PI3724H	B	4	PRESSURE INDICATOR
PI6427H	Y	4	PRESSURE INDICATOR
PI4253H	B	2	PRESSURE INDICATOR
PI6252H	Y	2	PRESSURE INDICATOR
PI3719H	B	6	PRESSURE INDICATOR
PI6058H	Y	6	PRESSURE INDICATOR

Valve #	Ring	Box	Nomenclature
PI4453H	B	4	PRESSURE INDICATOR
PI6423H	Y	4	PRESSURE INDICATOR
PI3747H	B	8	PRESSURE INDICATOR
PI6855H	Y	8	PRESSURE INDICATOR
PI3739H	Y	6	PRESSURE INDICATOR
PI3745H	B	6	PRESSURE INDICATOR
PI3729H	B	10	PRESSURE INDICATOR
PI7055H	Y	10	PRESSURE INDICATOR
PI3706H	Y	6	PRESSURE INDICATOR
PI3711H	B	6	PRESSURE INDICATOR
PI3705H	Y	6	PRESSURE INDICATOR
PI3710H	B	6	PRESSURE INDICATOR
PI3740H	Y	6	PRESSURE INDICATOR
PI3743H	B	6	PRESSURE INDICATOR
PI4250H	B	2	PRESSURE INDICATOR
PI4449H	B	4	PRESSURE INDICATOR
PI4852H	B	8	PRESSURE INDICATOR
PI5063H	B	10	PRESSURE INDICATOR
PI6248H	Y	2	PRESSURE INDICATOR
PI6413H	Y	4	PRESSURE INDICATOR
PI6852H	Y	8	PRESSURE INDICATOR
PI7052H	Y	10	PRESSURE INDICATOR
PI4061H	B	12	PRESSURE INDICATOR
PI6056H	Y	12	PRESSURE INDICATOR
PI4057H	B	12	PRESSURE INDICATOR
PI6052H	Y	12	PRESSURE INDICATOR
PI3721H	B	6	PRESSURE INDICATOR
PI3726H	B	4	PRESSURE INDICATOR
PI3731H	B	10	PRESSURE INDICATOR
PI3736H	B	2	PRESSURE INDICATOR
PI3749H	B	8	PRESSURE INDICATOR
PI3754H	Y	2	PRESSURE INDICATOR
PI4066H	B	12	PRESSURE INDICATOR
PI6060H	Y	6	PRESSURE INDICATOR
PI6065H	Y	12	PRESSURE INDICATOR
PI6429H	Y	4	PRESSURE INDICATOR
PI6857H	Y	8	PRESSURE INDICATOR
PI7057H	Y	10	PRESSURE INDICATOR

Failure Mode Effects Analysis

System: RHIC Cryogenic System
Operation Mode: Normal Operations

Item: 19

Failure: Open

Failure Effect: No impact. Normal operating position. Leakage during Pressure Indicator replacement.

Failure Detection: Manual valve. Visual detection. Escaping gas during pressure indicator removal.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6741M	Y	6	ISOLATION PI3704H
H6744M	Y	6	ISOLATION PI3705H
H6743M	Y	6	ISOLATION PI3706H
H6742M	Y	6	ISOLATION PI3707H
H6753M	Y	6	ISOLATION PI3708H
H6754M	B	6	ISOLATION PI3709H
H6757M	B	6	ISOLATION PI3710H
H6756M	B	6	ISOLATION PI3711H
H6755M	B	6	ISOLATION PI3712H
H6760M	B	6	ISOLATION PI3713H
H6751M	Y	6	ISOLATION PI3714H
H6758M	B	6	ISOLATION PI3716H
H6775M	B	6	ISOLATION PI3718H
H6776M	B	6	ISOLATION PI3719H
H6777M	B	6	ISOLATION PI3720H
H6778M	B	6	ISOLATION PI3721H
H6779M	B	6	ISOLATION PI3722H
H6770M	B	4	ISOLATION PI3723H
H6771M	B	4	ISOLATION PI3724H
H6772M	B	4	ISOLATION PI3725H
H6773M	B	4	ISOLATION PI3726H
H6774M	B	4	ISOLATION PI3727H
H3238M	B	10	ISOLATION PI3728H
H3239M	B	10	ISOLATION PI3729H
H3240M	B	10	ISOLATION PI3730H
H3241M	B	10	ISOLATION PI3731H
H3242M	B	10	ISOLATION PI3732H
H6765M	B	2	ISOLATION PI3733H
H6766M	B	2	ISOLATION PI3734H
H6767M	B	2	ISOLATION PI3735H
H6768M	B	2	ISOLATION PI3736H
H6769M	B	2	ISOLATION PI3737H
H6640M	Y	6	ISOLATION PI3738H
H6763M	Y	6	ISOLATION PI3739H
H6727M	Y	6	ISOLATION PI3740H
H6729M	Y	6	ISOLATION PI3741H
H6734M	B	6	ISOLATION PI3742H
H3234M	B	6	ISOLATION PI3743H
H3236M	B	6	ISOLATION PI3744H
H6814M	B	6	ISOLATION PI3745H
H4553M	B	8	ISOLATION PI3746H
H4554M	B	8	ISOLATION PI3747H

Valve #	Ring	Box	Nomenclature
H4555M	B	8	ISOLATION PI3748H
H4556M	B	8	ISOLATION PI3749H
H4557M	B	8	ISOLATION PI3750H
H3116M	Y	2	ISOLATION PI3751H
H3117M	Y	2	ISOLATION PI3752H
H3118M	Y	2	ISOLATION PI3753H
H3119M	Y	2	ISOLATION PI3754H
H3120M	Y	2	ISOLATION PI3755H
H6919M	B	12	ISOLATION PI4057H
H6920M	B	12	ISOLATION PI4058H
H6921M	B	12	ISOLATION PI4059H
H6922M	B	12	ISOLATION PI4060H
H4013M	B	12	ISOLATION PI4061H
H4028M	B	12	ISOLATION PI4062H
H6694M	B	12	ISOLATION PI4063H
H6695M	B	12	ISOLATION PI4064H
H6696M	B	12	ISOLATION PI4065H
H6697M	B	12	ISOLATION PI4066H
H6698M	B	12	ISOLATION PI4067H
H6907M	B	2	ISOLATION PI4249H
H6908M	B	2	ISOLATION PI4250H
H4213M	B	2	ISOLATION PI4251H
H6909M	B	2	ISOLATION PI4252H
H4251M	B	2	ISOLATION PI4253H
H6910M	B	4	ISOLATION PI4449H
H6911M	B	4	ISOLATION PI4450H
H4414M	B	4	ISOLATION PI4451H
H6912M	B	4	ISOLATION PI4452H
H4429M	B	4	ISOLATION PI4453H
H6913M	B	8	ISOLATION PI4849H
H4828M	B	8	ISOLATION PI4850H
H6914M	B	8	ISOLATION PI4851H
H6915M	B	8	ISOLATION PI4852H
H4861M	B	8	ISOLATION PI4853H
H6916M	B	10	ISOLATION PI5049H
H5054M	B	10	ISOLATION PI5050H
H5280M	B	10	ISOLATION PI5051H
H6917M	B	10	ISOLATION PI5062H
H6918M	B	10	ISOLATION PI5063H
H6903M	Y	12	ISOLATION PI6052H
H6904M	Y	12	ISOLATION PI6053H
H6905M	Y	12	ISOLATION PI6054H
H6906M	Y	12	ISOLATION PI6055H
H6027M	Y	12	ISOLATION PI6056H
H6724M	Y	6	ISOLATION PI6057H
H6725M	Y	6	ISOLATION PI6058H
H6787M	Y	6	ISOLATION PI6059H
H6788M	Y	6	ISOLATION PI6060H
H6789M	Y	6	ISOLATION PI6061H
H6091M	Y	12	ISOLATION PI6062H
H6092M	Y	12	ISOLATION PI6063H
H6093M	Y	12	ISOLATION PI6064H

Valve #	Ring	Box	Nomenclature
H6094M	Y	12	ISOLATION PI6065H
H6095M	Y	12	ISOLATION PI6066H
H6053M	Y	12	ISOLATION PI6073H
H6790M	Y	2	ISOLATION PI6248H
H6791M	Y	2	ISOLATION PI6249H
H6259M	Y	2	ISOLATION PI6250H
H6792M	Y	2	ISOLATION PI6251H
H6257M	Y	2	ISOLATION PI6252H
H6793M	Y	4	ISOLATION PI6413H
H6794M	Y	4	ISOLATION PI6418H
H6795M	Y	4	ISOLATION PI6423H
H6407M	Y	4	ISOLATION PI6424H
H6425M	Y	4	ISOLATION PI6425H
H6427M	Y	4	ISOLATION PI6426H
H6428M	Y	4	ISOLATION PI6427H
H6429M	Y	4	ISOLATION PI6428H
H6446M	Y	4	ISOLATION PI6429H
H6447M	Y	4	ISOLATION PI6430H
H6796M	Y	8	ISOLATION PI6849H
H6861M	Y	8	ISOLATION PI6850H
H6797M	Y	8	ISOLATION PI6851H
H6798M	Y	8	ISOLATION PI6852H
H6866M	Y	8	ISOLATION PI6853H
H6849M	Y	8	ISOLATION PI6854H
H6850M	Y	8	ISOLATION PI6855H
H6851M	Y	8	ISOLATION PI6856H
H6852M	Y	8	ISOLATION PI6857H
H6853M	Y	8	ISOLATION PI6858H
H6900M	Y	10	ISOLATION PI7049H
H6901M	Y	10	ISOLATION PI7050H
H6902M	Y	10	ISOLATION PI7051H
H7063M	Y	10	ISOLATION PI7052H
H7070M	Y	10	ISOLATION PI7053H
H7013M	Y	10	ISOLATION PI7054H
H7014M	Y	10	ISOLATION PI7055H
H7019M	Y	10	ISOLATION PI7056H
H7026M	Y	10	ISOLATION PI7057H
H7033M	Y	10	ISOLATION PI7058H

Failure Mode Effects Analysis

System: RHIC Cryogenic System
Operation Mode: Normal Operations

Date: Tuesday, August 30, 1994

Item: 19

Failure: Closed

Failure Effect: No pressure indication or constant pressure indication. No hazard; relief valves safe system.

Failure Detection: No pressure indication or constant pressure indication.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6741M	Y	6	ISOLATION PI3704H
H6744M	Y	6	ISOLATION PI3705H
H6743M	Y	6	ISOLATION PI3706H
H6742M	Y	6	ISOLATION PI3707H
H6753M	Y	6	ISOLATION PI3708H
H6754M	B	6	ISOLATION PI3709H
H6757M	B	6	ISOLATION PI3710H
H6756M	B	6	ISOLATION PI3711H
H6755M	B	6	ISOLATION PI3712H
H6760M	B	6	ISOLATION PI3713H
H6751M	Y	6	ISOLATION PI3714H
H6758M	B	6	ISOLATION PI3716H
H6775M	B	6	ISOLATION PI3718H
H6776M	B	6	ISOLATION PI3719H
H6777M	B	6	ISOLATION PI3720H
H6778M	B	6	ISOLATION PI3721H
H6779M	B	6	ISOLATION PI3722H
H6770M	B	4	ISOLATION PI3723H
H6771M	B	4	ISOLATION PI3724H
H6772M	B	4	ISOLATION PI3725H
H6773M	B	4	ISOLATION PI3726H
H6774M	B	4	ISOLATION PI3727H
H3238M	B	10	ISOLATION PI3728H
H3239M	B	10	ISOLATION PI3729H
H3240M	B	10	ISOLATION PI3730H
H3241M	B	10	ISOLATION PI3731H
H3242M	B	10	ISOLATION PI3732H
H6765M	B	2	ISOLATION PI3733H
H6766M	B	2	ISOLATION PI3734H
H6767M	B	2	ISOLATION PI3735H
H6768M	B	2	ISOLATION PI3736H
H6769M	B	2	ISOLATION PI3737H
H6640M	Y	6	ISOLATION PI3738H
H6763M	Y	6	ISOLATION PI3739H
H6727M	Y	6	ISOLATION PI3740H
H6729M	Y	6	ISOLATION PI3741H
H6734M	B	6	ISOLATION PI3742H
H3234M	B	6	ISOLATION PI3743H
H3236M	B	6	ISOLATION PI3744H
H6814M	B	6	ISOLATION PI3745H
H4553M	B	8	ISOLATION PI3746H
H4554M	B	8	ISOLATION PI3747H
H4555M	B	8	ISOLATION PI3748H

Valve #	Ring	Box	Nomenclature
H4556M	B	8	ISOLATION PI3749H
H4557M	B	8	ISOLATION PI3750H
H3116M	Y	2	ISOLATION PI3751H
H3117M	Y	2	ISOLATION PI3752H
H3118M	Y	2	ISOLATION PI3753H
H3119M	Y	2	ISOLATION PI3754H
H3120M	Y	2	ISOLATION PI3755H
H6919M	B	12	ISOLATION PI4057H
H6920M	B	12	ISOLATION PI4058H
H6921M	B	12	ISOLATION PI4059H
H6922M	B	12	ISOLATION PI4060H
H4013M	B	12	ISOLATION PI4061H
H4028M	B	12	ISOLATION PI4062H
H6694M	B	12	ISOLATION PI4063H
H6695M	B	12	ISOLATION PI4064H
H6696M	B	12	ISOLATION PI4065H
H6697M	B	12	ISOLATION PI4066H
H6698M	B	12	ISOLATION PI4067H
H6907M	B	2	ISOLATION PI4249H
H6908M	B	2	ISOLATION PI4250H
H4213M	B	2	ISOLATION PI4251H
H6909M	B	2	ISOLATION PI4252H
H4251M	B	2	ISOLATION PI4253H
H6910M	B	4	ISOLATION PI4449H
H6911M	B	4	ISOLATION PI4450H
H4414M	B	4	ISOLATION PI4451H
H6912M	B	4	ISOLATION PI4452H
H4429M	B	4	ISOLATION PI4453H
H6913M	B	8	ISOLATION PI4849H
H4828M	B	8	ISOLATION PI4850H
H6914M	B	8	ISOLATION PI4851H
H6915M	B	8	ISOLATION PI4852H
H4861M	B	8	ISOLATION PI4853H
H6916M	B	10	ISOLATION PI5049H
H5054M	B	10	ISOLATION PI5050H
H5280M	B	10	ISOLATION PI5051H
H6917M	B	10	ISOLATION PI5062H
H6918M	B	10	ISOLATION PI5063H
H6903M	Y	12	ISOLATION PI6052H
H6904M	Y	12	ISOLATION PI6053H
H6905M	Y	12	ISOLATION PI6054H
H6906M	Y	12	ISOLATION PI6055H
H6027M	Y	12	ISOLATION PI6056H
H6724M	Y	6	ISOLATION PI6057H
H6725M	Y	6	ISOLATION PI6058H
H6787M	Y	6	ISOLATION PI6059H
H6788M	Y	6	ISOLATION PI6060H
H6789M	Y	6	ISOLATION PI6061H
H6091M	Y	12	ISOLATION PI6062H
H6092M	Y	12	ISOLATION PI6063H
H6093M	Y	12	ISOLATION PI6064H
H6094M	Y	12	ISOLATION PI6065H

Valve #	Ring	Box	Nomenclature
H6095M	Y	12	ISOLATION PI6066H
H6053M	Y	12	ISOLATION PI6073H
H6790M	Y	2	ISOLATION PI6248H
H6791M	Y	2	ISOLATION PI6249H
H6259M	Y	2	ISOLATION PI6250H
H6792M	Y	2	ISOLATION PI6251H
H6257M	Y	2	ISOLATION PI6252H
H6793M	Y	4	ISOLATION PI6413H
H6794M	Y	4	ISOLATION PI6418H
H6795M	Y	4	ISOLATION PI6423H
H6407M	Y	4	ISOLATION PI6424H
H6425M	Y	4	ISOLATION PI6425H
H6427M	Y	4	ISOLATION PI6426H
H6428M	Y	4	ISOLATION PI6427H
H6429M	Y	4	ISOLATION PI6428H
H6446M	Y	4	ISOLATION PI6429H
H6447M	Y	4	ISOLATION PI6430H
H6796M	Y	8	ISOLATION PI6849H
H6861M	Y	8	ISOLATION PI6850H
H6797M	Y	8	ISOLATION PI6851H
H6798M	Y	8	ISOLATION PI6852H
H6866M	Y	8	ISOLATION PI6853H
H6849M	Y	8	ISOLATION PI6854H
H6850M	Y	8	ISOLATION PI6855H
H6851M	Y	8	ISOLATION PI6856H
H6852M	Y	8	ISOLATION PI6857H
H6853M	Y	8	ISOLATION PI6858H
H6900M	Y	10	ISOLATION PI7049H
H6901M	Y	10	ISOLATION PI7050H
H6902M	Y	10	ISOLATION PI7051H
H7063M	Y	10	ISOLATION PI7052H
H7070M	Y	10	ISOLATION PI7053H
H7013M	Y	10	ISOLATION PI7054H
H7014M	Y	10	ISOLATION PI7055H
H7019M	Y	10	ISOLATION PI7056H
H7026M	Y	10	ISOLATION PI7057H
H7033M	Y	10	ISOLATION PI7058H

Item: 20 Failure: Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally open valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4642A	B	6	ISOLATION CIRCULATO
H6739A	Y	6	ISOLATION CIRCULATO
H4641A	B	6	ISOLATION CIRCULATO
H6740A	Y	6	ISOLATION CIRCULATO
H6400A L	Y	4	ISOLATION M
H6800A L	Y	8	ISOLATION M
H4200A L	B	2	ISOLATION M
H4800A L	B	8	ISOLATION M
H5000A L	B	10	ISOLATION M
H7000A L	Y	10	ISOLATION M
H4000A L	B	12	ISOLATION M
H6000A L	Y	12	ISOLATION M
H4400A L	B	4	ISOLATION M
H6200A L	Y	2	ISOLATION M
H4500A L	B	6	ISOLATION M 4
H6600A L	Y	6	ISOLATION M 4

Item: 20 Failure: Closed

Failure Effect: No circulation. Magnet temperature rises with subsequent magnet quench.

Failure Detection: Normally open valve. Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4642A	B	6	ISOLATION CIRCULATO
H6739A	Y	6	ISOLATION CIRCULATO
H4641A	B	6	ISOLATION CIRCULATO
H6740A	Y	6	ISOLATION CIRCULATO
H6400A L	Y	4	ISOLATION M
H6800A L	Y	8	ISOLATION M
H4200A L	B	2	ISOLATION M
H4800A L	B	8	ISOLATION M
H5000A L	B	10	ISOLATION M
H7000A L	Y	10	ISOLATION M
H4000A L	B	12	ISOLATION M
H6000A L	Y	12	ISOLATION M
H4400A L	B	4	ISOLATION M
H6200A L	Y	2	ISOLATION M
H4500A L	B	6	ISOLATION M 4
H6600A L	Y	6	ISOLATION M 4

Item: 21 **Failure:** Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6759M	B	6	ISOLATION DELTA P IN
H6752M	Y	6	ISOLATION DELTA P IN

Item: 21 **Failure:** Closed

Failure Effect: No flow indication.

Failure Detection: Manual valve. No flow indication. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6759M	B	6	ISOLATION DELTA P IN
H6752M	Y	6	ISOLATION DELTA P IN

Item: 22 **Failure:** Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6731M	B	6	ISOLATION DELTA P O
H6761M	Y	6	ISOLATION DELTA P O

Item: 22 **Failure:** Closed

Failure Effect: High flow indication.

Failure Detection: Manual valve. High flow indication. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6731M	B	6	ISOLATION DELTA P O
H6761M	Y	6	ISOLATION DELTA P O

Item: 23

Failure: Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally open valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H7002A L	Y	10	ISOLATION H
H4802A L	B	8	ISOLATION H
H4202A L	B	2	ISOLATION H
H6202A L	Y	2	ISOLATION H
H4402A L	B	4	ISOLATION H
H4002A L	B	12	ISOLATION H
H6802A L	Y	8	ISOLATION H
H6002A L	Y	12	ISOLATION H
H5002A L	B	10	ISOLATION H
H6402A L	Y	4	ISOLATION H
H4502A L	B	6	ISOLATION H 4
H6602A L	Y	6	ISOLATION H 4
H6745A	Y	6	ISOLATION H 4 Linear PI
H4645A	B	6	ISOLATION H 4 Linear PI
H6702A	Y	6	ISOLATION H 8 Linear PI
H4602A	B	6	ISOLATION H 8 Linear PI

Item: 23

Failure: Closed

Failure Effect: No flow. Heat shield temperature increase with Magnet temperature rise and subsequent magnet quench.

Failure Detection: Normally open valve. Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H7002A L	Y	10	ISOLATION H
H4802A L	B	8	ISOLATION H
H4202A L	B	2	ISOLATION H
H6202A L	Y	2	ISOLATION H
H4402A L	B	4	ISOLATION H
H4002A L	B	12	ISOLATION H
H6802A L	Y	8	ISOLATION H
H6002A L	Y	12	ISOLATION H
H5002A L	B	10	ISOLATION H
H6402A L	Y	4	ISOLATION H
H4502A L	B	6	ISOLATION H 4
H6602A L	Y	6	ISOLATION H 4
H6745A	Y	6	ISOLATION H 4 Linear PI
H4645A	B	6	ISOLATION H 4 Linear PI
H6702A	Y	6	ISOLATION H 8 Linear PI
H4602A	B	6	ISOLATION H 8 Linear PI

Item: 24 Failure: Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally open valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6004A L	Y	12	ISOLATION R
H4004A L	B	12	ISOLATION R
H4804A L	B	8	ISOLATION R
H6804A L	Y	8	ISOLATION R
H6404A L	Y	4	ISOLATION R
H4404A L	B	4	ISOLATION R
H6204A L	Y	2	ISOLATION R
H4204A L	B	2	ISOLATION R
H5004A L	B	10	ISOLATION R
H7004A L	Y	10	ISOLATION R
H4504A L	B	6	ISOLATION R 4
H6604A L	Y	6	ISOLATION R 4
H6704A	Y	6	ISOLATION R 8
H4604A	B	6	ISOLATION R 8
H6401A L	Y	4	ISOLATION S
H4801A L	B	8	ISOLATION S
H6801A L	Y	8	ISOLATION S
H4201A L	B	2	ISOLATION S
H6201A L	Y	2	ISOLATION S
H6001A L	Y	12	ISOLATION S
H7001A L	Y	10	ISOLATION S
H4001A L	B	12	ISOLATION S
H4401A L	B	4	ISOLATION S
H5001A L	B	10	ISOLATION S
H6601A L	Y	6	ISOLATION S 4
H4501A L	B	6	ISOLATION S 4
H4601A	B	6	ISOLATION S 8
H6701A	Y	6	ISOLATION S 8

Failure Mode Effects Analysis

System: RHIC Cryogenic System
Operation Mode: Normal Operations

Item: 24

Failure: Closed

Failure Effect: Possible pressure drop.

Failure Detection: Normally open valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6004A L	Y	12	ISOLATION R
H4004A L	B	12	ISOLATION R
H4804A L	B	8	ISOLATION R
H6804A L	Y	8	ISOLATION R
H6404A L	Y	4	ISOLATION R
H4404A L	B	4	ISOLATION R
H6204A L	Y	2	ISOLATION R
H4204A L	B	2	ISOLATION R
H5004A L	B	10	ISOLATION R
H7004A L	Y	10	ISOLATION R
H4504A L	B	6	ISOLATION R 4
H6604A L	Y	6	ISOLATION R 4
H6704A	Y	6	ISOLATION R 8
H4604A	B	6	ISOLATION R 8
H6401A L	Y	4	ISOLATION S
H4801A L	B	8	ISOLATION S
H6801A L	Y	8	ISOLATION S
H4201A L	B	2	ISOLATION S
H6201A L	Y	2	ISOLATION S
H6001A L	Y	12	ISOLATION S
H7001A L	Y	10	ISOLATION S
H4001A L	B	12	ISOLATION S
H4401A L	B	4	ISOLATION S
H5001A L	B	10	ISOLATION S
H6601A L	Y	6	ISOLATION S 4
H4501A L	B	6	ISOLATION S 4
H4601A	B	6	ISOLATION S 8
H6701A	Y	6	ISOLATION S 8

Item: 25

Failure: Open

Failure Effect: No impact. Utility line not used during normal operations.

Failure Detection: Normally open valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4003A L	B	12	ISOLATION U
H4803A L	B	8	ISOLATION U
H4203A L	B	2	ISOLATION U
H6203A L	Y	2	ISOLATION U
H6403A L	Y	4	ISOLATION U
H6803A L	Y	8	ISOLATION U
H7003A L	Y	10	ISOLATION U
H6003A L	Y	12	ISOLATION U
H4403A L	B	4	ISOLATION U
H5003A L	B	10	ISOLATION U
H4503A L	B	6	ISOLATION U 4
H6603A L	Y	6	ISOLATION U 4
H4603A	B	6	ISOLATION U 8
H6703A	Y	6	ISOLATION U 8

Item: 25

Failure: Closed

Failure Effect: No impact. Utility line not used during normal operations.

Failure Detection: Normally open valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4003A L	B	12	ISOLATION U
H4803A L	B	8	ISOLATION U
H4203A L	B	2	ISOLATION U
H6203A L	Y	2	ISOLATION U
H6403A L	Y	4	ISOLATION U
H6803A L	Y	8	ISOLATION U
H7003A L	Y	10	ISOLATION U
H6003A L	Y	12	ISOLATION U
H4403A L	B	4	ISOLATION U
H5003A L	B	10	ISOLATION U
H4503A L	B	6	ISOLATION U 4
H6603A L	Y	6	ISOLATION U 4
H4603A	B	6	ISOLATION U 8
H6703A	Y	6	ISOLATION U 8

Item: 26

Failure: Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6056M L	Y	12	MANUAL ISOLATION M
H6253M L	Y	2	MANUAL ISOLATION M
H4407M L	B	4	MANUAL ISOLATION M
H6405M L	Y	4	MANUAL ISOLATION M
H6733M L	B	6	MANUAL ISOLATION M
H6623M L	Y	6	MANUAL ISOLATION M
H4831M L	B	8	MANUAL ISOLATION M
H6859M L	Y	8	MANUAL ISOLATION M
H5284M L	B	10	MANUAL ISOLATION M
H7067M L	Y	10	MANUAL ISOLATION M
H4007M L	B	12	MANUAL ISOLATION M
H4205M L	B	2	MANUAL ISOLATION M

Item: 26

Failure: Closed

Failure Effect: No flow. Magnet temperature rises with power supply shutdown possible.

Failure Detection: Manual valve. Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6056M L	Y	12	MANUAL ISOLATION M
H6253M L	Y	2	MANUAL ISOLATION M
H4407M L	B	4	MANUAL ISOLATION M
H6405M L	Y	4	MANUAL ISOLATION M
H6733M L	B	6	MANUAL ISOLATION M
H6623M L	Y	6	MANUAL ISOLATION M
H4831M L	B	8	MANUAL ISOLATION M
H6859M L	Y	8	MANUAL ISOLATION M
H5284M L	B	10	MANUAL ISOLATION M
H7067M L	Y	10	MANUAL ISOLATION M
H4007M L	B	12	MANUAL ISOLATION M
H4205M L	B	2	MANUAL ISOLATION M

Item: 27 Failure: Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6254M L	Y	2	MANUAL ISOLATION S
H4405M L	B	4	MANUAL ISOLATION S
H6426M L	Y	4	MANUAL ISOLATION S
H4805M L	B	8	MANUAL ISOLATION S
H6860M L	Y	8	MANUAL ISOLATION S
H5283M L	B	10	MANUAL ISOLATION S
H7066M L	Y	10	MANUAL ISOLATION S
H4005M L	B	12	MANUAL ISOLATION S
H6055M L	Y	12	MANUAL ISOLATION S
H4218M L	B	2	MANUAL ISOLATION S
H4534M L	B	6	MANUAL ISOLATION S
H6609M L	Y	6	MANUAL ISOLATION S
H4614M L	B	6	MANUAL ISOLATION S
H6705M L	Y	6	MANUAL ISOLATION S

Item: 27 Failure: Closed

Failure Effect: Possible pressure drop.

Failure Detection: Manual valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6254M L	Y	2	MANUAL ISOLATION S
H4405M L	B	4	MANUAL ISOLATION S
H6426M L	Y	4	MANUAL ISOLATION S
H4805M L	B	8	MANUAL ISOLATION S
H6860M L	Y	8	MANUAL ISOLATION S
H5283M L	B	10	MANUAL ISOLATION S
H7066M L	Y	10	MANUAL ISOLATION S
H4005M L	B	12	MANUAL ISOLATION S
H6055M L	Y	12	MANUAL ISOLATION S
H4218M L	B	2	MANUAL ISOLATION S
H4534M L	B	6	MANUAL ISOLATION S
H6609M L	Y	6	MANUAL ISOLATION S
H4614M L	B	6	MANUAL ISOLATION S
H6705M L	Y	6	MANUAL ISOLATION S

Item: 28 Failure: Open

Failure Effect: Flow from Heat Shield to Supply. Recooler empties. Magnet temperature rise with eventual magnet quench.

Failure Detection: Normally closed valve. Elevated pressure/temperature; zero recooler level. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6715A	Y	6	CROSSOVER S~B~HG 8
H4615A	B	6	CROSSOVER S~B~HG 8

Item: 28 Failure: Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6715A	Y	6	CROSSOVER S~B~HG 8
H4615A	B	6	CROSSOVER S~B~HG 8

Item: 29

Failure: Open

Failure Effect: No impact. Bypass dead-headed by second automatic valve.

Failure Detection: Normally closed valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4536A	B	6	BYPASS R 4
H6636A	Y	6	BYPASS R 4
H4636A	B	6	BYPASS R 8
H6736A	Y	6	BYPASS R 8

Item: 29

Failure: Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4536A	B	6	BYPASS R 4
H6636A	Y	6	BYPASS R 4
H4636A	B	6	BYPASS R 8
H6736A	Y	6	BYPASS R 8

Item: 30 Failure: Open

Failure Effect: No impact. Bypass dead-headed by second automatic valve.

Failure Detection: Normally closed valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4508A	B	6	BYPASS U 4
H6608A	Y	6	BYPASS U 4
H4608A	B	6	BYPASS U 8
H6708A	Y	6	BYPASS U 8

Item: 30 Failure: Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4508A	B	6	BYPASS U 4
H6608A	Y	6	BYPASS U 4
H4608A	B	6	BYPASS U 8
H6708A	Y	6	BYPASS U 8

Item: 31 Failure: Open

Failure Effect: No impact. Pressure/gas make-up for magnet line.

Failure Detection: Normally closed valve. Visual detection. Magnet line same pressure as supply line.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4524M	B	6	REF SUPPLY M Linear PI
H6607M	Y	6	REF SUPPLY M Linear PI

Item: 31 Failure: Closed

Failure Effect: No magnet line pressure/gas make-up. Possible circulator failure.

Failure Detection: Normally closed valve. Low magnet line pressure. Erratic circulator speed. Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4524M	B	6	REF SUPPLY M Linear PI
H6607M	Y	6	REF SUPPLY M Linear PI

Item: 32

Failure: Open

Failure Effect: Rapid magnet temperature rise with magnet quench.

Failure Detection: Normally closed valve. Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4639A	B	6	WARM GAS TO M LINE
H6738A	Y	6	WARM GAS TO M LINE

Item: 32

Failure: Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4639A	B	6	WARM GAS TO M LINE
H6738A	Y	6	WARM GAS TO M LINE

Item: 33 Failure: Open

Failure Effect: Recooler empties. Magnet temperature rises with subsequent magnet quench.

Failure Detection: Normally closed valve. Elevated pressure/temperature; zero recooler level. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4538A	B	6	WARM GAS TO S LINE
H6639A	Y	6	WARM GAS TO S LINE

Item: 33 Failure: Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4538A	B	6	WARM GAS TO S LINE
H6639A	Y	6	WARM GAS TO S LINE

Item: 34

Failure: Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
C3019H	B	6	CIRCULATOR @ 5ATM
C3018H	Y	6	CIRCULATOR @ 5ATM

Item: 34

Failure: Closed/No output

Failure Effect: No circulation. Magnet temperature rises with power supply shutdown possible.

Failure Detection: Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
C3019H	B	6	CIRCULATOR @ 5ATM
C3018H	Y	6	CIRCULATOR @ 5ATM

Item: 35 **Failure:** Full Scale High

Failure Effect: High flow indication causes low circulation. Magnet temperature rises with subsequent magnet quench.

Failure Detection: Elevated pressure/temperature/speed. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
DPT3008H	B	6	DELTA P TRANSDUCER
DPT3007H	Y	6	DELTA P TRANSDUCER

Item: 35 **Failure:** Full Scale Low

Failure Effect: No flow indication causes maximum circulator speed command. Potential for circulator shutdown by overspeed protection system.

Failure Detection: No/low flow indication with high circulator speed. Circulator speed alarm and/or shutdown.

Affected Components:

Valve #	Ring	Box	Nomenclature
DPT3008H	B	6	DELTA P TRANSDUCER
DPT3007H	Y	6	DELTA P TRANSDUCER

Item: 36 Failure: Maximum speed output

Failure Effect: Low circulation. Magnet temperature rises with subsequent magnet quench.

Failure Detection: Elevated pressure/temperature/speed with low flow. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
ST6746H	Y	6	5k~15kRPM C3018 TRA
ST4647H	B	6	5k~15kRPM C3019 TRA

Item: 36 Failure: Minimum speed output

Failure Effect: Circulator shutdown by overspeed protection system

Failure Detection: Constant low speed indication and command mismatch.

Affected Components:

Valve #	Ring	Box	Nomenclature
ST6746H	Y	6	5k~15kRPM C3018 TRA
ST4647H	B	6	5k~15kRPM C3019 TRA

Item: 37 Failure: Open

Failure Effect: Minor heat load increase with Magnet temperature rise.

Failure Detection: Manual valve. Visual detection. Elevated magnet temperature. Minor increase in refrigerator output.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6895M	Y	6	CIRCULATOR C3018 PU
H6826M	B	6	CIRCULATOR C3019 PU

Item: 37 Failure: Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6895M	Y	6	CIRCULATOR C3018 PU
H6826M	B	6	CIRCULATOR C3019 PU

Item: 38 **Failure:** Open

Failure Effect: Rapid magnet temperature rise with magnet quench.

Failure Detection: Manual valve. Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6894M	Y	6	CIRCULATOR C3018 W
H6823M	B	6	CIRCULATOR C3019 W

Item: 38 **Failure:** Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6894M	Y	6	CIRCULATOR C3018 W
H6823M	B	6	CIRCULATOR C3019 W

Item: 39 Failure: Open

Failure Effect: Significantly reduced circulation. Magnet temperature rises with subsequent magnet quench.

Failure Detection: Normally open valve. Visual detection. Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4533A	B	6	CIRCULATOR TEST Line
H6606A	Y	6	CIRCULATOR TEST Line

Item: 39 Failure: Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally open valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4533A	B	6	CIRCULATOR TEST Line
H6606A	Y	6	CIRCULATOR TEST Line

Item: 40 **Failure:** Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6732M	B	6	DELTA P CROSSOVER
H6762M	Y	6	DELTA P CROSSOVER

Item: 40 **Failure:** Closed

Failure Effect: No flow indication.

Failure Detection: Manual valve. No flow indication. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6732M	B	6	DELTA P CROSSOVER
H6762M	Y	6	DELTA P CROSSOVER

Item: 41

Failure: Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally open valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4600A	B	6	MONITOR CIR BYPASS
H6700A	Y	6	MONITOR CIR BYPASS

Item: 41

Failure: Closed

Failure Effect: Loss of instrumentation. Bypass dead-headed by manual valve. Possible pipe contamination.

Failure Detection: Normally open valve. Erroneous instrumentation. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4600A	B	6	MONITOR CIR BYPASS
H6700A	Y	6	MONITOR CIR BYPASS

Item: 42 **Failure:** Open

Failure Effect: No impact. No pressure source.

Failure Detection: Manual valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4277M	B	2	VACUUM ISOLATION 10
H4090M	B	12	VACUUM ISOLATION 10
H6088M	Y	12	VACUUM ISOLATION 10
H6276M	Y	2	VACUUM ISOLATION 12
H4480M	B	4	VACUUM ISOLATION 2
H6485M	Y	4	VACUUM ISOLATION 2
H4656M	B	6	VACUUM ISOLATION 4
H6785M	Y	6	VACUUM ISOLATION 4
H4877M	B	8	VACUUM ISOLATION 6
H6882M	Y	8	VACUUM ISOLATION 6
H5164M	B	10	VACUUM ISOLATION 8
H7086M	Y	10	VACUUM ISOLATION 8

Item: 42 **Failure:** Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4277M	B	2	VACUUM ISOLATION 10
H4090M	B	12	VACUUM ISOLATION 10
H6088M	Y	12	VACUUM ISOLATION 10
H6276M	Y	2	VACUUM ISOLATION 12
H4480M	B	4	VACUUM ISOLATION 2
H6485M	Y	4	VACUUM ISOLATION 2
H4656M	B	6	VACUUM ISOLATION 4
H6785M	Y	6	VACUUM ISOLATION 4
H4877M	B	8	VACUUM ISOLATION 6
H6882M	Y	8	VACUUM ISOLATION 6
H5164M	B	10	VACUUM ISOLATION 8
H7086M	Y	10	VACUUM ISOLATION 8

Item: 43 **Failure:** Open

Failure Effect: No impact. Pumpout header closed off by manual valves, vented by check valve.

Failure Detection: Manual valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4279M	B	2	VACUUM~VENT 10
H4050M	B	12	VACUUM~VENT 10
H6090M	Y	12	VACUUM~VENT 10
H6278M	Y	2	VACUUM~VENT 12
H4482M	B	4	VACUUM~VENT 2
H6470M	Y	4	VACUUM~VENT 2
H4629M	B	6	VACUUM~VENT 4
H6786M	Y	6	VACUUM~VENT 4
H4879M	B	8	VACUUM~VENT 6
H6893M	Y	8	VACUUM~VENT 6
H5166M	B	10	VACUUM~VENT 8
H7052M	Y	10	VACUUM~VENT 8

Item: 43 **Failure:** Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4279M	B	2	VACUUM~VENT 10
H4050M	B	12	VACUUM~VENT 10
H6090M	Y	12	VACUUM~VENT 10
H6278M	Y	2	VACUUM~VENT 12
H4482M	B	4	VACUUM~VENT 2
H6470M	Y	4	VACUUM~VENT 2
H4629M	B	6	VACUUM~VENT 4
H6786M	Y	6	VACUUM~VENT 4
H4879M	B	8	VACUUM~VENT 6
H6893M	Y	8	VACUUM~VENT 6
H5166M	B	10	VACUUM~VENT 8
H7052M	Y	10	VACUUM~VENT 8

Item: 44 **Failure:** Open

Failure Effect: Vent header contaminated by air.

Failure Detection: Checkvalve. Detectable only with individual test.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4814C	B	8	VENT CHECK 10
H6834C	Y	8	VENT CHECK 10
H5034C	B	10	VENT CHECK 12
H7034C	Y	10	VENT CHECK 12
H4040C	B	12	VENT CHECK 2
H6064C	Y	12	VENT CHECK 2
H4234C	B	2	VENT CHECK 4
H6234C	Y	2	VENT CHECK 4
H4434C	B	4	VENT CHECK 6
H6445C	Y	4	VENT CHECK 6
H4009C	B	6	VENT CHECK 8
H4029C	Y	6	VENT CHECK 8

Item: 44 **Failure:** Closed

Failure Effect: Loss of emergency venting and relief valve capacity. Adjacent magnet/valvebox relief valves have adequate capacity.

Failure Detection: Checkvalve. Detectable only with individual test.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4814C	B	8	VENT CHECK 10
H6834C	Y	8	VENT CHECK 10
H5034C	B	10	VENT CHECK 12
H7034C	Y	10	VENT CHECK 12
H4040C	B	12	VENT CHECK 2
H6064C	Y	12	VENT CHECK 2
H4234C	B	2	VENT CHECK 4
H6234C	Y	2	VENT CHECK 4
H4434C	B	4	VENT CHECK 6
H6445C	Y	4	VENT CHECK 6
H4009C	B	6	VENT CHECK 8
H4029C	Y	6	VENT CHECK 8

Item: 46 **Failure:** Open

Failure Effect: Flow from Heat Shield to Supply. Recooler level declines with Magnet temperature rise and subsequent magnet quench.

Failure Detection: Normally closed valve. Elevated pressure/temperature; zero recooler level. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4016A	B	12	CROSSOVER H~B~S 10
H6070A	Y	12	CROSSOVER H~B~S 10
H4039A	B	12	CROSSOVER H~B~S 2
H6016A	Y	12	CROSSOVER H~B~S 2
H4216A	B	2	CROSSOVER H~B~S 4
H6216A	Y	2	CROSSOVER H~B~S 4
H4416A	B	4	CROSSOVER H~B~S 6
H6416A	Y	4	CROSSOVER H~B~S 6
H4816A	B	8	CROSSOVER H~B~S 6
H6816A	Y	8	CROSSOVER H~B~S 6
H5016A	B	10	CROSSOVER H~B~S 8
H7016A	Y	10	CROSSOVER H~B~S 8

Item: 46 **Failure:** Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4016A	B	12	CROSSOVER H~B~S 10
H6070A	Y	12	CROSSOVER H~B~S 10
H4039A	B	12	CROSSOVER H~B~S 2
H6016A	Y	12	CROSSOVER H~B~S 2
H4216A	B	2	CROSSOVER H~B~S 4
H6216A	Y	2	CROSSOVER H~B~S 4
H4416A	B	4	CROSSOVER H~B~S 6
H6416A	Y	4	CROSSOVER H~B~S 6
H4816A	B	8	CROSSOVER H~B~S 6
H6816A	Y	8	CROSSOVER H~B~S 6
H5016A	B	10	CROSSOVER H~B~S 8
H7016A	Y	10	CROSSOVER H~B~S 8

Item: 47 **Failure:** Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally open valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4010A	B	12	CROSSOVER H~B~U 10
H6010A	Y	12	CROSSOVER H~B~U 10
H4220A	B	2	CROSSOVER H~B~U 12
H6220A	Y	2	CROSSOVER H~B~U 12
H4420A	B	4	CROSSOVER H~B~U 2
H6420A	Y	4	CROSSOVER H~B~U 2
H4520A	B	6	CROSSOVER H~B~U 4
H6620A	Y	6	CROSSOVER H~B~U 4
H4810A	B	8	CROSSOVER H~B~U 6
H6810A	Y	8	CROSSOVER H~B~U 6
H5010A	B	10	CROSSOVER H~B~U 8
H7010A	Y	10	CROSSOVER H~B~U 8
H4821A	B	8	CROSSOVER U~B~H 10
H6821A	Y	8	CROSSOVER U~B~H 10
H5021A	B	10	CROSSOVER U~B~H 12
H7021A	Y	10	CROSSOVER U~B~H 12
H4021A	B	12	CROSSOVER U~B~H 2
H6021A	Y	12	CROSSOVER U~B~H 2
H4211A	B	2	CROSSOVER U~B~H 4
H6211A	Y	2	CROSSOVER U~B~H 4
H4411A	B	4	CROSSOVER U~B~H 6
H6411A	Y	4	CROSSOVER U~B~H 6
H4621A	B	6	CROSSOVER U~B~H 8
H6721A	Y	6	CROSSOVER U~B~H 8

Item: 47 Failure: Closed

Failure Effect: Loss of instrumentation. Utility line not used for normal operations.

Failure Detection: Normally open valve. Erroneous instrumentation. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4010A	B	12	CROSSOVER H~B~U 10
H6010A	Y	12	CROSSOVER H~B~U 10
H4220A	B	2	CROSSOVER H~B~U 12
H6220A	Y	2	CROSSOVER H~B~U 12
H4420A	B	4	CROSSOVER H~B~U 2
H6420A	Y	4	CROSSOVER H~B~U 2
H4520A	B	6	CROSSOVER H~B~U 4
H6620A	Y	6	CROSSOVER H~B~U 4
H4810A	B	8	CROSSOVER H~B~U 6
H6810A	Y	8	CROSSOVER H~B~U 6
H5010A	B	10	CROSSOVER H~B~U 8
H7010A	Y	10	CROSSOVER H~B~U 8
H4821A	B	8	CROSSOVER U~B~H 10
H6821A	Y	8	CROSSOVER U~B~H 10
H5021A	B	10	CROSSOVER U~B~H 12
H7021A	Y	10	CROSSOVER U~B~H 12
H4021A	B	12	CROSSOVER U~B~H 2
H6021A	Y	12	CROSSOVER U~B~H 2
H4211A	B	2	CROSSOVER U~B~H 4
H6211A	Y	2	CROSSOVER U~B~H 4
H4411A	B	4	CROSSOVER U~B~H 6
H6411A	Y	4	CROSSOVER U~B~H 6
H4621A	B	6	CROSSOVER U~B~H 8
H6721A	Y	6	CROSSOVER U~B~H 8

Item: 48 **Failure:** Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally open valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4510A	B	6	CROSSOVER H~B~U MI
H6610A	Y	6	CROSSOVER H~B~U MI

Item: 48 **Failure:** Closed

Failure Effect: Loss of instrumentation. Bypass dead-headed by automatic valve. Possible pipe contamination.

Failure Detection: Normally open valve. Erroneous instrumentation. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4510A	B	6	CROSSOVER H~B~U MI
H6610A	Y	6	CROSSOVER H~B~U MI

Item: 49 **Failure:** Open

Failure Effect: Flow from Heat Shield to Supply. Recooler empties. Magnet temperature rise with eventual magnet quench.

Failure Detection: Normally closed valve. Elevated pressure/temperature; zero recooler level. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4516A	B	6	CROSSOVER HG~B~S 4
H6616A	Y	6	CROSSOVER HG~B~S 4

Item: 49 **Failure:** Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4516A	B	6	CROSSOVER HG~B~S 4
H6616A	Y	6	CROSSOVER HG~B~S 4

Item: 50 **Failure:** Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally open valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6716A	Y	6	CROSSOVER HG~B~S 8
H4616A	B	6	CROSSOVER HG~B~S 8

Item: 50 **Failure:** Closed

Failure Effect: Loss of instrumentation. Bypass dead-headed by automatic valve. Possible pipe contamination.

Failure Detection: Normally open valve. Visual detection. Erroneous instrumentation.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6716A	Y	6	CROSSOVER HG~B~S 8
H4616A	B	6	CROSSOVER HG~B~S 8

Item: 51 Failure: Open

Failure Effect: Magnet pressure & temperature fluctuates.

Failure Detection: Normally closed valve. Pressure and temperature fluctuations. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4030A	B	12	CROSSOVER M~S 10
H6030A	Y	12	CROSSOVER M~S 10
H4230A	B	2	CROSSOVER M~S 12
H6230A	Y	2	CROSSOVER M~S 12
H7030A	Y	10	CROSSOVER M~S 12
H4430A	B	4	CROSSOVER M~S 2
H6430A	Y	4	CROSSOVER M~S 2
H4036A	B	12	CROSSOVER M~S 2
H6005A	Y	12	CROSSOVER M~S 2
H4530A	B	6	CROSSOVER M~S 4
H6630A	Y	6	CROSSOVER M~S 4
H4830A	B	8	CROSSOVER M~S 6
H6830A	Y	8	CROSSOVER M~S 6
H4630A	B	6	CROSSOVER M~S 8
H6730A	Y	6	CROSSOVER M~S 8
H5030A	B	10	CROSSOVER M~S 8

Item: 51 Failure: Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4030A	B	12	CROSSOVER M~S 10
H6030A	Y	12	CROSSOVER M~S 10
H4230A	B	2	CROSSOVER M~S 12
H6230A	Y	2	CROSSOVER M~S 12
H7030A	Y	10	CROSSOVER M~S 12
H4430A	B	4	CROSSOVER M~S 2
H6430A	Y	4	CROSSOVER M~S 2
H4036A	B	12	CROSSOVER M~S 2
H6005A	Y	12	CROSSOVER M~S 2
H4530A	B	6	CROSSOVER M~S 4
H6630A	Y	6	CROSSOVER M~S 4
H4830A	B	8	CROSSOVER M~S 6
H6830A	Y	8	CROSSOVER M~S 6
H4630A	B	6	CROSSOVER M~S 8
H6730A	Y	6	CROSSOVER M~S 8
H5030A	B	10	CROSSOVER M~S 8

Item: 52 **Failure:** Open

Failure Effect: No impact. Utility line not used for normal operations.

Failure Detection: Normally closed valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4008A	B	12	CROSSOVER R~U 10
H6008A	Y	12	CROSSOVER R~U 10
H4038A	B	12	CROSSOVER R~U 2
H6037A	Y	12	CROSSOVER R~U 2
H4208A	B	2	CROSSOVER R~U 4
H6208A	Y	2	CROSSOVER R~U 4
H4408A	B	4	CROSSOVER R~U 6
H6408A	Y	4	CROSSOVER R~U 6
H4808A	B	8	CROSSOVER R~U 6
H6808A	Y	8	CROSSOVER R~U 6
H5008A	B	10	CROSSOVER R~U 8
H7008A	Y	10	CROSSOVER R~U 8

Item: 52 **Failure:** Closed

Failure Effect: No impact. Normal operating position. [One valve must be open to pressurize Utility line. This can be reconfigured. Utility line protected by relief valves.]

Failure Detection: Normally closed valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4008A	B	12	CROSSOVER R~U 10
H6008A	Y	12	CROSSOVER R~U 10
H4038A	B	12	CROSSOVER R~U 2
H6037A	Y	12	CROSSOVER R~U 2
H4208A	B	2	CROSSOVER R~U 4
H6208A	Y	2	CROSSOVER R~U 4
H4408A	B	4	CROSSOVER R~U 6
H6408A	Y	4	CROSSOVER R~U 6
H4808A	B	8	CROSSOVER R~U 6
H6808A	Y	8	CROSSOVER R~U 6
H5008A	B	10	CROSSOVER R~U 8
H7008A	Y	10	CROSSOVER R~U 8

Item: 53 **Failure:** Open

Failure Effect: No impact. Normal operating position. Bypass dead-headed by second automatic valve.

Failure Detection: Normally open valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6007A	Y	12	CROSSOVER S~B~H 10
H4015A	B	12	CROSSOVER S~B~H 10
H4035A	B	12	CROSSOVER S~B~H 2 Li
H6015A	Y	12	CROSSOVER S~B~H 2 Li
H4215A	B	2	CROSSOVER S~B~H 4 Li
H6215A	Y	2	CROSSOVER S~B~H 4 Li
H4415A	B	4	CROSSOVER S~B~H 6 Li
H6415A	Y	4	CROSSOVER S~B~H 6 Li
H6815A	Y	8	CROSSOVER S~B~H 6 Li
H4815A	B	8	CROSSOVER S~B~H 6 Li
H5015A	B	10	CROSSOVER S~B~H 8 Li
H7015A	Y	10	CROSSOVER S~B~H 8 Li

Item: 53 **Failure:** Closed

Failure Effect: Loss of instrumentation.

Failure Detection: Normally open valve. No pressure indication or constant pressure indication. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6007A	Y	12	CROSSOVER S~B~H 10
H4015A	B	12	CROSSOVER S~B~H 10
H4035A	B	12	CROSSOVER S~B~H 2 Li
H6015A	Y	12	CROSSOVER S~B~H 2 Li
H4215A	B	2	CROSSOVER S~B~H 4 Li
H6215A	Y	2	CROSSOVER S~B~H 4 Li
H4415A	B	4	CROSSOVER S~B~H 6 Li
H6415A	Y	4	CROSSOVER S~B~H 6 Li
H6815A	Y	8	CROSSOVER S~B~H 6 Li
H4815A	B	8	CROSSOVER S~B~H 6 Li
H5015A	B	10	CROSSOVER S~B~H 8 Li
H7015A	Y	10	CROSSOVER S~B~H 8 Li

Item: 54 **Failure:** Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally open valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4515A	B	6	CROSSOVER S~B~HG 4
H6615A	Y	6	CROSSOVER S~B~HG 4

Item: 54 **Failure:** Closed

Failure Effect: Loss of instrumentation. Bypass dead-headed by automatic valve. Possible pipe contamination.

Failure Detection: Normally open valve. Visual detection. Erroneous instrumentation.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4515A	B	6	CROSSOVER S~B~HG 4
H6615A	Y	6	CROSSOVER S~B~HG 4

Item: 55 **Failure:** Open

Failure Effect: Flow from Heat Shield through Utility to cold Return. Increased refrigerator heat load with consequent increase in Supply temperature. Can be reconfigured.

Failure Detection: Normally closed valve. Visual detection. Elevated pressure/temperature. Temperature indicator or power supply lead monitoring alarms. Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4820A	B	8	CROSSOVER H~B~U 10
H6820A	Y	8	CROSSOVER H~B~U 10
H5020A	B	10	CROSSOVER H~B~U 12
H7020A	Y	10	CROSSOVER H~B~U 12
H4020A	B	12	CROSSOVER H~B~U 2
H6020A	Y	12	CROSSOVER H~B~U 2
H4210A	B	2	CROSSOVER H~B~U 4
H6210A	Y	2	CROSSOVER H~B~U 4
H4410A	B	4	CROSSOVER H~B~U 6
H6410A	Y	4	CROSSOVER H~B~U 6
H4620A	B	6	CROSSOVER H~B~U 8
H6720A	Y	6	CROSSOVER H~B~U 8
H4011A	B	12	CROSSOVER U~B~H 10
H6011A	Y	12	CROSSOVER U~B~H 10
H4221A	B	2	CROSSOVER U~B~H 12
H6221A	Y	2	CROSSOVER U~B~H 12
H4421A	B	4	CROSSOVER U~B~H 2
H6421A	Y	4	CROSSOVER U~B~H 2
H4521A	B	6	CROSSOVER U~B~H 4
H6621A	Y	6	CROSSOVER U~B~H 4
H4811A	B	8	CROSSOVER U~B~H 6
H6811A	Y	8	CROSSOVER U~B~H 6
H5011A	B	10	CROSSOVER U~B~H 8
H7011A	Y	10	CROSSOVER U~B~H 8

Item: 55 **Failure:** Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4820A	B	8	CROSSOVER H~B~U 10
H6820A	Y	8	CROSSOVER H~B~U 10
H5020A	B	10	CROSSOVER H~B~U 12
H7020A	Y	10	CROSSOVER H~B~U 12
H4020A	B	12	CROSSOVER H~B~U 2
H6020A	Y	12	CROSSOVER H~B~U 2
H4210A	B	2	CROSSOVER H~B~U 4
H6210A	Y	2	CROSSOVER H~B~U 4
H4410A	B	4	CROSSOVER H~B~U 6
H6410A	Y	4	CROSSOVER H~B~U 6
H4620A	B	6	CROSSOVER H~B~U 8
H6720A	Y	6	CROSSOVER H~B~U 8
H4011A	B	12	CROSSOVER U~B~H 10
H6011A	Y	12	CROSSOVER U~B~H 10
H4221A	B	2	CROSSOVER U~B~H 12
H6221A	Y	2	CROSSOVER U~B~H 12
H4421A	B	4	CROSSOVER U~B~H 2
H6421A	Y	4	CROSSOVER U~B~H 2
H4521A	B	6	CROSSOVER U~B~H 4
H6621A	Y	6	CROSSOVER U~B~H 4
H4811A	B	8	CROSSOVER U~B~H 6
H6811A	Y	8	CROSSOVER U~B~H 6
H5011A	B	10	CROSSOVER U~B~H 8
H7011A	Y	10	CROSSOVER U~B~H 8

Item: 56 **Failure: Open**

Failure Effect: Flow from Heat Shield through Utility to cold Return. Increased refrigerator heat load with consequent increase in Supply temperature. Can be reconfigured.

Failure Detection: Normally closed valve. Visual detection. Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4511A	B	6	CROSSOVER U~B~H MI
H6611A	Y	6	CROSSOVER U~B~H MI

Item: 56 **Failure: Closed**

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4511A	B	6	CROSSOVER U~B~H MI
H6611A	Y	6	CROSSOVER U~B~H MI

Item: 57 **Failure:** Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4618M L	B	6	MONITOR CIR BYPASS I
H6707M L	Y	6	MONITOR CIR BYPASS I

Item: 57 **Failure:** Open

Failure Effect: No circulation. Magnet temperature rises with power supply shutdown possible.

Failure Detection: Manual valve. Visual detection. Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4618M L	B	6	MONITOR CIR BYPASS I
H6707M L	Y	6	MONITOR CIR BYPASS I

Item: 58 **Failure:** Open

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6287M	Y	2	LEAD ISOLATION 1
H6537M	Y	4	LEAD ISOLATION 1
H4752M	B	6	LEAD ISOLATION 1
H6891M	Y	6	LEAD ISOLATION 1
H4890M	B	8	LEAD ISOLATION 1
H6930M	Y	8	LEAD ISOLATION 1
H4143M	B	12	LEAD ISOLATION 1
H6068M	Y	12	LEAD ISOLATION 1
H4290M	B	2	LEAD ISOLATION 1
H6892M	Y	6	LEAD ISOLATION 10
H6931M	Y	8	LEAD ISOLATION 10
H4134M	B	12	LEAD ISOLATION 10
H4881M	B	8	LEAD ISOLATION 10
H6528M	Y	4	LEAD ISOLATION 10
H4281M	B	2	LEAD ISOLATION 10
H6293M	Y	2	LEAD ISOLATION 10
H4743M	B	6	LEAD ISOLATION 10
H6069M	Y	12	LEAD ISOLATION 10
SPARE4	Y	6	LEAD ISOLATION 11
SPARE6	Y	12	LEAD ISOLATION 11
H4133M	B	12	LEAD ISOLATION 11
H4880M	B	8	LEAD ISOLATION 11
H4742M	B	6	LEAD ISOLATION 11
H6538M	Y	4	LEAD ISOLATION 11
SPARE9	Y	2	LEAD ISOLATION 11
H4280M	B	2	LEAD ISOLATION 11
SPARE5	Y	8	LEAD ISOLATION 11
H6536M	Y	4	LEAD ISOLATION 2
H4142M	B	12	LEAD ISOLATION 2
H6929M	Y	8	LEAD ISOLATION 2
H6067M	Y	12	LEAD ISOLATION 2
H4889M	B	8	LEAD ISOLATION 2
H4751M	B	6	LEAD ISOLATION 2
H6286M	Y	2	LEAD ISOLATION 2
H4289M	B	2	LEAD ISOLATION 2
H6890M	Y	6	LEAD ISOLATION 2
H4288M	B	2	LEAD ISOLATION 3
H6535M	Y	4	LEAD ISOLATION 3
H4750M	B	6	LEAD ISOLATION 3
H4888M	B	8	LEAD ISOLATION 3
H4141M	B	12	LEAD ISOLATION 3
H4887M	B	8	LEAD ISOLATION 4
H6066M	Y	12	LEAD ISOLATION 4
H4140M	B	12	LEAD ISOLATION 4

Valve #	Ring	Box	Nomenclature
H4287M	B	2	LEAD ISOLATION 4
H6928M	Y	8	LEAD ISOLATION 4
H4749M	B	6	LEAD ISOLATION 4
H6285M	Y	2	LEAD ISOLATION 4
H6534M	Y	4	LEAD ISOLATION 4
H6889M	Y	6	LEAD ISOLATION 4
H4886M	B	8	LEAD ISOLATION 5
H6065M	Y	12	LEAD ISOLATION 5
H6927M	Y	8	LEAD ISOLATION 5
H6888M	Y	6	LEAD ISOLATION 5
H4748M	B	6	LEAD ISOLATION 5
H6533M	Y	4	LEAD ISOLATION 5
H6284M	Y	2	LEAD ISOLATION 5
H4286M	B	2	LEAD ISOLATION 5
H4139M	B	12	LEAD ISOLATION 5
H4285M	B	2	LEAD ISOLATION 6
H4885M	B	8	LEAD ISOLATION 6
H6062M	Y	12	LEAD ISOLATION 6
H4138M	B	12	LEAD ISOLATION 6
H6926M	Y	8	LEAD ISOLATION 6
H6887M	Y	6	LEAD ISOLATION 6
H4747M	B	6	LEAD ISOLATION 6
H6283M	Y	2	LEAD ISOLATION 6
H6532M	Y	4	LEAD ISOLATION 6
H6886M	Y	6	LEAD ISOLATION 7
H4137M	B	12	LEAD ISOLATION 7
H6061M	Y	12	LEAD ISOLATION 7
H4884M	B	8	LEAD ISOLATION 7
H6531M	Y	4	LEAD ISOLATION 7
H6282M	Y	2	LEAD ISOLATION 7
H4284M	B	2	LEAD ISOLATION 7
H6925M	Y	8	LEAD ISOLATION 7
H4746M	B	6	LEAD ISOLATION 7
H6885M	Y	6	LEAD ISOLATION 8
H4136M	B	12	LEAD ISOLATION 8
H4883M	B	8	LEAD ISOLATION 8
H6060M	Y	12	LEAD ISOLATION 8
H4745M	B	6	LEAD ISOLATION 8
H6530M	Y	4	LEAD ISOLATION 8
H6281M	Y	2	LEAD ISOLATION 8
H4283M	B	2	LEAD ISOLATION 8
H6924M	Y	8	LEAD ISOLATION 8
H4882M	B	8	LEAD ISOLATION 9
H4135M	B	12	LEAD ISOLATION 9
H6059M	Y	12	LEAD ISOLATION 9
H6923M	Y	8	LEAD ISOLATION 9
H6884M	Y	6	LEAD ISOLATION 9
H4744M	B	6	LEAD ISOLATION 9
H6529M	Y	4	LEAD ISOLATION 9
H4282M	B	2	LEAD ISOLATION 9
H6280M	Y	2	LEAD ISOLATION 9
H7141M	Y	10	LEAD ISOLATION A1

Valve #	Ring	Box	Nomenclature
H4495M	B	4	LEAD ISOLATION A1
H4767M	B	10	LEAD ISOLATION A1
H4488M	B	4	LEAD ISOLATION A11
H7147M	Y	10	LEAD ISOLATION A11
H4760M	B	10	LEAD ISOLATION A11
H4494M	B	4	LEAD ISOLATION A2
H4766M	B	10	LEAD ISOLATION A2
H7140M	Y	10	LEAD ISOLATION A2
H7139M	Y	10	LEAD ISOLATION A4
H4493M	B	4	LEAD ISOLATION A4
H4765M	B	10	LEAD ISOLATION A4
H7138M	Y	10	LEAD ISOLATION A5
H4492M	B	4	LEAD ISOLATION A5
H4764M	B	10	LEAD ISOLATION A5
H4491M	B	4	LEAD ISOLATION A6
H4763M	B	10	LEAD ISOLATION A6
H7137M	Y	10	LEAD ISOLATION A6
H4490M	B	4	LEAD ISOLATION A8
H4762M	B	10	LEAD ISOLATION A8
H7135M	Y	10	LEAD ISOLATION A8
H4489M	B	4	LEAD ISOLATION A9
H4761M	B	10	LEAD ISOLATION A9
H7134M	Y	10	LEAD ISOLATION A9
H4483M	B	4	LEAD ISOLATION B10
H4754M	B	10	LEAD ISOLATION B10
H7129M	Y	10	LEAD ISOLATION B10
SPARE7	B	4	LEAD ISOLATION B11
H4753M	B	10	LEAD ISOLATION B11
SPARE8	Y	10	LEAD ISOLATION B11
H4756M	B	10	LEAD ISOLATION B2
H4757M	B	10	LEAD ISOLATION B4
H4487M	B	4	LEAD ISOLATION B6
H7133M	Y	10	LEAD ISOLATION B6
H4486M	B	4	LEAD ISOLATION B7
H4759M	B	10	LEAD ISOLATION B7
H7132M	Y	10	LEAD ISOLATION B7
H4485M	B	4	LEAD ISOLATION B8
H4758M	B	10	LEAD ISOLATION B8
H7131M	Y	10	LEAD ISOLATION B8
H4484M	B	4	LEAD ISOLATION B9
H4755M	B	10	LEAD ISOLATION B9
H7130M	Y	10	LEAD ISOLATION B9

Item: 58
Failure: Closed

Failure Effect: No lead cooling. Power supply shutdown by voltage monitoring circuit.

Failure Detection: Manual valve. Visual detection. No lead flow indication. Power supply shutdown.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6287M	Y	2	LEAD ISOLATION 1
H6537M	Y	4	LEAD ISOLATION 1
H4752M	B	6	LEAD ISOLATION 1
H6891M	Y	6	LEAD ISOLATION 1
H4890M	B	8	LEAD ISOLATION 1
H6930M	Y	8	LEAD ISOLATION 1
H4143M	B	12	LEAD ISOLATION 1
H6068M	Y	12	LEAD ISOLATION 1
H4290M	B	2	LEAD ISOLATION 1
H6892M	Y	6	LEAD ISOLATION 10
H6931M	Y	8	LEAD ISOLATION 10
H4134M	B	12	LEAD ISOLATION 10
H4881M	B	8	LEAD ISOLATION 10
H6528M	Y	4	LEAD ISOLATION 10
H4281M	B	2	LEAD ISOLATION 10
H6293M	Y	2	LEAD ISOLATION 10
H4743M	B	6	LEAD ISOLATION 10
H6069M	Y	12	LEAD ISOLATION 10
SPARE4	Y	6	LEAD ISOLATION 11
SPARE6	Y	12	LEAD ISOLATION 11
H4133M	B	12	LEAD ISOLATION 11
H4880M	B	8	LEAD ISOLATION 11
H4742M	B	6	LEAD ISOLATION 11
H6538M	Y	4	LEAD ISOLATION 11
SPARE9	Y	2	LEAD ISOLATION 11
H4280M	B	2	LEAD ISOLATION 11
SPARE5	Y	8	LEAD ISOLATION 11
H6536M	Y	4	LEAD ISOLATION 2
H4142M	B	12	LEAD ISOLATION 2
H6929M	Y	8	LEAD ISOLATION 2
H6067M	Y	12	LEAD ISOLATION 2
H4889M	B	8	LEAD ISOLATION 2
H4751M	B	6	LEAD ISOLATION 2
H6286M	Y	2	LEAD ISOLATION 2
H4289M	B	2	LEAD ISOLATION 2
H6890M	Y	6	LEAD ISOLATION 2
H4288M	B	2	LEAD ISOLATION 3
H6535M	Y	4	LEAD ISOLATION 3
H4750M	B	6	LEAD ISOLATION 3
H4888M	B	8	LEAD ISOLATION 3
H4141M	B	12	LEAD ISOLATION 3
H4887M	B	8	LEAD ISOLATION 4

Valve #	Ring	Box	Nomenclature
H6066M	Y	12	LEAD ISOLATION 4
H4140M	B	12	LEAD ISOLATION 4
H4287M	B	2	LEAD ISOLATION 4
H6928M	Y	8	LEAD ISOLATION 4
H4749M	B	6	LEAD ISOLATION 4
H6285M	Y	2	LEAD ISOLATION 4
H6534M	Y	4	LEAD ISOLATION 4
H6889M	Y	6	LEAD ISOLATION 4
H4886M	B	8	LEAD ISOLATION 5
H6065M	Y	12	LEAD ISOLATION 5
H6927M	Y	8	LEAD ISOLATION 5
H6888M	Y	6	LEAD ISOLATION 5
H4748M	B	6	LEAD ISOLATION 5
H6533M	Y	4	LEAD ISOLATION 5
H6284M	Y	2	LEAD ISOLATION 5
H4286M	B	2	LEAD ISOLATION 5
H4139M	B	12	LEAD ISOLATION 5
H4285M	B	2	LEAD ISOLATION 6
H4885M	B	8	LEAD ISOLATION 6
H6062M	Y	12	LEAD ISOLATION 6
H4138M	B	12	LEAD ISOLATION 6
H6926M	Y	8	LEAD ISOLATION 6
H6887M	Y	6	LEAD ISOLATION 6
H4747M	B	6	LEAD ISOLATION 6
H6283M	Y	2	LEAD ISOLATION 6
H6532M	Y	4	LEAD ISOLATION 6
H6886M	Y	6	LEAD ISOLATION 7
H4137M	B	12	LEAD ISOLATION 7
H6061M	Y	12	LEAD ISOLATION 7
H4884M	B	8	LEAD ISOLATION 7
H6531M	Y	4	LEAD ISOLATION 7
H6282M	Y	2	LEAD ISOLATION 7
H4284M	B	2	LEAD ISOLATION 7
H6925M	Y	8	LEAD ISOLATION 7
H4746M	B	6	LEAD ISOLATION 7
H6885M	Y	6	LEAD ISOLATION 8
H4136M	B	12	LEAD ISOLATION 8
H4883M	B	8	LEAD ISOLATION 8
H6060M	Y	12	LEAD ISOLATION 8
H4745M	B	6	LEAD ISOLATION 8
H6530M	Y	4	LEAD ISOLATION 8
H6281M	Y	2	LEAD ISOLATION 8
H4283M	B	2	LEAD ISOLATION 8
H6924M	Y	8	LEAD ISOLATION 8
H4882M	B	8	LEAD ISOLATION 9
H4135M	B	12	LEAD ISOLATION 9
H6059M	Y	12	LEAD ISOLATION 9
H6923M	Y	8	LEAD ISOLATION 9
H6884M	Y	6	LEAD ISOLATION 9
H4744M	B	6	LEAD ISOLATION 9
H6529M	Y	4	LEAD ISOLATION 9
H4282M	B	2	LEAD ISOLATION 9

Valve #	Ring	Box	Nomenclature
H6280M	Y	2	LEAD ISOLATION 9
H7141M	Y	10	LEAD ISOLATION A1
H4495M	B	4	LEAD ISOLATION A1
H4767M	B	10	LEAD ISOLATION A1
H4488M	B	4	LEAD ISOLATION A11
H7147M	Y	10	LEAD ISOLATION A11
H4760M	B	10	LEAD ISOLATION A11
H4494M	B	4	LEAD ISOLATION A2
H4766M	B	10	LEAD ISOLATION A2
H7140M	Y	10	LEAD ISOLATION A2
H7139M	Y	10	LEAD ISOLATION A4
H4493M	B	4	LEAD ISOLATION A4
H4765M	B	10	LEAD ISOLATION A4
H7138M	Y	10	LEAD ISOLATION A5
H4492M	B	4	LEAD ISOLATION A5
H4764M	B	10	LEAD ISOLATION A5
H4491M	B	4	LEAD ISOLATION A6
H4763M	B	10	LEAD ISOLATION A6
H7137M	Y	10	LEAD ISOLATION A6
H4490M	B	4	LEAD ISOLATION A8
H4762M	B	10	LEAD ISOLATION A8
H7135M	Y	10	LEAD ISOLATION A8
H4489M	B	4	LEAD ISOLATION A9
H4761M	B	10	LEAD ISOLATION A9
H7134M	Y	10	LEAD ISOLATION A9
H4483M	B	4	LEAD ISOLATION B10
H4754M	B	10	LEAD ISOLATION B10
H7129M	Y	10	LEAD ISOLATION B10
SPARE7	B	4	LEAD ISOLATION B11
H4753M	B	10	LEAD ISOLATION B11
SPARE8	Y	10	LEAD ISOLATION B11
H4756M	B	10	LEAD ISOLATION B2
H4757M	B	10	LEAD ISOLATION B4
H4487M	B	4	LEAD ISOLATION B6
H7133M	Y	10	LEAD ISOLATION B6
H4486M	B	4	LEAD ISOLATION B7
H4759M	B	10	LEAD ISOLATION B7
H7132M	Y	10	LEAD ISOLATION B7
H4485M	B	4	LEAD ISOLATION B8
H4758M	B	10	LEAD ISOLATION B8
H7131M	Y	10	LEAD ISOLATION B8
H4484M	B	4	LEAD ISOLATION B9
H4755M	B	10	LEAD ISOLATION B9
H7130M	Y	10	LEAD ISOLATION B9

Item: 59 **Failure:** Open

Failure Effect: Flow to local warm Return header. Minor refrigerator heat load increase.

Failure Detection: Manual valve. Visual detection. Frosted valve. Minor increase in refrigerator output.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4017M	B	12	MONITOR TUBE H4000
H4019M	B	12	MONITOR TUBE H4005
H4069M	B	12	MONITOR TUBE H4010
H4070M	B	12	MONITOR TUBE H4015
H4063M	B	12	MONITOR TUBE H4020
H4062M	B	12	MONITOR TUBE H4035
H4214M	B	2	MONITOR TUBE H4205
H4212M	B	2	MONITOR TUBE H4210
H4217M	B	2	MONITOR TUBE H4215
H4250M	B	2	MONITOR TUBE H4218
H4222M	B	2	MONITOR TUBE H4220
H4428M	B	4	MONITOR TUBE H4405
H4418M	B	4	MONITOR TUBE H4407
H4417M	B	4	MONITOR TUBE H4410
H4412M	B	4	MONITOR TUBE H4415
H4422M	B	4	MONITOR TUBE H4420
H6735M	B	6	MONITOR TUBE H4500
H3233M	B	6	MONITOR TUBE H4501
H4512M	B	6	MONITOR TUBE H4510
H4517M	B	6	MONITOR TUBE H4515
H4522M	B	6	MONITOR TUBE H4520
H3237M	B	6	MONITOR TUBE H4600
H6819M	B	6	MONITOR TUBE H4601
H4617M	B	6	MONITOR TUBE H4615
H4622M	B	6	MONITOR TUBE H4620
H4829M	B	8	MONITOR TUBE H4800
H4812M	B	8	MONITOR TUBE H4801
H4833M	B	8	MONITOR TUBE H4810
H4817M	B	8	MONITOR TUBE H4815
H4822M	B	8	MONITOR TUBE H4820
H5012M	B	10	MONITOR TUBE H5010
H5017M	B	10	MONITOR TUBE H5015
H5022M	B	10	MONITOR TUBE H5020
H5033M	B	10	MONITOR TUBE H5283
H5281M	B	10	MONITOR TUBE H5284
H6028M	Y	12	MONITOR TUBE H6000
H6409M	Y	4	MONITOR TUBE H6000
H6052M	Y	12	MONITOR TUBE H6001
H6071M	Y	12	MONITOR TUBE H6007
H6012M	Y	12	MONITOR TUBE H6010
H6022M	Y	12	MONITOR TUBE H6015
H6017M	Y	12	MONITOR TUBE H6020

Valve #	Ring	Box	Nomenclature
H6217M	Y	2	MONITOR TUBE H6210
H6212M	Y	2	MONITOR TUBE H6215
H6222M	Y	2	MONITOR TUBE H6220
H6260M	Y	2	MONITOR TUBE H6253
H6256M	Y	2	MONITOR TUBE H6254
H6422M	Y	4	MONITOR TUBE H6402
H6417M	Y	4	MONITOR TUBE H6410
H6412M	Y	4	MONITOR TUBE H6415
H6424M	Y	4	MONITOR TUBE H6420
H6641M	Y	6	MONITOR TUBE H6600
H6726M	Y	6	MONITOR TUBE H6601
H6612M	Y	6	MONITOR TUBE H6610
H6617M	Y	6	MONITOR TUBE H6615
H6622M	Y	6	MONITOR TUBE H6620
H6728M	Y	6	MONITOR TUBE H6700
H6764M	Y	6	MONITOR TUBE H6701
H6717M	Y	6	MONITOR TUBE H6715
H6722M	Y	6	MONITOR TUBE H6720
H6862M	Y	8	MONITOR TUBE H6800
H6865M	Y	8	MONITOR TUBE H6801
H6812M	Y	8	MONITOR TUBE H6810
H6817M	Y	8	MONITOR TUBE H6815
H6822M	Y	8	MONITOR TUBE H6820
H7064M	Y	10	MONITOR TUBE H7000
H7017M	Y	10	MONITOR TUBE H7001
H7012M	Y	10	MONITOR TUBE H7010
H7069M	Y	10	MONITOR TUBE H7015
H7022M	Y	10	MONITOR TUBE H7020

Item: 59 **Failure:** Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4017M	B	12	MONITOR TUBE H4000
H4019M	B	12	MONITOR TUBE H4005
H4069M	B	12	MONITOR TUBE H4010
H4070M	B	12	MONITOR TUBE H4015
H4063M	B	12	MONITOR TUBE H4020
H4062M	B	12	MONITOR TUBE H4035
H4214M	B	2	MONITOR TUBE H4205
H4212M	B	2	MONITOR TUBE H4210
H4217M	B	2	MONITOR TUBE H4215
H4250M	B	2	MONITOR TUBE H4218
H4222M	B	2	MONITOR TUBE H4220
H4428M	B	4	MONITOR TUBE H4405
H4418M	B	4	MONITOR TUBE H4407
H4417M	B	4	MONITOR TUBE H4410
H4412M	B	4	MONITOR TUBE H4415
H4422M	B	4	MONITOR TUBE H4420
H6735M	B	6	MONITOR TUBE H4500
H3233M	B	6	MONITOR TUBE H4501
H4512M	B	6	MONITOR TUBE H4510
H4517M	B	6	MONITOR TUBE H4515
H4522M	B	6	MONITOR TUBE H4520
H3237M	B	6	MONITOR TUBE H4600
H6819M	B	6	MONITOR TUBE H4601
H4617M	B	6	MONITOR TUBE H4615
H4622M	B	6	MONITOR TUBE H4620
H4829M	B	8	MONITOR TUBE H4800
H4812M	B	8	MONITOR TUBE H4801
H4833M	B	8	MONITOR TUBE H4810
H4817M	B	8	MONITOR TUBE H4815
H4822M	B	8	MONITOR TUBE H4820
H5012M	B	10	MONITOR TUBE H5010
H5017M	B	10	MONITOR TUBE H5015
H5022M	B	10	MONITOR TUBE H5020
H5033M	B	10	MONITOR TUBE H5283
H5281M	B	10	MONITOR TUBE H5284
H6028M	Y	12	MONITOR TUBE H6000
H6409M	Y	4	MONITOR TUBE H6000
H6052M	Y	12	MONITOR TUBE H6001
H6071M	Y	12	MONITOR TUBE H6007
H6012M	Y	12	MONITOR TUBE H6010
H6022M	Y	12	MONITOR TUBE H6015
H6017M	Y	12	MONITOR TUBE H6020
H6217M	Y	2	MONITOR TUBE H6210
H6212M	Y	2	MONITOR TUBE H6215

Valve #	Ring	Box	Nomenclature
H6222M	Y	2	MONITOR TUBE H6220
H6260M	Y	2	MONITOR TUBE H6253
H6256M	Y	2	MONITOR TUBE H6254
H6422M	Y	4	MONITOR TUBE H6402
H6417M	Y	4	MONITOR TUBE H6410
H6412M	Y	4	MONITOR TUBE H6415
H6424M	Y	4	MONITOR TUBE H6420
H6641M	Y	6	MONITOR TUBE H6600
H6726M	Y	6	MONITOR TUBE H6601
H6612M	Y	6	MONITOR TUBE H6610
H6617M	Y	6	MONITOR TUBE H6615
H6622M	Y	6	MONITOR TUBE H6620
H6728M	Y	6	MONITOR TUBE H6700
H6764M	Y	6	MONITOR TUBE H6701
H6717M	Y	6	MONITOR TUBE H6715
H6722M	Y	6	MONITOR TUBE H6720
H6862M	Y	8	MONITOR TUBE H6800
H6865M	Y	8	MONITOR TUBE H6801
H6812M	Y	8	MONITOR TUBE H6810
H6817M	Y	8	MONITOR TUBE H6815
H6822M	Y	8	MONITOR TUBE H6820
H7064M	Y	10	MONITOR TUBE H7000
H7017M	Y	10	MONITOR TUBE H7001
H7012M	Y	10	MONITOR TUBE H7010
H7069M	Y	10	MONITOR TUBE H7015
H7022M	Y	10	MONITOR TUBE H7020

Item: 60 **Failure:** Open

Failure Effect: Flow through Pumpout header relief valve to atmosphere. Unacceptable leak, with depletion of helium inventory.

Failure Detection: Manual valve. Visual detection. Elevated temperature/low pressure. Frosted valve.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4087M	B	12	PUMPOUT H 10
H6874M	Y	8	PUMPOUT H 10
H6085M	Y	12	PUMPOUT H 10
H4869M	B	8	PUMPOUT H 10
H6273M	Y	2	PUMPOUT H 12
H5156M	B	10	PUMPOUT H 12
H7078M	Y	10	PUMPOUT H 12
H4274M	B	2	PUMPOUT H 12
H4082M	B	12	PUMPOUT H 2
H6080M	Y	12	PUMPOUT H 2
H6482M	Y	4	PUMPOUT H 2
H4477M	B	4	PUMPOUT H 2
H6782M	Y	6	PUMPOUT H 4
H6268M	Y	2	PUMPOUT H 4
H4653M	B	6	PUMPOUT H 4
H4269M	B	2	PUMPOUT H 4
H4874M	B	8	PUMPOUT H 6
H6879M	Y	8	PUMPOUT H 6
H6477M	Y	4	PUMPOUT H 6
H4472M	B	4	PUMPOUT H 6
H5161M	B	10	PUMPOUT H 8
H4648M	B	6	PUMPOUT H 8
H7083M	Y	10	PUMPOUT H 8
H6711M	Y	6	PUMPOUT H 8

Item: 60 Failure: Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4087M	B	12	PUMPOUT H 10
H6874M	Y	8	PUMPOUT H 10
H6085M	Y	12	PUMPOUT H 10
H4869M	B	8	PUMPOUT H 10
H6273M	Y	2	PUMPOUT H 12
H5156M	B	10	PUMPOUT H 12
H7078M	Y	10	PUMPOUT H 12
H4274M	B	2	PUMPOUT H 12
H4082M	B	12	PUMPOUT H 2
H6080M	Y	12	PUMPOUT H 2
H6482M	Y	4	PUMPOUT H 2
H4477M	B	4	PUMPOUT H 2
H6782M	Y	6	PUMPOUT H 4
H6268M	Y	2	PUMPOUT H 4
H4653M	B	6	PUMPOUT H 4
H4269M	B	2	PUMPOUT H 4
H4874M	B	8	PUMPOUT H 6
H6879M	Y	8	PUMPOUT H 6
H6477M	Y	4	PUMPOUT H 6
H4472M	B	4	PUMPOUT H 6
H5161M	B	10	PUMPOUT H 8
H4648M	B	6	PUMPOUT H 8
H7083M	Y	10	PUMPOUT H 8
H6711M	Y	6	PUMPOUT H 8

Item: 61

Failure: Open

Failure Effect: Flow through Pumpout header relief valve to atmosphere. Unacceptable leak, with depletion of helium inventory.

Failure Detection: Manual valve. Visual detection. Elevated temperature/low pressure. Frosted valve.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6872M	Y	8	PUMPOUT M 10
H4085M	B	12	PUMPOUT M 10
H4867M	B	8	PUMPOUT M 10
H6083M	Y	12	PUMPOUT M 10
H7076M	Y	10	PUMPOUT M 12
H4272M	B	2	PUMPOUT M 12
H6271M	Y	2	PUMPOUT M 12
H5154M	B	10	PUMPOUT M 12
H6078M	Y	12	PUMPOUT M 2
H6480M	Y	4	PUMPOUT M 2
H4080M	B	12	PUMPOUT M 2
H4267M	B	2	PUMPOUT M 4
H6266M	Y	2	PUMPOUT M 4
H4651M	B	6	PUMPOUT M 4
H6780M	Y	6	PUMPOUT M 4
H4872M	B	8	PUMPOUT M 6
H6475M	Y	4	PUMPOUT M 6
H6877M	Y	8	PUMPOUT M 6
H4470M	B	4	PUMPOUT M 6
H6709M	Y	6	PUMPOUT M 8
H5159M	B	10	PUMPOUT M 8
H7081M	Y	10	PUMPOUT M 8
H4475M	B	4	PUMPOUT M 2

Item: 61 **Failure:** Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6872M	Y	8	PUMPOUT M 10
H4085M	B	12	PUMPOUT M 10
H4867M	B	8	PUMPOUT M 10
H6083M	Y	12	PUMPOUT M 10
H7076M	Y	10	PUMPOUT M 12
H4272M	B	2	PUMPOUT M 12
H6271M	Y	2	PUMPOUT M 12
H5154M	B	10	PUMPOUT M 12
H6078M	Y	12	PUMPOUT M 2
H6480M	Y	4	PUMPOUT M 2
H4080M	B	12	PUMPOUT M 2
H4267M	B	2	PUMPOUT M 4
H6266M	Y	2	PUMPOUT M 4
H4651M	B	6	PUMPOUT M 4
H6780M	Y	6	PUMPOUT M 4
H4872M	B	8	PUMPOUT M 6
H6475M	Y	4	PUMPOUT M 6
H6877M	Y	8	PUMPOUT M 6
H4470M	B	4	PUMPOUT M 6
H6709M	Y	6	PUMPOUT M 8
H5159M	B	10	PUMPOUT M 8
H7081M	Y	10	PUMPOUT M 8
H4475M	B	4	PUMPOUT M 2

Failure Mode Effects Analysis

System: RHIC Cryogenic System **Date:** Tuesday, August 30, 1994

Operation Mode: Normal Operations

Item: 62 **Failure:** Open

Failure Effect: Flow through Pumpout header relief valve to atmosphere. Unacceptable leak, with depletion of helium inventory.

Failure Detection: Manual valve. Visual detection. Elevated temperature/low pressure. Frosted valve.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4646M	B	6	PUMPOUT M 8
H4089M	B	12	PUMPOUT R 10
H6087M	Y	12	PUMPOUT R 10
H6876M	Y	8	PUMPOUT R 10
H4871M	B	8	PUMPOUT R 10
H7080M	Y	10	PUMPOUT R 12
H6275M	Y	2	PUMPOUT R 12
H5158M	B	10	PUMPOUT R 12
H4276M	B	2	PUMPOUT R 12
H4084M	B	12	PUMPOUT R 2
H6082M	Y	12	PUMPOUT R 2
H4479M	B	4	PUMPOUT R 2
H6484M	Y	4	PUMPOUT R 2
H6784M	Y	6	PUMPOUT R 4
H4655M	B	6	PUMPOUT R 4
H6270M	Y	2	PUMPOUT R 4
H4271M	B	2	PUMPOUT R 4
H6881M	Y	8	PUMPOUT R 6
H4474M	B	4	PUMPOUT R 6
H4876M	B	8	PUMPOUT R 6
H6479M	Y	4	PUMPOUT R 6
H6713M	Y	6	PUMPOUT R 8
H5163M	B	10	PUMPOUT R 8
H7085M	Y	10	PUMPOUT R 8
H4650M	B	6	PUMPOUT R 8

Item: 62 **Failure:** Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4646M	B	6	PUMPOUT M 8
H4089M	B	12	PUMPOUT R 10
H6087M	Y	12	PUMPOUT R 10
H6876M	Y	8	PUMPOUT R 10
H4871M	B	8	PUMPOUT R 10
H7080M	Y	10	PUMPOUT R 12
H6275M	Y	2	PUMPOUT R 12
H5158M	B	10	PUMPOUT R 12
H4276M	B	2	PUMPOUT R 12
H4084M	B	12	PUMPOUT R 2
H6082M	Y	12	PUMPOUT R 2
H4479M	B	4	PUMPOUT R 2
H6484M	Y	4	PUMPOUT R 2
H6784M	Y	6	PUMPOUT R 4
H4655M	B	6	PUMPOUT R 4
H6270M	Y	2	PUMPOUT R 4
H4271M	B	2	PUMPOUT R 4
H6881M	Y	8	PUMPOUT R 6
H4474M	B	4	PUMPOUT R 6
H4876M	B	8	PUMPOUT R 6
H6479M	Y	4	PUMPOUT R 6
H6713M	Y	6	PUMPOUT R 8
H5163M	B	10	PUMPOUT R 8
H7085M	Y	10	PUMPOUT R 8
H4650M	B	6	PUMPOUT R 8

Item: 63 **Failure:** Open

Failure Effect: Flow through Pumpout header relief valve to atmosphere. Unacceptable leak, with depletion of helium inventory.

Failure Detection: Manual valve. Visual detection. Elevated temperature/low pressure. Frosted valve.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6873M	Y	8	PUMPOUT S 10
H4086M	B	12	PUMPOUT S 10
H6084M	Y	12	PUMPOUT S 10
H4868M	B	8	PUMPOUT S 10
H6272M	Y	2	PUMPOUT S 12
H5155M	B	10	PUMPOUT S 12
H7077M	Y	10	PUMPOUT S 12
H4273M	B	2	PUMPOUT S 12
H6079M	Y	12	PUMPOUT S 2
H4476M	B	4	PUMPOUT S 2
H4081M	B	12	PUMPOUT S 2
H6481M	Y	4	PUMPOUT S 2
H6267M	Y	2	PUMPOUT S 4
H4652M	B	6	PUMPOUT S 4
H6781M	Y	6	PUMPOUT S 4
H4268M	B	2	PUMPOUT S 4
H6476M	Y	4	PUMPOUT S 6
H4873M	B	8	PUMPOUT S 6
H6878M	Y	8	PUMPOUT S 6
H4471M	B	4	PUMPOUT S 6
H4647M	B	6	PUMPOUT S 8
H7082M	Y	10	PUMPOUT S 8
H6710M	Y	6	PUMPOUT S 8
H5160M	B	10	PUMPOUT S 8

Failure Mode Effects Analysis

Item: 63

Failure: Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H6873M	Y	8	PUMPOUT S 10
H4086M	B	12	PUMPOUT S 10
H6084M	Y	12	PUMPOUT S 10
H4868M	B	8	PUMPOUT S 10
H6272M	Y	2	PUMPOUT S 12
H5155M	B	10	PUMPOUT S 12
H7077M	Y	10	PUMPOUT S 12
H4273M	B	2	PUMPOUT S 12
H6079M	Y	12	PUMPOUT S 2
H4476M	B	4	PUMPOUT S 2
H4081M	B	12	PUMPOUT S 2
H6481M	Y	4	PUMPOUT S 2
H6267M	Y	2	PUMPOUT S 4
H4652M	B	6	PUMPOUT S 4
H6781M	Y	6	PUMPOUT S 4
H4268M	B	2	PUMPOUT S 4
H6476M	Y	4	PUMPOUT S 6
H4873M	B	8	PUMPOUT S 6
H6878M	Y	8	PUMPOUT S 6
H4471M	B	4	PUMPOUT S 6
H4647M	B	6	PUMPOUT S 8
H7082M	Y	10	PUMPOUT S 8
H6710M	Y	6	PUMPOUT S 8
H5160M	B	10	PUMPOUT S 8

Item: 64 **Failure:** Open

Failure Effect: Flow through Pumpout header relief valve to atmosphere. Unacceptable leak, with depletion of helium inventory.

Failure Detection: Manual valve. Visual detection. Elevated temperature/low pressure. Frosted valve.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4088M	B	12	PUMPOUT U 10
H6086M	Y	12	PUMPOUT U 10
H6875M	Y	8	PUMPOUT U 10
H4870M	B	8	PUMPOUT U 10
H5157M	B	10	PUMPOUT U 12
H4275M	B	2	PUMPOUT U 12
H7079M	Y	10	PUMPOUT U 12
H6274M	Y	2	PUMPOUT U 12
H6483M	Y	4	PUMPOUT U 2
H4083M	B	12	PUMPOUT U 2
H4478M	B	4	PUMPOUT U 2
H6081M	Y	12	PUMPOUT U 2
H6783M	Y	6	PUMPOUT U 4
H4270M	B	2	PUMPOUT U 4
H6269M	Y	2	PUMPOUT U 4
H4654M	B	6	PUMPOUT U 4
H6880M	Y	8	PUMPOUT U 6
H4875M	B	8	PUMPOUT U 6
H4473M	B	4	PUMPOUT U 6
H6478M	Y	4	PUMPOUT U 6
H4649M	B	6	PUMPOUT U 8
H6712M	Y	6	PUMPOUT U 8
H5162M	B	10	PUMPOUT U 8
H7084M	Y	10	PUMPOUT U 8

Item: 64 **Failure:** Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Manual valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4088M	B	12	PUMPOUT U 10
H6086M	Y	12	PUMPOUT U 10
H6875M	Y	8	PUMPOUT U 10
H4870M	B	8	PUMPOUT U 10
H5157M	B	10	PUMPOUT U 12
H4275M	B	2	PUMPOUT U 12
H7079M	Y	10	PUMPOUT U 12
H6274M	Y	2	PUMPOUT U 12
H6483M	Y	4	PUMPOUT U 2
H4083M	B	12	PUMPOUT U 2
H4478M	B	4	PUMPOUT U 2
H6081M	Y	12	PUMPOUT U 2
H6783M	Y	6	PUMPOUT U 4
H4270M	B	2	PUMPOUT U 4
H6269M	Y	2	PUMPOUT U 4
H4654M	B	6	PUMPOUT U 4
H6880M	Y	8	PUMPOUT U 6
H4875M	B	8	PUMPOUT U 6
H4473M	B	4	PUMPOUT U 6
H6478M	Y	4	PUMPOUT U 6
H4649M	B	6	PUMPOUT U 8
H6712M	Y	6	PUMPOUT U 8
H5162M	B	10	PUMPOUT U 8
H7084M	Y	10	PUMPOUT U 8

Item: 65

Failure: Open

Failure Effect: Minor increase in heat load.

Failure Detection: Normally closed valve. Minor increase in refrigerator output.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4209A	B	2	J T 225watt RECOOLER
H6224A	Y	2	J T 225watt RECOOLER
H4409A	B	4	J T 225watt RECOOLER
H6451A	Y	4	J T 225watt RECOOLER
H4558A	B	6	J T 225watt RECOOLER
H6605A	Y	6	J T 225watt RECOOLER
H4809A	B	8	J T 225watt RECOOLER
H6809A	Y	8	J T 225watt RECOOLER
H5009A	B	10	J T 225watt RECOOLER
H7009A	Y	10	J T 225watt RECOOLER
H4073A	B	12	J T 225watt RECOOLER
H6009A	Y	12	J T 225watt RECOOLER

Item: 65

Failure: Closed

Failure Effect: No flow. Recooler level declines with magnet temperature rise and power supply shutdown possible.

Failure Detection: Normally closed valve. Elevated pressure/temperature; low level indication. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4209A	B	2	J T 225watt RECOOLER
H6224A	Y	2	J T 225watt RECOOLER
H4409A	B	4	J T 225watt RECOOLER
H6451A	Y	4	J T 225watt RECOOLER
H4558A	B	6	J T 225watt RECOOLER
H6605A	Y	6	J T 225watt RECOOLER
H4809A	B	8	J T 225watt RECOOLER
H6809A	Y	8	J T 225watt RECOOLER
H5009A	B	10	J T 225watt RECOOLER
H7009A	Y	10	J T 225watt RECOOLER
H4073A	B	12	J T 225watt RECOOLER
H6009A	Y	12	J T 225watt RECOOLER

Item: 66 **Failure:** Full Scale High

Failure Effect: Inadequate flow. Recooler level declines with magnet temperature rise and power supply shutdown possible.

Failure Detection: Elevated pressure/temperature; high level indication. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
LI4252H	B	2	SUPERCON LEVEL PROB
LI6253H	Y	2	SUPERCON LEVEL PROB
LI4452H	B	4	SUPERCON LEVEL PROB
LI6477H	Y	4	SUPERCON LEVEL PROB
LI4001H	B	6	SUPERCON LEVEL PROB
LI4000H	Y	6	SUPERCON LEVEL PROB
LI4852H	B	8	SUPERCON LEVEL PROB
LI6852H	Y	8	SUPERCON LEVEL PROB
LI5052H	B	10	SUPERCON LEVEL PROB
LI7052H	Y	10	SUPERCON LEVEL PROB
LI4079H	B	12	SUPERCON LEVEL PROB
LI6057H	Y	12	SUPERCON LEVEL PROB

Item: 66 **Failure:** Full Scale Low

Failure Effect: Opens Recooler J-T valve. Minor increase in heat load.

Failure Detection: Constant low level output. Minor increase in refrigerator output.

Affected Components:

Valve #	Ring	Box	Nomenclature
LI4252H	B	2	SUPERCON LEVEL PROB
LI6253H	Y	2	SUPERCON LEVEL PROB
LI4452H	B	4	SUPERCON LEVEL PROB
LI6477H	Y	4	SUPERCON LEVEL PROB
LI4001H	B	6	SUPERCON LEVEL PROB
LI4000H	Y	6	SUPERCON LEVEL PROB
LI4852H	B	8	SUPERCON LEVEL PROB
LI6852H	Y	8	SUPERCON LEVEL PROB
LI5052H	B	10	SUPERCON LEVEL PROB
LI7052H	Y	10	SUPERCON LEVEL PROB
LI4079H	B	12	SUPERCON LEVEL PROB
LI6057H	Y	12	SUPERCON LEVEL PROB

Item: 67 **Failure:** Not in use - Open

Failure Effect: No impact. Bayonet capped, with relief valve.

Failure Detection: Normally closed valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4225A	B	2	DETECTOR SUPPLY
H6225A	Y	2	DETECTOR SUPPLY
H4425A	B	4	DETECTOR SUPPLY
H6462A	Y	4	DETECTOR SUPPLY
H4625A	B	6	DETECTOR SUPPLY
H6625A	Y	6	DETECTOR SUPPLY
H4825A	B	8	DETECTOR SUPPLY
H6825A	Y	8	DETECTOR SUPPLY
H5025A	B	10	DETECTOR SUPPLY
H7025A	Y	10	DETECTOR SUPPLY
H4072A	B	12	DETECTOR SUPPLY
H6013A	Y	12	DETECTOR SUPPLY

Item: 67 **Failure:** Not in use - Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4225A	B	2	DETECTOR SUPPLY
H6225A	Y	2	DETECTOR SUPPLY
H4425A	B	4	DETECTOR SUPPLY
H6462A	Y	4	DETECTOR SUPPLY
H4625A	B	6	DETECTOR SUPPLY
H6625A	Y	6	DETECTOR SUPPLY
H4825A	B	8	DETECTOR SUPPLY
H6825A	Y	8	DETECTOR SUPPLY
H5025A	B	10	DETECTOR SUPPLY
H7025A	Y	10	DETECTOR SUPPLY
H4072A	B	12	DETECTOR SUPPLY
H6013A	Y	12	DETECTOR SUPPLY

Item: 67 **Failure:** In use - Open

Failure Effect: Loss of automatic control by Collider Cryogenic Control System. Isolation valve on Experiment side of connection.

Failure Detection: Normally closed valve. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4225A	B	2	DETECTOR SUPPLY
H6225A	Y	2	DETECTOR SUPPLY
H4425A	B	4	DETECTOR SUPPLY
H6462A	Y	4	DETECTOR SUPPLY
H4625A	B	6	DETECTOR SUPPLY
H6625A	Y	6	DETECTOR SUPPLY
H4825A	B	8	DETECTOR SUPPLY
H6825A	Y	8	DETECTOR SUPPLY
H5025A	B	10	DETECTOR SUPPLY
H7025A	Y	10	DETECTOR SUPPLY
H4072A	B	12	DETECTOR SUPPLY
H6013A	Y	12	DETECTOR SUPPLY

Item: 67 **Failure:** In use - Closed

Failure Effect: No impact to Collider Cryogenics. Unscheduled loss of cryogenics to Experiment.

Failure Detection: Normally closed valve. Visual detection. Loss of flow/elevated temperature in Experiment cryogenics.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4225A	B	2	DETECTOR SUPPLY
H6225A	Y	2	DETECTOR SUPPLY
H4425A	B	4	DETECTOR SUPPLY
H6462A	Y	4	DETECTOR SUPPLY
H4625A	B	6	DETECTOR SUPPLY
H6625A	Y	6	DETECTOR SUPPLY
H4825A	B	8	DETECTOR SUPPLY
H6825A	Y	8	DETECTOR SUPPLY
H5025A	B	10	DETECTOR SUPPLY
H7025A	Y	10	DETECTOR SUPPLY
H4072A	B	12	DETECTOR SUPPLY
H6013A	Y	12	DETECTOR SUPPLY

Item: 68 **Failure:** Not in use - Open

Failure Effect: No impact. Line dead-headed by normally closed Detector Supply Valve. Bayonet and line contaminated by air.

Failure Detection: Normally closed. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
U0003H	B	2	1/2 IPS FEMALE BAYON
U0009H	Y	2	1/2 IPS FEMALE BAYON
U0004H	B	4	1/2 IPS FEMALE BAYON
U0010H	Y	4	1/2 IPS FEMALE BAYON
U0005H	B	6	1/2 IPS FEMALE BAYON
U0011H	Y	6	1/2 IPS FEMALE BAYON
U0006H	B	8	1/2 IPS FEMALE BAYON
U0012H	Y	8	1/2 IPS FEMALE BAYON
U0001H	B	10	1/2 IPS FEMALE BAYON
U0007H	Y	10	1/2 IPS FEMALE BAYON
U0002H	B	12	1/2 IPS FEMALE BAYON
U0008H	Y	12	1/2 IPS FEMALE BAYON

Item: 68 **Failure:** Not in use - Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
U0003H	B	2	1/2 IPS FEMALE BAYON
U0009H	Y	2	1/2 IPS FEMALE BAYON
U0004H	B	4	1/2 IPS FEMALE BAYON
U0010H	Y	4	1/2 IPS FEMALE BAYON
U0005H	B	6	1/2 IPS FEMALE BAYON
U0011H	Y	6	1/2 IPS FEMALE BAYON
U0006H	B	8	1/2 IPS FEMALE BAYON
U0012H	Y	8	1/2 IPS FEMALE BAYON
U0001H	B	10	1/2 IPS FEMALE BAYON
U0007H	Y	10	1/2 IPS FEMALE BAYON
U0002H	B	12	1/2 IPS FEMALE BAYON
U0008H	Y	12	1/2 IPS FEMALE BAYON

Item: 68 **Failure:** In use - Open/Leaks

Failure Effect: Minor helium leak.

Failure Detection: Minor increase in refrigerator output. Frosted fitting.

Affected Components:

Valve #	Ring	Box	Nomenclature
U0003H	B	2	1/2 IPS FEMALE BAYON
U0009H	Y	2	1/2 IPS FEMALE BAYON
U0004H	B	4	1/2 IPS FEMALE BAYON
U0010H	Y	4	1/2 IPS FEMALE BAYON
U0005H	B	6	1/2 IPS FEMALE BAYON
U0011H	Y	6	1/2 IPS FEMALE BAYON
U0006H	B	8	1/2 IPS FEMALE BAYON
U0012H	Y	8	1/2 IPS FEMALE BAYON
U0001H	B	10	1/2 IPS FEMALE BAYON
U0007H	Y	10	1/2 IPS FEMALE BAYON
U0002H	B	12	1/2 IPS FEMALE BAYON
U0008H	Y	12	1/2 IPS FEMALE BAYON

Item: 68 **Failure:** In use - Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed. Visual detection. Normal operations.

Affected Components:

Valve #	Ring	Box	Nomenclature
U0003H	B	2	1/2 IPS FEMALE BAYON
U0009H	Y	2	1/2 IPS FEMALE BAYON
U0004H	B	4	1/2 IPS FEMALE BAYON
U0010H	Y	4	1/2 IPS FEMALE BAYON
U0005H	B	6	1/2 IPS FEMALE BAYON
U0011H	Y	6	1/2 IPS FEMALE BAYON
U0006H	B	8	1/2 IPS FEMALE BAYON
U0012H	Y	8	1/2 IPS FEMALE BAYON
U0001H	B	10	1/2 IPS FEMALE BAYON
U0007H	Y	10	1/2 IPS FEMALE BAYON
U0002H	B	12	1/2 IPS FEMALE BAYON
U0008H	Y	12	1/2 IPS FEMALE BAYON

Item: 69

Failure: Open

Failure Effect: Magnet pressure bleeds into Return. Can be reconfigured.

Failure Detection: Normally closed valve. Magnet line pressure drop and/or Return pressure increase. Increased demand on circulator/refrigerator.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4006A	B	12	CROSSOVER M~U 10
H6006A	Y	12	CROSSOVER M~U 10
H4037A	B	12	CROSSOVER M~U 2
H6036A	Y	12	CROSSOVER M~U 2
H4206A	B	2	CROSSOVER M~U 4
H6206A	Y	2	CROSSOVER M~U 4
H4506A	B	6	CROSSOVER M~U 4
H6638A	Y	6	CROSSOVER M~U 4
H4406A	B	4	CROSSOVER M~U 6
H6406A	Y	4	CROSSOVER M~U 6
H4806A	B	8	CROSSOVER M~U 6
H6806A	Y	8	CROSSOVER M~U 6
H4606A	B	6	CROSSOVER M~U 8
H6706A	Y	6	CROSSOVER M~U 8
H5006A	B	10	CROSSOVER M~U 8
H7006A	Y	10	CROSSOVER M~U 8

Item: 69

Failure: Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
H4006A	B	12	CROSSOVER M~U 10
H6006A	Y	12	CROSSOVER M~U 10
H4037A	B	12	CROSSOVER M~U 2
H6036A	Y	12	CROSSOVER M~U 2
H4206A	B	2	CROSSOVER M~U 4
H6206A	Y	2	CROSSOVER M~U 4
H4506A	B	6	CROSSOVER M~U 4
H6638A	Y	6	CROSSOVER M~U 4
H4406A	B	4	CROSSOVER M~U 6
H6406A	Y	4	CROSSOVER M~U 6
H4806A	B	8	CROSSOVER M~U 6
H6806A	Y	8	CROSSOVER M~U 6
H4606A	B	6	CROSSOVER M~U 8
H6706A	Y	6	CROSSOVER M~U 8
H5006A	B	10	CROSSOVER M~U 8
H7006A	Y	10	CROSSOVER M~U 8

Item: 70

Failure: Open

Failure Effect: Flow from Heat Shield Supply bypassed to Heat Shield Return. Heat shield temperature increase with magnet temperature rise and subsequent magnet quench.

Failure Detection: Normally closed valve. Visual detection. Elevated pressure/temperature. Temperature indicators and Magnet quench.

Affected Components:

Valve #	Ring	Box	Nomenclature
LP2 C	B	4	LEAD POT "a" 3201512
LP2 B	B	10	LEAD POT "a" 3201512
LP2 A	Y	10	LEAD POT "a" 3201512
LP3 B	B	4	LEAD POT "b" 3201512
LP3 A	Y	10	LEAD POT "b" 3201512
LP4 A	B	10	LEAD POT "b" 3201512
LP1 C	B	2	LEAD POT 32015127 01
LP1 A	Y	4	LEAD POT 32015127 01
LP1 E	B	6	LEAD POT 32015127 01
LP1 D	B	8	LEAD POT 32015127 01
LP1 B	B	12	LEAD POT 32015127 01
LP5 B	Y	2	LEAD POT 32015127 05
LP5 A	Y	6	LEAD POT 32015127 05
LP5 D	Y	8	LEAD POT 32015127 05
LP5 C	Y	12	LEAD POT 32015127 05

Item: 70

Failure: Closed

Failure Effect: No impact. Normal operating position.

Failure Detection: Normally closed valve. Visual detection.

Affected Components:

Valve #	Ring	Box	Nomenclature
LP2 C	B	4	LEAD POT "a" 3201512
LP2 B	B	10	LEAD POT "a" 3201512
LP2 A	Y	10	LEAD POT "a" 3201512
LP3 B	B	4	LEAD POT "b" 3201512
LP3 A	Y	10	LEAD POT "b" 3201512
LP4 A	B	10	LEAD POT "b" 3201512
LP1 C	B	2	LEAD POT 32015127 01
LP1 A	Y	4	LEAD POT 32015127 01
LP1 E	B	6	LEAD POT 32015127 01
LP1 D	B	8	LEAD POT 32015127 01
LP1 B	B	12	LEAD POT 32015127 01
LP5 B	Y	2	LEAD POT 32015127 05
LP5 A	Y	6	LEAD POT 32015127 05
LP5 D	Y	8	LEAD POT 32015127 05
LP5 C	Y	12	LEAD POT 32015127 05