Instr Code	Tag #	Serv. Code	PID	GRID	LOC	Service Description	Instrument Type	Failure or Error Mode	Hazard or Effect	Hazard Class	Remarks or Recommendations
CV	1		SHT-1	3-	D	LAr Dewar - pressure building line check valve	check valve	fails open	nothing	Safe	
								fails closed	cannot raise pressure of LAr dewar	Safe	
DP	1		SHT-1	5-	C	LAr Dewar - Local liquid level indicator	local level indicator	incorrect reading	Level in the LAr dewar will be something different than indicated. May get more frequent fills or run empty.	Safe	Will stop operations if we run empty.
P	1		SHT-1	5-	C	LAr Dewar - Pressure gage	local pressure indicator	incorrect reading	Dewar Pressure may be higher or lower than indicated. Could cause operators to adjust pressure regulators incorrectly.	Safe	
R	1		SHT-1	3-	D	LAr Dewar - pressure builder regulator	pressure regulator	fails open	Pressure of LAr dewar will increase higher than desired. When it hits 100 psig, relief valves on supply line will relieve.	Safe	Will trigger alarms on dewar pressure.
								fails closed	Pressure of LAr dewar will decrease lower than desired.	Safe	Will start losing liquid level in Cryostat. Actuated Control valves may close due to insufficient pressure.
RV	1		SHT-1	3-	D	LAr Dewar - pressure builder trapped volume relief	relief valve	fails open	Leak liquid argon outside.	Safe	Wasteful. Relief pointed away from personnel.
								fails closed	Overpressure piping.	mechanical damage	small trapped volume.
S	1		SHT-1	3-	D	LAr Dewar - pressure builder line strainer	strainer	clogs	Pressure of LAr dewar may go low as pressure building loop will isolated.	Safe	LCV-105-A, Control valve will compensate by opening more.
V	1		SHT-1	3-	D	LAr Dewar - pressure builder isolation	manual valve	fails open	No effect. Normally open.	Safe	
								fails closed	Blocks pressure building loop on dewar. Pressure on LAr dewar will be lower than desired. Also can't do top fill.	Safe	Operational issue that could interupt operations.
CV	2		SHT-1	3-	E	LAr Dewar - economizer vaporizer check valve	check valve	fails open	Can withdraw cold from the dewar to the gas use line.	Safe	Line will get frosty.
								fails closed	Blocks pressure building loop on dewar. Pressure on LAr dewar will be lower than desired.	Safe	
RV	2		SHT-1	3-	D	LAr Dewar - fill line trapped volume relief	relief valve	fails open	Leak liquid argon outside.	Safe	Wasteful. Relief pointed away from personnel.
								fails closed	Overpressure piping.	mechanical damage	small trapped volume.
V	2		SHT-1	3-	D	LAr Dewar - bottom fill valve	manual valve	fails open	Can get liquid argon leakage out the fill port if CV-4 leaks.	Safe	Driver disconnecting hose will be wearing protective gear.
								fails closed	Cannot do a bottom fill of liquid argon dewar.	Safe	Pressure control during a fill is limited.
CV	3		SHT-1	3-	E	LAr Dewar - gas withdrawal line check valve	check valve	fails open	potential to back flow Ar/H2 into LAr dewar	Safe	Difficult to do. FCV-653-A needs to be in manual, open.
								fails closed	blocks gas argon supply, control valves close. Liquid to cryostat stops. Pressure builds until operational relief PSV-202-A opens.	Safe	Will trigger alarms on cryostat pressure and level.
V	3		SHT-1	3-	D	LAr Dewar - top fill valve	manual valve	fails open	Can get gas argon leakage out the fill port if CV-5 leaks.	Safe	
								fails closed	Cannot do a top fill of liquid argon dewar.	Safe	Pressure will build during a bottom fill and the tank blow down will need to be used during filling.
CV	4		SHT-1	3-	D	LAr Dewar - bottom fill line check valve	check valve	fails open	Can get backflow of liquid argon out the fill connection if V-2 is not closed all the way.	Safe	Driver disconnecting hose will be wearing protective gear.
								fails closed	Cannot do a bottom fill of liquid argon dewar.	Safe	Pressure control during a fill is limited.
V	4		SHT-1	5-	D	LAr Dewar - Full trycock and vent	manual valve	fails open	Will reduce pressure in the dewar and could allow air contamination into the dewar.	Safe	Operational issue that could interupt operations.
								fails closed	Must rely on liquid level indicator to know when full. Cannot blow down pressure of LAr dewar	Safe	
CV	5		SHT-1	3-	D	LAr Dewar - top fill line check valve	check valve	fails open	Gas will backflow out the fill connection if V-3 is not closed all the way.	Safe	
								fails closed	Cannot do a top fill of liquid argon dewar.	Safe	
V	5		SHT-1	5-	D	LAr Dewar - Liquid Argon supply isolation	manual valve	fails open	Normally open. Cannot isolate liquid supply at dewar.	Safe	LCV-105-A is used to control liquid flow.
								fails closed	Stops liquid flow to system.	Safe	Stops the experiment as liquid level in crysotat will drop.
V	6		SHT-1	5-	D	LAr Dewar - Gas Argon supply isolation	manual valve	fails open	normal		
								fails closed	blocks gas argon supply, control valves close. Liquid to cryostat stops. Pressure builds until operational relief PSV-202-A opens.	Safe	Will trigger alarms on cryostat pressure and level.
V	7		SHT-1	5-	D	LAr Dewar - Diverter valve for relief selection	diverter valve	fails open	Both relief sets can be on-line at once.	Safe	
								fails closed	Not possible. Mechanical design keeps one port open.	Safe	
V	7		SHT-1	3-	D	LAr Dewar - fill line vent valve	manual valve	fails open	If opened during fill will squirt/stream LAr on the ground. Driver wears protective gear. If open outside of filling process, no hazard.	Safe	

Instr Code	Tag #	Serv. Code	PID	GRID	LOC	Service Description	Instrument Type	Failure or Error Mode	Hazard or Effect	Hazard Class	Remarks or Recommendations
								fails closed	Cannot vent pressure and liquid from fill hose before disconnecting.	Safe	Pressure will drop as soon as fill hose fitting is loosened. Safety relief prevents mechanical damage.
V	8		SHT-1	5-	C	LAr Dewar - liquid level indicator liquid side isolation	manual valve	fails open	Normally open.	Safe	
								fails closed	Incorrect pressure and level indication.	Safe	Operator could make an error and overfill or pop relief valve by taking incorrect actions.
V	9		SHT-1	5-	C	LAr Dewar - liquid level indicator gas side isolation	manual valve	fails open	Normally open.	Safe	
								fails closed	Incorrect pressure and level indication.	Safe	Operator could make an error and overfill or pop relief valve by taking incorrect actions.
V	10		SHT-1	5-	C	LAr Dewar - liquid level indicator equalization	manual valve	fails open	incorrect pressure and level indication.	Safe	
								fails closed	. No effect. Normally closed. Can't check zero on LI.	Safe	
V	11		SHT-1	3-	E	LAr Dewar - economizer vaporizer isolation	manual valve	fails open	No effect. Normally open.	Safe	
								fails closed	Gas being withdrawn for gas use may be cold	Safe	
RPD	1A		SHT-1	5-	D	LAr Dewar - Safety Rupture disc	rupture disc	fails open	LAr Dewar pressure will blow down to atmospheric pressure. Will stop operations.	Safe	
								fails closed	Relief valve will protect dewar. Full capacity is not ensured.	Mechanical damage	Safety Rupture discs extremely reliable.
RPD	1B		SHT-1	5-	D	LAr Dewar - Safety Rupture disc	rupture disc	fails open	LAr Dewar pressure will blow down to atmospheric pressure. Will stop operations.	Safe	
								fails closed	Relief valve will protect dewar. Full capacity is not ensured.	Mechanical damage	Safety Rupture discs extremely reliable.
RV	2A		SHT-1	5-	D	LAr Dewar - Safety Relief Valve	relief valve	fails open	LAr Dewar pressure will blow down to atmospheric pressure. Will stop operations.	Safe	Possible dewar contamination. Have diverter valve to isolate and fix the valve.
								fails closed	Rupture disc will protect dewar.	Safe	Unlikely ASME code relief will fail closed.
RV	2B		SHT-1	5-	D	LAr Dewar - Safety Relief Valve	relief valve	fails open	LAr Dewar pressure will blow down to atmospheric pressure. Will stop operations.	Safe	Possible dewar contamination. Have diverter valve to isolate and fix the valve.
								fails closed	Rupture disc will protect dewar.	Safe	Unlikely ASME code relief will fail closed.
LCV	105	A	SHT-2	5-	D	LAr supply level control valve	Actuated level control valve	fails open	Liquid Argon overfills cryostat, liquid will go out vent	Safe	Local cold spot on roof at the vent exhaust
								fails closed	Cryostat liquid level will drop	Safe	Will need to interlock TPC high voltage to liquid level.
PSV	108	V	SHT-2	4-	D	filter insulating vacuum	parallel plate relief	fails open	Loss of vacuum on filter	Safe	Heat load will increase, liquid argon consumption will increase, will get frosting on filter vacuum jacket
								fails closed	Vacuum jacket not protected	Safe	Low probability 5x10-7 hr-1 that there will be a leak (pressurizing source) inside the vacuum jacket and 5x10-5 hr that the relief fails to open. Once every 4 million years that both occur.
PSV	109	A	SHT-2	4-	D	filter	relief valve	fails open	Will leak cryogen on the floor	Safe	The relief valve outlet is pointed in a safe direction, down. Operating point only 40 psig whereas relief set point is 100 psig.
								fails closed	Trapped volume with 77 liters of liquid cryogen inside will overpressurize piping.	Mech. Damage	Operational error could cause this. ASME code relief valve has low likelihood of failing to operate.
HV	110	A	SHT-2	6-	E	cryostat LAr supply/return VJ	manual valve	fails open	Could let vacuum up to atmosphere pressure in vacuum jacketed pipe section	Safe	Could get frosting on pipes going into cryostat
								fails closed	Cannot pump down vacuum jacketed pipe section	Safe	Frost on pipes. Vacuum jacket protected by relief.
PI	116	A	SHT-2	4-	E	filter	local pressure indicator	incorrect reading	operator will have bad information, will need to take other readings into consideration	Safe	redundant with PT117A and PI307A.
PT	117	A	SHT-2	4-	E	filter	pressure transmitter	incorrect reading	operator will have bad information, will need to take other readings into consideration	Safe	redundant with PI116A and PI307A or PI428A
HV	118	A	SHT-2	4-	E	filter pressure instrumentation isolation	manual valve (diaphragm)	fails open	normal state. Will have small gas leak if trying to remove instrumentation.	Safe	
								fails closed	Pressure instrumentation will be incorrect.	Safe	redundant pressure instrumentation can be used.
PSV	177	V	SHT-2	6-	F	LAr Supply VJ relief	relief valve	fails open	Will let vacuum up to atmosphere pressure in vacuum jacketed pipe section	Safe	Could get frosting on pipes going into cryostat
								fails closed	Vacuum jacket not protected	Safe	In the event of leak and pressurization of vacuum jacket, PIT178V or the KF clamp will fail.
PIT	178	V	SHT-2	6-	F	filtered liquid return at cryostat	pressure transmitter	incorrect reading	bad information	Safe	frost will give indication of bad vacuum. Redundant with PIT269V when pumping
TE	190	A	SHT-2	4-	D	filter bed temperature (top)	100 ohm platinum RTD	incorrect reading	filter overheats	Safe	PLC heater control loop monitors all five temperature sensors per filter and two temperature sensors per heater such that one sensor failure will not endanger the process. Hardwired interlocks protect the process independent of the PLC

Instr Code	Tag #	Serv. Code	PID	GRID	LOC	Service Description	Instrument Type	Failure or Error Mode	Hazard or Effect	Hazard Class	Remarks or Recommendations
TE	191	A	SHT-2	4-	D	filter bed temperature	100 ohm platinum RTD	incorrect reading	filter overheats	Safe	PLC heater control loop monitors all five temperature sensors per filter and two temperature sensors per heater such that one sensor failure will not endanger the process. Hardwired interlocks protect the process independent of the PLC
TE	192	A	SHT-2	4-	D	filter bed temperature	100 ohm platinum RTD	incorrect reading	filter overheats	Safe	PLC heater control loop monitors all five temperature sensors per filter and two temperature sensors per heater such that one sensor failure will not endanger the process. Hardwired interlocks protect the process independent of the PLC
TE	193	A	SHT-2	4-	D	filter bed temperature	100 ohm platinum RTD	incorrect reading	filter overheats	Safe	PLC heater control loop monitors all five temperature sensors per filter and two temperature sensors per heater such that one sensor failure will not endanger the process. Hardwired interlocks protect the process independent of the PLC
TE	194	A	SHT-2	4-	D	filter bed temperature (bottom)	100 ohm platinum RTD	incorrect reading	filter overheats	Safe	PLC heater control loop monitors all five temperature sensors per filter and two temperature sensors per heater such that one sensor failure will not endanger the process. Hardwired interlocks protect the process independent of the PLC
PIT	195	V	SHT-2	5-	D	Filter housing vacuum jacket	Vacuum transducer/gauge	incorrect reading	bad information	Safe	Condensation or frost will give indication of bad vacuum. Might pump on the VJ if the reading is incorrectly high.
PSE	201	A	SHT-2	7-	D	cryostat relief	rupture disk	fails open	Will vent argon gas into MC7. Cryostat pressure will drop, PCV220A will close. Two phase liquid & gas delivered to cryostat.	Safe	Unlikely to occur, PSV202A will keep pressure below 50% of rupture disc setting.
								fails closed	cryostat could overpressurize	mechanical damage	Very unlikely rupture disc will not burst. Multiple failures necessary. PCV-220-A controls pressure, PSV202A also
PSV	202	A	SHT-2	7-	D	cryostat relief	relief valve	fails open	Will vent argon gas into MC7. Cryostat pressure will drop, PCV220A will close. Two phase liquid & gas delivered to cryostat.	Safe	Unlikely to occur, 10-5 hr-1 (once every 11 years) for carbon steel reliefs in corrosive service.
								fails closed	cryostat could overpressurize	Safe	PSE-201-A will relieve at vessel MAWP
HV	203	A	SHT-2	7-	D	cryostat pressure instrumentation isolation	manual valve (diaphragm)	fails open	normal state. Will have small gas leak if trying to replace instrumentation.	Safe	
								fails closed	instrumentation readings innaccurate	Safe	Cryostat pressure control will fail, PCV-220-A may stay closed, Cryostat pressure will rise to 15 psig when PSV-202-A relieves.
HV	205	A	SHT-2	7-	C	cryostat pressure instrumentation isolation	manual valve (diaphragm)	fails open	Level instrumentation will read zero	Safe	This is okay, as Capacitance level probe, LT209A is used for control.
								fails closed	normal state. Cannot zero level gage	Safe	
HV	206	A	SHT-2	7-	C	cryostat pressure instrumentation isolation	manual valve (diaphragm)	fails open	normal state. Will have small gas leak if trying to replace instrumentation.	Safe	
								fails closed	Level instrumentation will be incorrect.	Safe	This is okay, as Capacitance level probe, LT209A is used for control.
LI	207	A	SHT-2	7-	C	cryostat level	local level indicator	incorrect reading	May underfill or overfill cryostat but only used as a reference against LT209A.	Safe	
LT	208	A	SHT-2	7-	C	cryostat level	level transmitter (dP)	incorrect reading	May underfill or overfill cryostat but only used as a reference against LT209A.	Safe	
LT	209	A	SHT-2	6-	D	cryostat level	level transmitter (capacitance)	incorrect reading	May underfill or overfill cryostat. If cryostat level is really lower, could get High Voltage discharge to ground inside cryostat.	Safe	A high voltage discharge to ground will trip off the experiment.
HV	210	A	SHT-2	5-	D	cryostat top flange between seal ports	manual valve (bellows)	fails open	could contaminate argon if vacuum pump, PU-268 isn't pumping.	Safe	
								fails closed	normal state.	Safe	Prevents pumping down space between seals. Valve can be changed out without issues.
HV	211	V	SHT-2	5-	D	cryostat end flange between seals port	manual valve (bellows)	fails open	could contaminate argon if vacuum pump, PU-268 isn't pumping.	Safe	
								fails closed	normal state.	Safe	Prevents pumping down space between seals. Valve can be changed out without issues.
TE	212	A	SHT-2	6-	C	cryostat metal temperature	100 ohm platinum RTD	incorrect reading	no effect, used to monitor cool down.	Safe	sort of redundant with TE-213 and TE214
TE	213	A	SHT-2	6-	C	cryostat bottom metal temperature	100 ohm platinum RTD	incorrect reading	no effect, used to monitor cool down.	Safe	sort of redundant with TE-212 and TE214

Instr Code	Tag #	Serv. Code	PID	GRID	LOC	Service Description	Instrument Type	Failure or Error Mode	Hazard or Effect	Hazard Class	Remarks or Recommendations
TE	214	A	SHT-2	6-	C	cryostat neck metal temperature	100 ohm platinum RTD	incorrect reading	no effect, used to monitor cool down.	Safe	sort of redundant with TE-212 and TE213
HV	217	V	SHT-2	6-	B	cryostat inner side flange double seal	manual valve (bellows)	fails open	could contaminate argon if vacuum pump, PU-268 isn't pumping.	Safe	
								fails closed	normal state.	Safe	Prevents pumping down space between seals. Valve can be changed out without issues.
PI	218	A	SHT-2	7-	D	cryostat vapor pressure	local pressure indicator	incorrect reading	Operator may think something is wrong.	Safe	Redundant with PT219A. Operator would look at control system, PT219A and PCV220A if he/she thought something was wrong with pressure control.
PT	219	A	SHT-2	7-	D	cryostat vapor pressure	pressure transmitter	incorrect reading	Would cause incorrect cryostat pressure control either higher or lower than desired.	Safe	Operational problem. Contamination more likely at low pressure, could open relief valve at >15 psig.
PCV	220	A	SHT-2	6-	F	cryostat over pressure vent	Actuated pressure control valve	fails open	Cryostat pressure will drop to just over atmospheric pressure.	Safe	Operational problem. Contamination more likely at low pressure.
								fails closed	Cryostat pressure will rise and PSV202A will open at 15 psig.	Safe	Will interlock LCV-105-A to close on high cryostat pressure >10 psig.
HV	221	A	SHT-2	7-	D	cryostat vapor sample near feed thru isolation, sample pt. 801	manual valve (diaphragm)	fails open	nothing	Safe	In series with HV-849-A.
								fails closed	unable to send cryostat gas to analyzers	Safe	Other sample points exist.
HV	222	A	SHT-2	7-	D	cryostat vapor sample near liquid isolation, sample pt. 801	manual valve (diaphragm)	fails open	nothing	Safe	In series with HV-849-A.
								fails closed	unable to send cryostat gas to analyzers	Safe	Other sample points exist.
HV	223	A	SHT-2	7-	D	cryostat liquid sample isolation, sample pt. 801	manual valve (diaphragm)	fails open	nothing	Safe	In series with HV-849-A.
								fails closed	unable to send cryostat vaporized liquid to analyzers	Safe	Other sample points exist.
V	227	A	SHT-2	6-	E	cryostat vent	check valve	fails open	contamination of cryostat liquid argon if PCV-220-A is left open and argon supply source is closed.	Safe	Operational nuisance. Might have to replace the liquid argon.
								fails closed	Same as PCV-220-A failing closed. Cryostat pressure will rise and PSV202A will open at 15 psig.	Safe	Will interlock LCV-105-A to close on high cryostat pressure >10 psig.
HV	228	A	SHT-2	6-	E	cryostat vent	manual valve	fails open	normal state. Only closed during cool down. Cool down will be inefficient.	Safe	
								fails closed	Will get two phase, gas and liquid to cryostat rather than only liquid.	Safe	Time Projection Chamber detector likes only pure liquid. Gas bubbles would rise outside of TPC.
PSV	250	V	SHT-2	7-	C	Cryostat vacuum jacket relief valve	parallel plate relief	fails open	Loss of cryostat insulating vacuum. Increased heat load, increased LAr consumption	Safe	May get condensation or frosting on cryostat. Extra boil-off gas goes to vent outside.
								fails closed	Cryostat vacuum jacket not protected from overpressurization	Safe	Double failure. Low probability that leak/pressurization source in vacuum jacket exists and relief does not open.
HV	251	V	SHT-2	7-	C	Cryostat vacuum jacket pump out	manual valve	fails open	Loss of cryostat insulating vacuum. Increased heat load, increased LAr consumption	Safe	May get condensation or frosting on cryostat. Extra boil-off gas goes to vent outside.
								fails closed	Normal state. Unable to pump down cryostat vacuum jacket	Safe	Operational nuisance if cannot open and cryostat vacuum is soft.
HV	255	A	SHT-2	6-	D	cryostat neck fill port	manual valve (bellows)	fails open	Will drop cryostat pressure and send cold gas argon to vacuum pump.	mechanical damage	May damage vacuum pump if valve is left open.
								fails closed	Normal state. Cannot perform initial system evacuation.	Safe	Purge during cooling may be sufficient to remove oxygen and moisture.
PSV	259	V	SHT-2	6-	D	cryostat end flange trapped volume relief	relief valve	fails open	Small chance of contamination of liquid argon if inner seal leaks	Safe	
								fails closed	Normal state	Safe	
PSV	260	V	SHT-2	6-	B	cryostat side flange trapped volume relief	relief valve	fails open	Small chance of contamination of liquid argon if inner seal leaks	Safe	
								fails closed	Normal state	Safe	
PIT	263	V	SHT-2	7-	C	Cryostat vacuum jacket pressure	Vacuum transducer/gauge	incorrect reading	May cause operator to evacuate/pump on vacuum jacket.	Safe	Poor vacuum may be indicated by cold vaccum jacket temperature. Good vacuum will have warm metal temperature.
PIT	264	V	SHT-2	6-	B	cryostat seal vacuum	pressure transmitter	incorrect reading	May cause operator to pump on seal	Safe	
PIT	265	V	SHT-2	6-	C	cryostat seal vacuum	pressure transmitter	incorrect reading	May cause operator to pump on seal	Safe	
PIT	266	V	SHT-2	6-	D	cryostat seal vacuum	pressure transmitter	incorrect reading	May cause operator to pump on seal	Safe	
HV	267	V	SHT-2	6-	C	cryostat active vacuum vent	manual valve	fails open	If pumping and valve opens, the vacuum will be lost and contamination could occur.	Safe	Operational nuisance

Instr Code	Tag #	Serv. Code	PID	GRID	LOC	Service Description	Instrument Type	Failure or Error Mode	Hazard or Effect	Hazard Class	Remarks or Recommendations
								fails closed	Normally closed.	Safe	Vacuum can be let up by other means like loosening a clamp.
PU	268	V	SHT-2	6-	C	cryostat vacuum dry scroll pump	pump	stops pumping	Vacuum will be lost during initial pump down	Safe	Operational nuisance at start up. After start up, will only pump on seal space infrequently. Small contamination risk if pumping on seal.
PIT	269	V	SHT-2	5-	C	cryostat vacuum header	pressure transmitter	incorrect reading	Operator may think pump is not good	Safe	Isolatible, pump may be swapped unnecessarily.
HV	270	V	SHT-2	5-	C	cryostat vacuum header isolation	manual valve	fails open	Cannot check ultimate pressure of pump	Safe	Other valves can be closed.
								fails closed	Active pumping on seals and/or cryostat vacuum jacket stops	Safe	Higher heat loads may result.
PSV	271	V	SHT-2	5-	C	Vacuum header relief valve	relief valve	fails open	Loss of cryostat insulating vacuum. Increased heat load, increased LAr consumption	Safe	Can operate with higher heat load.
								fails closed	Vacuum pump will not be protected. If positive pressure occurs vacuum pump damage could occur.	mechanical damage	
HV	300	Ar	SHT-2	3-	D	LAr transfer line filter bypass	Manual valve	fails open	Liquid Argon will not be filtered for particulates. Particulates from molecular sieve and Cu catalyst could make its way to the cryostat.	Safe	Build-up of particulates in cryostat could cause odd detector behavior.
								fails closed	Normal state. Cannot run during filter changeout.	Safe	Filter change out is not anticipated during the life of the experiment.
HV	301	Ar	SHT-2	3-	D	LAr transfer line filter isolation	Manual valve	fails open	Normal state. Cannot isolate filter for change out.	Safe	Filter change out is not anticipated during the life of the experiment.
								fails closed	Will stop liquid argon flow to cryostat. Liquid level will drop. Experiment will need to shut down.	Safe	High Voltage will shut off on low liquid level.
FL	302	Ar	SHT-2	3-	D	LAr transfer line filter	Particulate filter	clogs	Liquid argon flow to cryostat will decrease, LCV105A will compensate by opening more. Eventually liquid level in cryostat may drop and shut down the experiment.	Safe	Nuisance. Detector High Voltage will shut off on liquid level drop.
HV	303	Ar	SHT-2	3-	D	LAr transfer line filter isolation	Manual valve	fails open	Normal state. Cannot isolate filter for change out.	Safe	Filter change out is not anticipated during the life of the experiment.
								fails closed	Will stop liquid argon flow to cryostat. Liquid level will drop. Experiment will need to shut down.	Safe	High Voltage will shut off on low liquid level.
HV	305	Ar	SHT-2	3-	D	LAr transfer line filter pressure gauge equalizer	Manual valve	fails open	differential pressure indication across filter will be zero	Safe	Will not know filter is getting clogged. We do not expect filter to clog.
								fails closed	normal state	Safe	
PDI	306	Ar	SHT-2	3-	D	LAr transfer line filter pressure drop	Differentional Pressure gauge	incorrect reading	None, will not know pressure drop across the filter.	Safe	Will not know filter is getting clogged. We do not expect filter to clog.
PI	307	Ar	SHT-2	3-	D	LAr transfer line filter upstream pressure	Pressure gauge	incorrect reading	Operator may be concerned there is a problem with system supply pressure.	Safe	Redundant with PI116A and PT117A.
HV	308	Ar	SHT-2	3-	D	LAr transfer line filter vent	Manual valve	fails open	Will leak argon into the enclosure at a small rate.	Safe	Not normally used.
								fails closed	Normal state	Safe	Used to relieve pressure if isolating filter.
PSV	309	Ar	SHT-2	3-	D	LAr transfer line filter pressure relief	Relief valve	fails open	Will leak argon into the enclosure at a small rate.	Safe	
								fails closed	Trapped volume of ~1 liter of liquid argon	Safe	Operator should vent pressure thru HV308A if closing both upstream and downstream valves. Unlikely that relief valve will not open.
PR	400	H	SHT-2	1-	D	Ar/H2 from trailer	pressure regulator	fails open	Pressure downstream will rise to 100 psig and then relief valve, PSV-406-H will open keeping the pressure around 100 psig.	Safe	Downstream components are rated for greater than 100 psig. Also have relief valve PSV109A at filter at 100 psig.
								fails closed	Flow during regeneration will stop. Heater temperatures will rise and shut off heater.	Safe	TE413 or TE417 are the input to the interlock
HV	401	H	SHT-2	1-	D	H2/Ar pressure instrumentation	manual valve	fails open	Normal state except when removing PI for repairs.		
								fails closed	PI-402-H reading will be incorrect. Could run out of regeneration gas sooner than expected. Then same scenario as PR400H failing closed.	Safe	PI-404-H is redundant with PI-402-H.
PI	402	H	SHT-2	1-	D	regeneration gas trailer pressure	local pressure indicator	incorrect reading	Could run out of regeneration gas sooner than expected. Then same scenario as PR400H failing closed.	Safe	PI-404-H is redundant with PI-402-H.
PI	404	H	SHT-2	1-	D	Ar/H2 from trailer	pressure indicator on regulator	incorrect reading	Could run out of regeneration gas sooner than expected. Then same scenario as PR400H failing closed.	Safe	PI-404-H is redundant with PI-402-H.

Instr Code	Tag #	Serv. Code	PID	GRID	LOC	Service Description	Instrument Type	Failure or Error Mode	Hazard or Effect	Hazard Class	Remarks or Recommendations
PI	405	H	SHT-2	1-	D	Ar/H2 from trailer	pressure indicator on regulator	incorrect reading	Supply pressure to flow controllers will either be higher or lower than desired. If higher, can only go to 100 psig, then PSV-406-H will relieve. If lower, then might not get enough flow during regeneration and heater or filter will overheat. Heater will trip off on over temperature.	Safe	
PSV	406	H	SHT-2	1-	D	Ar/H2 from trailer relief	relief valve	fails open	Will relieve Ar/H2 gas outside. Could reduce supply pressure and regeneration gas flow.	Safe	Nuisance. Wastes gas.
								fails closed	Supply pressure to flow controller may exceed 100 psig if PR-400-H isn't set correctly. Could exceed pressure rating of a component.	Mechanical Damage	Need double failure of PR-400-H or operator error plus a relief valve not opening.
HV	407	H	SHT-2	1-	D	Ar/H2 from trailer	manual valve	fails open	Nothing, in series with flow controllers	Safe	
								fails closed	Stops regeneration gas flow. Heaters trip off on high temperature.	Safe	Same as FCV-424-H failing closed.
HV	408	H	SHT-2	1-	D	Trailer hose blowdown	manual valve	fails open	Will vent Ar/H2 outside. Could reduce supply pressure and regeneration gas flow.	Safe	
								fails closed	Normal state. Unable to properly blow down hose prior to disconnecting hose.	Safe	Hose will depressurize as soon as a fitting is untightened.
FL	409	H	SHT-2	4-	G	filter regeneration H2/Ar supply	particulate filter	clogs	Stops regeneration gas flow. Heaters trip off on high temperature.	Safe	
PI	410	H	SHT-2	4-	G	filter regeneration H2/Ar supply	local pressure indicator	incorrect reading	Used for information only. Redundant with PI-405-H.	Safe	
HV	411	A	SHT-2	4-	F	filter regeneration heater isolation	manual valve (ball valve)	fails open	Normal state.	Safe	
								fails closed	Stops regeneration gas flow. Heaters trip off on high temperature.	Safe	
HE	412		SHT-2	4-	F	filter regeneration	gas heater	fails	regeneration temperature not sufficient to regenerate the media	Safe	Operational nuisance.
TE	413		SHT-2	4-	F	regen gas heater (gas flow)	Type K TC	incorrect reading	May trip off regeneration heater.	Safe	Operational nuisance.
TE	414		SHT-2	4-	F	regen gas heater (heater surface)	Type K TC	incorrect reading	May trip off regeneration heater.	Safe	Operational nuisance.
TE	415		SHT-2	4-	F	regen gas heater (gas flow)	Type K TC	incorrect reading	May trip off regeneration heater.	Safe	Operational nuisance.
HE	416		SHT-2	4-	F	filter regeneration	gas heater	fails	regeneration temperature not sufficient to regenerate the media	Safe	Operational nuisance.
TE	417		SHT-2	4-	F	regen gas heater (gas flow)	Type K TC	incorrect reading	May trip off regeneration heater.	Safe	Operational nuisance.
TE	418		SHT-2	4-	F	regen gas heater (heater surface)	Type K TC	incorrect reading	May trip off regeneration heater.	Safe	Operational nuisance.
TE	419		SHT-2	4-	F	regen gas heater (gas flow)	Type K TC	incorrect reading	May trip off regeneration heater.	Safe	Operational nuisance.
HV	420	A	SHT-2	4-	E	filter regeneration pumpout	manual valve (ball valve)	fails open	Vents hot regeneration gas or liquid argon (needs HV-422-A open also). Valve outlet is capped and locked out except during filter evacuation which is the last regeneration step. During the filter evacuation sources of pressure are locked out.	Safe	This is administratively handled with cap and lock.
								fails closed	Normal state. Stops evacuation if pumping down on filter.	Safe	
TE	421	A	SHT-2	4-	E	filter regeneration inlet temperature	Type K TC	incorrect reading	May trip off regeneration heater.	Safe	Operational nuisance.
HV	422	A	SHT-2	4-	D	filter regeneration inlet isolation	manual valve (bellows)	fails open	Normal state during filter regeneration.	Safe	
								fails closed	Stops regeneration gas flow. Heaters trip off on high temperature.	Safe	
HV	423	A	SHT-2	4-	D	filter discharge gas sample	manual valve (diaphragm)	fails open	sends gas to analyzers	Safe	redundant with gas analyzer switch yard panel

Instr Code	Tag #	Serv. Code	PID	GRID	LOC	Service Description	Instrument Type	Failure or Error Mode	Hazard or Effect	Hazard Class	Remarks or Recommendations
								fails closed	stops flow to analyzers	Safe	gas analyzer readings incorrect
FCV	424	H	SHT-2	4-	G	filter regeneration argon supply	gas mass flow controller	fails open	During normal ops, if HV-422-A open, would supply regeneration gas to system. During regeneration, inefficient regeneration.	Safe	
								fails closed	Stops regeneration gas flow. Heaters trip off on high temperature.	Safe	
HV	425	A	SHT-2	5-	E	filter regeneration vent isolation	manual valve (bellows)	fails open	Vents liquid outside. Normally open during regeneration	Safe	May be opened during cool down.
								fails closed	Stops regeneration gas flow. Heaters trip off on high temperature.	Safe	
HV	426	A	SHT-2	5-	E	filter regeneration vent gas sample	manual valve (diaphragm)	fails open	sends gas to analyzers	Safe	redundant with gas analyzer switch yard panel
								fails closed	stops flow to analyzers	Safe	gas analyzer readings incorrect
HV	427	A	SHT-2	4-	F	filter regeneration heater isolation	manual valve (ball valve)	fails open	Normal state.	Safe	
								fails closed	Stops regeneration gas flow. Heaters trip off on high temperature.	Safe	
PI	428	H	SHT-2	4-	F	filter regeneration H2/Ar supply	local pressure indicator	incorrect reading	operator will have bad information, will need to take other readings into consideration	Safe	Redundant with PI116A and PT117A.
PSV	591	A	SHT-1	4-	E	LAr withdrawal main supply relief and trapped volume relief	relief valve	fails open	Leak liquid argon outside.	Safe	Wasteful. Relief pointed away from personnel.
								fails closed	Overpressure piping.	mechanical damage	small trapped volume.
AT	605	A	SHT-2	5-	E	filter regeneration vent gas sample	dewpoint meter	incorrect reading	Regeneration may be incomplete or go on longer than necessary	Safe	Will also monitor with AT-606-A
AT	606	A	SHT-3	4-	C	gas analyzers	dewpoint meter	incorrect reading	Bad data could lead to wrong conclusion about purity or contamination levels.	Safe	Could lead to operational decisions such as rejecting LAr or warming up or purging or regeneration of filters
AT	607	A	SHT-3	4-	B	gas analyzers	oxygen analyzer	incorrect reading	Bad data could lead to wrong conclusion about purity or contamination levels.	Safe	Could lead to operational decisions such as rejecting LAr or warming up or purging or regeneration of filters
AT	608	A	SHT-3	6-	B	gas analyzers	water analyzer	incorrect reading	Bad data could lead to wrong conclusion about purity or contamination levels.	Safe	Could lead to operational decisions such as rejecting LAr or warming up or purging or regeneration of filters
AE	609	A	SHT-3	6-	B	gas analyzers (AT-608 output)	dewpoint meter	incorrect reading	Bad data could lead to wrong conclusion about purity or contamination levels.	Safe	Could lead to operational decisions such as rejecting LAr or warming up or purging or regeneration of filters
AT	610	A	SHT-3	6-	C	gas analyzers	nitrogen analyzer	incorrect reading	Bad data could lead to wrong conclusion about purity or contamination levels.	Safe	Could lead to operational decisions such as rejecting LAr or warming up or purging or regeneration of filters
AT	611	A	SHT-3	6-	E	gas analyzers	oxygen analyzer	incorrect reading	Bad data could lead to wrong conclusion about purity or contamination levels.	Safe	Could lead to operational decisions such as rejecting LAr or warming up or purging or regeneration of filters
FL	650	A	SHT-2	4-	G	Particulate filter gas argon supply from 500 gal. dewar	filter	clogs	reduced flow for regeneration backfill	Safe	
HV	651	A	SHT-1	3-	D	Gas argon sample point 809 to analyzer	manual valve	fails open	flow goes to analyzer switch yard	Safe	redundant with valves in manifold panel.
								fails closed	stops flow to analyzers	Safe	
PI	652	A	SHT-2	4-	G	filter regeneration argon supply	local pressure indicator	incorrect reading	Used for information only. Redundant with PI-574-A.	Safe	
FCV	653	A	SHT-2	4-	G	filter regeneration argon supply	gas mass flow controller	fails open	Will pressurize piping up to HV-422-A. No effect.	Safe	HV-422-A will be closed except during regeneration activity.
								fails closed	Will block backfilling of filters after regeneration. Would need to backfill through another port.	Safe	Operational inconvenience.
HV	700	A	SHT-3	4-	E	gas analyzers - vacuum pump isolation	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	701	A	SHT-3	4-	E	gas analyzers - vacuum pump line purge	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none

Instr Code	Tag #	Serv. Code	PID	GRID	LOC	Service Description	Instrument Type	Failure or Error Mode	Hazard or Effect	Hazard Class	Remarks or Recommendations
HV	702	A	SHT-3	4-	E	gas analyzers - vacuuum pump isolation	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	703	A	SHT-3	5-	E	gas analyzers - sample line to vacuum pump	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	704	A	SHT-3	5-	E	gas analyzers - sample line to vacuum pump	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	705	A	SHT-3	5-	E	gas analyzers - sample line to vacuum pump	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	706	A	SHT-3	5-	E	gas analyzers - sample line to vacuum pump	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	707	A	SHT-3	5-	E	gas analyzers - sample line to vacuum pump	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	708	A	SHT-3	5-	E	gas analyzers - sample line to vacuum pump	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	709	A	SHT-3	5-	E	gas analyzers - sample line to vacuum pump	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	710	A	SHT-3	5-	E	gas analyzers - sample line to vacuum pump	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	711	A	SHT-3	5-	E	gas analyzers - sample line to vacuum pump	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	712	A	SHT-3	5-	E	gas analyzers - sample line to vacuum pump	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	713	A	SHT-3	5-	D	gas analyzers - sample line to vacuum pump	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	714	A	SHT-3	5-	D	gas analyzers - sample line to vacuum pump	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	715	A	SHT-3	5-	C	gas analyzers - dewpoint meter isolation	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	716	A	SHT-3	5-	C	gas analyzers - sample line to dewpoint meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	717	A	SHT-3	5-	C	gas analyzers - sample line to dewpoint meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	718	A	SHT-3	5-	C	gas analyzers - sample line to dewpoint meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	719	A	SHT-3	5-	C	gas analyzers - sample line to dewpoint meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	720	A	SHT-3	5-	C	gas analyzers - sample line to dewpoint meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	721	A	SHT-3	5-	C	gas analyzers - sample line to dewpoint meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	722	A	SHT-3	5-	C	gas analyzers - sample line to dewpoint meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	723	A	SHT-3	5-	C	gas analyzers - sample line to dewpoint meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	724	A	SHT-3	5-	C	gas analyzers - sample line to dewpoint meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	725	A	SHT-3	5-	C	gas analyzers - sample line to dewpoint meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	726	A	SHT-3	5-	C	gas analyzers - sample line to dewpoint meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	727	A	SHT-3	5-	C	gas analyzers - sample line to dewpoint meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	728	A	SHT-3	5-	B	gas analyzers - O2 meter isolation	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	729	A	SHT-3	5-	B	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	730	A	SHT-3	5-	B	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	731	A	SHT-3	5-	B	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	732	A	SHT-3	5-	B	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	733	A	SHT-3	5-	B	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	734	A	SHT-3	5-	B	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	735	A	SHT-3	5-	B	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	736	A	SHT-3	5-	B	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none

Instr Code	Tag #	Serv. Code	PID	GRID	LOC	Service Description	Instrument Type	Failure or Error Mode	Hazard or Effect	Hazard Class	Remarks or Recommendations
HV	737	A	SHT-3	5-	B	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	738	A	SHT-3	5-	B	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	739	A	SHT-3	5-	B	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	740	A	SHT-3	5-	B	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	741	A	SHT-3	6-	B	gas analyzers - H2O meter isolation	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	742	A	SHT-3	6-	B	gas analyzers - sample line to H2O meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	743	A	SHT-3	6-	B	gas analyzers - sample line to H2O meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	744	A	SHT-3	6-	B	gas analyzers - sample line to H2O meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	745	A	SHT-3	6-	B	gas analyzers - sample line to H2O meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	746	A	SHT-3	6-	B	gas analyzers - sample line to H2O meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	747	A	SHT-3	6-	B	gas analyzers - sample line to H2O meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	748	A	SHT-3	6-	B	gas analyzers - sample line to H2O meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	749	A	SHT-3	6-	B	gas analyzers - sample line to H2O meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	750	A	SHT-3	6-	C	gas analyzers - N2 meter isolation	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	751	A	SHT-3	6-	C	gas analyzers - sample line to N2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	752	A	SHT-3	6-	C	gas analyzers - sample line to N2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	753	A	SHT-3	6-	C	gas analyzers - sample line to N2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	754	A	SHT-3	6-	C	gas analyzers - sample line to N2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	755	A	SHT-3	6-	C	gas analyzers - sample line to N2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	756	A	SHT-3	6-	C	gas analyzers - sample line to N2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	757	A	SHT-3	6-	C	gas analyzers - sample line to N2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	758	A	SHT-3	6-	C	gas analyzers - sample line to N2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	759	A	SHT-3	6-	E	gas analyzers - O2 meter isolation	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	760	A	SHT-3	6-	E	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	761	A	SHT-3	6-	E	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	762	A	SHT-3	6-	E	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	763	A	SHT-3	6-	E	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	764	A	SHT-3	6-	E	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	765	A	SHT-3	6-	E	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	766	A	SHT-3	6-	E	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	767	A	SHT-3	6-	E	gas analyzers - sample line to O2 meter	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	768	A	SHT-3	5-	E	gas analyzers - vacuum pump out	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
V	769	A	SHT-3	4-	E	gas analyzers - vacuum pump	check valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
V	770	A	SHT-3	5-	D	gas analyzers - Dewpoint meter inlet	check valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
PR	771	A	SHT-3	5-	B	gas analyzers - O2 meter inlet	pressure regulator	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none

Instr Code	Tag #	Serv. Code	PID	GRID	LOC	Service Description	Instrument Type	Failure or Error Mode	Hazard or Effect	Hazard Class	Remarks or Recommendations
V	772	A	SHT-3	5-	B	gas analyzers - O2 meter inlet	check valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
V	773	A	SHT-3	6-	B	gas analyzers - H2O meter inlet	check valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
PR	774	A	SHT-3	6-	C	gas analyzers - N2 meter inlet	pressure regulator	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
V	775	A	SHT-3	6-	C	gas analyzers - N2 meter inlet	check valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
PR	776	A	SHT-3	6-	E	gas analyzers - O2 meter inlet	pressure regulator	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
V	777	A	SHT-3	6-	E	gas analyzers - O2 meter inlet	check valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	778	A	SHT-3	6-	F	gas analyzers - calibration gas	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
V	779	A	SHT-3	6-	F	gas analyzers - calibration gas inlet	check valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	780	A	SHT-3	6-	F	gas analyzers - argon gas supply	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	781	A	SHT-3	6-	F	gas analyzers - argon gas supply	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	782	A	SHT-3	6-	F	gas analyzers - argon gas supply	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	783	A	SHT-3	6-	F	gas analyzers - argon gas supply	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	784	A	SHT-3	6-	F	gas analyzers - argon gas supply	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	785	A	SHT-3	6-	F	gas analyzers - argon gas supply	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
V	786	A	SHT-3	6-	F	gas analyzers - argon gas supply	check valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	787	A	SHT-3	6-	F	gas analyzers - sample line to vacuum pump	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
HV	788	A	SHT-3	6-	F	gas analyzers - sample line to vacuum pump	manual valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
PI	789	A	SHT-3	5-	E	gas analyzers	local pressure indicator	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
FL	790	A	SHT-3	6-	F	O2 cartridge filter	filter	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
PI	790	A	SHT-3	5-	B	O2 analyzer input pressure	local pressure indicator	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
PI	791	A	SHT-3	6-	C	gas analyzers - N2 inlet	local pressure indicator	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
PI	792	A	SHT-3	6-	E	gas analyzers - O2 analyzer inlet	local pressure indicator	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
FI	793	A	SHT-3	4-	C	Dew point meter outlet flow	flow indicator	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
FI	794	A	SHT-3	4-	B	O2 analyzer flow	flow indicator	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
FL	795	A	SHT-3	6-	F	H2O cartridge filter	filter	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
FL	796	A	SHT-3	6-	F	O2 cartridge filter	filter	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
FI	797	A	SHT-3	6-	D	O2 analyzer flow	flow indicator	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
FL	798	A	SHT-3	5-	E	H2O cartridge filter	filter	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
PV	799		SHT-3	4-	D	gas analyzers	vacuum pump	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	none
AE	819		SHT-3	2-	F	vicinity of equipment	ODH O2 sensor	reads high	Won't trigger in event of ODH. ODH head is a safety device built to fail safe (low).	Safe	safety rated device
								reads low	ODH system activates, horns, sirens, stops flow into the building, ventilation turns on	Safe	
AE	820		SHT-3	2-	F	vicinity of equipment	ODH O2 sensor	reads high	Won't trigger in event of ODH. ODH head is a safety device built to fail safe (low).	Safe	safety rated device
								reads low	ODH system activates, horns, sirens, stops flow into the building, ventilation turns on	Safe	
FS	821		SHT-3	2-	E	ODH blower outlet duct	pressure differential switch	fails closed	Will indicate flow when there is none. Fan test will need to include check that switch changes state.	Safe	
								fails open	Indicates no flow when there is flow. Will get fan failure alarms from Autodialer, FIRUS	Safe	

Instr Code	Tag #	Serv. Code	PID	GRID	LOC	Service Description	Instrument Type	Failure or Error Mode	Hazard or Effect	Hazard Class	Remarks or Recommendations
HV	822	A	SHT-3	3-	G	filter regeneration gas sample	manual valve (diaphragm)	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	
AE	823		SHT-3	2-	F	vicinity of equipment	ODH O2 sensor	reads high	Won't trigger in event of ODH. ODH head is a safety device built to fail safe (low).	Safe	safety rated device
								reads low	ODH system activates, horns, sirens, stops flow into the building, ventilation turns on	Safe	
AE	824		SHT-3	2-	F	vicinity of equipment	ODH O2 sensor	reads high	Won't trigger in event of ODH. ODH head is a safety device built to fail safe (low).	Safe	safety rated device
								reads low	ODH system activates, horns, sirens, stops flow into the building, ventilation turns on	Safe	
HV	840	A	SHT-3	4-	G	gas analyzers	manual valve (diaphragm)	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	
HV	841	A	SHT-3	4-	G	gas analyzers	manual valve (diaphragm)	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	
PI	842	A	SHT-3	5-	H	gas analyzers	pressure indicator	incorrect reading	No consequence since analyzers are used for purity information only.	Safe	
PT	843	A	SHT-3	5-	H	gas analyzers	pressure transmitter	incorrect reading	No consequence since analyzers are used for purity information only.	Safe	
PI	844	A	SHT-3	5-	H	gas analyzers	pressure indicator	incorrect reading	No consequence since analyzers are used for purity information only.	Safe	
PT	845	A	SHT-3	5-	H	gas analyzers	pressure transmitter	incorrect reading	No consequence since analyzers are used for purity information only.	Safe	
PSV	846	A	SHT-3	5-	H	gas booster pump relief	relief valve	fails open	small gas leak into MC7. Anlayzer flow and readings may be wrong.	Safe	
								fails closed	Will not protect pump if dead headed.	Mechanical damage	
V	847	A	SHT-3	5-	G	gas analyzers	check valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	
HV	848	A	SHT-3	5-	G	gas analyzers	manual valve (diaphragm)	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	
HV	849	A	SHT-3	3-	H	gas analyzers	manual valve (diaphragm)	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	
HV	850	A	SHT-3	3-	H	argon supply for analyzer booster pump	manual valve (diaphragm)	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	
PCV	851	A	SHT-3	3-	H	argon supply for analyzer booster pump	pressure control valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	
PCV	852	A	SHT-3	4-	H	gas analyzer booster pump inlet restriction	control valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	
HV	853	A	SHT-3	4-	H	gas analyzer booster pump	manual valve (diaphragm)	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	
PU	854	A	SHT-3	5-	H	gas analyzer booster pump	postive displacment pump	turns on	If valves aren't open downstream, will dead head pump and cause relief valve to open.	Safe	
								turns off	No consequence since analyzers are used for purity information only.	Safe	
HV	855	A	SHT-3	3-	G	argon supply for analyzer booster pump	manual valve (diaphragm)	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	
HV	856	A	SHT-3	5-	G	analyzer booster pump test flowmeter	manual valve (diaphragm)	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	
FCV	857	A	SHT-3	5-	G	analyzer booster pump test flowmeter	manual flow control valve	fails open or closed	No consequence since analyzers are used for purity information only.	Safe	
PI	858	A	SHT-3	4-	H	gas analyzers	pressure indicator	incorrect reading	No consequence since analyzers are used for purity information only.	Safe	