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April 21, 1986

TO: J. O'Meara

FROM: R.L. Schmitt R L Schmitt

SUBJECT: New Muon What-If Analysis

The What-If analysis is attached. Most of the analysis is a repeat of existing worksheets. The contents are:

Star heat exchanger assembly

Refrigerator valve box

Refrigerator dry engine

Refrigerator wet engine

Liquid nitrogen storage & transfer line

Nitrogen circulation system

CCM helium

CCM hydraulics

CVM

The CVM section will be added later.

RLS/tg
cc: R. Dachniwskyj
R. Fast
J. Kelley
R.P. Smith
P. Stone
S. Stoy

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WHAT-IF WORKSHEET

COMPONENT Heat Exchanger Assembly
LOCATION Refrig. Bldg.
DATE 11-22-82
BY J. Colvin/T. Peterson

WHAT-IF	CONSEQUENCE/HAZARD	CONCLUSION/RECOMMENDATIONS
Finned copper tubing on high pressure side ruptures or breaks at silver solder joint.	High pressure helium gas will flow into low pressure side of heat exchanger.	Helium will vent out side of CDF building through low pressure relief valve.
Weld cracks in high pressure piping in vacuum space -or- weld cracks or ruptures in low pressure shell.	Loss of insulating vacuum and pressurization of vacuum tank.	SV-905-V will vent helium into building. Follow safety manual procedures Ch. 15.1.
Leaking stem packing on valves EV-106-H or EV-107-H	Helium will vent into building	Tighten stem packing bolts follow safety manual procedures Ch. 15.1.
Block & Bleed panel valves are opened or closed during operation	High pressure helium will flow to low pressure side	Up set of refrigeration operation - stress training in personnel

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WHAT-IF WORKSHEET

COMPONENT Valve Box
LOCATION Refrig. Bldg.
DATE 11-22-82
BY J. Colvin/T. Peterson

WHAT-IF	CONSEQUENCE/HAZARD	CONCLUSION/RECOMMENDATIONS
Spare bayonet valve is opened and plug is removed	Helium will vent into building	Close valve and follow safety manual procedure Ch. 15.1
Leak in JT or bypass valve stem packing	Helium will vent into building	Follow safety manual procedure Ch. 15.1 - This is not an ODH hazard.
Weld cracks or pipe ruptures in high or low pressure piping	Loss of insulating vacuum and pressurization of vacuum tank.	SV-901-V will vent helium into building follow safety manual procedures Ch. 15.1.

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WHAT-IF WORKSHEET

COMPONENT Koch Dry Engine
LOCATION Refrig. Bldg.
DATE 11-19-82
BY T. Peterson

WHAT-IF	CONSEQUENCE/HAZARD	CONCLUSION/RECOMMENDATIONS
DC Drive loses electrical power.	Engine has no restraining load.	If engine overspeeds the mechanical safety brake stops the engine and shuts off the gas supply. (EV-336-H).
DC Drive drives the engine and negative power circuit fails to trip drive off.	Drive forces engine to rotate, possible excessive wear or damage to equipment.	Circuit should be checked before commissioning of each drive. (This is being done)
DC Drive overspeeds without tripping off.	Possible excessive wear or damage to engine.	Mechanical safety brake stops engine, shuts off gas supply (EV-336-H) and drive.
Mechanical safety brake microswitch fails to close	Engine cannot be started.	Indicator light in controller signals interrupt at brake.
Mechanical safety brake microswitch fails to open	Brake tripped but DC Drive and gas supply are not shut off.	Negative power circuit shuts off drive and gas supply (EV-336-H).
Mechanical safety brake fails to open.	Engine cannot be run.	Negative power circuit and/or brake switch prevent engine operation.
Mechanical safety brake fails tc close.	Engine overspeeds.	DC Drive trips, off; shutoff valve (EV-336-H) closes.
V-belts break	Link to load is lost, engine overspeeds.	Mechanical safety brake stops engine shuts off DC drive and closes gas valve (EV-336-H).
Timing belt breaks	Like V-belts.	Like V-belts.

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WHAT-IF WORKSHEET

COMPONENT Koch Dry Engine
LOCATION Refrig. Bldg.
DATE 11-19-82
BY T. Peterson

WHAT-IF	CONSEQUENCE/HAZARD	CONCLUSION/RECOMMENDATIONS
Main drive shaft breaks between crank and main bearing.	Piston is free. Gas imparts kinetic energy to piston.	Piston catcher holds piston in engine, preventing possible personal injury.
Crank or connecting rod breaks.	Piston is free. Gas imparts kinetic energy to piston.	Piston catcher holds piston in engine, preventing possible injury.
Main shaft breaks between flywheel and main bearing.	Rotating flywheel is freed. Shutoff valve and engine frame may or may not hold it.	This event would be dangerous to people in the building.
Main shaft bearings wear, developing excess play.	Noise, cam and valve motion may be affected.	Checking for excess play is part of maintenance procedure.
Main shaft bearings sieze	Engine stops.	Negative power circuit trips off DC drive and gas supply (EV-336-H).
Piston pounds on contaminants or object in cylinder	Excess stress on crank, connecting rod, and driveshaft may result in fracture, freeing piston.	Piston catcher holds piston in engine, preventing possible personal injury.

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WHAT-IF WORKSHEET

COMPONENT Koch Wet Engine
LOCATION Refrig. Bldg.
DATE 11-19-82
BY T. Peterson

WHAT-IF	CONSEQUENCE/HAZARD	CONCLUSION/RECOMMENDATIONS
DC Drive loses electrical power.	Engine has no restraining load.	If engine overspeeds the mechanical safety brake stops the engine and shuts off the gas supply. (EV-351-H).
DC Drive drives the engine and negative power circuit fails to trip drive off.	Drive forces engine to rotate, possible excessive wear or damage to equipment.	Circuit should be checked before commissioning of each drive. (This is being done)
DC Drive overspeeds without tripping off.	Possible excessive wear or damage to engine.	Mechanical safety brake stops engine, shuts off gas supply (EV-351-H) and drive.
Mechanical safety brake microswitch fails to close	Engine cannot be started.	Indicator light in controller signals interrupt at brake.
Mechanical safety brake microswitch fails to open	Brake tripped but DC Drive and gas supply are not shut off.	Negative power circuit shuts off drive and gas supply (EV-351-H).
Mechanical safety brake fails to open.	Engine cannot be run.	Negative power circuit and/or brake switch prevent engine operation.
Mechanical safety brake fails to close.	Engine overspeeds.	DC Drive trips, off; shutoff valve (EV-351-H) closes.
V-belts break	Link to load is lost, engine overspeeds.	Mechanical safety brake stops engine shuts off DC drive and closes gas valve (EV-351-H).
Timing belt breaks	Like V-belts.	Like V-belts

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WHAT-IF WORKSHEET

COMPONENT Koch Wet Engine
LOCATION Refrig. Bldg.
DATE 11-19-82
BY T. Peterson

WHAT-IF	CONSEQUENCE/HAZARD	CONCLUSION/RECOMMENDATIONS
Main drive shaft breaks between crank and main bearing.	Piston is free. Gas imparts kinetic energy to piston.	Piston may be ejected from engine; serious personal injury could result.
Crank or connecting rod breaks.	Piston is free. Gas imparts kinetic energy to piston.	Piston may be ejected from engine; serious personal injury could result.
Main shaft breaks between flywheel and main bearing.	Rotating flywheel is freed. Shutoff valve and engine frame may or may not hold it.	This event would be dangerous to people in the building.
Main shaft bearings wear, developing excess play.	Noise, cam and valve motion may be affected.	Checking for excess play is part of maintenance procedure.
Main shaft bearings sieze	Engine stops.	Negative power circuit trips off DC drive and gas supply (EV-351-H).
Piston pounds on contaminants or object in cylinder	Excess stress on crank, connecting rod, and driveshaft may result in fracture, freeing piston.	Piston may be ejected from engine, serious personal injury could result.

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WHAT-IF WORKSHEET

COMPONENT LN2 Dewar
LOCATION New Muon
DATE
BY

WHAT-IF	CONSEQUENCE/HAZARD	CONCLUSION/RECOMMENDATIONS
Driver pressurizes dewar	Nitrogen will vent outside	Relief valve protects dewar. Relief valve on transfer line sized to handle maximum tanker output.
Vacuum goes soft	High boil off rate	Vent regulator maintains correct pressure. Pump down vacuum.
Vacuum shell develops cracks	Loss of insulating vacuum very high boil off rate	Reliefs on dewar protect it. Relief on line protects it and magnet.
Blow down valve is left open	Dewar pressure will not be maintained. Excessive use of nitrogen.	Heat leak to magnet will increase.
Strainer on pressure building loop plugs	Dewar pressure is not maintained.	Heat leak to magnet will increase. Warm strainer and clean.
Pressure building regulator leaks	Excessive use of nitrogen.	Vent regulator maintains correct pressure.

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WHAT-IF WORKSHEET

COMPONENT LN2 Dewar
LOCATION New Muon
DATE
BY

WHAT-IF	CONSEQUENCE/HAZARD	CONCLUSION/RECOMMENDATIONS
Vent regulator leaks	Excessive use of nitrogen	Pressure building loop maintains correct pressure.

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WHAT-IF WORKSHEET

COMPONENT LN2 transfer line
LOCATION New Muon
DATE
BY

WHAT-IF	CONSEQUENCE/HAZARD	CONCLUSION/RECOMMENDATIONS
Vacuum goes soft	Boiling of product. Increased pressure drop and possibly inadequate flow to magnet	Monitor TC gauges on line. Pump down vacuum when necessary.
Vacuum shell develops cracks	Rapid boiling of LN2	Internal line protected by PSV-446-N.
Internal bellows leak	Loss of insulating vacuum and pressurization of vacuum space	Vacuum relieved by 3" parallel plate reliefs.

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WHAT-IF WORKSHEET

COMPONENT Nitrogen Circulation
LOCATION New Muon
DATE 4/16/86
BY R.L. Schmitt

WHAT-IF	CONSEQUENCE/HAZARD	CONCLUSION/RECOMMENDATIONS
Phase separator runs dry	The pump stops on low power circulation stops.	Eventually this will trip magnets. CVM cannot be damaged. CCM can be cooled through bypass valve MV-464-N or supply valve MV-602-N.
Phase separator over flows	Liquid accumulates in vent stack.	A pressure switch will stop the nitrogen supply. All equipment is protected by two independent instruments and can withstand the head.
Pump seal leaks	Nitrogen will drip into the pit and vent into the Experimental Hall. ODH alarm will stop the nitrogen supply.	Splash shield will protect equipment on the floow. The alarm will alert operators to start the other pump.
Pump seal seizes	Possible seal damage.	Warm up pump and establish purge flow. Check for leakage

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WHAT-IF WORKSHEET

COMPONENT Magnet (CCM)
LOCATION New Muon
DATE
BY

WHAT-IF	CONSEQUENCE/HAZARD	CONCLUSION/RECOMMENDATIONS
Liquid helium level probe breaks	Does not endanger magnet	Second probe is installed and in operation.
Insulating vacuum deteriorates	Excessive helium boil off	High helium flow interlock will turn off power to the magnet.
Crack develops in vacuum shell	Loss of insulating vacuum. Liquid helium vaporizes	Helium space protected by two 1-1/2" reliefs and two 4" rupture disks
Helium vessel leaks into vacuum space	Vacuum space pressurized	Vacuum space is adequately protected by an 8" rupture disk and a 4" rupture disk
Flow through power leads is too low	Power leads heat	Interlock on power leads turns off power to the m agnet.
Flow to nitrogen shield is turned off or too low	Heat load to magnet increases and boil off increases	If boil off gets too high, power to the magnet is turned off.

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WHAT-IF WORKSHEET

COMPONENT Magnet (CCM)
LOCATION New Muon
DATE
BY

WHAT-IF	CONSEQUENCE/HAZARD	CONCLUSION/RECOMMENDATIONS
Flow switches not functioning	Magnet may be turned off unnecessarily or could run with a soft vacuum	For low flow voltage taps across leads serve as backup. Periodic reading of flow meters would alert to excess boil off.

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WHAT-IF WORKSHEET

COMPONENT Magnet Hydraulics
LOCATION New Muon
DATE
BY

WHAT-IF	CONSEQUENCE/HAZARD	CONCLUSION/RECOMMENDATIONS
Pump Breaks	Columns cannot be moved hydraulically/the columns could be broken if cooldown continues	This is not a problem because the columns can be moved manually using silicon bronze bolts and the cooldown can be stopped.
MV-662-HY has wrong setting	Columns can be moved quickly, therefore you risk breaking them. The helium cryostat loses its support.	This is detrimental to the coil. This risk is reduced by having only trained operators, following a check list to operate the hydraulic system.
Wrong column is moved or	The column can be damaged.	Loss of a single column is not detrimental to coil operation. This risk is reduced by having only trained operators, following a check list to operate the hydraulic system.
Column is moved in wrong direction	The column could be damaged.	Loss of a single column is not detrimental to coil operation. This risk is reduced by having only trained operators, following a check list to operate the hydraulic system.

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