WHAT IF	CONSEQUENCE / HAZARD	CONCLUSION / RECOMMENDATION
What if there is a power outage in MC7?	There is a UPS on the PLC and one on the ODH monitoring system so the control system will still work and the ODH monitors, horns and strobes will be functional. The UPS should last for at least 30 minutes. However, the ODH fan will not be operational. The vacuum pump will shut off. When the UPS dies, the control valves LCV-105-A and PCV-220-A will close with no electrical signal. The liquid in the system, 77 liters in the filter and 550 liters in the cryostat will boil off at a rate of about 5 liquid liters per hour. The pressure in the cryostat will rise to 15 psig and the operational relief, PSV-202-A, will open blowing down the pressure to about 13 psig, re-close, and then open again when pressure reaches 15 psig. The outlet of PSV-202-A is vented outdoors.	The system is safe and will continue to operate normally for at least 30 minutes (the estimated UPS run time is XX minutes). The ODH assessment takes power outage into account and the area is class 0. For short duration unplanned power outages the system will be uninterupted except that the experiment data taking will stop. For longer power outages, the ODH classification should be re-evaluated or the roll-up door should be opened so that there is ventilation in the building. It will take several days for all the liquid in the system to boil away.
What if there is a loss of vacuum on the filter?	The filter has it's own vacuum jacket. The heat load to the filter media and LAr would increase causing a higher gas fraction in the argon being delivered to the cryostat. The level control valve, LCV-105-A will open and the flow rate of argon will increase to try to deliver liquid to the cryostat. The liquid level in the cryostat may drop to the point where the high voltage interlock trips shutting of high voltage to the detector. There is a parallel plate relief on the vacuum jacket to protect it against over pressure. A control system alarm on low cryostat liquid level will be generated.	Without an alarm on the filter vacuum jacket pressure, loss of vacuum may not be realized until the problem was extreme causing much higher flows and the liquid level to drop. We will have an alarm on the filter and cryostat vacuum jacket pressure.
What if there is a loss of vacuum on the cryostat?	The cryostat holds 550 liters of liquid argon. The boil-off rate of the liquid will increase and the liquid level will start to drop. LCV-105-A will open increasing the rate of liquid supply to the cryostat.	Without an alarm on the cryostat vacuum jacket pressure, loss of vacuum may not be realized until the problem was extreme causing much higher flows and the liquid level to drop. We will have an alarm on the filter and cryostat vacuum jacket pressure.
What if the control system crashes?	If the control system crashes, then there will be a loss of signal to the control valves and they will close. A watch dog timer autodialer alarm will be sent notifying system experts of a communication problem. Eventually, the pressure in the cryostat will rise and the operational relief will open at 15 psig, venting the excess pressure outside. The operational relief will continue to protect the system from overpressure until the problem is fixed.	
What if the ODH fan outlet louvers get blocked by snow or is frozen shut by freezing rain?	The ODH fan is tested daily. If the louvers are blocked sufficiently that the flow switch is not activated then an ODH fan failure alarm will be generated and a system expert will go to MC7 to trouble shoot the problem. the problem will be remedied. The failure rate of the ODH fan is taken into account in the ODH assessment.	The louvers are significant, several inches long and are fixed open so that freezing rain will not cause any blockage or prevent them from opening because they are already open. In the event of a heavy snow, we will need to remember to clear the area by the EF-1 exhaust.
What if there is a loss of gas argon supply for the pneumatic control valves?	The control valves LCV-105-A and PCV-220-A are Badger Meter Type 884 valves with Type 766 air-to-open actuators. They operate with a pneumatic (in our case, gaseous argon) supply pressure in the range of 22 psig minimum to 60 psig maximum. When the pressure drops below 22 psig, the valves will start to be closed more than desired, being toally closed at 3 to 5 psig. The liquid in the cryostat and filter will boil at about 5 liters/hr (or less) generating about 2 scfm of gas. The ullage space of the cryostat is about 5 cubic feet. Neglecting the thermodynamic change to the liquid, the pressure in the cryostat will rise to 15 psig, the operating relief set point in 3 to 5 minutes. The pressure will stay at that pressure as the liquid boils away. I note that the relief valve, PSV-202-A has a capacity of ~100 scfm.	Safe.
What if the LAr dewar runs empty?	First, the liquid level, LT-686, in the LAr dewar will create an alarm so that an ermergency refill or controlled shut down can be initiated. Then when the LAr supply dewar is empty, the cryostat level will start to drop causing an alarm. The HV interlock will shut off the detector high voltage. The control valve PCV-220-A will continue to funtion until pressure in the LAr dewar drops below 22 psig. At pressures below 22 psig, the valve will be closed more than signal.	Safe, just stops the experiment.
What if the LAr dewar pressure decreases to < 15 psig due to driver forgetting to close the manual blow down valve after filling?	As the pressure drops, a low argon dewar pressure alarm on PT-687-A will be generated. The liquid supply control valve, LCV-105-A will need to open more as there will be less pressure differential across the valves. When the pressure drops below 22 psig, this becomes the same "What-IF" as a loss of gas argon supply pressure for the control valves.	

WHAT IF	CONSEQUENCE / HAZARD	CONCLUSION / RECOMMENDATION
What if there is a large snow fall?	The driveway for liquid argon deliveries to MC7 is long and narrow. In the event of a large, several foot snow, there won't be sufficient width to plow the snow to. A big end loader may be needed to remove snow to a pile upstream of the drive. Lacking that, we may run out of liquid argon. The rental dewar holds 1890 liters (500 gallons) of liquid. We expect to consume about 5 liters/hr. A full dewar will last 16 days.	We need to remember to keep the area by the ODH exhaust louvers clear of significant snow. The snow would need to be about 2 feet deep to block the exhaust.
What if there is a flange leak to the cryostat vacuum at bottom port?	There is a conflat flange in the vacuum space that has liquid argon on the inside and vacuum on the outside. If there is a flange leak, the cryostat vacuum will go soft. The dry vacuumpump will be used to actively pump on the cryostat vacuum. If the leak exceeds the pumping capacity then the cryostat will need to be emptied and the leak repaired.	Operational issue that will be discovered at the beginning of commissioning.
What if there is a flange leak to vacuum in the LAr supply and return "stingers"?	The LAr supply and return "stingers" have dielectric break type flanges on ISO flanges contained within an insulating vacuum jacket. It is possible and maybe probable that there may be a small liquid leak when the flanges get cold. Active pumping with the dry vacuum pump would then be required. A small relief vavle on the vacuum jacket protects the space from pressurization upon warm up or lack of pumping.	Could get frosty pipe sections going into the top flange of the cryostat.
What if there is a high voltage discharge from the HV probe to the cryostat?	The high voltage power supply will trip off in the event of a discharge. The location of the discharge is hard to predict. It is a gut feel that a high voltage discharge would not be able to damage the inner vessel which is 3/16" thick.	
What if the liquid level in the cryostat drops below the HV probe?	The high voltage power supply will trip off in on low liquid level interlock.	
What if there is an earth quake?	The effect of earthquakes are not applicable to the region of Illinois where Fermilab is located. The Uniform Building Code shows that Fermilab is in a class 0 seismic zone which means no design provisions for earthquakes are required.	