ATTACHMENT

9.3.1.a Considerations when Designing an Accelerator System for Safety

Text Pages 2 through 9

C-A OPM Procedures in which this Attachment is used.		
9.3.1		

Hand Processed Changes

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Collider-Accelerator Department Chairman Date

E. Lessard

Considerations When Designing an Accelerator System for Safety

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Environmental Issues

Safety Issues	Loss of radioactive cooling water or fire-protection water Inadvertent radioactive or gaseous air emissions Loss of radioactive waste or hazardous waste to ordinary waste stream Induced activity in soil and subsequent contamination of ground water Loss of oil and other hazardous material to trenches or to soil and groundwater
Potential Initiators of Safety Problems	Loss of pressure on domestic water supply Violation of procedures for removal of waste Cooling-water-pipe break and loss of water to a storm sewer and recharge basin Inadequate containment between accelerator structures and the contiguous earth Broken gas line or gas filled chamber
Items To Consider When Designing For Safety	Containment structure to protect soil and groundwater Special shields to reduce soil activation to as low as reasonably achievable Formal design reviews for modifications Drawing configuration control Domestic water supply equipped with back-flow preventers A system to hold-up spilled liquids A system for normal and emergency gas ventilation Specific waste-handling training for operators Lock-down of ordinary waste stream, hazardous waste stream, radioactive waste stream Removal of, or blocking-off, storm-sewer drain-lines near accelerator and equipment Alarms on local sumps and manual starting of sump pumps Air or water Permits in place if required Special procedures to inspect area or system for leaks on a periodic Basis Compliance with Suffolk County Article 12 Process Evaluation by Environmental Compliance Representative SBMS Pollution Prevention Subject Area

Personnel Exposure Issues

Safety Issues	Accidental exposure of workers to contamination or toxic materials
Potential Initiators of Safety Problems	Failure to follow the design review procedures Improper fabrication of accelerator devices High temperatures or pressures Cooling pipe break on systems with ethylene glycol Oil leak from capacitors, transformers, pumps, motors Unsafe practices for handling hazardous and toxic materials Fire near uranium or other pyrophoric metal
Items To Consider When Designing For Safety	Chief Mechanical Engineer certifies vessels, pressure chambers Chief Mechanical Engineer certifies construction and testing procedures Gas flow limits Operators trained on procedure for operation of gas or gas-mixing systems Fail-safe temperature or pressure interlocks Approved operator procedures and training for handling hazardous materials BNL Hazard Communication Training for operators Labeling of pipes and vessels as to contents Inspection of chemical and hazardous materials inventories Minimal combustible loading Operators trained in appropriate emergency procedures Workplace Hazard Analysis and Risk Assessment for facility

Flammable Or Combustible Materials Issues

Safety Issues	Loss of life or severe injury Damage to components or facilities Impact on the physics program due to fire-related interruptions
Potential Initiators of Safety Problems	Damaged or improperly connected electrical cables Ignition of flammable gases Ignition of flammable liquids Inadequate cooling design
Items To Consider When Designing For Safety	Sprinkler and halon protection systems for high-value areas or components High sensitivity fire-detection systems Selection of materials which reduce the potential for flame spread Emergency exhaust ventilation systems The use of strategically located exits The use of audible alarms to reduce the potential for loss of life Elimination of potential ignition sources On-site fire / rescue organization notified on movement of flammable materials Emergency planning and drills Limits on flammable gas or liquid inventory and on flow rates Required safety review for any modification on use of flammable gases or liquids On-site safety inspection for installed equipment or material containing large amounts of wood, paper, plastic or other combustible matter Use of fire wire fire-detection systems Electrical energy interlocks tripped by heat or smoke detectors Using refrigerators or containers that meet the criteria of Underwriters Laboratories or Factory Mutual for flammable materials Identifying and posting hazardous locations for flammable or combustible materials storage or use Written procedures whenever temporarily impairing fire detection/protection systems Fire watch Proper Training Workplace Hazards Analysis and Risk Assessment for facility.

Electrical Energy Issues

Safety Issues	Electrocution death and injury Electrical arcing and molten-metal spray injury
Potential Initiators of Safety Problems	Unsafe practices such as failing to follow LOTO rules Working and testing hot Poor package design Stored energy discharge Failed captive key system
Items To Consider When Designing For Safety	Approved procedures and training Control zones around energized parts with signs and barriers Use of permits to work hot Equipment specific lock out and tag out procedures Externally controlled manual discharge devices Automatic discharge of stored energy Safety grounding Installation of barriers on exposed bus, terminals, capacitor banks Sufficient insulation and clearances Captive-key system Use of a safety watch or two-man rule where appropriate Work Permits Workplace Hazard Analysis and Risk Assessment for facility

Oxygen Depletion Issues

Safety Issues	Asphyxiation
Potential Initiators of Safety Problems	Inadvertent entry into gas-filled confined space Inadvertent release of gas
Items To Consider When Designing For Safety	Entry procedure required for Confined Space Written procedures for purging any hazardous gases from Confined Spaces Use of an O_2 to calibrate oxygen deficiency meter prior to entry Safety reviews and functional testing before specific operations Ventilation ODH Training Workplace Hazard Analysis and Risk Assessment for facility

Hydrogen Issues

Safety Issues	Physical injury (e.g., eye injury, broken bones, etc.) Burns Fire/explosion damage to facility
Potential Initiators of Safety Problems	Fire near a hydrogen device Electrical sparking in a hydrogen enclosure
Items To Consider When Designing For Safety	Vacuum sensors where appropriate Hydrogen gas detectors in vent lines Fire wire around nearby equipment No smoking or open flame boundaries defined and posted Use of a separate hydrogen enclosure that meets Class I Division II criteria for electrical circuits in explosive atmospheres Controls on the introduction of ordinary equipment into the hydrogen enclosure Fire detectors in and around the enclosure Interlocks to turn off power to potential ignition sources should a fire develop, a vacuum leak be detected, or hydrogen gas be detected Automatic, fail-safe venting of hydrogen gas out a vent stack Trained operators who have procedures to respond to alarms Written procedures for the operators; for example, hydrogen venting, filling, testing for hydrogen gas leaks, etc. Safety reviews and functional testing before specific operations Evacuation alarms and training for operators and nearby personnel if required Verification of alarm annunciation Workplace Hazard Analysis and Risk Assessment for facility

Magnetic Fields and Electromagnetic Radiation Issues

Safety Issues	Reaction with medical implants Magnetic push or pull of heavy metal object Hyperthermia, Cataracts, Lenticular Opacities (rf) Destruction of retina (lasers)
Potential Initiators of Safety Problems	Inadvertent exposure to stray magnetic field near spectrometer magnet Exposure to rf radiation or laser light from improperly enclosed devices
Items To Consider When Designing For Safety	Areas with strong magnetic fields are to be fenced and posted with appropriate warnings Magnets with large gaps undergo an environmental review before turn on to ensure signs and warnings are present, to ensure loose ferrous objects are not present, and to ensure magnet will be properly restrained Measurement of magnetic fields around spectrometer magnets should be used to ensure fencing and posting are located appropriately Doors are posted with warnings for persons using a cardiac pacemaker Local barriers are placed around rf stations RFI gaskets are used on equipment to prevent rf radiation leakage Routine monitoring for rf radiation to determine if gaskets are effective Interlocks on laser barriers Eye protection for laser users Proper Training Workplace Hazard Analysis and Risk Assessment for facility

Thermal Energy Issues

Safety Issues	Burns Fires
Potential Initiators of Safety Problems	Spills of cryogenic liquids Contact with cold lines associated with liquid cryogenic systems Contact with hot surfaces of machinery or soldering irons Improper protective clothing for cutting and welding operations
Items To Consider When Designing For Safety	Insulation on cold surfaces On-site review of installation Use of a Cutting and Welding Permit Posting or fencing in boundaries for cutting and welding Fire Protection Devices Provided Proper Training Workplace Hazard Analysis and Risk Assessment for facility

Kinetic Energy Issues

Safety Issues	Physical injury (e.g., eye injury, broken bones, hearing loss, fatal injury, etc.) Facility damage
Potential Initiators of Safety Problems	Mis-operation of power tools or motorized equipment Pressure testing with inappropriate vessels or piping Inadvertent contact with rotating or moving machinery Improper rigging of accelerator apparatus or shielding Failure to wear proper personnel protective equipment
Items To Consider When Designing For Safety	Machine guards Written procedures for large equipment moves Chief Mechanical Engineer certification of large equipment moves Safety reviews and functional testing before specific operations Personnel protective equipment requirements Proper Training Workplace Hazard Analysis and Risk Assessment for facility

Potential Energy Issues

Safety Issues	Physical injury (e.g., eye injury, broken bones, hearing loss, etc.) Facility damage
Potential Initiators of Safety Problems	Release of stored energy associated with compressed gases or large vacuum spaces Puncture of a vacuum window Improper hoisting operation Failure to wear proper personnel protective equipment
Items To Consider When Designing For Safety	Pressure and vacuum equipment is designed to applicable codes Safety reviews and functional testing before specific operations Written procedures for use of compressed gas systems Window covers and shutters on vacuum windows Chief Mechanical Engineer certification of thin vacuum windows Chief Mechanical Engineer certification of vacuum or pressure vessels Written procedures for pressure testing or vacuum window testing Written procedures for in-house assembly of vacuum or pressure vessels Use of personnel protective equipment Proper Training Workplace Hazard Analysis and Risk Assessment for facility