PRELIMINARY HAZARDS ASSESMENT
Overview of the Technique

The facility being analyzed is first broken down into smaller parts, called systems and subsystems, to simplify the study. In some cases for a small facility, the entire facility may be analyzed without dividing it into smaller parts. For each part of the facility, the system drawings and operating procedures are studied and "What If" questions are developed. The study team addresses each question in turn, analyzing the potential hazards, consequences and the response of the facility and/or operators (i.e., what safeguards exist). Each part of the facility, or step in the procedure, is systematically reviewed. Recommendations are identified, as appropriate, and assignments are made for their follow up.

The success of a "What-If" analysis is highly dependent upon the thoroughness of the "What If" questions posed. The PrHA software will provide some questions that can be used. Alternatively, questions from previous studies may be used or the team can brainstorm questions at the outset of the study. It can be useful to have each member of the team individually prepare a list of "What If" questions prior to any team meeting. The lists of each team member should be merged and edited by the team leader. The revised list can then be circulated to the team for consideration prior to the actual team meeting. The "What-If" process is dynamic: as one question is asked other questions will occur to the team. These questions should be documented as they occur for later consideration.

It is useful if some structure is used in developing and categorizing "What If" questions. For example, questions can be developed around the three basic causes of accidents: equipment failure, human error and external events. Questioning can also be focused on hazard categories such as personnel injury and equipment damage.

The results of the team review sessions are documented in a "What-If" worksheet. The worksheet is usually a part of a final report prepared to document the study effort and findings.

Team Members

Process hazard analyses are usually performed by teams. The interaction of the team members results in a more thorough and complete review than would be accomplished by each individual working separately on the same project. A team typically consists of 5-7 individuals. One member is a person trained and knowledgeable in the PHA technique. The other members are usually selected for their knowledge of the process and/or technical contribution to the team.

The team leader is responsible for study preparation, guiding and managing the team, and supervising the study documentation and report generation. Team members provide information about the system to the team and identify hazard scenarios under the direction of the team leader. In some cases a technical secretary or scribe is employed to record results and prepare reports. Alternatively, the team leader assumes these responsibilities.

There is no one perfect combination of team members. However, since the team members need to be knowledgeable of the process and its operation, at least some of the team should come from the operating facility. A typical team may consist of the following members:

- Team Leader
- Process Engineering Representative
- Operations Representative
- Safety Representative
- Maintenance/Inspection Representative
- Facilities/Mechanical Engineering Representative

The actual composition of a specific team will depend upon the objectives of the study, the type of facility being studied, and other considerations. Other individuals may be used as resources for the team and brought into only those meeting sessions where their particular knowledge is needed. This approach keeps the core team to an efficient size.

PrHA Sessions

A PrHA team will require a number of hours to complete a study for a typical process. The team will therefore usually hold several meetings, or working sessions, spread over several days to perform the study. Since PrHA is tiring, the sessions are usually scheduled for the morning when the team members are most fresh. The sessions are normally scheduled to last for periods of 3-6 hours. Longer sessions or afternoon sessions tend to tire the members, reducing the effectiveness of the analysis and the quality of the study.

During each session, the PrHA team records their work in a worksheet. The basic purpose of the PrHA study is to identify potential hazard scenarios. Therefore, the team should not spend any significant amount of time trying to engineer a solution when a potential problem is uncovered. If a solution to the problem is obvious, the team should document their recommended solution. If a solution is not obvious, they should recommend that someone follow up and resolve the problem outside the PHA study. Also, if there is insufficient information available at the time to decide if a potential problem exists, the team should note it, assign someone to collect additional information, and continue with the study. The issue should be revisited later by the team, when additional information is available, to determine if a potential problem exists.

Success Factors

There are several factors that can influence the success of a PrHA study. These include:

- clearly understood statement of the study purpose, scope and objectives
- degree of preparation by the team leader
- experience of the team leader in leading PrHAs
- experience and breadth of knowledge of the team
- accuracy of the process drawings and other reference information
- adequacy of the study documentation
- adequacy of follow-up activities after the study is completed
- adequacy of meeting facilities

Defining a Study

The first step in conducting a PrHA is to explicitly state the purpose, scope and objectives of the study. They directly influence the content and emphasis of the study and the time that will be required to complete the study. Also be sure that the expected results of the study are clear to those who have requested the study. Sometimes, management has a perception of what the PrHA study will achieve which may be different from that of the team.

The purpose of the study is the underlying reason that the study was requested. Examples are:

· Comply with regulations

· Meet company policy requirements

· Address facility siting

It is also important to define the scope of the study. This includes specifying:

· physical boundaries of the system to be studied

· modes of operation to be included

· whether domino effects (effects on and from adjacent systems) are to be included

· what external events are to be treated

· extent to which recommendations for corrective actions will be developed

· whether severity and likelihood rankings will be used

· whether procedures will be treated implicitly or explicitly

Objectives are usually set by the person requesting the hazard analysis, but could be assisted by the PrHA team leader. The objectives provide a clear focus for the study. Examples are:

· Types of hazards to be treated

· Consequences to be considered

Types of hazards include:

· Toxic releases

· Fires and explosions

Possible consequences to be considered include:

- Public safety
- Public property damage
- Employee safety
- Liability
- Loss of plant or equipment
- Insurability
- Loss of production
- Environmental impact

Other study objectives may include such items as:

- Identify the major contributors to risk at the facility
- Determine possible accident sequences for emergency planning

Defining the Risk Rankings

Optionally, the team may assess the likelihood of a hazard scenario occurring, and the severity of its consequences, given that the scenario occurs. The likelihood and severity levels can then be used to estimate the relative risk. This allows prioritizing the scenarios to more effectively address the recommendations that may arise.
If a risk ranking of hazard scenarios is used, levels and definitions should be established for severity, likelihood and risk. These should be established prior to starting the team sessions and should be agreed upon by management.

One scheme used by the government for military and aerospace applications is given in MIL-STD-882B (2). Definitions for severity and likelihood from this source are shown below.

MIL-STD-882B definitions of severity:

Description	Cat	Mishap Definition
Catastrophic	I	Death or system loss
Critical	II	Severe injury, severe illness, or major system damage.
Marginal	III	Minor injury, minor occupational illness, or minor system damage.
Negligible	IV	Less than minor injury, occupational illness, or system damage.

MIL-STD-882B definitions of probability:

Description	Level	Specific Individual Item
Frequent	A	Likely to occur frequently
Probable	B	Will occur several times in life of an item
Occasional	C	Likely to occur sometime in life of an item

Remote	D	Unlikely but possible to occur
Improbable	E	So unlikely, assumed impossible

Various other schemes are possible.

In order to compare the potential hazards in various areas of the facility, several statistical comparisons can be made using these severity, likelihood and risk ranking estimates. The risk presented by any area of the plant depends on the number and types of hazards present, the number of ways they can be realized (causes), how likely they are to occur (likelihood) and the extent and magnitude of their consequences should they occur (number of consequences considered important and their severities).

A measure of the risk of any facility or area can then be obtained from the PHA worksheets by multiplying the number of occurrences and magnitude of each risk value in the "What If" analysis. This is called the risk prioritization factor (RPF). Thus, the more scenarios that a system or subsystem has of high risk, the greater the RPF. The scale transformation of the risk value is necessary so that a high risk corresponds to a high numerical rating.

It is unwise to base decisions solely on the risk estimates, since hazard scenarios with high severities and low consequences may be neglected. Many people take the position that high severity incidents are not acceptable no matter what the consequences.

In order to develop a risk ranking of the areas, analysts usually look for groupings of areas by RPF's. On this basis, areas can usually be divided into "First Priority", "Second Priority", "Third Priority", etc. for more detailed hazard analyses.

These prioritizations must be tempered by engineering judgment and a careful check of the original worksheets to see if any unusual conditions exist that could distort the area groupings derived by statistical means.

Additional insight into the risks presented by each area of the plant is provided by calculating the percent of the total scenarios in a system or subsystem in each severity and risk category, along with the total percent of scenarios with a high risk value. This provides an indication of systems that have a high proportion of high risk hazard scenarios and consequently are potential candidates for further analysis.

Carrying out the Review

The team uses the chosen PrHA technique to identify hazard scenarios. Different PrHA techniques vary in how they do this. Details are provided in the tutorials for each specific technique.

When evaluating the possible causes of a scenario, the PrHA team should keep in mind the three basic types of causes:

- Human error
- Equipment failure
- External events

A scenario is determined to be realistic, and is therefore subject to further review, if in the judgment of the team, there are sufficient credible causes to believe it can occur. In determining whether seemingly low probability events can occur, the relative probability of occurrence of the three basic types of causes should be kept in mind. The order of probability of occurrence generally is:

Human errors > Equipment failures > External events

Once realistic hazard scenarios are identified, any existing safeguards should be noted. If a risk ranking is being used, values of severity and likelihood are estimated. It is important that values are assigned consistently throughout the study.

If it is considered that a potentially significant hazard exists, and the existing safeguards are not adequate given the severity and/or likelihood of the event, a recommendation for corrective action may be made. An assignment of responsibility should be made to an individual or department for follow-up on the recommendation.

Even though the team leader prepares in advance for the study, in many cases the team may not have sufficient information, or knowledge, to determine whether a significant hazard potentially exists. In these cases, someone should be assigned to follow up and obtain additional information. This person can then report back to the PHA team at a subsequent meeting. The team can then assess whether or not a potential hazard exists and whether a recommendation is needed. If the problem is a lack of knowledge on the team's part, other specialists may be called in.

It is useful to track the progress of the study by marking on the P&ID those sections that have been studied. This can be done using a highlighter or by annotating the drawing. This procedure helps ensure complete coverage.

Documenting the Study

Proper documentation of a PrHA study will address the following items:

- documentation of the team sessions
- follow-up reports
- study report

A typical report may include the following sections:

Executive Summary

I. Introduction
II. Scope and Objectives
III. Study Approach
IV. Study Results/Findings
V. Conclusions

Appendixes

A. Description of Hazard Analysis Study Technique
B. Study Nodes and Drawings
C. Action Items
D. Hazard Analysis Study Worksheets

Prioritizing Action Items

The PrHA study may result in a large number of action items. The number of action items may be greater than the facility could reasonably be expected to handle at one time. To properly manage the action items, a method of prioritization of the action items is desirable to allow the facility to focus its resources. Several schemes are available to help prioritize the action items, including:

·Risk ranking: an estimate is made of the likelihood of the event and the severity if it were to occur. Risk is a combination of the likelihood and severity of an incident. A risk matrix, with likelihood and severity as the axes, is then used to determine the risk.

·Simple prioritization: a scale (e.g. 1 to 5, A to E, etc.) is used to subjectively prioritize the action items.

·Categorization: action items are categorized as either safety or procedural items. Higher priority is given to the safety items. Sub-categorization of the items in each category may also be done, such as into hardware (equipment) and procedural items. Procedural items are considered no (or low) cost items and easily accomplished.

Worksheet

Main System List: 1. Facility/Shell

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Design basis not reliable	1. Lack functionality and not support research	1	2	2	1. Performing a PrHA 2. Design is for future flexibility		
2. Emergency response for surrounding community	1. Local response team will come in force to respond to spill report				1. Area outside dock holds several vehicles	4. Need to design to insure adequate space for emergency response vehicles	Nolan Watson
	2. News and Information Services group will handle communicating				2. Emergency responders, News & Info, and regional affairs are part of the process 3. On-going plan for training outside emergency responders	5. Provide integrated, coordinated effort between university and local response team	Bryan Hall
3. Hazards from nearby facilities	1. Potential impact from Bio & Genome building for positioning of air intakes					6. Performing wind study to determine best positioning for air intakes	Nolan Watson
4. Building protection against vehicles	1. Addressed in Security						
5. Environmental threats (storms?)	1. Earthquake causing structural damage	4	2	8	1. Seismic design, Site Class C, including mechanical and electrical systems		
	2. Volcano dust will impact air intakes	1	2	2	2. SOP to not place chemicals/hazardous materials in vunerable areas		

Main System List: 1. Facility/Shell

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
	3. Wind storms causing building vibration and potential loss of services	1	3	3	3. Place building on alert if there is volcanic activity		
	4. Inability to access building may cause loss of research and expensive loss of resources and experimental time				4. SOP to shut down intakes in event of large amount of dust		
					5. Services underground, protected from wind		
6. Outside air intakes - foreign material entering	1. Problem with emissions from cars/buses causing indoor air quality problems	2	4	8	1. Location of air intakes to minimize entrainment of hazards		
	2. Particulates and/or gases introduced by terriorists or protestors causing danger to building staff	4	3	12	2. Air intakes not visible from street		
					3. Design limits access to roof from outside		
					4. Isolation dampers located on outside area intakes to isolate from outside environment		

Main System List: 2. Security

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			

Main System List: 2. Security

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. CBR (Chemical Biological Radiological Bomb)	1. Loss of life	4	2	8	1. Surveillance	9. Perform security assessment using program plans and data	Lauris Freidenfelds
	2. Loss of facility, research	4	2	8	2. Access Control		
	3. Collateral damage to surrounding community	4	2	8	3. Architectural construction to harden structure		
					4. Bio-security plan		
					5. Package screening		
2. Vehicle attack	1. Loss of life	4	2	8	1. Architectural construction to harden structure		
	2. Loss of partial facility	4	2	8	2. Survelliance		
	3. Collateral damage to surrounding community	4	2	8	3. Secure site design		
					4. CPTED design (Crime Prevention through Environmental Design)		
3. Cyber-security incl. telecom	1. Loss of research	1	3	3	1. Cyber security plan (CDC and UW)	10. Must be addressed to meet Federal requirements	Ray Wittmier
	2. Loss of use of building	1	2	2	2. Alternate means of communication		
	3. Compromise security program						
	4. Financial consequences	1	2	2			
4. Air traffic incident	1. Loss of life	4	2	8			
	2. Loss of partial facility	4	2	8			

Main System List: 2. Security

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
	3. Collateral damage to surrounding community	4	2	8			
5. Blockage to access to building (protest)	1. Loss of use of building	1	4	4	1. Access control		
	2. Loss of research				2. Survelliance		
	3. Potential physical violence				3. Alternate entry point		
					4. Police to clear blockage		
6. Protest attack							
7. Common crime							
8. Disgruntled employee/Insider Threat	1. Potential for threat or action against facility or personnel or research agents	4	3	12	1. Workplace violence assessment team		
					2. Panic alarms		
					3. Ability to turn off access		
					4. Sally port to contain person at entrance		
9. Non-specific target theft							
10. Sabatoge							

Main System List: 3. Dock/quarantine area

Subsystem: 1. Animal Receiving/Quarantine

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Infected animal arrives in quarantine	1. Animal cannot be moved into facility and must be kept isolated from other animals in quarantine	2	3	6	1. SOP for quarantine 2. Use reputable, audited breeding facilities for supply		
2. Control of biological materials	1. Attempt to receive package at wrong dock`				1. SOP for dock manager 2. Separate dock area for receiving other packages, including select agents		
3. Inadequate instructions	1. Confusion in area on what procedures are to be used				1. SOP on handling, tagging, and tracking animals		
4. Power failure?	1. Loss of lighting and heat in animal area				1. Emergency generator will provide backup power to area		
	2. Potential loss of quarantine				2. Dual power feeds to critical equipment		

Main System List: 3. Dock/quarantine area

Subsystem: 2. Common Dock Area

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Lack of guidance/training	1. Failure to store or handle materials properly				1. SOPs on handling of specific materials and		

Main System List: 3. Dock/quarantine area

Subsystem: 2. Common Dock Area

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
	2. Loss of sensitive materials requiring special handling				deliveries, including those requiring refrigeration/freezer storage		
2. Major hazards of materials being handled?	1. Gas cylinders may fall over if not properly chained				1. Provide cylinder storage area for full and empty cylinders		
	2. Reagents for laboratory will be received and may be leaking				2. Stock spill control supplies in the dock area for clean up of small chemical spills		
3. Personnel without proper access permission?	1. Unauthorized person could potentially enter building through dock area				1. Dock bay doors are down and locked from inside unless being used.		
					2. Dock personnel door will have same security as other personnel doors		
					3. Interior doors to critical areas have additional security protection		
4. Problems with use of fork lifts, transport devices on dock area	1. Damage to goods being received				1. Limited personnel in dock area		
	2. Personnel injury				2. Use of walking lifts or manual units in small area		
5. No provisions for winterization?	1. Ice in area surrounding dock				1. University provides treatment of areas during ice conditions		
	2. Hard rain may damage some received goods				2. Dock fully enclosed and heated		

Main System List: 3. Dock/quarantine area

Subsystem: 2. Common Dock Area

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
					3. Overhang over truck area to protect from rain		

Main System List: 4. ABSL-3 Animal Holding

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Issues with commissioning	1. Loss of use or delay in use	1	2	2	1. Defined commissioning criteria early in process		
					2. Performing commissioning		
2. Wrong bio-material into room?	1. Researchers may have access to agents they are not cleared to use				1. Security system would not allow unauthorized entry into room with certain agents	13. Need to review layout of rooms to reflect restrictions and needs of researchers while having flexibility.	Bryan Hall
3. Failure of monitoring devices?	1. Loss of pressure control in room				1. Systems on emergency power		
	2. Loss of telemetry in cages				2. Stock spare parts		
					3.		
4. Shutdown of BSC?	1. Agent difuse into room	2	3	6	1. Redundancy of biosafety cabinets are designed into room		
	2. Problem with research in cabinet				2. Annual testing and certification		
					3. Hood is alarmed		

Main System List: 4. ABSL-3 Animal Holding

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
					4. Personnel have PPE in addition to the hood		
5. Transportation of animals between animal areas	1. Containment may not be maintained				1. Use of transport container that is decontaminated on exterior to isolate animal	12. Need to add autoclave out of suite to remove items from containment	Nolan Watson
					2. Procedure room inside same suite in holding room		
					3. SOP to limit transport of animals outside containment		
6. Ability to decontaminate room	1. Room is not usable				1. One procedure room has the connections for utilities for racks so entire room can be moved if needed	11. Add backup ability to use paraformaldehyde decontamination	Nolan Watson
					2. VHP decontamination, portable		
					3. Use of materials that are compatible with decontamination materials		
7. Failure of protective gear?	1. Personnel exposure				1. SOP for inspection		
8. Transport of cages to wash/sterilizer area	1. Potential of moving cages through non-contained areas				1. SOP to minimize exposure	14. Change layout so cages remain in containment	Nolan Watson
9. Ability to autoclave in/out?	1. Not be able to remove bio-materials from room						

Main System List: 4. ABSL-3 Animal Holding

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
10. Personnel access control?	1. Addressed through security						
11. Loss of primary containment	1. Personnel exposure	3	2	6	1. Biosafety plan and training		
	2. Animal exposure effecting research				2. Preventive maintenance and certification of cabinets		
					3. Ability to remove equipment when needs replacement		
12. Problem with disposal of bio-hazard wastes	1. Loss of autoclave cause backup of waste				1. Redundancy of autoclaves		
					2. Freeze wastes until autoclave repaired		
13. Containment of spills	1. Liquids into hallways, other rooms				1. Limited amount of liquid in rooms		
					2. No hazardous materials used in rooms		
14. Problem with maintenace?	1. Inability to maintain space				1. Maintenance through stair or elevator to interstitial space or basement without entering containment.		
	2. Need to allow maintenance personnel into containment				2. Elevators allow transport of equipment for maintenance		
					3. Material can also enter dock area		

Main System List: 4. ABSL-3 Animal Holding

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
					4. Rooms are designed as "stand alone" to allow isolation of services for maintenance		

Main System List: 6. BSL-2 Labs

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Issues with commissioning	1. Delays or stops use of room				1. Planned commissioning and complete commissioning		
2. Wrong bio-material used in room?	1. Bring higher level select agent into room	4	3	12	1. SOP/training/supervision		
					2. Strict enforcement of regulations		
3. Failure of monitoring devices?	1. Loss of flow tracking	2	4	8	1. Annual testing and certification		
	2. Chemical fume hood in alarm				2. Monitored alarms for response		
4. Failure of freezers	1. Loss of specimens	1	3	3	1. Temperature monitoring remotely		
					2. Non-mechanical backup (CO2)		
					3. Vials in 2nd containment		

Main System List: 6. BSL-2 Labs

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
5. Shutdown of BSC?	1. Loss of research	1	3	3	1. Annual testing and certification		
	2. Contamination of room	2	3	6	2. N+1 redundancy		
6. Malfunction of fume hood controls	1. Insufficient or too high exhaust	3	3	9	1. Annual testing and certification		
					2. Selection of high quality hood vendors		
					3. ASHRAE 110 testing during commissioning		
					4. Training for staff		
7. Ability to autoclave?	1. Materials cannot be decontaminated	2	3	6	1. Vendor has service contract with university		
					2. Redundant autoclaves located in adjacent rooms		
8. Personnel access control?	1. See Security section						
9. Spill in room	1. Spill of reagents in room	3	4	12	1. Safety manuals and training for staff		
	2. Biological materials spill	2	4	8	2. 10 air changes per hour in room to remove fumes		
	3. Creation of flammable situation in room				3. Quantities limited in room		
					4. Fire supression		
10. Problem with maintenance?	1. Maintenance of eyewash and safety showers				1. Locate eyewash and safety showers in corridors	15. Need to verify location of these in BSL-2 labs	Nolan Watson

Main System List: 7. Corridors, elevators, and stairs

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Control of select agents entering building	1. Loss of control of select agent/agent in wrong area				1. SOP established for handling of materials when received by facility to meet Federal regulations	16. Additional review of procedures and policies for handling select agents	Karen VanDasen
					2. Office of Responsible Official is in building		
					3. Delivery only during normal hours		
2. Personnel access control?	1. See Security Section						
3. Failure of elevator during transport of materials between floors?	1. Personnel trapped in elevator with hazardous materials and/or animals	2	2	4	1. Elevator can be opened manually if stopped between floors		
					2.		
4. Transportation of animals between areas	1. If exterior of animal enclosure is not cleaned properly, could release contamination into other areas	2	2	4	1. SOP for cleaning enclosures prior to transport		
	2. If cage is dropped, animal could get out	3	1	3	2. Building is designed so that animals do not leave high containment		
					3. Cage designed to withstand dropping without failure		
5. Release of hazardous agent in hallway, stair	1. Exposure of personnel to agent	4	1	4	1. Select agents transported in multiple protection containers		

Main System List: 7. Corridors, elevators, and stairs

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
area of containment space	2. Potential for agent to migrate to other areas not contained	4	1	4	2. SOP on method of transport and where select agents can be moved through		
					3. Security limits on agents going into non-approved areas		
6. Power failure?	1. Personnel may be trapped on elevator				1. Stair and hallway will be equipped with battery powered emergency lighting to maintain during generator startup		
	2. Lighting may fail in stair area and hallway				2. See Failure of Elevator		

Main System List: 8. HVAC Supply and Exhausts

Subsystem: 1. HVAC System

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Loss of supply air to containment rooms	1. Loss of pressurization	1	3	3	1. N+1 redundancy		
	2. Loss of use of space and evacuation	1	3	3	2. Preventive maintenance		
					3. Monitored alarms for response		
2. Loss of exhaust from containment	1. Loss of pressurization	2	3	6	1. Preventive maintenance		
	2. Loss of use of	1	3	3	2. N+1 redundancy		

Main System List: 8. HVAC Supply and Exhausts

Subsystem: 1. HVAC System

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
rooms	space and evacuation				3. Monitored alarms for response		
3. Loss of heating and cooling coils	1. Extreme temperatures	1	3	3	1. N+1 redundancy		
					2. Cross connections between redundant air handlers to allow service from secondary coils		
					3. Monitored alarms for response		
4. Change out of HEPA filters that are contaminated	1. Potential exposure to personnel				1. Design for easy access for changeout	17. Need to look at design of HEPA for general exhaust in ABSL-3 and BSL-3 areas	Mike Connor
	2. Shutdown of research in area				2. HEPA designed for decon in place		
	3. Potential release of hazardous materials				3. Scheduled changeout of HEPA on BSC and HVAC exhausts		
					4. For BSL-2 labs, exhaust is manifolded so HEPA can be changed without shutdown		
					5. Separate lab and office area systems		
5. System reaction during power outage transition	1. Effect on pressure control of rooms for 5 - 10 minutes	1	3	3	1. Annual testing of emergency power systems with "live" building		
					2. Monthly testing of emergency generators against load bank		

Main System List: 8. HVAC Supply and Exhausts

Subsystem: 1. HVAC System

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
					3. Speed matching to allow quick recover		
					4. Control system on UPS		

Main System List: 9. Wastewater treatment

Subsystem: 1. Entire System

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Automation sets control point incorrectly?	1. Waste not treated properly	3	2	6	1. Limited access to control system		
	2. Tank overfilled	3	2	6	2. Limited setpoints in control software		
					3. Printed records for system, including time, temperature		
2. Failure of lift station to city sewer?	1. Accumulation of wastewater				1. Alarm to city. City will take action to insure operation.	18. Need to look at lift station for waste disposal	Bryan Hall
	2. Potential loss of use of building				2.		
	3. Sewage spill in bay						
3. Computer, automated systems fail?	1. Lose use of one tank				1. PLC retains info on step of program		
	2.				2. SOP on how to restart system		

Main System List: 9. Wastewater treatment

Subsystem: 1. Entire System

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
					3. Tanks are under separate control system, N+1 tanks		
4. Confusion in an emergency situation	1. Potential overfilling of system due to loss of level sensors in tanks				1. Operation only during normal hours		
					2. Secondary monitoring of drain lines to detect overflow condition		
5. Damage, plugging of pump by debris?	1. Loss of ability to transfer material out of tanks	1	2	2	1. Pumps will be piped to provide redundancy	19. Verify plan for pump redundancy for WWT	Mike Connor
6. Excess pressure?	1. Rupture of tank and/or line to tank	3	2	6	1. Pressure relief device on steam line and tank		
					2. Pressure transmitter on tank will alarm		
7. Excessively high/low tank level?	1. Potential overfilling of system due to loss of level sensors in tanks				1. Secondary monitoring of drain lines to detect overflow condition		
8. Failure of power, key utilities?	1. Loss of steam will cause system to not sterilize	3	2	6	1. Emergency generator will provide backup power to area		
	2. Loss of air may affect instrumentation and control valves	2	2	4	2. Boiler provides backup steam source for building		
	3. Loss of power will stop operation of the system so drain capacity is limited	2	2	4	3. Air compressor provides backup air source for building		

Main System List: 9. Wastewater treatment

Subsystem: 1. Entire System

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
9. Fire case?	1. Tanks may overheat and overpressurize				1. Fire supression		
	2. Control system may fail				2. Pressure relief device on steam line and tank		
					3. Control system set up to fail "safe"		
10. Overfilling?	1. An overfilled tank will fill up drain lines and could put liquid into first floor rooms				1. Redundant level sensors on tanks		
					2. SOP for operator to verify system conditions periodically		
11. Operator ignores critical alarm?	1. System may fail				1. Critical alarms are monitored remotely		
	2. System may operate incorrectly so un-sterilized material is released				2. SOP and training for operators on system operation and alarm response		
					3. System fails into "safe" mode		
12. Data storage lost?	1. Historical records of batch processes are lost	1	3	3	1. Data stored on computer is backed up onto media and removed from area		
13. Controls not accessible during emergency?	1. Not able to determine cause of emergency situation	3	3	9	1. Control panel will be installed outside the building in a secure location, including password protection	20. Verify location/type of remote access for controls for WWT	Mike Connor
	2. Not able to override systems remotely						
14. Plugged HEPA vent filter	1. Tanks not able to relieve pressure				1. Periodic maintenance of HEPA vent filter, including changeout	21. Confirm redundant HEPA on tank vent	Mike Connor

Main System List: 9. Wastewater treatment

Subsystem: 1. Entire System

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
	2. Failure of filter media allows bypass of vent gases	3	2	6	2. Tanks have emergency pressure relief		
					3. Redundant HEPA on tank vent skid		

Main System List: 10. Building Automation System (BAS)

Subsystem: 1. Building Automation System

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Power failure?	1. Loss of control of equipment	3	3	9	1. UPS dedicated to the BAS		
	2. Loss of pressurization control for containment rooms	3	3	9	2. BAS on emergency generator and listed as critical		
	3. Loss of directional air flow	3	3	9	3. Redundant equipment controlled from separate panels		
	4. Loss of ability to shed loads off generator	3	3	9			
2. Action out of sequence	1. If dampers close too soon, damage to dampers and equipment	1	3	3	1. Commissioning to insure proper sequencing		
	2. Chillers can freeze if pumps are not on	1	3	3	2. Hardwiring of critical interlocks		
					3. Password for operator override		
3. Staff ignores critical alarm?	1. System that is notifying may fail	3	3	9	1. SOP on responding to alarms		

Main System List: 10. Building Automation System (BAS)

Subsystem: 1. Building Automation System

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
	2. System failure may cause unsafe condition	3	3	9	2. Training for staff		
					3. Alarms designed to be easily identified as to cause		
					4. Alarm cannot be cleared unless condition is restored to normal		
4. Automation sets control point incorrectly?	1. Wrong pressure and/or flow control for containment spaces	2	3	6	1. Commissioning to insure setpoints are correct		
	2. Low/High temperature in chillers may cause operational problems for HVAC and other systems	1	2	2	2. Training for staff		
	3. Steam supply may not be available for autoclave	1	2	2	3. Password for operator override		
					4. Autoclaves require minimium steam pressure to operate		
5. Computer, automated systems fail?	1. Loss of control of equipment	3	2	6	1. System is DCS (Distributed Control) so panels have control over only sections of the building or limited numbers of systems		
	2. Loss of pressurization control for containment rooms	3	2	6	2. Redundant mechanical equipment is served by separate panels		
	3. Loss of directional air flow	3	2	6	3. Spares will be stocked so repair		

Main System List: 10. Building Automation System (BAS)

Subsystem: 1. Building Automation System

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
	4. Loss of ability to shed loads off generator and subsequent failure of generator	4	2	8	can be made quickly		
6. Controls not accessible during emergency	1. Inability to determine cause of alarms and extent of situation	4	2	8	1. Outside monitoring and control capability designed into the system		
	2. Inability to override systems during emergency	4	2	8	2. Dial in modem support provided in system		
7. Damper fails?	1. Loss of active containment for containment spaces	3	2	6	1. Preventive maintenance		
	2. Potential damage to ductwork and/or systems	2	2	4	2. Critical dampers are monitored with end switch		
8. Instrument air failure	1. Pneumatically actuated devices move to the failed positions	2	3	6	1. Main air feed through campus with backup air compressor located in basement		
	2. Loss of pressure control in containment	2	3	6	2. Alarms monitoring air pressure		
	3. APR doors fail	3	3	9			
9. Insufficient services, equipment, instrumentation for start-up, shutdown?	1. Inability to control systems from control panels	3	2	6	1. Manual overrides located on individual pieces of equipment and control panels		
10. Lack of guidance/training	1. Inability to properly maintain the system	3	2	6	1. Proper commissioning that encompasses training		

Main System List: 10. Building Automation System (BAS)

Subsystem: 1. Building Automation System

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
	2. Inability to properly operate the system	3	2	6	2. Documented procedures (SOPs)		
11. Lack of redundancy?	1. Failure of critical active containment systems	3	2	6	1. Proper design		
					2. Completion of Hazards Review in preliminary stage		
					3. Performance of a single point of failure analysis (SPOF)		
12. Off-site backup of data?	1. Loss of off-site backup will cause loss of historical data	1	2	2	1. SOP outlining change control and revision control		
	2. If PLC programs are stored on site, potential loss of PLC backup programs	1	2	2	2. SOP detailing backup procedures, including off site storage protocols		

Main System List: 10. Building Automation System (BAS)

Subsystem: 2. Data Servers

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. LIMS?							
2. Power failure?							
3. Access for service personnel?							

Main System List: 10. Building Automation System (BAS)

Subsystem: 2. Data Servers

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
4. Maintenance requirements?							
5. Communication with other systems							
6.							

Main System List: 11. Media Suite on 2nd floor

Subsystem: 1. Equipment in suite

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Failure of automated equipment?	1. Failure of glass washer/dryer may cause incomplete cleaning of glassware	2	3	6	1. Glass washer and dryer will have alarms to notify operator if cycle was incomplete or improperly operated		
	2. Failure of horizontal laminar flow hood may allow material to escape into the room	2	2	4	2. HLF hood used for preparing media only - no hazardous materials handled there		
2. No Access for service personnel?	1. Personnel would require clearances to enter research space				1. Equipment installed with service area behind units to allow service access without entering lab		
	2. Equipment would need to be moved for repair						

Main System List: 11. Media Suite on 2nd floor

Subsystem: 1. Equipment in suite

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
3. Key utilities fail when required?	1. Failure of steam on autoclave would cause equipment not to complete sterilization	3	2	6	1. Boiler provides backup steam source for building		
	2. Failure of power would stop all equipment.	1	3	3	2. Emergency generator will provide backup power to area		
	3. Failure of water supply would mean washers would not clean properly	2	2	4	3. Equipment has interlocks to monitor whether cycle was completed with proper services		
4. Leak during operation	1. Liquid would be on floor of service area and/or media suite from glass washer	2	3	6	1. Service area around equipment has curb for liquid containment	22. check on curb for liquid containment in media suite equipment room	Mike Connor
	2. Condensate from autoclave could get on floors of media suite	3	2	6	2. Drain lines are welded metal		
	3. Leaks from drain lines could impact operation of lab space on first floor	3	2	6	3. Preventive maintenance		
5. Operating procedure incorrect, unclear?	1. Equipment is damaged due to incorrect operation				1. SOP and training for operators on system operation and alarm response		
	2. Process is not completed correctly so labware is not clean and/or sterilized				2. Equipment has interlocks to monitor whether cycle was completed with proper services		

Main System List: 11. Media Suite on 2nd floor

Subsystem: 1. Equipment in suite

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
6. Issues with commissioning	1. Equipment not properly certified and calibrated				1. Use of commissioning agent that performs procedures to insure proper equipment operation		
	2. Delays in start up due to inability to commission				2. Commissioning to insure setpoints are correct		

Main System List: 12. Molecular Biology Lab

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. See Hazards Review for BSL-2 labs							

Main System List: 13. Procedure, Necropsy, Digestion, Tissue Harvesting

Subsystem: 1. Necropsy area/table

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Loss of ability to autoclave in/out?	1. Materials cannot be removed from the room unless bagged				1. Preventive maintenance	23. Look at issues of transport of bags to other autoclave	Nolan Watson

Main System List: 13. Procedure, Necropsy, Digestion, Tissue Harvesting

Subsystem: 1. Necropsy area/table

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
	2. Bagged materials would have to be transported to at Cage Wash				2. Amount of material small enough to store for some period until autoclave was repaired		
					3. Some materials could go through dunk tanks		
2. Control of biological materials	1. Wrong material may be brought into area				1. SOP established for handling of materials by facility to meet Federal regulations	24. Are they using any form of LIMS to track agents?	Nolan Watson
	2. Agents must be kept segregated				2. Two BSC cabinets available in area		
					3. Containers for agents are well labeled and tracked through facility		
3. Emergency situation?	1. Operators would be required to shower out and egress through main front exit					25. Need to check on emergency exit path from area (length)	Nolan Watson
4. Failure of power, key utilities?							
5. Transportation of animals between areas	1. Animals must go through separate door on north end						
6. Handling of alkali reagents (NaOH, KOH)	1. Spill of materials during load of tissue digester					26. Where is tissue digester? How large? Where is reagents? Where are cylinders?	Mike Connor
	2. CO2 leak from tanks						

Main System List: 13. Procedure, Necropsy, Digestion, Tissue Harvesting

Subsystem: 1. Necropsy area/table

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
7. Spill containment?							

Main System List: 13. Procedure, Necropsy, Digestion, Tissue Harvesting

Subsystem: 2. Digester

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Access for service personnel?							
2. Automation sets control point incorrectly?							
3. Confusion in an emergency situation							
4. Control valve failure?							
5. Controls accessible during emergency?							
6. Excessively high/low tank level?							
7. Failure of instrument air?							
8. Failure of monitoring devices?							

Main System List: 13. Procedure, Necropsy, Digestion, Tissue Harvesting

Subsystem: 2. Digester

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
9. HEPA damaged/blinded?							
10. High discharge temperature?							
11. High, low pH?							
12. Issues with commissioning							
13. Loss of steam?							
14. Operating procedure incorrect, unclear?							
15. Operator adds too few, too many batches?							
16. Power failure?							
17. Spill response/containment?							

Main System List: 14. Tissue Culture Labs on 2nd floor

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			

Main System List: 14. Tissue Culture Labs on 2nd floor

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. See BSL-2 evaluation for Hazards							

Main System List: 15. Procedure Room

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Automation sets control point incorrectly?	1. Pressure in room is not in control, may go positive in relation to outside rooms	3	2	6	1. SOP and training for operators on system operation and alarm response		
					2. Commissioning to insure setpoints are correct		
2. Wrong bio-material into room?	1. Staff could be in area where restricted agents are being handled	1	2	2	1. Access control		
	2. Cabinets or other equipment may not be classified to work with the agents				2. Bio-security plan		
					3. Containers for agents are well labeled and tracked through facility		
3. Failure of power, key utilities?	1. Loss of containment of select agents				1. Emergency generator will provide backup power to area		
	2. Loss of light during procedure on animal				2. Local lighting on battery backup for safety		

Main System List: 15. Procedure Room

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
	3. Loss of functioning of isolation cages						
4. Failure of protective gear?	1. Exposure of personnel to infectious agent				1. SOP for checking protective gear prior to donning		
	2. Injury to personnel				2. SOP on handling, tagging, and tracking animals		
5. Issues with commissioning	1. Delays in startup of facility				1. Performing commissioning		
	2. Improperly operating BSC				2. Selection of high quality hood vendors		
6. Breach of personnel access control?	1. Unauthorized person enters restricted area				1. Security system would not allow unauthorized entry into room with certain agents		
	2. Staff without proper clearance in area with select agent				2. SOP on verifying personnel prior to issuing badges and allowing entrance		
7. Plugged HEPA filter in BSC	1. Improper air flow through cabinet so face velocity too low. May result in operator exposure				1. Selection of high quality hood vendors		
					2. BSC equipped with monitoring of HEPA on outlet		
8. Shutdown of BSC?	1. same as failure of power						

Main System List: 16. Aerobiology Challenge suite

Subsystem: 1. Aerobiology Chambers

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Problems with decontamination	1. Inability to use room				1. Portable VHP available for each room	27. Verify paraformaldehyde can be used to decon aerobiology area	Nolan Watson
	2. Delay to research program				2. Allowances made to use paraformaldehyde as alternative decon		
					3. Two separate Aerobiology rooms to allow work to continue		
2. Animal isolation concerns	1. Inability to isolate animal would restrict amount of research that can be conducted concurrently						
3. Problems with removal of animal wastes	1. Area would become contaminated with liquid and solid wastes				1. Room equipped with floor drains to bio-waste treatment system	28. Verify what contingency in place to move animals out of non-functioning space	Nolan Watson
	2. Animals may need to be moved to other area				2. Solids can be autoclaved out of area		
4. Failure of power, key utilities?	1. Isolation cage would not function without power and containment would be lost				1. Emergency generator will provide backup power to area		
	2. Loss of water would be deterimental to condition of animals				2. Fresh water stored in building so can be supplied in emergency		
	3. Loss of bio-waste treatment may limit work and cleaning of cages and area				3. Solids can be autoclaved out of area		

Main System List: 16. Aerobiology Challenge suite

Subsystem: 1. Aerobiology Chambers

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
5. Failure of B3 cabinet during exposure	1. Potential exposure of worker to infectious agent				1. Emergency generator will provide backup power to area 2. Use of In-Tox device limits release of airborne contaminants into worker space 3. SOP for operators to wear protective gear during operation		
6. Transportation of bio-materials between areas	1. See Corridors, Elevators, and Stairs						

Main System List: 17. Cage wash area

Subsystem: 1. Cage Wash Area and Equipment

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Automation sets control point incorrectly?	1. Equipment does not operate properly and/or fails to operate				1. Commissioning to insure setpoints are correct 2. SOP/training/supervision		

Main System List: 17. Cage wash area

Subsystem: 1. Cage Wash Area and Equipment

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
2. Failure of power, key utilities?	1. Loss of power will cause equipment that is operating to fail, not completing the cycle				1. Emergency generator will provide backup power to area		
	2. Loss of steam will cause autoclaves and sterilizers to fail				2. Boiler provides backup steam source for building		
	3. Loss of water will cause washers to fail				3. Equipment has interlocks to monitor whether cycle was completed with proper services		
	4.						
3. Failure of tunnel washer?	1. Racks and cages cannot be washed at the rate they are used. Will impact R&D progress	3	3	9	1. Manual cleaning of cages and racks can be done		
					2. Stock spare parts		
4. Failure of cage washer?	1. Cages cannot be washed at the rate they are used. Will impact R&D progress	2	3	6	1. Manual cleaning of cages and racks can be done		
					2. Stock spare parts		
5. Failure of bottle washer?	1. Watering bottles cannot be washed automatically	1	3	3	1. Manual washing of bottles can be done	29. Are there facilities in the room to perform functions manually (sinks, drains)	Mike Connor
6. Failure of rack autoclave?	1. Racks cannot be autoclaved so cannot be returned to service	3	3	9		30. Need to evaluate problems from shutdown of rack autoclave	Nolan Watson
7. Failure of autoclave?	1. Materials cannot be autoclaved out of cage wash area	3	3	9			

Main System List: 17. Cage wash area

Subsystem: 1. Cage Wash Area and Equipment

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
8. Issues with commissioning	1. Delays to startup of facility				1. Performing commissioning		
	2. Improper operation of equipment				2. Insure vendors participate in commissioning		
9. Personnel access control?	1. Personnel with improper clearance in area	2	2	4	1. SOP on verifying personnel prior to issuing badges and allowing entrance		
					2. Access control		
10. Poor access to controls & equipment	1. Inability to maintain equipment				1. Review of equipment design and access requirements prior to purchase		
11. Transport of cages to wash/sterilizer area	1. See Corridors, elevators, and stairs						

Main System List: 18. Vaccine Lab

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Failure of HEPA to Class 100 Sterile filling area	1. Hazard only to media or product						
2. Failure of cold room	1. Hazard only to media or product						

Main System List: 18. Vaccine Lab

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
3. Concerns with access to equipment for maintenance?	1. If equipment cannot be accessed, maintenance cannot be performed				1. Separate area for equipment maintenance for most equipment		
	2. Maintenance personnel might require clearance to go into lab space				2. SOP for maintenance personnel on entering BSL-3 space		
4. Removal of equipment if required	1. Equipment too large may not be able to be removed if needed				1. Doorways have been sized so all equipment can be removed		
5. Failure of autoclave	1. Steam release into space				1. Autoclave has detection for failures		
	2. Cannot autoclave into space, will impact R&D effort				2. Stock spare parts		
6. Hazards of containment space	1. See BSL-3 lab for hazard review						

Main System List: 19. Core Instrument Lab on 1st floor

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Hazards are same as BSL-3 rooms							

Main System List: 20. Tissue processing and DNA sequencing

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Hazards comparable to BSL-2							

Main System List: 21. Shared Instrument Lab on 2nd floor

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Hazards are similar to BSL-2 labs							

Main System List: 22. Steam and Boilers

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Loss of campus steam	1. Failure of steam to building				1. Boiler provides backup steam source for building		
	2. Loss of research						
2. Failure of power, key utilities?	1. Loss of fuel supply will stop operation of boiler				1. Maintenance operation each month		
	2. Loss of power will lose controls for boiler				2. Emergency generator will provide backup power to area		

Main System List: 22. Steam and Boilers

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
					3. Redundant boilers, fed from opposite ends of switchboard		
3. Pressure control fails	1. High pressure steam into building system				1. Pressure relief device on steam line and tank		
4. Confusion in an emergency situation	1. Boiler does not get started if steam fails				1. Alarms designed to be easily identified as to cause		
	2. Loss and/or delay of research				2. SOP and training for operators on system operation and alarm response		
5. Failure of low water alarm	1. Boiler may blow up, causing severe damage	4	1	4	1. Boiler has redundant alarms as required by Code		
					2. Alarms are monitored		
6. Leak during operation	1. Steam and/or hot water released into basement area				1. Maintenance operation each month		
	2. Fuel oil spill in basement area				2. Liquid spill detection for fuel oil in storage area		
					3. Double wall piping for fuel oil		
7. Record keeping requirements of permits?	1. If records are not properly maintained, system may not be operated				1. UW Maintenance group will work with state to insure proper records and inspections		

Main System List: 23. Domestic cold water

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Problem with automatic watering system	1. Potential water flooding with sticking valve	1	3	3	1. Automatic watering not to be installed in ABSL3 area		
					2. Automatic watering only in aerobiology		
2. Loss of potable water supply to building	1. Equipment using water stops functioning				1. Equipment has interlocks to monitor whether cycle was completed with proper services		
	2. Staff cannot shower out of containment				2. Water is stored at roof level to provide water to animals and critical needs		
	3. Animals do not have water supply				3. Water is routed to shower areas out of containment		

Main System List: 24. Compressed Air System

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Campus air supply is interrupted	1. Failure of APR doors on BSL-3 Aerobiology labs				1. Compressor located in basement area provides automatic backup of campus air		

Main System List: 24. Compressed Air System

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
	2. Equipment requiring air stop operation				2. Equipment has interlocks to monitor whether cycle was completed with proper services		

Main System List: 25. Cylinder gases

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Transport of materials between floors?	1. Leaking cylnder in an elevator	3	1	3	1. Cylinders are transported on a cylinder cart		
	2. Drop a cylinder during transport	2	2	4	2. Cylinders will have screw caps to protect valves		
					3. SOP to examine cylinders prior to transport into the facility for leakage		
2. High pressure/regulator failure?	1. Overpressurize instrument	2	2	4	1. Dual stage regulators		
	2. Overpressurize other devices and/or piping	2	2	4	2. Installation of flow orifices		
					3. PRV on gas line with vent to a safe location		
3. Connection of wrong gas to service?	1. Potential dangerous situation with gas fed to wrong source	3	1	3	1. All gas systems are installed with correct CGA unique connections		

Main System List: 25. Cylinder gases

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
					2. Gas cylinders are checked prior to installation to insure proper mixture		
4. Leaks on cylinder?	1. Potential of gas into lab space	2	3	6	1. For minor leaks, use cylinder containment cap		
					2. For major leak, use cylinder enclosure		
					3. For hazardous cylinders, use gas cabinets for enclosure and venting		
5. Receiving and storage of full and empty cylinders?	1. Mix up of cylinder on dock or in lab	1	2	2	1. Dock area will have cylinder receiving area for full and empty cylinders		
	2. Accident with cylinder not properly chained	2	2	4			

Main System List: 26. Emergency Power

Subsystem: 1. Diesel Generator

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Emissions limitations?	1. NOx emissions when operated	1	4	4	1. Insure compliance to air permits	1. Verify whether generators need to be on air permit	Bryan Hall
2. Equipment, instrument	1. Stocks of agents lost	1	1	1	1. Redundant generators	2. UPS backup for security system to	Nolan Watson

Main System List: 26. Emergency Power

Subsystem: 1. Diesel Generator

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
fails?	2. Security breached	4	2	8	2. Maintenance operation each month	keep system operational	
	3. Potential community impact	1	2	2	3. SOP to instruct staff to start them manually if not starting automatically		
	4. Dangerous situation from lost exhaust (BSC) for current work	3	2	6			
3. Maintenance requirements?	1. Poor maintenance may increase chances generator will not work				1. Planned maintenance, including ability to connect load bank		
4. UPS for critical areas to ride through	1. Power going to be out for 10 - 30 seconds				1. Localized UPS for equipment	3. Planned replacement for systems that are part of emergency power system	Bryan Hall
	2. Lab pressurization affected				2. Maintain the UPS systems		
	3. Building will go into alarm						
	4. Computer based processes will shut down						
	5. Some processes do not restart automatically						
5. Failure of second generator	1. Only feed critical loads up to 50% of building	1	2	2	1. Planned maintenance, including ability to connect load bank		
					2. Load shedding scheme		

Main System List: 26. Emergency Power

Subsystem: 2. Transfer switch/panel

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Abilitiy to maintain panel without shutdown							
2. Power failure?							

Main System List: 27. Building Power

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Loss of one power feed	1. No consequence due to three feeds	1	3	3	1. Use of three building feeds to reduce likelihood of failure		
2. Loss of two power feeds	1. Generators will operate. Will have some time between failure and generator start	1	2	2	1. Use of three building feeds to reduce likelihood of failure	7. Review the size of generators to optimize operation and transition back to normal power	Mike Connor
					2. May use generator in conjunction with generator	8. Review comments from Public Briefiing in July	Mike Connor
3. Loss of three power feeds	1. Generator is only source of power.	1	2	2	1. Generators sized to handle critical loads		
4. Local power failure within building	1. Loss of power to equipment such as cold room or BSC	2	3	6	1. Quality control of breakers		
					2. Dual power feeds to critical equipment		

Main System List: 27. Building Power

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
					3. FLIR scans at commissioning and routine scan during operation		

Main System List: 28. Drain system, contained

Subsystem: 1.

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Acid attack? Stress corrosion? Caustic embrittlement? Hydrogen blistering?	1. Leakage and/or piping failures for system				1. SOP to instruct that containment drains will carry only biological waste 2. Polypropylene piping resistant to acid and caustic attack		
2. Leakage/operator exposure during maintenance or normal use	1. Potential exposure to hazardous materials	4	1	4	1. SOP on purging and decontamination of drain pipe prior to maintenance 2. Drains are dual contained with leak detection 3. Drains are sloped to minimize standing water		

Main System List: 29. Chilled water

Subsystem: 1. Cooling tower

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Power failure							
2. Cooling medium failure							
3. Instrument air failure							
4. Winterization?							
5. Access for service personnel?							
6. Controller or instrument failures?							
7. Expansion cooling effects?							
8. Foaming?							
9. High, low level?							
10. Increased load on system?							
11. Loss of controls?							
12. Maintenance requirements?							
13. Natural disaster (specify)							
14. Operator fails to align correct lines, valves?							

Main System List: 29. Chilled water

Subsystem: 1. Cooling tower

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
15. Operator overrides automatic controls?							
16. Plugged strainer, filter?							
17. Power failure?							
18. Speed control failure?							
19. Undersized equipment?							

Main System List: 29. Chilled water

Subsystem: 2. Pumps

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Blocked discharge?							
2. Access for service personnel?							
3. Failure of seal?							

Main System List: 29. Chilled water

Subsystem: 3. Chillers

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
1. Power failure							
2. Cooling medium failure							
3. Instrument air failure							
4. Winterization?							
5. Access for service personnel?							
6. Controller or instrument failures?							
7. Expansion cooling effects?							
8. Foaming?							
9. High, low level?							
10. Increased load on system?							
11. Loss of controls?							
12. Maintenance requirements?							
13. Natural disaster (specify)							
14. Operator fails to align correct lines, valves?							

Main System List: 29. Chilled water

Subsystem: 3. Chillers

Hazards							
Hazards	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
		S	L	RR			
15. Operator overrides automatic controls?							
16. Plugged strainer, filter?							
17. Power failure?							
18. Speed control failure?							
19. Undersized equipment?							