APPENDIX A

RADIATION PROTECTION DESIGN CONSIDERATIONS AND FEATURES (GUIDANCE)

RECORD OF REVISIONS

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0	2/9/04	Initial issue.	William Eisele, *HSR-12*	Gurinder Grewal, *FWO-DO*
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Please Contact the Responsible Esm Poc And Committee
for upkeep and interpretation issues

Section F1030.2	Radiation Protection POC/Committee

APPENDIX A: Radiation Protection Design Considerations and Features (Guidance)

The design considerations and features provided in this Appendix will assist in ensuring the radiological design objectives and requirements of this ESM Chapter are met. These items listed in this Appendix are not inclusive and not every item applies for every radiological design. Radiological design features depend on the radiological operations, type of facility, and risk factors, so the design features provided in this Appendix are guidance and will vary from project to project. The qualified project radiological engineer will assist the project or design effort in determining the appropriate design features. Additional design items might need to be considered based on the design of a new or modified operation or facility.

The project lead is responsible to ensure appropriate radiological design features and documentation with the design recommendation provided by the Project Radiological Engineer and IHS Coordinator, depending on the level of radiological activities.

1.0 FUNCTION AND OPERATIONAL REQUIREMENT (F&OR) DOCUMENT

An F&OR document or similar document must be provided by LANL to describe the various activities, operations, tasks, equipment, space, materials, hazardous materials, type and quantity of radioactive materials, and support equipment and systems in sufficient detail to demonstrate compliance with mission needs.

2.0 SAFETY ANALYSIS

A. Review the safety analysis to ensure there are no conflicts between the safety analysis requirements, occupational radiation protection design features, and security requirements.

B. Ensure features specified in the safety analysis are incorporated in the radiological engineering control and design features.

C. Integrate radiological engineering control and design features with safety analysis requirements.

3.0 ALARA AND RADIOLOGICAL DESIGN PLAN

A. Develop an ALARA and Radiological Design Plan for the project.

B. Evaluate the potential radiation dose without engineering controls.[ISD 121-1, 10CFR835.1003 & DOE O420.1]

C. Evaluate design engineering controls as the primary method and administrative controls to manage radiation exposure.

D. Document the engineering controls incorporated into the design and the impact with respect to radiation dose reduction. Evaluation of engineering control with respect to dose reduction to help select the best control design, i.e., shield walls give “x” dose reduction, added robotics gain an additional “y” dose reduction, etc. [ISD 121-1 & 10CFR835.1003]

E. When engineering controls are impractical, document the justification for the use of administrative controls instead of engineering controls, and obtain approval from the LANL project design team, which includes the Project Radiological Engineer, and operating group management. [ISD 121-1 & 10CFR835.1001]

F. Evaluate the design to ensure the estimated occupational dose is ALARA.[ISD 121-1 & 10CFR835.1002]

G. Ensure the design occupational dose is below 1 rem per year, average 0.5 mrem per hour (continuous occupancy) or 20% of the applicable standard in 10 CFR835.202 in areas not continuously occupied.[ISD 121-1 & 10CFR835.1002]

H. Ensure the design, under normal conditions, avoids release of airborne radioactive materials to the work place atmosphere.[ISD 121-1 & 10CFR835.1002]

I. Ensure design controls, under any situation, maintain the inhalation of radioactive material by workers to the levels that are ALARA.[ISD 121-1 & 10CFR835.1002]

J. Design operations, structures and facilities with appropriate materials to facilitate operations, maintenance, decontamination, decommissioning, and waste management.[ISD 121-1 & 10CFR835.1002]

K. Design areas or facility to ensure the appropriate entry controls into radiological areas are incorporated into the design.[ISD 121-1 & 10CFR835.1002]

4.0 RADIOLOGICAL DESIGN SCOPE

Develop the radiological design scope for the project using the F&OR and interaction with appropriate LANL personnel. The scope should address engineering features and controls for the following items: [ISD 121-1 & 10CFR835.1002/1101]

A. Protection of workers from high radiation areas and very high radiation areas (if needed),

B. Protection of workers in radiation areas,

C. Protection of workers from airborne radioactive materials,

D. Criticality safety

E. Prevent or minimize the release of radioactive material into the work place and environment,

F. Prevent or minimize the spread of contamination and incorporate features for decontamination, and

G. Decontamination (if applicable) and decommissioning of facility or operation.

5.0 RADIOLOGICAL CONDITION

Establish the radiological condition(s) and source term, with respect to the specific radiological operational area. This will be provided in the project's F&OR, radiological design criteria, and usually developed by the radiological designer and Project Radiological Engineer. The following items should need to be addressed to estimate the radiation dose rate, shielding requirements, radioactive material inventories, and radioactive contamination levels for the operation or facility (both routine and off- normal conditions): [ISD 121-1 & 10CFR835.1002]

A. Type of radiation. (e.g., alpha, beta, photon, neutron, proton, deuteron, heavy ions, etc.)

B. How the radiation is produced. (radioactive material, neutron producing source, [alpha, n], [n,γ], [γ, n], spontaneous fission, accelerator, critical assembly, activation product, x-ray generating device, radiation producing device or other means)

C. Chemical form.

D. Physical form (solid, liquid or gas)

E. Quantity or source term in each form.

F. Radioactive material form – sealed source, type of sealed or unsealed source.

G. Potential of contamination or airborne release.

H. Type of containment (glove box, hood, or other)

I. Radiological activity/operation permanent, temporary, or transportable.

6.0 FACILITY/OPERATION LAYOUT

A. Design incorporates appropriate layout of radiological operations and movement of radioactive materials to keep radiation levels ALARA. [ISD 121-1 & 10CFR835.1002]

B. Design optimizes traffic flow in radiological and non-radiological occupied areas to minimize radiological exposure to personnel. [ISD 121-1 & 10CFR835.1002]

C. Design optimizes change room size, layout and flow pattern to ensure the elimination of co-mingling. [ISD 121-1 & 10CFR835.1002]

D. Design incorporates appropriate number and location of fixed radiation survey or monitoring equipment. [ISD 121-1 & 10CFR835.1003]

E. Design ensures adequate operational, maintenance, production, research and additional shielding space. [ISD 121-1 & 10CFR835.1002]

F. Design maintains personnel entry control for each radiological area, commensurate with existing or potential radiation hazards. [ISD 121-1]

G. Incorporate appropriate design feature and controls for each access point entrance to high and very high radiation areas. [ISD 121-1 & 10CFR835.502]

H. Design ensures equipment and controls are located for ease of accessibility and to minimize radiological exposure to personnel during normal operation, including inspection, removal or replacement of equipment, shutdown, maintenance, and postulated off-normal conditions. [ISD 121-1 & 10CFR835.1002]

I. Design ensures high occupancy areas or existing uncontrolled areas are adequately protected for new or increased radiation sources. [ISD 121-1 & 10CFR835.1002]

J. Design ensures control room and non-radiological work areas are located away from or properly shielded from the radiological areas. [ISD 121-1 & 10CFR835.1002]

K. Design ensures adequate space, features, and controls for managing waste during collection, storage, and transfer/transport.

L. Design ensures hallways, doorways, and labyrinths are wide enough to permit personnel in personnel protective clothing and equipment, and items safe movement.

M. Design incorporates specific engineering features and controls for reducing occupational radiation exposure (shielding, hoods, glove boxes, confinement/containment structures or containers, interlocks, barricades, decontamination features, and remote operations) [ISD 121-1 & 10CFR835.1002]

N. Design ensures there is appropriate distance between serviceable components and any substantial radiation sources in the area. [ISD 121-1 & 10CFR835.1002]

O. Design of the operation or facility incorporates the appropriate protection for radiation workers, adjacent radiation workers, non-radiation workers, public and environment from hazards associated with the use of radioactive material or radiation producing devices during normal operation, and anticipated operational occurrences. Consider co-located or adjacent non-radiological hazards that could change radiological conditions under off-normal conditions. [ISD 121-1 & 10CFR835.1002]

P. Design eliminates confined space zones that require maintenance or operational activities unless determined essential.

Q. Design incorporates appropriate features to protect government property.

R. Consider the use of visual alarms to alert personnel to off normal conditions, i.e., red light above room actuated via CAM or other radiological alarms or by manual setting.

S. In facilities with potentially removable radioactive material, include appropriate design features to drain and store fire protection sprinkler water as potentially radioactive liquid waste for contamination control.

7.0 INSTALLATION OR SETUP CONSIDERATION IN AN ACTIVE RADIOLOGICAL AREA

A. Design systems or components to permit rapid installation or setup to minimize radioactive dose during installation in an existing radiological area or adjacent area. [ISD 121-1 & 10CFR835.1002]

B. Design rigging or cranes as permanent systems in the facility to provide ease of installation, where appropriate. [ISD 121-1 & 10CFR835.1002]

C. Perform modification or assembly of items in a non-radiological area prior to installation in radiological area, where appropriate. [ISD 121-1 & 10CFR835.1002]

8.0 MAINTENANCE AND OPERATIONS

A. Incorporate in the design permanent platforms, walkways, stairs, or ladders to permit safe access into or around radiological areas. Design platforms and work surfaces instead of ladders or other temporary structures, whenever possible. [ISD 121-1 & 10CFR835.1002]

B. Incorporate in the design adequate space to perform maintenance or service in a radiological area. [ISD 121-1 & 10CFR835.1002]

C. Design enables surveillance from outside high radiation areas, very high radiation areas or high hazard radiological areas through the use of camera monitors, viewing ports or remote instrumentation. [ISD 121-1 & 10CFR835.1002]

D. Design rigging or cranes as permanent systems in the facility to provide ease of operations, maintenance, or decommissioning, where appropriate. [ISD 121-1 & 10CFR835.1002]

E. Design components for use in radiological areas for ease of operations, maintenance and decontamination. [ISD 121-1 & 10CFR835.1002]

F. Design and select components for use in a radiological area with consideration for long service life, ease of removal, and low frequency of maintenance. [ISD 121-1 & 10CFR835.1002]

G. Incorporate in the design easy access, adequate workspace, adequate lay down areas and adequate lighting to serviceable components in lower radiation level areas. Design a designated equipment staging, filter bagging, and temporary waste storage areas for HEPA filter replacement, and maintenance operations depending on type and size of filtration systems. ISD 121-1 & 10CFR835.1002

H. Incorporate in the design systems that prevents personnel from inadvertently entering radiation areas, high radiation areas or high hazard radiological areas. ISD 121-1 & 10CFR835.1002

I. Provides operators with adequate shielding or distance from the radiological operation. ISD 121-1 & 10CFR835.1002

J. Design equipment to function in a radiological environment under normal and off-normal conditions. ISD 121-1 & 10CFR835.1002

K. Design remote handling, robotics, and automation into facility or operation, where appropriate. ISD 121-1 & 10CFR835.1002

L. Design systems or shielded transport carts for movement of radioactive material throughout the facility to minimize dose, where appropriate. ISD 121-1 & 10CFR835.1002

M. Design adequate space for the placement of permanent or temporary shielding to reduce radiation levels. If temporary shielding is considered, consider the need for storage area for temporary shielding. ISD 121-1 & 10CFR835.1002

N. Design systems, equipment or areas to provide proper access to perform technical surveillance requirement activities. ISD 121-1 & 10CFR835.1002

O. Design to eliminate or minimize routine maintenance in radiological areas to the extent practical through use of utility corridors and/or interstitial spaces.

P. Design maintenance access doors into plenums and chases so there is adequate space for the wearing of PPE and supplied air on personnel carrying tools and items like 2ft x 2ft x1ft filters.

Q. Design remote replacement of filter plenum components that require routine maintenance (i.e., lighting) so personnel do not have to enter the filter plenum to replace lighting or damaged fixtures, as appropriate.

9.0 SHIELDING AND DOSE RATE DETERMINATIONS

A. Design shielding, layout, and determine radiation dose rates with radiation source terms that are representative of the radiological condition.

B. Design utilizes an analysis or radiation transport code with appropriate assumption and operational/radiological criteria to ensure design incorporates the appropriate level of conservatism. NOTE: The level of conservatism usually depends on the degree of assumptions and the type of transport code or calculation.

C. Design radiological operations with appropriate shielding or separation distance. ISD 121-1 & 10CFR835.1002

D. Consider material flow and time of motion studies to determine source-worker geometry and stay times for routine operations and maintenance, where appropriate.

E. Select resuspension factors that are based on the physical and chemical forms of radioactive material during routine operations and maintenance.

F. Radiological analysis utilizes the appropriate material composition and fluence-to-dose conversion factors to determine shielding or dose rate values. The following are examples of appropriate information, materials and fluence-to-dose conversion factors at Los Alamos National Laboratory:

1. Altitude and air density constants per ESM Chapter 1 Section Z10.
2. Concrete composition from concrete companies providing material for project to include non-evaporated water content when dealing with neutron shielding or dose determinations ISD 121-1
3. Composition and density of compacted and non-compacted tuff (type of earth at Los Alamos National Laboratory) ISD 121-1
4. Appropriate fluence-to-dose conversion factors, and
5. Others specified by the project or design.

G. Minimize the number of penetrations through shield structures or properly design penetration to minimize radiation streaming. Design penetration with proper shielding or configuration. ISD 121-1 & 10CFR835.1002

H. Ensure uniform shielding across the structure when different materials are used. The different material might be due to a door, viewing window, penetration, etc. Viewing windows and doors should be properly shielded, so they are equivalent to adjacent shielding structures. ISD 121-1 & 10CFR835.1002

Note: Design glove box window shielding glass so it is attached to the outside of the glove box structure for easy replacement and will not interfere with the integrity of the glove box containment window.

I. Consider the design of shielding as permanent or temporary. Temporary shielding requires administrative controls and configuration control. ISD 121-1 & 10CFR835.1002

J. Consider the design of radiation shielding type and location with respect to ergonomic issues and time to perform tasks or operations. ISD 121-1 & 10CFR835.1002

K. Design adequate space to install temporary shielding if required for higher radiation levels – such as a possible change in design criteria and mission. DOE O420.1, ISD 121-1 & 10CFR835.1002

L. Design hot cells, shielded rooms, shielded storage rooms, shielded vaults, and other structures with appropriate room size, usability, shielding, storage location for radioactive sources and other features, when appropriate. ISD 121-1 & 10CFR835.1002

M. Ensure shielding design is integrated with facility structure with respect to floor loading, seismic loading and other structural design considerations.

N. Shielding and dose rate calculations document the assumptions, documented source term, material composition and densities, fluence-to-dose conversion factors, methodology, model, and other appropriate information. ISD 121-1 (Chapter 20) & 10CFR835(Subpart H)

O. Areas Occupied by Non-Radiological Workers (General Employee) - The design objective should be to maintain the average exposure level ALARA and below 0.1 rem (100 millirem) per year, unless otherwise stated by LANL Project Management Team or Project Design Criteria. ISD 121-1

10.0 CONTAMINATION CONTROL

A. Change Room. ISD 121-1 & 10CFR835.1002

1. Determine whether change room is required.
2. Design appropriate size and location for the male and female uncontrolled and controlled sides of change rooms.
3. Optimize personnel flow pattern to inhibit co-mingling.

B. Design floor-wall interface with rounded surface. Design curbs or containment devices to control the spread and accumulation of contaminants. ISD 121-1 & 10CFR835.1002

C. Design appropriate removal of contaminants by floor drains, vacuum system, etc. ISD 121-1 & 10CFR835.1002

D. Design sufficient space to decontaminate items that have a potential of becoming contaminated, i.e., flow drains, pumps, or vacuum.

E. Design appropriate features for personnel, equipment and waste generation, as appropriate.

F. Design floors or surfaces with proper slope to drains. ISD 121-1 & 10CFR835.1002

G. Choose surfaces that can easily be decontaminated via the use of appropriate materials, coatings, or finishes for walls, floors, equipment, items, counter tops, etc. ISD 121-1 & 10CFR835.1002

H. Minimize the spread and ease of decontamination by using appropriate sealing of penetration, seams, curved corners and gaps in walls, floors, ceilings, equipment and structures where potential contamination might exist. ISD 121-1 & 10CFR835.1002

I. Minimize crevices, holes, notches, recesses, socket-head cap screws, and knurled finishes. ISD 121-1 & 10CFR835.1002

J. Minimize the number of wall floor and ceiling penetrations and properly seal penetration where spread of surface or airborne contamination is a concern. ISD 121-1 & 10CFR835.1002

K. Design light fixtures and other items so the fixtures or items are enclosed to decrease chance of collecting contamination. ISD 121-1 & 10CFR835.1002

L. Design proper ventilation (filtration, room airflow patterns, and air exchanges) to control airborne radioactive material and inhalation by workers for normal and off-normal operations. ISD 121-1 & 10CFR835.1002

M. Design ventilation systems so adjacent rooms or areas do not affect each other. ISD 121-1/ Chapter 14 & 10CFR835.1002

N. Design filtration for ventilation system to meet radiological and safety bases. ISD 121-1/ Chapter 14 & 10CFR835.1002

O. Radioactive Liquid Waste ISD 121-1 & 10CFR835.1002

1. Design radioactive liquid drain lines with appropriate slope for length of pipe run, no collection areas and minimal bends and back-flow devices. ISD 121-1 & 10CFR835.1002
2. Depending on radiological operations, incorporate appropriate systems incorporate continuous monitoring and recording of radioactivity, flow, volume, pH, and other parameters required for material control and proper waste treatment operations.

3. Radiation monitors have a local alarm as well as in a control center alarm where corrective action can be initiated, unless otherwise directed. ISD 121-1 & 10CFR835.501
4. Design and construct waste storage or holding tanks and transfer lines are so that leakage is detected and contained before it reaches the environment. ISD 121-1 & 10CFR835.1001
5. Ensure design double-walled transfer pipelines or multi-pipe encasements are used when penetrating walls, external to the building, and where deemed necessary for the control of contamination spread. ISD 121-1 & 10CFR835.1102
6. Review nuclear criticality issues for liquid radioactive waste system, when appropriate. . ISD 121-1
7. Design eliminates potential cross-connection of radioactive drains with non-radioactive or sanitary drains that might be an unmonitored release pathway. ISD 121-1 & 10CFR835.1002

P. Design considers waste management systems to minimize distance from point of generation to storage and shipping areas, eliminate potential for cross-contamination, and prevent generation of mixed waste.

Q. Decontamination room (when required)

1. Determine appropriate location and size with respect to type of radiological work being performed. ISD 121-1 & 10CFR835.1002
2. Determine appropriate decontamination systems, showers and drains connected to the radioactive liquid waste line.

11.0 ACCESS CONTROL

A. The access controls for radiological areas are physical controls to prevent inadvertent or unauthorized access to High and Very High Radiation Areas, and certain accelerators and radiation-producing devices or facilities. The levels of access control depend on the potential hazard. Access control systems design consist of a series of physical and administrative features that when combined form a defense-in-depth system designed to tightly control access to radiological areas. Refer to the access control requirements in ISD 121-1, Radiation Protection.

12.0 LIQUID SYSTEMS (TANKS, PUMPS, SUMPS, AND SLURRY SYSTEMS)

A. Locate pumps and other liquid handling systems apart from the storage or holding tanks to reduce radiation exposure during maintenance. ISD 121-1 & 10CFR835.1002

B. Design sampling ports apart from the storage or holding tanks to reduce radiation exposure. ISD 121-1 & 10CFR835.1002

C. Provide adequate space to provide service on pumps or take samples. ISD 121-1 & 10CFR835.1002

D. Design containment (i.e., drip pan or catch basin) under the pumps and sample ports to contain potential spread of contamination. ISD 121-1 & 10CFR835.1002

E. Provide a drain in the pump casing when appropriate. ISD 121-1 & 10CFR835.1002

F. Cover pump seals to prevent contaminated liquids from being ejected from the pump. ISD 121-1 & 10CFR835.1001

G. Design or install dependable pumps to minimize the frequency of maintenance. Pumps requiring frequent maintenance should be equipped with flanged connections for easy removal when in a radiation, high radiation area or other high hazard radiological areas. ISD 121-1 & 10CFR835.1001

H. Design tanks, sumps, pumps, valves, pipes, traps and other items with mechanisms for flushing and decontamination and to ensure waste fluids are not held up long after operation. ISD 121-1 & 10CFR835.1001

I. Design tanks with an agitator or mixer mechanism for homogenous sampling and to minimize localized radioactive material buildup. ***NOTE***: Closely design agitator or mixer mechanisms with LANL's SB-CS Safety BasisCriticality Safety Group, when appropriate. ISD 121-1, 10CFR835.1002, ISD 121-1

J. Design sampling ports in as low as possible radiation area apart from the tanks. Ensure sampling ports have drip pans where needed. ISD 121-1 & 10CFR835.1002

K. Design the location of valves away from radiological operations, tanks, filters, demineralizers, etc., where appropriate and depending on radiation levels. ISD 121-1 & 10CFR835.1002

L. Design valve stems upright, unless otherwise stated and justified. ISD 121-1 & 10CFR835.1002

M. Design tank vents or relief pipes so they are directed to an appropriate drain. Ensure system vents are not pressurized, under normal and off-normal situations, to create a condition that could spread contamination. ISD 121-1 & 10CFR835.1002

N. Design or install valves for radiological use to minimize cavities and crevices for radiological use. ISD 121-1 & 10CFR835.1002

O. Design valves for installation or removal without cutting or welding, unless justified. ISD 121-1 & 10CFR835.1002

P. Design valves requiring frequent use in a radiation or high radiation area to be operated remotely, unless justified. ISD 121-1 & 10CFR835.1002

Q. Design unique radioactive liquid waste double walled pipes when penetrating through walls, outside building structures and underground. ISD 121-1 & 10CFR835.1002

R. Design components in a radiological area to facilitate draining, flushing and cleaning by chemical or mechanical methods. ISD 121-1 & 10CFR835.1002

S. Design appropriate shielding or other radiation exposure reduction techniques around tanks, pumps, filtration systems or sumps. ISD 121-1 & 10CFR835.1002

T. If a holding tank is designed, provide a drainage system beneath radiological tanks and ensure it is connected to the radioactive waste liquid system or a holding tank. (NOTE: Justify use of holding tank versus the direct connection to the radioactive waste liquid line.) Ensure the floor is properly sloped towards the drain. ISD 121-1 & 10CFR835.1002

U. Provide criticality monitors for tanks and filters, where appropriate. Contact LANL's SB-CS Safety Basis Criticality Safety Group for assistance in design. ISD 121-1

V. Evaluate the amount of nickel, manganese and cobalt in the design of tanks and other metal items, when neutron sources and potential (α,n) reactions are involved as they present activation issues. ISD 121-1 & 10CFR835.1002

W. Design large bends, avoid sharp bends in slurry system piping (minimum of five times the diameter or greater should be considered). ISD 121-1 & 10CFR835.1002

X. Design slurry systems with check valves or strainers at the interface with liquid systems, when appropriate. ISD 121-1 & 10CFR835.1002

Y. Design back-flush connections and/or other approved systems or structures, when appropriate. ISD 121-1 & 10CFR835.1002

Z. Design spent resin or slurry piping with full-ported valves and without screwed connections or orifices, unless justified. ISD 121-1 & 10CFR835.1002

AA. Design spent resin or slurry piping with a downward slope and design to maintain turbulent flow, unless justified. ISD 121-1 & 10CFR835.1002 xx

BB. Design slurry systems with minimal pipe connections and fittings. ISD 121-1 & 10CFR835.1002

CC. Design resin and slurry piping tees to ensure flow through the straight portions and the branch line is located above the run. ISD 121-1 & 10CFR835.1002

13.0 PIPING

A. Design lengths of pipe containing radioactive materials without traps, dead legs, low points or stagnant areas, unless justified. ISD 121-1 & 10CFR835.1002

B. Design section lengths of pipes with adequate draining ports, if needed. ISD 121-1 & 10CFR835.1002

C. Ensure rooms connected to a common drain line are kept at sufficiently negative pressure with respect to rooms.

D. Design pipes containing radioactive materials with appropriate slope, and minimize length and horizontal runs. ISD 121-1 & 10CFR835.1002

E. Segregate the piping system for radioactive and non-radioactive materials, when possible (e.g., not co-located in same pipe chase). This will reduce the radiation exposure during maintenance and repair of the pipes. ISD 121-1 & 10CFR835.1002

F. Design drip pans for low point pipe connections or other potential leaking pipe locations, where appropriate. ISD 121-1 & 10CFR835.1002

G. Minimize overhead pipes containing radioactive materials, unless justified. If overhead piping is installed, design a drip shield for overhead piping, or double walled piping, or other engineering features, as appropriate. ISD 121-1 & 10CFR835.1002

H. Incorporate drains at unavoidable low points or dead legs in the design to flush out radioactive residues. ISD 121-1 & 10CFR835.1002

I. Ensure liquid and solid waste from a radiologically controlled area have appropriate disposal. ISD 121-1 & 10CFR835.1002

J. Design pipes containing alpha-emitting radioactive materials without teflon washers, compression fittings, teflon seals, or other material susceptible to radiation damage. ISD 121-1 & 10CFR835.1002

14.0 INSTRUMENTATION

A. Provide specialty gases required for instrumentation (i.e., P-10 gas for PCMs) should be provided via a house gas system or ganged gas bottles as to prevent the loss of gas pressure, when changing gas bottles.

B. Provide for an in-place calibration of fixed instrumentation, when possible and practical.

C. Locate an instrument repair shop within the controlled area, where appropriate and practical, to minimize the movement of potentially contaminated instruments outside of the controlled area or facility.

D. Based on Safety Analysis or operational needs, design appropriate redundancy in instrumentation.

E. Locate instrument readouts in the lowest radiation level area or low hazard radiological areas, unless justified. [ISD 121-1 & 10CFR835.1002]

F. Design instrument taps or connections above the piping mid-plane, unless justified. [ISD 121-1 & 10CFR835.1002]

G. Functionally group the location of instruments, readout and controls are grouped functionally to minimize time spent in a radiological area. [ISD 121-1 & 10CFR835.1002]

H. Provide uninterrupted power supply (UPS) for appropriate radiological and non-radiological instruments and monitors. [ISD 121-1 & 10CFR835.1002]

I. Design instrumentation with flushing capability to reduce accumulation of deposits, where appropriate. [ISD 121-1 & 10CFR835.1002]

J. Design radiation monitoring as fixed systems, whenever possible. [ISD 121-1 & 10CFR835.1002]

K. Design into the facility the appropriate number of and location for the fixed air samplers (FAS) and continuous air monitors (CAM). [ISD 121-1 & 10CFR835.1002]

   NOTE: Depending on the room design, recommend the placement of a CAM every 200 ft^2 and FAS every 150 ft^2 at a minimum. Certain operations might need a CAM and FAS located directly at the work area or station, depending on operation and risk. [Based on LANL Experience]

L. Design appropriate radiation instrumentation or system with interlocks and other access control systems, where appropriate or required. [ISD 121-1 & 10CFR835.1002]

M. Design instrumentation to minimize contamination of the system and provide ease of decontamination. [ISD 121-1 & 10CFR835.1002]

N. Select instruments for long service life and low maintenance requirements, especially in radiological areas. [ISD 121-1 & 10CFR835.1002]

O. Design remote calibration into instrumentation that permits this capability, especially for instrumentation in a radiation, high radiation or high hazard radiological areas. [ISD 121-1 & 10CFR835.1002]

P. Ensure the proper radiation instruments are selected for the type and intensity of radiation. Ensure sufficient redundancy and capability (e.g., range, rugged construction, and will not fail in high radiation fields, etc.) for normal operation and emergency conditions. [ISD 121-1 & 10CFR835.1002]

15.0 VENTILATION

A. Evaluate the radiological activities and determine and verify ventilation requirements. ISD 121-1 & 10CFR835.1002

B. Include a magnahelic gauge at HEPA filtration assembly central location or facility monitoring location so proper function of the filter can be evaluated such as material loading or leaks in gaskets to damaged HEPA filters, where appropriate.

C. Ensure radioactive waste generated by exhaust ventilation systems during operation and maintenance activities (such as filters) are included in the overall waste management strategy.

D. Ensure the flow of air is from the lesser to the potentially greater airborne contamination area. ISD 121-1 & 10CFR835.1002

E. Ensure appropriate pressure gradients between a specific area and adjacent areas. Evaluate impact of pressure gradient changes with adjacent areas to design appropriate ventilation system, proper location of air monitoring instruments, etc. ISD 121-1 & 10CFR835.1002

F. Determine the filtration requirements (type of filter, and the number of stages) for the ventilation system and workplace area, which is usually directed by safety basis requirements. ISD 121-1 & 10CFR835.1002

G. Include an interlock system between the supply and exhaust air to ensure that when the exhaust shuts down the supply shuts down. This will prevent the over-pressurization of certain areas and the potential of spreading contamination from airborne radioactive materials. ISD 121-1 & 10CFR835.1002

H. Design the ventilation system with an exhaust gate after the filter plenum to prevent back draft from outside wind into the plenum and through the facility during filter replacement work, where appropriate.

I. Provide an appropriate amount of shielding for filter banks or separate filter banks from each other to permit working on one with the other filter bank operational. Ensure there is an appropriate amount of space to perform testing and balancing, maintenance, and filter change out. ISD 121-1 & 10CFR835.1002

J. Design ventilation systems (ducts and plenums) to minimize radioactive material buildup, excluding filters. ISD 121-1 & 10CFR835.1002

K. Include appropriate ports and openings to decontaminate ductwork. ISD 121-1 & 10CFR835.1002

L. Design confinement and ventilation systems adequately for the required level of protection from airborne contamination with respect to air flow patterns, location of air supply, penetrations, exhaust, and other relative items. ISD 121-1 & 10CFR835.1002

M. Design confinement and ventilation system so as not to release radioactive materials to the workplace atmosphere including the change room, where appropriate. ISD 121-1 & 10CFR835.1002

N. Segregate room air flow and volumes from the uncontrolled and controlled areas, including the change room, where appropriate. ISD 121-1 & 10CFR835.1002

O. Do not pass supply air ducts through radiological areas and exhaust air from a controlled area through an uncontrolled area, unless approved by LANL's IHS-IP Ventilation SMEs and RP-3 Radiological Engineering Team. ISD 121-1 & 10CFR835.1002

P. Ensure that supply air ducts are under sufficient positive pressure with respect to adjacent areas, if the air ducts passes through a potentially radioactive airborne area. ISD 121-1 & 10CFR835.1002

Q. Design systems to ensure that the exhaust air duct is under negative pressure until air ducts reaches environmental release ports or exhaust fans. ISD 121-1 & 10CFR835.1002

R. Design systems to ensure that process fittings, valves and equipment for tritium processes are installed inside a ventilated hood or glove box, where appropriate. ISD 121-1 & 10CFR835.1002

S. Design ventilation system to reduce moisture/humidity prior to HEPA filters. ISD 121-1 & 10CFR835.1002

T. Design ventilation sampling and monitoring per ANSI N13.1, "Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities." Incorporate single-point representative sampling with shrouded probe into the design as specified by LANL ENV- Meteorology and Air Quality Group. LIR404-10-01

U. Design minimal number of bends and minimal length of tubing in the radioactive air sampling or monitoring system. Include non-reactive materials in the design for ductwork and monitoring systems. ISD 121-1, LIR404-10-01 & 10CFR835.1002

V. Ensure the exhaust stack from facility and adjacent facilities is located away from the supply air building intake system. ISD 121-1 & 10CFR835.1002

W. Evaluate the location of the facility's supply air intake with respect to facility and surrounding facility exhausts.

16.0 FILTERS AND DEMINERALIZERS

A. Route vents and relief valves to a radioactive liquid waste line drain. ISD 121-1 & 10CFR835.1002

B. Evaluate the potential of filters and demineralizers becoming radiation sources and shield appropriately. ISD 121-1 & 10CFR835.1002

C. Ensure that filters are designed to minimize servicing frequency. ISD 121-1 & 10CFR835.1002

D. Ensure that filter plenum containment is designed to allow efficient removal of filters. ISD 121-1 & 10CFR835.1002

E. Ensure that filter containment is located in low occupancy and low traffic areas, and in a location away from high hazards and radiological areas, whenever possible. ISD 121-1 & 10CFR835.1002

F. Include an appropriate amount of space to remove filters, especially if filters require shielding or remote handling is required. ISD 121-1 & 10CFR835.1002

G. Design filtration systems with smaller filter sizes for ease of handling during replacement or provide a mechanical system to move larger filters, where appropriate.

H. Provide appropriate level of filtration (roughing, HEPAs or both) for the inlet air system. ISD 121-1 & 10CFR835.1002

I. Evaluate the need for roughing filters prior to HEPAs in the exhaust ventilation system and incorporate in design, if justified. ISD 121-1 & 10CFR835.1002

J. Evaluate criticality issues with the filtration system. Contact LANL's SB-CS Criticality Safety Group for assistance and guidance. [ISD 121-1]

17.0 SUPPLIED PERSONNEL BREATHING AIR

A. Provide engineering controls so breathing air is not required, but if engineering controls are impractical consider using a supplied breathing air system.

B. Design the connection to breathing air with a unique connector. [ISD 121-1 & 10CFR835.1001]

C. Include a back-up breathing air system, when appropriate. [ISD 121-1 & 10CFR835.1001]

D. Design a specific sounding alarm into the breathing air system, when appropriate and consistent with the facility or Laboratory. [ISD 121-1 & 10CFR835.1001]

E. Ensure appropriate supplied breathing air and systems are adequate and meet requirements. Contact IHS-IP for details related to breathing air and to ensure requirements have not changed.

18.0 IMPLEMENTATION OR MODIFICATION DESIGN CONSIDERATIONS:

Develop an installation plan to minimize radiation dose. Consider the following:

A. Will temporary shielding be a requirement?

B. Will additional or temporary ventilation be required?

C. Will temporary containment be required?

D. Will decontamination of items, systems, components and/or work area be required?

E. Will systems require flushing?

F. Will ~~a~~ separate tool sets be required in the radiologically controlled area and uncontrolled areas? If so, include an appropriate radiological tool crib area in the design.

G. Will there be any special installation or coordination required?

H. Will special design features be required due to an adjacent radiological activity?

I. Will special training be required for installers or operators (i.e., mock-up, classroom, etc.)?

J. Installation plan must incorporate safety personnel, lighting, temperature, humidity, and communication requirements.

19.0 WASTE MINIMIZATION

A. Design operations, processes and facilities to minimize waste generation with respect to filters, seals, consumables, etc. [ISD 121-1 & 10CFR835.1002]

B. Design operations, processes, and facilities to avoid generation of mixed waste and to minimize generation of radioactive waste.

C. Use bio-based fluids for hydraulic equipment and bio-based lubricants for mechanical equipment, where possible. Use oil-less vacuum pumps, where possible.

D. Avoid mercury containing devices and low-mercury lamps, where possible.

E. Incorporate "green" chemistry strategies through evaluation of non-hazardous material substitution alternatives, where possible.

F. Design operations, processes and facilities to segregate the non-radioactive waste stream from radioactive waste stream with appropriate space to accommodate waste containers. ISD 121-1 & 10CFR835.1002

G. Evaluate material selection to minimization of hazardous, radioactive, and mixed waste generation. Material selection considers environmental concerns, such as those that promote energy efficiency, resource conservation, and indoor air quality.

H. Due to the physical and financial burden of managing hazardous, radiological, and mixed waste at LANL, waste minimization and avoidance is evaluated and incorporated into the design, operations, maintenance, decontamination, and decommissioning of any facility, process, or activity involving radioactive material.

20.0 DOE STANDARDS

Consider the guidance in applicable DOE Standards including:

- DOE-STD-1098; Radiological Control
- DOE-STD-1128, Guide to Good Practices for Occupational Radiological Protection in Plutonium Facilities, Reaffirmation with Errata, May 2003
- DOE-HDBK-1129; DOE Handbook Tritium Handling and Safe Storage
- DOE-STD-1132, Design Considerations
- DOE-STD-1136, Guide of Good Practices for Occupational Radiological Protection in Uranium Facilities
- DOE-STD-1298-98; Guide to Good Practices for Occupational Radiological Protection in Plutonium Facilities (Reaffirmation with Errata May 2003), Reaffirmation with Errata; DOE Standard
- DOE-HDBK-3010-94; Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities, Volume 1
- DOE-HDBK-3010-94; Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities, Volume 2