Radiation Protection System installation for the Accelerator Production of Tritium / Low Energy Demonstration Accelerator Project (APT/LEDA).

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Abstract

The APT/LEDA personnel radiation protection system installation was accomplished using a flexible, modular proven system which satisfied regulatory orders, project design criteria, operational modes, and facility requirements. The goal of providing exclusion and safe access of personnel to areas where prompt radiation in the LEDA facility is produced was achieved with the installation of a DOE-approved Personnel Access Control System (PACS). To satisfy the facility configuration design, the PACS, a major component of the overall radiation safety system, conveniently provided five independent areas of personnel access control. Because of its flexibility and adaptability the Los-Alamos Neutron-Science-Center-(LANSCE)-designed Radiation Security System (RSS) was efficiently configured to provide the desired operational modes and satisfy the APT/LEDA project design criteria. The Backbone Beam Enable (BBE) system based on the LANSCE RSS provided the accelerator beam control functions with redundant, hardwired, tamper-resistant hardware. The installation was accomplished using modular components.

RADIATION PROTECTION SYSTEM

Los Alamos National Laboratory's MPF-365 at TA-53 is a four-story building attached to a 470-foot-long underground tunnel. See Figure 1. In 1997 the Accelerator Production Of Tritium (APT) Low Energy Demonstration Accelerator (LEDA) project started installation work in MPF-365. The LEDA project accelerator consists of five major components:

1. The Injector Support Platform, which is movable with a detachable Ion Source Injector (LEBT).
2. The Radio Frequency Quadrapole (RFQ) section.
3. High Energy Beam transport (HEBT).
4. Water Shielded Beam Stop Vessel.
5. Detachable/Movable pump cart which supplies high pressure water to the beam stop.

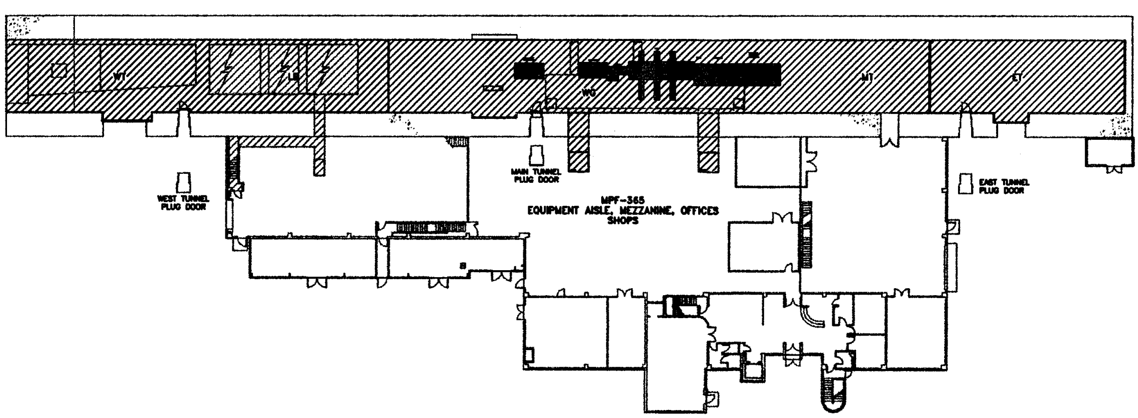

Figure 1 Layout of MPF-365 building

The LEDA accelerator is located over RF tunnels through which the waveguides travel to the RFQ. The foot print of the LEDA accelerator uses only about one-fourth of the accelerator tunnel's available floor area. The accelerator tunnel was divided into three major areas for Personnel Access Control Systems (PACS) protection. The East Tunnel (ET) is separated from the main tunnel (MT) section, where the accelerator is located by a sliding gate and chain link fence. The West Tunnel (WT) is separated from the Main Tunnel (MT) section by a second gate and chain link fence. The Wave Guide Basement (W/G), the fourth PACS area, has two shafts and tunnels from the equipment aisle to a room below the main tunnel. There are two hatches located between the main tunnel and waveguide lower room. The fifth PACS area is an old laser basement (LB) which is accessed from the equipment aisle with stairs and tunnels. It is located below the west tunnel section. There is a shield door in the LB access tunnel hallway. The east and west tunnel areas have roll-up door, and plug-shield-door access to the outside of the facility. The main tunnel has two shield doors and a plug-shield door for access to the equipment aisle.

There are three run permit modes of beam transport operation.

1. Injector Stand roll-back Transport. (ISRB)
2. Low Energy Beam Transport. (LEBT)
3. High Energy Beam Transport. (HEBT)

Run Permit mode	Beam Operations	Prompt Radiation Hazard[1]	Minimum Requirements	
			With HPRF to RFQ	Without HPRF to RFQ
Injector Rolled Back	The injector is physically disconnected from the RFQ. The 75 keV beam may be delivered up through the end of the injector transport.	No	Main Tunnel and Waveguide Basement PACS secured for HPRF operation. No access to accelerator. BBE is made up through Injector Rolled back limit switches.	Beam tunnel may be open. BBE is made up through Injector Rolled back limit switches.
Low Energy Beam Transport (LEBT)	The injector and RFQ are physically connected. The 75 keV beam can only be delivered to the plunging beam stop (PBS) located in the injector transport.	No	Main Tunnel and Waveguide Basement PACS secured. No access to accelerator. BBE made up through PBS in-limit switches.	Beam tunnel may be open. BBE made up through PBS in-limit switches.
High Energy Beam Transport (HEBT)	The injector and RFQ are physically connected. The RFQ is in operation and produces nominal 6.7 MeV beam for delivery to the high power beam stop located at the end of the HEBT. In this mode, the PBS may be inserted during beam operation.	Yes	All PACS are secured, door limit switches indicate closed and SRI water level indicates okay which collectively makes up BBE. No access to accelerator.	Not applicable *because HPRF required for this mode of operation.*

TABLE 1. Description of various LEDA Run Permit Modes.

Two hardware devices were selected by LEDA to ensure protection of personnel from prompt radiation. The two devices are the Injector Plunging Beam Stop (PBS) located at the output of the injector stand and High Voltage Interlock controls for the generation of High Power Radio Frequency (HPRF) energy.

The five areas of PACS system installations were reviewed for entry and exit requirements. Conduit plants were designed and drawn by LEDA personnel with collaboration and guidance from Protective System Team members. Sweep patterns and PACS warning sign placement was a collaborative effort with standards for distance and height supplied by Protection System and the LEDA Safety Team.

Installation of the five areas of Personnel access Control Systems (PACS) began in the summer of 1998. During this installation phase, the operational requirements for a Back Bone Enable System (BBE) were generated and the design of the logic configuration was started. The control for the Injector Plunging Beam Stop (PBS) was assigned to the “B” Backbone of the system. The High Power Radio Frequency (HPFQ) control was assigned to the “A” Backbone of the Backbone Enable system. Fabrication of the BBE equipment started in the fall of 1998.

The different types of access doors and hatches and their locations within the five PACS areas required several solutions. Roll-up doors were implemented with dual door-switch assemblies feeding a single door-monitor assembly. The specially designed door-switch assemblies are located at the bottom on the track for the door curtain. The hatches located between the Main Tunnel (MT) and Wave Guide Tunnel (WG) required dual standard switches mounted on a Wire-way duct located within the Wave Guide (WG) Basement area. Two switches from this switch assembly feed a door monitor for the Main Tunnel (MT) and two switches feed a door monitor for the Wave Guide Tunnel (WG).

A fence and gate were fabricated to control access to the Main Tunnel (MT). The Main Tunnel requirement of fork lift access during open periods required two gates with closed indication for each gate. The right gate was made the primary PACS gate with exit bypass during sweep procedures. The left gate is to be used only during open use periods and is bolted to the floor during beam delivery operations.

The Backbone Enable (BBE) system was designed using criteria from LEDA Operations Team. See Table 1 showing operation modes of LEDA. The off-the-shelf concept with customized logic allowed installation within a 3-month period. There were several hardware adaptations which allowed unusual requirements to be met.

1. Injector stand dual-switch assemblies for the roll-back position using armored cable plant.
2. The PBS became a dual use beam plug, with operational beam controls as well as personnel safety with BBE inputs from dual switches.
3. A mini-dual Protective System Backbone for HPRF control, which uses relay-to-fiber-optic transition for klystrons interlock inputs.
4. The adapting of the water shield design for beam stop water levels indications to dual BBE inputs. Two different levels were used.
5. Adapting double shield doors at the main tunnel entrance and the three radiation shield plug doors to dual BBE inputs.

The goal of initial operation and testing of the APT/LEDA accelerator under a proven safety envelope was achieved in part with the successful installation of the PACS and BBE Systems. Timely installation of five PACS areas and two BBE systems allowed LEDA operations to rapidly achieve readiness and the efforts resulted to four milliamps of beam on Tuesday the 16th of March 1999 at 6:00 PM.

REFERENCES

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