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Revision 0

CCP
Real-Time Radiography
LANL Unit #1

(Equipment #LANL-RTR-01)
Equipment Description

EFFECTIVE DATE: 03/26/2008

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RECORD OF REVISION

Revision Number	Date Approved	Description of Revision
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TABLE OF CONTENTS

LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AK	Acceptable Knowledge
ALARA	As Low As Reasonably Achievable
amp	ampere
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CCP	Central Characterization Project
CFR	Code of Federal Regulations
DOE	Department of Energy
HVAC	Heating, Ventilation, and Air Conditioning
Hz	hertz
kHz	kilohertz
kV	kilovolts
kVA	kilovolt amperes
kW	kilowatts
LED	Light Emitting Diode
m	meters
mA	milliamps
mm	millimeter
MCU	Mobile Characterization Unit
mrem/hr	millirem per hour
mR/hr	milliroetogen per hour
NDA	Nondestructive Assay
NDE	Nondestructive Examination
NFPA	National Fire Protection Association
PCB	Polychlorinated biphenyls
PLC	Programmable Logic Controller
PPM	parts per million
R/hr	Roentgens per hour
RGD	Radiation Generator Device
RTR	Real-Time Radiography
STD	Standard
SWB	Standard Waste Boxes
TRU	Transuranic
UL	Underwriter’s Laboratory
V	Volts

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

VAC	Volt Alternating Current
VOC	Volatile Organic Compound
WIPP	Waste Isolation Pilot Plant

SUMMARY

The Real-Time Radiography (RTR) LANL Unit 1 (Equipment #LANL-RTR-01) is a self-contained non-intrusive X-ray unit, physically housed in a mobile container 48 feet in length by 8 feet wide used to X-ray Transuranic (TRU) waste drums up to 85 gallons in volume and Standard Waste Boxes (SWBs). Radiography is a nondestructive qualitative and semi-quantitative technique that involves X-ray scanning of waste containers to identify and verify waste container contents. Radiography is used to examine the waste container to verify its physical form. This technique can detect prohibited items such as liquid wastes and containerized gases, which are prohibited for the Waste Isolation Pilot Plant (WIPP) disposal. Radiography examination must achieve the following:

- Verify and document the physical form of each waste container.
- Identify any prohibited waste in the waste container.
- Confirm that the physical form of the waste matches its waste stream description (i.e., homogeneous solids, soil/gravel, or debris waste [including uncategorized metals]).

The LANL-RTR-01 will provide a Nondestructive Examination (NDE) functionality that is designed to meet the requirements of CCP-PO-001, *CCP Transuranic Waste Characterization Quality Assurance Project Plan,* CCP-PO-002, *CCP TRU Waste Certification,* and CCP-PO-003, *CCP Transuranic Authorized Methods for Payload Control*.

This Equipment Description is not an authorization basis document. It is a piece of Central Characterization Project's (CCP) configuration management program and is intended to be used as technical information for the Host site's use when incorporating CCP's equipment into their safety basis. This Equipment Description is a central coordinating link among the engineering design documents, the facility authorization basis, and implementing procedures. This Equipment Description does not originate requirements or basis information, but rather collects that information into a convenient usable form. The Equipment Description consolidates information about the LANL-RTR-01 system into one document.

1.0 SYSTEM DESCRIPTION

The LANL-RTR-01 is used to X-ray TRU waste drums up to 85 gallons in volume and to determine their content attributes. The LANL-RTR-01 currently is not configured to load SWBs, but has the capability to examine SWBs. The RTR system is used to verify that the physical form matches the waste stream description and that the waste matrix code assigned to the waste container is consistent with Acceptable Knowledge (AK) of the waste. The system is also used to estimate waste material parameter weights and identify prohibited items in the waste container.

The LANL-RTR-01 system contains an X-ray tube. The radiographic images are produced utilizing a Radiation Generator Device (RGD) with an operating range of 20 to 420 kilovolts (kV). The high energy X-rays penetrate the steel container into an image intensifier. A high-resolution camera then records the image from the intensifier onto digital media. Digital Imaging provides 100 percent imaging of the contents of the drums and provides a non-intrusive inspection of packages containing hazardous, nuclear, and mixed waste.

In order to keep personnel exposure levels As Low As Reasonably Achievable (ALARA), the radiography system has been designed and constructed in accordance with American Nuclear Standards Institute (ANSI) N43.3-193, Installations Using Non-Medical X-ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV, “exempt shielded installed” (Ref. 2). This class provides the highest degree of inherent safety because radiation protection does not depend on compliance with any operation limitations. The LANL-RTR-01 unit also has the advantage of not requiring restrictions outside the enclosure since the inherent shielding is sufficient to meet the maximum permissible dose equivalent requirements for non-controlled areas. At the operator’s console, and immediately around the exterior of the trailer, the measured radiation levels are normally less than one millirem per hour (mrem/hr). The radiation-generating device and the drum being inspected are enclosed in a lead-shield enclosure (vault). The doors to this enclosure are fitted with redundant interlock switches so that X-ray generation is not possible unless all doors are securely closed. The operator control station is fitted with closed-circuit television monitors that provide constant visual surveillance of the shielded enclosure and conveyor area. Audible and visual alarms are provided to warn personnel near impending and actual X-ray generation.

The LANL-RTR-01 layout is shown in Attachment 2, Typical LANL Real-Time Radiography #1 Layout. Access to the exterior loading conveyor and drum loading area is at the side of the LANL-RTR-01 trailer. There is one set of stairs required for personnel access to the control room located on the street side of the trailer. Drums are directly loaded onto the inside loading conveyor system. The conveyor system is inside the physical boundaries of the trailer (no outside conveyor used in the process). The personnel access stairway extends out from the side of the trailer.

Structures, systems, and components for the LANL-RTR-01 should be, at a minimum, classified as Balance-of-Plant to assure that proper design, operations, and maintenance requirements are assigned to provide for the health and safety of the

worker and the environment and to ensure compliance with the other Host site requirements. Notwithstanding, the LANL-RTR-01 system classification is Mission-Critical (Section 2.2, DOE Standard (STD) 3024-98, *Content of System Design Descriptions* [Ref. 3]).

1.1 Facility, Major Components, and Subsystems

1.1.1 Facility

The LANL-RTR-01 is housed in a base Commercial Trailer (Class Code 10, Sub Code 6, Semi-Trailer) that allows mobile movement of the equipment to remote locations. The LANL-RTR-01 compared to DOE standards is considered a Relocatable Structure (DOE-STD-1088-95, *Fire Protection for Relocatable Structures* [Ref. 4]). The RTR units are classified as Type V (000) structures per National Fire Protection Association (NFPA) 220, *Standard on Types of Building Construction* (Ref. 5). NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, Section 3-5 (Ref. 6), requires that buildings used to handle and store radioactive materials have either a fire-resistive or noncombustible construction (Type I or Type II in accordance with NFPA 220). NFPA 801, Section 3-8, requires the interior finish of these buildings to be limited combustible.

The exterior walls of the unit are steel, over a steel stud frame of a standard trailer truck. The Operator Control Room walls in LANL-RTR-01 are steel with steel studs. (Note: there is no insulation on the trailer walls, ceiling, or floor.) The Operator Control Room ceiling is composed of steel (shell of the trailer) with interior steel studs. A drop plastic lighting panel system is connected to the steel studs of the roof of the trailer. The Operator Control Room floor is vinyl tile over plywood sub-flooring, which is placed over the steel frame of the trailer structure. The vault consists of a lead-lined steel-framed vault, which is connected to the steel floor of the trailer (the vault is not part of the trailer structure walls, floor, or ceiling, but is positioned within the trailer). The floor is covered with steel plates over the structural frame of the trailer.

The trailer unit is partitioned into three sections as follows:

- The Control Room is located at the front end of the trailer and includes an Administrative Area.
- The LANL-RTR-01 X-ray vault enclosure is located in the middle area of the trailer.
- The Equipment Bay is located at the back end of the trailer.

1.1.1.1 Control Room

The Control Room is used to store office and access equipment.

The Control Room of the LANL-RTR-01 normally consists of the following:

- Operator console (audio/video setup)
- Main breaker panel
- Main electric panel
- Office desk

The Equipment Bay (rear storage) of the LANL-RTR-01 normally consists of the following:

- High voltage generator
- Air compressor
- Oil cooler

Access to the loading conveyor and container loading area is at the side of the LANL-RTR-01 trailer.

The mechanical boundary for the LANL-RTR-01 is the container loading and unloading conveyor. Once the container is placed on the conveyor of the LANL-RTR-01, it is considered part of the unit. Once the container has been removed from the conveyor of the LANL-RTR-01, it is no longer considered part of the unit.

The electrical boundary for the LANL-RTR-01 is the circuit breaker panel contained within the unit where the external power is attached to the system and control of individual circuits within the unit is provided by the panel.

The LANL-RTR-01 system is a stand-alone, self-contained system that requires electrical support from the Host site to operate.

1.1.2 Major Components

The LANL-RTR-01 is composed of the following major system components:

- X-ray vault enclosure
- X-ray equipment
- Conveyor system

1.1.2.1 X-ray Vault Enclosure

The shielded X-ray vault houses the X-ray machine, which consists of a shielded X-ray tube (lead tube head box) and a shielded image intensifier box.

The X-ray vault includes access doors with radiation safety interlocks, to prevent X-ray operation with the shielded door open. One door is manually closed by operators prior to starting the X-ray and one door is automatically closed from the Control Console. An Emergency Stop is also provided inside the X-ray vault, enabling personnel to deactivate the X-ray unit in the unlikely event that the door is closed and the unit is started while a person is inside the vault.

The doors are closed and X-ray generation is initiated as follows. The operating range is from 20 kV to 420 kV and power is produced by the oil-insulated high-tension generators, which are located in the equipment bay or rear storage area, and is supplied to the X-ray tube via a high-tension cable. X-rays are produced in the X-ray tube head and are passed through the rotating drum. The X-rays are focused on the image intensifier located in the lead-lined housing.

Vault Loading Door

The vault loading door is located at the middle side of the trailer. The vault door is pneumatic and is remotely operated from the Control Console in the control room. The vault door opens and allows a forklift to load containers onto the conveyor system. Personnel are restricted from entering the shielded vault or enclosure during operation of the system and meets the definition of “guarded by location” as specified in American Society of Mechanical Engineers (ASME) B20.1, *AMSE Boiler & Pressure Vessel Code, Safety Standards for Conveyors and related Equipment* (Ref. 9).

The X-ray enclosure incorporates dual safety switches on the vault loading doors, which are routinely opened by working personnel. The switch assembly is designed to meet the requirements of Code of Federal Regulations (CFR) Title 21 Part 1020.40, *Performance Standards for Ionizing Radiation Emitting Products, Subsection 1020-40, Cabinet X-ray Systems*, which requires such doors to have two interlocks, one of which must directly break the primary power circuit of the X-ray high voltage power supply (Ref. 8).

Upon door opening, a conventional snap-action switch interrupts X-ray by removing a signal from the X-ray generator in its logic circuitry. This interruption of X-ray is achieved gently, as if the operator had initiated the stop button. This is called the logic interlock. The logic interlock gives no protection against failure of the switch internal mechanism, welding of the switch contacts or malfunction of X-ray generator.

A separate heavy-duty switch breaks the primary power circuit of the X-ray high voltage power supply. This is called the primary interlock. Without primary power, the high voltage power supply cannot operate. No X-ray can be made while the door is open, regardless of any malfunction of the logic interlock switch or X-ray generator. The heavy-duty switch is designed as simply as possible, to minimize its risk of failure. A conductor is rigidly attached to the door by fixed hardware. When the door opens, the conductor is removed from the power circuit, preventing X-ray production. The interruption of X-rays by the primary interlock is less gentle, more like unplugging the

unit while it is running at full power, but this rarely happens except when a malfunction exists in the logic interlock circuit.

Vault Personnel Access Door

The vault personnel access door is located inside the Control Room for personnel access into the shielded X-ray vault and is manually operated. Three screws are removed prior to entry into the X-ray vault. Radiation safety interlocks are also provided on the access door to prevent X-ray operation with the door open.

1.1.2.1.1 Radiological Shield Design

The shielded vault forms a protective shell around all RGD X-ray operations to protect personnel from X-rays produced by the RGD. It is designed to meet the requirements of ANSI N43.3 for classification as an “exempt shielded installed” (Ref. 2). The X-ray vault room, housed in the middle of the trailer, is constructed using a steel framework that supports panels of metallic lead. Lead butt joints are covered to completely enclose the room, except for the ceiling. Two doors open into the shielded vault: the loading door and access door. These doors have shielding to match the wall in which they are installed and additionally have features, as appropriate, to reduce shine at door edges. Penetrations for cables are shielded by a louver box with shielding features similar to the door.

Because the RTR trailer is a mobile facility designed for transportation on public highways, several features differentiate this shielded vault from a conventional fixed facility.

- X-ray Collimation - The 60-degree cone angle of the X-ray tubehead is collimated by a 1 inch thick lead disc fixed to the tube window. The disc has an oval port. The larger aperture in the vertical plane allows for full illumination of the image intensifier with a vertical offset between the RGD focal spot and the image intensifier center.
- X-ray Shutters - An X-ray shutter assembly is provided to collimate the X-ray beam and consequently reduce X-ray beam scatter. The X-ray shutter assembly attaches to the exit port of the X-ray tubehead and its four shutter panels are independently operated from the Control Console in the control room. All shutters may be closed completely to protect the imaging system during X-ray warm-up. A 3 millimeter (mm) thick copper filter is fitted to the collimator. The primary beam passes through this filter, which reduces the lower energy X-rays by up to 20 percent.

1.1.2.2 X-ray Equipment

The LANL-RTR-01 system includes the X-ray machine and the equipment necessary to operate the machine. The X-ray machine consists of a shielded X-ray tube, located within the shielded X-ray vault enclosure, which operates in the range of 20 kV to 420 kV.

The X-ray Generator consists of the following:

- *Mains Input* 208 – 480 volts (V) ±15 percent, 50/60 hertz (Hz), single phase
- *Input Power* 10 kilowatts (kW) max
- *Output Power* 4.2 kW max
- *Tube Voltage* 20-420 kV
- *Tube Current* 10 milliamps (mA) at 420 kV
- *Focal Spots* 4.5 millimeters (mm) by 4.5 mm and 1.5 mm by 1.5 mm
- *Insulation* ceramic

The primary X-ray beam is oriented parallel to the trailer's long axis. The emerging conical X-ray beam is highly collimated by a vendor-supplied, specially shaped lead insert added to the X-ray window. The collimator is not removable without dismantling the X-ray enclosure shield box surrounding the tube. Routine X-ray cable service does not require disassembly of the shield.

The primary X-ray beam is limited to a maximum vertical travel in the center of the shielded enclosure of approximately 48 inches. The primary beam cannot impinge the ceiling or the floor of the enclosure. The front-to-rear beam width is limited to an included angle of approximately 12 degrees. The beam width can be further narrowed or closed by remotely operated shutters with 0.5 inch thick movable tungsten leaves/blades. The 12-degree collimator and the movable tungsten shutter assembly allow system operators to maximize image quality by reducing or minimizing non-image-forming scatter radiation. A 3 mm thick copper filter is fitted to the collimator. The primary beam passes through this filter, which reduces the lower energy X-rays by up to 20 percent.

The vertical travel of the X-ray primary beam centerline is restricted by the RGD X-ray manipulator limits. Using the trailer floor for reference, the primary beam centerline ranges from 24 to 72 inches above the trailer floor. The trailer floor is at an approximate elevation of 51 inches from the outside ground level. Therefore, the primary beam centerline ranges from 75 to 123 inches above ground level.

1.1.2.2.1 Radiation Generator Device X-ray Controls and Equipment Safety Circuits

The RGD X-ray controller is a Gulmay MP1 and is located to the left of the Control Console. The Gulmay X-ray system is a proven industrial X-ray unit. X-ray control and equipment safety features are described in the Gulmay MP1 Technical Manual.

Operating parameters may be entered manually by tactile control dials or a keypad. The controller is capable of storing and retrieving up to 999 separate exposure profiles. It features a Light Emitting Diode (LED) digital display of the operating parameters (i.e. kV, mA, and time). There is also an alphanumeric display to prompt for operator input from the keypad and provide status and fault decoding information. There are four indicator lights: MAINS, X-RAY ON, POWER, and SAFETY. To initiate X-ray generation, the controller must have valid operating settings for all parameters, all interlock circuits must be complete, and the X-ray Controller Key switch (SW1) must be in Position 3 (↗).

1.1.2.2.2 Radiation Generator Device X-ray Power Supply

The RGD X-ray power supply provides the voltage and current necessary to energize the RGD for X-ray production. The constant potential power supply consists of a high frequency controller that is switched at 15 kilohertz (kHz) to provide input voltage to the two high voltage generators; one negative and one positive. The high voltage generators are capable of producing -225 kV and +225 kV. X-ray unit voltage can be varied from 20 to 420 kV. The X-ray unit current can be varied up to the maximum to 20.0 mA. The maximum power output is 4.2 kW.

Built-in equipment interlocks protect the X-ray tube and electronics from:

- Over voltage (kV)
- Over current (mA)
- Over temperature
- Low coolant flow
- Filament damage

1.1.2.2.3 Radiation Generator Device X-ray Tubehead

The RGD X-ray tubehead is oil-cooled. It is fitted with a metal-ceramic X-ray tube. The maximum operating voltage of the tube is 420 kV. At full power, radiation output from the X-ray tubehead is of the order of 2,000 Roentgens per hour (R/hr) [measured]. The anode of the X-ray tube has two focal spots. The large spot measures approximately 4.5 mm by 4.5 mm. The small spot measures approximately 1 mm by 1 mm. The X-ray tubehead is located to the right when looking into the vault from the vault access door or on the left when looking into the vault from the vault loading door.

1.1.2.2.4 Radiation Generator Device X-ray Cooling System

The RGD X-ray tubehead produces a significant amount of heat during X-ray generation and is cooled by circulating oil through the RGD tubehead and around the target (anode). The oil is cooled using an oil-to-air heat exchanger system located in the equipment room. An integrated equipment interlock prevents the generation of X-rays if the oil temperature exceeds 70°C, or if the oil flow drops below 14 liters/minute.

1.1.2.2.5 Oil Insulated High-Tension Generator (X-ray Cooler)

The X-ray system cooling is a 4.5 kW oil-to-air cooler. This cooler has an over temperature sensor, flow switch, pressure gauge, safety interlocks, low oil alarm, and easy-view oil level indicator. The system has an over temperature trip which will shut down if the coolant oil temperature reaches about 110° F. Normal operating temperature range is 32°F to about 100°F. The actual oil temperature depends on running time and energy (kV) at which the equipment operates.

The Shell DIALA® Oil AX, used for coolant has a flash point of 295° F (NFPA 30, Section 1.7.3.1, Class IIIB—any liquid that has a flash point at or above 200°F (93°C) (Shell Safety Data for X-ray System Oil Tube [Ref. 7]).

The coolant level of the X-ray cooler through the inspection window is inspected visually. If the coolant level is low, coolant is added as specified in the X-ray operating manual to bring the coolant level up to the correct level.

1.1.2.2.6 Vertical Positioning of Radiation Generator Device and Image Intensifier Systems

The X-ray tubehead and image intensifier system are each attached to individual positioning carriage assemblies with drive motors to enable vertical scanning of drums being examined. The X-ray and the image intensifier system use identical drives with the same motor utilizing synchronized gears.

1.1.2.2.7 X-ray Image Intensifier

The 16 inch X-ray image intensifier is located directly opposite the X-ray tubehead. X-rays impinge on the scintillating surface and are converted to visible light. The light photons are immediately converted to electrons in a photo cathode, then accelerated and focused on a 1 inch image phosphor at the rear of the tube. The electronic energy is converted back to visible light that is gathered by the charged-coupled device camera and viewed on the monitor in the control room. The X-ray image intensifier has three magnification modes (16 inches, 12 inches, and 9 inches) that may be used to magnify objects.

1.1.2.2.8 Conveyor System and Control

A forklift transfers a container onto the conveyor system inside the shielded vault room. The conveyor system is controlled from the Control Console in the control room.

The conveyor system includes a remotely controlled conveyor of approximately 8 feet in length with a turntable in the middle of the conveyor. The conveyor system is load rated at 1,000 pounds. The conveyor system is chain driven by an electric motor. The embedded turntable also contains electrically-driven rollers that act in unison with the rest of the conveyor rollers. The turntable allows a 360-degree rotation to allow thorough drum inspections. The conveyor system is designed to handle 55/85 gallon

drums and SWBs. The X-ray tube and image intensifier are mounted on a synchronized worm gear that permits travel in two directions (vertically and horizontally). The conveyor system and X-ray worm gears are remotely controlled via the Programmable Logic Controller (PLC) operated at the operators control panel.

1.1.3 Subsystems

1.1.3.1 Civil and Structural

Attachment 2 shows the basic layout of the LANL-RTR-01 unit.

1.1.3.1.1 Operator Control Room

Walls: The Operator Control Room walls in LANL-RTR-01 are steel with steel studs. (Note: there is no insulation on the trailer walls, ceiling, or floor.)

Ceiling: The Operator Control Room ceiling is composed of steel (shell of the trailer) with interior steel studs. A drop plastic lighting panel system is connected to the steel studs of the roof of the trailer.

Floor: The Operator Control Room floor is vinyl tile over plywood sub-flooring, which is placed over the steel frame of the trailer structure.

1.1.3.1.2 Vault Enclosure

Walls: The vault consists of a lead-lined steel-framed vault, which is connected to the steel floor of the trailer (the vault is not part of the trailer structure walls, floor, or ceiling, but is positioned within the trailer).

Ceiling: The vault enclosure ceiling is a lead-lined steel-frame.

Floor: The floor is covered with steel plates over the structural frame of the trailer.

1.1.3.1.3 Trailer Physical Dimensions

- Length: 48 feet
- Width: 8 feet (with stairs attached approximately 16 feet required)
- Height: 12 feet
- Gross Weight: 75,000 pounds

1.1.3.2 Mechanical and Material

The LANL-RTR-01 climate control system consists of one mounted HVAC/Heater unit with ventilation ducts.

The unit is constructed to minimize combustible loading.

1.1.3.3 Chemical and Process

CCP-PO-002 requires that TRU waste not contain explosives, corrosives, or compressed gases. Non-radionuclide pyrophoric materials are prohibited at the WIPP. Additionally, flammable Volatile Organic Compounds (VOCs) are restricted to less than 500 parts per million (ppm) within payload container headspace (a level that would not challenge integrity of the container). Polychlorinated biphenyls (PCBs) are also limited to less than 50 ppm. Therefore, chemical hazards are not expected to result in significant consequences or significantly contribute to accidents involving radiological materials. Hazardous materials are present in less than reportable quantities or threshold planning quantities.

Based on the chemical inventory (chemicals are limited to small quantities used in maintenance or contamination in mixed TRU waste), it is not anticipated that threshold quantities of the *Occupational Safety and Health Administration Process Safety Management Standard* (29 CFR 1910.119) would be exceeded (Ref. 10).

There are no compressed gases used in this process.

1.1.3.4 Electrical Power

1.1.3.4.1 Electrical

The access to the electrical power feed panel and the communication lines is in the "Belly Storage" under the unit of the LANL-RTR-01 trailer. Electrical power cable and communication lines are routed from the electrical power feed panel to the site-supplied distribution panel.

All electrical equipment meets NFPA 70 National Electric Code minimum standards (e.g., enclosures power interlocks, four-prong plug, breakers, fuses, ground-fault circuit interrupt (Ref. 11).

- 220/208, Single Phase, 100 amp

Electrical power for the RTR system is under key control. Two separate keys operate the key switches located in the control room:

1. Control Panel Power Key – located on the Control Console
2. X-ray Controller Key – located on the RGD X-ray controller (Gulmay)

Both keys must be inserted and the Safety Circuits in the proper orientation before X-rays can be generated. The startup sequence for generating X-rays are performed in accordance with CCP-TP-121, *CCP RTR #1 Operating Procedure* (Ref. 23).

Lighting

There are fluorescent light fixtures controlled by light switches inside the structure access door and two other light-switches; one is located directly outside the vault door (control room side) and the other is located in the loading room at the end of the trailer.

Outlets

Duplex receptacles are positioned along each wall (120 Volt Alternating Current [VAC], 20 amps). Receptacles are spaced no more than 10 feet apart and each wall shall have at least two receptacles. The outlets are powered by a 20 kilovolt amperes (kVA) stabilized power transformer.

Electrical devices, such as receptacles and light switches are suitable for industrial service and have at least a 20 amp rating. All devices are Underwriter's Laboratory (UL) listed.

Grounding Lugs

Ground lugs are provided on the outside of the trailer.

Disconnects

The service panel is mounted inside the control room of the trailer. A service disconnect is provided on the outside wall of the structure. The disconnect is Single Phase 220/208 V and is fused for 125 amps.

2.0 DESIGN REQUIREMENTS

2.1 Specific Requirements

While quantitative design requirements have not been identified for the LANL-RTR-01, the system must be capable of assuring that prohibited items are identified in inspected drums do not exceed that permitted by CCP-PO-001, CCP-PO-002, and CCP-PO-003. The facility at which the LANL-RTR-01 operates must also establish that the system, in its site-specific implementation, meets *Nuclear Safety Management*, 10 CFR 830 (Ref. 12), 10 CFR 835, *Occupational Radiation Protection* (Ref. 13), and other requirements applicable to that site.

2.2 Codes and Standards

While codes and standards have not been identified as design requirements, a number of codes and standards have been used in the “as-built” system and are identified, where applicable.

3.0 OPERATIONAL INFORMATION

3.1 System Control Features

3.1.1 Manual Controls

The following sections describe the functions of some of the various switches located on the control panel.

3.1.1.1 Emergency Shutdown/Override:

There are two emergency shutdowns/overrides:

- Control Panel (red mushroom button is located on the control panel)
- Inside the X-ray vault enclosure near both the personnel access door and the loading/unloading door street side

3.1.1.2 Emergency Stops

Emergency stops are provided to allow personnel operating near the RGD to shut off the X-rays. Two red mushroom button emergency stop actuators are provided. One at the Control Console (ES-1) and the other inside the shielded vault near the vault access door and loading door (ES-2).

All emergency stop actuators are connected to normally-closed latching switches. All emergency stop switches are wired in series to the control contactor located in the main control junction box. When any one of these switches is opened, the control contactor drops out. This, in turn, drops out the power contactor, which removes electrical power from the RGD, image intensifier manipulators and imaging systems. Power is also removed from the interlock relay, which opens Circuit 2 and inhibits X-ray production. Note that power is not removed from the RGD controller, which allows cooling oil to continue to flow.

All emergency stop switches latch in position. To restore the RGD circuit, it is necessary to reset the actuator that was tripped at its physical location. To reinitiate X-rays after emergency stop reset, the X-ray start sequence requires reactivation of the system power key switch (KSW1).

3.1.1.2.1 Warning Signals – X-ray Production

Audible and visible warning signals are provided for X-ray production. These signals include the following:

- Pre-warning signals 20 seconds before X-ray generation is started
- Warning signals when X-ray generation starts and is on
- Warning signals associated with X-ray production include the following:
  - Two illuminated X-Ray ON signs located outside the shielded vault doors; one (X-20) over the vault access door inside the RTR Operator Area and the second (X-20) over the vault loading door facing the enclosure.
  - One red warning light visible for 360 degrees, is located on the outside of the shielded vault on the roof of the enclosure.
  - A warning light stack with an amber and a red light is located inside the shielded vault. In addition, an audible alarm is included with this warning light stack.
  - A rotating red light is also provided on the outside on the roof of the trailer above the loading area.

When the green Start button on the Control Console is pressed to initiate X-rays, the pre-warning time begins and the pre-warning annunciators are activated:

- The Pre-Warn lamp on the RGD X-ray controller (Gulmay) illuminates
- An audible alarm sounds
- The amber warning lights are illuminated

Pre-warning time is adjustable. For this application, it is set to 20 seconds in compliance with ANSI N43.3, Section 5.1.5.1. After the end of the pre-warning time, high voltage is transferred to the X-ray tube, the pre-warning signals stop, and the radiation warning signals start:

- X-rays ON warning lamp on the RGD X-ray controller (Gulmay) flashes
- Red warning lights flash
- X-Ray ON signs are illuminated

All X-ray warning signals are operated with 24 volts direct current. They are controlled by the RGD X-ray controller via two relays in the main control junction box.

3.1.1.3 Warning Signals – Conveyor System

There are no warning signals only associated with the roller conveyor system.

3.1.2 Fire Protection

The RTR unit is equipped with several smoke detectors. These detectors can be linked to the Host site fire dispatch systems. Fire extinguishers are located throughout the trailer. There is a disabled FM-200 fire suppression system in the LANL-RTR-01 unit.

3.1.3 Industrial Hazards

3.1.3.1 Common Hazards

A Process Hazard Review was performed to analyze general hazards associated with the RTR systems (WSMS-TR-06-0034, *Process Hazard Review for RTR Systems* [Ref. 17]). The most common hazards associated with RTR systems are: high energy X-rays, high voltages, and pinch points. These hazards are addressed in safety training for personnel who operate the system. CCP-HSP-007, *CCP Health and Safety Program Plan for Operations at LANL*, has additional information on hazards associated with LANL-RTR-01 (Ref. 19).

3.1.3.2 Additional Precautions and Limitations

3.1.4 Operating Environment and Natural Phenomena

The characterization units and associated equipment were not designed and built to DOE Natural Phenomena Hazard standards. The associated equipment is not seismically qualified. The LANL-RTR-01 structure does not perform an emergency function and is not Safety Significant or Safety Class.

3.1.5 Instrumentation and Control

3.1.5.1 Security/Television Monitoring Systems

The operator control station is fitted with closed-circuit television monitors that provide constant visual surveillance of the shielded enclosure and conveyor area. Audible and visual alarms are provided to warn personnel near impending and actual X-ray generation.

Closed-circuit cameras are provided to observe operations in the shielded vault and enclosure rooms. All cameras are used by the RTR operator to assure that all personnel are clear before X-ray operations commence, and to observe the mechanical systems during operation. The two cameras provided include the following:

- Camera 1: Provides observation of inside the X-ray vault enclosure.
- Camera 2: Provides observation of outside the loading area.

Camera images are displayed on the surveillance monitor mounted above the Control Console. Each camera has a separate monitor.

4.0 REFERENCES

1. DOE/WIPP-02-3122, *Contact-Handled Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, U.S. Department of Energy, Carlsbad Field Office, Carlsbad, NM

2. ANSI N43.3, Installations Using Non-Medical X-ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV

3. DOE-STD-3024-98, Content Of System Design Descriptions

4. DOE-STD-1088-95, Fire Protection for Relocatable Structures

5. NFPA 220, *Standard on Types of Building Construction*, National Fire Protection Association, Quincy, MA

6. NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, National Fire Protection Association, Quincy, MA

7. Shell Safety Data for X-ray System Oil Tube head coolant (MSDS Number 60.030.9)

8. 21 CFR 1020, *Performance Standards for Ionizing Radiation Emitting Products, Subsection 1020-40, Cabinet X-ray Systems*, Code of Federal Regulations, U.S. Department of Energy, Washington, DC

9. ASME B20.1, *AMSE Boiler & Pressure Vessel Code, Safety Standards for Conveyors and related Equipment*

10. *Process Safety Management (PSM) of Highly Hazardous Chemicals*, Code of Federal Regulations, Title 29, Part 1910.119, Labor, U.S. Occupational Safety and Health Administration, Washington, D.C.

11. NFPA 70, National Electrical Code

12. *Nuclear Safety Management*, Code of Federal Regulations, Title 10 Part 830, U.S. Department of Energy, Washington, DC

13. 10 CFR 835 *Occupational Radiation Protection*, U.S. Department of Energy, Washington, DC

14. DOE-STD-1027-92, “Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports

15. ANSI 1998, American Nuclear Standards Institute

16. ANSI 1989, American Nuclear Standards Institute

17. WSMS-TR-06-0034, *Process Hazard Review for RTR Systems*
18. CCP-CM-001, *CCP Equipment Change Authorization and Documentation*
19. CCP-HSP-007, *CCP Health and Safety Program Plan for Operations at LANL*
20. CCP-PO-003, *CCP Transuranic Authorized Methods for Payload Control (CCP CH-TRAMPAC)*
21. CCP-TP-028, *CCP Radiographic Test and Training Drum Requirements*
22. CCP-TP-140, *CCP Equipment Maintenance*
23. CCP-TP-121, *CCP RTR #1 Operating Procedure*
24. CCP-PO-001, *CCP Transuranic Waste Characterization Quality Assurance Project Plan*
25. CCP-PO-002, *CCP TRU Waste Certification*

Attachment 1 – Equipment Setup Requirements

Central Characterization Project (CCP)

Mobile Characterization Unit (MCU) Installation Specifications

Equipment: Real-Time Radiography Unit (LANL-RTR-01)

Summary: Table A contains information regarding general site installation and preparation information for the LANL-RTR-01 MCU.

Table A Installation Specifications	
Weight	Approx. weight of trailer – 75,000 pounds
Primary Electrical Requirements (including overcurrent protection and grounding)	All electrical equipment meets NFPA 70 National Electric Code minimum standards (e.g., enclosures power interlocks, 4-prong plug, breakers, fuses, ground-fault circuit interrupt). • 220/208, Single-phase, 100 amp Electrical power for the RTR system is under key control. Two separate keys operate the key switches located in the control room: 1. System Power Key (KSW1) – located on the Control Console 2. X-ray Controller Key (KSW2) – located on the RGD X-ray controller (Gulmay) Both keys must be inserted and the safety circuits set in the proper orientation before X-rays can be generated. Grounding Lugs Ground lugs are provided on the outside of the trailer. Disconnects The service panel is mounted inside the control room of the trailer. A service disconnect is provided in the “Belly Storage” in the bottom of the unit.

Attachment 1 – Equipment Setup Requirements (Continued)

Table A Installation Specifications (Continued)	
Fire Suppression	The RTR unit is equipped with several smoke detectors. These detectors can be linked to the Host site fire dispatch systems. Fire extinguishers are located throughout the trailer. The unit also has a disabled FM-200 fire suppression system.
Communication	Two phone lines and two Ethernet data lines are located in the control room.
Recommended Minimum Required Area for Loading/Unloading	When positioning the RTR #1 for operation it is necessary to accommodate for forklift maneuverability. It is necessary to have 20 feet of clearance on the street side of the trailer and a minimum of 5 feet on the curb side of the trailer. These are suggested lengths and should be evaluated by the Host site.
Leveling	The Host site shall provide a hard surface (concrete floor, concrete pads, asphalt, or dirt or gravel can also be considered or other suitable surfaces to maintain the trailer load). The vault doors are very heavy; therefore, the trailer must be as level as possible to assist in the manual closing of the vault doors and to avoid any industrial accidents. The trailer should be parked in an area where the following is taken into consideration: a) The front of the trailer is at a level equal to, or higher than, the rear of the trailer. If the front pitch is too low, the stairs will not function and closing the heavy vault doors could result in a safety hazard. The pitch of the surface should be no more than 4 inches over the 8 foot width of the landing pads. The grade of the surface should be no more than 6 inches over the span between the leveling jacks. b) Once the trailer is properly located, chock the wheels and unhook the trailer. When lowering the four landing gears, install a minimum of 12 inch square by 1/2 inch think steel plate or hard wood under the four pads. Position the jack spacers as necessary and lower all four manual leveling legs until they touch the ground or spacers. c) Disengage the tractor from the trailer.

Attachment 1 – Equipment Setup Requirements (Continued)

Table A Installation Specifications (Continued)	
	d) Utilize a carpenter's level to manually level the trailer by raising or lowering each jack. Use appropriate sized shims (steel or hardwood) under the front and back jacks as required. The goal is to have the trailer floor area as level as possible to support operations. e) Remove the office stairs and handrail assemblies from the storage portion of the trailer. f) Mount the stair assembly to the trailer attach points, install and pin handrails in place. Level the stairs, as required. **NOTE:** Due to location of the rear tandem near the back of the trailer, the turning radius for maneuvering the trailer into position will be approximately 40 feet (12.2 meters [m]).
Separation Distances	Structure shall not be placed over control valves, access ways to underground utilities, utility corridors, gas mains, or water mains. Exception: structure may be placed above those utility lines that service the structure itself. The structure shall not be placed beneath vital power lines or lines over 600 volts such that fire in the structure could damage the lines. Such structure should also not be placed under other vital utilities, such as communication cables and inerting gas lines, unless the structure is protected by an automatic fire suppression system. Service conduct clearances and disconnects should be in accordance with NFPA 70. The structure should not be placed closer than 50 feet (15.2 m) to a fire hydrant. At least one fire hydrant supplied by an adequate and reliable water distribution system should be located so that it does not require more than 300 feet (91.4 m) of fire hose to reach any exterior portion of the structure. However, since the structure is less than 5,000 square feet in floor area, and the Maximum Possible Loss is less than $1 million dollars, this structure can be exempted from these requirements. Structure should not be closer than 50 feet to a fire hydrant.

Attachment 1 – Equipment Setup Requirements (Continued)

Table A Installation Specifications (Continued)	
Emergency Egress	Structure should not be located where they impede or otherwise hinder personnel egress or ingress to, or within, other facilities or structures. Structure should not be located where they impede or otherwise hinder the access of emergency response vehicles to other facilities or structures. Structures should not be placed inside permanent facilities that do not have sprinkle unless a fire hazards analysis demonstrates that there is no significant increase in fire risk to the facility. Structures that are placed inside permanent facilities should be protected with the same level of fire protection as provided for the permanent facility. Structure shall be placed so emergency vehicles can operate within 100 feet of the structure. The space between the structure and the road should be free of natural obstructions that would prevent or severely restrict access by emergency responders. Security barriers should be designed in a manner that permits emergency access. Landscaping and similar non-essential obstructions should not restrict emergency access. Site location for structure should be evaluated for wildland fire exposures.

Attachment 2 – Typical LANL Real-Time Radiography #1 Layout