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CCP-CM-021

Revision 0

CCP
Real Time Radiography
Unit #6 (RTR-6)

(Equipment #NDE-RTR-06)

Equipment Description

EFFECTIVE DATE: 05/16/2007

Mark Pearcy

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LIST OF ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
amp	amphere
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CCD	Charge-Coupled Device
CCP	Central Characterization Project
CFR	Code of Federal Regulations
cm	centimeter
DOE	Department of Energy
DVD	Digit Versatile Disc
E-STOP	Emergency Stop
ED	Equipment Description
HC	Hazard Category
HVAC	Heating, Ventilation, and Air Conditioning
MCU	Mobile Characterization Unit
NDA	Nondestructive Assay
NDE	Nondestructive Examination
NFPA	National Fire Protection Association
PPE	Personnel Protective Equipment
RCT	Radiological Control Technician
RGD	Radiation Generator Device
RTR	Real Time Radiography
RWP	Radiological Work Permit
STD	Standard
TRU	Transuranic
TV	Television
UL	Underwriters Laboratory
VAC	Volt Alternating Current
WIPP	Waste Isolation Pilot Plant
WIPP WAC	Waste Isolation Pilot Plant Waste Acceptance Criteria

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SUMMARY

The Real-Time Radiography (RTR) Unit # 6 (Equipment #NDE-RTR-06) is used to X-ray Transuranic (TRU) waste drums up to 85 gallons in volume. Radiography is a non-destructive 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 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 RTR-6 will provide a Nondestructive Evaluation (NDE) function that is designed to meet the requirements of the WIPP Waste Acceptance Criteria (WAC) (Department of Energy [DOE]/WIPP-02-3122 [Ref. 1]).

This Equipment Description (ED) not an authorization basis document. It is a piece of Central Characterization Project (CCP's) 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 ED is a central coordinating link among the engineering design documents, the facility authorization basis, and implementing procedures. This ED does not originate requirements or basis information, but rather collects that information into a convenient usable form. The ED consolidates information about the RTR Unit # 6 system into one document.

1.0 SYSTEM DESCRIPTION

The Mobile RTR NDE Unit #6 (Equipment No. NDE-RTR-06) is used to X-ray TRU waste drums up to 85 gallons in volume and to determine their content attributes. The RTR-6 system contains an X-ray tube. The radiographic images are produced utilizing a Radiation Generator Device (RGD) with operating range of 30 kV to 320kV. The high energy X-rays penetrate the steel container onto an image intensifier. A high-resolution camera then records the image from the intensifier onto Digital media. Digital imaging of 100% of the contents of the drums provides non-intrusive inspection of packages containing hazardous, nuclear, and mixed waste.

There are normally only minimum personnel radiological restrictions on the outside of the RTR unit during X-ray operations. However, some Host Sites may require limited radiation posting during operations. Background radiation levels from adjacent storage areas or when using other NDE/Nondestructive Assay (NDA) mobile units must be less than 2.5 mR/hour so as not to adversely affect the measurements taken in this unit.

Radiography is a non-destructive 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 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])

Structures, Systems, and Components for the RTR-6 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 RTR-6 system classification is Mission-Critical (Section 2.2, DOE Standard [STD] 3024-98 [Ref. 2]).

1.1 Facility, Major Components, and Subsystems

1.1.1 Facility

The RTR unit is classified as Type V (000) structures per National Fire Protection Association (NFPA) 220, *Standard on Types of Building Construction* (Ref. 3). NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, Section

3-5 (Ref. 4), requires buildings used to handle and store radioactive materials to have either a fire-resistive or noncombustible construction (Type I or Type II in accordance with NFPA 220 [Ref. 3]). NFPA 801, Section 3-8, requires that the interior finish of these buildings to be limited combustible (Ref. 4). The interior finish for the RTR-6 is combustible to some extent as discussed below.

The exterior walls of the unit are steel, over a steel stud frame of a standard trailer truck. The Operator Control Room walls in the RTR-6 unit are covered by fire retardant vinyl. The Control Room ceiling is composed of steel (shell of the unit) with interior steel studs covered by vinyl. A drop plastic lighting panel system is connected to the steel studs of the roof of the unit. The Control Room floor is tile. The X-ray Vault consists of a lead-lined steel-framed Vault, which is connected to the steel floor of the unit (the X-ray Vault is not part of the unit structure walls, floor, or ceiling, but is positioned within the unit). The Loading Area consists of vinyl-covered walls and ceiling over plywood connected to the steel studs of the outside walls of the unit. The floor is covered with steel plates over the structural frame of the unit.

The RTR-6 is a stand-alone, self-contained system that is permanently placed within an 8 foot by 48 foot unit. Access to the loading platform on the RTR unit is through a single door on the road side of the unit. Access area by forklift is a minimum of 20 feet from the side loading access door. Access to the unloading platform on the unit is through a single door on the side of the unit. Access area by forklift is a minimum of 20 feet from the rear unloading access door. All remaining access areas require a minimum of 3 feet 6 inches.

The RTR-6 basic unit is a conex box. The RTR-6 unit is divided into three separate rooms: the Control Room, Equipment Room, and the X-ray Vault. A sliding door is used to access the Equipment Room from the Control Room and a lead lined sliding door is used to access the Vault Room from the Equipment Room. There is one 36-inch door from the Control Room to enter the Equipment Operating Room. Egress personnel doors are equipped with standard panic hardware on the inside of the door and a standard key lock on the outside of the door. The key lock does not affect the operations of the panic bar. Figure 1 (shown in Attachment 2) shows the basic layout of the RTR-6 unit.

The RTR-6 unit is divided into four sections:

- Control Room (Photos 1 through 5)
- RTR Vault (Photos 6 through 511)
- Conveyor (Photos 12 through 514)
- Unloading Bay (Back end of the unit) (Photo 15)

The Control Room is located in front of the unit and adjacent to the Equipment Room. The Operator must exit the Control Room, enter the Equipment Room through a personnel sliding door, and enter the Vault Room through a lead sliding door. The Equipment Room includes all of the hydraulic pumps and the X-ray cooler. The Control Room includes the bank controllers necessary for operating the RTR System, and contains the following equipment:

- Operator's Console
- Audio/Video Subsystem. The Audio/Video subsystem is comprised of an image intensifier integrated closed circuit camera, raw video monitor, image processor, digital video recorders, process video monitor, and video printer. Additionally, there is a closed circuit video camera and dedicated monitor for surveillance of the X-ray Vault and loading area with the Vault doors open.

1.1.2 Major Components

The RTR units are composed of the following major system components:

- X-ray Vault Enclosure
- X-ray Equipment
- X-ray Cooler
- Conveyor System and lift table with drum rotation (inside conveyor, outside conveyor)

1.1.2.1 X-Ray Vault

The X-ray Vault is a shielded lead lined Vault with lead shielding varying from 1/2 to 3/4 inches of lead on the walls, floor, and ceiling. There are normally only minimum radiological restrictions on occupancy on the outside of the RTR units during X-ray operations. In order to keep personnel exposure levels As Low As Reasonably Achievable (ALARA), the mobile radiography system has been designed and constructed in accordance with American Nuclear Standards Institute (ANSI) 43.3 – 1993 exempt shielded installation (Ref. 5). This class provides the highest degree of inherent safety because radiation protection does not depend on compliance with any opening limitations. The operator control station is fitted with closed-circuit television monitors that provide constant visual surveillance of the shielded enclosure, in-feed conveyor (Equipment Bay)-load side and unload Bay, and drum lifting and examination activities.

Electronic Vault doors open to allow drum loading and unloading. The X-ray Vault load door faces the Equipment Bay. The unloading door of the X-ray Vault faces the end of the unit or unloading bay area. The X-ray Vault doors are verified closed and locked before operations begin and remained locked during X-ray operations.

The shielded X-ray Vault houses the X-ray machine, which consists of a shielded X-ray tube. The image intensifier is an electronic device used to detect X-ray radiation and convert the energy into a visible light image viewable by the human eye.

The X-ray Vault includes access doors with radiation safety interlocks, to prevent X-ray operation with the shielded door open. Safeguards (e.g., Emergency Stops [E-STOP]) are also provided inside the X-ray Vault, enabling personnel to deactivate the X-ray unit in the unlikely event that the door was closed and the unit was started while a person was inside the Vault.

1.1.2.2 X-Ray Equipment

The RTR-6 system X-ray tube operates in the range of 30 kV to 320 kV, and power is produced by the oil-insulated high-tension generators, which are located in the Vault area, and are 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, which protrudes from the enclosure.

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

The Shell DIALA ® Oil AX, used for coolant has a flash point of 295° F and is a Class IIIB combustible liquid (NFPA 308, Section 1.7.3.1, Class IIIB—any liquid that has a flash point at or above 200° F (93° C) (Ref. 6).

The coolant level of the X-ray cooler is inspected visually through the inspection window. 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.

1.1.2.4 Conveyor System

The conveyor system includes two hydraulically and remotely controlled conveyors of approximately 4 feet and 8 feet in length, respectively. The conveyor system is used to remotely move the TRU waste drums through the X-ray system. A hydraulic lift is used to place the drums on the conveyor and remove them from the conveyor following the RTR examination.

The steel motorized rollers are 2-1/2 inches by 11 gauge steel tubing, with flanged type bearings pressed into straight ends. The frame is formed of steel channel. Bearings are removable type, heavy-duty ball bearing, zinc-plated, and grease packed.

1.1.2.5 Lift Table (Drum Manipulator)

The hydraulically controlled lift table (drum manipulator), located inside the X-ray vault, is remotely operated to allow movement of the entire drum through the X-ray field. The manipulator can raise or lower the drum.

1.1.3 Subsystems

1.1.3.1 Civil and Structural

The exterior walls of the unit are steel, over a steel stud frame of a standard trailer truck. The Operator Control Room walls in the RTR-6 unit are covered by fire retardant vinyl. The Control Room ceiling is composed of steel (shell of the unit) with interior steel studs covered by vinyl. A drop plastic lighting panel system is connected to the steel studs of the roof of the unit. The Control Room floor is tile. The X-ray Vault consists of a lead-lined steel-framed Vault, which is connected to the steel floor of the unit (the X-ray Vault is not part of the unit structure walls, floor, or ceiling, but is positioned within the unit). The Loading Area consists of vinyl-covered walls and ceiling over plywood connected to the steel studs of the outside walls of the unit. The floor is covered with steel plates over the structural frame of the unit.

The RTR-6 unit is a single prefabricated insulated stand-alone structure. The RTR-6 structure is classified as a Type V (000) structure in accordance with NFPA 220 (Ref. 3). NFPA 801, Section 3-5 (Ref. 4), 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 RTR-6 structure meets these requirements. The exterior walls are constructed of carbon steel over steel studs. The interior walls/ceiling are insulated with Miro-Aire duct board insulation panels, which are fiberglass batting with an aluminum foil on the side that faces the room. The insulated wall, ceiling, and equipment doors are Underwriters Laboratory (UL) Fire Hazard Classification fire rated with a flame spread rate of less than 25 and smoke development rate less than 50.

1.1.3.1.1 Operator Control Room

<u>Walls</u>: The walls are 3/8 inch plywood with vinyl PYRO PanL-fire Retardant wall cover connected directly onto the plywood. The 3/8 inch plywood is connected directly to 2 inch by 4 inch wood studs. (The 2 inch by 4 inch studs are connected to the exterior metal walls of the unit.)

<u>Ceiling</u>: The Control Room ceiling is composed of steel (shell of the unit) with interior steel studs covered by vinyl. A drop plastic lighting panel system is connected to the steel studs of the roof of the unit.

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Floor: The floor is tile over the steel frame of the unit. The control room also houses the Control Console (computer, printer, office chairs, and a working desk), Main Breaker Panel, external mounted two 1-ton Heating, Ventilation, and Air Conditioning (HVAC) Units, Uninterruptible Power Supply, 3.1 kVA-Best # FE3.1 kVA with STM2-s, Electrical Panel, and Fire Extinguishers

1.1.3.1.2 Equipment Room

Walls: Same as Control Room walls above.

Ceiling: The ceiling is vinyl PYRO PanL-fire Retardant (same as wall substructure).

Interior wall: The interior wall is 2 inch by 4-inch steel studs. Three-eighths inch plywood (both sides of wall) is secured to steel studs. Two-inch thick solid foam insulation is between the studs. Vinyl PYRO PanL-Fire Retardant is fastened with nylon drive rivets. Seams and corners are fitted with 1/8 inch heavy-duty structoglas accessories.

Floor: Same as the Control Room floor above. This area also maintains the X-ray cooler.

The wall dividing the Equipment Operating Room and Control Room is made of carbon steel studs covered on both sides by carbon steel panels. This wall is insulated with Dow Chemical Grayboard brand insulation (tongue and groove) with a UL Fire Hazard Classification fire rate at a flame spread rate of less than five and smoke development rate of less than 165 (American Society of Testing and Materials [ASTM] E-84, Ref. 7).

1.1.3.1.3 Vault Enclosure

Walls: The Vault consists of a lead-lined steel-framed Vault, which is connected to the steel floor of the trailer.

Ceiling: The Vault Enclosure ceiling is the lead-lined steel-frame of the trailer.

Floor: The Vault Enclosure floor is steel-frame of the trailer.

1.1.3.1.4 Loading Area

Walls: The Loading Area consists of vinyl-covered walls and ceiling over plywood connected to the steel studs of the outside walls of the trailer. The floor is covered with steel plates over the structural frame of the trailer.

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

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1.1.3.2 Mechanical and Material

An HVAC unit is provided for the purpose of comfort of the operators, who are located in the Control Room. There are no heating or cooling units provided for radiological operations in the X-ray Vault or Equipment Bay (drum loading areas).

The HVAC unit is an external mounted 2-ton, 208 Volt Alternating Current (VAC)/three-phase BARD.

The unit is constructed to minimize combustible loading. No wood or cellulose materials is used (except for shipping bracing, covers, etc. that will be removed prior to use) unless approved by the engineer.

Insulation materials are non-combustible to the greatest degree possible. Flame spread data and material description cut sheets are provided on all insulation materials.

Floors are a non-skid surface except in areas where permanent equipment is installed.

Outside surfaces of containers are painted gray or white. Interior painted surfaces are a neutral color.

The mechanical boundary for RTR-6 is the drum loading and unloading stations. Once the drum has been placed on the loading platform of the RTR conveyor, it is considered part of the RTR. Once the drum has been removed from the unloading platform of the RTR conveyor, it is no longer considered part of the RTR.

1.1.3.3 Chemical and Process

The WIPP WAC requires that TRU waste not contain explosives, corrosives, or compressed gases. Non-radionuclide pyrophoric materials are prohibited at WIPP. Additionally, flammable Volatile Organic Compounds are restricted to less than 500 parts per million within a payload container headspace (a level that would not challenge the integrity of the container). Polychlorinated biphenyls are also limited to less than 50 parts per million. 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, contamination in mixed TRU waste), it is not anticipated that threshold quantities of the Occupational Safety and Health Act Process Safety Management Standard (Title 29 Code of Federal Regulations [CFR] Part 1910.119) would be exceeded (Ref. 8).

Generators ensure that TRU waste is not in free-liquid form, that minor residual liquids remaining in well drained internal containers (e.g., bottles, cans) do not exceed 1 inch (2.5 centimeter [cm]) in the bottom of any container and that the total liquid in the waste package does not exceed 1.0 vol. %. There are no compressed gases used in this process.

1.1.3.4 Electrical Power

The RTR-6 is a stand-alone, self-contained system that requires electrical power to operate. Refer to the Operating procedure (CCP-TP-165, *CCP RTR #6 Operating Procedures Unit* [Ref. 20]). All RTR equipment is designed and installed in accordance with the minimum standards of the National Electric Code and NFPA 70, *National Electrical Code* (Ref. 9).

Electrical supply for RTR-6 is 220 V, 100 A, single phase. The electrical power feed panel is located on the outside wall of the RTR trailer. All RTR equipment is designed and installed in accordance with the minimum standards of the National Electric Code and NFPA 70, *National Electrical Code* (Ref. 9).

The distribution panel is mounted inside the equipment room. A service disconnect is provided on the outside wall of the unit. Ground lugs are also provided on the outside of the unit.

There are fluorescent light fixtures controlled by light switches beside access door of the operator control room.

The electrical boundary for RTR-6 is the circuit breaker panel contained within the RTR where external power is attached to the system and control of individual circuits within the RTR is provided by the panel.

1.1.3.5 Instrumentation and Control

1.1.3.5.1 Audio/Video Recording Media System Setup

The audio/video recording media subsystem is comprised of an Image Intensifier with integrated Charge-Coupled Device (CCD) camera, raw video monitor, precision video recorder, video character generator, and video printer. Additionally, there is a CCD video camera and a dedicated monitor for surveillance of the X-ray Vault and two additional CCD video cameras, one at load and one at unload. Powering of equipment can be verified with the pilot lights on each piece of equipment. Only new Digital Versatile Discs (DVDs) are used. The DVDs are labeled with the date and batch number. Labels are marked with the appropriate project title. The audio/video equipment is automatically powered up with the system key-on switch. This can be verified with the pilot lights on each piece of equipment.

1.1.3.5.2 Security/TV Monitoring System

The Security/TV Monitoring System includes the following:

- Four, strategically-placed, security cameras (one on the incoming conveyor, two in the X-ray Vault, and one on the back side of the unit for monitoring outside)
- Four, black and white, security monitors (located in the control room)
- One (divided in four channels), 17-inch black and white flat screen monitor (located in the control room)
- A video system for recording the images (located in the control room)
- Two Pioneer DVD recorders

The image intensifier, located in the X-ray Vault, converts the X-ray image into a visible-light image. The visible-light image is detected by a high-resolution closed circuit video camera and the image is displayed on a solid-state Television (TV) monitor.

The video system includes a DVD recorder, an alphanumeric character generating drive for videotronics, and an audio track for audio narrative.

To produce a clear picture of various thickness materials, the X-ray may be varied from 0-320 kV and 0-12 mA. The system is also equipped with a large and small focus to provide a 1:1 image size and a 30% enlarged picture.

1.1.3.5.3 Safety Controls/Features

The system includes the following interlocks and safety features:

- X-ray exposure cannot be initiated until all the Vault doors are in the closed position.
- The system is equipped with ALARM X-ray safety system.
- After the “X-RAY ON” button is depressed, an amber beacon located inside the chamber is illuminated and an alarm sounds for 20 seconds, as a warning that X-ray production/inspection is to begin.
- Following the 20-second delay, X-ray exposure begins and the red beacon inside the Vault, a red light on the X-ray Controller, and the “Very High Radiation” sign over the rear Vault door are illuminated.
- Anyone left inside the Vault during X-ray initiation can stop X-ray exposure by depressing the red E-STOP button located on the junction box in the Vault.

- X-ray exposure cannot be re-activated after the E-STOP button is depressed until the E-Stop button is reset and the fault message is cleared at the X-ray Controller.
- The X-ray Vault is only entered to perform maintenance of equipment.

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2.0 DESIGN REQUIREMENTS

2.1 Specific Requirements

While quantitative design requirements have not been identified for the RTR-6, the system must be capable of assuring that fissionable material in its inspected drums does not exceed that permitted by the WIPP WAC (Ref. 1). The facility at which the RTR-6 operates must also establish that the system, in its site-specific implementation, meets 10 CFR 830 (Ref. 10), 10 CFR 835 (Ref. 11), 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 Warning Lights

X-ray pre-warning alarm stack lights are located in the Vault and loading area. The amber beacon flashes 30 seconds before X-rays are produced, warning the operator that the system is about to energize. The red beacon flashes for 10 seconds before the system energizes. Warning lights in the X-ray Vault and loading areas remain illuminated any time the X-ray generator is on.

3.1.2 Warning Lights

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

3.1.2.1 Emergency Shutdown Switches

RTR-6 is equipped with emergency shutdowns/overrides at the operator console (i.e., red mushroom button located on the operator's bench board) and on the inside of X-ray Vault and at the end of the conveyor. Once pushed, all systems stop, including any mechanical movement of the motorized conveyors (i.e., inside and outside conveyors).

3.1.2.1.1 Operating Personnel Emergency Shutdown Instructions

- **Amber Beacon/Rotating Light On** is located on top of the control box. Anyone inside the Vault may stop the X-ray by pressing the Red E-STOP Button inside the Vault.
- **X-ray Pre-warning Alarm** is located on top of the control box. Anyone inside the Vault may stop the X-ray emission by pressing the Red E-STOP Button inside the Vault.
- **Red Beacon/Rotating Light** is located on top of the control box. Anyone inside the Vault may stop the X-ray emission by pressing the Red E-STOP Button inside the Vault.
- **Emergency Stop Button** is located on the front side of the control box and must be pressed immediately by anyone inside the X-ray Vault if X-rays are started as indicated by the activation of the warning alarm, flashing amber beacon, or flashing red beacon.

3.1.3 Fire Protection

There are no automated fire suppression systems in the RTR-6 unit. Two smoke detectors and one hand-held A-B-C fire extinguishers are located within the unit (NFPA 10, *Portable Fire Extinguishers*, 1998 Edition). This extinguisher is provided for manual extinguishing of incipient fires.

3.1.4 Nuclear Criticality Safety

Per DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, criticality hazards are not a concern for Hazard Category (HC)-III facilities (Ref. 12). Isotope inventory thresholds for HC-III facilities, established in Attachment 1 of the referenced DOE standard, preclude the potential for a criticality event.

3.1.4.1 Process Evaluations

A criticality evaluation of the individual equipment/processes/facilities is not needed due to the insufficient inventory of fissionable material mandated by HC-III classification, provided an Inventory Control Program is in place.

The minimum theoretical quantity of Pu-239 necessary for criticality, assuming favorable configuration, moderation, and reflection, is 450 grams (ANSI 1998 [Ref. 13]). Although a package might contain material favorable for moderation or reflection, inadvertent repackaging into a critical configuration is very improbable due to the low inventory of fissile material and the waste form geometry.

The RTR-6 processes one drum at a time. WIPP WAC criteria and Acceptable Knowledge evaluations precluded any TRU waste drum(s) being processed to the RTR-6 for analysis that would challenge criticality safety (Ref. 1). DOE facilities, where this equipment may operate, is normally operated under a Safety Analysis or documented safety basis documents, which establishes bound limits and inventory controls for TRU waste drums.

3.1.4.2 Waste Drum Contamination on Surface

The surface records are checked to verify that the surface contamination levels on the exterior surface of the drum do not exceed the limits for removable, total contamination, specified below:

3.1.4.2.1 Alpha Contamination on Drum Surface

Waste drums are not acceptable if removable alpha contamination on the drum surface exceeds 20-dpm/100 cm^2.

3.1.4.2.2 Beta Contamination on Drum Surface

Waste drums are not acceptable if removable Beta contamination on the drum surface exceeds 200-dpm/100 cm^2.

3.1.4.3 Waste Drum Dose Rate Limits

Drum handling and radiological control requirements are determined by the external radiation dose rate.

3.1.5 As Low As Reasonably Achievable

Radiological posting is used to alert personnel to the presence of radiation and radioactive materials and to aid in minimizing exposures and preventing the spread of contamination. Radiological posting are installed before work begins, and updated periodically when changes in radiological conditions occur or are expected.

The area of operation around the characterization equipment may be posted as Controlled Area that bounds a larger area of operations around the equipment. Each access point to a controlled area (as defined at Sec. 835.2) shall be posted whenever radiological areas or radioactive material areas exist in the area. Individuals who enter only controlled areas without entering radiological areas or radioactive material areas are not expected to receive a total effective dose equivalent of more than 0.1 rem (0.001 sievert) in a year. Signs used for this purpose may be selected by the contractor to avoid conflict with local security requirements (Ref. 11).

Routine contamination surveys should be performed of the immediate area outside of the RTR-6 unit.

3.1.5.1 Radiation and Other Hazards

The RTR-6 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, which operates in the range of 30kV to 320kV.

The Personnel Protective Equipment (PPE) for normal operations is leather gloves when handling drums, safety shoes, and thermoluminescent dosimeters. Additional PPE may be used such as work coveralls and safety glasses. PPE for abnormal conditions shall be specified by Radiological Control Technician (RCT) or addressed in the host site Radiological Work Permit (RWP). PPE is worn before starting any operations. Workers who will be working in a radiation area must have read and signed the applicable host site RWP, and received orientation to applicable work package.

There are normally only minimum personnel radiological restrictions on the outside of the RTR-6 unit during X-ray operations. However, some Host Sites may require limited radiation posting during operations.

Background radiation levels from adjacent storage areas or when using other NDE/NDA mobile units must be less than 2.5 mR/hour so as not to adversely effect the measurements taken in this unit.

The RTR-6 system contains an X-ray tube, which operates in the range of 30 kV to 320 kV and up to 320 kV power is produced by the oil-insulated high-tension generators, which are located in the equipment room, and is supplied to the X-ray tube via a high-tension cable. The system is filled with oil from the equipment room.

3.1.5.2 As Low As Reasonably Achievable (ALARA)

Radiological posting is used to alert personnel to the presence of radiation and radioactive materials and to aid in minimizing exposures and preventing the spread of contamination. Radiological posting are installed before work begins, updated periodically when changes in radiological conditions occur or are expected.

The area of operation around the characterization equipment may be posted as Controlled Area that bounds a larger area of operations around the equipment. Each access point to a Control Area (as defined at 835.2) shall be posted, whenever radiological areas or radioactive materials areas exist in the area. Individuals who enter only the Controlled Areas or radioactive material areas are not expected to receive a total effective dose equivalent of more than 0.1 rem (0.001 sivert) in a year [835.602(a)] (Ref. 11).

Routine contamination surveys should be performed of the immediate area outside of the RTR-6 unit.

Radiological areas are posted with signs containing the standard radiation symbol with black or magenta lettering on yellow background [835.601 (b) and 835.601 (c)] [1]. The radiological postings are displayed to signify the actual or potential radiological conditions of the area. Postings are maintained in a legible condition and updated based on the most recent survey results. Signs and labels shall contain the standard radiation-warning trefoil colored magenta or black on yellow background. Lettering shall be either magenta or black. Magenta is the preferred color over black [835.601 (a)]. Unless circumstances do not permit, the standard radiation-warning trefoil should be oriented with one blade downward and centered on the vertical axis. Lettering should not be superimposed on the standard radiation-warning trefoil (ANSI 1989 [Ref. 15]). The size of the lettering used on the sign should not detract from the clarity of the standard radiation-warning trefoil (Ref. 11).

Physical barriers are used to designate the posted boundaries, when required by the Host Site RWP. All work conducted in these areas is controlled by the approved Host Site RWPs. All physical barriers shall be placed so that they are clearly visible from all directions and various elevations. They should not be easily walked over or under, except at identified access points. Rope, tape, chain, and similar barriers used to designate the boundaries of posted areas should be yellow and magenta in color. *No control(s) shall be installed at any radiological area exit that would prevent rapid evacuation of personnel under emergency conditions* [835.501 (e)][1] (Ref. 11).

3.1.5.3 Radiological Posting Areas

Radiological areas are posted with signs containing the standard radiation symbol with black or magenta lettering on yellow background. The radiological postings are displayed to signify the actual or potential radiological conditions of the area. Postings are maintained in a legible condition and updated based on the most recent survey results.

Physical barriers are used to designate the posted boundaries. All work conducted in these areas is controlled by the approved Host Site RWP.

Only authorized personnel shall be in the operating area during characterization activities. However, some Host Sites may require limited radiation posting during operations.

Radiological Controls: The Host Site will provide Radiological Control Inspectors to support all drum handling, characterization, and loading activities. Appropriate signs, barricades, and postings are considered part of radiological controls.

3.1.6 Industrial Hazards

3.1.6.1 Common Hazards

A Process Hazard Review was performed to analyze hazards associated with the RTR systems (Ref. 14). 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 operator the system. See CCP-HSP-009, *CCP RTR Health and Safety Plan* for additional information (Ref. 17).

3.1.6.2 Additional Precautions and Limitations

Prior to certified operation, the RTR-6 TS ensures that the Operator(s) have met the requirements for test and training drums as defined in CCP-TP-028, CCP *Radiographic Test and Training Drum Requirements* (Ref.18).

The system includes the following interlocks and safety features:

- X-ray exposure CANNOT be initiated until the Vault doors are in the closed position.
- After the X-ray ON button is depressed, an amber beacon located inside the chamber is illuminated and an alarm sounds for 20 seconds as a warning that X-ray generation is to begin.
- Following the 20-second delay, X-ray exposure begins and the red beacon located inside the chamber, a red light on the X-ray Controller, and the “Very High Radiation” sign over the rear Vault door are illuminated.
- Anyone trapped inside the enclosure can prevent X-ray exposure by depressing the red E-STOP button located on the junction box in the Vault.
- X-ray exposure CANNOT be re-activated after the E-STOP button is depressed until the E-STOP button is reset and the fault message is cleared at the X-ray Controller.
- High energy X-rays, high voltages, and pinch point are potential hazards associated with the RTR-6 system. These hazards are addressed in safety training for personnel who operate the RTR-6 system.
- After the X-ray “Start” button is depressed, an amber beacon located inside the Vault chamber is illuminated 30 seconds warning of X-ray generation is to begin. The red beacon illuminates 10 second before X-ray operation begins.
- A video camera maintains surveillance of the Vault at all times.
- X-ray exposure CANNOT be re-activated after the E-STOP button is depressed until the emergency button is reset and the fault message is cleared at the X-ray controller.
- Do not attempt to open the Vault doors when X-ray system is in operations.
- Do not leave the system operating unattended at anytime.
- RTR-6 doors are locked when system is unattended.

Additional information regarding RTR-6 system safety operations can be found in Appendices B and C of this document.

3.1.7 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 RTR-6 structure does not perform an emergency function and is not Safety Significant or Safety Class.

3.1.8 Software/Human Interface

The Personal Computer located inside the control room serves as the primary controller of the system. The computer either directly or indirectly controls all sub-systems.

The RTR-6 operation has only one phone line and one data line. Modular jacks are provided inside the container and terminal blocks outside. Surge suppressors for the phone and data line are also provided.

3.1.9 Safety Controls/Features

The system includes the following interlocks and safety features:

- X-ray exposure CANNOT be initiated until all the Vault doors are in the closed position.
- The system is equipped with ALARM X-ray safety system.
- After the “X-RAY ON” button is depressed, an amber beacon located inside the chamber is illuminated and an alarm sounds for 20 seconds, as a warning that X-ray production/inspection is to begin.
- Following the 20-second delay, X-ray exposure begins and the red beacon inside the Vault, a red light on the X-ray Controller, and the “Very High Radiation” sign over the rear Vault door are illuminated.
- Anyone left inside the Vault during X-ray initiation can stop X-ray exposure by depressing the red E-STOP button located on the junction box in the Vault.
- X-ray exposure cannot be re-activated after the E-STOP button is depressed until the E-Stop button is reset and the fault message is cleared at the X-ray Controller.
- The X-ray Vault is only entered to perform maintenance of equipment.

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4.0 REFERENCES

1. DOE/WIPP-02-3122, *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant (WAC)*

2. DOE-STD-3024-98, *Content of System Design Descriptions*.

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

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

5. ANSI N 43.3-1993, *General Safety on Installations Using Non-Medical X-ray and Sealed Gamma-Ray Sources Energies Up to 10 MeV, American Nuclear Society*.

6. NFPA 308, National Fire Protection Association, Quincy, MA

7. ASTM E-84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428

8. CFR 29, Occupational Safety and Health Standards, Subsection 1910.119, Hazardous Materials, Code of Federal Regulations, U.S. Department of Energy, Washington, DC

9. NFPA 70, *National Electrical Code*, National Fire Protection Association, Quincy, MA.

10. 10 CFR 830, *Nuclear Safety Management*, Subpart B, Safety Basis Requirements, Code of Federal Regulations, U.S. Department of Energy, Washington, DC

11. 10 CFR 835, *Occupational Radiation Protection*, U.S. Department of Energy, Washington, DC

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

13. *American National Standards Institute* (ANSI) 1998

14. WSMS-TR-06-0034, *Process Hazard Review for RTR Systems*

15. *American National Standards Institute* (ANSI) 1989

16. CCP-CM-001, *CCP Equipment Change Authorization and Documentation*

17. CCP-HSP-009, *CCP RTR Health and Safety Plan*

18. CCP-TP-028, *CCP Radiographic Test and Training Drum Requirements*

19. CCP-TP-140, *CCP Equipment Maintenance*

20. CCP-TP-165, *CCP RTR #6 Operating Procedure*.

Attachment 1 – Equipment Setup Requirements

Central Characterization Project (CCP)

Mobile Characterization Unit (MCU) Installation Specifications

Equipment: Real Time Radiography Unit (NDE-RTR-06)

Summary: Table A contains information regarding general site installation and preparation information for the RTR-6 unit.

Table A Installation Specifications

Weight	Approximate weight of unit – 75,000 lbs.
Primary Electrical Requirements (including overcurrent protection and grounding)	220V, Single Phase, 100 amphere (amp) (Unit) <u>Power Installation</u>: Power requirements are 220V single phase with neutral and ground at 100 amps. For 100 amp service, a 2 AWG 5 conductor cable is used. 120 VAC, 20 amp, duplex receptacles are positioned along each wall. Receptacles are spaced no more than 10 feet apart and each wall shall have at least two receptacles. All receptacles are Ground Fault Circuit Interrupter protected. Two receptacles are on a dedicated 20-amp circuit for use at the personnel work area desk. Ground lugs are provided on the outside of the unit. The lug is sized to accommodate the same size wire as the service entrance conductors.
Fire Suppression	The RTR-5 is equipped with several smoke detectors. These detectors can be linked to host site fire dispatch systems. Fire extinguishers (shown in Photograph 26) are located in the loading area and Control Room.
Communication	One phone line and two Ethernet data lines are located in the control room.
Footprint	8’ x 48’ access area by forklift is a minimum of 20’ from the side loading access door and rear loading access door.

Attachment 1 – Equipment Setup Requirements (Continued)

Leveling	Surface area for placement of the RTR-6 structure should be level as possible. This structure should be placed on a hardened surface capable of maintaining load distribution (e.g., concrete, asphalt, tested compacted soil capable of maintaining load). Drainage around the structure must be adequate to remove surface water away from the unit. The Vault doors are very heavy; therefore, the unit must be as level as possible to assist in the manual closing of one of the Vault doors and to avoid any industrial accidents and excessive ware of equipment.
Anchoring Points	Anchor to ground or it back to unit all conveyors before operating the system with heavy drums (drums grater than, or equal to, 200 pounds) To anchor conveyors to the ground, use a 3/8 inch diameter by 12-inch long spike with a 3/8 inch flat washer through at least two mounting holes of each foot pad and outrigger. All external conveyors must be properly secured to the ground. Do not anchor conveyors until all mechanical components have been installed and verified (e.g., via Host site or local authorities) for proper positioning and heights.

Attachment 2 – Figures

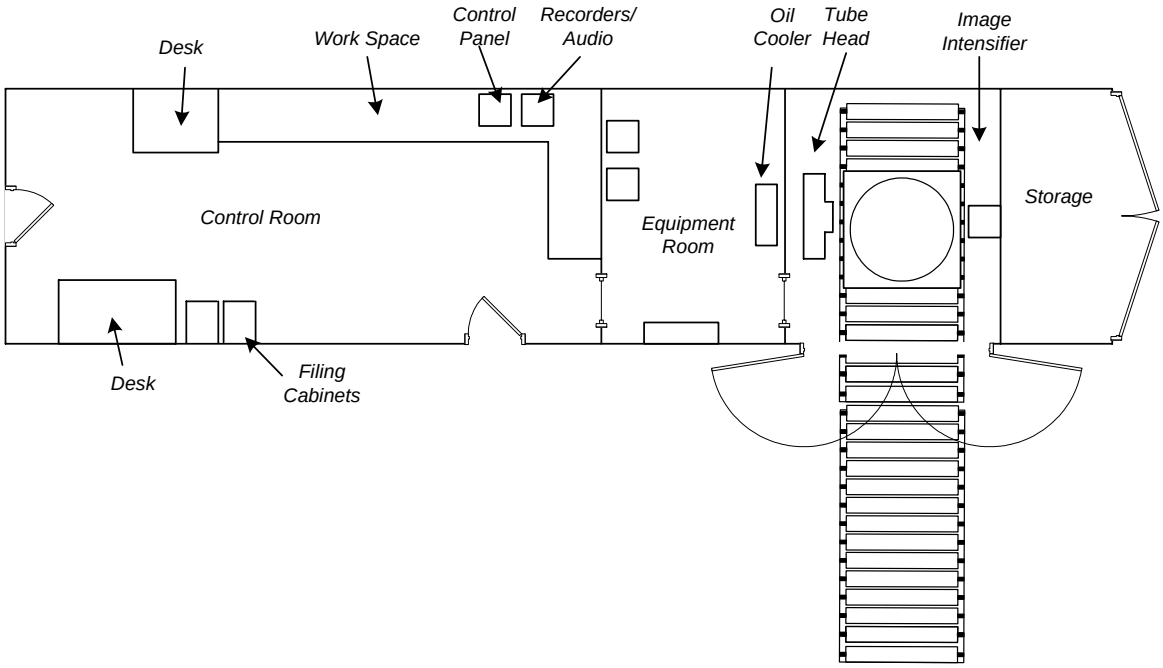

Figure 1. RTR-6 Unit Layout

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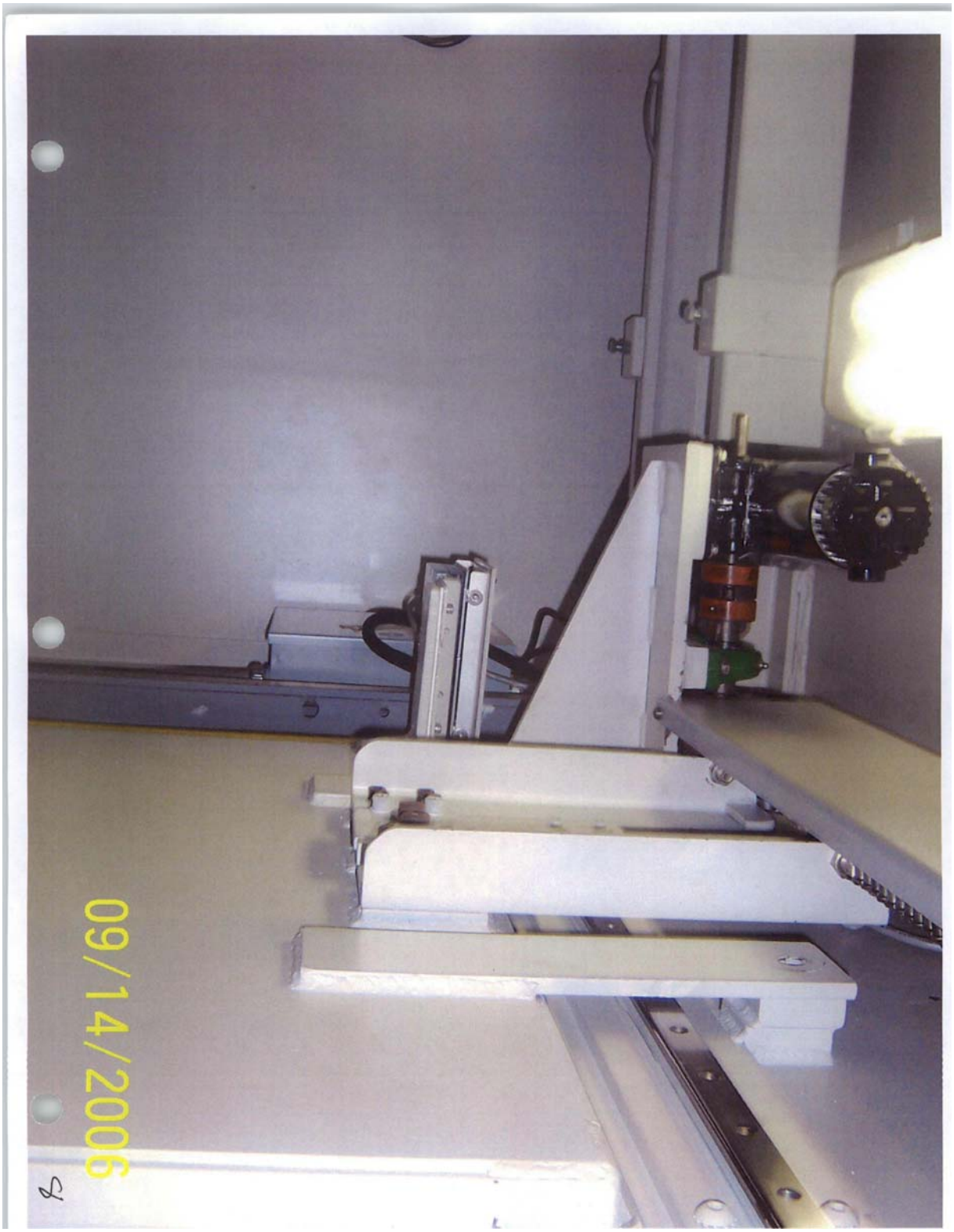

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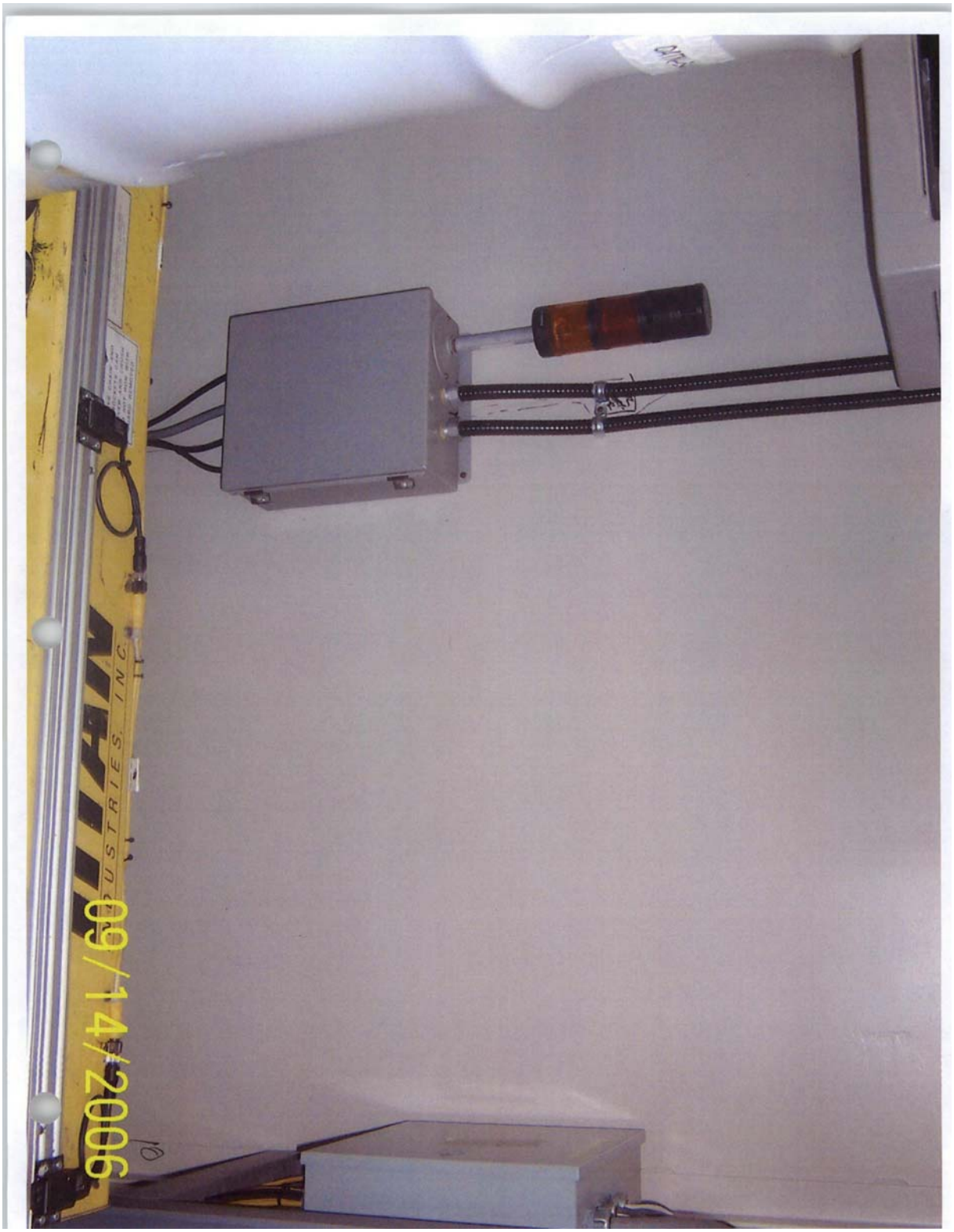

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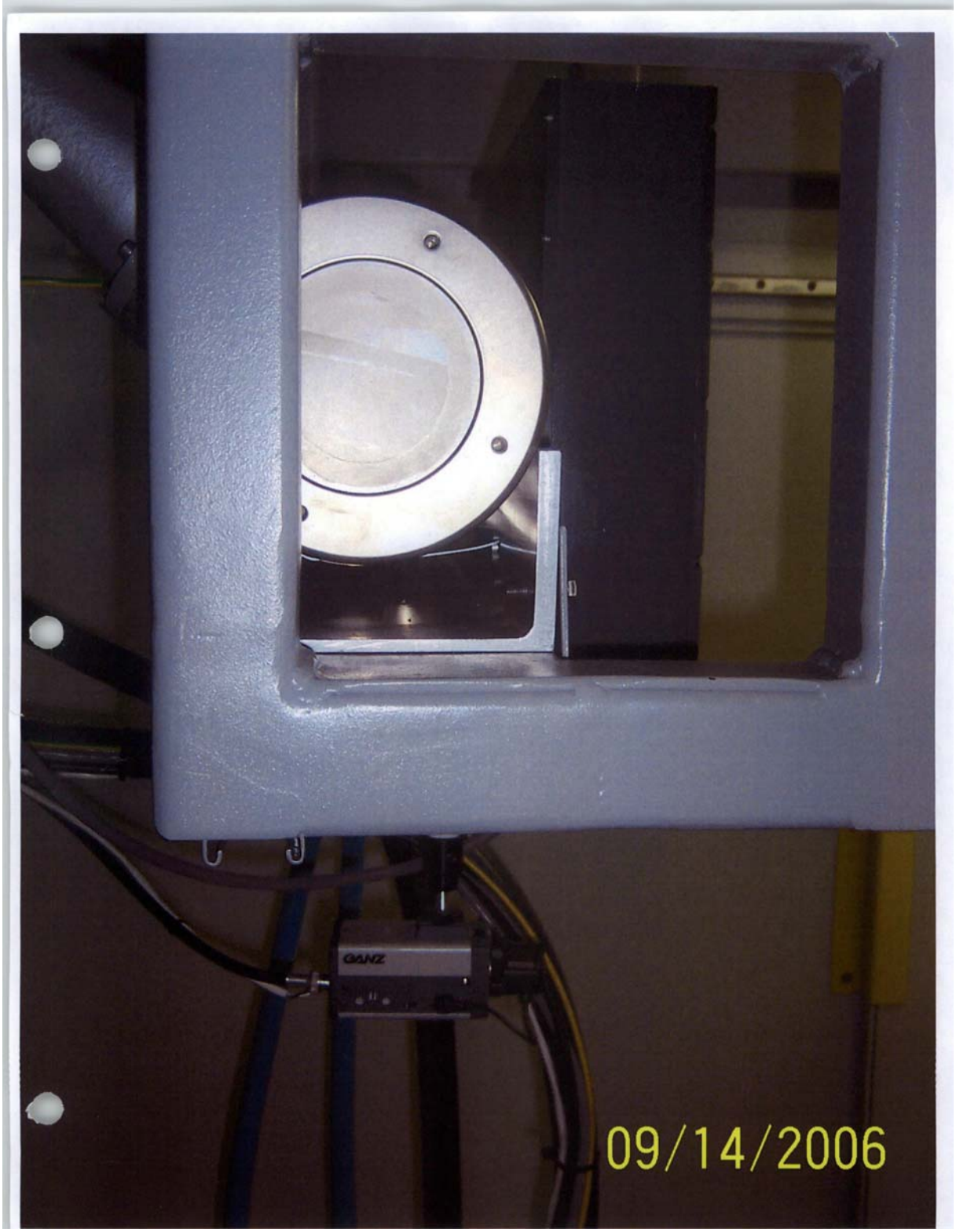

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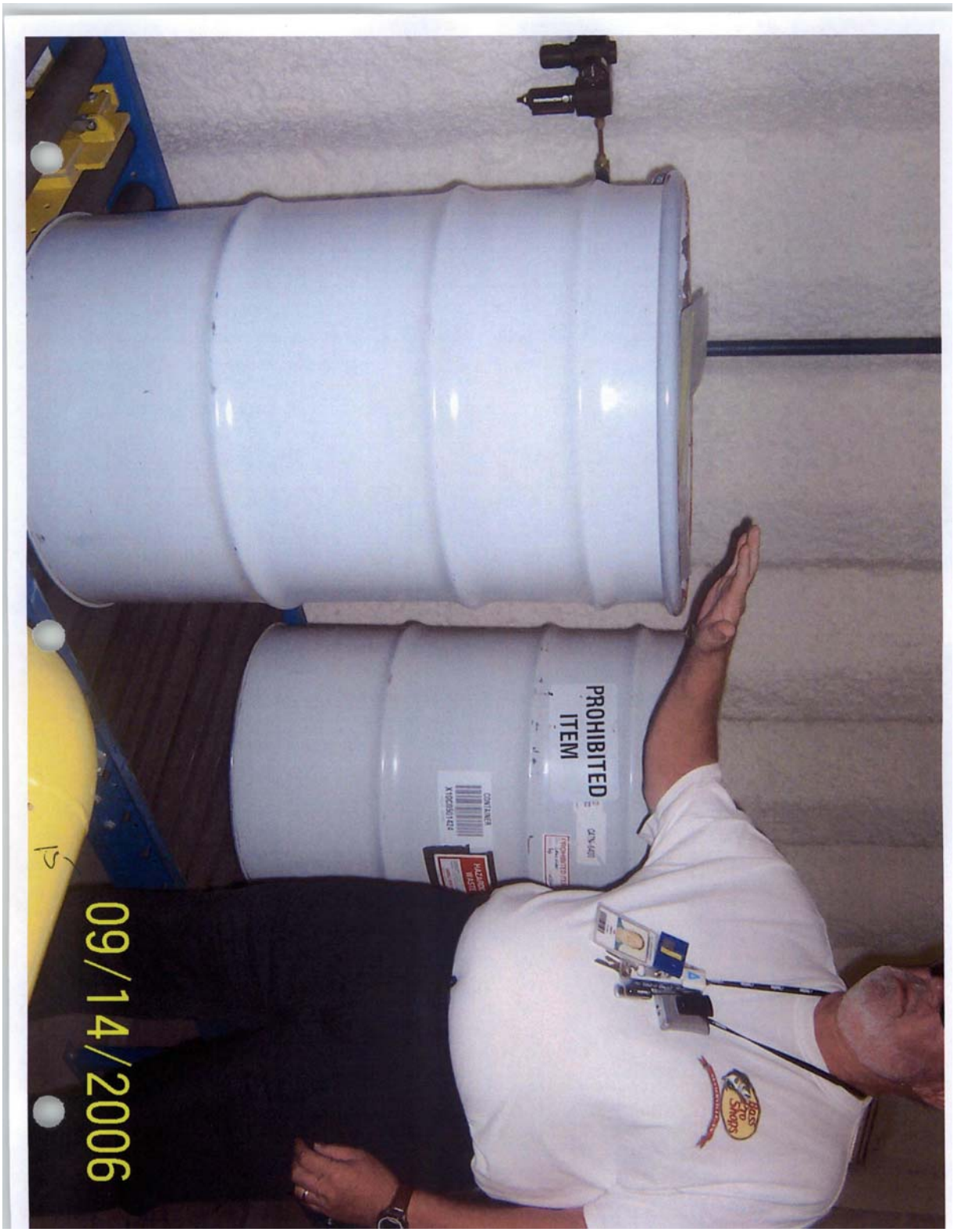
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