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RADIOLOGICAL AND HAZARDOUS MATERIAL PROTECTION

7.1 Radiological Protection

This section discusses (1) the radiological hazards to the worker and off-site public as a result of RH TRU waste handling and emplacement activities, (2) the WIPP radiological control program and organization, and (3) the WIPP "As Low As Reasonably Achievable" (ALARA) policy and program. Waste containers accepted for disposal at the WIPP are surveyed prior to release from the generator sites, and are required to meet the 10 CFR 835[1] external contamination limits. Therefore, WIPP normal operations do not involve or entail any planned or expected releases of airborne radioactive materials to the workplace or the environment.

As part of normal operations activities, the shipping containers, although having met the 10 CFR 835 [1] limits prior to shipping, are closely inspected for damage and surveyed for radiation and radioactive contamination prior to unloading.

7.1.1 Radiological Control Program and Organization

7.1.1.1 Radiological Control Program Objectives

The objective of the radiological control program is to ensure the exposure of employees and the general public to radiation and radioactive materials is within the guidelines of 10 CFR 835 [1]; DOE-STD-1098-99[2], DOE G-441.1-2[3] 40 CFR Part 191, Subpart A;[4] 40 CFR 61, Subpart H;[5] DOE Orders 5400.5,[6] and 6430.1A[7] respectively, and that such exposures are kept ALARA. These objectives are met by ensuring that:

- ALARA Design Reviews are conducted to ensure facility changes comply with 10 CFR 835, Subpart K, Design and Control [12].
- Shipments of radioactive material are handled in accordance with Remote-Handled Waste Acceptance Criteria (RH WAC) [9] limitations, U.S. Department of Transportation (DOT) regulations,[10] and WIPP internal operating procedures.
- Shielding, posting, and access control are used to reduce direct radiation exposure from external radiation.
- Containment and ventilation engineering controls are designed to reduce internal exposures during normal operations.
- Areas where the radioactive waste is unloaded are monitored with alarm capabilities for airborne radioactivity.
- Personnel receive a level of radiation protection training appropriate to their assignments.
- Area Radiation monitors are utilized to provide indication of waste radiation exposure rates as processing progresses through the various phases of RH waste handling.

- Appropriate access/egress control techniques and radiological surveys of personnel and equipment are used to prevent the spread of external contamination.
- A source control program is in place to minimize the potential for the spread of contamination, unnecessary exposure to personnel, loss, theft, sabotage, or improper disposal of radioactive sources.
- A respiratory protection program is in place, and respiratory protective equipment will be used during abnormal activities where personnel could be exposed to high surface contamination and/or airborne radioactivity.
- Instruments and equipment are properly calibrated so that accurate radiation, contamination, and airborne radioactivity surveys can be performed.
- Radiological work procedures and instructions provide for an ALARA review prior to commencement of work, for jobs in which radiation and/or radioactive contamination are expected to exceed trigger levels established by the WP 12-5, WIPP Radiation Safety Manual.[11]
- Appropriate personnel dosimetry devices are supplied, and a radiation exposure record system is maintained.
- An internal dose-assessment program (whole-body counting and bioassay) is in place.
- Radiological Protection management is notified of any unusual or unexpected radiological conditions.
- Every radiological worker is given the authority to stop radiological work if there is evidence that radiological controls are being compromised.
- An effluent and environmental monitoring and/or sampling program is in place to detect releases to the environment, and to verify that facility releases are maintained at a minimum.
- The radiological control program is conducted in accordance with written and approved procedures.
- Access to areas where RH waste has been handled will be controlled in accordance with 10 CFR 835.502[12].

7.1.1.2 Administrative Organization

Radiation safety responsibilities are shared by Operations and the Safety and Health (S&H) Department. The Sections of the S&H Department are Industrial Safety and Hygiene, Nuclear Safety, WIPP Laboratories, and Radiation Safety & Emergency Management. The management organization described in the following paragraphs implements the radiological control program.

Safety and Health (S&H) - The Manager of S&H has responsibility for all activities concerning industrial safety and radiation protection of employees and the general public. With regard to radiological control, the S&H Manager is responsible for the training of radiation workers and Radiological Control Technicians, emergency planning, and the ALARA program. The S&H Manager is also responsible for coordinating these activities with cognizant governmental agencies. Within the organization of the Management and Operating Contractor, the Radiation Safety & Emergency Management Manager reports to the Manager of S&H.

Operational and Programmatic Radiological Safety

Operational Radiation Safety is the responsibility of the CH Radiological Control (CHRC) Manager. The CHRC Manager maintains the radiological safety of the plant by regularly evaluating and assessing surface contamination, radiation levels, and airborne radioactivity levels in radiological work area with respect to approved limits. In addition, the CHRC Manager directs operational health physics activities and ensures the performance monitoring of routine and special WIPP facility operations.

Programmatic Radiation Safety is the responsibility of the Radiation Safety and Emergency Management (RS&EM) Manager. The RS&EM Manager establishes training programs for qualification and re-qualification of Radiological Control Technicians and approving other radiological training programs consistent with 10CFR835 [1] and DOE Orders. The RS&EM Manager approves radiological procedures and is required to review them to ensure their adequacy. The ALARA Coordinator and radiological engineering activities are also directed by the RS&EM Manager.

The RS&EM Manager and designees have the authority to stop operations when an actual or impending loss of radiological control is identified. In addition, because of the importance of radiation safety, the RS&EM Manager has a direct line of communication to the General Manager in matters of radiation safety.

Minimum qualifications for radiological control program personnel are in accordance with applicable DOE Orders and Guidance.

Dosimetry - The RS&EM Manager is responsible for operating and maintaining a personnel dosimetry program to determine radiation exposure to employees and visitors. In addition, the RS&EM Manager is responsible for implementing and operating the internal dosimetry program. The RS&EM Manager has the authority to remove from further exposure, employees who have either reached or exceeded the established administrative radiation exposure limits or not demonstrated their continuing understanding of, or compliance with, the WIPP radiological control program.

7.1.2 ALARA Policy and Program

7.1.2.1 Policy Considerations

It is the firm commitment of the WIPP management that occupational radiological exposures are kept ALARA. This policy, as reflected in administrative programs and procedures established in accordance with 10 CFR 835,[1] and DOE G- 441.1-2[3] ensures that the design basis of the WIPP facility will maintain individual occupational radiation exposures to an ALARA level of less than 1 rem (10 mSv) per year, per person. A site-specific administrative control level may be established at less than 1 rem (10 mSv) per year, per person, in accordance with WP 12-5, WIPP Radiation Safety Manual.[11] ALARA issues are reviewed by the WIPP ALARA Committee. The ALARA Committee and the overall radiological control program are operated in accordance with WP 12-2, WIPP ALARA Program Manual.[14] The ALARA program provides for pre and post job reviews of work which exceeds pre-set triggers as well as routine reviews of programs and procedures which involve control of radiation exposures.

7.1.2.2 Design Considerations

The ALARA techniques applied to the WIPP facility design were based on DOE exposure guide DOE/ EV/1830-T5,[?] as appropriate for this first-of-a-kind facility. Future design modifications will be in accordance with 10 CFR 835,[1] DOE G-441.1-2[3], DOE O 420.1,[15] Facility Safety, and DOE O 430.1A,[16] Life-Cycle Asset Management, and other codes, standards, and orders applicable at the time of modification. Chapter 4 presents details of plant design and operations.

The ALARA criteria were applied during the design of the plant through a series of design reviews by nuclear and health physics specialists from the responsible Architect-Engineer organization. During the operational disposal-phase, ensuring exposures are kept ALARA is the responsibility of all levels of management. Operationally, the manager for RH waste handling is responsible for developing and implementing procedures and the operation of equipment to ensure personnel exposures are maintained ALARA.

Changes to the RH facility and equipment will follow the Engineering Change Order process in accordance with WP 09-CN3007.[17] Completion of Attachment 1 of WP 09-CN3007 will cause the cognizant engineer to perform an evaluation of the need for ALARA review in accordance with Attachment 4, ALARA Screening Checklist, of WP 12-2, WIPP ALARA Manual[14].

An ALARA design review has been conducted for the facility changes for the Remote Handled waste processes. This review was conducted in accordance with DOE G-441.1-2[3].

7.1.2.3 Operational Considerations

Radiological exposure to plant personnel during operations will be kept ALARA by continued review of operations and training. Radiological Control Technicians (RCTs) will participate directly with RH waste handling and provide up to date information to Waste Handling Operators as to radiation levels and locations where exposures can be minimized. The WIPP ALARA Program is described in the WIPP ALARA Manual, WP 12-2.[14]

The Manager of S&H, or designees, will monitor performance of the waste handling operations by reviewing exposures, procedures, and incident reports, and recommending corrective action when required. The DOE and the Management and Operating Contractor (MOC) will supplement this program through periodic audits of exposure records and procedures, as well as investigations of all incidents.

7.1.3 Radiological Exposure Control

7.1.3.1 Radiological Protection Design Features

7.1.3.1.1 Plant Arrangement Designs for Keeping Exposures ALARA

The design of the RH systems and facilities have been reviewed for ALARA considerations using the ALARA Design Review format specified in WP 12-2[11].

<u>Facility Arrangement</u> - For radiological control purposes, the areas in the WIPP facility to which access is managed to protect individuals from exposure to radiation and/or radioactive materials are identified as Controlled Areas, and are administrated in accordance with the WP 12-5.[11] The Controlled Areas are segregated from other operating areas by physical barriers (e.g., tape, rope, fences, walls, bulkheads).

The surface Controlled Areas are primarily located in and around the Waste Handling Building (WHB), and are separated from other areas by a fence and walls (Figure 4.1-2).

A Controlled Area will be established in the underground disposal area during disposal operations. Engineering control features are incorporated in the arrangement of the underground disposal area. The disposal area is isolated from the construction area by physical barriers or postings and separate ventilation flow paths discussed in Chapter 4. The disposal areas are normally excavated in groups of rooms called panels, as indicated in Figure 4.1-3. Personnel entering Controlled Areas will have completed General Employee Radiological Training (GERT) or be escorted. In this way, personnel in Controlled Areas will have adequate knowledge not to enter areas requiring further training or monitoring.

Access control and personnel traffic patterns are considered in the plant layout to minimize the potential for spreading contamination, and to minimize personnel radiation exposure.

<u>Waste Handling Building - General Arrangement</u> - A Controlled Area will be established in the WHB, as required to support Waste Handling operations. All entrances to Controlled Areas will be posted and personnel must either have completed GERT or be escorted by an individual who has completed GERT. Individuals who have completed this level of training are knowledgeable in the requirements for entry and following the requirements of the radiological areas within the Controlled Areas.

Air locks are located between areas with either different levels of contamination potential or large pressure differentials. The ventilation system and air locks act to mitigate the spread of contamination by maintaining pressure differentials between radiological areas. This is done to ensure that any leakage is directed into areas with higher potentials for contamination.

<u>RH TRU Waste Handling Area Arrangement</u> - Shielded road casks containing RH waste canisters and 55-gal drums will arrive at the WIPP Facility on a tractor-trailer and will be received into the WHB through an entry on the RH side. The RH side of the WHB contains two major areas for handling RH mixed waste: the RH bay and the transfer complex. The transfer complex is divided into four areas designed for specific functions: the Cask Unloading Room (CUR) , the Transfer Cell, the Hot Cell, and the Facility Cask Loading Room.

The RH bay is a high-bay area for shielded road cask receiving and subsequent handling operations. For contamination control, the WHB ventilation system is designed to maintain negative pressures where postulated accidents could occur. This means the Transfer Cell will be at a lower pressure than either the RH bay or the Facility Cask Loading Room.

Upon arrival, radiological surveys, security checks, and shipping documentation reviews will be performed to ensure compliance with Department of Transportation requirements. Upon completion of these checks, the hazardous waste manifest will be signed to release the driver.

Following shielded road cask inspections, the cask will be moved into the RH bay. Once the trailer is in position, more detailed exposure rate surveys will be conducted where work will be performed around the cask.

72B Road Cask Handling

After the radiological surveys are completed, the impact limiters will be removed from the shielded road cask while it is on the trailer. The newly exposed areas previously covered by the impact limiters will then be surveyed for dose rates and surface contamination. The shielded road cask will be unloaded from the trailer using the 140/25-ton bridge crane and rotated to a vertical position, then placed on the road cask transfer car. The road cask transfer car will then move the road cask to the work platform. The work platform provides personnel access to the head area of the road cask for unloading and shipment preparations, including conducting radiological surveys, performing physical inspections or minor maintenance, and decontamination, if necessary. As the outer lid is removed, dose rate and contamination surveys will be performed. As part of the outer lid removal process, pressure is equalized through a HEPA filter assembly. The filter is verified free of contamination before the lid is unbolted.

When activities at the cask preparation stand are complete, the road cask transfer car moves the shielded road cask into the concrete-shielded CUR. The CUR 25-ton crane and cask lift fixture will lift the road cask to clear the transfer car so the empty car can be removed from the room. The 25-ton crane positions the road cask over the CUR floor shield valve.

The floor shield valve when closed separates the CUR from the Transfer Cell. The floor shield valve is interlocked with the Hot Cell and Transfer Cell shield valves in a manner that allows only one to be open. These Interlocks ensure that differential pressures are maintained to ensure any contamination is maintained within the RH transfer complex.

The floor shield valve will be opened, and the road cask lowered onto the awaiting shuttle car in the Transfer Cell. After disconnecting and raising the lift fixture, the floor valve will be closed. After the road cask has been lowered onto the shuttle car, the shuttle car will position the road cask at the road cask inner vessel (IV) lid de-tensioner station. The robotic de-tensioner loosens the bolts on the IV lid (the bolts remain in the lid and are kept out of the bolt holes by springs). The shuttle car is then positioned so that the road cask is aligned directly under the Transfer Cell shielded ceiling valve in preparation for transferring the canister into the facility cask.

Using the Facility Cask Loading Room 6.25-ton grapple hoist, the inner cask lid will be removed and contamination smears obtained remotely. The smears are transported from the Transfer Cell to the location where the analysis is performed using a vacuum driven smear delivery system. After the smears have been counted, the lid will be lowered to a location next to the road cask. The waste canister pintle will be smeared and analyzed using the same system. The RH waste canister will be lifted by the grapple hoist from the road cask (through the open ceiling shield valve) into the vertically oriented facility cask. During the lift, smears will be taken to verify that the waste canister contamination levels are within WIPP criteria. If contamination is detected greater than 100 times the WIPP limit, the contaminated canister will be returned to the road cask and returned to the shipper. Also during its lifting from the road cask into the facility cask, the identity of the waste canister will be checked against that listed on the hazardous waste manifest and the WIPP Waste Information System (WWIS) to verify that the canister is suitable for emplacement.

After the waste canister has been transferred to the facility cask, the inner lid will be placed on the road cask. The road cask will be moved to the RH Bay where the inner lid will be removed and the internals surveyed for contamination. If a surface area of less than 6 sq. ft is found to be contaminated at levels less than 100 times the WIPP limit, it will be decontaminated. If contamination area greater than 6 sq. ft and/or levels greater than 100 times the WIPP limit is detected, the cask will be returned to the shipper for decontamination.

10-160B Road Cask Handling

After the radiological surveys are completed, the top impact limiter will be removed from the 10-160B shipping cask while it is on the trailer. As the road cask is lifted from the trailer using the 140/25-ton bridge crane, newly exposed areas will be surveyed for contamination and dose rates prior placement on the road cask transfer car. If water is found in the lower impact limiter, it will be pumped out and stored until an analysis shows that the activity is less than the DOE Derived Concentration Guide prior to disposal. Then the cask will be vented through a HEPA filter assembly. The HEPA filter assembly will be surveyed for surface contamination after the pressures have equalized. Operations will install the lid lift fixture and remove the road cask lid bolts.

After the cask lid is unbolted, the cask will be moved into the CUR, with the Hot Cell Shield Plug installed. The CUR shield door will be closed, the Hot Cell Shield Plugs removed and the road cask lid lifted into the Hot Cell. The contents of the cask will be lifted into the Hot Cell using the Hot Cell 15 ton crane.

Contamination surveys will be conducted as the10-160B cask is disassembled and its contents are being removed. Smears will be taken of the underside of the lid and on drums and carriage as they are brought into the Hot Cell.

The waste drums from the cask will be surveyed for contamination using manipulators which will take smears and place them in the shielded Transfer Drawer. The drawer allows the transfer of the smears out of the Hot Cell while maintaining shield integrity. After the drums have been surveyed and the identity of each drum verified, the lid will be placed on the 10-160B road cask and the Hot Cell shield plugs re-installed. The road cask will be moved to the RH Bay where the lid will be removed and the internals surveyed for contamination. If a surface area of less than 6 sq. ft is found to be contaminated at levels less than 100 times the WIPP limit, it will be decontaminated. If contamination area greater than 6 sq. ft and/or levels greater than 100 times the WIPP limit is detected, the cask will be returned to the shipper for decontamination. Once the drums are identified and surveyed clean, they will be placed in facility canisters and then transferred from the Hot Cell through the Hot Cell shield valve into the Transfer Cell. If contamination greater than 100 times the WIPP limit is detected, the drums will be repackaged and returned to the shipper.

The Hot Cell shield valve when closed separates the Hot Cell from the Transfer Cell. The Hot Cell shield valve is interlocked with the Cask Loading Room floor shield valve and Transfer Cell shield valves in a manner that allows only one to be open. These Interlocks ensure that differential pressures are maintained to ensure any contamination is maintained within the RH transfer complex.

The facility canister is placed into the shielded insert on the shuttle car. The shuttle car is then positioned so that the shielded insert is aligned directly under the Transfer Cell ceiling shield valve in preparation for transferring the facility canister into the facility cask. The Facility Cask Loading Room 6.25-ton grapple hoist is used to lift the facility canister from the shielded insert (through the open ceiling shield valve) into the vertically-oriented facility cask in the Facility Cask Loading Room.

Transfer to Facility Cask

The facility cask, located in the Facility Cask Loading Room, is connected to the floor mounted facility cask rotating device which rotates the facility cask from a horizontal to the vertical position. The required electrical and air connections are made to the facility cask. The telescoping port shield is raised to mate with the bottom of the facility cask and the shield bell is lowered to mate with the top shield valve of the facility cask to ensure shielding continuity during the waste canister transfer. The operating console used for performing these operations is located behind a shadow shield in the north portion of the Facility Cask Loading Room.

Once the waste canister is loaded and the facility cask shield valves are closed, the facility cask will be rotated to the horizontal position. The facility cask will then be monitored for external dose rates. The door to the waste shaft will then be opened, accessing the waste hoist conveyance. The facility cask transfer car will be loaded onto the waste hoist conveyance and lowered to the waste shaft station underground.

Underground Facility Cask Handling

At the Underground waste shaft station, the facility cask will be moved from the waste hoist cage by the facility cask transfer car. A 41-ton forklift will be used to remove the cask from the transfer car and transport the cask to the disposal room. There the facility cask will be placed on the horizontal emplacement equipment, which will have been previously aligned with a horizontal hole bored into the room wall. The horizontal emplacement equipment will then insert the canister into the hole. A shield plug will then be inserted into the hole to provide radiation shielding. After the emplacement equipment is moved, radiation exposure rate surveys will be conducted around the shield plug and smears taken from the facility cask. Radiological postings will be used if required, based on these surveys.

Routine surveys will be conducted of the RH waste processing area and equipment to verify that there is no long-term buildup of contamination.

7.1.3.1.2 Equipment and Component Designs for Keeping Exposures ALARA

This section summarizes the design features used for general classes of equipment and major components. These classes of equipment are common to many of the plant systems. Therefore, the features employed to maintain exposures ALARA for each system are similar.

Waste Handling Equipment - Features to facilitate decontamination, such as smooth cleanable surfaces and the elimination of square corners and crevices, are incorporated in the handling equipment design, where practicable. Mechanical handling equipment is designed for easy replacement for decontamination and/or repair.

Forklifts are designed to transport the waste packages while minimizing the potential for accidents. They also ensure the effective securing of waste packages to minimize waste handling time.

Instruments - Whenever practical, instrumentation and control devices are located in low radiation areas and away from radiation sources. Instruments, that for functional reasons are located in areas with a relatively high radiation background, are designed for easy removal to areas with a lower radiation background for calibration or repair.

Lighting - Multiple electric lights are provided. Sufficient illumination is provided so that the loss of a single lamp does not require immediate entry and replacement of the defective lamp.

HVAC Equipment - The environmental control systems for areas with a potential for contamination are designed for contamination-free replacement of filter elements.

7.1.3.1.3 Radiation Shielding

7.1.3.1.3.1 Design Objectives

The objective of radiation shielding is to minimize the exposure of personnel to the radiation sources described below. Radiation shielding is one of the methods utilized to maintain the exposure of personnel to radiation ALARA.

7.1.3.1.3.2 Direct Radiation Sources

The direct radiation sources that are the bases for shielding design are categorized from RH TRU waste. The direct radiation sources described in this section use maximum expected values and conservative assumptions to ensure a conservative basis for radiation shielding design. The representative characteristics of these radiation sources are described below.

RH TRU Waste - RH waste composition is defined in DOE/CAO 95-1121.[18] This report classifies the waste into material types (e.g. plastic, soil, metal, etc.) And provides information on packaging materials and radionuclide inventory. Approximately 96.5 percent of the total RH-TRU activities is contributed by Cs-137, Sr-90, Pu-241, and Y-90. Thus, the remaining radionuclides contribute a very small fraction of the total curies for the repository.

7.1.3.1.3.3 Design Description

To meet the original shielding design objectives, the following general guidelines were used:

- Radiation shielding thicknesses must ensure that the dose rate due to uncollided and scattered radiation through the shield are less than the maximum levels specified for each design radiation zone. Shield wall thicknesses are shown in plant arrangement drawings.

- Principal shielding materials are ordinarily concrete/rebar, lead, steel, or salt. Shielding materials for viewing windows include leaded glass and mineral oil. Temporary shielding, such as lead blankets, bricks, or other materials may also be employed, as required, during maintenance or other operations.

- Temporary shielding for openings such as doors, hatches, windows, ventilation ducting, and piping should be designed to prevent radiation streaming. Penetrations through primary shielding are typically placed so that they do not provide a direct line through the shield wall to the radiation source. Design features such as offset piping connections, stepped doors or hatches, shadow shields, and labyrinths are incorporated in the shielding design, wherever applicable. Shielding for large diameter penetrations is provided by additional concrete or steel around a penetration. Shielding can also be provided by the addition of shield collars or leaded grout around pipes and penetrations.

- Access to potentially high radiation areas involves passage through shield doors or labyrinth walls. This prevents direct radiation streaming into adjacent areas. Labyrinth shielding is designed so that the exposure due to uncollided and scattered radiation is less than the maximum levels specified for the adjacent area.

  Current design requirements specify that routinely occupied areas have radiation levels less than 1,000 mrem/year [8]. It is expected that the facility will meet this requirement as it was designed to handle wastes up to 400,000 R/hour. These levels will be verified during initial operations

Within the RH TRU Waste Handling Area, RH TRU waste canisters are handled within shielded casks. The facility cask provides shielding while the RH TRU waste canisters are moved from the facility cask loading room to the disposal locations underground. Figure 4.2-16 shows the facility cask shielding.

The facility cask provides a cylindrical steel and lead shield enclosure around one RH TRU canister, and has shield valves at either end. The facility cask design includes sufficient shielding to reduce gamma radiation levels to less than 200 mrem/h (2 mSv/hr) at the surface of the cask from a RH canister with 7,000 rem/hr dose rate[19]. Design and operation of the facility cask will be reviewed should a significant RH TRU neutron contribution be identified which requires a design change of the road cask..

Within the Underground Disposal Areas, personnel exposures are maintained ALARA using a combination of component and equipment shielding and administrative controls. The facility cask construction provides shielding for operators and helps maintain doses ALARA during transport of the waste. When transferring a RH TRU canister from the facility cask to the disposal location in the underground salt, horizontal emplacement and retrieval equipment (HERE) shielding overlap with the facility cask to minimize radiation streaming paths.

A shielding plug will be inserted into the waste borehole to reduce radiation levels in occupied areas of the panel to maintain radiation exposures ALARA while additional waste handling operations are conducted. While the underground equipment help maintain doses ALARA, other activities will be included to maintain ALARA doses. These include using a remote operating console 20 ft (6.1 m) from the emplacement equipment and RCT coverage to determine low exposure rate areas for the operators during the transfer. Operator time in radiation fields will also be minimized based on surveys performed and directions provided by the RCTs when waste movement is not in progress.

7.1.3.1.3.4 Method of Shielding Analysis

The radiation source terms used for shielding design are based on a source term of 100 rem (1 Sv) per hour for the emplacement equipment[19,20] and 7000 rem (70 Sv) per hour for all other components and areas[21] in the RH process. The Transfer Cell and Hot Cell were designed for exposure rates up to 400,000 rem (4,000 Sv) per hour.[22]

Shielding analysis was performed by the Architect-Engineer for the WIPP Project by use of the QAD-P5A computer code and input parameters.[23,24] This code is a multi-group, multi-region point kernel, general purpose shielding code for estimating the effects of gamma rays originating in a volume distributed source. The point kernel method utilized by the code involves representing the source volume by a number of point sources, and computing the line of sight distance from each point source to the detector point. Using the distance the gamma ray travels through the shielding and the attenuating characteristics of the shielding materials, the geometric attenuation and material attenuation are determined. The point kernel representing the energy transferred by the uncollided photon flux along a line of sight path is combined with an appropriate buildup factor to account for the contribution from the scattered photons.

Gamma scattering calculations are used to estimate dose rates around labyrinth and shadow shielding. The G^3 computer code and input parameters are used for gamma scattering calculations.[25] The code calculates gamma scattering from a point source to a series of point detectors. The code evaluates the uncollided flux at specified scatter points, and multiplies it by the product of the differential cross section for scattering toward the detector point and the number of electrons in the elemental volume associated with the scatter point (the center of the elemental volume).

The ANISN computer code, with the Cask 40-group neutron/gamma cross section library, is used for neutron and secondary gamma calculations to confirm adequate shield thicknesses.[26,27] This code is a multi-group, multi-region, one dimensional, discrete ordinates transport code that solves the Boltzmann transport equation in slab, cylindrical, or spherical geometries for neutron and gamma radiation.

These computer codes are used to calculate dose rates for various shielding thicknesses. The radiation sources in the computer code are modeled as closely as possible to the actual geometries, dimensions, and physical conditions. The design objective of the shielding was to limit surface dose rates to less than 200 mrem (2 mSv) per hour with a RH canister of 1000 rem (10 Sv) per hour [28].

Shielding Integrity and Verification - The integrity of the shielding and its design features is ensured by the adherence to the requirements and recommended practices described in ANSI N101.6-1972,[29] with the following additional criteria:

- In addition to the applied loads requirements listed in Section 4.3.3 of ANSI N101.6-1972,[29] the concrete radiation shield structural analysis also considers steady-state and transient thermal loads.

- Detailed thermal stress analysis in the design of reinforcement for controlling thermal cracking (temperature reinforcement) in specific concrete radiation shields is included in determining variables used in equations for bending moment and tensile stress, as described in Section 6.4 of ANSI N101.6-1972.[29]

- Reinforcing steel or other means are provided for transferring shear and other forces through a construction joint, as described in Section 8.8.7 of ANSI N101.6-1972.[29]

Shielding surveys will be conducted around the outside of the shield walls during initial RH waste handling. The surveys will focus on potential streaming paths but general area surveys will also be conducted. Locations where general area radiation levels could cause individuals to exceed 5 mrem (.05 mSv) in any one hour or 100 mrem (1 mSv) in a year will be posted and barricaded and shielding corrections initiated, if necessary.

7.1.3.2 Radiological Practices

7.1.3.2.1 Radiation Safety Training

Radiation safety training is conducted at the WIPP facility to ensure that each worker understands: (1) the general and specific radiological aspects of their assignment, (2) their responsibility to their co-workers and the public for safe handling of radioactive materials, and (3) their responsibility for minimizing their own radiation exposure. The level of training for each employee is commensurate with the requirements of their job category.[11]

7.1.3.2.2 Radiological Control Procedures

The following procedures are established by policy to help ensure that radiation exposures to the general public, operating personnel, and the environment are within regulatory limits and ALARA.

Radiation and Contamination Surveys - Radiological Control Technicians (RCTs) perform routine radiation and contamination surveys of the facility and surveys of the waste packages upon receipt. In addition, RCTs will perform surveys on normally inaccessible areas when they are opened for maintenance and/or inspections. These areas include ventilation piping, drains, and overhead structural surfaces in the waste handling areas. Routine survey areas and frequencies are established in accordance with health physics procedures and manuals, and are based upon the probability of contamination and changes in radiation level, and upon personnel occupancy. These surveys consist of measurements for dose rate and contamination, as appropriate, for the specific area.

RCTs also provide job coverage surveys during the processing of RH shipping casks. These surveys include contamination surveys when new surfaces are exposed and exposure rate surveys when shielding is removed.

The records of the survey results are retained in a permanent file by the CH Rad Con section, and are reviewed shortly after survey performance, so that trends indicative of problem areas are identified as early as possible. Radiation and contamination surveys and associated records are described in Chapter 5 and Chapter 7 of the WIPP Radiation Safety Manual,[11] respectively.

Access Control - Access to radiological areas of the facility is controlled in accordance with 10 CFR 835[1] Only personnel who have successfully completed the requirements specified in the WIPP Radiation Safety Manual[11] will be allowed unescorted entry to the radiological areas of the site. All other personnel will require an escort. Personnel monitoring will be in accordance with WP 12-3, Dosimetry Program,[30] and the WIPP Radiation Safety Manual.[11]

The WIPP policy addressing visitors is described in Chapter 3 of the WIPP Radiation Safety Manual.[11]

Personnel entering a Controlled Area are required to obtain GERT prior to entering. Personnel performing radiological work in a radiological area are required to sign-in on a Radiological Work Permit (RWP), issued in accordance with Chapter 3 of the WIPP Radiation Safety Manual.[11]

The RWP specifies the controls necessary for the planned entry, and may require additional monitoring devices, protective clothing, respiratory equipment, etc. If a supplemental dosimeter is required, personnel must log in and out of the area to record the dosimeter readings. The necessity for these control items may be based exclusively on radiation level, a combination of surface contamination and radiation level, an area of airborne radioactivity, or the potential for occurrence of any of these conditions. When required, these additional control items will be prescribed, and personnel will be properly equipped prior to entering the work area.

Exposure control is accomplished by identifying areas containing sources of radiation and/or contamination, and controlling personnel access into these areas.

Access to high radiation areas is controlled in accordance with 10 CFR 835.502, High and Very High Radiation Areas,[12] unless exempted by DOE headquarters. All areas that have high radiation levels will have access controlled by approved means give in 10 CFR 835.

Radiological areas are designated and defined in 10 CFR 835[1] and the WIPP Radiation Safety Manual,[11] as follows:

- Radiological Area - Any area within a controlled area defined as a Radiation Area, High Radiation Area, Very High Radiation Area, Contamination Area, High Contamination Area, or Airborne Radiation Area.
- Controlled Area - Any area to which access is controlled in order to protect individuals from exposure to radiation and radioactive materials.
- Radiological Buffer Area (RBA) - An intermediate area established to prevent the spread of potential radioactive contamination. The area may surround Contamination Areas, High Contamination Areas, and Airborne Radioactivity Areas.
- Radioactive Material Area (RMA) - Any area within a controlled area, accessible to individuals, in which items or containers of radioactive material exist and the total activity of radioactive material exceeds the applicable values in Appendix E of 10 CFR 835.[1]
- Radiation Area - An area accessible to personnel in which the dose rate is greater than 0.005 rem (0.05 mSv) per hour, but less than or equal to 0.1 rem (1 mSv) per hour, at 11.8 in (30 cm) from the source, or from any surface that the radiation penetrates.
- High Radiation Area - An area, accessible to personnel, in which the dose rate is greater than 0.1 rem (1 mSv) per hour at 11.8 in (30 cm), but less than or equal to 500 rad (5 Gy) per hour, at 39.4 in (1 m) from the radiation source, or from any surface that the radiation penetrates.
- Very High Radiation Area - An area, accessible to personnel, in which the dose rate is greater than 500 rad (5 Gy) per hour at 39.4 in (1 m) from a radiation source or from any surface that the radiation penetrates.
- Contamination Area - Any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed the removable surface contamination values specified in Appendix D of 10 CFR 835.[1]
- High Contamination Area - Any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed 100 times the removable surface contamination values specified in Appendix D of 10 CFR 835.[1]
- Airborne Radioactivity Area - Any area, accessible to individuals, where: 1) The airborne radioactivity, above natural background, exceeds or is likely to exceed the Derived Air Concentration (DAC) values listed in Appendix A or Appendix C of 10 CFR 835,[1] or 2) An individual present in the area without respiratory protection could receive an intake exceeding 12 DAC-hours in a week

Personnel Monitoring Program - Personnel at the WIPP facility are monitored for both internal and external exposure as described in Section 7.1.3.2.6.

A routine external exposure monitoring program at the WIPP facility measures the radiation dose received by personnel. The external dose measurement program is described in Chapter 5 of the WIPP Radiation Safety Manual,[11] and WP 12-3, Dosimetry Program.[30]

Internal exposure measurement is described in Chapter 5 of the WIPP Radiation Safety Manual,[11] and the Dosimetry Program.[30] The WIPP program for internal exposure measurement may use the techniques of in-vitro bioassay examination (e.g., urinalysis, and/or fecal analysis) and in-vivo bioassay examination (whole-body counting and chest counting). Bioassay will be performed periodically for workers who handle radioactive materials as a normal function of their job. Internal dose assessment may be triggered by high airborne activity in work areas and/or unexpected contamination incidents.

Personnel dosimetry records are maintained by Dosimetry, which ensures that occupational exposure records are maintained in a readily retrievable data base, to permit ready accounting of employees' accumulated radiation exposure. Maintenance of personnel radiation exposure records is described in WP 12-3, Dosimetry Program Manual.[30]

Airborne Radioactivity Monitoring Program - The airborne radioactivity monitoring program complies with 10 CFR 835,[1] and verifies that the survey program described above is detecting contamination control problem areas, and those problem areas are corrected before loose surface contamination becomes airborne. The equipment used for air sampling and monitoring is described in Section 7.1.3.2.6. The airborne monitoring program is described in Chapter 5 of the WIPP Radiation Safety Manual.[11]

Respiratory Protection Program - A variety of types of respiratory protection equipment for non-routine operations such as maintenance, emergency use, and mine rescue are available at the WIPP facility.

Only respiratory protection equipment approved for use by the National Institute of Occupational Safety and Health (NIOSH) is used at the WIPP facility.

Workers who may be required to wear respiratory protection equipment must attend a training program on the equipment use during abnormal and emergency conditions. They are fitted for the devices they are required to wear, and are given a special medical examination to ensure that there is compatibility with wearing the devices.

The respiratory protection program meets the requirements of ANSI Z88.2-1992.[31] Respiratory protection is addressed in Chapter 5 of the WIPP Radiation Safety Manual,[11] and WP 12-IH.02, WIPP Industrial Hygiene Program.[32]

Radioactive Material Control - There are two facets to the control of radioactive material. The first is radioactive source control. Radioactive sources, Plutonium, Strontium/Yttrium, and Cesium are used to test, calibrate, and check the operation of radiation detection instrumentation. Radioactive sources are also brought on-site by external organizations for testing, radiography, and soil density operations. Use of sources on-site by external organizations is controlled in accordance with WP 12-HP3200, Radioactive Material Control[33]. The cognizant individual requesting the outside organization is responsible for informing the Radiological Control Manager of the plan. The Radiological Control Manager will ensure the external organization meets training and source documentation requirements and then will authorize bringing the source on site. The radioactive source control program ensures that proper control, including leak testing, inventory, transfer, and disposal of these sources are maintained at all times to prevent loss/theft, spread of contamination, and other abnormal occurrences involving radioactive sources.

The second facet of the radioactive material control program is the control of radioactive material produced from radiological work processes performed on-site. Any item used in a process that involves known or suspected presence of radioactive contamination or radioactive materials is surveyed prior to release from a radiological area. Items which could contain internal or masked (e.g., painted) contamination will be evaluated prior to release. If the survey indicates the presence of radioactive material on the item, then the item is either decontaminated or disposed of as site-derived waste, as directed by the CH RadCon Manager.

7.1.3.2.3 Radiological Control Facilities

Control Points - Personnel leaving Contamination, High Contamination, and Airborne Radioactivity Areas are also required to check out. Personnel leaving Contamination, High Contamination, and Airborne Radioactivity Areas are also required to perform a personnel survey prior to exit.

Personnel Access Control Points - As discussed in Section 7.1.3.2.2, access to the areas at the WIPP facility where radioactive materials are handled is controlled and limited to personnel who have successfully completed the requirements of Chapter 6 of the WIPP Radiation Safety Manual.[11]

Laboratory Facilities - Radiological analysis facilities are located in the Safety and Emergency Services Building, and the WHB. The counting equipment located in the laboratories is described in Section 7.1.3.2.6. A sample preparation facility, which is used to prepare samples for analysis, is also located near the Safety and Emergency Services Building. The sample preparation facility has appropriate equipment for radiochemical separation of radionuclides in the samples for counting.

Calibration Facilities - The dose rate instrument calibration facility is located near the Shielded Calibration Room of the Support Building. Contamination survey instruments are calibrated in the TRUPACT Maintenance Facility OHP office in the WHB. Calibration equipment is described in Section 7.1.3.2.6.

Equipment Decontamination Stations - Decontamination or overpacking of major equipment will be conducted as discussed in Section 4.3.1. Decontamination can be accomplished in place, according to established procedures.

Dosimetry Laboratory - The laboratory is located in the Safety and Emergency Services Building. The TLD equipment in the laboratory is described in Section 7.1.3.2.6. No radioactive materials, other than those used for calibration purposes, are permitted in the Dosimetry Laboratory.

Plant Clothing Facility - Plant clothing will be obtained from the clothing issue room in the Support Building. Plant clothing items, which are assumed or have been shown by survey to be contaminated, will be disposed of as site-generated waste.

7.1.3.2.4 Radiological Control Equipment

Various types of protective clothing and equipment are stocked at the WIPP facility to protect personnel from contamination. Protective clothing is provided for body, head, hand, and foot protection.

Contamination control equipment is used to prevent or limit the spread of radioactive contamination, and to assist in its removal. The equipment is stored and routinely inventoried in cabinets in or near areas where it is normally used.

7.1.3.2.5 Radiological Posting

When required, areas within the WIPP facility, including the underground disposal area, are posted in accordance with 10 CFR 835,[1] and the WIPP Radiation Safety Manual,[11] to specify the actual or potential radiological hazard. Posting provides necessary information and access control for minimizing personnel radiation exposures and the potential spread of contamination, as described in Section 7.1.3.2.2.

7.1.3.2.6 Radiation Protection Instrumentation

The instrumentation used by the health physics personnel can be divided into four categories:

- Fixed radiation counting instruments (laboratory type)
- Portable radiation/contamination survey instruments
- Airborne radioactivity sampling and monitoring instruments
- Personnel Monitoring Instruments

Instruments are repaired and calibrated by WIPP Maintenance personnel, RCTs, or off-site calibration facilities. In some cases, specialized instruments may be returned to the manufacturers for repair and calibration. If the instruments have been used in areas where they have the potential to be contaminated, they will be surveyed for radioactive contamination before any maintenance/calibration can start.

Fixed Radiation Counting Instruments - Fixed radioactivity counting instruments are located in the counting laboratories and at specific task monitoring stations. These monitoring locations include the RH Bay, Facility Cask Loading Room, and the Transfer Cell Service Room. These instruments are used to verify radiological conditions are within limits during job coverage and receipt surveys. The instruments selected possess the sensitivities required for monitoring airborne contamination and verifying that dose rates are below the WIPP WAC criteria.

These instruments are periodically calibrated using approved procedures and with standard sources, traceable to the National Institute of Standards and Technology (NIST). Instrument response and operation is verified each operating day to verify that the instrument background and calibration have not changed.

The instruments in the counting laboratories include gross radioactivity counters and spectrographic systems.

When required, samples are prepared for counting in the sample preparation facility. Sample preparation for counting may include evaporation, ashing, partitioning, chemical separation, or placing samples in containers that conform the sample to a defined geometry.

Portable Radiation Survey Instruments - The portable radiation detection instruments are used to perform radiation and contamination surveys in the field.

Portable dose rate instruments are normally calibrated in the calibration room using a shielded calibrator and/or other smaller NIST traceable sources and approved procedures. Portable contamination instruments are calibrated with NIST traceable sources and approved procedures. Prior to use, these instruments are checked for response with a check source containing a nominal amount of radioactivity. Those instruments that cannot be calibrated at the WIPP are sent to a calibration facility that has been approved by WIPP Quality Assurance.

Portable instruments include alpha contamination detectors, beta contamination detectors, gamma survey meters, and neutron survey meters.

Airborne (Area) Radiation Monitoring Instruments - Gamma area radiation monitoring (ARM) instruments are utilized to provide indication of RH waste radiation levels and to verify shielding is operating as expected. An ARM and a neutron spectrometer are located on the Cask Preparation Station work platform. The ARM provides a remote indication of dose rates where workers are unbolting the 10-160B cask lid in addition to the local dose rate surveys conducted by RCTs prior to the work starting. The neutron spectrometer is utilized to determine the appropriate correction factor for the dosimeters used by personnel working around the waste.

ARMs are also located in the Transfer Cell and Hot Cell to provide indication of the radiation levels of the waste being moved through the areas. An ARM is located in the Facility Cask Loading Room to verify that the shield collar properly engages on the facility cask as canisters are being pulled up from the Transfer Cell.

Personnel Monitoring Instruments and Service - The WIPP facility has a personnel dosimetry program that conforms to the requirements of 10 CFR 835.[1] The program is certified by the Department of Energy Laboratory Accreditation Program for Personnel Dosimetry (DOELAP), and is conducted in accordance with the WP 12-3,[30] WIPP Dosimetry Program.

Direct reading dosimeters are used when required by a RWP. These dosimeters are used to keep track of exposure in between TLD readouts. The TLD reading is the record of exposure. Personnel monitoring for external contamination is performed using the survey instruments previously discussed. Portal Monitors are placed at the WIPP site security gate to monitor personnel for radiation sources.

It is the intent of the radiological control program to qualify all employees who handle waste to perform contamination surveys on their clothing and body. In addition, when special operations are conducted, contamination surveys of personnel are performed by or under the direction of a qualified Radiological Control Technician. Bioassay programs will be administrated in accordance with WP 12-3, Dosimetry Program.[30]

A radiation monitoring system supplements the personnel and area radiation survey provisions of the plant radiological control program to ensure that radiation exposures are maintained ALARA. The radiation monitoring system includes continuous air monitors for radioactive particulate and fixed air samplers (FASs). The radiation monitoring alarms give visual and/or audible signals that annunciate locally, and, for select systems, in the Central Monitoring Room (CMR). These alarms require operator response and corrective actions. Most of the radiation monitoring system instruments are supplied with an Uninterruptible Power Supply (UPS) in the event of a power outage.

Calibration of Radiation Survey Instruments - All radiological instruments calibrations shall be traceable to NIST or the equivalent recognized standards and/or technologies. The portable dose rate instruments are calibrated with a shielded calibrator that minimizes radiation exposure to the calibration technician. Portable sources are used to calibrate fixed instruments such as the area radiation monitors and continuous air monitors. Sources are checked out and under the direct control of Radiological Control Technicians during the calibration activities in accordance with WP 12-HP3200, Radioactive Material Control[33]. Radiation survey instrument calibration records are maintained for the life of the facility.

Instruments receive periodic electronic calibration using NIST traceable, calibrated electronic sources.

Airborne Radioactivity Monitoring - Occupied radiological areas on the surface and underground are monitored, when deemed necessary by health physics practices. CAMs must be located in occupied areas where an individual is likely to receive 40 or more DAC-hours in a year as per 10 CFR 835.[1] CAMs utilized specifically in the RH process for monitoring occupied area are situated to monitor the Facility Cask Loading Room and the RH bay. CAMs are also utilized in the Hot Cell exhaust, CUR and adjacent to the cannister lift station in the Transfer Cell to provide indication of gross contamination as waste canisters/drums are moved.

The design features of the airborne monitoring equipment depend on their function. The monitors continually collect and measure airborne particulates by pulling air through a filter in proximity to an integral beta-gamma and/or alpha spectrometer. The airborne radioactivity monitor provides a local and, in some locations, a remote readout and alarm in the CMR. Meters, audible and visual alarms provide a clear and unambiguous indication of alarm conditions. As appropriate, each monitoring system is set to alarm within acceptable levels of the limits in 10 CFR 835.[1]

FASs, located near potential points of release, provide indication of releases at much lower levels than general area samples or CAMs. In the case of transuranic isotopes the local FAS may be the first indication of releases and can determine intakes at lower levels than routine bioassay sampling. Area sampling FASs, located adjacent to room exhausts, may provide an indication of activities that could be causing releases of airborne radioactivity before they are detected by job coverage air sampling.

FASs are installed to collect airborne particulates on a fixed filter medium. The fixed air sampler filters are removed and counted periodically to document average radioactive particulate concentrations.

In addition to the permanently installed equipment, portable CAMs and portable air samplers are provided. The portable air samplers and portable CAMs are similar to those described above. Portable samplers normally are used for sampling routine/non-routine operations, for emergency air sampling, or to temporarily replace inoperable equipment.

The CAMs are calibrated periodically and after repairs, using standards that are traceable to the NIST. The source and detector geometry during calibration are the same as the sample and detector geometry in actual use.

7.1.4 Dose Assessment for Normal Operations

7.1.4.1 On-site Dose Assessment

This section provides a summary of the dose assessments for the primary, occupationally exposed groups involved in waste handling operations at the WIPP facility. Waste containers accepted for disposal at the WIPP are expected to meet the 10 CFR 835[1] external contamination limits. Therefore, WIPP normal operations do not involve or entail any planned or expected releases of airborne radioactive materials. As such, the projected occupational worker dose from normal operations is a result of direct radiation from waste containers only, with no contribution from internal dose (CEDE) to airborne radiological materials.

Table 7.1-1 provides an estimate of personnel dose associated with the receipt, handling, and emplacement of a 72B waste canister. The estimate is based on a time-motion study conducted as part of the 1988 RH TRU Waste Pre-operational Checkout (DOE/WIPP-88-013)[34] modified to reflect current RH waste handling methodologies. The dose rates used with the time-motion study are based on source term evaluations[35] using a waste matrix and photon spectra based on the WIPP Baseline Inventory Report (BIR)[18]. The study concluded that a collective dose of 5 person-mrem would result from handling one average RH canister [36].

Table 7.1.2 provides an estimate of personnel dose associated with the receipt, handling, and emplacement of a RH waste canister in a 10-160B Shipping Cask. The estimate is based on a review and documentation of video tapes of processing a 10-160B shipping cask. The dose rates utilized with the time-motion study are based on source term evaluations using a waste matrix and photon spectra based on the WIPP BIR [18] and for waste expected from Argonne National Laboratory. The study concluded that a collective dose of 13.7 person-mrem would result from handling the waste contained in each 10-160B shipping cask.

Individual shipments may vary significantly from these estimated dose per shipment estimates but this value can be used for planning and dose estimates for work groups involved in RH waste processing.

7.1.4.2 Off-site Dose Assessment

As discussed in Section 7.1.4.1, waste containers accepted for disposal at the WIPP are expected to meet the 10 CFR 835[1] external contamination limits. Therefore, WIPP normal operations do not involve or entail any planned or expected releases of airborne radioactive materials. The WIPP is operated in compliance with the release standards of 40 CFR 191 Subpart A[4] and 40 CFR 61 Subpart H.[5] Once RH waste disposal operations begin, confirmatory measurements will be performed.

7.1.4.3 Effluent Sampling Systems/ Monitoring

The effluent sampling system consists of FASs for the confirmation of the presence or absence of airborne particulate radioactivity releases.

FASs are installed in the air stream of each release point to collect periodic confirmatory particulate samples from the total volume of air being discharged. The samplers consist of a sampling probe, a filter holder, and a vacuum supply. Sample location may have multiple filters to allow parallel sampling for outside agencies.

The analysis data from the FAS is used for quantifying total airborne particulate radioactivity discharged. This is done to demonstrate compliance with the mandated regulatory requirements contained in

40 CFR 191, Subpart A,[4] and 40 CFR 61, Subpart H.[5] These regulations place stringent requirements on the allowable annual dose equivalent to any member of the public. The sampling period and sample volume are maximized to provide a reasonable lower limit of detection.

7.1.4.4 Underground Monitoring Systems

The underground air monitoring system utilizes continuous air monitors (CAMs) to indicate airborne radioactivity levels in the air from the active waste disposal rooms. In case of increases in the airborne radioactivity, an alarm occurs and exhaust flow is shifted through HEPA filtration prior to release the environment.

The effluent monitoring systems are designed and environmentally qualified to withstand the effects of the Design Basis Earthquake, and are installed with backup power to allow monitoring in the event of a power failure.

References for Section 7.1

1. 10 CFR 835, Occupational Radiation Protection, January, 1993.

2. DOE-STD-1098-99, DOE Radiological Control Standard, July, 1999.

3. DOE-G-441.1-2, DOE Occupational ALARA Program Guide.

4. 40 CFR 191, Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Wastes, Subpart A, Environmental Standards for Management and Storage.

5. 40 CFR 61, Environmental Protection Agency Regulations on National Emission Standards for Hazardous Air Pollutants, Subpart H, National Emission Standard for Radionuclide Emissions from Department of Energy (DOE) Facilities.

6. DOE Order 5400.5, Radiation Protection of the Public and the Environment, June, 1990.

7. DOE Order 6430.1A, General Design Criteria Manual, December, 1983.

8. 10 CFR 835, Subpart K, Design and Control

9. DOE/WIPP-Draft 7-3123, Remote-Handled Waste Acceptance Criteria for the Waste Isolation Pilot Plant.

10. U.S. Department of Transportation, Title 49, Code of Federal Regulations.

11. WP 12-5, WIPP Radiation Safety Manual.

12. 10 CFR 835.502, High and Very High Radiation Areas

13. G-10 CFR 835/B2, Occupational ALARA Program, Implementation Guide for Use with 10 CFR 835, November 1994.

14. WP 12-2, WIPP ALARA Manual.

15. DOE O 420.1, Facility Safety, October 1995.

16. DOE O 430.1A, Life-Cycle Asset Management, August 1995.

17. WP 09-CN3007, Engineering and Design Document Preparation and Change Control

18. DOE/CAO 95-1121, U.S. Department of Energy Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report (BIR), December 1995.

19. Bechtel Document D-41-F-20, Facility Cask Design Description, (WIPP Library microfiche).

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21. System Design Description WH00, WH03 RH Waste Handling Equipment

22. Bechtel Document D-76-K-02, Design Basis, Radiological Protection (General), (WIPP Library microfiche).

23. ORNL-4181, Modifications of the Point-Kernel Code QAD-P5A: Conversion to the IBM-360 Computer and Incorporation of Additional Geometry Routines, July 1968.

24. LA-3573, QAD: A Series of Point - Kernel General-Purpose Shielding Programs, April 1967.

25. LA-5176, G^3: A General Purpose Gamma-Ray Scattering Program, June 1973.

26. Union Carbide Corp., Report No. K-1693, A User’s Manual for ANISN: A One Dimensional Discrete Ordinates Transport Code with Anisotropic Scattering, June 1973.

27. ORNL-RSIC-CLC23, Cask-40 Group Coupled Neutron and Gamma-Ray Cross Section Data, Revision D, March 12, 1974.

28. System Design Description WH00, Section 2.2.1

29. ANSI N101.6-1972, Concrete Radiation Shields.

30. WP 12-3, Dosimetry Program.

31. ANSI Z88.2-1992, American National Standard for Respiratory Protection.

32. WP 12-IH.02, WIPP Industrial Hygiene Program.

33. WP 12-HP3200, Radioactive Material Control

34. DOE/WIPP-88-013, 1988 RH TRU Waste Pre-operational Checkout

35. WIPP Radiological Control Position Paper 00-02 titled "Dose Rate Prediction Methodology for Remote Handled Transuranic Waste Workers at the Waste Isolation Pilot Plant"

36. WIPP Radiological Control Position Paper 00-03 entitled "Time-Motion-Dose Estimate Study for Remote Handled Waste Processing at WIPP", July 2000.

Table 7.1-1, Dose Estimates by Task and Worker Type for the 72B RH Waste Process

Task No.*	Activity	Waste Handlers (mrem)	Security (mrem)	RCTs (mrem)	Shaft Tenders (mrem)
1.0	Receive Truck	0.00	0.07	0.05	0.00
2.0	Transfer to Hold Area	0.02	0.00	0.28	0.00
4.0	Transfer to WHB	0.04	0.00	0.00	0.00
5.0	Offload Cask	1.25	0.00	0.48	0.00
6.0	Cask Preparation	2.63	0.00	0.29	0.00
10.0	Facility Cask Loading	0.00	0.00	0.00	0.00
11.0	Transfer Facility Cask to Conveyance	0.00	0.00	0.00	0.00
12.0	Transfer Facility Cask to Storage Area	0.07	0.00	0.00	0.00
14.0	Emplace Waste Canister	0.00	0.00	0.00	0.00
15.0	Emplace Shield Plug	0.01	0.00	0.00	0.00
Worker Type Totals		4.02	0.07	1.10	0.00
Total collective dose per RH Shipment = 5.2 person-millirem					

*Task numbers as identified in DOE/WIPP-88-013

Table 7.1-2, Dose Estimates by Task and Worker Type for the 10-160B RH Waste Process

Task No.*	Activity	Waste Handlers (mrem)	Security (mrem)	RCTs (mrem)	Shaft Tenders (mrem)
1.0	Receive Truck	0.00	0.03	0.03	0.00
2.0	Transfer to Hold Area	0.01	0.00	0.25	0.00
3.0	Transfer to WHB	0.00	0.00	0.00	0.00
4.0	Prepare Trailer and Cask	2.22	0.00	0.20	0.00
5.0	Offload Cask to transfer car	4.85	0.00	0.43	0.00
6.0	Cask transfer to CUR	5.13	0.00	0.00	0.00
7.0	Facility Cask Loading	0.06	0.00	0.03	0.00
8.0	Transfer facility cask to Conveyance	0.00	0.00	0.00	0.00
9.0	Transfer facility cask to Storage Area	0.07	0.00	0.00	0.00
10.0	Emplace Waste Canister	0.00	0.00	0.00	0.00
11.0	Emplace Shield Plug	0.06	0.00	0.00	0.00
Worker Type Totals		12.30	0.03	0.94	0.00
Number of facility cask transfers per 10-160B receipt = 3.3 Total dose per each RH Facility Canister Emplaced = 13.3 person-millirem					

7.2 Hazardous Material Protection

This section (1) provides an assessment of the potential for occupational and public exposure to non-radiological hazardous materials as a result of normal operations during the WIPP disposal phase, and (2) describes the WIPP programs in place for control of non-radiological hazards, and for protection of the worker and the public. An assessment of the potentials for non-radiological exposure as the result of abnormal operations and accidents is included in Chapter 5, Hazards and Accident Analysis.

Hazardous material protection is an integral part of the overall WIPP Industrial Safety program[1], as developed and implemented in WP 12-IH.02, WIPP Industrial Hygiene Program.[2] The organization responsible for implementation is the WIPP SH&S Industrial Safety and Hygiene (IS&H) section. Implementation of the defined program elements will ensure control of occupational health hazards originating from chemical, biological, and physical (excluding ionizing radiation) agents.

Requisition, procurement, use, handling, and storage of non-TRU waste hazardous materials are controlled by the WIPP Nonradioactive Hazardous Materials Environmental Compliance Manual,[3] and implementing procedures. Implementation of this program will ensure compliance with the Toxic Substances Control Act[4] (TSCA); the Superfund Amendments and Re-authorization Act[5] (SARA); the Occupational Safety and Health Act[6] (OSHA); the Comprehensive Environmental Response, Compensation, and Liability Act[7] (CERCLA), the Mine Safety and Health Act[8] (MSHA), and the U.S. Code of Federal Regulations (CFR).

7.2.1 Hazardous Material Sources

The primary occupational, non-radiological hazard to both the worker and the public during normal operations is from the airborne release of volatile organic compound (VOC) gases from TRU mixed waste containers during waste handling and emplacement operations. Lead and other heavy metals are present in TRU mixed waste, but pose hazards to workers and the public only under accident conditions, as discussed in Chapter 5. Exposure assessments for workers and the off-site public in the following sections are based on the releases of the average drum headspace VOC concentrations into the WHB and the Underground via diffusion through the containers and casks vent filters.

7.2.2 Hazardous Material Exposure Assessment for Normal Operations

The exposure assessments presented in this section are summarized from, or based on the environmental impacts analysis provided in the WIPP RCRA Permit Application.[9]

7.2.2.1 Off-site Exposure Assessment

The potential environmental and public impacts associated with the airborne release of VOCs during normal operations, summarized in this section, are assessed in detail in the WIPP RCRA Permit Application.[9] Based on the most recent headspace sampling of TRU mixed waste and toxicity data, nine VOCs were identified as the most prevalent and, of these, carbon tetrachloride, methylene chloride, and chloroform are considered potential carcinogens.

The average void volume was used to calculate the total grams of a VOC in the gas phase of each TRU mixed waste drum. The "void volume" or "headspace" is the total volume of a drum occupied by gases. The average void volume within a drum was calculated to be 5.2 cubic feet (147 liters, 6.56 moles at STP).

The compliance point relevant to air emissions for the RCRA Permit Application[9] for off-site exposure assessment is the WIPP site boundary. The RCRA Permit Application[9] assessment uses conservative assumptions, which tend to overestimate the consequences of releases. Table 7.2-1 lists the maximum public exposure concentration at the site boundary from VOC air emissions from both the Waste Handling Building (WHB) and the Underground, calculated assuming a 35-year operational and decommissioning/closure period. As shown in the table, the largest projected carcinogen health risk to a hypothetical member of the public residing at the WIPP Site boundary would be for carbon tetrachloride, at about 100 times below the public exposure health-based levels. The total risk from contributions from all nine emissions is considerably less than the acceptable risk level.

7.2.2.2 On-site Exposure Assessment

The potential occupational exposures associated with the airborne release of VOCs during normal operations, are also shown in Table 7.2-1. The highest occupational exposure concentrations from the WHB and Underground VOC air emissions are from methylene chloride, which are well below 29 CFR 1910.1000[10] (OSHA) 8-hour time weighted average (TWA) permissible exposure limits (PELs).

7.2.3 Industrial Hygiene Program

The WIPP Industrial Hygiene Program encompasses the comprehensive aspects of Industrial Hygiene defined by DOE Order 440.1,[11] excluding ionizing radiation, physical safety, fire prevention, medical examinations, and formal training, which are addressed by other programs.

The WIPP Industrial Hygiene Program acts to protect WIPP workers by anticipating, recognizing, evaluating, and controlling chemical, physical, biological, and ergonomic factors and/or stressors in the workplace. The PELs used in hazard evaluation and hazard communication shall not exceed those in the mandatory standards of DOE Order 5480.4,[12] Attachment 2.

7.2.3.1 ALARA Policy

The WIPP Industrial Hygiene Program seeks to ensure that employee exposures to hazardous materials are ALARA. The program uses the following controls to meet this goal:

- The use of approved and controlled procedures that provide administrative or engineering controls that minimize or eliminate exposure to hazardous materials
- Furnishing employees the necessary personal protective equipment
- Training employees to recognize potential hazards, take safety precautions, understand consequences of an accident, and know the actions to take in case of an accident
- Monitoring the work environment to obtain personnel and area exposure data
- Review and approval of all chemical use and storage at the WIPP
- Maintain Material Safety Data Sheets (MSDS)

7.2.3.2 Hazard Identification, Evaluation, and Elimination

WIPP (IS&H) identifies, defines, and evaluates controls in the occupational environment for those stresses which could be detrimental to employee health and safety. These stresses, whether chemical (e.g., liquid, particulate, vapor, or gas); physical (e.g., electromagnetic radiation, noise, vibration, extremes of temperature or pressure); biological (e.g., agents of infectious disease); or ergonomic (e.g., body position in relation to task) are recognized by familiarization with the work environment, review of first aid records, and hazard control.

IS&H uses methods available, either by laboratory analysis or instrument monitoring, to define environmental conditions of the workplace. The following activities are included, but not limited to: hearing conservation, dust sampling, characterization of mine gases, control of toxic fumes and vapors, sanitation inspections and potable water supply sampling, evaluating OSHA and MSHA compliance for on-site activities, review of proposed project facilities, and evaluation of other hazards by periodic monitoring of work areas. With respect to these activities, assurance of equipment calibration and maintenance and record keeping of inspections are maintained. These methods are outlined in WP 12-IS.01, Industrial Safety Program[1] and WP 12-IH.02, WIPP Industrial Hygiene Program.[2]

An on-site industrial hygiene laboratory calibrates and prepares sampling equipment for personnel exposure measurements, to analyze mine atmospheres, water potability, and chemical exposure hazards. Respirator fit testing and maintenance are also an industrial hygiene responsibility.

The WIPP Hazard Communication Program is discussed in detail in WP 12-IH.02, WIPP Industrial Hygiene Program.[2] The program includes material hazard training, MSDS management, inventory/listing of hazardous materials on-site, control of hazardous material purchase requisitions by IS&H prior to purchase, material container labeling requirements, on-the-job training requirements, and employee responsibility requirements concerning hazardous materials used in the work area.

The Industrial Hygiene Program is outlined in WP 12-IH.02, WIPP Industrial Hygiene Program.[2]

7.2.3.3 Chemical Management

Management of hazardous materials is implemented by guidance contained in WP 02-EC.04.[13] Guidelines are provided for procurement, receipt, distribution, tracking, storage, transportation, use, recycling, and disposal of hazardous materials.

Each WIPP employee receives as part of the General Employee Training (GET), hazard communication training and hazard recognition training. All employees who work with hazardous materials receive hazard communication training and RCRA training.

As an overview of site chemical usage purchase requisitions, MSDS, and Action Requests are reviewed. This minimizes use of hazardous materials by allowing for substitution of materials and maintains an ALARA approach to carcinogens and very toxic materials. During the review, availability of appropriate storage, personal protective equipment, and the need for personnel training are also evaluated.

Hazardous materials are logged into the warehouse upon arrival. IS&H receives copies of all MSDS for materials brought on the site whether by WTS or by subcontractors. Copies of MSDS are available to all employees during all shifts. Training on the OSHA Hazard Communication Standard is a requirement of all personnel who work with or enter areas where hazardous materials are used.

Periodic inspections of work and storage areas are performed to evaluate safe work conditions, proper storage, and effectiveness of engineering controls.

7.2.3.4 Air Monitoring

7.2.3.4.1 Non-radioactive Air Contaminants

WP 12-IH1828[14] implements the WIPP Air Quality Monitoring Program. To ensure compliance with American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLV), administrative or engineering controls are determined and implemented whenever possible. When such conditions are not feasible to achieve full compliance, protective equipment and/or protective measures are used to keep employee exposures to air contaminants within prescribed limits. Any equipment and/or technical measures used must be approved by WIPP IS&H personnel.

When necessary, IS&H monitors or tests the air in areas where hazardous chemicals are stored, and in areas where workers may be exposed to concentrations of airborne fumes, mists, or vapors. All surveys are recorded; records contain the location, time, job description, or occurrences that may be associated with the contaminants and instruments used. All available inventories, reports and monitoring data are available to the Health Services personnel in order to assist the medical monitoring program.

In the WIPP Underground, airborne concentrations of mists, fumes, or vapors will be monitored and sampled as needed, or upon request, by suitable devices such as Draeger pumps or other portable grab sample monitors. If relevant air concentrations are found in excess of the TLVs, immediate corrective actions will be taken as determined by IS&H, and the air will be periodically tested until in compliance.

Air quality monitoring equipment is calibrated per manufacturers' recommendations, with an accurate record kept of pre-calibration conditions of the instrument. Functional tests are performed daily. Competency of individuals required to use air monitoring equipment is verified. Functional testing competency requires a formal training program.

7.2.3.4.2 Diesel Emissions

Vehicle emissions of Underground equipment are periodically monitored in accordance with WP 12-IH.02, Industrial Hygiene Program,[2] to assure the health and safety of personnel. Incomplete combustion of diesel fuels causes contaminants of carbon monoxide, carbon dioxide, and nitrogen dioxide. The air in the Underground is periodically monitored for these contaminants, to ensure compliance within TLV limits. Vehicles are checked for carbon monoxide and nitrogen dioxide emissions after preventive maintenance checks and during scheduled overview inspections.

7.2.3.5 Workplace Monitoring

IS&H surveys are a means of evaluating and maintaining a safe and healthful workplace. Examples of items surveyed are drinking water potability; local exhaust ventilation systems; and chemical, physical, and biological hazards. Sampling of the environment involves calibration of equipment, actual sampling, and recording the results in terms of the actual stress. Surveys are conducted in accordance with the WIPP Industrial Hygiene Program.[2]

7.2.3.6 Occupational Medical Program

The occupational medical site personnel, as defined in the Occupational Medical Program,[15] work in close cooperation and coordination with other departments to optimize the maintenance of a healthful work environment. Pre-employment, periodic, return to work, and termination health examinations are coordinated with the Human Resources Department. Diagnosis and treatment of occupational injuries and illnesses are coordinated with all departments where these incidents may occur. Health maintenance and preventive medical activities are coordinated with IS&H.

The program overview is performed by an occupational medical physician, who works part-time under contract to the WIPP facility. The physician is assisted by an on-site occupational health nurse and emergency service technicians (ESTs). The ESTs provide 24-hour emergency medical coverage on the site.

The occupational medical program is designed to accomplish the following:

- Ensure the health and safety of employees in their work environments, through the application of occupational health principles

- Determine the physical fitness of employees to perform job assignments without undue hazard to themselves, fellow employees, or the public at large

- Ensure the early detection and treatment of employee occupational illness, or injuries, by means of scheduled periodic health evaluations and a wellness awareness program

7.2.4 Environmental Monitoring

DOE Order 5400.1, General Environmental Protection Program[17], requires DOE facilities to conduct an environmental monitoring program to safeguard the safety of the public and the environment. WIPP environmental monitoring is performed in accordance with DOE/WIPP 99-2194, WIPP Environmental Monitoring Plan[16] which was written in accordance with the guidelines in DOE Order 5400.1[17]. Environmental monitoring was initiated in 1984 and will continue throughout the operational life of the facility. The data collected prior to receipt of CH TRU waste was used to establish the baseline measurements.

It is estimated that 98.9 percent of the total CH-TRU Curies is contributed by Pu-238, Pu-239, Pu-240, and Am-241, while 96.5 percent of RH TRU Curies is contributed by Co-60, Sr-90, Cs-137, Pu-239, Pu-240, and Am-241. There are a few other radionuclides associated with TRU wastes but are so low in quantities and contribute insignificantly to the total radioactivity and radiation doses that they are not measured. All samples obtained during environmental monitoring are analyzed for Pu-238, Pu-239+240, Am-241, U-234, U-235, U-238, K-40, Cs-137, Co-60, and Sr-90. These radionuclides are found in either the TRU waste or occur naturally in the environment. Radiological environmental sampling determined the amount and type of naturally occurring radioactivity in the WIPP area prior to operational status and provides a comparison between pre-operational and operational radiological observations to detect potential impacts. Environmental monitoring is conducted throughout the year and the analytical data is reported in the annual Site Environmental Report.[18]

7.2.4.1 Airborne Particulate

Airborne particulate samples are collected at seven different locations around WIPP site general area using low-volume continuous air samplers which collect samples on fiberglass filter paper at a rate of approximately 2.0 ft^3 (56 to 63 L) per minute air flow. The samples are collected at a height of 6.5 to 10 ft (1.95 to 3.05 m). Samples are collected weekly and composited quarterly. The quarterly samples are equivalent to approximately 7000 m^3 of air. The detection limits with alpha spectrometer for Pu-238, and Pu-239+240 and uranium are 5.9E-5 to 3.4E-5 pCi/m^3. The gamma emitters detection limit are in the range of 1.0E-3 to 1.2E-2 pCi/m^3. Suspect activity from any radiochemistry analysis is investigated by performing procedure WP 02-EM3004, Radiological Data Verification and Validation.[19]

7.2.4.2 Soil Samples

Annual soil samples are collected at the approximate locations of air particulate sampling. The soil samples are collected in three depth profiles: 0-0.8 in (0-2 cm),0.8-2.0 in (2-5 cm) and 2.0-4.0 in (5-10 cm). These depth profile measurements provide information to understand the vertical migration of radionuclides.

7.2.4.3 Groundwater

Biannual groundwater samples are collected from six brine water wells located around the WIPP site. These wells vary in depths ranging from 617 to 879 ft (188 to 268 m). One biannual groundwater sample is collected from a 225 ft (68.6 m) deep Class II shallow water well suitable for agricultural purposes. Additionally, measurements are taken at 70 well bores and are used to perform groundwater level surveillance of six water-bearing zones in the WIPP area. Groundwater surface elevations in the vicinity of WIPP may be influenced by site activities, such as pumping tests for site characterization, water quality sampling, or shaft sealing. Collection of groundwater quality data continues to assist the DOE in meeting performance assessment, regulatory compliance, and permitting requirements. The data also provides radiological and non-radiological water quality input to the WIPP Environmental Monitoring Program; a means to comply with future groundwater inventory and monitoring regulations; and input for making land-use decisions.

7.2.4.4 Surface Water

Surface water samples are collected annually from various locations in the WIPP vicinity. Because of the absence of surface waters near the WIPP facility, the water found in stock tanks, typically man-made catchment basins provided for livestock, provides the majority of the surface water samples. Other water samples are obtained from the upper Pecos River, Brantley lake, and Lake Carlsbad.

Retention basins and storm water diversion berms have been constructed to contain and control storm water discharges. At least one water sample from the retention basins is obtained and analyzed annually.

WIPP effluent water to the sewage lagoons (not storm water) is sampled and analyzed annually.

7.2.4.5 Sediments

The majority of annual sediment samples are collected at the same locations as surface water samples. Sediment samples are collected in water approximately 1.5 ft (0.5m) deep except for the upper Pecos River and Carlsbad locations. No sediment sample is collected at the sewage lagoons.

7.2.4.6 Biota Samples

Uptake of radionuclides by plants and animals is an important factor in estimating the intake of radionuclides in humans through ingestion. Annual vegetation samples are collected at the same locations that soil and air samples are taken. Fish samples are obtained from 3 different Pecos River locations. Cattle, deer, game birds, and rabbit samples are collected as available (i.e. road kill).

7.2.5 Volatile Organic Compound (VOC) Monitoring

The VOC monitoring activities have focused on the air pathway since 1991. The airborne emission of VOCs is the only credible release pathway from the WIPP facility during disposal operations, and the final closure design basis requires this pathway to be eliminated upon final closure.

The DOE has prepared a VOC monitoring plan which describes the aspects of a VOC monitoring strategy. The plan has been prepared so that the DOE can show that the assumptions and predictions used to demonstrate compliance to the environmental performance standards are valid.

A baseline VOC monitoring program was conducted at the WIPP facility and the results of the baseline program were used, in part, to define the confirmatory monitoring program for the disposal phase. VOC monitoring will be conducted throughout the disposal phase of operations to determine VOC concentrations attributed to open and closed panels. The Confirmatory VOC Monitoring Plan[20] describes a sampling and analysis program to confirm the theoretical calculations. The VOC monitoring program is capable of quantifying VOC concentrations in the ambient mine air at the WIPP and addresses the following elements:

1. Rationale for the design of the monitoring program, based on:

    - Possible pathways from WIPP during the active life of the facility
    - VOC sampling operations at WIPP
    - Optimum location of the ambient mine air monitoring stations to confirm theoretical calculations

2. Descriptions of the specific elements of the monitoring program including:

    - The type of monitoring conducted.
    - The location of the monitoring stations
    - The monitoring frequency
    - The specific hazardous constituents monitored
    - The implementation schedule for the monitoring program
    - The equipment used at the monitoring stations
    - The sampling and analytical techniques used
    - Data recording and reporting procedures

VOC Sampling in the Underground for target VOC compounds takes place at two locations designated as air monitoring stations VOC-A and VOC-B. VOC-B samples for VOCs in the upstream sources (inlet ventilation air to TRU waste disposal panels) and VOC-A samples the underground exhaust air which is the total of VOCs from upstream sources plus any VOC releases from emplaced TRU waste. Confirmatory VOC sampling began with initial TRU waste emplacement in Panel 1. Some sampling, however, was conducted prior to waste disposal to evaluate the monitoring system. For each quantified target VOC, the concentrations measured at Station VOC-B will be subtracted from the concentrations measured at Station VOC-A to assess the magnitude of VOC releases, if any, from the emplaced waste

Monitoring is performed using the concepts of pressurized sample collection in stainless steel canisters described in the US EPA Compendium Method TO-14A. The TO-14A sampling concept uses 6-liter passivated stainless-steel canisters to collect integrated air samples at each sample location. This conceptual method will be used as a reference for collecting the samples at WIPP.

The VOC monitoring program will be run under a Quality Assurance Project Plan[21] that has been prepared in accordance with the document entitled EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations,[22] (EPA 1994). Quality Assurance criteria for the target analytes are presented in Attachment N, Table N-4, of the Hazardous Waste Facility Permit.[23] Definitions of the criteria are given in Attachment N, along with a discussion of other aspects of the Quality Assurance Program including sample handling, calibration, analytical procedures, data reduction, validation and reporting, performance and system audits, preventive maintenance, and corrective actions

References for Section 7.2

1. WP 12-IS.01, Industrial Safety Program.

2. WP 12-IH.02, WIPP Industrial Hygiene Program.

3. WP 02-5, WIPP Nonradioactive Hazardous Materials Environmental Compliance Manual.

4. 40 CFR 702-799, Toxic Substances Control Act.

5. 40 CFR 300-399, Superfund Amendments and Re-authorization Act.

6. 29 CFR 1900-1999, Occupational Safety and Health Act.

7. 40 CFR 300-372, Comprehensive Environmental Response, Compensation, and Liability Act.

8. 30 CFR, Sub-chapter N, Metal and Non-Metal Mine Safety and Health, 9th Edition, July 1997.

9. DOE/WIPP 91-005, Resource Conservation and Recovery Act Part B Permit Application, Rev. 6.

10. 29 CFR 1910.1000, Air Contaminants, July 1993.

11. DOE Order 440.1, Worker Protection Management for DOE Federal and Contractor Employees.

12. DOE Order 5480.4, Environmental Protection, Safety, and Health Protection Standards.

13. WP 02-EC.04, Hazardous Material Management Plan.

14. WP 12-IH1828, Air Quality Monitoring.

15. WP 15-HS.02, Occupational Health Manual.

16. DOE/WIPP 96-2194, WIPP Environmental Monitoring Plan, 1996.

17. DOE Order 5400.1, General Environmental Protection Program.

18. DOE/WIPP 99-2225, Waste Isolation Pilot Plant 1998 Site Environmental Report, October 1999

19. WP 02-EM3004, Radiological Data Verification and Validation

20. WP 12-VC.01, Confirmatory Volatile Organic Compound Monitoring Plan.

21. WP 12-VC.02, Quality Assurance Project Plan for Confirmatory Volatile Organic Compound Monitoring

22. EPA QA/R-5, EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, 1994.

23. Hazardous Waste Facility Permit No. NM4890139088-TSDF, issued by the New Mexico Environment Department October 27, 1999.

Table 7.2-1, Maximum Occupational and Public Exposure From Underground Waste VOC Emissions

Indicator Volatile Organic Compounds (ppmv)	Worker Receptor Concentration		OSHA 8 Hour TWA[b] (ppmv)	Estimated Risk for Carcinogens and Hazard Quotients for Non-Carcinogens for Public Exposure to Waste Emissions	Acceptable Level of Risk[f]
	Surface	Underground			
Carbon Tetrachloride	3.0E-04	1.2E-02	10	3E-08	1E-06
Chlorobenezene[a]	6.9E-04	2.9E-02	75	4E-06[e]	1
Chloroform	2.7E-04	1.0E-02	50[c]	2E-09	1E-06
1,1-Dichloroethylene	1.2E-03	4.7E-02	5[d]	2E-09	1E-05
1,2-Dichloroethane	3.8E-04	1.5E-01	50	8E-10	1E-06
Methylene Chloride	4.5E-03	1.6E-02	25	6E-10	1E-06
1,1,2,2-Tetrachloroethane	3.2E-04	1.3E-02	5	3E-09	1E-05
Toluene[a]	1.6E-03	6.7E-02	200	3E-07[e]	1
1,1,1-Trichloroethane	4.0E-03	1.6E-01	350	2E-08	1E-05

a. Non-Carcinogen (all others are class B2 or C carcinogens)
b. 8 hour time weighted averages (TWA) except for chloroform
c. Ceiling value limit not to be exceeded
d. 8 hour threshold limit value (TLV) - TWA from ACGIH
e. Non-Carcinogen hazard quotient
f. Acceptable level of risk for carcinogens is the probability of developing cancer, and for non-carcinogens is a hazard quotient less than or equal to 1