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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 normal (routine) CH and 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.

The radiological control philosophy at the WIPP is "Start Clean - Stay Clean," which emphasizes the prevention of radioactive contamination. This philosophy dictates the immediate securing of any radiological work, when radioactive contamination above established levels is found, or a release of radioactive contamination is known or suspected. Normal work will not resume until the area, including personnel and equipment, has been released in accordance with contamination control procedures, and approval from the Radiological Control Manager has been obtained.

As part of normal operations activities, the waste 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 and transfer to the underground for disposal. Decontamination or overpack (waste containers damaged during waste handling operations) will be undertaken, if required, and as approved by management as discussed in Section 4.3.1. Decontamination and operations involving overpack of damaged containers are considered abnormal activities, and the risk to workers and the public is addressed qualitatively through the hazards analysis process in Chapter 5.

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]; 40 CFR Part 191, Subpart A;[2] 40 CFR 61, Subpart H;[3] DOE Orders 5400.5,[4] and 6430.1A[5] respectively, and that such exposures are kept ALARA. These objectives are met by ensuring that:

- Shipments of radioactive material are handled in accordance with WIPP Waste Acceptance Criteria (WAC)[8] limitations, DOT regulations,[9] and internal operating procedures.

- Shielding, posting, and access control may be employed to reduce direct radiation exposures.

- Engineering controls are designed to reduce 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.

- 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 (decontamination and overpack operations).
- 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.[10]
- 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.

7.1.1.2 Administrative Organization

Radiological Control is a functional part of the Environment, Safety and Health (ES&H) Department. The Sections of the ES&H Department are Industrial Safety and Hygiene, Emergency Management, RCRA Permitting, Environmental Compliance and Support, Environmental Monitoring, Nuclear Compliance, WIPP Laboratories, and Radiological Control. The management organization described in the following paragraphs implements the radiological control program.

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

<u>Radiological Control</u>- The Radiological Control Manager is responsible for maintaining radiological safety of the plant by regularly evaluating and assessing surface contamination, radiation levels, and airborne radioactivity concentrations in radiological work areas with respect to approved limits.

The Radiological Control Manager is also responsible for directing operational health physics activities; performing surveillance of routine and special WIPP facility operations; establishing training programs for qualification and re-qualification of radiological control technicians; and approving other radiological training programs consistent with 10 CFR 835,[1] and applicable DOE Orders. The Radiological Control Manager is required to review radiological control procedures annually to determine their adequacy.

The Radiological Control Manager and designees have the authority to stop operations when an actual or impending loss of radiological safety control is identified. In addition, because of the importance of radiation safety, the Radiological Control 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 Radiological Control Manager is responsible for operating and maintaining a personnel dosimetry program to determine radiation exposure to employees and visitors. In addition, the Radiological Control Manager is responsible for implementing and operating the internal dosimetry program. The Radiological Control 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/EV/1830-T5,[11] 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.[10]

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,[11] as appropriate for this first-of-a-kind facility. Future design modifications will be in accordance with 10 CFR 835,[1] DOE Orders O 420.1,[6] Facility Safety, and O 430.1,[7] 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, the responsibility for ensuring that exposures are kept ALARA is the responsibility of all levels of management. Operationally, the manager responsible for waste handling will develop and implement procedures and operation of equipment to ensure waste handler exposures are maintained ALARA.

7.1.2.3 Operational Considerations

Radiological exposure to plant personnel will be kept ALARA by continued review of operations and training. The WIPP ALARA Program is described in the WIPP ALARA Manual, WP 12-2.[12]

The Manager of ES&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

Facility Arrangement - 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 WIPP Radiation Safety Manual.[10] The Controlled Areas are segregated from other operating areas by physical barriers (e.g., fences, walls, bulkheads). The Controlled Areas on the surface 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 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.

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.

Waste Handling Building - General Arrangement - A Controlled Area will be established in the WHB, as required to support Waste Handling operations. Personnel access into the operating areas of the building is through a controlled access corridor from the TRUPACT Maintenance Facility.

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.

CH TRU Waste Handling Area Arrangement - The surface waste handling equipment and facilities in the CH TRU waste handling area are arranged so that waste handling flow patterns are as direct as possible from TRUPACT II unloading to hoist loading.

RH TRU Waste Handling Area Arrangement - The RH TRU waste handling area is arranged for efficient handling of shielded road casks and waste canisters, and includes an area for shielded road cask preparation and decontamination, as required. The enclosed Cask Unloading Room is located below the hot cell. Here, a ventilation barrier provided by an inflatable seal between the cask and hot cell floor, provides the means for controlling the potential spread of contamination during cask unloading. The hot cell is arranged to allow inspection, and, if required, over packing of the canisters before they are lowered into the canister transfer cell and subsequently transferred to the Facility Cask.

A Crane Maintenance Room and a Manipulator Repair Room are provided next to the hot cell, behind shielding, to allow removing hot cell equipment to areas with a lower radiation background for repair. This reduces the need to enter the hot cell.

Personnel access into the hot cell is through air locks from the main operating gallery. A room below the hot cell operating gallery houses the hot cell HEPA filters.

Radiation sources and shield penetrations are arranged to prevent radiation streaming, and to reduce radiation levels in accessible areas.

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.

Remote handling equipment in the hot cell includes the hot cell crane and the master/slave manipulators. The hot cell crane can be moved into the Crane Maintenance Room using manual override, if crane failure occurs in the hot cell. This allows maintenance in a separate area, and minimizes the need for access into the hot cell. The master/slave manipulators can be removed from the operating gallery side of the hot cell for maintenance and brought into the manipulator repair room, an area with a lower radiation background.

Forklifts and transporters are designed to expedite the loading and unloading of 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 CH 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 and summarized in Table 7.1-1.

CH TRU Waste - CH TRU waste will primarily be received in standard waste boxes (SWBs) and 55-gallon drums. Because of higher anticipated activity density, the 55-gallon drum is used as the reference CH TRU waste radiation source for shielding analysis. The CH TRU waste source container used for this analysis is 24 inches in diameter, and 35 inches long (the approximate dimensions of a DOT 17C 55-gallon drum). These drums can be stacked in the underground no more than three high, due to the limited height of the disposal drift. Some space remains above the stack, for emplacement of backfill material and airflow over the waste packages during the disposal operations.

Although the CH TRU waste contains alpha and beta emitting nuclides, the primary radiation of interest in shielding calculations is gamma rays. Alpha and beta particles are completely shielded by the waste containers, and do not contribute to the external dose, with the possible exception of a beta-generated bremsstrahlung contribution to the gamma spectrum. For shielding design calculations, a spectrum representing typical waste containing TRU nuclides and fission products was derived. The gamma spectrum selected as representative of the CH TRU waste is characterized by a RH TRU radionuclide distribution, with a reduced photon source. The selected RH TRU spectrum is believed to yield conservative results since the photon energies are greatly skewed to the higher energies. Photon energies for CH TRU radionuclides are typically much lower.

The average and maximum gamma source strengths used in the CH TRU waste shielding calculations are based on a design average CH TRU waste surface exposure rate of 10 mrem/h (0.10 mSv/h), and the maximum CH TRU waste surface exposure rate of 200 mrem/h (2 mSv/h). The resultant design basis CH TRU waste gamma source strengths are shown in Table 7.1-1. Although, some components of CH waste produce neutrons by spontaneous fission, the contribution to the total dose rate is less than a few percent.

7.1.3.1.3.3 Design Description

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

- Radiation shield 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 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 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.

The CH TRU Waste Handling Area is arranged for efficient handling of the CH TRU waste containers. Traffic flow and adequate space for waste transfer activities are considered in the layout of this area. A separate enclosed area, located in the southeast corner of the CH Bay and shielded by concrete walls, is provided for temporary holding of discrepant shipments of CH TRU wastes that cannot be immediately emplaced.

Within the RH TRU Waste Handling Area, RH TRU waste canisters are handled within shielded casks, or by remote means within the shielded hot cell enclosure. The primary shielding in the hot cell complex is provided by the shipping cask shields or the hot cell walls. The hot cell complex is designed for a 45 rem/h (450 mSv/hr) neutron surface dose rate and a gamma surface dose rate of 400,000 rem/h (4,000 Sv/hr).

The hot cell is an integral part of the Waste Handling Building. The shield walls are primarily constructed of reinforced concrete. Remote operations using the hot cell crane and master slave manipulators are observed through closed circuit television and shielded viewing windows at hot cell work stations. A shielded pass-through drawer is utilized to introduce supplies into the hot cell, to remove waste materials from the cell, and to transfer swipes. An interlocked shielded door and labyrinth shield walls at the personnel access to the hot cell reduce radiation levels from sources in the cell. The shipping cask unloading room, crane maintenance room, facility cask loading room, manipulator repair room, and canister transfer room are separate functional areas integrated with the hot cell.

A Shielded Room for hot cell crane maintenance is provided next to the hot cell. Normally, personnel are not permitted in the crane maintenance room during hot cell operations. However, in the event of a crane failure requiring maintenance, the crane can be moved into the crane maintenance room, where a steel shield gate reduces the dose rates from within the hot cell. Under most conditions, dose rates during these maintenance activities will be less than 0.5 mrem/h (5E-03 mSv/hr) in the maintenance room. Under no conditions are personnel allowed in the crane maintenance room when a canister is raised above a position on top of the cask unloading room.

The Facility Cask provides shielding while the RH TRU waste canisters are moved from the canister transfer cell to the disposal locations underground. Figure 4.3-16 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 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, for wastes meeting the WIPP WAC. Design and operation of the facility cask will be reviewed should a significant RH TRU neutron contribution be identified.

Within the Underground Disposal Areas, no permanent shielding is required. The facility cask construction provides shielding for operators and helps maintain doses ALARA. When transferring a RH TRU canister from the facility cask to the disposal location in the underground salt, horizontal emplacement and retrieval equipment shielding overlap with the facility cask to minimize radiation streaming paths.

7.1.3.1.3.4 Method of Shielding Analysis

The radiation sources used for shielding design are based on maximum values expected during plant operations. Shielding thicknesses ensure that the sum of the dose rates due to uncollided and scattered radiation through the shield wall during waste canister handling are within the limits of the radiation zone specified for the area.

Shielding analysis was performed by the Architect-Engineer for the WIPP Project by use of the QAD-P5A computer code and input parameters.[13,14] 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.[15] 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.[16,17] 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 RH waste handling area shielding is designed to comply with the design radiation dose rates. In the CH TRU waste handling area, the interim holding area shielding thicknesses are based on storing drums that contain the average gamma source strengths, as described in Section 7.1.3.1. The separate shielded holding area shielding is based on the full-capacity holding of drums that contain the maximum gamma source strength.

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,[18] with the following additional criteria:

- In addition to the applied loads requirements listed in Section 4.3.3 of ANSI N101.6-1972,[18] 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.[18]

- 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.[18]

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.[10]

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. These procedures also support the "Start Clean - Stay Clean" philosophy, which emphasizes the prevention of radioactive contamination as well as its movement or spread.

Radiation and Contamination Surveys - Health physics personnel perform routine radiation and contamination surveys of all accessible areas of the facility, surveys of the waste packages upon receipt, and various other types of surveys to detect contamination and its potential spread and expected radiation dose rates. 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. The records of the survey results are retained in a permanent file by the Operational Health Physics 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,[10] 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 Chapter 3 of the WIPP Radiation Safety Manual[10] 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 Manual,[19] and Chapter 5 of the WIPP Radiation Safety Manual.[10]

The WIPP policy addressing visitors is described in Chapter 3 of the WIPP Radiation Safety Manual.[10]

Personnel entering a Controlled Area are required to obtain General Employee Radiological Training (GERT) prior to entering. Personnel performing radiological work in a radiological area are required to sign-in on an access control log or access control computer in addition to signing in on a Radiological Work Permit (RWP), issued in accordance with Chapter 3 of the WIPP Radiation Safety Manual.[10]

The RWP specifies the controls necessary for the planned entry, and may require additional monitoring devices, protective clothing, respiratory equipment, etc. 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.

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

- 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) - An area or structure where radioactive material is used, handled, or stored.

- Radiation Area - An area, accessible to personnel, in which the dose rate is greater than 0.005 rem/hr (0.05 mSv/hr), but less than or equal to 0.1 rem/hr (1mSv/hr), at 11.8 inches (30 centimeters) 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/hr (1 mSv/hr) at 11.8 inches (30 centimeters), but less than or equal to 500 rad/hr (5 Gy/hr), at 39.4 inches (100 centimeters) 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/hr (5 Gy/hr) at 39.4 inches (100 centimeters) from a radiation source or from any surface that the radiation penetrates.

- Contamination Area - Area where contamination levels are greater than the values specified in Appendix D of 10 CFR 835,[1] but less than or equal to 100 times those levels.

- High Contamination Area - Area where contamination levels are greater than 100 times the values specified in Appendix D of 10 CFR 835.[1]

- Airborne Radioactivity Area - Area where the measured concentration of airborne radioactivity, above natural background, exceeds, or is likely to exceed :

  10 percent of the Derived Air Concentration (DAC) values listed in 10 CFR 835

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,[10] and WP 12-3, Dosimetry Program Manual.[19]

Internal exposure measurement is described in Chapter 5 of the WIPP Radiation Safety Manual,[10] and the Dosimetry Program Manual.[19] 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 on a routine basis. Baseline bioassay will be performed on workers who handle radioactive materials as a normal function of their job.

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.[19]

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.[10]

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

Only respiratory protection equipment approved for use by the National Institute of Occupational Safety and Health 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.[20] Respiratory protection is addressed in Chapter 5 of the WIPP Radiation Safety Manual,[10] and WP 12-IH.02, WIPP Industrial Hygiene Program.[22]

Radioactive Material Control - There are two facets to the control of radioactive material. The first is radioactive source control. Radioactive sources 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. 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. 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 Radiological Control Manager.

7.1.3.2.3 Radiological Control Facilities

Control Points - All personnel leaving RBA's, RMA's, Contamination, High Contamination, and Airborne Radioactivity Areas (ARA) are required to check out. Personnel leaving RBAs, Contamination, High Contamination, and ARAs 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.[10]

Personnel decontamination will be performed in accordance with approved procedures.

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 in the Shielded Calibration Room of the Support Building. Contamination survey instruments are calibrated in the area of the health physics office. 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,[10] 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 survey instruments
- Area radiation monitoring instruments
- Airborne radioactivity sampling and monitoring instruments

Instruments are repaired and calibrated by health physics personnel. In some cases, specialized instruments may be returned to the manufacturers for repair and calibration.

<u>Fixed Radiation Counting Instruments</u> - Fixed radiation counting instruments are located in the counting laboratories, and are used primarily for analyzing process monitoring samples and environmental samples taken in and around the WIPP facility. The instruments selected for use in the laboratories possess the sensitivities required for performing environmental and operational activities.

These instruments are periodically calibrated with standard sources, traceable to the National Institute of Science and Technology (NIST). Instrument background and response to calibrated check sources are determined before 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, grinding, chemical separation, or placing samples in containers that conform the sample to a defined geometry.

<u>Portable Radiation Survey Instruments</u> - 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 in the area of the health physics office 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 Q&RA.

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

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,[19] WIPP Dosimetry Program Manual.

Digital dosimeters are used when a dose rate above background is expected or exists. 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 and in-vivo programs will be administrated in accordance with WP 12-3, Dosimetry Program Manual.[19]

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 area radiation monitors, 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 calibrations of radiological instruments shall be traceable to NIST or other equivalent recognized standards. 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 (CAMs). Radiation survey instrument calibration records are maintained for the life of the facility.

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

Area Radiation Monitoring - Area radiation monitors are provided, as needed, in normally accessible areas to provide indications of changes in the surrounding operational environment within the plant.

Area radiation monitors continuously monitor gamma radiation. The monitors activate local and remote alarms upon the detection of radiation levels higher than the limits specified for a given work area. Separate alarms are activated by the failure of a monitor.

Each monitor is periodically calibrated using sources certified by or traceable to the NIST. Detector operation is checked using radioactive sources. Instrument failure alarms are provided locally and in the CMR.

Airborne Radioactivity Monitoring - Occupied radiological areas on the surface and underground are monitored, when required, by CAM equipment per 10 CFR 835. CAMs must be located in occupied areas that may have the potential to equal or exceed one DAC of the radionuclides of interest, and other areas as deemed appropriate by WIPP management.

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 or alpha detector. 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 are installed to collect airborne particulates on a fixed filter medium. The fixed air sampler filters are removed and counted periodically to evaluate cumulative radioactive particulate concentrations.

In addition to the above 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. The results are representative values, determined by estimating dose rates based on shielding analyses, the characterization of the waste forms (see Chapter 5), time and motion/manpower studies for the handling of the waste, and the estimated quantities of waste received. The time and motion/manpower information used is based on the current concept of staffing levels and the organization planned for WIPP facility operations. This assessment considers normal waste handling operations only. Abnormal operations, such as decontamination and overpack operations (of waste containers damaged during the waste handling process) are addressed in Appendix C, HAZOP Session Summary Table.

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 7.1-2 provides the estimated annual external exposure to workers during normal CH TRU waste handling operations. The exposure is based on an initial disposal rate of five shipments per week, per the National TRU Waste Management Plan.[21] Upon receipt of waste, the actual annual external exposure will be monitored and controlled per the WP 12-5, WIPP Radiation Safety Manual,[10] and Table 7.1-2 will be updated as necessary.

7.1.4.1.1 Radiation and Contamination Zones and Radiological Areas

For design purposes, waste handling and disposal areas were divided into radiation and contamination zones. Each zone was designed to minimize and confine both direct radiation and potential contaminants if they occur, using static barriers, such as permanent and temporary walls and shielding, and by the dynamic controls provided by the ventilation systems. The design objective was to provide the ability to operate with an administrative control level of 1.0 rem/year (10 mSv) per person or less.

For operational purposes, designated radiological areas are dynamic and subject to frequent change depending on activities and radiological conditions in the areas.

7.1.4.1.2 Normal Operations Dose Estimates

Normal operations encompass the transfer of CH TRU transporters and containers from the point of receipt to the disposal area without an abnormal occurrence.

The following items are inputs to the analysis of the dose estimates included in Table 7.1-2:

- The average dose rate for a CH TRU waste drum is estimated based on information provided by waste generators and reflected in WIPP Radiation Safety Paper 96-01,[25] entitled "Dose Estimation, Radiological Area Posting and Access Control Policy for Initial Waste Receipt."

The number of people who could receive radiation exposure in a given area is based on manpower studies for the CH TRU areas both aboveground and underground at the facility. The primary occupationally exposed groups considered in the dose assessment are waste handling personnel and radiation control personnel. Estimated exposure times are based on time and motion analyses of the functional steps constituting the preoperational checkouts. In unshielded areas, estimated exposure rates are based on the exposure rates from waste containers and the expected range of distances between radiation sources and personnel. The data used in this analysis is conservative compared to the actual waste handling operation anticipated.

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 will be operated in compliance with the release standards of 40 CFR 191 Subpart A[2] and 40 CFR 61 Subpart H.[3] Once operations begin, confirmatory measurements will be performed as discussed below.

7.1.4.2.1 Effluent Sampling/Monitoring and Environmental Monitoring

7.1.4.2.1.1 Effluent Sampling Systems

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

Samplers are installed near each release point to collect the particulate samples from a representative fraction of the total volume of air being discharged. The samplers consist of a sampling probe, a filter holder, and a vacuum supply.

Other design features are included to improve sampling efficiency.

The FAS filter holder is designed to prevent in-leakage of ambient air, and to support the filter under the design pressure of the vacuum supply. Furthermore, the holder is designed so that particulate matter is uniformly deposited on the filter.

The data from the FASs provide a method 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,[2] and 40 CFR 61, Subpart H.[3] 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.

The Department of Energy (DOE), Westinghouse Waste Isolation Division (WID), New Mexico Environment Department (NMED), and Environmental Evaluation Group (EEG) have signed a protocol[23] that is an agreement for WID to provide NMED and EEG with routine and non-routine (radiation alarm) effluent sample filters for independent analysis. The methods for sample filter transfer to NMED and EEG are described in the protocol[23] and in WP 12-HP3500, Airborne Radioactivity.[24]

7.1.4.2.1.2 Effluent Monitoring Systems

Radiation Effluent Monitoring System (REMS) may be located near the release points in the effluent airstreams. These instruments monitor the extracted air from the effluent ventilation stream for radioactive particulates to provide an alarm in case of a significant accidental release.

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. 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.

3. 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.

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

5. DOE Order 6430.1A, General Design Criteria Manual, December 12, 1983.

6. DOE Order O 420.1, Facility Safety, October 1995.

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

8. WIPP-DOE-069, TRU Waste Acceptance Criteria for the Waste Isolation Pilot Plant, Rev. 5, February 1996.

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

10. WP 12-5, WIPP Radiation Safety Manual, Revision 3, March 1997.

11. DOE/EV/1830-T5, A Guide to Reducing Radiation Exposure to As Low As Reasonably Achievable (ALARA), April 1984.

12. WP 12-2, WIPP ALARA Manual, Revision 3, September 1998.

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

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

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

16. 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.

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

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

19. WP 12-3, Dosimetry Program Manual, Revision 7, March, 1999.

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

21. DOE/NTP-96-1204, The National Transuranic Waste Management Plan, September 1996.

22. WP 12-IH.02, WIPP Industrial Hygiene Program, Rev. 0, December 5, 1997.

23. Protocol for Providing Effluent Monitoring System Filters to the New Mexico Environment Department and the Environmental Evaluation Group, November 1992.

24. WP 12-HP3500, Airborne Radioactivity, Rev. 2, April 28, 1995.

25. WIPP Radiation Safety Paper 96-01 entitled "Dose Estimation, Radiological Area Posting and Access Control Policy for Initial Waste Receipt."

26. WIPP Radiological Control Position Paper, No. 97-05, "*Dose Assessment for Hand Emplacement of MgO Sacks Around CH Waste 7 Packs at the Waste Isolation Pilot Plant,*" April, 1997.

Table 7.1-1, CH TRU Waste - Gamma Source Strength

Energy (MeV)	Average* Source Strength (MeV/cc-sec)	Maximum** Source Strength (MeV/cc-sec)
0.10	5.33E - 3	1.07E - 1
0.15	9.11E + 0	1.82E + 2
0.30	3.51E + 0	7.02E + 1
0.45	5.48E + 0	1.10E + 2
0.70	7.49E + 1	1.50E + 3
1.00	7.33E + 1	1.47E + 3
1.50	6.12E + 2	1.22E + 4
2.00	5.10E + 0	1.02E + 2

* Calculated exposure rate at surface of drum - 10 mrem/h (0.10 mSv/h)
** Calculated exposure rate at surface of drum - 200 mrem/h (2.00 mSv/h)

Table 7.1-2, Normal CH TRU On-site Annual External Radiation Dose Estimates

Operation	Personnel	Total Dose* rem/person-yr (mSv/person-yr)
CH TRU Waste Handling	Waste Handlers	** 14.6 (146)
	Radiological Control	3.6 (36)

* Assumes 15 TRUPACTs/week (5 shipments) and 50 weeks/year. Total dose indicated is not per individual, but that shared among a number of workers, e.g., 14.6 rem/yr ÷ 20 workers (waste handlers at full throughput = .73 rem/yr/individual (7.3 mSv/yr/individual.)

** Worker dose associated with the emplacement of MgO sacks around the perimeter of a 7-Pack was evaluated, and found to be in the range of 70-90 μrem per 7-Pack (105-135 mrem annually).[26]

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7.2 Hazardous Material Protection

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

Hazardous material protection, as implemented by the WIPP Industrial Hygiene Program, is an integral part of the overall WIPP Industrial Safety program, as developed and implemented in WP 12-IH.02, WIPP Industrial Hygiene Program.[1] The organization responsible for implementation is the WIPP ES&H 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 WP 02-RC.01, Site Generated Non-Radioactive Hazardous Waste Management ,[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, nonradiological 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 waste handling building and the underground via diffusion through the drum 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.[15]

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.[15] 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[15] for off-site exposure assessment is the WIPP site boundary. The RCRA Permit Application[15] 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 and from 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 WHB and underground VOC air emissions are from methylene chloride, which are well below Occupational Safety and Health Administration (OSHA) 29 CFR 1910.1000[9] 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,[10] 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 permissible exposure limits used in hazard evaluation and hazard communication shall not exceed those in the mandatory standards of DOE Order 5480.4,[11] 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[2] and WP 12-IH.02, WIPP Industrial Hygiene Program.[1]

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.[1] The program includes material hazard training, Material Safety Data Sheet (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.[1]

7.2.3.3 Chemical Management

Management of hazardous materials is implemented by guidance contained in WP 02-EC.04.[12] 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 Resource Conservation and Recovery Act (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 Westinghouse or by subcontractors. Copies of MSDS are available to all employees during all shifts. Training on the Occupational, Safety and Health Administration (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 Nonradioactive Air Contaminants

WP 12-828[13] 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 other 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.

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 on a periodic basis, 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,[1] 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 monitored for these contaminants, to ensure compliance within TLV limits. Vehicles are checked for carbon monoxide and nitrogen dioxide 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.[1]

7.2.3.6 Occupational Medical Program

The occupational medical site personnel, as defined in the Occupational Health Program Plan,[14] 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, emergency service technicians (ESTs), and fire protection technicians (FPTs). The ESTs/FPTs 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 Radiological Soil Monitoring

Radiological soil monitoring has been implemented to establish baseline parameters. Samples have been collected and analyzed from a total of 37 locations within a 50 mi (80 km) radius of the WIPP facility. At each location, samples from three depths have been collected and either analyzed for 19 different radionuclides or archived for future reference.

The sampling activities have been divided into three geographic areas. These include the WIPP site group, which has the smallest scale and consists of eight locations at the cardinal compass directions from the center of the Property Protection Area (PPA). Because of the proximity to the WIPP facility, this group is perhaps of the most interest in identifying potential radiological releases from operations. The next area is the Five Mile Ring, at a radius of approximately 5 mi (8 km) from the center of the PPA, with 16 locations. The last area is the Outer Sites, with 13 locations representing a variety of habitats, soil types, and land uses in southeastern New Mexico. The data and analytical results from each of these sampling locations have been presented in the Statistical Summary of the Radiological Baseline Program for the Waste Isolation Pilot Plant.[16]

7.2.5 Hydrologic Radioactivity Monitoring

The hydrologic radioactivity monitoring program has been designed to measure characteristic radiological levels in surface-water bodies, bottom sediments, and groundwater. Water samples have been collected and analyzed for 18 different radionuclides. The resulting data from the surface-water and groundwater sampling programs have been analyzed independently. Bottom sediments have been analyzed for 17 different radionuclides. The baseline results of these programs were presented in the Statistical Summary of the Radiological Baseline Program for the Waste Isolation Pilot Plant.

7.2.6 Surface-Water and Sediment Monitoring

Much like the soil-sampling programs, the surface-water and sediment-monitoring programs serve as measures of confirmatory monitoring for the detection of atmospheric radionuclide releases. As a release to the atmosphere is the only release scenario considered credible for the operational life of the facility, data are compared to the previously established baseline. During the Disposal Phase, statistically significant changes will be studied to evaluate if the WIPP programs are a contributor to an increase in the radionuclides detected.

Data collected as part of the nonradiological groundwater surveillance program has been used to develop a database to support the background water quality characterization report. By the end of 1990, the groundwater of interest had been characterized, and the objective of the program shifted from characterization to surveillance. Collection of groundwater quality data continues to assist the DOE in meeting performance assessment, regulatory compliance, and permitting requirements. The data also provide radiological and nonradiological 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.[15]

Because of the absence of surface waters in the vicinity of the WIPP facility, the geographic sampling group that could provide the data of most interest is the stock tanks. These are typically man-made catchment basins, five of which were chosen because of their location with respect to the WIPP facility. In addition to these five stock tanks, the WIPP effluent water (sewage lagoons) and influent water have been sampled and analyzed annually. The results are provided in Appendix D4 of DOE/WIPP 91-005.[15]

7.2.7 Volatile Organic Compound Monitoring

The VOC monitoring program 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. With over two and one-half years of data, a credible basis for determining the WIPP's background levels of the targeted VOCs has been established.

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. Validity is shown when observed emissions are equal to or less than those predicted. The VOC Confirmatory Monitoring Plan (VCMP) is provided in Appendix D20 in DOE/WIPP 91-005.[15] The VCMP includes monitoring design, sampling and analysis procedures, and quality assurance objectives.

This VCMP describes a sampling and analysis program to confirm the theoretical calculations. The monitoring program is capable of quantifying VOC concentrations in the ambient mine air at the WIPP. The VCMP addresses the following information requirements:

- Rationale for the design of the monitoring program, based on possible pathways, operations, engineered and natural barriers, and monitoring locations optimized for detection.

- Descriptions of the specific elements of the monitoring program including the type of monitoring, the location of stations, the frequency of sampling, the target analytes, the schedule for implementation, the equipment used, the sampling and analytical techniques, and the data recording and reporting procedures.

The design of the VCMP used the results of background VOC monitoring activities at the WIPP. These data are presented in Appendix D21 of DOE/WIPP 91-005.[15] These data represent the anticipated background levels of VOCs during operations at the WIPP.

The DOE's intent is to collect air samples upstream and down stream of Panel 1, beginning just prior to waste emplacement, and proceeding until at least six months following completion of panel closure. The DOE will continue monitoring until the criterion for terminating monitoring are met. These criterion are established in Appendix D20 of DOE/WIPP 91-005[15] for each target analyte.

The current VOC monitoring program uses EPA Compendium Method TO-14. The DOE has had success with TO-14 at the WIPP if care is taken in placing samplers to avoid high dust, and if stringent cleaning requirements are imposed for the clean canisters. This is necessary because of the extremely low concentrations that are being monitored. The DOE is evaluating the use of the Fourier Transform Infra-Red (FTIR) technique for monitoring VOCs at WIPP. This method is being used successfully at other locations, and has recently been approved by the EPA for measuring the concentration of VOCs in the headspace gases of drums of TRU waste. If FTIR becomes viable, the monitoring plan will be revised, and the revisions will be submitted to the NMED for approval prior to implementation.

The VCMP will be run under a Quality Assurance Plan that conforms to the document entitled EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations,[17] (EPA 1994). Quality Assurance criteria for the target analytes are presented in Table D-10 of DOE/WIPP 91-005.[15] Definitions of these criteria are given in Appendix D20 of DOE/WIPP 91-005,[15] 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-IH.02, WIPP Industrial Hygiene Program, Rev. 0, August, 1998.

2. WP 12-IS.01, Industrial Safety Program, Rev. 1, March, 1999.

3. WP 02-RC.01, Site Generated Non-Radioactive Hazardous Waste Management, Rev.0, April 1996.

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. Title 30, Code of Federal Regulations, Subchapter N, Metal and Non-Metal Mine Safety and Health, 9th Edition, July 1997.

9. 29 CFR 1910.1000, Air Contaminants, July 1993.

10. DOE Order 440.1, Worker Protection Management for DOE Federal and Contractor Employees, September 30, 1995.

11. DOE Order 5480.4, Environmental Protection, Safety, and Health Protection Standards, May 1984.

12. WP 02-EC.04, Hazardous Material Management Plan, Revision 1, December 1998.

13. WP 12-828, Air Quality Monitoring Procedure, Revision 0, February 1998.

14. WP 15-HS.02, Occupational Health Program Plan, Revision 1, March 1999.

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

16. DOE/WIPP 92-037, Statistical Summary of the Radiological Baseline Program for the Waste Isolation Pilot Plant, 1992.

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

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	100	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. TWA for up to a 10 hour day in a 40 hour workweek
d. 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

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