2.0 Work Planning, Hazards Analysis, and Hazard Controls

An effective radiation protection program must begin with good work planning and hazards analysis, so that the potential hazards associated with the work are recognized and understood. This section includes an overview of the radiation hazards and types of controls associated with the activities performed by TSD couriers. The next three subsections discuss the requirements for establishing a formal radiation protection program to protect workers transporting radioactive materials, and to control contamination hazards. The next four subsections provide additional details on specific elements of the radiation protection program, including exposure monitoring and administrative controls, procedures and implementation, training, and hazard controls during accidents. The final subsection provides a summary analysis of the effectiveness of TSD's radiation protection program and the associated hazards analysis and hazard controls.

Overview of Potential Radiation Hazards and Controls

The nature of TSD courier activities is such that there are two potential radiation concerns:

- Direct exposure to ionizing radiation (also called external exposure), which results from exposure to gamma and/or neutron radiation emitted through the shipping containers by radioactive materials being shipped
- Contamination, most significantly the potential to inhale or ingest radioactive materials (e.g. dust) or track contamination outside a controlled area (e.g., to employees' homes via contaminated shoes or clothing).

TSD personnel could be exposed to such radiation hazards at various times as part of their normal or emergency duties:

- While they are near (e.g., in the tractor cab) SSTs that contain radioactive materials
- During SST entry to check package identification of the items being shipped and the methods for ensuring that packages do not move or shift while being transported (referred to as package tiedowns)
- During escort of radioactive air shipments, at which time the couriers accompany the shipments
- While waiting at loading/unloading/staging facilities, which are sometimes at or near sites that contain radioactive hazards
- During accident conditions.

The radiation doses to TSD personnel have historically been very low.

Radiation exposure records indicate that the radiation dose to TSD employees has historically been very low, averaging near zero mrem/year. Most TSD personnel report that their dose reports almost always indicate zero. The recorded doses are generally very low because of the controls in place to eliminate, reduce, or mitigate radioactive hazards. Examples include:

- Programs and procedures that govern TSD courier operations
- Radiological hazard training for courier personnel
- A dosimetry program to measure and control exposure
- Requirements on packages and shipping configurations that limit the dose rate and contamination levels associated with TSD shipments
- Radiation protection programs to control radiation levels and contamination at the nuclear facilities visited by couriers.

DOE requires that TSD shipments comply with U.S. Department of Transportation (DOT) requirements for shipping radioactive materials over public highways (except where security and classification concerns take precedence). The DOT requirements govern such aspects of shipping as packaging and maximum allowable radiation limits outside the transport vehicle. As a DOE organization, TSD is also subject to a variety of DOE requirements, such as DOE orders, policies, and directives. DOE facilities that ship or receive radioactive materials are also subject to DOE requirements, which include provisions for establishing radiation protection programs and performing surveys to determine radiation and contamination levels.

Table 1 provides an overview of the opportunities for radiological exposure and the conditions and controls that have resulted in very low recorded doses to date. The effectiveness of and potential concerns with the various controls are discussed in the remainder of this section.

Table 1. Overview of Courier Activities and Controls

Courier Activity with Potential For Radiological Exposure	Conditions and Controls that Have Resulted in Low Doses[1]
While near SSTs containing radioactive materials	Department of Transportation regulations govern radiation levels outside the SST resulting from the cargo. These radiation levels must be kept below specified levels. The containers used to package radioactive materials are designed to attenuate ionizing radiation, and the packaging methods are designed to prevent dispersal or leakage of radioactive materials. The SST itself provides additional shielding. Surveys for radiation and contamination provide further assurance that exposures are within limits.
When entering SSTs to check package identification and tiedowns	Packaging limits exposure, and surveys verify that the dose rates and contamination are within limits. Further, couriers normally enter an SST containing radioactive materials only when they are at a shipping/receiving point. When performing the required checks, the couriers are usually only in the SST for a short time (about 15 minutes). TSD couriers are not authorized to pack, unpack, load, or unload radioactive material or items containing radioactive material; these operations are performed by the shipper/receiver.
While escorting radioactive air shipments	Packaging of radioactive materials limits exposure. Exposure time is limited.
Waiting at loading/unloading/staging facilities, which are sometimes at or near sites that contain radioactive hazards	Entries into radiological controlled areas at loading/unloading sites are controlled by site procedures.
During accident conditions	Accidents are rare, and none have been serious enough to cause exposures. Procedures are in place in the event of accidents.

[1] Many controls, such as training, procedures, and administrative control limits, are applicable to all of the listed activities.

Formal Radiation Protection Programs

DOT regulations (49 CFR requirements) and DOE regulations (such as 10 CFR 835) require that organizations establish a formal radiation protection program to protect workers. A formal radiation program is a documented and approved program in which the organization specifies processes for identifying, controlling, and monitoring exposure to radiation. A typical program would include features such as:

- Procedures and technical basis documents that identify potential sources of radiological hazards and the appropriate mitigation techniques
- Individual dosimeters (worn by individuals while on the job) to measure the amount of external radiation that an individual has encountered
- Monitoring individuals to determine whether they have ingested, inhaled, or absorbed radioactive materials internally using mechanisms such as whole body counts (in which a person is placed in a device designed to measure the amount of radioactivity in an individual's body) or bioassays (in which fluid or tissue samples are extracted from an individual and measured)
- Monitoring and recording exposures to ensure that individuals do not exceed applicable limits (e.g., 5000 mrem per year for most individuals and lower limits for certain individuals, such as pregnant women)
- Training programs that are intended to ensure that personnel have an adequate understanding of radiation hazards, posting and labeling, hazard controls, and their responsibilities.

According to Department of Transportation regulations, TSD is not required to establish a formal radiation protection program because of historically low exposures.

According to DOT regulations, organizations that transport radioactive materials are not required to establish a formal radiation protection program when dose levels less than 500 mrem/yr or a transportation index of less than 200 is anticipated. According to TSD records, the dose levels for TSD personnel have historically been near zero mrem/yr, which is well below the DOT threshold for establishing a formal radiological protection program. Thus, TSD is exempt from establishing a formal radiation protection program under DOT regulations. In addition, on September 2, 1997, the DOT published its intent to withdraw the radiation protection program requirement effective September 30, 1997.

TSD has a conditional exemption from DOE requirements for a formal radiation protection program.

DOE regulations (such as 10 CFR 835), however, specify that DOE organizations that use or store radioactive materials must establish a formal radiation protection program. TSD was granted an exemption from 10 CFR 835 for transportation activities in December 1995. The exemption included the four conditions shown in Table 2.

The TSD radiation protection program document delineates management and workforce responsibilities and TSD commitments regarding compliance with requirements/regulations. The radiation protection program incorporates the applicable conditions of the exemption to 10 CFR 835. TSD management approved the TSD radiation protection program on July 29, 1997. A draft version of the TSD radiation protection program had been used since 1992. Section 9 of the "Transportation Safety Analysis Report (TSAR) for U. S. Department of Energy (DOE) Transportation Safeguards Division (TSD) Operations Volume I: Highway Operations, Issue A, Revision 0," dated April 30, 1996, also describes a TSD radiation protection program. TSD management indicated that the TSAR was not yet in use.

The TSD radiation protection program meets the applicable conditions of the exemption to 10 CFR 835. (TSD no longer uses radioactive check sources, so the condition regarding control of check sources is no longer applicable. See discussion in this section under Hazard Controls During Accidents.)

Table 2. Conditions for Exemption to 10 CFR 835

1. Continue the following radiological practices:
   - Conduct triennial audits of transportation related radiological activities.
   - Provide personnel dosimeters to TSD personnel involved in the use and storage of check sources and in transportation related activities.
   - Require that TSD personnel involved in transportation activities receive the equivalent of General Employee Radiological Training.
   - Maintain records of the results of personnel monitoring.
   - Provide reports of monitoring results to individuals.
   - Provide source custodians with the equivalent of Radiological Worker I training.
2. TSD will develop a technical basis to demonstrate that there is not a credible path for uptake or intake of radioactive material by its personnel.
3. TSD will use the requirements in DOE Notice 441.1, section 6.e, to control exposure to check sources possessed by TSD.
4. TSD will institute an administrative control level of 2 rem Total Effective Dose Equivalent per year. Approval by the Assistant Secretary for Defense Programs is required prior to allowing a TSD employee to exceed this dose level.

Program requirements are appropriate but are not consistently implemented.

The requirements incorporated in the radiation protection program are adequate for TSD operations. However, some conflicts between the program and implementation documents and actual practices were identified. For example, the administrative control limits defined in the radiation protection program for limiting the amount of exposure to TSD personnel are different from those presented during courier training. Courier training presentations include administrative control limits and corresponding actions at 50 mrem, 80 mrem, and 100 mrem. The radiation protection program only identifies an administrative control limit of 2 rem (2000 mrem). In addition, radiation protection program provisions state that shipment/vehicle certification forms are used for all TSD radiological shipments. This is inconsistent with the current practice, which does not use the forms at Department of Defense sites. Further, the radiation protection program does not include commitments to develop a TSD contamination control program, which were identified in occurrence reports (ALO-TSD-TSS-1991-001, 002 and 1992-005). Such differences could contribute to inconsistent implementation or failures to implement specified actions.

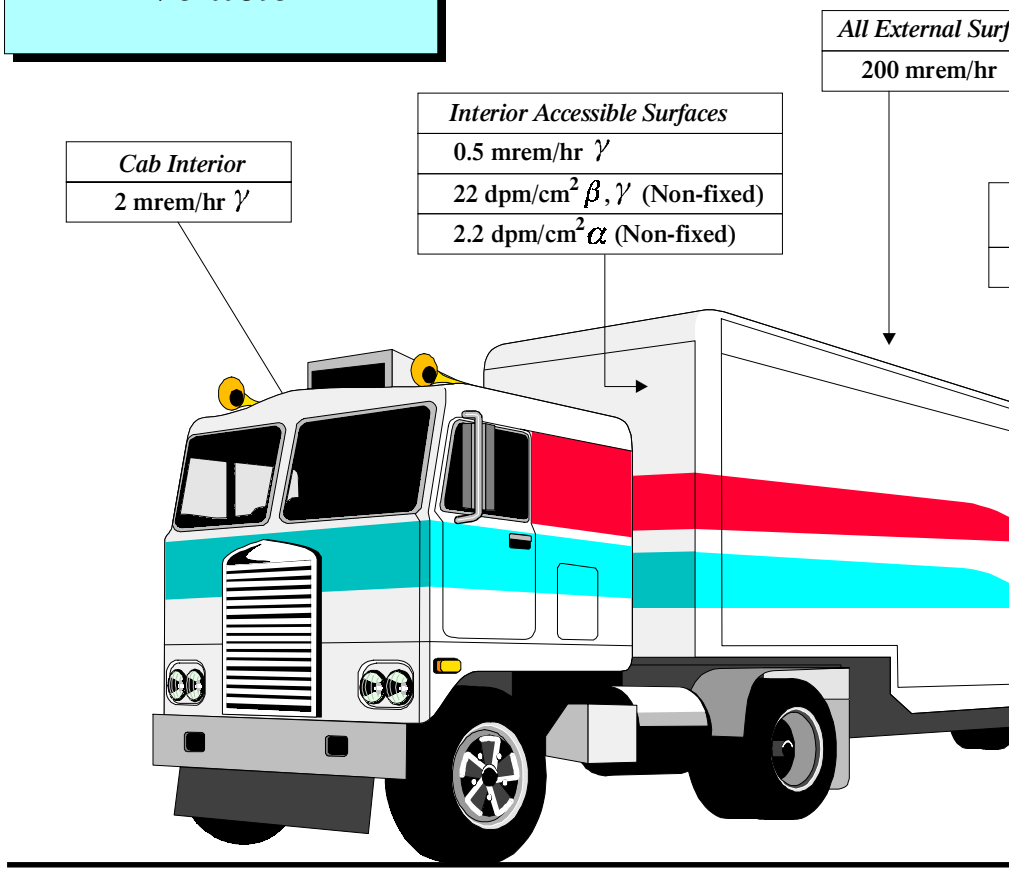
Hazard Controls for Transporting Radioactive Materials

DOT has an extensive set of requirements governing shipments of radioactive materials. For example, DOT specifies that the maximum levels of radiation outside the transport vehicle be less than specified criteria (e.g., 10 mrem per hour at 2 meters from the vehicle), as shown in Figure 2. Similarly, contractor programs at the sites visited required that DOT/DOE radiation and contamination level requirements be met for SST shipments.

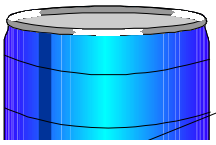
TSD personnel are not involved in loading or unloading the SST. Shippers/receivers are responsible for properly packaging shipments and performing radiological surveys to assure compliance with requirements. Typically, the shippers perform various actions to control hazards and verify that the applicable requirements are met before the loaded vehicles are permitted to leave the site and enter onto public roads. Such hazard controls include:

- **Material Packaging and Certification.** Radiological hazards associated with shipments are primarily mitigated by the packaging and certification requirements. The maximum allowable radiation levels for packages are shown in Figure 2. Most radioactive materials must be

Vehicle



Package Limits



*Individual Package Limits **
200 mrem/hr γ
22 dpm/cm^2 β, γ
2.2 dpm/cm^2 α
* If Shipped by Exclusive Use (Closed transport vehicle, fixed

2

2

shipped in DOT or Nuclear Regulatory Commission-approved containers that meet specified criteria and quality assurance standards. Other items, such as nuclear weapons, are shipped in accordance with DOE-approved methods.

- **Radiation Surveys.** The trucks are monitored with survey instruments designed to measure the levels of direct radiation being emitted from an object to verify that the radiation levels are within allowable limits.

- **Surveys of Packages To Detect Contamination.** Such surveys involve taking and analyzing "swipe" samples of the external surfaces of shipping containers to verify that contamination levels are below applicable standards.

- **Surveys of Vehicles.** Swipe samples of the interior of SSTs are taken and analyzed to verify that they are within limits. Such surveys are required after unloading operations and when vehicles are brought in for periodic maintenance between shipments.

Radiological surveys are performed appropriately.

The Oversight team reviewed a sample of radiological survey results and observed unloading and loading procedures at selected sites. This sample indicates that surveys are being conducted as required for SST shipments. The only exception noted was that fully assembled nuclear weapons being shipped from the Pantex Plant to Department of Defense sites are not surveyed. The quality control processes for nuclear weapons are stringent and involve various measures to ensure that weapons are not contaminated. However, sampling weapons during the loading/unloading process may be prudent as an additional control that needs to be balanced against other concerns associated with nuclear weapons (e.g., minimizing contact with the nuclear weapons and minimizing bringing equipment, such as radiation monitors, in close proximity to high explosives).

Although the loading/unloading and survey activities are performed by the shipper/receiver, TSD personnel perform certain actions at the shipping/receiving point, such as checking the package tiedowns, verifying package identification numbers, checking equipment, and coordinating with the facility to document that the shipment meets requirements. Security provisions require that two individuals perform this task (this security provision is often referred to as the two-person rule). Observations by the Oversight team and review of records indicate that TSD personnel performed these activities in accordance with their procedures, except that one required form is not consistently completed and not adequately incorporated into procedures.

Forms used to certify that shipments meet packaging requirements are not used consistently.

The noted exception involves the use of Form AL F 5600.3, Vehicle and Shipment Certification Form, which is required by AL Supplemental Directive 5610.14 as a mechanism to obtain certification from shippers/receivers that vehicles/shipments meet radiological contamination/radiation level requirements for all shipments. The certification form is not used for Department of Defense shipments and aircraft shipments. Two versions of the certification form were being used, each version specifying different requirements: a 1986 version required certification to 49 CFR 173 requirements, and a 1994 version required certification to DOE requirements. The requirement to use the form was not incorporated into the Courier Standard Operating Procedure (SOP). Interviews with TSD personnel and a review of trip files indicated that the forms were not always used as required. The failure to use the forms consistently and correctly does not in itself result in a hazard to workers (at the three facilities reviewed, the shippers and receivers were performing the required activities effectively, except for surveys of aircraft, which are discussed below). The form is TSD's mechanism for ensuring that the facilities certify that the applicable requirements are met. The form is therefore an important control that is not being properly implemented.

When shipping materials by aircraft, measures similar to those for shipping radioactive materials over highways (e.g., packaging and radiation and contamination surveys of packages) are required. In addition to monitoring packages for radiation and contamination, 49 CFR 175.705 requires periodic contamination surveys of aircraft. The frequency of

these surveys is to be based on the potential for contamination. The potential for contamination from packaged tritium shipments (the main shipment) is low; however, TSD has not established a program for performing periodic contamination surveys of TSD-owned aircraft at any frequency. A review of records indicates that radiological surveys of aircraft have not been performed since 1995. These aircraft are also used for personnel transport.

Contamination Hazards

In response to the exemption condition, TSD recently (drafted in 1995 and completed August 1997) finalized a technical basis document regarding the potential for uptake of radioactive materials. A conclusion of the technical basis document was that the potential for uptake of radioactive materials by couriers during routine operations was very low. Correspondingly, TSD determined that it would continue its practice of not routinely performing any bioassays or whole body counts of couriers. TSD procedures call for such bioassays only in the event of a known contamination incident. The Oversight team's review indicates that the technical basis document is credible and the use of bioassay sample collection and analysis for contamination incidents is appropriate, particularly in light of the observed effectiveness of surveys and the historically low frequency of reported contamination incidents involving SSTs (none reported since 1992).

There have been no reportable contamination events in the past five years.

The Oversight team reviewed reportable occurrences in the DOE Occurrence Reporting and Processing System (covering 1989 to the present). No reportable occurrences were found in the Occurrence Reporting and Processing System that involved a TSD employee being contaminated as a result of checking shipment cargo in SSTs or air transport. Further, there were no reported instances involving contamination above allowable limits in the last five years. There were three instances where fixed, low levels of contamination above the specified limits were found during surveys being conducted by shipper/receivers in SSTs; the latest such contamination event occurred in 1992. The fact that there have been no reported contamination events indicates that procedures implemented by the shippers and receivers are effective at controlling contamination. The additional radiation surveys of the SSTs performed at the courier sections by the host facilities (i.e., the managing and operating contractors at Sandia National Laboratories, the Pantex Plant, and the Y-12 Plant) provide additional assurance that contamination is being effectively controlled.

Potential contamination hazards at one area had not been adequately analyzed.

However, couriers raised concerns about the potential for contamination at an area at the Y-12 Plant referred to as the "bone yard." The bone yard consists of an asphalt pad and a break room bordered on three sides by contamination areas and high contamination areas. TSD recently began using the bone yard after not doing so for several years (see discussion in Section 3 related to employee concerns). Surveys performed around the perimeter indicated that the radiation levels were at or near "background" levels (radiation levels from natural sources or unrelated man-made radiation, such as residual radiation from above ground nuclear testing that occurred until the 1960s). The contamination controls at this area had not been adequately analyzed, and there are several potential contamination hazards:

- The contaminated and highly contaminated areas are not protected from the weather, potentially allowing contamination to spread.
- There were no buffer areas between the contaminated and highly contaminated areas and the work area for the couriers.
- Drums were stacked three high on rotting pallets, with potential for falling near the break room.
- Power cords and vehicle chocks were lying on the ground near the area of high contamination. TSD management indicated that the power cords had not been used recently.

Although contamination controls were generally effective at the facilities reviewed, the hazards

associated with operational changes, such as the decision to again use the "bone yard" for courier activities, have not been adequately analyzed.

Exposure Monitoring and Administrative Controls

Consistent with the conditions of its exemption to 10 CFR 835, TSD monitors the amount of external exposure received by its couriers through the use of thermoluminescent dosimeters (TLDs).

Historical dosimetry records show that the external radiation dose levels recorded for couriers have been very low, averaging near zero mrem/year. TSD has established an administrative control level of 100 mrem/year. Most couriers interviewed reported that their quarterly dose reports are nearly always zero.

TSD radiation exposures are historically much less than the administrative control limits.

Couriers are trained to wear the TLDs anywhere between neck and waist. Personnel interviewed were familiar with this requirement. Because of the relatively low height of many of the shipping containers that TSD carries, many of the sources of radiation are located at waist level or below. TSD's practice of wearing the TLDs between the waist and neck is consistent with industry practices and provides a valid estimate of doses to the upper body and vital organs. It may, however, slightly underestimate the exposure to the couriers' legs and lower body. Considering the low radiation levels outside the shipping containers and the historically very low doses received by couriers, the doses to the legs and lower bodies would still be very small and much less than regulatory limits. The administrative control limits established by TSD provide a substantial margin of safety (i.e., the TSD administrative control limit of 100 mrem/year is less than the 2000 mrem/year control limit specified by EH in the conditions to the exemption to 10 CFR 835, which are less than the regulatory limit of 5000 mrem/year).

Some transportation escorts indicated that they often did not wear their TLDs as required in their standard operating procedure. Proper use of TLDs is the key element in the monitoring program. Although the expected dose rates are small, failure to consistently wear TLDs defeats the purpose of the program and is not an acceptable practice.

The dosimetry equipment was appropriate for the hazards associated with TSD work activities. TSD's dosimetry program is managed by Sandia National Laboratories (SNL). The SNL dosimetry program is accredited by the DOE Laboratory Accreditation Program, which provides independent checks to verify that dosimetry programs are adequate. The SNL accreditation encompasses most radiation conditions, including those encountered by the TSD couriers. However, the expected radiation conditions are not clearly specified in the TSD technical basis document for dosimetry.

Procedures and Implementation

Many aspects of the TSD radiation protection program are implemented through the Courier SOP, which contains procedures for courier operations. In most cases, the Courier SOP adequately describes how couriers are to perform duties related to the radiation protection program.

The Courier Standard Operating Procedure is not adequately maintained.

The Courier SOP is not being adequately maintained and updated to ensure that the copies used in the field accurately reflect all current TSD policies and procedures. TSD Headquarters documents procedural changes through Operational Change Notices, which are distributed to the courier sections and serve as interim documentation of the change pending formal revision of the Courier SOP document. Over 37 Operational Change Notices have been issued since the last formal revision of the Courier SOP document three years ago. These notices were typically placed in the Courier SOP binder, but some were missing, and some required "pen and ink" changes that had not been made as specified.

Other operational changes had not been documented at all by TSD Headquarters. For example, in September 1996 TSD removed radiation monitoring equipment from TSD convoys and changed the emergency response duties of the couriers, no longer requiring them to conduct radiological monitoring at the scene of an accident involving an SST. However, the pre-trip equipment checklist in the Courier SOP still shows the radiation monitor that was used for this purpose, and procedures still specify use of this

instrument in some conditions; thus, instruments required by procedures are no longer available. TSD management stated that the Courier SOP is being revised.

Activities observed during this review were generally performed appropriately.

The Oversight team observed specific TSD activities, including off-loading of a shipment at SNL and loading of a shipment and pre-trip activities at the Pantex Plant. During these activities, the team observed tasks performed by the shipper/receivers (including radiological surveys, package movements, and tiedown installation/removal) and tasks performed by TSD personnel (including opening SSTs, checking tiedowns, verifying package identification numbers, securing trailers, and conducting pre-trip briefings). Most observed activities were performed appropriately and in accordance with procedures.

However, some concerns were identified with regard to implementation of radiological controls. As noted elsewhere in this section, forms used to certify that vehicles/shipments meet radiological contamination/radiation level requirements were not always used as required. Information obtained during interviews indicated that some transportation escorts were not wearing TLDs while transporting radioactive material, as required in the Courier SOP.

One procedural violation involving parking the trailers has apparently not been corrected for several years.

In addition, controls are in place to prevent SST use prior to completion of radiological surveys and maintenance at the courier section sites. This system had failed in December 1994, when three SSTs left the Pantex Plant without the required radiological surveys being performed (Occurrence Report ALO-TSD-TSS-1994-007). Parking the SSTs on the ready line was identified as a contributing factor at that time. The Oversight team found that SSTs were incorrectly parked in the ready line at both the Albuquerque and Pantex Courier Section sites. This procedural violation has apparently not been corrected several years after it was documented in an occurrence report.

Training

Radiological training is administered by the Training Section within the TSD Support Branch and presented by Training Specialists assigned to each courier section, using lesson plans and course materials developed and provided by the Support Branch. Radiological training for TSD personnel includes periodic completion of General Employee Radiological Training (GERT), Understanding Radiation, and Emergency Response Radiological Concerns courses. The training courses meet requirements specified in the conditions to the exemption to 10 CFR 835, and most TSD personnel interviewed demonstrated a basic knowledge of radiation.

Couriers have been trained to control radiation exposure by limiting their time inside the trailers.

TSD couriers were trained on and displayed an understanding of the radiation protection concept of "time, distance, and shielding" (i.e., minimize the time of exposure, maximize the distance from the radiation source, and maximize the amount of shielding between the source and individuals) to reduce the amount of external exposure they receive from the shipping containers. When checking shipments inside the SST, couriers recognized that they should minimize the time they spend in the SST to reduce their exposure; couriers have little control over distance and shielding because they must pass in close proximity to the containers to perform their duties. Couriers indicated that they are not normally inside the SST for longer than 10 to 15 minutes when conducting the required checks.

Although couriers were able to recite basic radiation knowledge during interviews, some of their concerns about radiation protection appear to stem from weaknesses in their understanding of some aspects of radiation and basic radiation protection principles. Some couriers did not clearly differentiate between radiation and contamination, did not correctly understand the purposes of bioassays and whole body counts, or could not relate the potential biological effects to exposure levels. Some couriers indicated that they distrust their TLDs because the results reported to them consistently indicate zero exposure even though they are worn at sites where radioactive material is present and/or when the couriers are near containers of radioactive materials.

Weaknesses in courier understanding of contamination and radiation effects had been previously identified.

Weaknesses in courier understanding of contamination and radiation were previously identified, in part, by TSD contractor training personnel. In addition, a weakness in GERT training was identified in an AL assessment; i.e., it includes only one set of ten questions that is used repeatedly. Continued improvements in training programs may help ensure that personnel have a clear understanding of some aspects of radiation hazards, which could help to alleviate misunderstandings and miscommunications between couriers and management.

Hazard Controls During Accidents

TSD SSTs make several hundred trips per year and travel many thousands of miles annually, and their rate of accidents is significantly lower than national averages. However, TSD experiences occasional vehicular accidents. Containers used to transport materials are designed to withstand specified accident conditions (e.g., they meet specified standards for fire resistance and leak rates) without dispersion of materials. None of the accidents to date have caused any release of hazardous materials. TSD couriers could be subjected to increased radiation exposure (either direct radiation or through the spread of contamination) if containers are breached or materials are released during an accident.

In an accident, couriers are trained to respond to protect the shipment and establish a control boundary.

TSD personnel have procedures and are trained to cope with accident conditions. Their primary responsibilities as described in the Courier SOP (Section XIV) and courier training (e.g., the Emergency Response-Radiological Concerns Lesson Plan) are to provide security for the shipment, perform life saving/ first aid actions, notify the appropriate organizational elements, and establish a control boundary to limit exposure and spread of contamination.

Historically, TSD used radiation monitoring equipment (TBM-3S instruments) to measure radiation fields during accident conditions. This equipment was to be used to establish a radiation control boundary and measure both direct radiation (gamma fields) and contamination (although the instruments are not well suited to measure alpha radiation).

In 1995, TSD made changes relating to the use of radiation monitoring instruments during accident conditions. Specifically, Operational Change Notice 95-04 deleted the requirement to perform alpha contamination surveys at accident sites and changed the levels for establishing a radiation control boundary. These changes were based on a document titled "Recommendations for use of the TBM-3S," which was developed by Waste Isolation Pilot Plant personnel. It recommended that couriers discontinue use of the instrument for alpha-contamination surveys; that TSD use the instrument to measure gamma fields to establish a radiological control boundary at a safe distance (e.g., 5 mrem/hr); and that assessment of radiological contamination on personnel and surrounding surfaces be delegated to Radiological Assistance Program teams as the TSD mission permits.

TSD did not document a technical basis for the decision to remove radiation monitoring equipment from the trailers.

More recently, TSD changed its approach and now relies on the arrival of a Radiological Assistance Program team to perform radiation measurements following accidents. Accordingly, radiation monitors and the associated small radioactive check sources (which are used to verify operability of the instrument) were removed from TSD vehicles during September 1996 in accordance with a TSD memorandum. There is no documented technical basis supporting the removal of these monitors or justifying the time period that it would require to obtain survey readings (which could be up to four hours, assuming that the Radiological Assistance Program team arrives within their allotted time). Further, the removal of the instruments is inconsistent with the recommendations of the study performed by Waste Isolation Pilot Plant personnel, which indicated that they should not be used for contamination surveys but should be used to establish a radiation control boundary.

These changes have not been adequately coordinated or effectively implemented:

- The change notice did not identify all required changes.

- The "pen and ink" changes were not completed as specified in the four Courier SOPs reviewed.

- The Courier SOP section on emergency response still requires the use of monitors.

- Almost all couriers interviewed expressed concern with the removal of the monitors and indicated that the basis for removal had not been adequately communicated.

Summary Analysis

Radiation records indicate that exposures are very low and significantly less than the administrative control limit, which are a factor of 50 lower than the regulatory exposure limits. Further, the scope of the radiation protection program is appropriate, and TSD has established a credible technical basis for concluding that the likelihood of radiation uptakes for contamination is low. The low radiation exposures and low potential for contamination are largely attributable to controls established by DOE (including DOT regulations mandated by DOE) that are implemented by the shippers and receivers, including requirements for packaging radioactive materials and performing radiation and contamination surveys.

With a few exceptions, TSD's radiation protection program meets applicable requirements.

With a few exceptions, TSD has identified applicable requirements, established a program that meets applicable requirements, adequately defined the work activities involving potential radiation hazards, analyzed and understands the hazards, and implemented controls that are sufficient to prevent significant exposure to radiation. It is also notable that TSD management had implemented radiation protection controls, including an external dosimetry program, prior to being required to do so by 10 CFR 835 and the subsequent conditions of the exemption.

Although the controls implemented by shippers and receivers, in conjunction with the TSD radiation protection program, are generally effective in controlling radiation exposure to couriers, a number of potential concerns were identified:

- A few potential hazards have not been formally analyzed, including the potential for contamination at the bone yard and the impact of responding to accidents without the radiation monitoring instruments.

- Some controls have not been defined or established, such as surveys of aircraft used for shipping radioactive material (which are also used for passenger transport, although not concurrently with radioactive shipments), and program documents and operating procedures are inconsistent and not well maintained.

- TSD's implementation of procedures has not been consistent or rigorous, and some longstanding procedure problems have not been addressed, such as forms and procedural violations involving incorrect parking of SSTs in the ready line. There are indications that some transportation escorts do not wear their TLDs as required by the Courier SOP.

- Training programs have been only partially effective in ensuring that couriers understand radiation and contamination hazards.

Although improvements are needed, the potential for significant exposure is low.

These deficiencies indicate that TSD needs to place more emphasis on ensuring that hazards analysis, program documentation, and procedures are current, and that requirements are rigorously implemented. Such deficiencies create a potential for unmonitored exposures or undetected contamination events. Notwithstanding these deficiencies, the potential for significant exposure is low because the nature of the courier activities is such that there are few opportunities to receive a significant exposure, and there was no evidence that significant exposures have resulted from any of the identified weaknesses.