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July 27, 2001

James Lieberman, Esq.
Office of General Counsel
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

Re: Examples of Local/Non-Agreement State Efforts to Regulate Atomic Energy Act Materials

Dear Jim:

In accordance with our prior conversations and in anticipation of the August 2 meeting between UniTech Services Group, Inc. (UniTech) representatives and the NRC Staff, I am providing you with six copies of a brief summary containing examples of regulatory requirements that have been imposed by local or non-Agreement State governments on radioactive material subject to the Nuclear Regulatory Commission's (NRC) exclusive regulatory authority under the Atomic Energy Act (AEA materials). The package also contains some relevant supporting reference materials. While these are not the only examples that could be identified, we believe that they are sufficient to demonstrate the nature of UniTech's concern and the need for corrective or clarifying action by the NRC.

As you review the enclosed materials, please note that in each case the primary, if not exclusive, purpose of the regulation is to protect workers or the public from the radiation hazards of AEA materials. Local and non-Agreement State governments simply may not regulate in the preempted field, let alone in a manner that is more stringent than, and potentially in conflict with, NRC requirements.

Template 06C002

ERIDS 06C01

I hope that the enclosed information will help facilitate our discussion when we meet. In the meantime, if you have any questions, I can be reached at 202-467-7502.

Sincerely,

Donald J. Silverman

cc: George Bakevich
Mike Fuller

ATTACHMENT

Examples of Local and Non-Agreement State Regulation of AEA Material

Jurisdiction	Summary of Regulation	Status	References
Pennsylvania	Pennsylvania's Department of Environmental Protection ("DEP") has adopted rules setting forth regulatory requirements for solid waste facilities to: (1) implement and obtain approval of a radiation protection action plan in the event of a radiation alarm; (2) monitor for radiation in accordance with a DEP guidance document; (3) conduct radiological surveys of vehicles; and (4) notify the DEP and take response actions in the event of a radiation alarm or if certain dose rates are detected. The DEP applies, among other things, a 4 mrem drinking water pathway standard.	The rules are in effect.	• 25 Pa. Code §§ 273.140a; 273.223. **(Ref. A)**. • Guidance Document on Radioactivity Monitoring at Solid Waste Processing and Disposal Facilities, Department of Environmental Protection. **(Ref. A)**.
Kentucky	The Kentucky Natural Resources and Environmental Protection Cabinet issued a RCRA permit to DOE authorizing operation of a solid waste landfill at the Paducah Gaseous Diffusion Plant. The RCRA permit contained conditions prohibiting placement in the landfill of "[s]olid waste that exhibits radioactivity above de minimis levels" and prohibiting placement of "solid waste that contains radionuclides" prior to review and approval of a Waste Characterization Plan.	In a decision of the Sixth Circuit Court of Appeals, the court affirmed a District Court decision that the permit conditions were preempted by the AEA. United States v. Kentucky, 2001 U.S. App. LEXIS 11591 (June 5, 2001).	• United States v. Kentucky, 2001 U.S. App. LEXIS 11591 (June 5, 2001). **(Ref. B)**.
Oak Ridge, Tennessee	Oak Ridge developed a methodology for establishing radionuclide limits for its sewage sludge. According to the City of Oak Ridge Department of Public Works, the Industrial Pretreatment	This program is in effect.	• Guidance on Radioactive Materials in Sewage Sludge and Ash at Publicly Owned Treatment Works,

	Program ("IPP") is a set of guidelines that has been adopted pursuant to the Clean Water Act. The City of Oak Ridge used the sewage sludge criteria outlined in the IPP to establish facility specific discharge limitations for entities that discharge radioactive materials to the POTW. The IPP includes limits on discharges of individual radionuclides and general quantity limits that are more stringent than the NRC limitations. Thus, Oak Ridge regulates discharges of AEA materials in a manner more restrictive than the NRC and relies on the Clean Water Act for its authority.		ISCORS, Revised Draft, June 2000 (see pp. F-2 to F-3). **(Ref. C)**. • Affidavit of Elisabeth Stetar, Interstate Nuclear Services Corp. v. City of Santa Fe, CIV 98-1224 (Dist. N. M. Oct. 13, 1999)(see pp. 6-8). **(Ref. D)**. • Conversation with Kenneth Glass, Wastewater Treatment Facility, Oak Ridge, TN, June 6, 2001. • Conversation with Bruce Giles, City of Oak Ridge Department of Public Works, July 6, 2001.
St. Louis, MO	The City of St. Louis has adopted a local ordinance (Metropolitan St. Louis Sewer District Ordinance No. 8472 (Article V, Section 13)) to limit radioactive discharges from industrial users. The draft NRC POTW Guidance document states that the purpose of these requirements is to ensure that the concentration of radioactive discharges does not pose a hazard for the Sewer District employees and does not adversely affect the district's sludge disposal options. The Ordinance prohibits the discharge of "any radioactive material except those wastes which are authorized for disposal into sanitary sewers under applicable State and Federal regulations *and as specifically authorized by the Director*" of the sewer district. The Ordinance also contains a limit of 1 curie per year *for the aggregate discharge from all users* to each of the sewer district's treatment plants which	The City Ordinance is in effect.	• Metropolitan St. Louis Sewer District Ordinance No. 8472, Article V(A)13, (Aug. 14, 1991)(see pp. 14 – 15). **(Ref. E)**. • Guidance on Radioactive Materials in Sewage Sludge and Ash at Publicly Owned Treatment Works, ISCORS, Revised Draft, June 2000 (see p. F-2). **(Ref. C)**.

	is a more conservative requirement than that of the NRC. Excreta from individuals undergoing medical diagnosis or treatment with radiological materials are exempt from this prohibition. Licensees are required to write the sewer district requesting approval to discharge radioactive materials and indicating the isotopes and the amounts to be discharged annually. The district then approves the discharges. The district requires quarterly reports from the licensees to ensure compliance with the Ordinance and State and Federal regulations.		
North East Ohio Regional Sewer District ("NEORSD")	NEORSD in Cleveland regulates discharges of radiological materials to its system by use of questionnnaires and permit conditions. NEORSD restricts the concentrations of cobalt-60 that can be discharged to the sewer by a licensee to 100 pCi/l, whereas the NRC sewer discharge limit is 3,000 pCi/l.	This regulatory program is in effect.	• Affidavit of Elisabeth Stetar, Interstate Nuclear Services Corp. v. City of Santa Fe, CIV 98-1224 (Dist. N. M. Oct. 13, 1999)(see p. 9). **(Ref. D)**.

Subchapter A. GENERAL

Sec.

§ 273.1. Scope.

This chapter sets forth application and operating requirements for persons and municipalities that operate municipal waste landfills. The requirements in this chapter are in addition to the applicable requirements in Chapter 271 (relating to municipal waste management—general provisions).

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§ 273.140a. Radiation protection action plan.

(a) An application shall contain an action plan specifying procedures for monitoring for and responding to radioactive material entering the facility, as well as related procedures for training, notification, recordkeeping and reporting.

(b) The action plan shall be prepared in accordance with the Department's "*Guidance Document on Radioactivity Monitoring at Solid Waste Processing and Disposal Facilities*," Document Number 250-3100-001, or in a manner at least as protective of the environment, facility staff and public health and safety and which meets all statutory and regulatory requirements.

(c) The action plan shall be incorporated into the landfill's approved waste analysis plan, under § 271.613 (relating to waste analysis plan).

Source

The provisions of this § 273.140a adopted December 22, 2000, effective December 23, 2000, 30 Pa.B. 6685.

Cross References

This section cited in 25 Pa. Code § 273.223 (relating to radiation monitoring and response).

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§ 273.223. Radiation monitoring and response.

(a) An operator shall implement the action plan approved under § 273.140a (relating to radiation protection action plan).

(b) An operator shall monitor incoming waste in accordance with the Department's "*Guidance Document on Radioactivity Monitoring at Solid Waste Processing and Disposal Facilities*," Document Number 250-3100-001 or in a manner at least as protective of the environment, facility staff and public health and safety. Monitoring shall meet the requirements of this section and the facility's approved radiation protection action plan.

(c) Radiation detector elements shall be as close as practical to the waste load and in an appropriate geometry to monitor the waste. The radiation monitoring system shall be set to alarm at a level no higher than 10 microroentgen per hour (μR/hr) above the average background at the facility when any of the radiation detector elements is exposed to a cesium-137 gamma radiation field. Radiation detector elements shall be shielded to maintain the average background below 10 μR/hr. If capable of energy discrimination, the radiation monitoring system shall be set to detect gamma rays of a 50 kiloelectron volt (keV) energy and higher.

(d) An operator shall have portable radiation monitors capable of determining the radiation dose rate and presence of contamination on a vehicle that has caused an alarm. Upon a confirmed exceedance of the alarm level in subsection (c), a radiological survey of the vehicle shall be performed.

(e) An operator shall notify the Department immediately and isolate the vehicle when radiation dose rates of 20 μSv/hr (2 mrem/hr) or greater are detected in the cab of a vehicle, 500 μSv/hr (50 mrem/hr) or greater are detected from any other surface, or contamination is detected on the outside of the vehicle.

(f) Monitoring equipment shall be calibrated at a frequency specified by the manufacturer, but not less than once a year.

(g) If radioactive material is detected, the vehicle containing the radioactive material may not leave the facility without written Department approval and an authorized United States Department of Transportation exemption form.

Source

The provisions of this § 273.223 adopted December 22, 2000, effective December 23, 2000, 30 Pa.B. 6685.

DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bureau of Radiation Protection and
Bureau of Land Recycling and Waste Management

DOCUMENT NUMBER: 250-3100-001

TITLE: Final Guidance Document on Radioactivity Monitoring at Solid Waste Processing and Disposal Facilities.

EFFECTIVE DATE: September 16, 2000

AUTHORITY: Solid Waste Management, Act of July 7, 1980, P.L., No. 97, as amended, 35 P.S. Sections 6018.101-6018.1003; Radiation Protection Act, Act of July 10, 1984, P.L. 688, No. 147, 35 P.S. Sections 7110.101-7131.1101; The Administrative Code of 1929, Section 1917-A, 71 P.S. Section 510-17; Solid Waste Regulations, 25 Pa. Code Chapters 273, 277, 279, 281, 283, 284, 288, 289, 293, 295 and 297; Radiological Health Regulations, 25 Pa. Code Chapters 215-240.

POLICY: To protect the environment and the public health, safety and welfare from the possible dangers of radioactive material that is delivered to solid waste processing and disposal facilities.

APPLICABILITY: This guidance document applies to all owners and operators of solid waste processing and disposal facilities that are required by regulation to monitor for radiation from incoming loads of waste, and to those facilities that choose to monitor even though not required. This guidance document also applies to all Department personnel and activities involved with waste facility permitting, operations and enforcement, radiation protection, grants, monitoring, administration and emergency response.

DISCLAIMER: The policies and procedures outlined in this guidance document are intended to supplement existing requirements. Nothing in the policies or procedures will affect regulatory requirements.

The policies and procedures herein are not an adjudication or a regulation. There is no intent on the part of the Department to give these rules that weight or deference. This document establishes the framework, within which DEP will exercise its administrative discretion in the future. DEP reserves the discretion to deviate from this policy statement if circumstances warrant.

PAGE LENGTH: 44 pages

LOCATION: Volume 5, Tab 7

DEFINITIONS: See attached.

GUIDANCE DOCUMENT ON RADIOACTIVITY MONITORING AT SOLID WASTE PROCESSING AND DISPOSAL FACILITIES

TABLE OF CONTENTS

DEFINITIONS

Absorbed Dose: Measure of energy absorbed by material interacting with radiation. The unit in the older conventional system is the rad, which is equal to the energy of 100 ergs per gram of irradiated material. In the System International (SI), the unit for absorbed dose is the gray (Gy), which is equal to 100 rads.

Activity: Rate of decay for radioactive material. The older conventional unit is the curie (Ci). The System International (SI) unit is becquerel (Bq), where $1Ci = 3.7 \times 10^{10}$ Bq.

Byproduct Material: (1) Radioactive material, except special nuclear material, yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material and (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium or thorium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute "byproduct material" within this definition. (10 CFR § 20.1003)

Decay: Transformation of atoms of a radioactive element to atoms of another by emission of alpha or beta particles (positive or negative), or gamma rays from its nucleus. The resulting decay product may be radioactive or stable.

Department or DEP: The Pennsylvania Department of Environmental Protection.

Dose Equivalent: The dose of an ionizing radiation that will cause the same biological effect as one rad of x rays or gamma-rays. In the older conventional system, the unit is the rem. In the SI system, the unit is the sievert (Sv), 1Sv = 100 rem. Dose equivalent is calculated by multiplying absorbed dose (rad, Gy) by a quality factor (QF) that accounts for the effectiveness of the radiation, relative to gamma or x rays, in causing a biological effect, i.e., rem = rad x QF; Sv = Gy x QF. *(Note: For this guidance, and x ray or gamma radiation, rem = rad = R.)*

DOT: The U.S. Department of Transportation.

DOE: The U.S. Department of Energy.

EPA: The U.S. Environmental Protection Agency. *(Note: According to the revised Federal Radiation Emergency Response Plan (FRERP), EPA is responsible for providing assistance to states in managing incidents involving radioactive material of unknown origin that is found outside of Nuclear Regulatory Commission (NRC) licensed facilities unless the radioactive material is clearly associated with a NRC licensee, in which case the NRC assumes responsibility for assistance. In general, federal agencies provide assistance at the request of the state.)*

Exposure Rate: An older measurement quantity of intensity for x ray or gamma radiation causing ionization of air. It is still in practical use in the U.S.A.; measured in roentgen (R) or microroentgen (μR) per unit time, usually an hour, as in Rh^{-1} or μRh^{-1}. 1 R = 2.58 E-4 C/kg of air.

Half-life: The time required for half the atoms of a quantity of a radioactive material to decay or become transformed to another nuclide.

Isotope: A chemical element with the same atomic number (i.e., number of protons), but different atomic mass.

Multichannel Analyzer (MCA): An electronic instrument which, when coupled with an appropriate detector, can determine the energy associated with various radiations and thereby identify the radioactive material emitting the radiation.

NARM: Naturally occurring or accelerator-produced radioactive material. The term does not include byproduct, source or special nuclear material.

NORM: Naturally occurring radioactive material is a radioisotope that is radioactive in its natural physical state, not man-made, but does not include source or special nuclear material.

NRC: The U.S. Nuclear Regulatory Commission, which is the federal agency responsible for the regulation of power and research reactors, and radioactive materials produced in nuclear reactors, and certain quantities of uranium and thorium.

Radioactive Material (RAM): A material – solid, liquid or gas - which emits radiation spontaneously.

Radiation: The ionizing particles (alpha, beta, others) or photons (x or gamma ray) emitted by radioactive materials in the process of decay or nuclear transformation.

Radioisotope:	A radioactive isotope of an element.
Source Material:	(1) Uranium or thorium or any combination of uranium and thorium in any physical or chemical form; or (2) ores which contain, by weight, 0.05 percent or more, of uranium, thorium, or any combination of uranium and thorium. Source material does not include special nuclear material. (10 CFR § 20.1003)
Special Nuclear or Material:	(1) Plutonium, uranium-233, uranium enriched in the isotope 233 in the isotope 235, and in any other material that the Nuclear Regulatory Commission, pursuant to the provisions of section 51 of the Atomic Energy Act of 1954 determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched by any of the foregoing but does not include source material. The term "Department" shall be substituted for the term "Commission" when the Department assumes Agreement State status from the Nuclear Regulatory Commission. (10 CFR § 20.1003)
TEDE:	Total effective dose equivalent. Means the sum of the deep dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). (10 CFR § 20.1003.)
TENORM:	Technologically enhanced naturally occurring radioactive materials. It is naturally occurring radioactive material not specifically subject to regulation under the laws of the Commonwealth or Atomic Energy Act (Public Law 83-703, 68 Stat. 921, 42 U.S.C. §2011 et seq.), but whose radionuclide concentrations or potential for human exposure have been increased above levels encountered in the undisturbed natural environment by human activities.
Transuranic (TRU) Radioactive Material:	The term "transuranic radioactive material" means material contaminated with elements that have an atomic number greater than 92, including neptunium, plutonium, americium and curium. TRU waste disposal is strictly regulated by the NRC and DOE.

TECHNICAL GUIDANCE

Background

The Department has the responsibility of protecting the health and safety of the citizens of the Commonwealth and the environment from toxic and hazardous materials in the environment. This includes most sources of radiation. With increasing frequency, radioactive materials have been detected in the municipal waste stream by monitors installed at waste processing and disposal facilities. Radioactive material (RAM) can also appear in the residual waste stream. Sometimes the radiation comes from naturally occurring radioactive material (NORM), but most often it comes from man-made radioactive materials. Man-made radioisotopes are regulated by the U.S. Nuclear Regulatory Commission (NRC) and / or the individual states. Accelerator-produced radioactive materials are regulated by the Commonwealth. Naturally occurring radioactive materials (NORM) are not regulated in Pennsylvania unless resulting radiation doses exceed the limits set forth in Title 25, Chapter 219 of the Pennsylvania Code. However, in the case of radium-226, the Commonwealth can regulate individual discrete sources above 0.1 microcurie (μCi), as set forth in Chapter 217. Thus, one can have RAM that is regulated (through specific or general license), unregulated, deregulated, or exempted from regulation by a variety of federal and state regulatory authorities, and yet the material may cause a solid waste facility radiation monitor to alarm.

Almost everything in the world contains small amounts of radioactive elements, which in turn emit radiation. Most radiation found in the natural environment comes from NORM and cosmic radiation from space, with minor amounts from past above ground testing of nuclear weapons, the nuclear fuel cycle, and perhaps effluents from medical and industrial uses of radioisotopes. Most of the alarm events with radiation monitoring of the municipal waste stream in Pennsylvania have been from short-lived isotopes often used in medical procedures. However, a number of very dangerous RAM sources have been recovered in recent years (e.g., 4.2 Ci Ir-192 and 20 mCi radium-beryllium neutron sources). It is possible that the medical isotopes are getting into the waste stream directly from the medical facilities via contaminated items getting into general trash by mistake. Alternately, the contaminated items are discarded in municipal waste from homes of patients who have had nuclear medicine procedures and been discharged from the treating facility. Other credible routes to the waste stream include contaminated items being discarded in regular trash containers by mistake from clinical or research laboratories, industrial facilities, misplaced encapsulated RAM sources, and construction, residual or industrial waste containing NORM, TENORM or other types of radioactive material.

State and federal regulations require that those who are licensed to handle radioactive materials will maintain strict controls relative to the use and disposal of the material, and will take appropriate actions to prevent unauthorized releases of radioactive materials in solid waste. Nonetheless, for some radioactive materials licensed by NRC or state regulations, once radioisotopes have been administered to patients, and are not likely to cause a dose to an individual above the proscribed public dose limit, the RAM is no longer regulated and patients can be discharged from the treating facilities. The potential amount of radioisotope in a patient's body that may be released from a medical facility is noted in NRC Regulatory Guide 8.39.[1] It should be noted, even small amounts of radioisotopes used for diagnostic tests or radioactivity retained on items touched by patients may emit enough radiation to set off a facility radiation monitoring alarm. Licensees are encouraged to investigate ways of effectively monitoring institutional waste streams coming from facilities using radioactive material before the waste leaves the facility. The NRC has recently issued guidance to RAM licensees for the "Management of Wastes Contaminated with Radioactive Materials" in Information Notice 99-33.

Additionally, there are a number of consumer and industrial items containing RAM in general use that are distributed under a regulatory "exemption" or "general license;" that is, the fabricator or distributor must be licensed but the individual owner/user does not have a "specific license." Examples of exempt RAM include some types of smoke detectors, self-luminous watches or clocks, and many others. Some of these consumer items, like smoke detectors are assumed by the NRC to be discarded in municipal waste during their normal life cycle, however return to the manufacturer is recommended. Other RAM is supposed to be returned to the manufacturer for proper recycle or low-level radioactive waste disposal (e.g., self-luminous tritium EXIT signs). For the more hazardous higher activity sources, the NRC and the Department are presently developing registration requirements to inventory generally licensed (GL) devices used in industry and other areas.

It is interesting to note the first time an alarm went off at one large landfill in Pennsylvania, the cause was a load of sludge containing TENORM (specifically radium-226) from a facility that treated oil and gas well brine. Similarly, most rocks, bricks, gypsum wall board, slag from metal processing, waste from coal ash or coke processing, and similar residuals contain some natural radioactivity. Depending on their origin, these materials may emit enough radiation to set off the radiation alarms at solid waste facilities. These are all examples of NORM or TENORM.

[1] Regulatory Guide 8.39, Release of Patients Administered Radioactive Materials. U.S. Nuclear Regulatory Commission, Washington, DC April 1997. A copy of the relevant table from Regulatory Guide 8.39 is attached to this guidance document as Exhibit B.

Given the above examples of RAM that may set off waste facility radiation alarms, materials that are regulated, deregulated, exempt or unregulated, there are no current standards for radiation monitor alarm set points, and the potential for serious impact on human health and the environment - the DEP Bureaus of Radiation Protection and Land Recycling and Waste Management have recommended to the Department's Solid Waste Advisory Committee and the Environmental Quality Board, that the Department promulgate regulations requiring monitoring for radiation and radioactive materials at the following types of facilities:

- Municipal waste landfills. (25 Pa. Code Ch. 273)
- Construction/demolition waste landfills. (25 Pa. Code Ch. 277)
- Municipal Waste transfer facilities. (25 Pa. Code Ch. 279)
- Commercial municipal waste composting facilities that will receive sewage sludge or unseparated municipal waste, or both. (25 Pa. Code Ch. 281)
- Resource recovery and other municipal waste processing facilities. (25 Pa. Code Ch. 283)
- Commercial infectious or chemotherapeutic waste processing facilities. (25 Pa. Code Ch. 284)
- Noncaptive residual waste landfills. (25 Pa. Code Ch. 288)
- Noncaptive residual waste disposal impoundments. (25 Pa. Code Ch. 289)
- Noncaptive residual waste transfer facilities. (25 Pa. Code Ch. 293)
- Noncaptive residual waste composting facilities. (25 Pa. Code Ch. 295)
- Noncaptive residual waste incinerators and other noncaptive residual waste processing facilities. (25 Pa. Code Ch. 297)

Operators of these facilities must comply with the new regulatory requirements as they are adopted and phased in. Requirements may be implemented by following the recommendations of this guidance document. Briefly, the facilities will have to be equipped with suitable gamma radiation detection devices to monitor incoming loads of waste for radioactive materials in the waste, and will be required to have an appropriate Action Plan that is approved by the Department. These, and the other applicable requirements and recommendations, are discussed herein. It is the Department's belief that these regulations and guidance will be a model for all solid waste facility operators that monitor for radioactive material in incoming waste loads. For Pennsylvania solid waste facilities not required to monitor, but wish to do so as a best management practice, this guidance document should be followed.

General Considerations

Detecting radiation and dealing with radioactive materials in the waste stream is a multiple phase process, including:

- Monitoring and detection of gamma radiation,
- Personnel Training,
- Awareness of items that may contain RAM,
- Initial response to the detection of RAM,
- Notifications - within the company, to DEP, and to others as necessary,
- Characterization,
- Disposition, and
- Record keeping.

The details of these phases may vary somewhat with the type of facility; but in most respects they are similar, except for disposition of the radioactive material. In some cases the facility may have the option of onsite processing or disposal with Department concurrence or pre-approval. Alternately, the waste load may be rejected. However, once RAM has been identified in the waste, it may not be transported on public roads without an evaluation for compliance with DOT regulations. The Department has the authority to exempt carriers from DOT regulations with the scenario of RAM in waste if certain conditions are satisfied.

Action Plans

The Department's regulations require specified facilities to have an approved Action Plan to give direction to operating staff and facility users regarding procedures for detecting and dealing with radioactive material in the waste stream. Action Plans will be part of the solid waste facility permit by modification, and must be approved by the Department. Guidance for preparation of Action Plans and their content is described below, and is also provided in Appendix D. As part of the submission of a proposed Action Plan, the Department may approve the processing and / or disposal of short lived RAM (e.g., I-131, Tc-99m, Tl-201, etc.) from a patient having undergone a medical procedure, small quantities of TENORM, and consumer products containing RAM. This will require providing appropriate justification and / or pathway analysis for modeling potential public and facility staff doses.

Dose Limits for Public and Workers

The public and occupational annual dose limits that will be utilized by the Department in evaluating proposed Action Plans are as follows:

Facility staff -	5,000 mrem	(considered as "occupationally" exposed)
Facility staff -	100 mrem	(if considered member of the "public")
Vehicle driver -	100 mrem	(considered member of the public)
General Public -	4 mrem	(for the drinking water pathway)
General Public -	10 mrem	(for the air pathway)
General Public -	25 mrem	(all pathways combined)

The above public radiation dose limits are all TEDE, where an external deep dose and internal committed dose is summed. It is important to emphasize that all public and facility staff exposure to radiation should be maintained as-low-as-reasonably-achievable (ALARA). As stated above, some facility staff may be considered members of the public, if it is unlikely they will exceed the 100 mrem per year dose limit. However, certain personnel may be considered occupationally exposed workers if higher exposures are anticipated (e.g., the individual that may be performing vehicle surveys). The Action Plan should include consideration of relevant requirements outlined in the Department's Standards for Protection Against Radiation (25 Pa Code Ch. 219) and Notices, Instructions and Reports to Workers (25 Pa Code Ch. 220) if personnel are to be considered occupationally exposed.

In all reviews of proposed Action Plans, the Department will perform evaluations to ensure solid waste processing or disposal does not endanger the environment, facility staff and public health and safety. Therefore proposed Action Plans should describe the potential exposure pathways for members of the general public, and how these expected doses were modeled. For certain solid waste facilities where processing solid waste may release RAM to the environment, the Department recommends the use of basic and conservative regulatory computer codes for such pathway analysis and dose modeling, e.g., the EPA's CAP88 or DOE/NRC's RESRAD codes. These codes and support documentation can be downloaded from various internet web sites. However, valid manual calculations using dispersion equations and published dose conversions factors are equally acceptable to the Department.

Detection of Radiation

The Department's revised solid waste regulations require radiation monitoring and response at the solid waste facilities specified above. Additionally, the regulations state that the radiation detector elements shall be as close as practical to the waste load, and in an appropriate geometry to monitor the waste. The Action Plan should require notification to the Department for conditions specified in the regulations (i.e., radiological conditions noted below in Action Level Two), the detection of prohibited RAM, or the case when a waste load is rejected and a DOT Exemption Form must be issued. Action Plans should address the two basic scenarios, or Action Levels, when radiation is detected from a truck or waste container:

1. Action Level One: A radiation monitor alarm at the facility indicating the potential presence of radioactive material in a waste load.

(Note: The regulations require a gamma exposure rate from a cesium –137 source, at a level no higher that 10 $\mu R\ h^{-1}$ above the average local background, at any detector element, shall cause an alarm at the facility. Instrument background shall be kept below 10 $\mu R\ h^{-1}$ using shielding if needed, and the system shall be set to detect gamma ray energies of 50 kiloelectron volts and higher.)

2. Action Level Two: Radiation dose rates of 20 $\mu Sv\ h^{-1}$ (2 mrem h^{-1}) or greater in the cab of the waste transport vehicle, 500 $\mu Sv\ h^{-1}$ (50 mrem h^{-1}) or greater from any other surface, or the detection of contamination on the outside of the vehicle shall require immediate notification of the Department, and isolation of the vehicle.

Measurements should be made in accordance with guidance provided in Appendix D.

IDENTIFICATION AND DISPOSITION OF RADIOACTIVE MATERIAL FOUND IN THE WASTE STREAM

1. Landfill or Disposal Impoundment

A. RAM from Patients Having Undergone a Nuclear Medicine Procedure

If the gamma spectroscopy or other measurement indicates the radiation is from a radioisotope with a half-life of 65 days or less, the DEP Area Health Physicist may authorize the contents of the waste load to be processed and/or disposed of immediately. (See Appendix A for telephone numbers during normal and non-business hours.) This is provided there is a high likelihood, through radioisotope identification, the RAM is from a patient having undergone a medical procedure, and the disposal does not endanger the health or safety of the facility staff, the public or the environment. Alternately, as noted above, the facility may provide justification (e.g., considering the facility's engineered barriers, all the RAM will decay in place) in the proposed Action Plan, and apply for a blanket approval to dispose of short lived RAM from patients treated with radioisotopes.

For reference, the total estimated radioactivity that may be released in a patient is detailed in NRC Regulatory Guide 8.39, which is duplicated in Appendix B as Table 1. The solid waste facility operator will always have the option to reject any waste load causing an alarm; however, no vehicle containing RAM shall leave the facility without written approval and an authorized DOT Exemption Form issued by the Department.

Upon formal request and appropriate environmental analysis, the Department's Director of the Bureau of Radiation Protection may authorize disposal of RAM with a half-life greater than 65 days, if the material is not under state or federal regulatory controls and / or disposal restrictions. (See Appendix D for additional guidance.)

B. Naturally Occurring Radioactive Material

If the gamma spectroscopy or other measurement indicates the radiation is from NORM or TENORM, the Action Plan should outline an approach to determine the nature of the waste, or perhaps cover material, entering the facility. If the radiation source is determined to be from the undisturbed natural environment of the Commonwealth (e.g., cover material soil or rock with elevated NORM levels), then there are no disposal restrictions and the material can be accepted at the facility. Similarly, if the source is determined to be potassium or any related compound (e.g., potassium permanganate used for odor control), with a natural abundance K-40, there are no processing or disposal restrictions.

In the case where process knowledge would indicate the presence of TENORM, the DEP Area Health Physicist may authorize immediate disposal. However, the following conditions must be satisfied: a) the volume of waste does not exceed one cubic meter, b) the gamma radiation level at a distance of 5 cm from any source surface does not exceed 0.5 $\mu Sv\ h^{-1}$ (50 $\mu rem\ h^{-1}$), and c) the concentration of combined radium isotopes does not exceed 5.0 $pCi\ g^{-1}$. A facility may submit, in their proposed Action Plan, to obtain a blanket approval for disposal of such small quantities of waste with TENORM. For a blanket approval, the applicant shall provide appropriate justification (e.g., presence of engineered barriers) in the proposed Action Plan. Disposal of waste with TENORM of higher volumes, emitting higher radiation levels, or at higher radium concentrations, may be approved by the Department's Director of the Bureau of Radiation Protection. Such evaluations shall require the appropriate environmental assessment and pathway analysis to demonstrate that the annual dose to any member of the public is unlikely to exceed those values noted above. (See Appendix D for additional guidance.)

Again, the facility operator may reject any waste load causing an alarm, however, no vehicle containing RAM shall leave the facility without written Department approval and an authorized DOT exemption form.

C. Consumer Products Containing Radioactive Material

If certain consumer products containing radioactive material are observed in waste or cause an alarm - and are subsequently identified through a visual means to be an individual commodity smoke detector, radium dial watch / clock, exempt thorium metal alloy (e.g., welding rod), or uranium glaze / glass product – a facility may propose in their Action Plan that such an individual waste product be disposed of immediately. A recent life cycle analysis of these exempt RAM sources by the NRC notes that the above public dose limits will not be exceeded in such a disposal scenario (see NRC NUREG-1717). The facility Action Plan could have such an allowed disposal scenario for the specific individual items noted above, but should prohibit the disposal of aggregate quantities of these exempt devices or other products without written approval by the Department. It is recommended that smoke detectors, when found, be returned to the manufacturer for appropriated disposal. If a "generally licensed" tritium EXIT sign is found in any waste stream, it shall be returned to a licensed manufacturer for recycle or shipped for proper low-level radioactive waste disposal.

Consumer products containing exempt radioactive materials may be recovered by the facility, and stored for ultimate disposal as low level radioactive waste by the operator. Alternately, the facility operator may reject any waste load causing an alarm; however, no vehicle containing RAM shall leave the facility without written Department approval and an authorized DOT exemption form.

2. Other Facilities

A. RAM from Patients Having Undergone a Nuclear Medicine Procedure

If the gamma spectroscopy or other measurement indicates the radiation is from a radioisotope with a half-life of 65 days or less, the DEP Area Health Physicist may authorize the contents of the waste load to be processed and/or disposed of immediately. (See Appendix A for telephone numbers during normal and non-business hours.) This is provided there is a high likelihood, through radioisotope identification, the RAM is from a patient having undergone a medical procedure, and the disposal does not endanger the health or safety of the facility staff, the public or the environment. Alternately, the facility may provide in the proposed Action Plan, the justification through modeling that the above general public dose limits are met, and apply for a blanket approval to dispose of short lived RAM from patients treated with radioisotopes.

For reference, the total estimated radioactivity that may be released in a patient is detailed in NRC Regulatory Guide 8.39, which is duplicated in Appendix B as Table 1. The solid waste facility operator will always have the option to reject any waste load causing an alarm, or forward the waste load to a solid waste facility that will process or dispose of the material. However, no vehicle containing RAM shall leave the facility without written approval and an authorized DOT Exemption Form issued by the Department.

Upon formal request and appropriate environmental analysis, the Department's Director of the Bureau of Radiation Protection may authorize processing or disposal of RAM with a half-life greater than 65 days, if the material is not under state or federal regulatory controls and / or disposal restrictions. (See Appendix D for additional guidance.)

B. Naturally Occurring Radioactive Material

If the gamma spectroscopy or other measurement indicates the radiation is from NORM or TENORM, the Action Plan should outline an approach to determine the nature of the waste entering the facility. If the radiation source is determined to be from the undisturbed natural environment of the Commonwealth (e.g., soil or rock with elevated NORM levels), then there are no processing or disposal restrictions and the material can be accepted at the facility. Similarly, if the source is determined to be potassium or any related compound (e.g., potassium permanganate used for odor control), with a natural abundance K-40, there are no processing or disposal restrictions.

In the case where process knowledge would indicate the presence of TENORM, the DEP Area Health Physicist may authorize immediate disposal. However, the following conditions must be satisfied: a) the volume of waste does not exceed one cubic meter, b) the gamma radiation level at a distance of 5 cm from any source surface does not exceed 0.5 $\mu Sv\ h^{-1}$ (50 $\mu rem\ h^{-1}$), c) the concentration of combined radium isotopes does not exceed 5.0 $pCi\ g^{-1}$, and d) the processing or disposal of such material will not cause any above stated general pubic dose limit to be exceeded. A facility may submit, in their proposed Action Plan, to obtain a blanket approval for disposal of such small quantities of waste with TENORM. For a blanket approval, the applicant shall provide appropriate justification and modeling in the proposed Action Plan.

Processing or disposal of waste with TENORM of higher volumes, emitting higher radiation levels, or at higher radium concentrations, may be approved by the Department's Director of the Bureau of Radiation Protection. Such evaluations shall require the appropriate environmental assessment and pathway analysis to demonstrate that the annual dose to any member of the general public is unlikely to exceed those values noted above. (See Appendix D for additional guidance.)

Again, the facility operator may reject, or forward to a landfill that will accept it, any waste load causing an alarm. However, no vehicle containing RAM shall leave the facility without written Department approval and an authorized DOT Exemption Form.

C. Consumer Products Containing Radioactive Material

If certain consumer products containing radioactive material are observed in waste or cause an alarm - and are subsequently identified through a visual means to be an individual commodity smoke detector, radium dial watch / clock, exempt thorium metal alloy (e.g., welding rod), or uranium glaze / glass product – a facility may propose in their Action Plan that such an individual waste product be processed or disposed of immediately. A recent life cycle analysis of these exempt RAM sources by the NRC notes that the above public dose limits should not be exceeded in such processing or disposal scenario (see NRC NUREG-1717). The facility Action Plan could have such an allowed processing or disposal scenario for the specific individual items noted above, but should prohibit the processing or disposal of aggregate quantities of these exempt devices or other products without written approval by the Department. It is recommended that smoke detectors, when found, be returned to the manufacturer for appropriated disposal. If a "generally licensed" tritium EXIT sign is found in any waste stream, it shall be returned to a licensed manufacturer for recycle or shipped for proper low-level radioactive waste disposal.

Consumer products containing exempt radioactive materials may be recovered by the facility, and stored for ultimate disposal as low level radioactive waste by the operator. Alternately, the facility operator may reject, or forward to a landfill that will accept it, any waste load causing an alarm. However, no vehicle containing RAM shall leave the facility without written Department approval and an authorized DOT exemption form.

3. Records and Reports

A. Each person or municipality who operates a waste processing or disposal facility which has detected radioactive materials in any manner or radiation levels in excess of Action Level One to cause an alarm shall maintain records of each incident, containing the information set forth in section b, below, in the facility's daily operational record.

B. The daily operational record should include information required by regulation, such as the following:

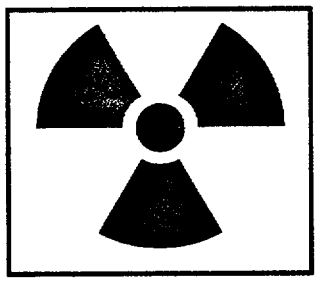
1) Date, time and location of the occurrence,
2) A brief narrative description of the occurrence,
3) Specific information on the origin of the material, if known,
4) A description of the RAM involved, if known,
5) The name, address and telephone number(s) of the supplier, handler or transporter of the RAM contaminated waste, the name of the driver, and
6) The final disposition of the material (processed, disposed, or rejected).

C. The facility's annual report should include a record of detected RAM summarizing the above information.

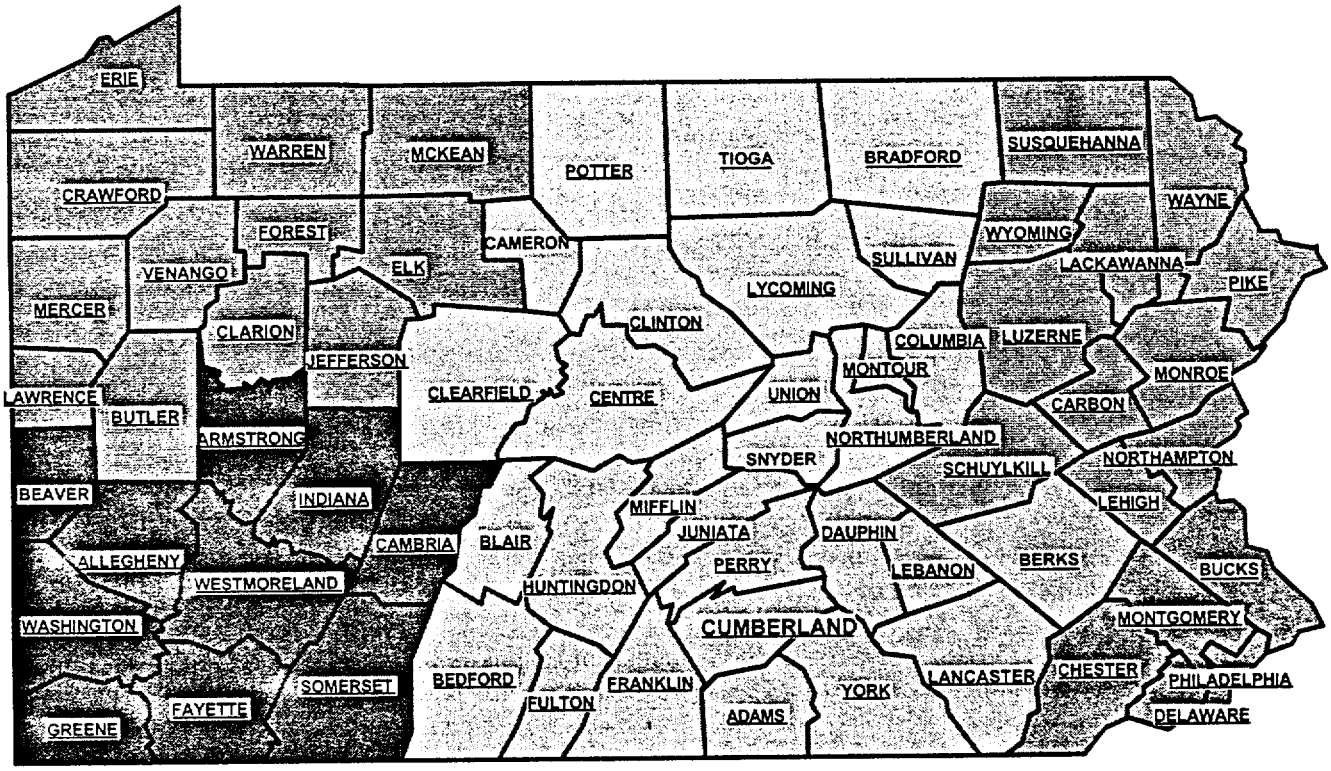
4. Monitoring and Equipment

Facilities monitoring for radiation emitted from radioactive material must have appropriate monitoring equipment onsite. (See Appendix C for more information). Employees should be trained on proper use of all fixed and portable equipment. Additionally, facility operational staff should be trained to visually monitor waste during transfer or unloading for the potential presence of RAM. Specifically, they should be able to identify the caution "radiation symbol" on containers, and items that may not be detected by gamma monitors (e.g., tritium "EXIT" signs).

RADIATION SYMBOL



APPENDIX A. NOTIFICATION OF INCIDENTS OF RAM IN SOLID WASTE AND/OR REQUEST FOR DOT EXEMPTION FORM (Rev. 2-1-01)



- North West Regional Office
- North Cent Regional Office
- North East Regional Office
- South West Regional Office
- South Cent. Regional Office
- South East Regional Office

Department of Environmental Protection

Area Health Physicist	Area Health Physicist	Area Health Physicist
James G. Yusko, CHP Business hours: (412) 442-4227	James Kopenhaver Business hours: (717) 705-4712	Ivna Shanbaky, Ph.D. Business hours: (610) 832-6041
Northwest Region: Butler, Clarion, Crawford, Elk, Erie, Forest, Jefferson, Lawrence, McKean, Mercer, Venango and Warren Counties. Emergency Coordinator Non-business hours: (800) 373-3398	**Northcentral Region:** Bradford, Cameron, Clearfield, Centre, Clinton, Columbia, Lycoming, Montour, Northumberland, Potter, Snyder, Sullivan, Tioga and Union Counties. Emergency Coordinator Non-business hours: (570) 327-3696	**Northeast Region:** Carbon, Lackawanna, Lehigh, Luzerne, Monroe, Northhampton, Pike, Schuylkill, Susquehanna, Wayne and Wyoming Counties. Emergency Coordinator Non-business hours: (570) 826-2511
Southwest Region: Allegheny, Armstrong, Beaver, Cambria, Fayette, Greene, Indiana, Somerset, Washington and Westmoreland Counties. Emergency Coordinator Non-business hours: (412) 442-4000	**Southcentral Region:** Adams, Bedford, Berks, Blair, Cumberland, Dauphin, Franklin, Fulton, Huntingdon, Juniata, Lancaster, Lebanon, Mifflin, Perry and York Counties. Emergency Coordinator Non-business hours: (877) 333-1904	**Southeast Region:** Bucks, Chester, Delaware, Montgomery and Philadelphia Counties. Emergency Coordinator Non-business hours: (610) 832-6000

APPENDIX B. ACTIVITIES AND DOSE RATES FOR AUTHORIZING PATIENT

RELEASE FROM MEDICAL FACILITIES[1]

Table 1. Activities and Dose Rates for Authorizing Patient Release†				
Radioactive Material	COLUMN 1 Activity at or Below Which Patients May Be Released		COLUMN 2 Dose Rate at 1 Meter, at or Below Which Patients May Be Released*	
	(GBq)	(mCi)	(mSv/hr)	(mrem/hr)
Ag-111	19	520	0.08	8
Au-198	3.5	93	0.21	21
Cr-51	4.8	130	0.02	2
Cu-64	8.4	230	0.27	27
Cu-67	14	390	0.22	22
Ga-67	8.7	240	0.18	18
I-123	6.0	160	0.26	26
I-125	0.25	7	0.01	1
I-125 implant	0.33	9	0.01	1
I-131	1.2	33	0.07	7
In-111	2.4	64	0.2	20
Ir-192 implant	0.074	2	0.008	0.8
P-32	**	**	**	**
Pd-103 implant	1.5	40	0.03	3
Re-186	28	770	0.15	15
Re-188	29	790	0.20	20
Sc-47	11	310	0.17	17
Se-75	0.089	2	0.005	0.5
Sm-153	26	700	0.3	30
Sn-117m	1.1	29	0.04	4
Sr-89	**	**	**	**
Tc-99m	28	760	0.58	58
Tl-201	16	430	0.19	19
Y-90	**	**	**	**
Yb-169	0.37	10	0.02	2

† The activity values were computed based on 5 millisieverts (0.5 rem) total effective dose equivalent.
* If the release is based on the dose rate at 1 meter in Column 2, the licensee must maintain a record as required by 10 CFR 35.75(c) because the measurement includes shielding by tissue. See Regulatory Position 3.1, "Records of Release," for information on records.
** Activity and dose rate limits are not applicable in this case because of the minimal exposures to members of the public resulting from activities normally administered for diagnostic or therapeutic purposes.

[1] **Source:** Regulatory Guide 8.39, Release of Patients Administered Radioactive Materials. U.S. Nuclear Regulatory Commission, Washington, D.C. April 1997.

APPENDIX C. GUIDELINES FOR RADIOLOGICAL MONITORING EQUIPMENT

1. General Information About Radiation Detectors

In general, radiation detection equipment consists of a detector and electronics to convert the signal received by the detector into meaningful values. The passage of radiation through the detector (or probe) causes an impulse to be generated within the detector, which is converted into a preset unit, usually counts per minute (cpm). There are two general types of detectors likely to be used in municipal and residual waste monitoring. The first, called a Geiger-Muller (G-M) counter with thin window probe, converts electrical discharge pulses into counts, which are displayed on a meter. This is the best type of detector for detecting beta particles, because most of the beta particles that pass into the detector will register. However, certain low-energy beta particles will not penetrate through the outer wall of the detector and, therefore, will not be detected. Examples of radioactive materials emitting such low-energy beta particles include carbon-14 and tritium (hydrogen-3), which are commonly used in medical research programs and may inadvertently be disposed of in waste. This type of detector is gas-filled and is less efficient at detecting gamma radiation because most pass through the detector without causing a pulse to be generated. Nevertheless, G-M counters are normally used in hand-held instruments, and a "pancake" type thin window G-M probe can be used for alpha, beta, and gamma measurements when properly calibrated.

The second type of radiation detector also uses a probe that converts the impulses caused by the radiation striking the detector surface into counts, which are recorded on the meter. However, this type of detector differs from the G-M counter in that the signal transferred to the meter is dependent on the radiation type and energy striking the detector. Typically, this type of radiation detector is called a scintillation detector. Scintillation detectors convert the radiation energy into a light impulse within the probe. The amount of light generated is based on the amount of radiation that strikes the probe. This light impulse is then converted to a measurement that may be used to determine the energy of the radiation and the total amount of radiation. Because of this capability, scintillation detectors are useful in determining the type of radioactive material present in the waste as well as the relative radiation hazard associated with the material. Scintillation detectors are also more efficient at detecting gamma radiation than a G-M counter because they are solid material (i.e., a greater number of interactions occur between the detector and the radiation yielding a greater number of counts). Zinc sulfide scintillation detectors may be used to quantify the amount of alpha particle radiation from contamination materials, although this is often conducted in laboratories rather than field settings. In addition, the scintillation medium may be liquid, thus allowing greater contact of the medium with the radioactive

material and further increasing the efficiency of the measurement. Liquid scintillation is often used to quantify the amount of radioactive materials that emit low-energy beta particles, such as carbon-14 and tritium. However, this technique is employed exclusively in laboratories, rather than in the field.

Sodium iodide (NaI) crystals, germanium crystals, zinc sulfide coatings, and specially formulated plastic materials are the most common media used in solid scintillation detectors. Plastic scintillation detectors may be more sensitive to beta/gamma radiation than NaI detectors due to size and window thickness, however neither detect alpha radiation. In addition, plastic detectors are usually more resistant to environmental stresses than NaI detectors and can be purchased in larger sizes, allowing better geometry for detection of radioactive material in waste. However, though plastic detectors may be less expensive than NaI detectors, they may not offer the same degree of discrimination in terms of identifying the energies of the gamma radiation. Solid state germanium detectors are often used in laboratories for precise determination of the type and amount of radioactive materials present. Although some germanium detectors are sufficiently rugged to be used in the field, most are designed for use in laboratories.

2. Facility Monitoring Equipment

Many solid waste facilities have installed radiation detection equipment at the entrance portal to the facility or in conjunction with other onsite facilities, such as scales. In such installations, the radiation detector elements (e.g., NaI crystals) are typically installed to screen incoming waste and should be installed, operated, and maintained in a manner that ensures that the measurements are meaningful and fulfill the objectives for detecting radiologically contaminated waste. The detectors should be positioned as close as practical to the waste load, and calibrated so that they measure radiation [in $\mu R\ h^{-1}$, or equivalent counts per unit time] emitted from vehicles that are used to haul the solid waste into or out of the facility. The waste load portal detectors are normally scintillation type detectors. In the scenario where time permits (i.e., waste loads are infrequent) or fixed portal monitors become inoperable, hand-held microR meters may be used to scan incoming waste loads.

Both fixed and portable scintillation and G-M detectors can be calibrated to display radiation in units of exposure rate ($\mu R\ h^{-1}$), or dose equivalent rate ($\mu rem\ h^{-1}$). Equipment that display in counts per unit time should have calibration factors that can be related to these qualities. The radiation unit displayed by the detector is less important than the selection of the appropriate type of radiation detector element or probe, and the proper subtraction of background radiation is made. Factors that should be considered when developing radiation detection and monitoring programs are:

- Area background radiation level,
- Detector efficiency and ruggedness,
- Detector calibration and response checks,
- Detector positioning and shielding,
- Detector element physical protection,
- Counting time,
- Alarm set point,
- Overall system sensitivity, and
- Alarm response procedures and training.

Because of the complex nature of radiation detection instrumentation and the multiple objectives for which such instruments may be deployed, facility staff should be trained to determine the appropriate type of instrument and / or detector probe to be used at a facility based on the established operational objectives. In addition, it is recommended that only individuals with proper experience and training (e.g., manufacturer's representative or knowledgeable health physicist) should be permitted to initially install, calibrate fixed radiation detection equipment.

3. Monitoring Equipment – General Recommendations

Facilities shall comply with specific regulatory requirements, but the following general recommendations for monitoring equipment may be used for initial detection of radioactive material at solid waste facilities:

A. Monitoring equipment should consist of both portable (hand-held) and fixed radiation monitoring equipment. Portable instrumentation should have multiple probes for contamination and a range of gamma dose rate measurements (i.e., 10 $\mu R\ h^{-1}$ to over 50 $mrem\ h^{-1}$).

B. Fixed monitoring equipment should be capable of detecting and displaying ambient background radiation levels. For both portable and fixed instrumentation, the equipment should provide a visual readout of the $\mu Sv\ h^{-1}$, $\mu rem\ h^{-1}$, $\mu R\ h^{-1}$ or count rate (e.g., cpm) level. Should the background radiation level be above 10 $\mu R\ h^{-1}$, the detector elements will require shielding to maintain the rate below this level.

C. The readout on the instrumentation should allow either scale multiplying factors or logarithmic scales to display higher radiation levels.

D. Portable instrumentation should be powered either by replaceable batteries or power cells with charging units and provide indication if battery/power cell capacity is not at levels for proper unit function. Fixed instrumentation should be line operated (e.g., 110 volt AC).

E. Waste monitors should be installed according to the manufacturers recommendations, with the radiation detectors as close as practicable to the waste load (i.e., close as possible and preventing physical damage). The alarm set-point for fixed monitoring equipment shall be no higher than 10 $\mu R\ h^{-1}$ above background, with a cesium-137 gamma radiation field at the radiation detector element(s). The ambient gamma background in Pennsylvania ranges from about 5 $\mu R\ h^{-1}$ to 25 $\mu R\ h^{-1}$. Instrument readings in microroentgen per hour ($\mu R\ h^{-1}$), or equivalent counts per unit time (e.g., cpm), will need to be averaged during calibration to determine the appropriate alarm set point. If capable of energy discrimination, the radiation monitor shall be set to detect gamma rays of a 50 kiloelectron volt (keV) energy or higher.

   The alarm should provide an audible signal to the operator and may provide a visible signal that the alarm set point has been exceeded. The operator should be able to reset the audible signal from the readout position. Written indication of radiation levels, such as by a data log print out or chart recording, may be available as an option for the readout.

F. The detector element assemblies for fixed monitoring may be located at or near the weigh scale for vehicles. Provision should be made to stop or slow the vehicle during the monitoring for radioactive material, with a geometry and collimation of the radiation detectors to maximize system sensitivity. It is recommended an appropriate housing and other barriers be installed to protect the detector assembly from physical damage due to vehicles and from environmental conditions, such as precipitation, high humidity, and thermal variation.

G. If the detector assembly for fixed monitoring equipment is supplied with electrical power other than the monitoring unit, provision should be made to display power condition or availability to the detector assembly.

H. The range of readout for portable (hand-held) monitoring equipment and various probes should be 0.01 to approximately 100 mrem h^{-1}, and have a known gamma energy response. A "pancake" type G-M probe will be adequate for gross counting of wipes taken for gross contamination evaluations of vehicles. Again, hand-held micoR meters would be suitable for temporary vehicle monitoring if fixed systems become inoperable.

I. The monitoring equipment used at solid waste facilities should be calibrated no less frequently than annually, and (if utilized) its function should be tested on a daily basis using a check source for which the instrument's expected response has been previously determined.

4. Evaluation Equipment

If a radiation alarm is determined to be valid, evaluation of waste may require supplies, calibrated survey meters with capabilities similar to those specified above, and may require any of the following to determine the specific radioisotope, and if contamination is present:

A. Portable multichannel analyzer (MCA) coupled to a sodium iodide (NaI) detector or solid state detector. Appropriate calibration source(s) will also be needed to check the library of spectra.

B. Probes for survey meter capable of detecting beta and gamma radiation. Depending on the survey meter and probe(s) used for beta / gamma monitoring, a different probe could be obtained for alpha monitoring, if desired.

C. Supplies for taking samples for laboratory analysis, such as wipes (or smears), containers for water and soil/waste samples, plastic bags, indelible markers, trowels, tongs, etc. would be useful to have on hand.

D. Plastic tarps, disposable protective clothing and gloves for personnel handling potentially contaminated waste. *(Note: the use of some types of protective mask requires that the employing firm have an approved respirator qualification program.)*

E. A supply of radiation warning signs, rope, tape, etc.

F. Supplies and information for data analysis, e.g., scientific calculator, survey forms, tables of radioisotopes with half-life, etc.

APPENDIX D. GUIDELINES FOR ACTION PLANS FOR DETECTION AND HANDLING OF RADIOACTIVITY AT SOLID WASTE FACILITIES

1. Procedures for Development and Review of Action Plans

A. Qualifications of Persons Preparing the Action Plan

Plans should be prepared by individuals having, at a minimum, the following qualifications:

1) Two years of on-the-job training in health physics; or one year of on-the-job training in health physics plus one year of formal college level study in health physics, physics, chemistry, biology, engineering, or radiation science.

2) Experience with radiation detection and measurement, and in developing radiation safety procedures and plans.

Comprehensive certification by the American Board of Health Physics satisfies numbers 1 and 2, above. It is recommended that facilities employ a certified health physicist (CHP) as a consultant for developing and implementing their Action Plan.

B. Implementation of the Action Plan

The provisions of the Action Plan should be activated whenever situations arise in which the pre-established action levels are exceeded.

C. Persons Responsible for Implementation of the Action Plan

Each facility should designate an individual responsible for implementation of the Action Plan. This individual should have adequate authority to implement the plan. In the event that the individual(s) implementing the Action Plan is/are different from the individual who prepared the Action Plan, the Action Plan should specify a minimum one day training session in the fundamentals of radiation safety and detection.

(Note: Provided onsite operational facility personnel are able to appropriately respond to the radiological scenarios at Action Levels One and Two, the Action Plan may reference the use of corporate or consultant health physics support staff for further RAM characterization.)

D. Revision of the Plan

The plan should be reviewed and updated periodically by the permittee. At a minimum, this should occur when any of the following occurs:

1) Applicable Department regulations or policies are revised.

2) The Action Plan fails during an incident.

3) The facility operation changes in a manner that would interfere with implementation of the Action Plan.

4) The individual responsible for implementing the plan changes.

5) The monitoring equipment used is changed.

6) The designated area for vehicles in which RAM has been detected changes.

7) As otherwise required by the Department.

2. Content and Format of Action Plans

A. General Instructions

The main elements of the Action Plan should cover all the appropriate regulatory requirements, and are described in this basic guidance document. Details are outlined below. Certain Action Plan elements may not be entirely applicable or appropriate for a specific facility or type of incident. In these cases, the person preparing the Action Plan should act accordingly and provide a brief explanation as to why the Action Plan element(s) in question are not applicable or appropriate.

The most important thing to remember in developing an Action Plan is that the actual effectiveness of the plan will depend upon its simplicity, readability and summary instructions for facility operational staff.

B. Action Levels

The Action Plan must be designed to address two radiological scenarios or action levels, namely:

Action Level One: A radiation monitor alarm at the facility indicating the potential presence of radioactive material in a waste load.

(Note: The regulations require a gamma exposure rate from a cesium –137 source, at a level no higher that 10 $\mu R\ h^{-1}$ above the average local background, at any detector element, shall cause an alarm at the facility. Instrument background shall be kept below 10 $\mu R\ h^{-1}$ using shielding if needed, and the system shall be set to detect gamma ray energies of 50 kiloelectron volts and higher.)

Action Level Two: Radiation dose rates of 20 $\mu Sv\ h^{-1}$ (2 mrem h^{-1}) or greater in the cab of the waste transport vehicle, 500 $\mu Sv\ h^{-1}$ (50 mrem h^{-1}) or greater from any other surface, or the detection of contamination on the outside of the vehicle shall require immediate notification of the Department, and isolation of the vehicle.

The Action Plan should provide for notification of the Department.

1) For Action Level One, notification and request for DOT Exemption Form prior to rejection of a waste load, or request for disposal or processing approval of RAM in solid waste if blanket approval was not requested.

2) For Action Level Two, notification must be made immediately.

C. Detection and Initial Response

Fixed and portable radiation monitoring systems shall be calibrated annually to a traceable cesium-137 source. This radiation standard shall be traceable to the U.S. National Institute of Standards and Technology. Radiation monitors may be response checked daily on a relative basis. If the alarm level of 10 $\mu R\ h^{-1}$ over background is exceeded when a vehicle is at the monitoring location, the following procedures are recommended:

1) Reset the monitor alarm and evaluate the vehicle or container a second time.

2) If the alarm level is still exceeded, promptly survey the vehicle surfaces at a distance of 5 cm with a portable radiation survey meter to determine if Action Level Two levels are exceeded, and if an area of highest radiation level can be determined. Mark this location with chalk if other gamma spectroscopy measurements are to be performed.

3) If surveying the vehicle with a portable survey meter at 5 cm fails to reveal the presence of radioactive material, scan the driver with a portable survey meter (or have him/her stand between the monitor detectors) to determine if the driver has triggered the alarm. Alarms have been triggered by drivers who have undergone nuclear medicine procedures involving radioactive material. If this is the case, and the driver alone has triggered the alarm, no further action under this guidance document is necessary.

4) **Action Level One**: If the radiation monitor alarmed on a second count, the following procedures are recommended:

   a) Remove the vehicle to the Designated Area for vehicles found to contain RAM. (See D below.) Contact the individual responsible for supervising response to alarms at the facility. If the waste load is to be rejected, contact the appropriate DEP Area Health Physicist for approvals. If disposal or processing is considered, keep the load onsite until the nature of the RAM and proper actions are determined. Do not allow the vehicle or container to leave the facility without the permission of the Department, and the driver being issued a DOT Exemption Form signed by the Department's Area Health Physicist or their authorized representative. If a driver leaves the facility with a contaminated waste load, they must carry a copy of the signed DOT Exemption Form. *(Note: once a solid waste facility has an approved Action Plan, it is anticipated that facility survey data and DOT Exemption Form can be exchanged via fax to allow for immediate action on the part of the Department.)*

   b) If the driver leaves with the vehicle without a DOT Exemption Form and before the RAM can be evaluated, contact the Pennsylvania State Police and provide them with any information you may have on the vehicle such as make, model, color, company name, license plate number, time left and the direction in which the vehicle was traveling and, if possible, the intended destination. This is to ensure that the driver does not dispose of the contaminated waste improperly. Notify the appropriate DEP Area Health Physicist listed in Appendix A and apprise that individual of the situation.

5) Action Level Two: If the dose rates indicated by a radiation survey at a distance of 5 cm equal or exceed either limit in this Action Level on the exterior or in the cab of the vehicle, remove the driver and all other personnel from the immediate area. Similarly, if contamination is detected by wiping vehicle areas that may have contacted the waste during loading, or seams that may leak liquid, isolated the vehicle and call the Department's Area Health Physicist for your location as listed in Appendix A. Proceed as directed by the Area Health Physicist.

D. Designated Area

The Action Plan should include the location of a Designated Area for vehicles found to contain RAM. This area is to be used for surveys, and if needed, to isolate a vehicle or container to maintain personnel radiation exposure ALARA. If surveys show that either exterior dose rate limit in Action Level Two is exceeded, but there is no removable contamination on the exterior of the vehicle and the dose rate in the cab is below 50 mrem/hr, the vehicle should be promptly moved to the Designated Area for an addition characterization or evaluation by facility or Department staff. The area should be appropriate for the various types of RAM potentially found in waste, size of facility, size of truck, employees in the proximity of the truck, and any other suitable steps warranted by the potential situation at hand and site-specific facility layout. Protection of the health and safety of facility operators, and the environment, may be achieved through consideration of time, distance, shielding, and contamination containment.

E. Characterization

If blanket approval is requested for immediate disposal or processing of short lived RAM from patients, NORM, TENORM, or individual consumer products containing RAM (as described above), the Action Plan must have procedures for characterizing the radioactive material present in the waste. Characterization is best executed under the direct supervision of the person who prepared the Action Plan, or another similarly trained and qualified individual. The Action Plan should address steps to confirm the radiation level detected by the monitoring device and identify the radioisotope(s).

At Action Level One, the procedure to identify the radioisotope must include means to determine the gamma ray spectrum. Procedures used in the characterization phase should be situation specific and will be determined by many factors including the type of truck and how it is loaded, the nature of the waste, radiation levels indicated by the survey, highest dose rate, location of RAM in the load, instrumentation, personnel available, weather, and other factors.

At Action Level Two, radiation protection personnel from DEP, and perhaps federal agencies, may come onsite to provide additional guidance and assistance.

In general, appropriate characterization procedures should include the following:

1) If the cab radiation level is over 2 mrem/hr, vehicle surface is over 50 mrem/hr, or contamination is detected - immediately notify the Department's Area Health Physicist. If there is no contamination and the cab radiation level is less than 50 mrem/hr, promptly relocate the vehicle or container to the Designated Area. Using appropriate instrumentation and measurement set-up, identify the radioisotope (i.e., via gamma spectroscopy).

   If the gamma spectroscopy indicates the radiation is from RAM with a half-life of 65 days or less and is most likely from a patient having undergone a medical procedure, the DEP Area Health Physicist may authorize the contents to be processed or disposed of immediately in the facility, provided there is minimal risk to workers. Alternately, the waste load may be rejected. As noted above, a solid waste facility may apply for a blanket approval to process or dispose of certain RAM in waste (i.e., short lived radioisotopes form patients, NORM, TENORM and individual consumer products).

2) Survey the exterior of the vehicle with a portable survey meter set at the most sensitive setting and holding the survey meter no more than two inches (5 cm) from all vehicle surfaces. Mark areas where radiation levels appear to be the highest. If containerized, monitor the waste during unloading from the vehicle. If the radiation levels from the vehicle or any container exceeds 50 mrem/hr at any time during unloading, stop removing the waste, remove personnel from the area and call the DEP Health Physicist at the numbers provided in Appendix A.

3) If contamination is found or the dose rate on the vehicle or cab exceed Action Level Two, Department staff will oversee the surveying the waste vehicle or containers (if waste is containerized in the vehicle). Personnel who are handling the waste to isolate the source should have appropriate training, wear radiation monitoring devices, protective clothing, including coveralls, boots, gloves and dust masks to avoid skin contamination, inhalation, or ingestion with the radioactive material or other potentially hazardous material. The Action Plan and facility should provide for personal protective equipment for facility or consultant personnel if waste off-loading is anticipated.

4) If the waste is containerized, remove the individual waste containers (if not contaminated) from the vehicle and survey each with a survey meter. Look for signs and container labels that might identify the radioactive material or other hazards and the point of origin. Caution should be exercised to ensure that injuries do not occur during removal of the waste containers. Do not attempt to open containers and sort through the waste. The waste may contain sharps, biological waste, and other pathological or hazardous waste that could cause immediate, and more significant risks to the workers.

5) If the waste load is in bulk form and can not be processed or disposed of in the facility or rejected, remove the bulk waste until the estimated location of the radioactive source is approached. Survey bulk waste removed with the portable meter to isolate the RAM. When the source is located, attempt to separate the RAM from the waste, provided it can be done without jeopardizing the health and safety of workers due to other hazards present in the waste. The Action Plan should specify precautions to be taken to monitor external exposure and prevent workers from becoming contaminated by the radioactive material in this process. The contaminated material should be placed in containers and taken to the Designated Area where it can be stored safely and in a manner that protects facility staff, and prevents environmental contamination (e.g., due to runoff, infiltration, pests, etc.) until the means of disposition is determined.

6) If radiation is detected at more than 0.5 mSv h^{-1} (50 mrem h^{-1}) above background levels on the surface of any container, isolate this area within the facility property and contact the DEP Area Health Physicist.

7) The area(s) where radioactive material is identified per (5) and (6) above, should be roped off or otherwise secured to prevent persons from entering areas where radiation levels exceed 0.02 mSv h^{-1} (2 mrem h^{-1}), and labeled with appropriate signs. Radiation levels in areas occupied by operational staff should be kept ALARA. The contaminated waste should be physically secured against removal or inadvertent disposal or else be under observation by facility staff at all times.

8) If radioactive material is not detected in any of the waste containers or in the bulk waste, resurvey the exterior of the vehicle. Mark any areas where radiation levels exceed background levels. The source of the radiation may be the transport vehicle itself (i.e., contamination or a small sealed source).

F. Determination of Origin.

The plan should include procedures to determine the place where the waste originated that contained RAM. These procedures should be thorough (e.g., interview driver) and capable of providing the best attempt to determine the origin of the waste. This effort is most likely to be successful with monitoring at the transfer station.

G. Disposition and/or Storage.

The plan should have procedures for rejection, disposition, or perhaps storage for decay of the waste containing RAM in accordance with the requirements and recommendations set forth in this guidance document. The procedures must take into account the radiation level, the type and amount of waste involved, the radioactive material present in the waste, the form in which the radioactive material is present, availability of the storage option at the waste processing site, and the health and safety of personnel handling such waste or present in the immediate area.

Experience to date indicates that many, if not most, alarms at solid waste facilities involve radioactive materials used in medical procedures which have half-lives sufficiently short (i.e., less than 65 days) that it is practical to either process or dispose of the waste immediately, or to store the waste in a secure area until it has decayed to a non-radioactive form. If the waste is contaminated with short-lived radioisotopes from medical procedures, and the facility operator requests blanket approval to disposed or processed at a solid waste facility immediately, the proposed Action Plan should contain a justification and / or pathway analysis indicating that the RAM will decay in place or not cause a radiation dose to the general public above respective limits noted above. Similarly, for NORM, TENORM or individual consumer products containing RAM, the disposal or processing shall not cause a radiation dose to the general public above applicable limits.

H. Training

The Action Plan should provide for training of individuals responsible for implementing the plan in the areas of:

1) Fundamentals of radiation safety.

2) Operation of the monitoring instrumentation used by the facility, including daily operation and other response checks.

3) All aspects of the Action Plan.

I. Other Items to be Included

1) Provision for written alarm procedures to be posted where they can be seen by the personnel performing the waste monitoring. The alarm procedures should be coordinated in advance with facility personnel, including appropriate notification of DEP or other applicable state or local agencies and authorities.

2) Posting of notices so that waste haulers will be aware of the procedures that will be followed if radiation and radioactive material is detected in their vehicle, including notification of out-of-state radiation protection authorities and declaration of where the waste will be returned. Again, any rejected waste load must have an approved DOT Exemption Form from the Department.

3) Procedures to ensure that at least one individual per shift is trained in and responsible for the implementation of response procedures in the event an alarm is activated.

4) Informing customers in advance of the procedures in the event that an alarm point is exceeded, especially if the procedures include "waste load rejection" provisions under which the suspect waste may be promptly returned to the shipper.

5) Instructing facility personnel on the appropriate procedures to be followed in the event the alarm is activated. The instructions should include graduated contingency plans in the event that RAM in waste is detected, or criteria of Action Level Two is exceeded.

APPENDIX E. BACKGROUND INFORMATION ON RADIOACTIVE MATERIAL IN SOLID WASTE

1. Introduction

Radioactive material is used for a variety of beneficial purposes in the United States, including medical diagnosis and treatment and materials testing. The use and disposal of most types of radioactive material are regulated by the Nuclear Regulatory Commission (NRC) and individual states. Other types of radioactive material are regulated by the Environmental Protection Agency (EPA) and the States. Although low-level radioactive waste must be disposed of in a licensed radioactive waste disposal facility, occasionally unregulated RAM (e.g., from patients having undergone a medical procedure) is found at solid waste processing sites that are not licensed by the NRC or states for the control radiation hazards. Additionally, with increasing frequency, NORM, TENORM or consumer products are detected, as well as less frequent lost or improperly discarded higher hazard radioactive sources.

Radioactive materials in municipal waste have been detected with increasing frequency at landfills, incinerators, transfer stations, and associated facilities. This increase can be partially attributed to increased use of radiation detection instruments at the solid waste facilities. The operators of facilities have been installing such instruments in response to concerns by regulatory agencies and the public or in an attempt to limit liability for potentially costly remedial actions for radioactive contamination. When radioactive contamination is detected, it often prompts an emergency response until the potential hazards posed by the waste are determined and the material is properly controlled.

2. Sources of the Contamination

It should be noted just about everything contains some trace amount of radioactivity, and the earth is continually bathed in cosmic radiation from space. Radioactive materials exist naturally in soil, rocks, and water. There are a great many of these radioactive materials in construction materials, food, and waste. These materials may also be concentrated artificially above naturally occurring levels in their use or production (i.e., TENORM). In addition to these naturally occurring radioactive materials, municipal waste may also contain radioactive materials that have been introduced in consumer products (e.g., most domestic smoke detectors contain the radioactive material americium-241). These detectors enter the waste stream when consumers dispose of them in municipal waste.

Although the NRC and the Agreement States (States that have assumed regulatory control over certain nuclear materials through an agreement with NRC) strictly control the possession, use, storage, transportation and disposal of certain radioactive materials through their licensing and inspection activities, on occasion, radioactive material can find its way into municipal solid waste streams. Over the last several years, the Department and NRC have monitored event reports involving detection of radioactive materials in municipal wastes. Based on reported incidents, the principal man-made sources of radioactively contaminated waste in municipal waste landfills are medical facilities, private and university laboratories and radiopharmaceutical manufacturers.

The radioactive materials reported in contaminated waste have consisted primarily of the following radioisotopes: iodine-131, technetium-99, thallium-201, gallium-67, iodine-123, indium-111, etc. In most cases, such RAM has been legitimately released within patients in accordance with the NRC and state requirements. However, in other cases the event has been caused in violation of applicable requirements, such as lost sealed sources of cobalt-57 and iridium-192.[1]

In the practice of nuclear medicine, radioactive materials are administered to patients for the diagnosis or treatment of illnesses such as thyroid cancer or dysfunction. NRC and Agreement State regulations allow patients receiving radiopharmaceuticals to leave the hospital or clinic when the amount of radioactive material present in their bodies has dropped to certain levels or they present a low exposure potential to members for their family and the public. (See Appendix B). After these patients leave the hospital, they may inadvertently contaminate ordinary trash that is then disposed of in municipal solid waste disposal facilities. Contaminated materials that have been generated by nuclear medicine practices and detected at municipal solid waste facilities include diapers, bed linen, disposable medical supplies and general trash (for example, food, plastic and paper dishes and utensils, newspapers and magazines). Again, these items often become contaminated with radioactive materials when they are contacted by patients that have received the nuclear medicine administration, either while the patient is in the hospital or after the patient has returned home. Although the amount of radioactivity in the municipal waste is often small, detection systems used by solid waste facilities are often sensitive enough to detect the radioactive contamination.

[1] Of particular note and concern is an incident that occurred in Pennsylvania when an high activity iridium-192 source used in cancer treatment was inadvertently disposed of as medical or "red bag" waste - see NRC document number NUREG-1480 for more information.

Hospital, clinics, laboratories and universities use radioactive materials in research, including the marking and detection of molecules in genetic research, the study of human and animal organ systems, and in the development of new drugs. There is a potential that municipal wastes may become contaminated with radioactive materials when contaminated laboratory trash is inadvertently mixed with municipal waste. Contaminated materials may include contaminated glass or plastic, gloves, animal bedding, or paper lab countertop protectors. Waste from radiopharmaceutical manufacturers is similar to the waste produced by laboratories and universities. On rare occasions, sealed sources are mistakenly discarded from such facilities, and shall be retrieved when detected.

In addition to radioactive material that may inadvertently be included in municipal solid waste, solid waste facilities may detect NORM, which is found in a variety of common household or construction materials. NORM, such as radium, thorium or uranium is often found in bricks, wall board or building rubble containing these construction materials. It should be noted, this NORM was present in the base material that was used to produce these construction materials. Natural potassium also contains trace amounts of the radioisotope potassium-40 (K-40). In sufficient quantities, NORM potassium salts may trigger radiation alarms. In no case, because of radiological concerns, shall the presence of potassium or any related compound (with K-40 at natural abundance levels) prevent the immediate disposal or processing of solid waste.

The NRC and most Agreement States allow licensees with waste contaminated with radioactive material having a short half-life (e.g., less than 65 days), to be held for at least ten half-lives onsite at licensed facilities. After this period, the licensees are allowed to dispose of the decayed waste, if it is indistinguishable from background radiation levels based on an appropriate survey. There have been occasions when municipal waste becomes contaminated when a licensee fails to properly monitor radioactively contaminated waste before releasing it for disposal as ordinary trash. In other reported detection incidents, licensees may have properly managed the waste, but the disposal facility's detection equipment was more sensitive than the licensee's equipment.

The NRC and some Agreement State regulations also allow small quantities of specific radioactive materials used in clinical or laboratory tests to be disposed of as if they were not radioactive. Although no incidents involving the disposal of these types of radioactive material have been reported, incidents involving medical waste have shown that detection systems are capable of detecting the low levels of radioactivity associated with these exempted materials.

Some radioactive materials that could contaminate solid waste include:

Radioisotope	Half-Life	Radiation Type
Iodine-131	8 days	beta, gamma
Iodine-125	60 days	Gamma
Iodine-123	13 hours	Gamma
Technetium-99m	6 hours	Gamma
Indium-111	2.8 days	Gamma
Thallium-201	73 hours	Gamma
Gallium-67	3.3 days	Gamma
Cobalt-57	270 days	Gamma
Hydrogen-3	12 years	Beta
Iridium-192	74 days	beta, gamma
Potassium-40	1.3×10^9 years	beta, gamma
Radium-226	1600 years	alpha, gamma
Uranium-238	4.5×10^9 years	alpha, gamma
Thorium-232	1.4×10^{10} years	alpha, gamma
Americium-241	432 years	alpha, gamma

Lastly, under NRC and Agreement State regulations, some sources and devices may be possessed under a General License. These items include industrial gauging equipment, tritium "EXIT" signs, etc. There is a real potential for such items to be present in solid waste streams. When they are identified through radiation alarms, or visual observation of a GL device or radiation warning symbol, the waste processing facility shall investigate, isolate the item, and contact the Department if needed. Action Plans should contain procedures for the appropriate response if a tritium (hydrogen-3) EXIT sign, or other package with a caution radiation symbol, is observed during processing or disposal of solid waste.

3. What is Radioactivity and Radiation?

The term "radiation" as it relates to "radioactive materials" means the energetic emissions given off by the material as it decays. Ionizing radiation produces charged particles, or ions, in the material that it encounters. Potential adverse effects from radiation on humans are caused by these charged particles, and the energy they deposit in tissues and organs.

Detailed information on radioactivity and radiation is provided in Appendix F.

If you have questions about radiation or require more information, please contact the Bureau of Radiation Protection at the Department of Environmental Protection in Harrisburg (717) 787-2480 or the Area Health Physicist listed in Appendix A for your location.

APPENDIX F. RADIATION PROTECTION FUNDAMENTALS

1. What is Radiation?

Radiation is energy that comes from a source and travels through any kind of material and through space. Light, radio, and microwaves are types of radiation. The kind of radiation discussed in this appendix is called *ionizing radiation* because it can produce charged particles (ions) in matter.

Ionizing radiation is produced by unstable atoms. Unstable atoms differ from stable atoms because unstable atoms have an excess of energy or mass or both. Radiation can also be produced by high voltage devices (e.g., x-ray machines).

Unstable atoms are said to be *radioactive.* In order to reach stability, these atoms give off, or emit, the excess energy or mass. These emissions are called *radiation*. The kinds of radiation are electromagnetic (like light) and particulate . (i.e. mass given off with the energy of motion). Gamma radiation and x rays are examples of electromagnetic radiation. Beta and alpha radiation are examples of particulate radiation.

Interestingly, there is a "background" of natural radiation everywhere in our environment. It comes from space (i.e., cosmic rays) and from naturally occurring radioactive materials contained in the earth and in living things. Background radiation levels are typically 5 to10 $\mu R\ h^{-1}$ depending on location, but may be as high as 25 $\mu R\ h^{-1}$.

Radiation from Various Sources

External Background Radiation	60 mrem/yr, U.S. Average
Natural K-40 Radioactivity in Body	40 mrem/yr
Air Travel Round Trip (NY- LA)	5 mrem
Chest X-ray Internal Dose	10 mrem per film
Radon in the Home	200 mrem/yr (variable)
Man-made (medical x rays, etc.)	60 mrem/yr (average)

2. Types of Radiation

The radiation one typically encounters is one of four types: alpha radiation, beta radiation, and gamma (or X) radiation.

A. Alpha Radiation

Alpha radiation is a heavy, very short range particle, and actually an ejected helium nucleus. Some characteristics of alpha radiation are:

1) Alpha radiation is not able to penetrate human skin.
2) Alpha emitting materials can be harmful to humans if the materials are inhaled, swallowed, or absorbed through open wounds.
3) A variety of instruments have been designed to measure alpha radiation. Special training in the use of these instruments is essential for making accurate measurements.
4) A thin window Geiger-Mueller (GM) probe can detect the presence of alpha radiation.
5) Instruments cannot detect alpha radiation through even a thin layer of water, dust, paper, or other material, because alpha radiation is not penetrating.
6) Alpha radiation travels only a short distance (a few inches) in air, but is not an external hazard.
7) Alpha radiation is not able to penetrate clothing.

Examples of some alpha emitters: radium, radon, uranium, thorium.

B. Beta Radiation

Beta radiation is a light, short range particle, and actually an ejected electron. Some characteristics of beta radiation are:

1) Beta radiation may travel several feet in air and is moderately penetrating.
2) Beta radiation can penetrate human skin to the "germinal layer," where new skin cells are produced. If high levels of beta emitting contaminants are allowed to remain on the skin for a prolonged period of time, they may cause skin injury.
3) Beta emitting contaminants may be harmful if deposited internally.
4) Most beta emitters can be detected with a survey instrument and a thin window G-M probe (e.g., "pancake" type). Some beta emitters, however, produce very low energy, poorly penetrating, radiation, that may be difficult or impossible to detect. Examples of these difficult to detect beta emitters are hydrogen-3 (tritium), carbon-14, and sulfur-35.
5) Clothing provides some protection against beta radiation.

Examples of some pure beta emitters: strontium-90, carbon-14, tritium, and sulfur-35.

C. Gamma (or X) Radiation

Gamma radiation or x rays are very long range, penetrating electromagnetic radiation. Some characteristics of gamma radiation are:

1) Gamma radiation or x rays are able to travel many feet in air, and many inches in human tissue. It readily penetrates most materials, and is sometimes called "penetrating" radiation.
2) X rays are like gamma rays. X rays, too, are penetrating radiation. Sealed radioactive sources and machines that emit gamma radiation and x rays respectively constitute mainly an external hazard to humans.
3) Gamma radiation and x rays are electromagnetic radiation like visible light, radiowaves, and ultraviolet light. These electromagnetic radiations differ only in the amount of energy they have. Gamma rays and x rays are the most energetic of these.
4) Dense materials are needed for shielding from gamma radiation. Clothing provides little shielding from penetrating radiation, but will prevent contamination of the skin by these materials.
5) Gamma radiation is easily detected by survey meters with a sodium iodide detector probe.
6) Gamma radiation and/or characteristic x rays frequently accompany the emission of alpha and beta radiation during radioactive decay.

Examples of some gamma emitters are: iodine-131, cesium-137, cobalt-60, radium-226, technicium-99m.

3. How is Radiation Measured?

In the United States, radiation dose or exposure is often measured in the older units called rad, rem, or roentgen (R). For practical purposes with gamma and x rays, these units of measure for exposure or dose are considered equal.

Smaller fractions of these measured quantities often have a prefix, such as, milli (m) means 1/1000. For example, 1 rad = 1,000 mrad. Micro (μ) means 1/1,000,000. So, 1,000,000 μrad = 1 rad, or 10 μR = 0.000010 R.

The "System International" of units (SI system) for radiation measurement is now the official system of measurement, and uses the "gray" (Gy) and "sievert" (Sv) for absorbed dose and equivalent dose respectively.

1 Gy = 100 rad
1 mGy = 100 mrad
1 Sv = 100 rem
1 mSv = 100 mrem

With radiation counting systems, radioactive transformation events can be measured in units of "disintegrations per minute" (dpm) and because instruments are not 100% efficient, "counts per minute" (cpm). Background radiation levels are typically less than 10 $\mu R\ h^{-1}$, but due to differences in detector size and efficiency, the cpm reading on a fixed portal monitor and various hand-held survey meters will vary considerably.

4. How Much Radioactive Material is Present?

The size or weight of a quantity of material does not indicate how much radioactivity is present. A large quantity of material can contain a very small amount of radioactivity, or a very small amount of material can have a lot of radioactivity.

For example, uranium-238, with a 4.5 billion year half life, has only 0.00015 curies of activity per pound, while cobalt-60, with a 5.3 year half life, has nearly 513,000 curies of activity per pound. This "specific activity," or curies per unit mass, of a radioisotope depends on the unique radioactive half-life, and dictates the time it takes for half the radioactive atoms to decay.

In the U.S., the amount of radioactivity present is traditionally determined by estimating the number of *curies* present. The more curies present, the greater amount of radioactivity and emitted radiation.

Common fractions of the curie are the millicurie (1 mCi = 1/1000 Ci) and the microcurie (1 μCi = 1/1,000,000 Ci). In terms of transformations per unit time, 1 μCi = 2,220,000 dpm.

The System International of units (SI system) uses the unit of becquerel (Bq) as its unit of radioactivity. One curie is 37 billion Bq. Since the Bq represents such a small amount, one is likely to see a prefix noting a large multiplier used with the Bq as follows:

37 GBq = 37 billion Bq = 1 Curie
1 MBq = 1 million Bq = ~ 27 microcuries
1 GBq = 1 billion Bq = ~ 27 millicuries
1TBq = 1 trillion Bq = ~ 27 Curies

5. How Can You Detect Radiation?

Radiation cannot be detected by human senses. A variety of instruments are available for detecting and measuring radiation.

The most common of these are:

Geiger-Mueller (G-M) Tube or Probe -- A gas-filled device that creates an electrical pulse when radiation interacts with the gas in the tube. These pulses are converted to a reading on the instrument meter. If the instrument has a speaker, the pulses also give an audible click. Common readout units are: roentgens per hour (R/hr), milliroentgens per hour (mR/hr), rem per hour (rem/hr), millirem per hour (mrem/hr) and counts per minute (cpm). G-M probes (e.g., "pancake" type) are most often used with hand-held radiation survey instruments.

Sodium Iodide Detector -- A solid crystal of sodium iodide creates a pulse of light when radiation interacts with it. This pulse of light is converted to an electrical signal, which gives a reading on the instrument meter. If the instrument has a speaker, the pulses also give an audible click. Common readout units are: microroentgens per hour (μR/hr), and counts per minute (cpm). Sodium iodide detectors are often used with hand-held instruments and large stationary radiation monitors. Special plastic "scintillator" materials are also used in place of sodium iodide.

(Note: For practical purposes, consider the rad, roentgen, and the rem to be equal with gamma or x rays. So, 1 mR/hr is equivalent to 1 mrem/hr.)

6. How Can You Keep Radiation Exposure Low?

Although some radiation exposure is natural in our environment, it is desirable to keep radiation exposure as low as reasonably achievable (ALARA) in an occupational setting. This is accomplished by the techniques of time, distance, and shielding.

Time: The shorter the time in a radiation field, the less the radiation exposure you will receive. Work quickly and efficiently. Plan your work before entering the radiation field.

Distance: The farther a person is from a source of radiation, the lower the radiation dose. Levels decrease by a factor of the square of the distance. Do not touch radioactive materials. Use shovels, or remote handling devices, etc., to move materials to avoid physical contact.

Shielding: Shielding behind a massive object (such as a truck, dumpster, or pile of dirt) provides a barrier that can reduce radiation exposure.

7. What is Radioactive Contamination?

If radioactive material is not in a sealed source container, it might be spread onto other objects. Contamination occurs when material that contains radioactive atoms is deposited on materials, skin, clothing, or any place where it is not desired. It is important to remember that radiation does not spread or get "on" or "in" people; rather, it is radioactive *contamination* that can be spread. A person contaminated with radioactive material will receive radiation exposure until the source of radiation (the radioactive material) is removed.

-- A person is *externally* contaminated if radioactive material is on the skin or clothing.

-- A person is *internally* contaminated if radioactive material is breathed in, swallowed, or absorbed through wounds.

-- The *environment* is contaminated if radioactive material is spread about or is unconfined.

8. How Can You Work Safely Around Radiation or Contamination?

You can work safely around radiation and/or contamination by following a few simple precautions:

A. Use time, distance and shielding to reduce exposure.
B. Avoid contact with the contamination.
C. Wear protective clothing that if contaminated, can be removed.
D. Wash with non-abrasive soap and water any part of the body that may have come in contact with the contamination.
E. Assume that all materials, equipment, and personnel that came in contact with the contamination are contaminated. Radiological monitoring is recommended before leaving the scene.

9. Is it Safe to be Around Sources of Radiation?

A single high-level radiation exposure (i.e., greater than 10,000 mrem) delivered over a very short period of time may have potential health risks. From follow-up of the atomic bomb survivors, we know acutely delivered very high radiation doses can increase the occurrence of certain kinds of disease (e.g., cancer) and possibly negative genetic effects. To protect the public, radiation workers (and environment) from the potential effects of chronic low-level exposure (i.e., less than 10,000 mrem), the current radiation safety practice is to prudently assume similar adverse effects are possible with low-level protracted exposure to radiation. Thus, the risks associated with low-level medical, occupational and environmental radiation exposure are conservatively calculated to be proportional to those observed with high-level exposure. These calculated risks are compared to other known occupational and environmental hazards, and appropriate safety standards have been established by international and national radiation protection organizations (e.g., ICRP and NCRP) to control and limit potential harmful radiation effects.

Annual Radiation Dose Limits- TEDE

Facility staff -	5,000 mrem	(considered as "occupationally" exposed)
Facility staff -	100 mrem	(if considered member of the "public")
Vehicle driver -	100 mrem	(considered member of the public)
General Public -	4 mrem	(for the drinking water pathway)
General Public -	10 mrem	(for the air pathway)
General Public -	25 mrem	(all pathways combined)

Both public and occupational dose limits are set by federal (i.e., EPA and NRC) and state agencies (i.e., DEP) to limit cancer risk.

(Note: It is important to remember when dealing with radiation sources in other materials or waste that there may be chemical or biological hazards separate and distinct from the radiation hazard. These chemical or biological hazards are often more dangerous to humans than the radiation hazard.)

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UNITED STATES OF AMERICA, Plaintiff-Appellee, v. COMMONWEALTH OF KENTUCKY; KENTUCKY NATURAL RESOURCES & ENVIRONMENTAL PROTECTION CABINET, SECRETARY, Defendants-Appellants.

No. 00-5247

UNITED STATES COURT OF APPEALS FOR THE SIXTH CIRCUIT

252 F.3d 816; 2001 U.S. App. LEXIS 11591; 2001 FED App. 0184P (6th Cir.)

May 2, 2001, Argued

June 5, 2001, Decided

June 5, 2001, Filed

PRIOR HISTORY:
[*1] Appeal from the United States District Court for the Western District of Kentucky at Paducah. No. 99-00087. Thomas B. Russell, District Judge.

DISPOSITION:
AFFIRMED.

CASE SUMMARY

PROCEDURAL POSTURE: Plaintiff, state environmental agency, appealed from a judgment of the United States District Court for the Western District of Kentucky ruling that federal law preempts permit conditions imposed by the agency relating to the disposal of radioactive waste in a landfill operated by the U.S. Department of Energy (DOE).

OVERVIEW: The state's permit conditions prohibited the DOE from placing in its landfill solid waste that exhibits radioactivity above de minimis levels and required submission of a "Waste Characterization Plan" concerning the radioactive waste to defendant state agency for its review and approval. On appeal, the state argued that: (1) the district court erred in concluding that the challenged permit conditions were preempted by federal law; and (2) the district court should have abstained from hearing this case under the Declaratory Judgment Act and the Burford abstention doctrine. The court of appeals observed that the permit conditions constituted state regulation of source, special nuclear, or byproduct material, as defined by the Atomic Energy Act and concluded that the federal government had not waived its immunity from the permit conditions at issue and affirmed the district court's judgment on this alternate ground. The appellate court added that because the DOE presented a facial preemption claim, the district court properly found that it should not abstain in deference to a state court proceeding.

OUTCOME: The district court's judgment was affirmed in its entirety, where, inter alia, the district court did not err in refusing to abstain from hearing the case, notwithstanding concurrent pending litigation between the same parties in state court.

CORE CONCEPTS

Energy & Utilities Law : Nuclear Power Industry : Atomic Energy Act
Congress enacted the Atomic Energy Act (AEA) in 1954 to promote the development of atomic energy for peaceful purposes under a program of federal regulation and licensing. Congress has subsequently amended the AEA to create a dual regulatory structure, whereby the federal government regulates the radiological safety aspects involved in the construction and operation of a nuclear plant, and the states retain their traditional responsibility in the field of regulating electrical utilities for determining questions of need, reliability, costs, and other related state concerns.

Energy & Utilities Law : Nuclear Power Industry : Atomic Energy Act
The Atomic Energy Act regulates three different classes of radioactive material: source material, special nuclear material, and byproduct material. *42 U.S.C.S. §§ 2014*(e), (z), (aa). Source material includes uranium, thorium, and other materials that U.S. Department of

Energy deems necessary for the production of special nuclear material. *42 U.S.C.S. §§ 2014*(z), 2091. Special nuclear material includes plutonium, enriched uranium, and other material capable of releasing substantial quantities of atomic energy. *42 U.S.C.S. §§ 2014*(aa), 2071. Byproduct material includes (1) any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material, and (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. *42 U.S.C.S. § 2014*(e).

Energy & Utilities Law : Nuclear Power Industry : Atomic Energy Act
The Atomic Energy Act grants the U.S. Department of Energy and the Nuclear Regulatory Commission exclusive responsibility for regulating source, special nuclear, and byproduct material. *42 U.S.C.S. §§ 2201*(b), (i)(3).

Environmental Law : Hazardous Wastes & Toxic Substances : Resource Conservation & Recovery Act
The Resource Conservation and Recovery Act (RCRA), *42 U.S.C.S. §§ 6901* thru 6992k, prohibits the treatment, storage, or disposal of hazardous waste at private or governmental facilities without a permit issued by either the United States Environmental Protection Agency or an authorized state. *42 U.S.C.S. §§ 6925*(a), 6961. The RCRA expressly contemplates that state and local governments will play a lead role in solid waste regulation. *42 U.S.C.S. § 6901*(a)(4).

Environmental Law : Hazardous Wastes & Toxic Substances : Resource Conservation & Recovery Act
Under the Resource Conservation and Recovery Act, *42 U.S.C.S. §§ 6901* thru 6992k, hazardous waste is defined as solid waste, or a combination of solid wastes, that, for enumerated reasons, creates public health and environmental dangers. *42 U.S.C.S. § 6903*(5). Solid waste, however, does not include source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954. *42 U.S.C.S. § 6903*(27).

Constitutional Law : Supremacy Clause
Under the U.S. Constitution's Supremacy Clause, U.S. Const. art VI, § 2, Congress may preempt state law so long as it acts within its constitutionally delimited powers.

Constitutional Law : Supremacy Clause
State law can be preempted in either of two general ways. If Congress evidences an intent to occupy a given field, any state law falling within that field is preempted. If Congress has not entirely displaced state regulation over the matter in question, state law is still preempted to the extent it actually conflicts with federal law, that is, when it is impossible to comply with both state and federal law, or where the state law stands as an obstacle to the accomplishment of the full purposes and objectives of Congress.

Civil Procedure : Appeals : Standards of Review : De Novo Review
Constitutional Law : Supremacy Clause
Whether a federal statute preempts state or local law is a question of federal law, which federal appellate courts review de novo.

Administrative Law : Judicial Review : Standards of Review : General Rules
Courts must give considerable weight to an executive department's construction of a statutory scheme it administers and deference to its administrative interpretations.

Environmental Law : Hazardous Wastes & Toxic Substances : Resource Conservation & Recovery Act
Environmental Law : Hazardous Wastes & Toxic Substances : Treatment, Storage & Disposal
Environmental Law : Hazardous Wastes & Toxic Substances : Radioactive Substances
Energy & Utilities Law : Nuclear Power Industry : Atomic Energy Act
According to Department of Energy (DOE) and Environmental Protection Agency (EPA) rulings pertaining to mixtures of radioactive and hazardous waste, the Atomic Energy Act governs the radioactive portion of the waste mixture and the Resource Conservation and Recovery Act (RCRA), *42 U.S.C.S. §§ 6901* thru 6992k, governs the hazardous portion. *51 Fed. Reg. 24,504* (July 3, 1986); *52 Fed. Reg. 15,937* (May 1, 1987); *53 Fed. Reg. 37,045* (Sept. 23, 1988). Under this dual regulatory scheme, DOE has exclusive authority to regulate the radioactive component of waste mixtures, whereas EPA — or states authorized by EPA under the RCRA — retain the authority to regulate the hazardous portion.

Energy & Utilities Law : Nuclear Power Industry : Atomic Energy Act
The federal government has occupied the entire field of nuclear safety concerns, except the limited powers expressly ceded to the states. Accordingly, the Atomic Energy Act preempts any state attempt to regulate materials covered by the Act for safety purposes.

Environmental Law : Hazardous Wastes & Toxic Substances : Radioactive Substances
While federal law does not preempt state regulation of solid waste, states may not regulate the radioactive component of solid waste. The U.S. Department of Energy

has exclusive authority to regulate the radioactive component of waste mixtures, whereas the Environmental Protection Agency (EPA) — or states authorized by EPA under the Resource Conservation and Recovery Act (RCRA), *42 U.S.C.S. §§ 6901* thru 6992k, — retain the authority to regulate the non-radioactive portion.

Constitutional Law : Supremacy Clause
When the federal government completely occupies a given field or an identifiable portion of it, the test of preemption is whether the matter on which the state asserts the right to act is in any way regulated by the federal government.

Civil Procedure : Appeals : Standards of Review : De Novo Review
Environmental Law : Litigation & Administrative Proceedings : Defenses
The federal government is immune from state regulation except to the extent waived. Waivers of federal immunity must be unequivocal, and are to be strictly construed in favor of the United States. The issue of whether the United States has waived its sovereign immunity is a question of law subject to de novo review.

Civil Procedure : State & Federal Interrelationships : Abstention Doctrine
Civil Procedure : Appeals : Standards of Review : De Novo Review
Civil Procedure : Appeals : Standards of Review : Abuse of Discretion
There is little practical distinction between review for abuse of discretion and review de novo in abstention cases, inasmuch as the district court's discretion to abstain is narrowed by a federal court's obligation to exercise its jurisdiction in all but the most extraordinary cases.

Civil Procedure : State & Federal Interrelationships : Abstention Doctrine
When state and federal courts have concurrent jurisdiction to decide preemption questions, a federal court should abstain to allow the state court to consider the preemption issues. However, if the issues present facially conclusive claims of federal preemption, federal courts will not abstain, but instead will decide the preemption question.

Civil Procedure : State & Federal Interrelationships : Abstention Doctrine
Abstention is not required in a case presenting facially conclusive claims of federal preemption, where resolution of the dispute does not require the court to interpret state law or make factual findings.

Civil Procedure : State & Federal Interrelationships : Abstention Doctrine
A federal court may abstain from exercising its jurisdiction in a declaratory judgment action where another suit is pending in a state court presenting the same issues, not governed by federal law, between the same parties.

Civil Procedure : State & Federal Interrelationships : Abstention Doctrine
A federal district court may properly abstain from exercising its subject matter jurisdiction based on considerations of wise judicial administration, giving regard to conservation of judicial resources and comprehensive disposition of litigation. Factors relevant to a court's decision to abstain under this Colorado River doctrine include: (1) whether the state court or the federal court has assumed jurisdiction over the res or property; (2) which forum is more convenient to the parties; (3) whether abstention would avoid piecemeal litigation; (4) which court obtained jurisdiction first; and (5) whether federal law or state law provides the basis for the decision on the merits.

Civil Procedure : State & Federal Interrelationships : Abstention Doctrine
Burford abstention applies (1) if a case presents difficult questions of state law bearing on policy problems of substantial public import whose importance transcends the result in the case then at bar, or (2) if the exercise of federal review of the question in a case and in similar cases would be disruptive of state efforts to establish a coherent policy with respect to a matter of substantial public concern.

Civil Procedure : State & Federal Interrelationships : Abstention Doctrine
Burford abstention is not justified where no difficult question of state law is presented.

Civil Procedure : State & Federal Interrelationships : Abstention Doctrine
There is no doctrine requiring abstention merely because resolution of a federal question may result in the overturning of a state policy.

COUNSEL:
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ON BRIEF: Mark A. Posnansky, OFFICE OF LEGAL SERVICES, Frankfort, Kentucky, for Appellants.

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JUDGES:
Before: NORRIS and COLE, Circuit Judges; STEEH, District Judge. *

* The Honorable George Caram Steeh, United States District Judge for the Eastern District of Michigan, sitting by designation.

OPINIONBY:
R. GUY COLE, JR.

OPINION:

R. GUY COLE, JR., Circuit Judge. The Commonwealth of Kentucky, acting through the Secretary of the Kentucky Natural Resources and Environmental Protection Cabinet ("Cabinet"), appeals from the district [*2] court's ruling that federal law preempts permit conditions imposed by the Cabinet relating to the disposal of radioactive waste in a landfill operated by the United States Department of Energy ("DOE"). For the following reasons, we **AFFIRM** the judgment of the district court.

I. BACKGROUND

The Paducah Gaseous Diffusion Plant (the "Plant") is an active uranium enrichment facility owned by the DOE, located in McCracken County, Kentucky. The Cabinet regulates disposal of solid waste at the Plant through the issuance of permits. In 1994, DOE submitted a permit application to the Cabinet for the construction and operation of a contained solid waste landfill at the Plant. In February 1995, the Cabinet issued a permit to DOE authorizing the construction of the landfill.

After verifying that DOE had completed construction in accordance with the approved plans, the Cabinet issued another permit to DOE on November 4, 1996, authorizing operation of the landfill. This operating permit contained conditions relating to the disposal of radioactive materials in the landfill. Specifically, Condition 11 prohibited DOE from placing in the landfill "solid waste that exhibits radioactivity [*3] above de minimis levels." Condition 12 prohibited DOE from placing in the landfill "solid waste that contains radionuclides ... until a Waste Characterization Plan for radionuclides has been submitted to the Division of Waste Management for review and approval."

DOE appealed the imposition of these permit conditions through Kentucky's administrative process. On January 15, 1999, a state Hearing Officer issued a report recommending that the Secretary affirm the Cabinet's imposition of the challenged permit conditions. DOE filed objections and the Cabinet responded. On February 18, 1999, the Secretary entered a final order affirming and adopting the Hearing Officer's report and recommendation. The Secretary accordingly dismissed DOE's administrative appeal.

DOE then filed a petition for judicial review of the Cabinet's final action in Kentucky state court on March 22, 1999. Under Kentucky law, DOE was required to file its petition for state court review of the Cabinet's action within thirty days of the Cabinet's final order. See Ky. Rev. Stat. § 224.10-470(1). DOE alleges that it filed its state court action to preserve its rights under state law.

On April 1, 1999, ten days [*4] after filing its state court action, DOE filed the instant action in the United States District Court for the Western District of Kentucky seeking declaratory and injunctive relief. In its complaint, DOE challenged the permit conditions at issue on the grounds that: (1) the Atomic Energy Act of 1954, *42 U.S.C. §§ 2011-2297g-4*, preempts state regulations relating to the disposal of radioactive materials; (2) the conditions violate the federal government's sovereign immunity from state regulation; and (3) the Commonwealth failed to comply with its own statutes and regulations in imposing the conditions. On April 27, 1999, the Cabinet filed a motion to dismiss DOE's complaint, arguing that: (1) the district court should decline jurisdiction over DOE's action based upon the discretion accorded it under the Declaratory Judgment Act, *28 U.S.C. § 2201*, and under the **Burford** abstention doctrine, see ***Burford v. Sun Oil Co., 319 U.S. 315, 87 L. Ed. 1424, 63 S. Ct. 1098 (1943)***; (2) DOE's preemption and sovereign immunity claims fail to state a claim for which relief can be granted; and (3) the challenged permit [*5] conditions comport with Kentucky law.

The district court denied the Cabinet's motion to dismiss on November 5, 1999. The court found that it was not required to decline jurisdiction over the case inasmuch as DOE had presented a facially conclusive claim of federal preemption, the resolution of which did not require the court to interpret state law or make factual findings. The court further found that federal law preempts the Cabinet's attempt to regulate DOE's disposal of radioactive waste in the landfill. The court accordingly entered judgment for DOE and dismissed the case.

On appeal, the Cabinet argues that: (1) the district

court erred in concluding that the challenged permit conditions are preempted by federal law; and (2) the district court should have abstained from hearing this case based upon the discretion accorded it under the Declaratory Judgment Act and the **Burford** abstention doctrine.

II. DISCUSSION

A. Statutory and Regulatory Overview

Congress enacted the Atomic Energy Act ("AEA") in 1954 to promote the development of atomic energy for peaceful purposes under a program of federal regulation and licensing. **See *Pac. Gas & Elec. Co. v. State Energy Res. Conservation & Dev. Comm'n, 461 U.S. 190, 206-07, 75 L. Ed. 2d 752, 103 S. Ct. 1713 (1983).*** [*6] Congress has subsequently amended the AEA to create a dual regulatory structure, whereby the federal government regulates the "radiological safety aspects involved in the construction and operation of a nuclear plant," and the states "retain their traditional responsibility in the field of regulating electrical utilities for determining questions of need, reliability, costs, and other related state concerns." ***Id. at 205.***

The AEA regulates three different classes of radioactive material: source material, special nuclear material, and byproduct material. **See** *42 U.S.C.* § *2014*(e), (z), (aa). Source material includes uranium, thorium, and other materials that DOE deems necessary for the production of special nuclear material. *42 U.S.C.* §§ *2014*(z), 2091. Special nuclear material includes plutonium, enriched uranium, and other material capable of releasing substantial quantities of atomic energy. *42 U.S.C.* §§ *2014*(aa), 2071. Byproduct material includes "(1) any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process [*7] of producing or utilizing special nuclear material, and (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content." *42 U.S.C.* § *2014*(e).

The AEA grants DOE and the Nuclear Regulatory Commission exclusive responsibility for regulating source, special nuclear, and byproduct material. **See** *42 U.S.C.* § *2201*(b), (i)(3). Pursuant to this authority, DOE has developed and implemented an extensive regulatory regime for managing radioactive materials and limiting the release of radioactivity. **See, e.g., General Environmental Protection Program,** DOE Order 5400.1 (1988); **Radiation Protection of the Public and the Environment,** DOE Order 5400.5 (1990); **Radioactive Waste Management,** DOE Order 435.1 (1999) (establishing requirements for managing low-level radioactive waste, including waste characterization, waste treatment, disposal, and environmental monitoring). These regulatory standards are designed to assure that the public, workers, and the environment are not exposed to unsafe levels of radiation. **See** DOE [*8] Order 435.1 § 4.

In 1976, Congress passed the Resource Conservation and Recovery Act ("RCRA"), which amended the Solid Waste Disposal Act of 1965, *42 U.S.C.* §§ *6901*-6992k. Congress enacted the RCRA to end the environmental and public health risks associated with the mismanagement of hazardous waste. **See *Sierra Club v. United States Dep't of Energy, 734 F. Supp. 946, 947 (D. Colo. 1990).*** Generally, the RCRA prohibits the treatment, storage, or disposal of hazardous waste at private or governmental facilities without a permit issued by either the United States Environmental Protection Agency ("EPA") or an authorized state. **See id.;** *42 U.S.C.* §§ *6925*(a), 6961. The RCRA expressly contemplates that state and local governments will play a lead role in solid waste regulation. **See** *42 U.S.C.* § *6901*(a)(4).

Under the RCRA, hazardous waste is defined as "solid waste, or [a] combination of solid wastes[,]" that, for enumerated reasons, creates public health and environmental dangers. *42 U.S.C.* § *6903*(5). "Solid waste," however, does not include "source, special nuclear, [*9] or byproduct material as defined by the Atomic Energy Act of 1954." *42 U.S.C.* § *6903*(27). Indeed, the RCRA expressly provides:

> Nothing in this chapter shall be construed to apply to (or to authorize any State, interstate, or local authority to regulate) any activity or substance which is subject to ... the Atomic Energy Act of 1954 except to the extent that such application (or regulation) is not inconsistent with the requirements of such Act[].

42 U.S.C. § *6905*(a).

B. Preemption

Under the Constitution's Supremacy Clause, U.S. Const. art VI, § 2, Congress may preempt state law so long as it acts within its constitutionally delimited powers. **See *McCulloch v. Maryland, 17 U.S. 316, 427, 4 L. Ed. 579 (1819)*** ("It is of the very essence of supremacy, to remove all obstacles to its action within its own sphere, and so to modify every power vested in subordinate governments, as to exempt its own operations from their own influence.") The Supreme Court has established a general framework by which preemption questions are analyzed:

> State law can be preempted in either of two general [*10] ways. If Congress evidences an intent to occupy a given field, any state law falling within that field is preempted.

If Congress has not entirely displaced state regulation over the matter in question, state law is still preempted to the extent it actually conflicts with federal law, that is, when it is impossible to comply with both state and federal law, or where the state law stands as an obstacle to the accomplishment of the full purposes and objectives of Congress.

Silkwood v. Kerr-McGee Corp., 464 U.S. 238, 248, 78 L. Ed. 2d 443, 104 S. Ct. 615 (1984). Whether a federal statute preempts state or local law is a question of federal law, see ***Musson Theatrical, Inc. v. Fed. Express Corp., 89 F.3d 1244, 1257 (6th Cir. 1996),*** which we review de novo, see ***GTE Mobilnet v. Johnson, 111 F.3d 469, 475 (6th Cir. 1997).***

The district court noted that while the RCRA governs the disposal of hazardous waste, and the AEA governs the disposal of radioactive waste, no statute specifically delegates authority to regulate a mixture of the two types of waste. n1 Accordingly, the district court turned to the relevant federal [*11] agencies' construction of the AEA and RCRA for interpretative guidance. See ***Chevron, U.S.A., Inc. v. Natural Res. Defense Council, Inc., 467 U.S. 837, 843, 81 L. Ed. 2d 694, 104 S. Ct. 2778 (1984)*** (requiring courts to give considerable weight to executive department's construction of a statutory scheme it administers and deference to its administrative interpretations). The court found that, according to DOE and EPA rulings pertaining to mixtures of radioactive and hazardous waste, the AEA governs the radioactive portion of the waste mixture and the RCRA governs the hazardous portion. See **EPA Notice: State Authorization to Regulate Hazardous Components of Radioactive Wastes Under the Resource Conservation and Recovery Act**, *51 Fed. Reg. 24,504* (July 3, 1986); **DOE Final Rule: Radioactive Waste; Byproduct Material**, *52 Fed. Reg. 15,937* (May 1, 1987); **EPA Clarification Notice: Clarification of Interim Status Qualification Requirements for the Hazardous Components of Radioactive Mixed Waste**, *53 Fed. Reg. 37,045* (Sept. 23, 1988). Under this dual regulatory scheme, DOE has exclusive authority to regulate the radioactive [*12] component of waste mixtures, whereas EPA — or states authorized by EPA under the RCRA — retain the authority to regulate the hazardous portion. See ***In re Westinghouse Materials Co. of Ohio, 1991 EPA ALJ LEXIS 19, No. RCRA-V-W-89-R-11, 1991 WL 303402*** (E.P.A. Dec. 31, 1991) (applying dual regulatory scheme to disposal of waste mixtures). Based on the agencies' interpretation of the AEA and the RCRA, the district court concluded that the Cabinet's attempt to impose conditions on DOE's disposal of radioactive materials in the landfill was preempted by federal law.

> n1 DOE acknowledges that the waste it intends to place in the landfill contains both a radioactive component (**i.e.**,"source, special nuclear, and byproduct material") and a non-radioactive component. As such, a mixture of solid waste and radioactive waste comprises the waste in question in this case.

On appeal, the Cabinet objects to the district court's conclusion on several grounds. The Cabinet first asserts [*13] that the challenged permit conditions are not preempted by the AEA because the Cabinet has the statutory authority under Kentucky law to regulate solid waste disposal. Thus, the Cabinet contends that the challenged permit conditions do not constitute regulation of radioactive materials, but rather merely address the fact that DOE's solid waste may be contaminated with radionuclides. The Cabinet further argues that the district court failed to support its conclusion with specific factual findings as to how the permit conditions conflict with the requirements of the AEA. Because the AEA does not expressly address the disposal of solid waste contaminated with radionuclides, the Cabinet argues, it was error to conclude that the AEA preempts the permit conditions without finding actual conflicts between the state and federal requirements.

The Cabinet's arguments are not well-taken. As the Supreme Court unequivocally stated in **Pacific Gas & Electric**, "the federal government has occupied the entire field of nuclear safety concerns, except the limited powers expressly ceded to the states." *461 U.S. at 212.* Accordingly, the AEA preempts any state attempt to regulate materials [*14] covered by the Act for safety purposes. See **id.** Here, the challenged permit conditions specifically limit the amount of "radioactivity" and "radionuclides" that DOE may place in its landfill. The sources of such "radioactivity" and "radionuclides" are materials covered by the AEA, **i.e.**, source, special nuclear, and byproduct materials. The Cabinet seeks to impose these conditions to protect human health and the environment. The permit conditions therefore represent an attempt by the Cabinet to regulate materials covered by the AEA based on the Cabinet's safety and health concerns, and are thus preempted.

The fact that the Cabinet is authorized, under state law, to regulate solid waste disposal is irrelevant to our preemption analysis. Thus, the Cabinet's reference to its state law authority to ensure that only solid waste is placed in the landfill misses the point. n2 The disposal limits imposed by the challenged conditions constitute regulation of materials covered by the AEA. They are therefore preempted. Similarly, the Cabinet's assertion that it has the "right under state law" to prohibit any

radioactive materials from being placed in the landfill is incorrect. [*15] The Supreme Court rejected a similar argument in **Pacific Gas & Electric**:

> Respondents ... argue ... that although safety regulation of nuclear plants by states is forbidden, a state may completely prohibit new construction until its safety concerns are satisfied by the federal government. We reject this line of reasoning. State safety regulation is not preempted only when it conflicts with federal law. Rather, the federal government has occupied the entire field of nuclear safety concerns ....

461 U.S. at 212.

> n2 DOE argues that the Cabinet incorrectly characterizes Kentucky law as authorizing it to ensure that only solid waste is placed in the landfill. Because the extent of the Cabinet's state law authority to regulate solid waste is irrelevant to our preemption analysis, however, we need not address DOE's argument based on Kentucky law.

While federal law does not preempt state regulation of solid waste, see ***City of Philadelphia v. New Jersey, 437 U.S. 617, 620-21 n.4, 57 L. Ed. 2d 475, 98 S. Ct. 2531 (1978),*** [*16] states may not regulate the radioactive component of solid waste. As the district court correctly concluded, DOE has exclusive authority to regulate the radioactive component of waste mixtures, whereas EPA — or states authorized by EPA under the RCRA — retain the authority to regulate the non-radioactive portion. See ***In re Westinghouse Materials Co. of Ohio, 1991 EPA ALJ LEXIS 19, 1991 WL 303402,*** at *6-8 (applying dual regulatory scheme to disposal of waste mixtures). Because the challenged permit conditions regulate materials covered by the AEA, they are therefore preempted.

The Cabinet relies on the Tenth Circuit's decision in ***United States v. New Mexico, 32 F.3d 494 (10th Cir. 1994),*** to rebut this conclusion. In **New Mexico**, the United States challenged permit conditions imposed by the state addressing the presence of radionuclides in the incineration of hazardous waste at a DOE facility. ***Id. at 495.*** The case presented the question of whether the permit conditions were within the scope of the RCRA's waiver of federal sovereign immunity. ***Id. at 496.*** The court held that conditions imposed by the state on DOE's [*17] hazardous waste incinerator were "requirements" under state law, and thus were applicable to the DOE facility under the RCRA. ***Id. at 498.*** The court expressly noted, however, that DOE did not raise the issue of whether the conditions were preempted by the AEA as state regulation of radioactive materials; rather, DOE relied solely on its argument that the conditions were not "requirements" under the RCRA's waiver provision. ***Id. at 498 n.4.*** Thus, **New Mexico** did not address the same issue presented in this case, **i.e.**, whether state regulation of the radioactive component of solid waste is preempted by the AEA. The Cabinet's reliance on **New Mexico** in support of its preemption argument is misplaced.

The Cabinet's argument that the district court erred in failing to identify specific conflicts between the challenged conditions and federal law also must fail. As noted previously, the Supreme Court has stated that the AEA preempts the field of state regulation of radioactive materials. ***Pac. Gas & Elec., 461 U.S. at 212.*** "When the federal government completely occupies a given field or an identifiable portion of it, [*18] as it has done here, the test of preemption is whether 'the matter on which the state asserts the right to act is in any way regulated by the federal government.'" ***Id. at 213*** (quoting ***Rice v. Santa Fe Elevator Corp., 331 U.S. 218, 236, 91 L. Ed. 1447, 67 S. Ct. 1146 (1947)***). Under such test, DOE need not identify specific conflicts between the Cabinet's permit conditions and federal law in order to establish preemption. The district court's failure to make specific factual findings regarding the conflict between the federal and state requirements was therefore not in error.

C. Federal Sovereign Immunity

DOE also argues that the Cabinet's challenged permit conditions are invalid because the United States has not waived its federal sovereign immunity to state regulation of radioactive materials at federal facilities.

The federal government is immune from state regulation except to the extent waived. See ***United States v. Mitchell, 445 U.S. 535, 539, 63 L. Ed. 2d 607, 100 S. Ct. 1349 (1980).*** The Supreme Court has held that waivers of federal immunity must be unequivocal, ***id. at 538,*** and are [*19] to be strictly construed in favor of the United States, ***United States v. Nordic Village, Inc., 503 U.S. 30, 34, 117 L. Ed. 2d 181, 112 S. Ct. 1011 (1992).*** The issue of whether the United States has waived its sovereign immunity is a question of law subject to de novo review. See **United States v. $515,060.42 in *U.S. Currency, 152 F.3d 491, 504 (6th Cir. 1998).***

While the district court did not address DOE's sovereign immunity argument in light of its holding that the Cabinet's regulations are preempted by federal law, DOE could have prevailed on this alternate theory as well. Neither the AEA nor any other federal law waives federal immunity from regulation of DOE facilities by states with respect to materials covered by the AEA. While the Cabinet is correct to point out that the RCRA waives federal immunity to state regulation of federal

facilities with respect to solid waste, see *42 U.S.C. § 6961*(a), the RCRA's definition of "solid waste" expressly excludes materials covered by the AEA, see *42 U.S.C. § 6903*(27). As discussed previously, the Cabinet's permit conditions constitute state [*20] regulation of source, special nuclear, or byproduct material, as defined by the AEA. Accordingly, the United States has not waived its immunity from the permit conditions at issue. We therefore affirm the district court's judgment on this alternate ground.

D. Abstention

Aside from its preemption argument, the Cabinet contends that the district court should have abstained from hearing this case based upon the discretion accorded it under the Declaratory Judgment Act and the **Burford** abstention doctrine. While we normally review de novo a district court's decision to abstain, see ***Fed. Express Corp. v. Tennessee Pub. Serv. Comm'n, 925 F.2d 962, 967 (6th Cir. 1991)***, we have at least on one occasion reviewed such a decision for abuse of discretion, see ***Romine v. Compuserve Corp., 160 F.3d 337, 341, 343 (6th Cir. 1998)***. As the Second Circuit has noted, however, "there is little practical distinction between review for abuse of discretion and review de novo" in abstention cases, inasmuch as the district court's discretion to abstain "is narrowed by a federal court's obligation to exercise its jurisdiction in all but the most extraordinary [*21] cases." ***Hachamovitch v. DeBuono, 159 F.3d 687, 693 (2d Cir. 1998)***.

The Cabinet's abstention argument is two-fold. First, it contends that the district court should have declined jurisdiction over DOE's complaint based upon the discretion accorded it under the Declaratory Judgment Act, *28 U.S.C. § 2201*. See ***Brillhart v. Excess Ins. Co. of America, 316 U.S. 491, 86 L. Ed. 1620, 62 S. Ct. 1173 (1942)*** (ordering federal district court to dismiss § 2201 action in favor of pending state court proceeding). The Cabinet further asserts that the judicially-created doctrine of abstention set out in ***Burford v. Sun Oil Co., 319 U.S. 315, 87 L. Ed. 1424, 63 S. Ct. 1098 (1943)***, and its progeny required the district court to decline jurisdiction over this case. Neither of the Cabinet's abstention arguments has merit.

In a case procedurally similar to this one, we addressed the "interplay between preemption and abstention" presented here:

> When state and federal courts have concurrent jurisdiction to decide preemption questions, a federal court should abstain to allow the state court to consider the [*22] preemption issues. However, ... if the issues present facially conclusive claims of federal preemption, we will not abstain, but instead will decide the preemption question.

GTE Mobilnet, 111 F.3d at 475. See also ***New Orleans Public Serv., Inc. v. Council of New Orleans, 491 U.S. 350, 362, 105 L. Ed. 2d 298, 109 S. Ct. 2506 (1989)*** (noting that where determination of preemption claim would not disrupt state's attempt to ensure uniformity in treatment of an essentially local problem, abstention is not required); ***Bunning v. Commonwealth of Kentucky, 42 F.3d 1008, 1011 (6th Cir. 1994)*** (concluding that "abstention is not required in a case presenting facially conclusive claims of federal preemption, where resolution of the dispute does not require the court to interpret state law or make factual findings"); ***Norfolk & W. Ry. Co. v. Pub. Utilities Comm'n, 926 F.2d 567, 573 (6th Cir. 1991)*** ("Abstention is not required when the naked question, uncomplicated by ambiguous language, is whether the state law on its face is preempted.")

In light of the foregoing principles, the district court in this case correctly [*23] found that abstention was inappropriate. DOE's action for declaratory and injunctive relief presented a facially conclusive claim of federal preemption, inasmuch as a determination of the preemption question did not require a "detailed analysis of state law," ***GTE Mobilnet, 111 F.3d at 478***, or the "making of findings on disputed facts," ***Norfolk & W. Ry. Co., 926 F.2d at 573***. Indeed, the district court was not required to inquire "beyond the four corners" of the challenged state order in resolving the preemption question. ***New Orleans Pub. Serv., Inc., 491 U.S. at 363***. Because DOE presented a facial preemption claim, the district court properly found that it should not abstain in deference to the state court proceeding.

None of the judicially-created abstention doctrines cited by the Cabinet refute this conclusion. In **Brillhart**, the Supreme Court held that a federal court may abstain from exercising its jurisdiction in a declaratory judgment action "where another suit is pending in a state court presenting the same issues, **not governed by federal law**, between the same parties." *316 U.S. at 495* [*24] (emphasis added). Here, the essence of DOE's complaint is that the AEA preempts the conditions imposed by the Cabinet in the landfill permit. Such a claim presents an issue of federal law. See ***Musson Theatrical, Inc., 89 F.3d at 1257***. Thus, the reasoning of **Brillhart**, which expressly applies only to declaratory judgment actions "not governed by federal law," *316 U.S. at 495*, does not support abstention in this case. n3

> n3 In support of its abstention argument under **Brillhart**, the Cabinet relies on ***International Association of Entrepreneurs v. Angoff, 58 F.3d***

1266 (8th Cir. 1995). The court in **Angoff** affirmed the district court's decision to abstain because it found the plaintiff's federal suit to be an "attempt to circumvent the removal statute's deadline by using the Declaratory Judgment Act as a convenient and temporally unlimited back door to federal court." ***Id. at 1270.*** Here, DOE's declaratory judgment action is not an attempt to avoid defending against a state court action. Rather, DOE has a compelling interest in choosing a federal forum to seek a declaration of its federal statutory immunity from state regulation. **See *United States v. Pennsylvania, 923 F.2d 1071 (3d Cir. 1991)*** (holding that district court should not have abstained in light of federal government's right to seek declaration of immunity under federal statute in the federal forum of its choice). Thus, the Cabinet's reliance on **Angoff** is misplaced.

[*25]

Neither does the Supreme Court's decision in ***Colorado River Water Conservation District v. United States, 424 U.S. 800, 47 L. Ed. 2d 483, 96 S. Ct. 1236 (1976),*** favor abstention. In **Colorado River**, the Supreme Court held that, in rare circumstances, a federal district court may properly abstain from exercising its subject matter jurisdiction based on considerations of "wise judicial administration, giving regard to conservation of judicial resources and comprehensive disposition of litigation." ***Id. at 817*** (internal quotation marks and citation omitted). Factors relevant to a court's decision to abstain under **Colorado River** include: (1) whether the state court or the federal court has assumed jurisdiction over the res or property; (2) which forum is more convenient to the parties; (3) whether abstention would avoid piecemeal litigation; (4) which court obtained jurisdiction first; and (5) whether federal law or state law provides the basis for the decision on the merits. **See *Moses H. Cone Mem'l Hosp. v. Mercury Construction Corp., 460 U.S. 1, 15-16, 23, 74 L. Ed. 2d 765, 103 S. Ct. 927 (1983).***

On balance, [*26] these factors weigh strongly against abstention in this case. While neither the federal court nor the Kentucky state court has assumed jurisdiction over property in this case, and neither party has alleged that one court is significantly more convenient than the other, the remaining factors favor federal court resolution of this dispute. The federal case will resolve the entire dispute between DOE and the Cabinet, such that abstention is not required to avoid piecemeal litigation. Although DOE instituted the Kentucky state court action just prior to filing suit in federal court, the federal case has been fully litigated whereas no action has been taken by the parties in the state case. Finally, federal law provides the basis for the decision on the merits. Thus, the Cabinet's argument under the **Colorado River** abstention doctrine is not well-taken.

Finally, the Cabinet's argument for abstention under **Burford** also must fail. **Burford** abstention applies (1) if a case presents "difficult questions of state law bearing on policy problems of substantial public import whose importance transcends the result in the case then at bar," or (2) if the "exercise of federal review [*27] of the question in a case and in similar cases would be disruptive of state efforts to establish a coherent policy with respect to a matter of substantial public concern." ***Colorado River, 424 U.S. at 814.***

Neither of these two circumstances is presented here. As previously noted, this case involves a question of preemption under federal law, not a question of state law. Thus, the Cabinet cannot satisfy the first ground for **Burford** abstention. **See *New Orleans Pub. Serv., Inc., 491 U.S. at 362-63*** (holding that **Burford** abstention is not justified where no difficult question of state law is presented). Nor can the Cabinet satisfy the second ground for **Burford** abstention. The district court's adjudication of DOE's action does not stand to disrupt Kentucky's efforts to establish a coherent policy with respect to solid waste management, except to the extent such policy oversteps Kentucky's authority by regulating radioactive materials. "There is ... no doctrine requiring abstention merely because resolution of a federal question may result in the overturning of a state policy." ***Id. at 363*** (quoting ***Zablocki v. Redhail, 434 U.S. 374, 380 n.5, 54 L. Ed. 2d 618, 98 S. Ct. 673 (1978)).*** [*28] **Cf. *Coalition for Health Concern v. LWD, Inc., 60 F.3d 1188, 1194-95 (6th Cir. 1995)*** (distinguishing **New Orleans Public Service, Inc.** on the grounds that plaintiffs' federal court claims in **LWD** could not be decided without interfering with Kentucky's policies governing the issuance of hazardous waste incineration permits.)

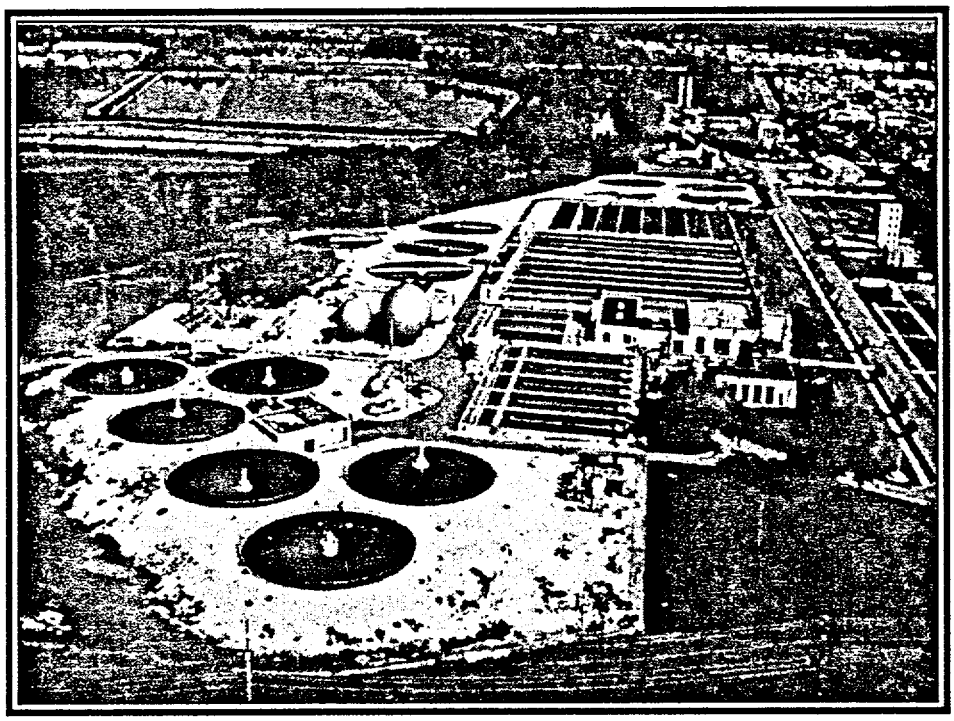
Accordingly, we find that the district court did not err in refusing to abstain in this case, notwithstanding the concurrent pending litigation between the same parties in Kentucky state court.

III. CONCLUSION

For the foregoing reasons, we **AFFIRM** the decision of the district court in its entirety.

United States Environmental Protection Agency | United States Nuclear Regulatory Commission | June 2000

Guidance on Radioactive Materials in Sewage Sludge and Ash at Publicly Owned Treatment Works



Interagency Steering Committee on Radiation Standards
Sewage Sludge Subcommittee

Revised Draft
June 2000

This document resulted from interagency discussions. The Interagency Steering Committee on Radiation Standards, Sewage Sludge Subcommittee, is composed of representatives from the Environmental Protection Agency (EPA), Nuclear Regulatory Commission (NRC), Department of Energy, Department of Defense, State of New Jersey, the city of Cleveland and the county of Middlesex, New Jersey. This document has not been approved by the respective agencies and does not represent the official position of any participating agency at this time.

This document is a draft, available for review and comment. Comments should be provided to the EPA or NRC contact listed in Chapter 7. The Subcommittee prefers that comments be provided by October 13, 2000. The final version of this document will be produced after the survey of radioactivity in sewage sludge is complete. The subcommittee currently plans to produce the final version in Fall 2001.

Cover photo courtesy of Water Environment Federation, Alexandria, VA

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1 INTRODUCTION

Authorities that operate Publicly Owned Treatment Plants (POTWs) have many considerations to address in the monitoring and daily operation of the treatment plants. One of these considerations is the potential for radioactive materials to become concentrated in the treatment plant. Radioactive materials are typically not a major concern at POTWs; however, they are a component of the waste stream that is less understood.

There are more than 16,000 POTWs in the United States. The Nuclear Regulatory Commission (NRC) estimated that of the more than 24,000 regulated users of Atomic Energy Act (AEA) radioactive materials, about 9,000 users have a potential to release radioactive materials to the sewer (GAO, 1994). Naturally occurring radioactive material may also enter sewer systems. Considering the many means for deposition and concentration of material in sewer systems, radioactive materials may concentrate in the wastewater systems and in sewage sludge and ash.

In the United States there have been no identified cases in which radioactive materials in sewage systems have been a threat to the health and safety of POTW workers or the public. There have been a small number of facilities where elevated levels of contamination have been detected. Based upon past experience, there is the potential for radioactive material to concentrate in sewage sludge and ash, but such material is not likely to pose a threat to the health and safety of workers or the public.

The Sewage Sludge Subcommittee of the Interagency Steering Committee on Radiation Standards (ISCORS) is comprised of representatives from several federal agencies (see Section 4.4 for more information about ISCORS). The subcommittee is assisting NRC and the Environmental Protection Agency (EPA) in developing this guidance for POTWs and in performing a survey of radioactive material in sewage sludge and ash. One purpose of this document is to inform POTW authorities of the possibility for radioactive materials to concentrate in sewage sludge and incinerator ash. A second purpose is to help the POTW authorities determine what they may want to do about any radioactive materials present in their sewage sludge or ash.

Recent Example of Radioactive Material Concentrating in Sewage Sludge

There are certain geographical areas of the U.S. where relatively high radium concentrations occur in ground water and a number of public drinking water supplies depend upon ground water as their source of water. Some of these supplies have radium levels that exceed the drinking water standard for radioactive material. In treating the drinking water to remove the radium, a wastewater is created, which may contain much of the removed radium. When this wastewater is discharged to the sanitary sewer, the radium can be reconcentrated in sewage sludge produced by the sewage treatment plant. In some cases, the sludge is treated by composting and used as a soil conditioner or organic fertilizer by farmers and the general public. Several States are aware of this problem and are in the process of evaluating the radium levels in these materials.

Elevated Levels of Radioactive Material

The term "elevated levels of radioactive material," as used throughout this document, refers to measured or detected levels of radioactive material that would, in the opinion of the ISCORS member agencies, alert the POTW that some appropriate actions may be warranted. The various appropriate actions, which are described in this document, are suggested as best or prudent management practices that could be taken to ensure that worker safety, and public health and environmental protection have not been compromised. The presence of such "elevated levels" in a particular sewage sludge or ash sample does not imply that a dangerous or hazardous condition exists, but rather that the POTW may want to consider taking some appropriate action.

At the time this draft guidance was prepared, the "elevated levels" term had not been quantified. The use of this term, therefore, does not imply some quantified incremental exceedance of an existing benchmark or standard. Determining whether there is any concern for worker safety or general public health at any measured level of radioactive materials in a particular sludge sample is dependent upon a number of factors, and should be considered on a case by case basis.

As efforts by the ISCORS Sewage Sludge Subcommittee to conduct a survey and to perform dose modeling are completed, the term "elevated levels" could be further refined to include quantified ranges of radioactive material concentrations in various types of sewage sludge and ash products that correspond to suggested best management practices.

1.1 Reported Incidences of Radioactive Contamination

In their 1994 report, *Nuclear Regulation: Action Needed to Control Radioactive Contamination at Sewage Treatment Plants*, the General Accounting Office (GAO) described nine cases where contamination was found in sewage sludge or ash or the wastewater collection system, which have resulted in considerable cleanup expense to the POTW authority or specific industrial

dischargers of the wastewater (see Table 1). There have also been a few additional cases identified that are still under evaluation.

TABLE 1. Sewage Treatment Plants Where Elevated Levels of Radioactive Material Were Found

Location	Year Found	Radionuclides	Actions Taken
Tonawanda, New York	1983	Americium-241	State spent over $2 million cleaning up treatment plant. No final decision has been made regarding radioactive material found in the landfill.
Grand Island, New York	1984	Americium-241 Hydrogen-3 Polonium-210	No plant cleanup was warranted.
Oak Ridge, Tennessee	1984	Cobalt-60 Cesium-134 Cesium-137 Manganese-54	Soil around sewer line cleaned up, and some special sludge disposal occurred.
Royersford, Pennsylvania	1985	Manganese-54 Cobalt-58 Cobalt-60 Strontium-89 Zinc-65 & others	No plant cleanup was warranted.
Erwin, Tennessee	1986	Americium-241 Plutonium-239 Thorium-232 Uranium	Sludge digester cleaned up.
Washington, D.C.	1986	Carbon-14 Hydrogen-3 Phosphorous-32&33 Sodium-22 Sulfur-35 & others	No plant cleanup was warranted.
Portland, Oregon	1989	Thorium-232	Sewage lines cleaned up and pretreatment system added.
Ann Arbor, Michigan	1991	Cobalt-60 Manganese-54 Silver-108m, 110m Zinc-65	No plant cleanup was warranted.
Cleveland, Ohio	1991	Cobalt-60	Treatment plant cleanup and related activities have cost over $1 million.

Source: GAO, 1994.

The U.S. Nuclear Regulatory Commission (NRC) conducted a limited survey in the mid-1980s to determine if radioactive material discharged to sewage systems was concentrated in sludge.

This took place at the facilities of 15 radioactive material users (licensees) and associated sewage treatment plants. The sampling revealed no reconcentration problems (GAO 1994).

In 1986, the EPA published a literature review titled *Radioactivity of Municipal Sludge* (EPA 1986). The literature search and follow-up telephone survey identified nine references containing data on radioactivity concentrations in sewage sludges. These references included the results of one-time surveys and ongoing monitoring programs by local authorities and state agencies, results for individual facilities and facilities from as many as 10 cities, and reports of incidents of sludge contamination reported by NRC. The data obtained varied widely with respect to the purpose of data collection, type of material sampled, number of samples, and radionuclides analyzed. The available data identified four radionuclides as most frequently reported: iodine-131, radium-226, americium-241, and cesium-137.

The NRC and EPA efforts to characterize radioactive materials in sewage sludge and ash are discussed in Section 1.3 and Chapter 4.

1.2 Selected Examples of Contamination

Despite efforts to identify POTWs with radioactive contamination through surveys, most of the cases involving elevated levels of radioactive materials at POTWs have been discovered through measurements obtained for other purposes. As shown in Table 1, at least five of these instances warranted some mitigative action. A brief discussion of three of these cases illustrate the need for the POTW authority to be aware of the possibilities of radioactive contamination and the potential consequences.

Oak Ridge, Tennessee, Sanitary Sewage Treatment Facility

In March of 1984, staff from the Oak Ridge weapons complex was performing a survey to identify if any material contaminated with mercury or uranium from the complex had been used as fill in the surrounding community. Elevated radiation readings were detected along Emory Valley Road. Soil samples revealed contamination from radioactive cesium-137 and cobalt-60. During this time, the Quadrex Corporation notified the Tennessee Division of Radiological Health that contaminated sediment was detected in Quadrex' drain sump. The Quadrex facility was involved in the decontamination of large pieces of radioactively contaminated equipment, such as duct work and piping. The process produced large volumes of water with low levels of contamination. Subsequent examination of the sewage collection system confirmed the soil and sediment contaminations were related and that the Quadrex plant was probably responsible for the releases. Cracks in the sewer line apparently resulted in the radioactive material contaminating the soil.

Further examination showed that contamination had also occurred at the Oak Ridge Waste Treatment Plant (ORWTP). Surveys at the ORWTP showed contamination of both sewage sludge in a digester storage tank, as well as sludge placed on drying beds in November 1983.

Quadrex agreed to assist in decontaminating the exposed contaminated sludge and to assist the city in conducting measurements when portions of the old sewer line were to be excavated. The contaminated sludge was subsequently disposed in a sanitary landfill.

In the late 1980s, it was discovered that, in addition, routine, licensed discharges of several different radionuclides (e.g., Co-60, Cs-137, and uranium) from multiple facilities resulted in reconcentration of radioactive materials in sewage sludges. This occurred even though the discharge levels were reportedly only small fractions of regulatory limits. (Since then, NRC's regulatory discharge limits have been changed, which has reduced the concentrations of radioactive materials in sewage sludge.) These routine discharges to the sewer led to the expenditure of considerable resources over the past ten years.

The most significant concern related to radioactive material discharges faced by the Oak Ridge POTW managers was the possibility that radionuclides, even at low levels, may have inhibited their ability to continue land applying the sludge, the practice of land application of the Oak Ridge sludge was frequently called into question. In response, Oak Ridge developed a site-specific, risk-based methodology for establishing radionuclide limits for its sewage sludge (see Appendix F).

Portland, Oregon Contaminated Wastewater Collection Lines

Thorium-232 was detected in wastewater collection lines in Portland, Oregon, in 1989. While contamination did not reach the treatment facility, the collection lines were contaminated and sewer workers took special precautions. The generator of the wastewater containing the Th-232 was identified, remediated the contamination, and installed a pretreatment system to reduce discharges.

The Cleveland, Ohio Southerly Sewage Treatment Plant

The Southerly plant is operated by the Northeast Ohio Regional Sewer District (NEORSD). It is an activated sludge facility that produced 103,000 wet tons of filter cake and incinerated 97,000 tons of the filter cake in 1992. During an aerial survey conducted in April 1991 of licensees in the area, NRC inspectors noted elevated readings of radiation at the sewage treatment plant. Subsequent ground level measurements indicated radioactive cobalt-60 was present, primarily in areas where ash had accumulated in fill areas and storage lagoons. Additional surveys were conducted in September 1991 and March 1992 to determine the extent of the contamination. These measurements of ash deposits indicated no new contamination had occurred since 1991. The highest direct radiation readings were found when a probe was lowered into animal burrows made in the residue deposits.

This suggested that the concentration of material was higher below the surface. From the records of the areas where the ash was placed, it appeared that the contamination occurred in the late 1970s, and perhaps in the early 1980s.

In 1992, NEORSD developed a remediation plan to remove ash from three storage lagoons which were filled to near capacity. Remediation was completed in 1993, resulting in 174,000 cubic yards of contaminated ash stabilized on site in two areas that are fenced (total of about 25 acres) and capped with six inches of dirt. Radiation measurement devices were placed at the periphery of the area and seven monitoring wells were installed. Some contamination still exists in other areas of the site and the NEORSD is working with the NRC to assess its extent and degree. In 1994, NEORSD terminated sewer service to the wastewater generator.

As of February 2000, the remediation costs incurred by NEORSD included about $1,800,000 for the on-site remediation and related activities and $120,000 to erect the fence around the fill and holding pond areas. The NRC spent about $370,000 on radiation exposure assessment, soil sampling and analyses, and other surveys. The POTW authority engaged in a series of legal actions to recover the costs from the waste generator; about $1,200,000 was recovered. To date, the generator has failed to meet the NEORSD criteria for restoration of sewer service.

Based on the cases identified thus far, though rare, the contamination of a POTW with radioactive material can have serious financial consequences.

1.3 Congressional Interest

A joint House and Senate hearing was held in May 1994 to officially release and address questions raised in a General Accounting Office (GAO) report, *Actions Needed to Control Radioactive Contamination of Sewage Treatment Plants* (GAO 1994). The hearing and GAO report were stimulated by concerns associated with the elevated levels of radioactive materials in sewage sludge incinerator ash at the NEORSD's Southerly plant described in Section 1.2. Testimony presented by both NRC and EPA during the hearing noted that there was no indication of a widespread problem in this area and that the NEORSD incident appeared to be an isolated incident. However, at the hearing NRC and EPA committed to jointly develop guidance for POTWs and to collect more data on the concentration of radioactive materials in samples of sewage sludge and ash from POTWs across the country.

Since the hearing and GAO report, the NRC and EPA, with the assistance of other federal agencies participating on the ISCORS Sewage Sludge Subcommittee, have been addressing questions regarding radioactive materials in sewage sludge and ash from POTWs. The Subcommittee, formed by ISCORS in 1996, developed an initial draft of this joint NRC/EPA

guidance document for POTWs, which was issued in May 1997 for public comment. The Subcommittee is also in the process of conducting a comprehensive survey of radioactive materials in sewage sludge and ash from 300 POTWs nationwide. The survey will focus on POTWs in regions where the potential for elevated levels of radioactive materials in wastewaters may exist. The results of this survey will be published in a survey report and summarized in the final version of this guidance document.

2 PURPOSE

One purpose of this document is to inform POTW authorities of the possibility for radioactive materials to concentrate in sewage sludge and incinerator ash. A second purpose is to help the POTW authorities determine what they may want to do about the radioactive materials present in their sewage sludge or ash. This guidance is not intended to serve as a comprehensive reference regarding radioactivity. However, it provides information on important issues related to the control of radioactive materials that may enter POTWs.

This guidance document poses the following questions; answers to these questions are found in various sections of the report, as cited below:

Is There Radioactive Material in My Treatment Plant?

One of the first things a POTW authority needs to realize is that there is radioactive material in the wastewater their system treats. Chapter 3 discusses why there is radioactive material in sewage sludge and when the presence of these materials may be of concern. Chapter 5 discusses how to determine if there are elevated levels of radioactivity and who can help in the unlikely event that there are elevated levels.

Who Are the Other Players in My Specific Case?

The Federal and State regulatory authority over radioactive materials, sewage sludge, and industries which may discharge into sewage systems is complex. Further information on regulatory authorities is available in Chapter 4.

What Should the POTW Authority Consider Doing to Determine if There Is a Problem With Levels of Radioactive Materials?

There are several steps to consider in evaluating whether a POTW may have a problem regarding radioactive contamination. Chapter 5 describes what a POTW can do to determine if there is radioactive contamination at their facility, and who can help. Appendix A is a primer on

radioactivity and radioactive materials. The information provided in Appendix A should be helpful in understanding the nomenclature and some of the basics about the health risks of radioactivity.

What Can the POTW Authority Do if Contamination is Found?

There are several options for consideration if contamination is found. There are a number of options that a POTW may want to consider. Chapter 6 presents the options, as well as their legal and technical aspects.

3 WHY IS THERE RADIOACTIVE MATERIAL IN SEWAGE SLUDGE AND ASH? WHAT IS THE CONCERN?

Radioactive materials are an ever-present component of the natural environment and are also produced through some human activities. Generally, the presence of radioactive materials is a concern only when concentrations become sufficiently elevated above background levels to potentially pose a health risk or in cases where the ability of a POTW to use or dispose of the sludge or ash is inhibited. There have not been many known occurrences of such elevated concentrations since the 1980s. This section explores sources of radioactive materials that may reach a POTW and why they may become a concern to POTW personnel and the public.

3.1 Types of Sources

There are three general sources of radionuclides in the environment: natural sources, natural sources concentrated or enhanced by human activity, and man-made sources. Radioactive material from all of these types of sources have the potential to enter sewage systems.

Sources of Radioactivity

Natural Sources. Geologic formations, water, and soils that contain small amounts of radioactive elements, typically known as naturally-occurring radioactive materials (NORM).

Natural Sources Concentrated or Enhanced by Human Activity. Naturally-occurring radioactive materials, technologically enhanced by human activity, known as TENORM.

Man-made Sources. Radioactive materials generated by human activities such as accelerator material (often referred to as NARM); nuclear byproduct material, source material, or special nuclear material; and fallout from nuclear weapons testing.

3.1.1 Natural Sources

Natural sources of radiation include geologic formations and soils that contain uranium, radium, radon, and other nuclides that are radioactive. Water originating in or moving through the formations and soil may transport the radioactive materials either dissolved in the water itself or

attached to dissolved and suspended solids in the water. Radon is also released to the atmosphere from soil and water.

The amount of naturally-occurring radioactive materials in the ground varies widely. Some areas with elevated levels of naturally-occurring radioactive materials include locations such as those underlain by phosphate ore and uranium ore deposits. The lowest levels are generally found in sandy soils of the Atlantic and Gulf Coasts. Figure 1 shows average indoor screening-level radon concentrations by county in the U.S. These average concentrations may roughly correspond to the general levels of uranium and radium in soils in the area.

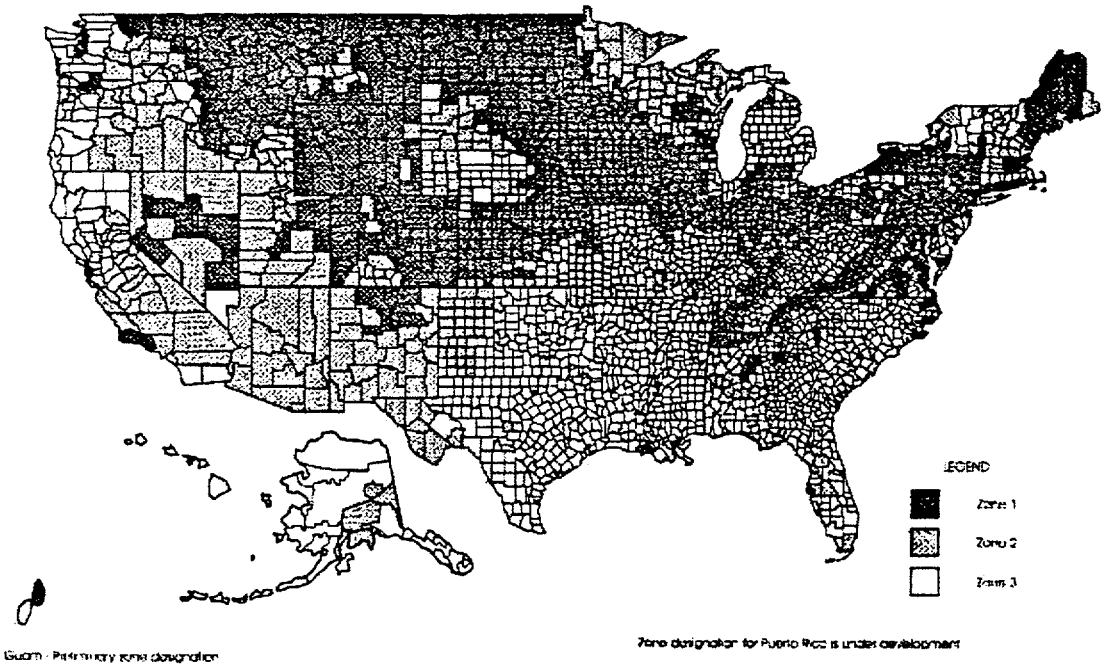

Figure 1. Average indoor-air, screening-level concentrations of radon in the U.S. From EPA (1993a). Zone 1 counties have a predicted average indoor screening level greater than 4 pCi/L. Zone 2 counties have a predicted average between 2 and 4 pCi/L, and Zone 3 counties have a predicted average less than 2 pCi/L.

3.1.2 Natural Sources Concentrated or Enhanced by Human Activity

Levels of naturally-occurring radioactive materials can be enhanced by human activity and by technologies associated with extraction processes. These materials, when enhanced by human activity, are known as Technologically-Enhanced Naturally Occurring Radioactive Materials (TENORM). Examples of TENORM include articles made from or coated with naturally-occurring radioactive materials and wastes from mineral and petroleum production, burning coal, and geothermal energy production.

radioactive materials. Table 2 summarizes the sources and pathways by which radioactive materials may reach POTWs.

Table 2. Sources and Potential Pathways for Radioactive Materials to Reach POTWs

Discharges to POTWs	Treatment Process	Infiltration and Inflow
• Drinking water and drinking water residuals that contain NORM • Sewage with radioactive materials from food and medical procedures • Wastewater from NRC or Agreement State licensees handling radioactive materials in unsealed form • Wastewater from industries handling or processing materials containing NORM • Exempt or unlicensed radioactive materials	• Process chemicals with radioactive materials (e.g., lime, fly ash, waste pickle liquor, or wood ash)	• Infiltrating ground water containing NORM • Surface waters runoff containing NORM or fallout, via combined sewers

The local drinking water supply may contain NORM found in the soil or geologic media from which the water is removed. The local drinking water treatment facility may remove some of the radioactive materials from the raw water by ion exchange, precipitation, coagulation, or filtering of dissolved or suspended solids. The resulting residuals are sometimes disposed of by discharge to the wastewater collection system. Any radioactive materials remaining in the finished water supply would eventually be transported to the POTW along with waste waters.

Two other domestic sources of radioactive materials in sewage are food and medical procedures. Radioactive materials in food are digested and discharged to the POTW when excreted. Bananas and brazil nuts are examples of food containing radioactive materials (e.g., potassium-40) (Eisenbud and Gesell 1997). Similarly, radioactive materials (e.g., iodine-131, technetium-99m, and thallium-201) used in the diagnosis and treatment of medical conditions are also discharged to the POTW when excreted.

Other potential sources of radioactive materials include facilities with NRC and Agreement State licenses. All licensees are authorized by the regulations (see section 4.1 for details about the regulations) to discharge radioactive materials to the sewers; however, it is estimated that only about

20 percent of NRC licensees actually do so. The main reason most licensees do not discharge radioactive material to the sewers is that they possess only sealed sources, which are extremely unlikely to be released into sewers. Other licensees may have unsealed sources, but not in liquid form, and hence there is no radioactivity released to wastewater.

Many licensees which use radioactive materials in liquid form do not need to discharge to the sewers because: 1) the materials used are very short-lived and can decay in short-term storage and then be discharged as non-radioactive, or 2) the material may contain wastes that cannot be disposed of into sanitary sewers, if the material is non-dispersible or due to the presence of other non-radioactive pollutants. These pollutants may be prohibited from discharge into sewers by regulations other than NRC's regulations, such as the Clean Water Act.

Radioactive material is handled in "unsealed" forms in the nuclear fuel fabrication industry, in the production of radiopharmaceutical medicines, and in research. Limits in quantities and concentrations that the NRC and Agreement States allow to be discharged to the sanitary sewer are based on a fraction of the dose limit that can be received by an individual member of the public (see section 4.1 for the dose limits).

Table 3 lists types of NRC licensees that could dispose radioactive materials into the sewer system and radionuclides previously found in POTW sewage or those that could be present. It should be noted that a broad scope licensee is usually authorized to possess and use any radionuclide with an atomic number from 1 to 83. This means that many more radionuclides than those listed in Table 3 could be disposed into the sanitary sewer. The half lives and types of radiation emitted by these radionuclides are listed in Appendix A, Table A-1.

Licenses may be issued for specific applications, such as for industrial radiography, irradiators, well logging or specific medical uses. In such cases, the application, the physical and chemical states and the radioactivity of the materials are well defined. In other cases, the application is not as well defined, such as medicine and research. The physical and chemical form and activity will depend on the nature of the medical treatment, diagnosis or research being conducted. To accommodate undefined or changing applications, broad scope licenses are issued (e.g., to hospitals, universities, and research facilities).

For POTWs that serve large medical institutions, a major portion of the radioactive discharges to the sewer comes from patients. POTWs serving large medical centers and universities in which extensive research is conducted may receive discharges from both the research activities and from patients. A complicating factor is that some patients reside far away from the medical centers. Wastes from these patients will probably be discharged to the POTW serving the patients' residences. Refer to Table 3 for radionuclides commonly used in the medical facilities.

Table 3. Types of NRC and Agreement State Licensees and Typical Radionuclides		
Academic (broad scope)	**Medical (broad scope, nuclear pharmacies)**	**Manufacturing and Distribution (broad scope, nuclear laundries, decontamination services)**
Carbon-14 Cobalt-60 Cesium-137 Hydrogen-3 Iodine-125/131 Iron-59 Manganese-54 Phosphorus-32 Phosphorus-33 Sulphur-35	Carbon-14 Chromium-51 Cobalt-57 Gallium-67 Indium-111 Iodine-125/131 Iron-59 Phosphorus-32/33 Strontium-89/90 Sulphur-35 Technetium-99m Thallium-201	Americium-241 Antimony-125 Cobalt-60 Cesium-134/137 Hydrogen-3 Iodine-125/131 Manganese-54 Niobium-95 Phosphorus-32 Plutonium-238/239/240 Polonium-210 Strontium-89/90 Sulphur-35 Uranium-233/234/235/238 Zirconium-95
Research and Development (broad scope)	**Others (e.g., ore processing mills, uranium enrichment plants)**	
Carbon-14 Cesium-134 Hydrogen-3 Iodine-125/131 Phosphorus-32 Sulphur-35	Plutonium-238/239/240 Radium-226 Thorium-228/232 Uranium-233/234/235/238	

Radioactive material can also enter a POTW in chemicals used in wastewater treatment. In addition, infiltrating ground water may contain radioactive materials from natural sources that were either dissolved or attached to suspended solids as the water flows through soils and geologic formations. Similarly, surface water and sediment in runoff containing NORM or fallout may enter the POTW via combined sewers. The amount of radioactive materials entering POTWs by infiltration and inflow will vary depending upon the degree of infiltration and inflow, and the amount of natural sources and fallout in the service area.

3.3 Why Radioactive Materials May Be of Concern at a POTW

Although it is unlikely that radionuclide levels in sewage sludges and ash at most POTWs across the country pose a concern for treatment plant workers or the general public, it is possible that

low concentrations of radioactive material from natural and man-made sources could become concentrated in sewage sludge and ash at some POTWs. However, there are low amounts of radioactive materials that are legally authorized, under federal and state laws and regulations, to be disposed into the sanitary sewer system. This section addresses POTW operations that have potential to cause concerns due to exposure to radiation. (For more information regarding radioactivity, see Appendix A.)

3.3.1 Reconcentration of Radioactive Materials at POTWs

The purpose of wastewater treatment facilities is to reduce or remove pollutants from wastewater in order to ensure adequate water quality before the treated effluent is reused or discharged to surface waters. The removal of radionuclide contaminants by various wastewater treatment processes and the usual association of these contaminants with solids can cause the concentration of the contaminants to increase, or reconcentrate, in sewage sludge and ash. Radioactive materials disposed of into the sanitary sewer in dilute form may become reconcentrated in the sludge solids during different stages of wastewater treatment and sludge processing, in a manner similar to some heavy metals.

Reconcentration may occur during physical, biological, or chemical processes. Sludge treatment and processing may result in increasing the concentration of the radioactive contaminant by decreasing the concentration of other components. Final concentration will depend on the characteristics of the processes used at the treatment facility, the efficiencies of those processes, as well as the chemical form of the radionuclides and their half-lives.

Radioactive materials found in sewage are partitioned between the liquid and solid phases of the influent. During treatment, the concentrations of radionuclides change as the solids are removed and the treatment processes remove radionuclides from the wastewater. Because radionuclide concentrations in wastewater influents are very dilute, there is generally no concern unless the radionuclide concentrations are increased, or reconcentrated, during the treatment process.

A study by Ainsworth et al. reported that reconcentration of dissolved radionuclides (those not associated with the suspended solids) is unlikely to occur during primary treatment (Ainsworth et al., 1994). Reconcentration is possible during secondary treatment, but neither the mechanism(s) or unit process(es) involved are understood in a quantitative manner.

Reconcentration can also occur during sludge treatment (Ainsworth et al., 1994). It can potentially result from the physical, chemical, and biological removal of radionuclides from the sewage and sewage sludge produced during wastewater treatment. Physical processes that increase the solids content of the sludge without loss of radioactive materials may lead to reconcentration. Sludge handling techniques that may contribute to reconcentration include digestion, dewatering,

and incineration. Incineration may be the most significant process, because the total mass of the sludge is greatly reduced by water removal and combustion of organic material.

Although there is a potential for a reconcentration of radioactive materials in the sludges or ash at POTWs, there have only been limited surveys of radiation levels in sewage sludge or sludge products. A recent study by the Association of Metropolitan Sewerage Agencies (AMSA) revealed the presence of both man-made radioactive material and NORM at low levels in sewage sludges and sludge products (NBP 1999). AMSA coordinated an extensive sampling effort as part of their national survey conducted in 1995. While this was a voluntary survey and was not structured to ensure a statistically representative result, samples from 55 POTWs in 17 states do provide a significant database. Studies by NRC and EPA to determine the presence and levels of radioactive materials at POTWs and in the sludges or ash are ongoing (NRC and EPA 1999). Table 4 summarizes results from the AMSA study and the pilot study (preliminary phase) of the NRC and EPA project.

3.3.2 Radiation Exposure Due to POTW Operations

Based on what is known about the potential for reconcentration at POTWs, possible sources of radiation exposure would be at sludge processing or handling areas at the POTW and at off-site locations where the sewage sludge or ash is disposed or used. People most likely to be exposed to elevated levels of radioactive materials would be sewage sludge or ash handling personnel at the POTW or members of the public near disposal or land application sites. Three primary ways for these people to be exposed to radiation associated with POTW operations are inhalation, ingestion, and direct exposure (see Figure 2).

Inhalation of alpha- or beta-emitting radioactive materials is a concern because radioactive material taken into the body results in radiation doses to internal organs and tissues (e.g., lining of the lungs). POTW workers could inhale radioactively contaminated dust during ash or sludge handling operations. The drier the material, the more likely it could be resuspended into the air when it is handled. Measures taken by POTW workers to avoid inhalation of biological pathogens and chemically toxic materials in sludge and ash dust may effectively reduce the possible exposure to radioactive materials. Members of the public could also inhale contaminated dust blown from disposal or land application sites or dust from handling sewage sludge products made available for public use.

Ingestion of alpha- or beta-emitting radioactive materials is a concern for the same reason as inhalation. It may occur when food crops are grown on areas where sludge or ash have been applied to the land as fertilizer or soil conditioner. Ingestion could also occur when the materials migrate into the ground water or surface waters used as drinking water sources. POTW workers could ingest radioactive materials if they fail to observe good sanitary practices, such as washing their hands before eating after handling sewage sludge or ash.

Table 4. Summary of Concentrations of Radioactivity in Sludge and Ash from AMSA Survey and NRC/EPA Pilot Survey (pCi/g) [1]

Radio-nuclide	AMSA			NRC/EPA Pilot		Radio-nuclide	AMSA			NRC/EPA Pilot	
	min	median	max	min	max		min	median	max	min	max
gross alpha	nd	7.4	80.1			Bi-207	nd	nd	nd		
gross beta	nd	15.0	61.5			Tl-201				nd	24
H-3				nd	30.4	Tl-208	nd	0.16	2.08	nd	0.6
Be-7	nd	1.54	50.03	nd	22	Bi-212	nd	0.47	11.48	nd	2.0
C-14				nd	nd	Bi-214	0.12	0.66	39.1	nd	16
Na-22	nd	nd	0.031			Pb-212	0.08	0.48	7.3	0.2	2.0
K-40	nd	4.5	60.8	2.0	16	Pb-214	0.14	0.71	46.48	nd	17
Cr-51				nd	4.0	Ra-223				nd	0.06
Mn-54	nd	nd	0.06			Ra-224				nd	4.0
Co-57	nd	nd	0.09			Ra-226	nd	1.74	118.12	1.0	29
Co-60	nd	nd	0.05	nd	6.0	Ra-228				nd	9.0
Zn-65	nd	nd	nd			Ac-227	nd	nd	3.86		
Sr-89				nd	7.0	Ac-228	nd	1.30	51.08		
Sr-90				nd	0.7	Th-227				nd	0.1
Nb-94	nd	nd	nd			Th-228				nd	2.0
Ru-106	nd	nd	0.23			Th-229	nd	nd	nd		
Ag-108m	nd	nd	1.08			Th-230				nd	2.0
Ag-110m	nd	nd	nd			Th-232				0.01	1.0
Cd-109	nd	nd	6.28			Th-234				nd	12
Sb-125	nd	nd	nd			Pa-231	nd	nd	1.34		
I-125				nd	1.0	Pa-234m				nd	15
I-131	nd	2.6	174.6	nd	70	U-234				0.2	44
Cs-134	nd	nd	0.08			U-235	nd	nd	0.93	nd	3.0
Cs-137	nd	nd	0.37	nd	1.0	U-238				0.2	12
Ba-140				nd	nd	Np-237	nd	nd	1.97		
Ce-144	nd	nd	nd			Pu-238				nd	0.03
Eu-152	nd	nd	0.1			Pu-239				nd	0.08
Eu-154	nd	nd	0.13			Am-241	nd	nd	0.58	nd	nd
Eu-155	nd	nd	2.82			Am-243	nd	nd	1.27		
Gd-153	nd	nd	2.24			Cm-243	nd	nd	1.41		

[1] nd = not detected

Sources: AMSA data, for 55 POTWs, from NBP (1999); NRC/EPA pilot study data, for 9 POTWs, from NRC and EPA (1999).

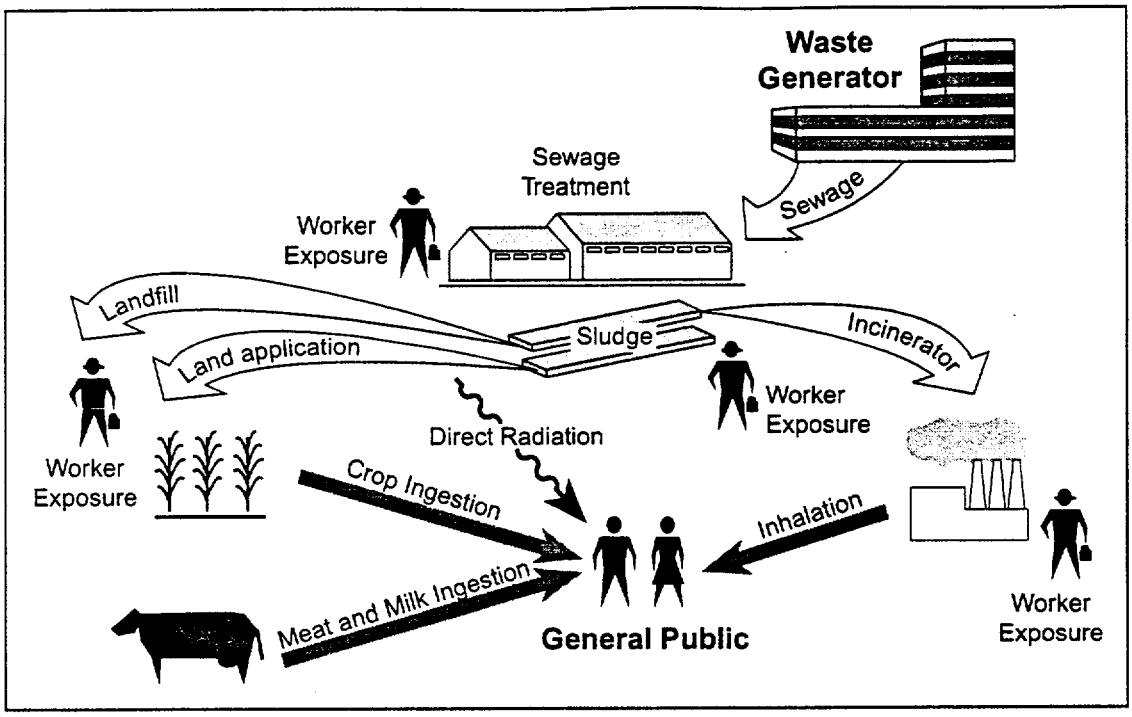

Figure 2. Primary Pathways for Radiation Exposure Due to POTW Operations

Measures taken to limit the potential ingestion of heavy metals at land application sites would help to reduce possible exposure to radioactive materials. Similarly, measures taken by POTW workers to avoid ingestion of pathogen-containing materials would serve to prevent ingestion of radioactive materials.

Radioactive materials that emit gamma radiation are of concern because the gamma rays pose an external radiation exposure hazard. Because gamma rays can pass through common construction materials, the distance between the radioactive material and the person is a factor in the amount of exposure the person receives.

POTW workers most likely to receive direct exposure are workers that handle sludge and ash. Farmers and other members of the public who use sewage sludge products or ash as fertilizer or soil conditioners could receive direct exposure to gamma radiation if these materials are present.

3.3.3 How Radiation Doses from Sewage Sludge and Ash Compare to Average Radiation Doses from All Sources

Almost everything, including people, contains some radioactive material. Naturally-occurring radioactive materials are found in the earth, in the materials used to build our homes, and

in the food and water we ingest. Even the air we breathe contains some radioactive gases and particles. People are exposed to radiation on a daily basis from both natural and man-made origin.

Human exposure to radiation sources is derived primarily from background natural radiation; however, a person's occupation, geographic location, time spent outdoors, need for diagnostic medical treatments and testing, time spent traveling in airplanes, and other activities can determine the relative contributions of natural, man-made, and global fallout sources. On the average, 80 percent of human exposure to radiation comes from natural sources: radon gas, the human body, outer space, rocks, and soil. The remaining twenty percent comes from man-made radiation sources, primarily x-rays. Diagnostic medical and dental x-rays, radiation treatment and other applications of nuclear medicine contribute approximately 10 to 15 percent of the average annual human dose. Certain consumer products (television sets and other electrical appliances, smoke detectors, building materials and tobacco products) and to a lesser extent, airport and other types of inspection equipment, contribute approximately three to five percent of the average radiation dose.

It is estimated that less than one percent of the average annual dose to humans from background radiation is a result of global fallout. Global fallout results from nuclear accidents (e.g., Chernobyl) and from nuclear weapons testing during the 1940s to 1960s. Although above-ground testing ceased in the United States in 1963, radiation remaining in the atmosphere continues to account for a residual level of background human exposure.

The average radiation dose to an individual in the U.S. is about 360 mrem/yr. (The term "dose" and other background information on radioactivity are described in Appendix A.) Typical values for annual exposure to radiation within the U.S. are summarized in Table 5.

Terrestrial radiation comes from radioactive material that is naturally occurring in the environment. Radon occurs in the environment and is listed separately in Table 5 because of radon's significant contribution to radiation exposure (see also Figure 1). Cosmic radiation comes from outer space and some of it penetrates through the atmosphere covering the earth. The amount of cosmic radiation will vary depending on the altitude and latitude where one lives. Internal radiation comes primarily from ingested natural radioactive substances, such as potassium-40.

As demonstrated by the ranges shown in Table 5, radiation exposure can vary greatly, as the various factors that contribute to total exposure are not constant from location to location, and an individual's lifestyle and daily activities vary this amount. For example, the atmosphere serves as a shield against cosmic radiation; therefore, dose increases with altitude. The dose at an altitude of one mile at Denver (60 mrem/yr) is about double that at sea level (30 mrem/yr). Also, a flight on a commercial airliner increases an individual's dose from cosmic gamma rays about 1 mrem for each cross-country flight.

Table 5. Average Annual Exposure to Radiation		
Source of Radiation	**Average Exposure (mrem/yr)**	**Typical Range of Variability (mrem/yr)**
Natural Sources		
Terrestrial	30	10-80
Radon	200	30-500
Cosmic	30	30-80
Internal	40	20-100
Man-Made Sources		
Medical	50	
Consumer products	10	
Other (Nuclear fuel cycle and occupational)	1	
TOTAL	**360**	**90-760**

Sources: NCRP 1987a, for average exposure values; Huffert et al. 1994 for ranges of variability.

Dose rates from terrestrial sources vary from about 10 to 80 mrem/yr across the U.S. The major sources in the ground are potassium, thorium, uranium, and uranium progeny. The higher doses are associated with uranium deposits in the Colorado Plateau (Figure 3), granitic deposits in New England, and phosphate deposits in Florida (Figure 4). The lowest rates are the sandy soils of the Atlantic and Gulf coastal plains. Annual doses for individuals living in brick homes may increase up to 10 mrem/yr due to naturally-occurring thorium, uranium, and radium found in clays often used to make bricks.

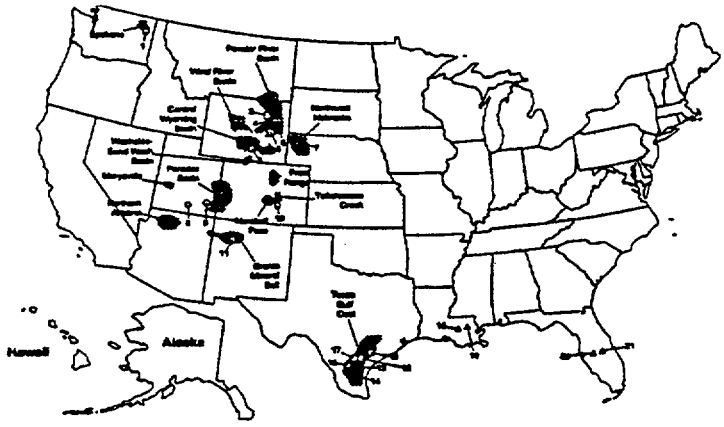

Figure 3. Uranium deposits in the U.S. Reference DOE (1997).

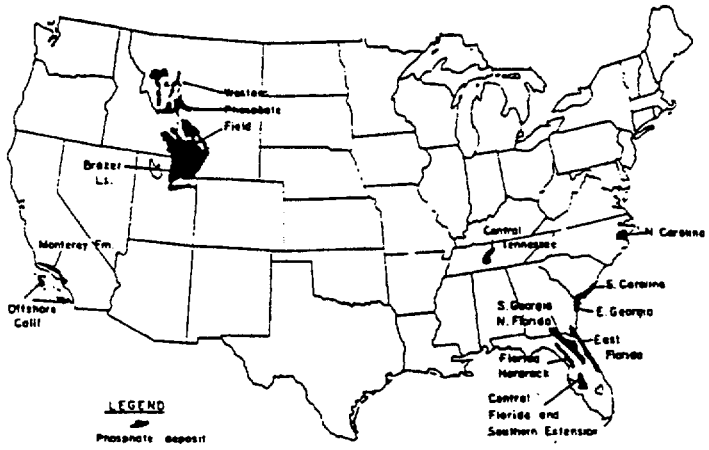

Figure 4. Major phosphate deposits in the U.S. with significant uranium content. Reference EPA (1993b).

The principal naturally-occurring radionuclides in food are potassium-40 (a common example is bananas) and radium-226 (e.g., in brazil nuts). Radium in water, particularly ground water, varies across the U.S. Radium is present in higher concentrations in some states, such as Georgia, Illinois, Minnesota, Missouri, Kansas and Wisconsin.

Table 6 lists some radionuclides present in background that may be present in POTW sewage sludge and ash. All of these radionuclides are from terrestrial sources, except strontium-90 and cesium-137, which are due to radioactive fallout from atmospheric testing of nuclear weapons. A more comprehensive list of radionuclides may be found in Table A-1.

Table 6. Some Background Radionuclides that May be Present in POTW Sewage Sludge and Ash

Radionuclide	Type of Radiation	Half-Life
Potassium-40	gamma	1.3 billion yrs
Rubidium-87	beta	47 billion yrs
Strontium-90	beta	28.6 yrs
Cesium-137	beta, gamma	30 yrs
Radium-226	alpha, gamma	1600 yrs
Radium-228	beta	5.7 yrs
Thorium-232	alpha	14 billion yrs
Uranium-238	alpha	4.5 billion yrs

Half-life values from DOE/EH-0070 (DOE, 1988)

Radiation doses at POTWs are generally insignificant compared to background radiation under most conditions. However, under conditions at POTWs where elevated levels of radionuclides have been detected, there is the possibility that doses to POTW workers and to the general public could be of concern. Studies attempting to quantify these doses, however, have failed to identify actual exposures that would indicate a potential health risk.

The NRC conducted a study to estimate maximum radiation exposures to POTW workers and others who could be affected by low levels of radioactivity in wastewater (Kennedy et al. 1992). The study used scenarios, assumptions, and parameter values generally selected in a manner to produce prudently conservative estimates of individual radiation doses. However, the quantities of radionuclides released into the sewer systems were assumed to be the maximum allowed under NRC regulations. Thus, the calculations were intended to be based on realistic or prudently conservative conditions at POTWs, but based on maximized releases to sewer systems. The estimates of these hypothetical exposures to workers range from zero to a dose roughly equal to natural background levels (Kennedy et al. 1992). Table 7 summarizes the results for some of the scenarios considered.

Table 7. Hypothetical Maximum Doses Associated With POTW Operations (mrem/yr)

Individual	Exposure Source	Primary Exposure Pathway	Hypothetical Maximum Doses (mrem/yr)
POTW sludge process operator	Sludge in processing equipment	External	360
POTW incinerator operator	Incinerator ash	Inhalation of dust	340
POTW heavy equipment operator	Sludge or ash in truck	External	210
Farmers or commercial operators	Land applied sludge	Ingestion via local crops, external	17
Landfill equipment operator	Ash disposed in landfill	External	64
Resident on former landfill site	Ash disposed in former landfill	Inhalation via resuspension of dust, ingestion via garden vegetables	170

Source: Kennedy et al. 1992.

3.4 Summary

Radioactive materials are a natural part of the environment and a byproduct of human activity. These materials may enter POTWs by water infiltration or inflow, domestic discharges, and permitted or accidental discharges.

Processes at POTWs can reconcentrate radioactive materials in sewage sludge and ash. People working with or near the sludge at the POTW, those working at disposal sites, and users of sludge products could be exposed to any radionuclides that reach the POTW. Exposure could occur from inhalation of dust, ingestion of contaminated food, or direct exposure. Estimates of hypothetical maximum doses indicate that doses from these exposures could range from 0 to 340 mrem/year in addition to the average dose of 360 mrem/year from all other sources. POTW workers at facilities where radionuclides have been found are estimated to have received minimal to non-detectable additional doses.

4 WHAT ARE THE RELEVANT REGULATORY AGENCIES AND WHAT ARE THEY DOING?

The regulatory framework for radioactive materials in wastewater is somewhat complex; there are many levels of authority and types of requirements. Federal Guidance on radiation exposure to workers and the public is prepared under the authority of the EPA as approved by the President. Regulations are issued and enforced by various agencies at different levels of government, depending upon the type of radioactive material and the agreements arranged. Information provided in this section includes only those aspects most germane to the types of materials that may enter wastewater and therefore affect POTW operations.

The primary division of the regulatory framework is based on the origin of radioactive material. In general, man-made radioactive materials are regulated differently than NORM.

Radioactive materials consisting of source, byproduct, and special nuclear material are subject to the provisions of the Atomic Energy Act (AEA). In addition, when these materials are in the commercial-private sector, they are subject to the rules of the NRC. When these materials are in the defense sector in weapons development operations, they are under the control of the Department of Energy (DOE). This guidance focuses on the NRC regulations, rather than the DOE requirements, primarily because POTWs are more likely to be concerned with waste generators in the commercial sector.

The AEA allows the NRC to establish formal agreements with states, granting the states with authority to develop and oversee the implementation of specific regulations regarding use and possession of source, byproduct and special nuclear materials generated or used at these facilities.

States with such an agreement, i.e., Agreement States, are required to maintain a radiation protection program that is adequate to protect public health and safety and is compatible with that of the NRC. A current list of Agreement States is provided in Appendix B and the relevant state agencies that are designated with the authority to develop and oversee the regulations are listed in Appendix E.

The lead federal agency in the regulation of NORM and TENORM is EPA. The DOE also regulates TENORM at DOE facilities. In addition, some state and local authorities also regulate various aspects of the materials discussed above. Other radioactive materials are generally regulated by the States. More detailed information on the role and regulations of the NRC, Agreement States, EPA, state agencies, and local authorities, as well as ISCORS, is provided in the following sections.

4.1 NRC and Agreement States

The NRC and Agreement States regulate the possession, use, and disposal of certain radioactive materials, and also develop and implement guidance and requirements governing licensed activities, inspection and enforcement activities to ensure compliance with the requirements. The primary radiation protection regulations for AEA materials regulated by the NRC are contained in the Code of Federal Regulations (CFR), Title 10, Part 20. Section 20.1301 of these regulations contains the dose limit for members of the public, which is 100 mrem/year from operations of an NRC-licensed facility. Section 20.2003 describes the limits on sewer disposal for radioactive materials. This regulation sets limits on the quantity of radioactive material that may be discharged to the sewer in one month and the total annual discharge. In 1991, the NRC revised the regulatory provisions that limit releases to the sewer, due to the discovery of problems with metallic radioactive materials disposed of as finely dispersed materials. The NRC regulations now require that all radioactive materials disposed to the sewer be readily soluble (or be readily dispersible biological material) in water.

With some specified exceptions, any activity involving source, byproduct, and special nuclear material must be conducted under a license issued by the NRC or an Agreement State. The exempt activities are described in NRC's 10 CFR Part 30, Part 40, and other Parts. For example, exemptions from specific licensing include some consumer products, such as smoke detectors and luminous watches.

Licenses are issued to licensees only after NRC or the Agreement State is satisfied that the licensee has the qualified staff, equipment, procedures, instrumentation, training programs, and management oversight deemed necessary to operate the proposed program in a safe manner and within the restrictions specified in the license. Both NRC and Agreement States monitor their licensees by means of periodic inspections. The frequency of inspections depends on the type of license issued to the licensee, and will vary from annual inspections for the larger licensees, such as

hospitals, radiopharmaceutical companies, and other large users of byproduct materials, to inspections once every 3-5 years for small licensees who may use only one small radioactive source in a routine and well-established application. The license may be suspended or revoked if NRC or the Agreement State finds that the licensee's operation does not meet minimum safety standards. Additional information about NRC and Agreement State licensing and enforcement is provided in Appendix I.

The NRC has evaluated the possible pathways that humans may be exposed to radioactive materials in sewage and the behavior of radioactive materials in the POTW environment (Kennedy et al. 1992, Ainsworth et al. 1994).

4.2 U.S. Department of Energy (DOE)

Under the Atomic Energy Act, the Department of Energy Organization Act (DOA), and other related federal statutes, DOE has been assigned broad responsibility for protection of the public, the environment, and real or personal property from radiological hazards associated with its research, development, weapons production, and other activities. Operators of DOE facilities are responsible for compliance with internal directives which contain specific requirements for managing radioactive materials. For a summary of these directives, consult "The Long-term Control of Property: Overview of Requirements in Orders DOE 5400.1 and 5400.5," which can be obtained from DOE's Office of Environment, Safety and Health website (http//:tis.eh.doe.gov/oepa/) under the section entitled "Policy and Guidance - Radiation Protection."

DOE internal directives restrict the release of radioactive material to the environment by setting an annual general public dose limit based on all pathways of potential exposure. Controls are in place at each DOE nuclear facility to ensure that releases of radioactivity from all sources are monitored so that general public exposures are well below the general public dose limit. Any release of liquid waste that contains radionuclides that meets the protective levels established in DOE internal directives is considered a "federally permitted release," and as such, is subject to treatment by a process selected through the Best Available Treatment procedure, and is also subject to the As Low As Reasonably Achievable standard. Although federally permitted releases to sewage systems are not subject to prior notice or approval by the POTW operator, DOE internal directives do require that radioactivity levels be controlled so that a local POTW's wastewater treatment and sludge management processes are not disrupted.

4.3 EPA

Under the Atomic Energy Act (AEA) of 1954 as amended and the Reorganization Plan 3 of 1970, EPA has authority to establish generally applicable environmental standards for the protection of the general environment from radioactive materials. In addition, the AEA directs EPA to promulgate the Federal Guidance on radiation exposure to workers and the public. EPA also establishes regulations addressing what industries may discharge to POTWs, as well as regulations concerning the POTWs effluent and sludge solids. This section describes EPA's role and regulations for each of these types of facilities. TENORM in sewage sludge and ash from a POTW could also be regulated by EPA.

4.3.1 Role in Regulating Facilities That May Discharge to POTWs

EPA regulates the discharge of contaminants in wastewater effluents through the National Pollution Discharge Elimination System (NPDES). Industries with processes that may discharge TENORM include those that process certain mineral substances, such as titanium and zircon.

EPA also regulates the discharges of waste material from contaminated facilities cleaned up under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). If such facilities discharge to a sanitary sewer, EPA has the authority to regulate the limits for both man-made radioactive materials and TENORM. EPA may also grant authority to a state to serve as the regulator of CERCLA cleanups.

EPA also establishes radiation-related standards in other areas that may indirectly affect the consideration of both man-made radioactive materials and TENORM at a POTW. For example, under the Clean Air Act (CAA) EPA may limit radionuclide releases to the air from facilities (e.g., elemental phosphorous plants). These facilities may generate waste products containing radioactive materials that could enter the sanitary sewer system.

Another radiation-related standard that may indirectly affect POTWs, includes EPA's standards for radionuclides in drinking water. These regulations, encompassing both man-made radioactive materials and TENORM, have caused many municipalities to incorporate water treatment that removes radioactive materials from the influent water before releasing it to the service connections. EPA has prepared draft guidelines ("Suggested Guidelines for Disposal of Drinking Water Treatment Wastes Containing Radioactivity," June 1994) that specifically recommend landfill disposal of all drinking water treatment plant residuals, rather than discharge to the sanitary sewer system. At the present time, these guidelines have not been issued as official Agency guidance. It has been noted in several instances that a municipal water treatment facility discharged residue with elevated radioactive material content from this process to the sanitary sewer system.

4.3.2 Role in Regulating POTWs

EPA regulates POTWs in several ways. EPA regulates the discharge of wastewater from POTWs. The Clean Water Act (CWA), as amended, is implemented by the EPA and is designed to protect the waters of the United States (e.g., rivers, lakes, and wetlands) from pollution. The CWA is implemented through the National Pollutant Discharge Elimination System (NPDES). This system requires all pollutant discharges to the waters of the U.S. to comply with certain pollutant discharge criteria. Permits are issued to dischargers (including both industries and POTWs), specifying the discharge conditions and monitoring requirements to ensure these conditions are met. This permitting function may be delegated by EPA to individual states.

EPA implements the CWA National Pretreatment Program. Under this program, facilities discharging a significant amount of wastewater to the POTW must limit their discharges of specific pollutants to the sanitary sewers. By limiting the discharge of these pollutants, the sewage treatment plants receiving the discharges are better able to meet their NPDES permit conditions, to protect the treatment plant workers from these pollutants and to keep pollutants in the sewage sludge produced by these plants below specified limits.

The Supreme Court determined that three types of radioactive materials — source material, special nuclear material, and byproduct material — are not "pollutants" within the meaning of the CWA. Therefore, the EPA has no authority under the CWA to regulate these materials. However, EPA has authority to regulate radioactive materials that are not source, special nuclear, or byproduct material regulated under the AEA (e.g., TENORM).

EPA also regulates the use and disposal of sewage sludge produced by POTWs. The relevant regulations are found in the Code of Federal Regulations in Chapter 40 Parts 257, 403, and 503, but do not address radioactive material in sewage sludge at this time. Under the Resource Conservation and Recovery Act (RCRA), EPA cannot directly regulate as hazardous waste radioactive material in sewage sludge that is subject to the AEA. However, EPA could regulate the non-AEA components of the sludge under RCRA.

When sewage sludge is incinerated, some radioactive material may be emitted. Under the Clean Air Act (CAA), EPA has no direct authority to regulate the concentration of radioactive materials in sewage sludge/ash at POTWs. However, radionuclides were expressly included in the initial list of hazardous air pollutants in Part 112(b) of the CAA, and EPA has authority to establish National Emission Standards for Hazardous Air Pollutants (NESHAPs) under Part 112 of the CAA for facilities that emit radionuclides to the ambient air. Although EPA does not regulate the concentration of radionuclides in sewage sludge/ash directly under the CAA, the measures required to control emissions of hazardous air pollutants from POTWs may indirectly affect the concentration of radionuclides in sewage sludge.

Under the CWA, EPA determines the pollutants for which it will establish sewage sludge use and disposal standards (i.e., 40 CFR Part 503) based on current information about the potential for adverse consequences to human health and the environment. Part 405(d) of the CWA requires EPA, based on available information, to establish numerical pollutant limits for pollutants present in sewage sludge in concentrations that may adversely affect public health and the environment. These standards must be adequate to protect public health and the environment from reasonably anticipated adverse effects. This authority, in combination with the Agency's authority under AEA to establish generally applicable environmental standards for the protection of the general environment from radioactive material and to establish NESHAPs for hazardous air pollutants (including radionuclides) under part 112 of the CAA for facilities which emit radionuclides to the ambient air, would appear to provide adequate authority to establish numerical limits for any radionuclides in sewage sludge/ash for most end use and disposal practices if deemed necessary to protect public health and the environment. While the definition of "pollutant" in the NPDES Regulations (40 CFR 122.2) specifically exempts radioactive materials that are regulated under the AEA as amended (42 U.S.C. 2011 et seq.), the Pretreatment Regulations (40 CFR Part 403) do not separately define "pollutant," but do prohibit "interference," which includes a discharge which "inhibits or disrupts the POTW, its treatment processes or operations, or its sludge processes, use or disposal" [40 CFR 403.3(i)]. The sewage sludge standards (40 CFR Part 503) separately define "pollutant" without reference to the AEA, and as discussed above could use EPA's authority under AEA to establish generally applicable environmental standards for the protection of the general environment from radioactive material in sewage sludge/ash.

These standards could then trigger action on the part of POTWs through their contracts or permits with licensees to dispose of waste into the treatment works to avoid pass through and interference for the POTW. However, the nature of the arrangement between the POTW and its customers will depend upon state and local law as well as any applicable requirements in EPA's pretreatment program (40 CFR Part 403). In some cases, there are local permits issued to POTW users that would govern the circumstances of discharges to the POTWs. In other cases, the arrangements are purely contractual and the relationship between the POTW and its users (including whether the users must notify the POTW before the discharging of radioactive material) would be a matter of negotiation between the parties.

4.4 ISCORS

NRC and EPA formed the Interagency Steering Committee on Radiation Standards (ISCORS) in 1995 to expedite the resolution and coordination of regulatory issues associated with radiation standards. The objectives of the committee include the following: (1) facilitate a consensus on acceptable levels of radiation risk to the public and workers, (2) promote consistent risk assessment and risk management approaches by setting and implementing standards for occupational and public protection from ionizing radiation, (3) promote completeness and coherence of federal

standards for radiation protection, and (4) identify interagency issues and coordinate their resolution. In addition to NRC and EPA, ISCORS membership also includes senior managers from the Department of Defense, the Department of Energy, the Department of Labor's Occupational Safety and Health Administration, the Department of Transportation, and the Department of Health and Human Services. Representatives of the Office of Management and Budget, Office of Science and Technology Policy, and the States are observers at meetings.

ISCORS formed a Sewage Sludge Subcommittee. This subcommittee is assisting NRC and EPA in conducting the NRC/EPA sewage survey and in developing this POTW guidance document. The member agencies of ISCORS agree there is not yet enough information on occurrence and levels of radioactive materials in sewage sludge and ash to develop any conclusive regulatory decisions. Most of the information available is due to unusual circumstances that triggered discovery of incidents in the course of other business. These incidents also generally resulted from practices prior to the recent changes in NRC regulations for the restricted licensees releases to the sewer. The Sewage Sludge Subcommittee is evaluating the occurrence of radioactive materials in sewage sludge, including the sampling of sewage sludge and ash from POTWs across the country and is conducting modeling to evaluate the dose associated with radioactive material in sewage sludge and ash. These activities are being conducted to support consideration of the need for future regulatory actions. Some of the regulatory actions that may be considered include the following:

- NRC regulations that would further limit the sanitary sewer discharge of man-made radioactive materials.
- EPA regulations that would further limit the discharge of NORM through NPDES permits.
- EPA regulations that would include requirements for radioactive materials in sewage sludge/ash use and disposal practices.

4.5 State Agencies

In addition to the role of state agencies as NRC Agreement States, states have been active regarding the issue of potential radioactive contamination at POTWs. Many states (both Agreement and non-Agreement States) have legislative authority and have promulgated regulations regarding TENORM, in a manner similar to the regulations regarding man-made radioactive materials. For example, some states have established licensing and inspection requirements for users of TENORM. Other states require users of TENORM to register with the state, rather than being issued a license. To date, nine states have approved regulations for TENORM, and several states have TENORM-related guidance, as it applies primarily to the oil and gas industries and the mining industry. State radiation control programs may also address the following areas:

1. X-ray machines,
2. Licensing of radiological technologies,
3. Accelerator-produced radioactive materials,
4. Source, by-product, or special nuclear materials (if Agreement State),

5. Radon awareness,
6. Certification programs for radon tester or mitigators,
7. Non-ionizing sources of radiation, such as radio frequency sources, lasers and others,
8. Drinking water standards for radium, radon and others,
9. Cleanup of radioactively contaminated sites,
10. Monitoring around nuclear power plants,
11. Emergency response to nuclear power plants and radioactive materials incidents,
12. Low-level radioactive waste siting, and
13. Laboratory services.

Examples of state involvement in addressing radioactive contamination at POTWs include the case studies presented in Chapter 1 (i.e., Tennessee and Oregon). State radiation control programs are good contacts for the POTW operator for information about radiation control. State radiation control programs are composed of individuals who have studied radiation and have experience with that particular states' problems.

4.6 Local Authorities

The role and authority of local jurisdictions, especially POTW authorities, is one of the more complex of the relationships related to POTWs and radioactive material. In general, POTWs have the same authority concerning radioactive material as they do for any other material in influents to the POTW. However, the U.S. Supreme Court has held that for radioactive materials covered by the AEA, Federal authority preempts other regulatory authorities when the issue is radiation protection (Pacific Gas & Electric Co. v. State Energy Conservation Comm., 461 U.S. 190, 1983). However, the resolution of particular preemption issues is often highly fact dependent. Therefore, if the basis for the state or local government action is something other than the protection of workers and the public from the health and safety hazards of regulated materials, it may be that the action is not preempted. Thus, if a POTW has sound reasons other than radiation protection to impose certain pretreatment requirements or certain prohibitions on receipt of such waste, it may be possible to do so. However, as this is an unsettled area of the law with little case law upon which to rely, it is difficult to predict whether unusual cost by the POTW would be a sufficient reason that would avoid a successful preemption challenge.

The nature of the arrangement between the POTW and its customers will depend upon state and local law as well as any applicable requirements in EPA's pretreatment program (40 CFR Part 403). In some cases, there are local permits issued to POTW users that would govern the circumstances of discharges to the POTWs. In other cases, the arrangements are purely contractual and the relationship between the POTW and its users (including whether the users must notify the POTW before the discharging of radioactive material) would be a contract condition.

Two relatively recent court cases have addressed issues of local authority on radiation matters, but do not provide definitive answers. In Cleveland, Ohio, a discharger of radioactive materials was unable to obtain a restraining order to prevent local authorities from terminating sewer service based on the radioactive materials in its wastewater. The POTW's actions were supported by restraining orders from both state and federal courts, but a settlement of the overall case precluded either state or federal court from reaching a final opinion. Therefore, there remains some uncertainty in this case.

In Sante Fe, New Mexico, a discharger has obtained a summary judgement in Federal Court, which appears to prevent local authorities from regulating environmental matters generally, including radioactive discharges. However, this decision was based on interpretation of New Mexico statues. The Court held that while state law authorizes local governments to construct and operate sewage treatment plants, the regulation of environmental matters generally has not been delegated to local authorities and may only be exercised at the state level. However, because the Court's decision was based entirely on New Mexico laws, the case has little precedential value in interpreting federal law or laws of other states.

5 WHAT CAN A POTW OPERATOR DO TO DETERMINE IF THERE IS RADIOACTIVE CONTAMINATION AND WHO CAN HELP?

Although POTWs may not be the primary regulatory authority, there are several steps, listed below, that a POTW may consider if they have concerns regarding radioactivity. Depending on the outcome of the preceding step(s), it is possible that not every step is necessary. It is also likely that the cost for each succeeding step will be more than the cost of the preceding step. The steps include the following:

1. Determine what radioactive materials may be discharged into or otherwise enter the wastewater collection and treatment system.

2. Determine if screening surveys or sampling for radioactive material at the POTW should be performed and if necessary how to perform them.

3. Evaluate any external radiation exposure of collection system workers or POTW personnel through screening surveys or sampling.

4. Evaluate any potential radiation exposure of workers or the general public related to the use or disposal of sewage sludge or ash through screening surveys or sampling.

Prior to taking the steps described in this chapter, the POTW authority may want to consider employing a consultant when evaluating the potential for a radioactive contamination problem. Part of the POTW's consideration will depend upon available resources and experience of the authority's own personnel, as well as the initial findings regarding the number and complexity of the sources of radioactive material in the service area. Assistance and advice are available to the POTW authority from the appropriate State Radiation Control Program, the NRC Regional Office, and the EPA Regional Radiation Program. Information regarding these programs and offices, including contact information, is provided in Appendices B, C, D, and E.

5.1 Determine What Radioactive Materials May be Discharged into or Otherwise Enter the Wastewater Collection and Treatment System

The POTW operator should identify the source(s) of radioactive materials that enter the wastewater system. As described in Chapter 3, the sources of potential contamination may be from man-made and/or naturally occurring materials. To determine potential sources of man-made radioactive materials, the POTW operator should identify facilities in the service area that are licensed to use radioactive materials. A list of licensees, obtained from the appropriate regulatory agency, should be used to determine likely sources.

If the POTW is in an Agreement State, the state can provide a list of the licensees and the material(s) they are licensed to use. If the POTW is not in an Agreement State, the POTW must check with the NRC (e.g., the NRC Regional Office) to identify the licensees that are located in their service area. If the POTW services any federal government facilities, it will also be necessary to contact the NRC Regional Office, even in an Agreement State. These facilities cannot be licensed by the State and are always under NRC purview. For example, Army, Navy, and Air Force facilities are licensed by the NRC.[1] In all States, the POTW should contact the State radiation control program office for information regarding non-AEA man-made radioactive materials (i.e., accelerator produced material, NARM). If there is a DOE facility in the service area, the POTW should contact the DOE facility directly to determine if there may be a potential for the discharge of radioactive materials to the sanitary sewer. Contacts at specific DOE facilities may be obtained from the DOE Office of Environment, Safety and Health website (http://www.eh.doe.gov/portal) under "DOE and the Community," "Contact Us."

To determine if information is available regarding the potential presence of TENORM in the service area, the POTW operator should contact the State Radiation Control Agency (see Appendix E). EPA regional radiation program managers (see Appendix D) may also be able to assist in this question.

[1] Additional information for Navy and Air Force facilities may be obtained from the corresponding Service Coordinating Committee. The Navy Committee can be contacted directly at 703/602-2582 and the Air Force Committee can be contacted directly at 210/536-3331.

Information on what radioactive material is authorized for use is as important as identifying the user. For instance, if a wastewater discharger only uses a "sealed source," it is unlikely the facility would discharge radioactive material in the sewer system. This information can be requested from the licensee or from the NRC or Agreement State. After the likely sources of radioactive materials have been identified, the discharger should be contacted to determine if any continuous or accidental releases may have occurred.

5.2 Determine if Screening Surveys or Sampling for Radioactive Material at the POTW Should Be Performed and if Necessary How to Perform Them

In Section 5.1 above, a number of suggested steps were provided for a POTW to follow in learning what available information may exist on radioactive materials entering into or being discharged into the sanitary sewer system. Following are some criteria which may be useful in determining if it is appropriate to sample the POTW facility sludge or ash for radionuclide content:

1. Is the facility located in an area with elevated levels of uranium and radium occurrence in soils or bedrock (see Figure 1, Figure 3, or Figure 4)?

2. Have water treatment plants which may discharge residuals into the sewer system reported exceedances of EPA drinking water MCLs for radium, or for alpha and beta emitting radionuclides? The current standards are: combined radium-226/228, 5 pCi/L; a combined standard of 4 mrem/yr for beta emitters; and a gross alpha standard of 15 pCi/L, not including radon and uranium (see 40 CFR Part 141).

3. Are there industrial facilities in the POTW service area for the following industries which discharge significant quantities of untreated process waste water into the sewer system: ceramics, electronics, minerals or metal fabrication (any one of aluminum, copper, gold, silver, phosphate, potassium, vanadium, zinc, zirconium, tin, rare earths, molybdenum, titanium, depleted uranium, radium), paper and pulp, metal foundry and engine manufacture, luminous watch and clock manufacture, cement or concrete, optics, electric lighting, gypsum board manufacture, welding, paint and pigment, or fertilizer manufacture? What percentage of total discharge to the system is provided by these facilities? All of these industries have been associated with the use of TENORM materials or production of TENORM wastes.

4. Are there NRC or Agreement State licensees, DOE facilities, Department of Defense facilities in the service area that discharge to the sewer system in the following categories: medical, medical laboratory, research & development college or university, nuclear laundries, decommissioning facilities for byproduct material facilities, UF_6 production plants, hot cell operations, uranium enrichment plants, or uranium fuel fabrication plants. Are there State

licensed accelerators which may discharge to the sewer system? Are there facilities which discharge landfill leachate or Superfund site discharges in the service area? How many licensees are there in the system and how much do they discharge annually? What percentage of total discharge to the system is provided by these facilities?

While there have been few studies conducted to evaluate the volumes and movement of radionuclides throughout the sewage system and their accumulation and occurrence in sewage sludge or ash, a POTW can make some qualitative judgements about whether sampling or surveying is prudent based on an informed analysis of dischargers to the system.

- If there are no occurrences of any of the items listed above in the system, the likelihood of finding contamination by radioactive materials in the sewage sludge and ash is unlikely, but still remotely possible. Sampling would not likely be warranted.

- If both criteria 1 and 2 are true, the possibility does exist that NORM could be elevated in the sludge and ash and would merit testing.

- If either (or both) criteria 1 and 2 are true, and industries listed in criteria 3 are present in the service area, the possibility exists that NORM or TENORM could occur in the sludge and ash, and merit testing of the POTW sludge and ash.

- If criteria 4 is true, and there are either multiple licensees in the service area, or the licensees may discharge a significant fraction of wastewater in the sewer system (more than a few percent), it may be appropriate to periodically sample and test the sludge and ash for the presence of radionuclides, particularly those that are man-made. Since the volume of wastewater discharged from a licensee may not be indicative of the amount of radionuclides discharged during the year, reviewing licensee discharge records may be a better indicator of what, and how much, is entering the system.

- If any of criteria 1, 2, or 3 are true and criteria 4 is true, the likelihood exists for occurrence of NORM, TENORM, and man-made radionuclides in the sewage sludge or ash, and it may be appropriate to sample the sewage sludge or ash.

Further information on identifying and dealing with new industrial sources, radioactive contaminants, and individual facilities is provided in a guidance document developed by the National Biosolids Partnership (NBP 1999).

The results of the ongoing, joint NRC and EPA survey and associated dose modeling being conducted by the ISCORS Sewage Sludge Subcommittee (see Section 4.4) may be helpful to POTWs when deciding whether they should sample.

5.3 Evaluate Any Potential External Radiation Exposure of Collection System Workers or POTW Personnel Through Screening Surveys or Sampling

There may be a potential for external radiation exposure (i.e., from outside the body, rather than from ingestion or inhalation) to collection system workers and POTW personnel if gamma radiation emitting radionuclides are discharged into the wastewater system (more information regarding the various types of radionuclides is provided in Appendix A). If the potential for such discharges is determined, the POTW should initiate an evaluation. This evaluation may be conducted using two methods: (1) use a radiation survey meter to identify any points at which such contamination exists, and (2) use an integrating radiation measuring device to determine if any exposures could occur over time. It may be advisable to hire a health physics consultant to assist in the selection of appropriate survey methods and instruments.

A source of useful information on such surveys is a federal consensus document, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*. This manual may provide useful information on planning and conducting a survey involving potential contamination of surface soils and building surfaces. This document, prepared specifically for site surveys involving radiological contaminants, contains useful information on sampling procedures, field measurement methods and instrumentation, quality assurance and quality control procedures and interpretation of results. This information was developed as a consensus approach by four federal agencies (EPA, DOE, NRC and DOD) to determine whether dose or risk-based release criteria for buildings and soils have been met. In the context of a POTW survey for radiological contaminants, the methods and procedures contained in this manual should be generally applicable. The MARSSIM document and related informational tools can be obtained from the EPA's Office of Radiation website (http://www.epa.gov/radiation/marssim/).

Direct measurement can be conducted with an instrument using a sodium iodide detector tube or a very sensitive Geiger Muller detection device. The instrument should be able to detect gamma radiation in the micro-roentgen per hour range.

In taking measurements along the collection system, it is best to focus on system junctions and bends that are immediately downstream from the wastewater generator of concern. These are points that allow the accumulation of radioactive material. Prior to taking collection system measurements, it is important to create a baseline of the background radiation levels; a background measurement should be taken in the general vicinity of the system before taking measurements in the collection system itself. If possible, these background measurements should be taken upstream of the discharger over grassy areas. Table 8 provides typical ranges of radioactive material concentrations found in U.S. soils and common items such as fertilizers and building materials, as well as the range of radioactive material concentrations detected during the pilot survey of sludges

and ash from nine POTWs. This table is taken from Appendix B of the pilot survey report (NRC and EPA 1999).

Table 8. Concentration Ranges from Pilot Survey and for Typical U.S. Background in Soil, Fertilizer, and Building Materials (pCi/g-dry weight)

	Common materials			Pilot study results	
Radio-nuclide	Soil[1]	Phosphate Fertilizer[2]	Building Materials[1]	Sludge	Ash
Am-241	NDA[3]	NDA	NDA	ND[4]	ND
Ba-140	NDA	NDA	NDA	ND	ND
Be-7 *	NDA	NDA	NDA	ND - 22	4.0 - 13
Bi-212	0.1 - 3.5	0.1 - 4.6	0.1 - 3.7	ND - 2.0	ND - 2.0
Bi-214	0.1 - 3.8	4.0 - 140	2.5 - 5.05	ND - 2.0	.02 - 16
C-14 *	NDA	NDA	NDA	ND	ND
Co-60	NDA	NDA	NDA	ND - 6.0	ND
Cr-51	NDA	NDA	NDA	ND - 4.0	ND
Cs-137	0.1 - 0.2[6]	NDA	NDA	ND - 1.0	0.03 - 0.08
H-3 *	NDA	NDA	NDA	ND - 30.4	ND
I-125	NDA	NDA	NDA	ND - 1.0	ND - 0.3
I-131	NDA	NDA	NDA	ND - 70	ND - 4.0
K-40 *	2.7-19	32 - 160[7]	0.8 - 30	2.0 - 8.0	14 - 16
Pa-234m *	0.1 - 3.8	4.0 - 140	0.2 - 5.0[5]	ND - 15	ND - 9.0
Pb-212 *	0.1 - 3.5	<0.1 - 4.6	0.1 - 3.7	0.2 - 2.0	1.0 - 2.0
Pb-214 *	0.1 - 3.8	4.0 - 140	0.2 - 5.0	ND - 2.0	2.0 - 17
Pu-238	NDA	NDA	NDA	ND - 0.03	ND - 0.01
Pu-239	NDA	NDA	NDA	ND - 0.08	ND - 0.01
Ra-223 *	<0.1 - 0.2	0.2 - 6.6	<0.1 - 0.2[5]	ND - 0.06	ND
Ra-224 *	0.1 - 3.5	<0.1 - 4.6	0.1 - 3.7[1]	ND - 1.0	0.5 - 4.0
Ra-226 *	0.1 - 3.8	0.1 - 24	0.1 - 3.5	1.0 - 29	3.0 - 25
Ra-228 *	0.1 - 3.5	<0.1- 4.6	0.1 - 3.7	ND - 2.0	2.0 - 9.0
Sr-89	NDA	NDA	NDA	ND - 7.0	ND - 0.8
Sr-90	NDA	NDA	NDA	ND - 0.7	ND
Th-227 *	<0.1 - 0.2	0.2 - 6.6	<0.1 - 0.2	ND - 0.1	ND
Th-228 *	0.1 - 3.5	<0.1 - 4.6	0.1 - 3.7	ND - 1.0	ND - 2.0
Th-230 *	0.1 - 3.8	4.0 - 140	0.2 - 5.0	ND - 1.0	0.5 - 2.0
Th-232 *	0.1 - 3.5	<0.1 - 4.6	0.1 - 3.7	0.01 - 0.9	0.4 - 1.0
Th-234 *	0.1 - 3.8	4.0 - 140	0.2 - 5.0	ND - 12	2.0 - 5.0
Tl-201	NDA	NDA	NDA	ND - 24	ND
Tl-208 *	0.1 - 3.5	<0.1 - 4.6	0.1 - 3.7	ND - 0.5	ND - 0.6
U-234 *	0.1 - 3.8	4.0 - 140	0.2 - 5.0	0.2 - 44	5.0 - 8.0
U-235 * [8]	<0.1 - 0.2	0.2 - 6.6	<0.1 - 0.2	ND - 3.0	ND - 1.4
U-238 *	0.1 - 3.8	4.0 - 140	0.2 - 5.0[5]	0.2 - 12	2.0 - 5.0

See next page for footnotes.

Table 8. Concentration Ranges from Pilot Survey and for Typical U.S. Background in Soil, Fertilizer, and Building Materials (pCi/g-dry weight): Footnotes

[1] Reference: Tykva and Sabol 1995. This reference is the source of data for concentrations of radionuclides in soil and building materials except for the concentrations of U-238, U-235, and Cs-137 which came from references 5 and 6, respectively. The concentrations of the daughters or decay products of U-238, such as Th-234, Ra-226, etc., those of U-235, such as Th-227 and Ra-223, and those of Th-232 are set equal to those of their respective parent radionuclides by assuming that the daughters are in secular radioactive equilibrium with the parent radionuclides.

[2] Source for data on fertilizers: NCRP (1987b), pp. 24-32. This is the source of data for the concentrations of radionuclides in fertilizers except for the concentration of K-40 in soil which came from the reference in note 7.

[3] NDA - No data available

[4] ND - Not detected. The radionuclide was not detected in some of the samples during the pilot study.

[5] Reference: Eisenbud and Gesell (1997).

[6] Cs-137 concentration range in soil obtained from Figure 4-4, p. 94 of NCRP (1976).

[7] Source for data on K-40 in fertilizer: (EPA 1993b).

[8] Values for U-235 in soil, fertilizer and building materials were based on the concentrations of U-238 in the same materials and the natural ratio of U-235 to U-238.

[9] The symbol "<" which appears throughout the table is an abbreviation for the words "less than."

[10] * = naturally occurring radionuclide

If there is reason to believe that there is an exposure problem to collection system workers then appropriate monitoring of the collection system may be necessary. Monitoring down manholes in the collection system may result in highly variable measurements. These variations may be a few times the background levels and may result from the construction materials used in the manhole. Marked variations may be observed between concrete and brick, or even among different concrete or brick materials. These variations are largely due to the natural radioactive materials in the construction materials. If elevated values are found, further investigation may be warranted. Consultation with the radiation regulatory authority is recommended. More detailed information on this issue may be found in the National Biosolids Partnership guidance (NBP 1999).

At the POTW, direct radiation measurements should be taken at locations where solid materials accumulate, including grit chambers and points of sludge collection. If incineration of sludge is performed, the residual ash should also be measured. Background measurements should

be made away from the sludge collection point. Some variability in measurements can be expected. These measurements are necessary to compare levels in sewage sludge and ash samples.

To identify changes over time, POTW operators may also want to employ an integrating measurement device that accumulates radiation exposure over time. It is also possible to periodically conduct follow-up surveys using direct radiation measurements; however, integrating measurement devices are more effective for time analyses.

Although there are expensive self-recording types of devices available, it may be more cost effective to use some thermoluminescent dosimeters (TLD). These devices are crystal structures that store the energy imparted by incident radiation so that it can be subsequently measured to evaluate the exposure received. The selection of the particular TLD to use should be made after consultation with the vendor, including a discussion of the particular use intended.

The locations selected for placing the TLDs should be determined carefully, in a manner similar to the location selection process for the direct radiation measurements. Several of the TLDs should be placed in an area removed from sludge processing (e.g., an office desk, cabinet) to serve as a background measurement. The TLD devices used for system measurements can be hung down manholes or over areas where sludge is collected, or over conveyer belts where sludge is transported. The TLDs should be left in place for a period of a few weeks to a month and then returned to the vendor for evaluation.

5.4 Evaluate Any Potential Radiation Exposure of Workers or the General Public Related to the Use or Disposal of Sewage Sludge and Ash Through Screening Surveys or Sampling

In addition to evaluating the potential for exposures to POTW workers from radioactive materials in sewage sludge and ash, POTWs may also need to evaluate potential exposures to other workers who handle or manage sludge and ash or to members of the public.

5.4.1 How to Evaluate if There Are Any Potential External Radiation Exposure Problems with the Disposal or Reuse of Sewage Sludge and Ash

If a thorough survey of sludge accumulation points indicates there is no problem with elevated readings, there is a reduced probability that land application sites or landfills will have radioactive contamination. However, materials placed in these sites in the past may have caused contamination. Also, there may be areas where repeated applications have occurred, causing a buildup of material that would not have been detected otherwise.

A survey of land application sites or landfills where sludge has been disposed is a prudent step if there is reason to believe that elevated levels of radioactive materials may have been discharged to the system. Measurement of radiation levels in these areas can be made with the same instrument used for the collection and treatment systems. Background levels should be measured in areas without sludge or ash for comparison purposes. Some variation in background levels should be expected due to local soil conditions. If levels significantly above background are found, it is suggested that the appropriate radiation control authority be consulted.

In cases where the POTW uses or disposes of sewage sludge/ash or contracts it out, the following factors may be considered to decide whether to perform measurements at the use or disposal sites:

- Indications that there has been radioactive contamination in the POTW.
- The liability arrangements between the POTW and the contractor.
- The adequacy of available records on past sewage sludge/ash applications.
- The frequency and amount of sewage sludge/ash applications to each site.

Based on these factors, the POTW may want to collect samples at the sludge or ash disposal site.

5.4.2 How to Evaluate if There are any Potential Internal Radiation Exposure Problems with the Disposal or Reuse of Sewage Sludge/Ash

Following the steps described above, any significant occurrence of radioactive contamination at a collection system or POTW should have been detected. If there is a determination of potential contamination from the direct radiation measurements, a determination of what radioactive material caused the problem should be made. Such a determination would also be necessary to identify the possibility of ingestion or inhalation of radioactive material during wastewater collection and treatment, or sewage sludge and ash use or disposal practices. In these cases, it may be necessary to take physical samples of the sewage sludge, ash, or other residual material and have this material analyzed at a laboratory with the capability for such an assessment. Other cases where sampling and analysis may be required are circumstances where the possible radioactive contamination is not detectable by the methods previously described. These would be instances where the radiation emitted was only alpha or weak beta radiation. Such radioactive materials include some man-made elements that are heavier than uranium, and more common radioactive materials, such as hydrogen-3 (tritium) and carbon-14.

If it is found that the sampling of sewage sludge and ash should be conducted (either because of detected contamination or undetected radioactive materials are believed to be present), a carefully planned program should be executed. Analysis of sewage sludge and ash samples may become expensive. An initial gamma scan and gross alpha and gross beta determination may be useful as an inexpensive screening tool for further analysis. Further assessments may require analyses for specific radioactive materials.

A gamma spectrometer is used to estimate gamma-emitting radionuclide concentrations. Gamma spectrometry can discriminate among various radionuclides on the basis of characteristic gamma and x-ray energies to provide a nuclide-specific measurement. Gross alpha or gross beta activity analyses are used to screen samples to determine the need for nuclide-specific analyses.

The EPA guidance, *POTW Sludge Sampling and Analysis Guidance Document* (1989), provides information on conducting sampling and analysis of sludge.[2] Information on how to collect samples, what containers to put them in, how to preserve them, and other sampling steps, should be worked out in consultation with the selected analysis vendor. Also, some analyses require specific time periods for counting radionuclide decay emissions or collecting radon or other decay products. These time periods may vary with the radionuclides being tested and can take several days or weeks to complete.

A radiochemical laboratory should be selected before sampling so that the laboratory may be consulted on the analytical methodology and sampling protocol. A list is maintained by the Conference of Radiation Control Program Directors (CRCPD) of laboratories that provide radiological analysis of diverse materials, have quality assurance and quality control programs, and will perform work for government and private firms. Appendix J lists those laboratories from the January 2000 CRCPD list that have indicated they perform analyses of sludge samples. To evaluate the laboratory, the following considerations should be made:

- Does the laboratory possess the appropriate well-documented procedures, instrumentation, and trained personnel to perform the necessary analyses?
- Is the laboratory experienced in performing the same or similar analyses?
- Does the laboratory have satisfactory performance evaluation results from formal monitoring or accreditation programs? The laboratory should have a formal quality assurance (QA) program in place. The laboratory should be able to provide a summary of QA audits and proof of participation in inter-laboratory cross-check programs. Equipment calibrations should be performed using National Institute of Standards and Technology (NIST) traceable reference radionuclide standards whenever possible.
- Is there an adequate capacity to perform all analyses within the desired time frame?
- Does the laboratory provide an internal quality control review of all generated data that is independent of the data generators?
- Are there adequate protocols for method performance documentation and sample security?

[2] The EPA guidance document can be obtained from the Education Resource Information Center (ERIC number W134) by calling (800) 276-0462 or the National Technical Information Center (NTIS number PB93-227957) at (800) 553-NTIS.

Typical Analysis Costs

Costs for analysis will depend on the type of analyses that are requested. The more detailed or complicated the analysis, the more expensive and time demanding the analysis becomes. Gamma spectroscopy analysis for one sample could cost a few hundred dollars, gross alpha/beta analysis may cost a few hundred dollars and costs for radiochemical analysis for alpha and beta emitters may range from several hundred to over one thousand dollars, depending on the radionuclides analyzed.

If there is any concern by the POTW operator regarding potential radiological contamination of buildings or facilities where sewage sludge or ash is land applied or disposed in a landfill, there may be a need to conduct an appropriate radiological survey. As discussed in Section 5.3, a source of useful information on such surveys is the MARSSIM.

6 WHAT TO DO IF ELEVATED LEVELS OF RADIOACTIVE MATERIALS ARE FOUND

Elevated levels of radioactivity at a POTW do not necessarily mean that workers or the public are in danger. POTW operators should evaluate the risks and determine the appropriate course of action through consultation with radiation regulatory authorities and health specialists. Actions may also be needed to prevent interference with use or disposal of sewage sludge and ash, to prevent a reoccurrence, or to clean up contaminated areas.

6.1 Contact Regulatory Agencies for Assistance

If elevated levels of radioactive materials are suspected or detected, the POTW should first consult with their state radiation regulatory agency (see Appendix E). Based on the initial contact with the state, the POTW may also need to contact the NRC regional office or the EPA regional Radiation Program Manager (see Appendices C and D, respectively). These regulatory agencies are valuable sources of information on radiation and radiation protection and may assist the POTW in addressing the situation and in communicating with the public. They can also help identify possible sources of the radionuclides, assist in establishing an appropriate course of action, and take enforcement actions if needed to correct the problem.

The regulatory agency may determine that the levels are not sufficiently elevated to cause concern for worker or public health and safety. In that case, no additional action by the POTW would be needed to protect workers. However, the POTW should convey the regulator's findings to the POTW workers so that they know there is no cause for concern. A letter or other documentation from the regulator would be useful in communicating with workers that the levels do not pose a concern.

6.2 Protect Workers

When there are elevated levels of radioactivity, the most important concern for the POTW should be the protection of the workers and the public. If consultations with the regulatory agency indicate there may be a concern regarding exposure to the POTW workers, the POTW may need to obtain the services of a qualified consultant, such as a health physicist, to evaluate the radiation levels at the plant and disposal sites. The consultant can recommend appropriate protective measures that are commensurate with the radiation hazards to keep exposure levels as low as reasonably achievable. These measures may include: limiting the amount of time workers spend near units with elevated levels of radioactivity; increasing the distance between workers and the radiation source(s); and increasing the shielding between the source(s) and the workers.

Many of the measures that protect workers from radiation hazards are the same as those used at POTWs to protect against pathogens. Personal hygiene practices such as washing hands before eating prevents ingestion of radionuclides as well as pathogens. Similarly, the use of dust masks in sludge and ash handling areas reduces the potential for health risks from inhaling dust and the radionuclides in the dust.

If elevated levels of radioactivity have been identified, the POTW employees should be informed. The POTW employees should also be provided with factual information on the risks associated with the level of radiation exposure. Regulatory agencies or health physicists may have literature available to assist in communicating with POTW personnel.

6.3 Prevent Reoccurrence or Reduce Radiation Levels

POTWs, in consultation with the regulatory agencies, should determine what can be done to prevent reoccurrences, reduce radiation levels, and prevent interference with use or disposal of sewage sludge and ash. Each situation will be unique and the appropriate actions will vary from no additional action to regulatory enforcement. The approach taken will be affected by the answers to several questions that the POTW and the regulator may explore.

1. Where did the radionuclides come from? Consultation with the regulatory agency could identify whether the radionuclides are naturally-occurring, TENORM, or man-made. See Section 3.1 for a description of these types of sources. For man-made sources, the presence of specific radionuclides could help regulators determine if a licensee is the source.

2. How did the radionuclides get to the POTW? As discussed in Section 3.2, radionuclides may reach the sewers and POTW in several ways. For example, radionuclides may enter the POTW via discharges, POTW treatment processes, or infiltration and inflow. To determine the location of discharges that may cause contamination, the POTW may need to take samples from the sewers leading from the sources. The necessity of sampling should be discussed with the NRC

or state contact prior to initiation. Based on this information, the POTW should be able to determine the source(s) of any radioactive materials that may enter the POTW.

3. How often are radionuclides expected to reach the POTW? Knowing the timing of releases enables POTW operators to plan for their arrival. For example, some users of radioactive materials are allowed to continuously or intermittently release small amounts of radionuclides to the sewer system. Accidental discharges may only occur once or infrequently. Naturally occurring radionuclides may reach the POTW continuously or periodically following precipitation events that increase infiltration and inflow.

4. Who is responsible for controlling the sources of the radionuclides to prevent reoccurrences and interference with use and disposal of sewage sludge and ash? Regulatory agencies are responsible for setting license conditions and limits to protect human health. Licensees are responsible for operating or handling their materials in accordance with regulations and their license conditions. Land owners may be responsible for controlling erosion that carries natural sources into the sewer system through inflow. POTW operators are responsible for maintaining an effective infiltration and inflow program, which could reduce the potential for natural sources to reach the POTW.

5. Are the appropriate controls in place to minimize releases of radionuclides to the POTW? The POTW may want to evaluate the effectiveness of the controls used by the discharger to minimize releases of radionuclides. The POTW may need to consult with the regulatory agency to review the regulations and license conditions imposed on a discharger, or their implementation by the discharger. The POTW should review infiltration and inflow controls if that is the source.

The POTW can work with the regulator to decide on appropriate actions to prevent reoccurrences. Examples of these actions include:

- If the release was a one-time accident and future releases are unlikely, action to prevent reoccurrence may not be needed.
- Require notification of planned or accidental discharges. The POTW may wish to request notification from the source facility when future releases occur. Notification would enable the POTW to monitor the condition at the POTW and take measures to protect workers if necessary. POTWs may lack the authority to require notification, but could request it as a voluntary measure by the user and consult with the Local Emergency Planning Committee (LEPC) and State Emergency Response Committee (SERC).
- Work with dischargers to encourage use of spill prevention measures to reduce the potential for accidental releases.

- Impose appropriate additional local controls on the discharger, such as local discharge limits and regular reporting of discharges.
- Request that regulators take enforcement action against dischargers who violate license conditions and contribute to the elevated levels.
- Provide regulators with information on problems created by the dischargers. This information may be useful for the regulator in deciding whether to modify the release limits.
- Correct infiltration and inflow problems that transport naturally-occurring radionuclides to the POTW.

6.4 Corrective Actions for Contaminated Areas

In rare instances, sewage sludge and ash management may cause contamination of equipment or disposal sites; the POTW may be responsible for removing the contamination. Consultation with the regulatory agencies should be pursued to determine any requirements that may apply.

Cleanup of contaminated sites can be a costly endeavor for the POTW. Depending upon the applicable state or federal laws, some dischargers may be liable for portions of the cleanup costs if their discharges caused the contamination. Legal counsel should be consulted as to whether any dischargers may be liable for portions of the cost.

7 COMMENTS OR QUESTIONS ON THIS GUIDANCE

If you have any questions or comments regarding this guidance document, please contact either NRC or EPA:

Duane Schmidt
U.S. Nuclear Regulatory Commission
Decommissioning Branch
Mail Stop T-7F27
Washington, DC 20555-0001
(301) 415-6919, or e-mail to: dws2@nrc.gov

Robert Bastian
U.S. Environmental Protection Agency
Office of Wastewater Management (4204)
Ariel Rios Building
1200 Pennsylvania Avenue, NW
Washington, DC. 20460
(202) 260-7378, or e-mail to: bastian.robert@epa.gov

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APPENDIX A
FUNDAMENTALS OF RADIATION

What is Radiation?

Radiation is energy in the form of high speed particles and electromagnetic waves (photons) that are released from unstable atoms. Radiation with enough energy to separate molecules or remove electrons from atoms is known as ionizing radiation. Non-ionizing radiation does not have enough energy to remove electrons from their orbits. Radioactivity is the property that some unstable atoms have of undergoing spontaneous transformation, decay, or disintegration, which emits radiation. Materials that contain radioactive atoms are known as radioactive materials.

Radiation is in every part of our lives. It occurs naturally in the earth and can reach us through cosmic rays from outer space. Radiation may also occur naturally in the water we drink or the soils in our backyard. It even exists in food, building materials, and in our own human bodies. Radiation is used for scientific purposes, medical reasons, and power (e.g., the U.S. Navy uses radiation to power submarines through the water). People also come into contact with radiation through man-made sources such as X-rays, nuclear power plants, and smoke detectors.

The radiation of interest in this guidance is ionizing radiation. At excessive levels, the process of ionization can cause disease and injury to plants and animals. The three most common types of ionizing radiation are:

- Alpha radiation - positively charged particles that are emitted from naturally-occurring and man-made radioactive material. The alpha particle has the least ability to penetrate other materials. Most alpha particles can be stopped by a single sheet of paper or the top layer of skin. Consequently, the principal hazard from alpha emitters to humans is occurs when the material is ingested or inhaled. The limited penetration of the alpha particle means that the energy of the particle is deposited within the tissue (e.g., lining of the lungs) nearest the radioactive material once inhaled or ingested. Examples of alpha emitters are radon, thorium, and uranium.

- Beta radiation - negatively charged particles (electrons) that are typically more penetrating but have less energy than alpha particles. Beta particles can penetrate human skin or sheets of paper, but can usually be stopped by thin layers of plastic, aluminum, or other materials. Carbon-14 and hydrogen-3 (or tritium) are two common beta emitters. Although they can penetrate human skin, beta particles are similar to alpha particles in that the predominant hazard to humans comes from ingesting or inhaling the radioactive materials that emit beta radiation. Other examples of beta emitters are phosphorus-32 and strontium-90. Some radioactive materials emit positively charged electrons, or positrons.

- Gamma (or X-ray) radiation - the most penetrating type of radiation. They can pass through the human body and common construction materials. Thick and dense layers of concrete, steel, or lead are used to stop gamma radiation from penetrating to areas where humans can be exposed. Gamma emitters can pose both external and internal radiation hazards to humans. technetium-99m is an example of a gamma emitter that is widely used in medical diagnosis. Other gamma emitters include thallium-201 and selenium-75.

Some radionuclides emit more than one type of radiation. For example, cesium-137 and iodine-131 are both gamma and beta emitters. Potassium-40, a common naturally-occurring radionuclide, is also a beta/gamma emitter. Radium-226 emits both alpha and gamma radiation.

How is Radiation Measured?

Whether it emits alpha or beta particles or gamma rays, the quantity of radioactive material is typically expressed in terms of its radioactivity or simply its activity and is measured in curies. One curie equals 37 billion atomic disintegrations per second. Activity is used to describe a material, just as one would discuss the length or weight of a material. For example, one would say "the activity of the uranium in the container is 2 curies." Generally, the higher the activity of the material, the greater the potential health hazard associated with that material if it is not properly controlled. At nuclear power reactors, the activity of radioactive material may be described in terms of hundreds to millions of curies, whereas the units typically used to describe activity in the environment and at POTWs are often microcuries (μCi) or picocuries (pCi). A microcurie is one one-millionth (1/1,000,000) of a curie and a picocurie is one one-trillionth (1/1,000,000,000,000) of a curie.

The activity of a radionuclide decreases or decays at a constant rate. The time it takes the activity of a radioactive material to decrease by half is called the radioactive half-life. After one half-life, the remaining activity would be one-half (½) of the original activity. After two half-lives, the remaining activity would be one fourth (1/4), after three half-lives one eighth, and so on. For example, if a radionuclide has a half-life of 10 years, the amount of material remaining after 10 years would be ½ of that originally present. After 100 years (10 half-lives), the remaining activity would be 1/1024 of the amount that was originally present. Some radioactive materials have extremely short half-lives measured in terms of minutes or hours; for example, technetium-99m, used in medical procedures, has a half-life of 6 hours. Others have half-lives measured in terms of millions to billions of years; for example, naturally occurring thorium-232 has a half-life of 14 billion years, and natural uranium-238 has a half-life of 4.5 billion years. Half-lives for a number of radionuclides are shown in Table A-1.

Table A-1. Radiation Types and Half-Lives for Radionuclides		
Radionuclide	**Type of Radiation**	**Half-life**
Actinium-228	beta, gamma	6.1 hours
Americium-241	alpha, gamma	458 years
Antimony-125	beta, gamma	3 years
Barium-140	beta, gamma	13 days
Beryllium-7	gamma	53 days
Bismuth-212 Bismuth-214	alpha, beta, gamma beta, gamma	61 minutes 20 minutes
Carbon-14	beta	5730 years
Cesium-134 Cesium-137	beta, gamma beta, gamma	2 years 30 years
Chromium-51	gamma	28 days
Cobalt-56 Cobalt-57 Cobalt-60	positron, gamma gamma beta, gamma	77 days 271 days 5 years
Europium-154	beta, gamma	16 years
Gallium-67	gamma	3 days
Hydrogen-3 (tritium)	beta	12 years
Indium-111	gamma	2.8 days
Iodine-123 Iodine-125 Iodine-129 Iodine-131	gamma gamma beta, gamma beta, gamma	13 hours 60 days 20 million years 8 days
Iridium-192	beta, gamma	74 days
Iron-59	beta, gamma	45 days
Lead-210 Lead-212 Lead-214	beta, gamma beta, gamma beta, gamma	22 years 11 hours 27 minutes
Manganese-54	gamma	303 days
Niobium-95	beta, gamma	35 days
Phosphorus-32 Phosphorus-33	beta beta	14 days 25 days

Table A-1. Radiation Types and Half-Lives for Radionuclides (continued)		
Radionuclide	**Type of Radiation**	**Half-Life**
Plutonium-238 Plutonium-239 Plutonium-240	alpha alpha alpha	86 years 24,400 years 6580 years
Polonium-210	alpha	138 days
Potassium-40	beta, gamma	1.25 billion years
Protactinium-234 Protactinium-234m	beta, gamma beta, gamma	6.7 hours 1.2 minutes
Radium-223 Radium-224 Radium-226 Radium-228	alpha, gamma alpha, gamma alpha, gamma beta	11 days 3.6 days 1600 years 5.8 years
Radon-222	alpha	3.8 days
Selenium-75	gamma	120 days
Strontium-89 Strontium-90	beta beta	52 days 28 years
Sulphur-35	beta	87 days
Technetium-99m	gamma	6 hours
Thallium-201 Thallium-202 Thallium-208	gamma gamma beta, gamma	3 days 12 days 3.1 minutes
Thorium-227 Thorium-228 Thorium-230 Thorium-232 Thorium-234	alpha, gamma alpha, gamma alpha, gamma alpha beta, gamma	18.5 days 2 years 75,000 years 14 billion years 24 days
Uranium-233 Uranium-234 Uranium-235 Uranium-238	alpha, gamma alpha alpha, gamma alpha	162,000 years 247,000 years 710 million years 4.5 billion years
Zinc-65	beta, gamma	245 days
Zirconium-95	beta, gamma	64 days

Some radioactive materials decay to form other radioactive materials. These decay products, in turn, decay, eventually forming stable nuclides. Each material formed through decay has a unique

set of radiological properties, such as half-life and energy given off through decay. In the case of the radioactive materials found at POTWs, the radioactive materials present may consist of one or more separate decay "chains" or "series." The naturally-occurring uranium, actinium, and thorium decay chains are illustrated in Figures A-1, A-2, and A-3.

Some of the radioactive materials in these chains emit gamma rays when they decay. The intensity of gamma radiation in air or exposure rate is measured in roentgens (R) or microroentgens (μR) per unit time, usually an hour, as in R/hr or μR/hr. In the environment, exposure rates are typically measured in terms of μR/hr. For example, in many parts of United States the exposure rate from natural sources of radiation is between 5 and 15 μR/hr. This ambient level is referred to as the background exposure rate.

Many commercially available radiation detectors measure radiation fields in terms of μR/hr or counts per minute (cpm). Counts per minute refers to the number of radiation interaction events of ionizing particles or photons that are detected, or counted, in a minute by the detector. Only a fraction of those particles or photons that interact with the detector result in counts. The number of counts per minute can be related to exposure rate or radiation dose for a known radionuclide for which the instrument has been calibrated.

Radiation dose is a measurement or estimate of the body's exposure to ionizing radiation. It is typically measured in units of rem. In the environment and at POTWs, doses are often measured in terms of millirem (mrem). A millirem is one one-thousandth (1/1,000) of a rem; a microrem (μrem) is one-millionth (1/1,000,000) of a rem. The dose rate is expressed in terms of dose per unit time, again usually an hour, as millirem/hr. For external radiation, exposure rates are often equated to dose rates using the conversion of 1 μR/hr = 1 μrem/hr. Doses from internal exposure to radioactive material that has been ingested or inhaled are more difficult to determine. Computer models that account for the distribution and excretion of the radioactive material within the body are used for estimating doses and dose rates from internal radioactive contamination.

What are the Effects of Radiation Exposure?

Radiation may cause a range of effects when it interacts in, or passes through, living tissue. Human health effects begin at the cellular level. Some cells are unaffected by the radiation while others may be damaged but survive and reproduce normally. However, some damaged cells may survive in a modified form, which could potentially result in cancer. Some cells may die from the exposure to radiation.

Other health effects occur to organs and the whole body. Effects from low doses of radiation (tens of, rems) may include birth defects and genetic effects. High doses of radiation (hundreds of rems) over short periods of time may cause organ damage and, if high enough, death. Doses

associated with exposures to natural background radiation or typical radioactive materials in POTWs are thousands of times lower than the high doses that cause significant biological damage.

At low doses, the principal concern associated with radiation exposure is the possible occurrence of cancer years after the exposure occurs. Other effects such as birth defects and genetic effects are not likely. For such low doses, the likelihood of producing cancer has not been directly established because it is not possible to distinguish cancers produced by such low levels of radiation from cancers that occur normally. The risk of developing cancer is usually expressed in terms of probability of an adverse health effect because a given dose of radiation does not produce a cancer in all cases.

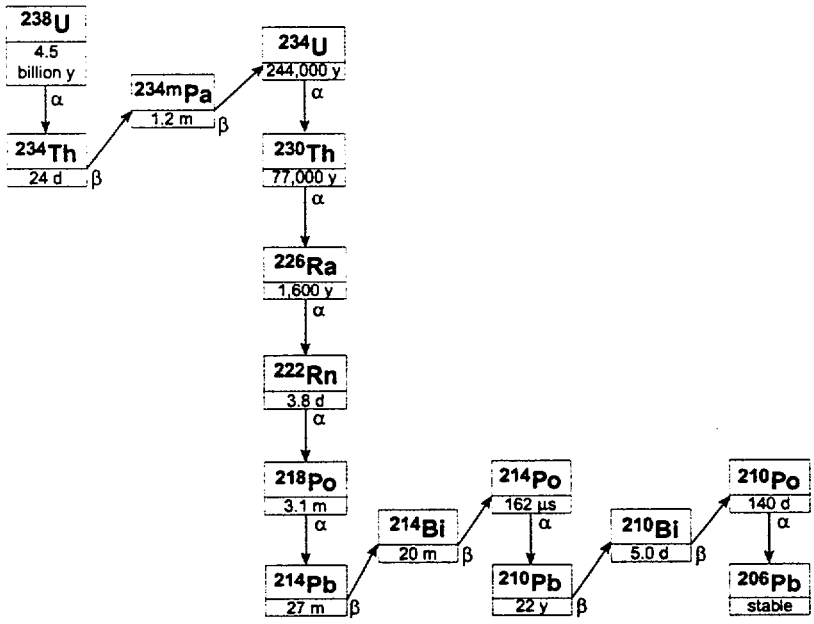


Figure A-1. Uranium (^{238}U) Decay Series.

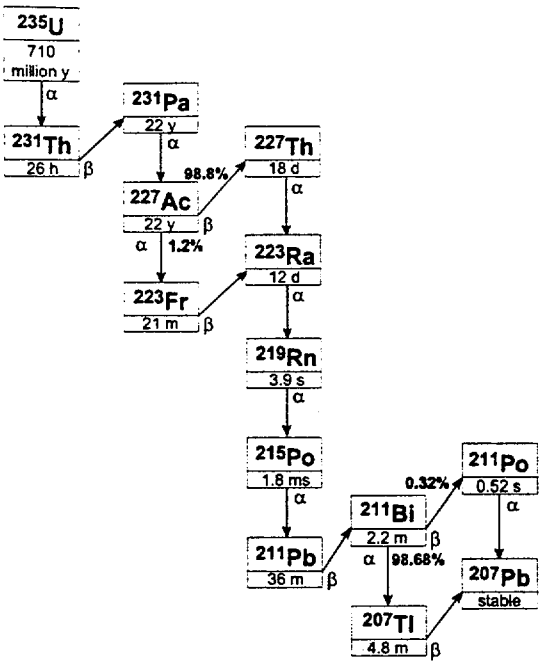


Figure A-2. Actinium (^{235}U) Decay Series.

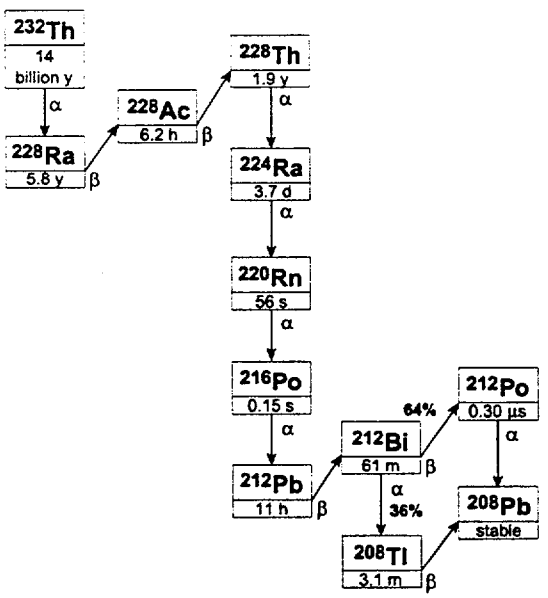


Figure A-3. Thorium (^{232}Th) Decay Series.

APPENDIX B
NRC AND EPA REGIONAL OFFICES BY STATE AND IDENTIFICATION OF AGREEMENT STATES

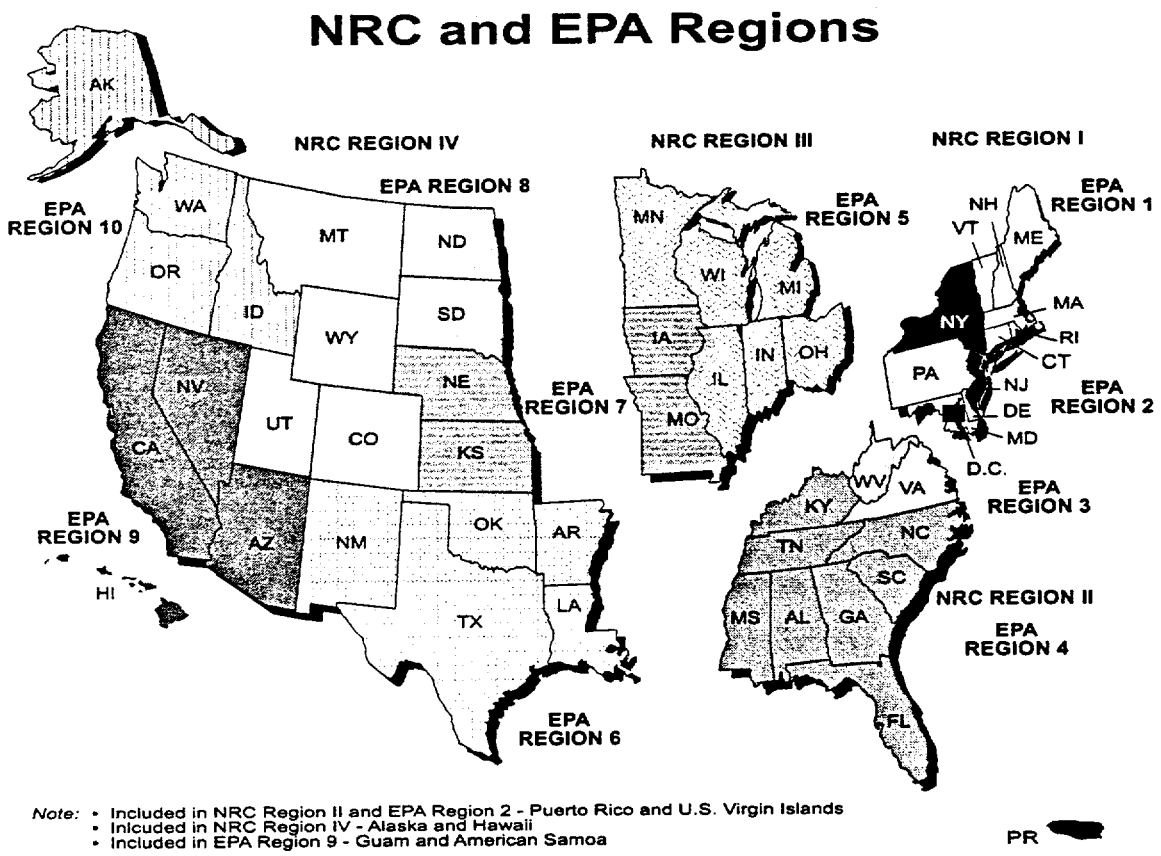
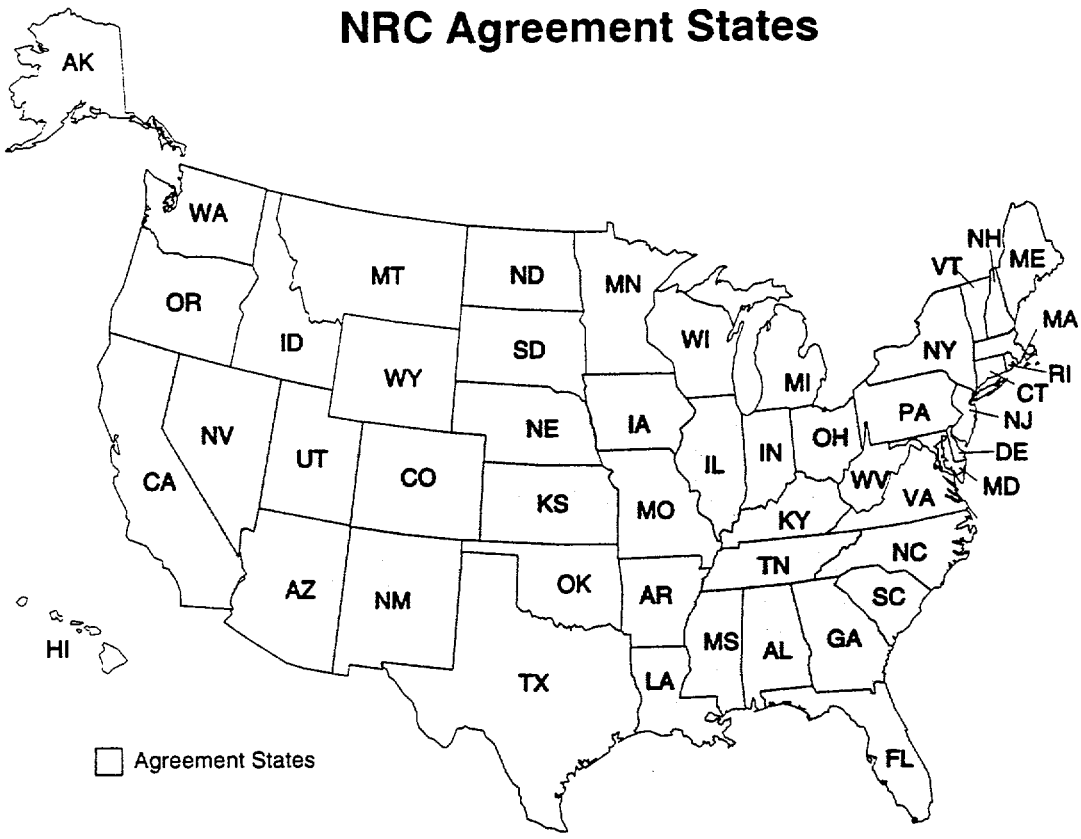


Figure B-1. Delineation of the NRC and EPA regions.



Source: Nuclear Regulatory Commission

Figure B-2. Delineation of NRC Agreement States.

APPENDIX C
NRC REGIONAL OFFICES

Region and address	Division of Nuclear Materials Safety	State Agreements Officer
Region I 475 Allendale Road King of Prussia, PA 19406-1415	(610) 337-5000	(610) 337-5042
Region II Sam Nunn Atlanta Federal Center 61 Forsyth St, SW Suite 23T85 Atlanta, Ga 30303-8931	(404) 562-4000	(404) 562-4704
Region III 801 Warrenville Road Lisle, IL 60532-4351	(630) 829-9500	(630) 829-9661
Region IV Harris Tower 611 Ryan Plaza Drive, Suite 400 Arlington, TX 76011-8064	(817) 860-8100	(817) 860-8116 (817) 860-8287

APPENDIX D
EPA REGIONAL OFFICES

EPA Radiation Program Managers	
Jim Cherniack, RPM USEPA Region 1 1 Congress St. Suite 1100 Boston, MA 02114-2023 Phone: (617) 918-1533 Fax: (617) 918-1505 http://www.epa.gov/region01/	Paul A. Giardino, RPM USEPA Region 2 290 Broadway New York, NY 10007-1866 Phone: (212) 637-4010 Fax: (212) 637-4942 http://www.epa.gov/region02/
Robert Kramer, RPM USEPA Region 3 1650 Arch Street Philadelphia, PA 19103-2029 Phone: (215) 814-2704 Fax: (215) 814-2101 http://www.epa.gov/region03/	Paul Wagner, RPM USEPA Region 4 Atlanta Federal Center 61 Forsyth Street, SW Atlanta, GA 30303-3104 Phone: (404) 562-9100 Fax: (404) 562-9066 http://www.epa.gov/region04/
Mike Murphy, RPM USEPA Region 5 (AE-17J) 77 West Jackson Boulevard Chicago, IL 60604-3507 Phone: (312) 353-6686 Fax: (312) 353-0617 http://www.epa.gov/region5/	Steve Vargo, RPM USEPA Region 6 (6PD-T) Fountain Place 12th Floor, Suite 1200 1445 Ross Avenue Dallas, TX 75202-2733 Phone: (214) 665-6714 Fax: (214) 665-6762 http://www.epa.gov/region06/
Robert Dye, RPM USEPA Region 7 (ARTD/RALI) 901 North 5th Street Kansas City, KS 66101 Phone: (913) 551-7605 Fax: (913) 551-7065 http://www.epa.gov/region07/	Milton W. Lammering, RPM USEPA Region 8 (P2-TX) 999 18th Street Suite 500 Denver, CO 80202-2466 Phone: (303) 312-6147 Fax: (303) 312-6064 http://www.epa.gov/region08/

EPA Radiation Program Managers (continued)	
Michael S. Bandrowski, RPM USEPA Region 9 (Air-6) 75 Hawthorne Street San Francisco, CA 94105 Phone: (415) 744-1048 Fax: (415) 744-1073 http://www.epa.gov/region09/	Jerry Leitch, RPM USEPA Region 10 (OAQ-107) 1200 Sixth Avenue Seattle, WA 98101 Phone: (206) 553-7660 Fax: (206) 553-0110 http://www.epa.gov/region10/

EPA Satellite Locations and Laboratories	
U.S. EPA National Air and Radiation Environmental Laboratory (NAREL) 540 South Morris Avenue Montgomery, AL 36115-2601 Phone: (334) 270-3400 Fax: (334) 270-3454 http://www.epa.gov/narel/	U.S. EPA Radiation and Indoor Environments National Laboratory P.O. Box 98517 Las Vegas, NV 89193-8517 Phone: (702) 798-2476 http://www.epa.gov/radiation/rienl/

APPENDIX E
STATE AGENCIES FOR RADIATION CONTROL
(as of March 4, 1999)

For an up to date listing of the State radiation control contacts given below, see the Conference of Radiation Control Program Directors' (CRCPD) web page at URL: http://www.CRCPD.org/ and then go to the "SR Control Agencies" tab.

Kirksey E. Whatley, Director Division of Radiation Control State Department of Public Health State Office Building 434 Monroe Street Montgomery, AL 36130-1701 Phone - (334) 206-5391	Douglas Dasher Alaska Department of Environmental Conservation 610 University Avenue Fairbanks, AK 99709 Phone - (907) 451-2172
Aubrey V. Godwin, Director Arizona Radiation Regulatory Agency 4814 South 40th Street Phoenix, AZ 85040 Phone - (602) 255-4845 ext. 222	Jared Thompson Division of Radiation Control & Emergency Management Department of Health 4815 West Markham Street, Slot 30 Little Rock, AR 72205-3867 Phone - (501) 661-2173
Edgar D. Bailey, C.H.P., Chief Radiologic Health Branch Food, Drugs & Radiation Safety Division State Department of Health Services P.O. Box 942732 Sacramento, CA 94234-7320 Phone - (916) 322-3482	Warren (Jake) Jacobi Laboratory and Radiation Services Division Colorado Department of Public Health and Environment 8100 Lowry Blvd Denver, CO 80220-6928 Phone - (303) 692-3036
Dr. Edward L. Wilds, Jr., Director Department of Environmental Protection Bureau of Air Management Division of Radiation 79 Elm Street Hartford, CT 06106-5127 Phone - (860) 424-3029	Allan Tapert, Program Administrator Office of Radiation Control Division of Public Health Plan Review, Permitting & Enforcement Federal and Water Streets, Room 224 P.O. Box 637 Dover, DE 19903 Phone - (302) 739-3787
Phillip Sumner, Supervisory Health Physicist Department of Health Environmental Health Administration 614 H Street, NW, Room 1016 Washington, DC 20001 Phone - (202) 727-7218	William A. Passetti, Chief Office of Radiation Control Department of Health 2020 Capital Circle SE, Bin# C21 (HSER) Tallahassee, FL 32399-1741 Phone - (850) 487-1004

Thomas E. Hill, Manager Radioactive Materials Program Department of Natural Resources 4244 International Parkway, Suite 114 Atlanta, GA 30354 Phone - (404) 362-2675	Russell Takata, Supervisor Radiation Section Noise, Radiation, and Indoor Air Quality Branch Department of Health 591 Ala Moana Boulevard Honolulu, HI 96813-4921 Phone - (808) 586-4700
Doug Walker INEEL Oversight Program Laboratory Improvement Section State Laboratories, Division of Health Department of Health and Welfare 900 N. Skyline Drive Idaho Falls, ID 83402 Phone - (208) 528-2617	Richard Allen, Manager Office of Environmental Safety Illinois Department of Nuclear Safety 1035 Outer Park Drive Springfield, IL 62704 Phone - (217) 782-1322
John Ruyack, Director Indoor and Radiologic Health Division State Department of Health 2 North Meridian Street, 5F Indianapolis, IN 46204-3003 Phone - (317) 233-1325	Donald A. Flater, Chief Bureau of Radiological Health Iowa Department of Public Health Lucas State Office Building 321 East 12th Street Des Moines, IA 50319 Phone - (515) 281-3478
Vick Cooper, Director X-Ray & RAM Control Section Bureau of Air & Radiation Department of Health & Environment Forbes Field, Building 283 J Street & 2nd North Topeka, KS 66620 Phone - (785) 296-1561	Vicki D. Jeffs, Supervisor Radioactive Materials Section Kentucky Radiation Control Program 275 East Main Street Frankfort, KY 40621 Phone - (502) 564-3700
J. Kilren Vidrine, ES Coordinator Office of Water Resources Louisiana Department of Environmental Quality P.O. Box 82215 Baton Rouge, LA 70884-2215 Phone - (225) 765-0534	Jay Hyland, Program Manager Radiation Control Program Division of Health Engineering State House, Station 10 157 Capitol Street Augusta, ME 04333 Phone - (207) 287-5677

Carl Trump Radiological Health Program Air and Radiation Management Administration Maryland Department of the Environment 2500 Broening Highway Baltimore, MD 21224 Phone - (410) 631-3300	Robert M. Hallisey, Director Radiation Control Program Department of Public Health 305 South Street, 7th Floor Jamaica Plain, MA 02130 Phone - (617) 727-6214
David W. Minnaar, Chief Radiological Protection Section Drinking Water & Radiological Protection Division Michigan Department of Environmental Quality 3423 N. Martin Luther King, Jr. Boulevard P.O. Box 30630 Lansing, MI 48909-8130 Phone - (517) 335-8197	Judith Ball Minnesota Dept of Health Environmental Health Division 717 Delaware St SE Minneapolis, MN 55440-9441 Phone - (651) 215-0945
Robert W. Goff, Director Division of Radiological Health State Department of Health 3150 Lawson Street P.O. Box 1700 Jackson, MS 39215-1700 Phone - (601) 987-6893	Gary W. McNutt, Environ. Specialist IV Bureau of Environmental Epidemiology Department of Health 930 Wildwood Drive P.O. Box 570 Jefferson City, MO 65102-0570 Phone - (573) 751-6160
George Eicholtz, Coordinator Radiological Health Program Montana Department of Public Health and Human Services Cogswell Building Licensure Bureau P.O. Box 200901 Helena, MT 59620-2951 Phone - (406) 444-5266	Richard P. "Dick" Nelson, Director Department of Regulation and Licensure Nebraska Health and Human Services 301 Centennial Mall South P.O. Box 95007 Lincoln, NE 68509-5007 Phone - (402) 471-2133
Stanley R. Marshall, Supervisor Radiological Health Section Department of Human Resources 400 West King Street, Room 101 Carson City, NV 89710 Phone - (702) 687-5394 x 276	Diane E. Tefft, Administrator Radiological Health Bureau Division of Public Health Services Health and Welfare Building 6 Hazen Drive Concord, NH 03301-6527 Phone - (603) 271-4588

Dr. Jill Lipoti Assistant Director for Radiation Protection Programs Division of Environmental Safety, Health & Analytical Programs Department of Environmental Protection P.O. Box 415 Trenton, NJ 08625-0415 Phone - (609) 984-5636	William Floyd Bureau of Hazardous & Radioactive Materials Water and Waste Management Division Department of Environment 2044 Galisteo Road P.O. Box 26110 Santa Fe, NM 87502 Phone - (505) 827-1862
Barbara Youngberg, Radiation Section Chief New York State Department of Environmental Conservation 50 Wolf Road Albany, NY 12233 Phone - (518) 457-2225	Wendy Tingle, Radioactive Waste Coordinator Division of Radiation Protection 3825 Barrett Drive Raleigh, NC 27609-7221 Phone - (919) 571-4141
Dana K. Mount, Director Division of Environmental Engineering Department of Health 1200 Missouri Avenue, Room 304 P.O. Box 5520 Bismarck, ND 58506-5520 Phone - (701) 328-5188	Roger L. Suppes, Chief Ohio Department of Health Bureau of Radiological Health 35 East Chestnut Street P.O. Box 118 Columbus, OH 43266-0118 Phone - (614) 644-2727
Mike Broderick, Environmental Program Administrator Department of Environmental Quality Radiation Management Section 1000 NE 10th Street Oklahoma City, OK 73117-1212 Phone - (405) 702-5100	Ray D. Paris, Manager Radiation Protection Services State Health Division 800 N.E. Oregon Street Portland, OR 97232 Phone - (503) 731-4014 x 660
William Kirk, Section Chief Environmental Monitoring Bureau of Radiation Protection 400 Market Street P.O. Box 8469 Harrisburg, PA 17101 Phone - (717) 783-9730	Marie Stoeckel, Chief Division of Occupational & Radiological Health Department of Health 3 Capital Hill, Room 206 Providence, RI 02908-5097 Phone - (401) 222-2438

Pearce O'Kelley, Chief Bureau of Radiological Health Department of Health & Environ. Control 2600 Bull Street Columbia, SC 29201 Phone - (803) 737-7403	Virgil R. Autry, Director Division of Radioactive Waste Management Bureau of Solid and Hazardous Waste Department of Health & Environmental Control 2600 Bull Street Columbia, SC 29201 Phone - (803) 896-4244
Eric Meintsma Department of Environmental and Natural Resources Surface Water Quality 523 E. Capital St. Pierre, SD 57501 Phone - (605) 773-3351	Debra Shults Division of Radiological Health Department of Environment and Conservation L&C Annex, 3rd Floor 401 Church Street Nashville, TN 37243-1532 Phone - (615) 532-0426
Charles R. Meyer, Chief Bureau of Radiation Control Texas Department of Health 1100 West 49th Street Austin, TX 78756-3189 Phone - (512) 834-6688	William J. Sinclair, Director Division of Radiation Control Department of Environmental Quality 168 North 1950 West P.O. Box 144850 Salt Lake City, UT 84114-4850 Phone - (801) 536-4250
Paul E. Clemons, Chief Division of Occupation & Radiological Health Department of Health 108 Cherry Street P.O. Box 70 Burlington, VT 05042 Phone - (802) 865-7731	Leslie P. Foldesi, M.S., CHP Director, Radiological Health Program Commonwealth of Virginia Department of Health P.O. Box 2448 Richmond, VA 23218 Phone - (804) 786-5932
Terry C. Frazee, Supervisor Radioactive Materials Section Division of Radiation Protection 7171 Cleanwater Lane, Bldg 5 P.O. Box 47827 Olympia, WA 98504-7827 Phone - (360) 236-3221	Beattie DeBord, Chief Radiological Health Program 815 Quarrier Street Charleston, WV 25301 Phone - (304) 558-3526

Paul Schmidt, Manager Radiation Protection Unit Bureau of Public Health Department of Health & Family Service P.O. Box 309 Madison, WI 53701-0309 Phone - (608) 267-4792	Larry Robinson Water Quality Division Wyoming Department of Environmental Quality 122 West 25th Street Herschler Building Cheyenne, WY 82002 Phone - (307) 777-7075
David Saldana Puerto Rico 787-274-7815	

APPENDIX F
EXAMPLES OF POTWS THAT HAVE RADIONUCLIDE MATERIALS PROGRAMS

Albuquerque, New Mexico

The City of Albuquerque has drafted a Radioactive Discharge Monitoring Program (RDMP). This will be a voluntary program of monitoring and reporting. The Albuquerque POTW has found they have the responsibility to be aware of all discharges to the sewer system that could impact operations at the treatment plant or impact the health and safety of employees and the public. The POTW will implement a program of discharger registration that requires dischargers to (1) periodically report their radionuclide discharges, (2) allow the POTW to perform surveillance monitoring, and (3) commit to voluntarily limit their discharges to levels that are as low as reasonably achievable (ALARA). These registrations will be issued and monitoring of the discharges will be permitted in accordance with a city sewer use and wastewater control ordinance. The agreement could be in the form of an amendment to an existing sewer discharge permit.

The Albuquerque POTW obtained a list of licensed radioactive materials users in the municipal service area from the appropriate regulatory authority (New Mexico is an Agreement State). Each of the licensees was evaluated to determine whether or not they discharge or have the potential to discharge radioactive materials to the sewer. This included an initial walk-through to familiarize the RDMP staff with the nature of the operation and potential opportunities for waste minimization.

The POTW will negotiate discharge limits with the dischargers so that the aggregate regulated discharges from all licensed facilities is ALARA and produces no greater than 1 in 10,000 excess risk of fatal cancer to the most exposed individual. The POTW will work with potential dischargers to prevent accidental releases of radioactive materials.

The Albuquerque POTW retains a certified Health Physicist to interpret the reports from the dischargers and from monitoring the dischargers and the treatment facility. The health physicist uses radiation exposure models to ensure the radiation dose to the "most exposed" individual is ALARA.

The dischargers will be asked to provide annual reports regarding the discharges they have made or plan to make to the sewer. In addition, the RDMP staff collects samples from the facilities' sample locations on a regularly scheduled basis and/or unannounced. The samples are analyzed by the State. To date the radionuclides found in the sewage have been of medical origin. Gamma radiation detectors installed in the plant have indicated that no measurable radiation exposure is being received by plant workers.

Formal adoption of the RDMP plan awaits passage of a revised sewer use and wastewater control ordinance. It has been stalled for more than 2 years due to its "political sensitivity." Unless there is a demand by dischargers for the change to occur, the situation will remain "as is."

St. Louis, Missouri

The City of St. Louis has its own requirements to limit radioactive discharges from industrial users. The district is concerned that low-level radioactive materials being discharged to the sewer system by numerous small sources may be concentrated by the district's wastewater treatment processes and possibly pose a hazard for the employees and adversely affect the district's sludge disposal options.

The District Ordinance for sewer use contains a limit of 1 curie/yr for the aggregate discharge from all users in a watershed (except excreta from individuals undergoing medical treatment or diagnosis). This number is currently under review.

The district requested lists of licensees from the NRC and the State and wrote the licensees letters informing them of the limits for radionuclide dischargers. Licensees are required to write the sewer district requesting approval to discharge radioactive materials and indicating the isotopes and the amounts to be discharged annually. The district then approves the discharges. The district requires quarterly reports from the licensees to ensure compliance with the District Ordinance and State and Federal regulations. The licensee's discharge permit is then modified to incorporate the approval of discharges and the reporting requirements.

As alternatives to discharging to the sewer system, licensees are encouraged to consider shipping the waste to an approved low-level radioactive waste disposal site or storing the waste for at least ten half-lives to allow sufficient decay to background levels prior to disposal to the sewer.

Oak Ridge, Tennessee

In response to its sewage sludge contamination problems (see Section 1.2), Oak Ridge developed a site-specific, risk-based methodology for establishing radionuclide limits for its sewage sludge. The sewage sludge criteria were then used to determine allowable plant releases that provided a basis for setting facility specific discharge criteria through the city's existing pretreatment program. Additionally, the city included a "radioactive materials" section in its pretreatment questionnaire which is filled out by all industrial users. The city also established an inexpensive screening program designed to ensure that elevated levels of radionuclides from spills or illegal discharges, would not reach the land application site.

The city of Oak Ridge was strongly supported by Tennessee's state radiation control program. Also aiding in the success of the program was ORWTP's close working relationship with local industry. The city of Oak Ridge expended considerable effort in developing a program that controlled radionuclide discharges in a manner that was not detrimental to local industry and still provided protection for the POTW.

APPENDIX G
GLOSSARY AND ACRONYMS

AEA ... Atomic Energy Act

Agreement State ... States with formal agreements with NRC that grant the states the authority to develop and oversee the implementation of specific regulations regarding the generation and use of AEA material and maintain radiation protection programs that are adequate to protect public health and safety compatible with that of the NRC.

Background Radiation ... Radiation from cosmic sources, *naturally occurring radioactive material (NORM)*, including radon (except as a decay product of *source* or *special nuclear material*), and global fallout as it exists in the environment from the testing of nuclear explosive devices or from nuclear accidents like Chernobyl which contribute to *background radiation* and are not under the control of the cognizant organization. *Background radiation* does not include radiation from *source, byproduct*, or *special nuclear materials* regulated by the cognizant Federal or State agency.

Becquerel (Bq) ... The International System (SI) unit of activity equal to one nuclear transformation (disintegration) per second. 1 *(Bq)* = 2.7×10^{-11} *curies* (Ci) = 27.03 picocuries.

Byproduct Material ... In general, any radioactive material (except *special nuclear material*) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing *special nuclear material.*

Contamination ... The presence of *elevated levels of radiation* where you don't want it.

CPM ... counts per minute

Curie ... The customary unit of radioactivity. One *curie* (Ci) is equal to 37 billion atomic disintegrations per second (3.7×10^{10} dps = 3.7×10^{10} Bq), which is approximately equal to the decay rate of one gram of ^{226}Ra. Fractions of a *curie*, e.g., picocurie (pCi) or 10^{-12}Ci and microcurie (μCi) or 10^{-6} Ci, are levels typically encountered in the environment.
microcurie **(μCi)** ... one one-millionth (1/1,000,000) of a curie
picocurie **(pCi)** ... one one-trillionth (1/1,000,000,000,000) of a curie

Elevated Levels of Radiation ... Levels of radioactive material in sewage sludge or ash that should alert a POTW that some appropriate action(s) may be warranted (see Section 1 of the report).

Exposure Rate ... The amount of ionization produced per minute in air by X-rays or gamma rays. The unit of exposure rate is roentgens/hour (R/h); typical units are microroentgens per hour (μR/h), i.e., 10^{-6} R/h.

Gamma Radiation ... Penetrating high-energy, short-wavelength electromagnetic radiation (similar to X-rays) emitted during *radioactive decay*. Gamma rays are very penetrating and require dense materials (such as lead or steel) for shielding.

HP ... Health Physicist

ISCORS ... The Interagency Steering Committee on Radiation Standards.

NARM ... Naturally occurring or accelerator-produced radioactive material, such as radium, and not classified as *source material*.

Naturally Occurring Radionuclides ... Radionuclides and their associated progeny produced during the formation of the earth or by interactions of terrestrial matter with cosmic rays.

NORM ... Naturally-occurring radioactive materials.

Radioactivity (or activity) ... The mean number of nuclear transformations occurring in a given quantity of radioactive material per unit of time. The International System (SI) unit of radioactivity is the *becquerel (Bq)*. The customary unit is the *curie (Ci)*.

Radioactive Half Life ... The time required for one-half of the atoms of a particular *radionuclide* present to disintegrate.

Radioactive Decay ... The spontaneous transformation of an unstable atom into one or more different nuclides accompanied by either the emission of energy and/or particles from the nucleus, nuclear capture or ejection of orbital electrons, or fission. Unstable atoms decay into a more stable state, eventually reaching a form that does not decay further or has a very long *radioactive half-life*.

Radionuclide ... An unstable nuclide that undergoes *radioactive decay*.

Reconcentration ... The increase in the concentration of radioactive materials in sewage sludge or ash resulting from wastewater and sludge treatment within the POTW.

rem (radiation equivalent man) ... The conventional measurement unit of radiation dose for estimating the body's effects from exposure to ionizing radiation. The corresponding International System (SI) unit is the *sievert (Sv)*: 1 Sv = 100 rem.
millirem ... one one-thousandth (1/1,000) of a rem
microrem ... one one-millionth (1/1,000,000) of a rem

Roentgen (R) ... intensity of photon (gamma or x-ray) radiation.
microroentgen (μR) ... one one-millionth (1/1,000,000) of a roentgen.

Source Material ... In general, uranium and/or thorium other than that classified as *special nuclear material.*

Special Nuclear Material ... In general, plutonium, ^{233}U, and uranium enriched in ^{235}U; material capable of undergoing a fission reaction.

TENORM ... Naturally occurring radioactive materials whose concentrations are increased by or as a result of past or present human practices. TENORM does not include background radiation or the natural radioactivity of rocks or soils. TENORM also does not include uranium or thorium in source material as defined in the AEA and NRC regulations.

APPENDIX H
SOURCES OF ADDITIONAL INFORMATION

ASTM E 181-82 (Reapproved 1991), "Standard General Methods for Detector Calibration and Analysis of Radionuclides," American Society for Testing and Materials, Philadelphia, Pennsylvania 19103.

CRCPD Publication 94-1, "Directory of Personnel Responsible for Radiological Health Programs," Conference of Radiation Control Program Directors, Inc., Frankfort, Kentucky 40601.

Miller, W.H., et al, 1996, "The Determination of Radioisotope Levels in Municipal Sewage Sludge," Health Physics, v. 71, no. 3, p. 286.

Miller, M.L., Bowman, C.R., an M.G. Garcia, 1997, "Avoiding Potential Problems ...

NCRP Report No. 50, "Environmental Radiation Monitoring," 1976, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

NCRP Report No. 58, "A Handbook of Radioactivity Measurement Procedures." 1985, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

APPENDIX I
ADDITIONAL INFORMATION ON NRC AND AGREEMENT STATE LICENSING AND ENFORCEMENT

This appendix provides additional information about how NRC and Agreement States License users of radioactive materials, and how the agencies enforce the regulations.

Who Must Obtain a License and What Happens If this Isn't Done?

According to NRC's 10 CFR Part 30, Section 30.3:

> Except for persons exempt as provided in this part and Part 150 of this chapter, no person shall manufacture, produce, transfer, receive, acquire, own, possess, or use byproduct material except as authorized in a specific or general license issued pursuant to regulations in this chapter.

This means that, with a few specified exceptions, any activity involving byproduct material must be conducted under a license issued by the NRC or an Agreement State. The exempt activities are described in NRC's 10 CFR Part 30. Most exemptions from specific licensing are for consumer products, such as smoke detectors.

Persons who are required to obtain an NRC license but fail to do so would be in violation of federal law and, when discovered, would be subject to the penalties appropriate for such violations. In any case, such persons would most likely be unable to obtain the byproduct materials they need, because suppliers of such materials generally require copies of the license authorizing possession and use of the materials before the materials are delivered to the user.

What Radioactive Materials Are Exempt from Licensing?

Section 30.3 cited above mentions certain exemptions from the NRC licensing requirements. These exemptions include certain DOE activities and also users of articles containing byproduct materials in concentrations and quantities below specified levels. These articles include some instruments containing luminous dials, such as timepieces, balances, marine compasses, electron tubes, gas or smoke detectors, and some other products. It should be noted that the manufacturers and distributors of these exempt devices are subject to NRC licensing.

In addition to the above, some radioactive materials may be exempt from licensing because they fall below NRC-established concentration or quantity levels. These levels do not apply to materials that have already been licensed but have for some reason, such as decay, diminished to activities below these levels. The exemption applies only to the initial determination of whether or

not a potential user or owner of byproduct material needs to be licensed or is exempt from such a requirement. Once licensed, byproduct material remains under the conditions of the license regardless of how small the activities become because of decay or any kind of partitioning of the original licensed quantity.

Why Are Some Industrial and Medical Facilities Not Licensed?

Some facilities that use radioactive materials may not be licensed by the NRC if the material they use is not byproduct material. Examples of such facilities would be those that use accelerators or accelerator-produced radioactive materials. However, even though such facilities may not come under NRC's jurisdiction, and are therefore not licensed by the NRC, they are usually within the jurisdiction of a state and may be licensed by that state if their activity requires licensing. Exceptions to this may be certain federal facilities and their prime contractors, such as DOE facilities which, although not licensed by NRC or the states, are regulated by internal DOE Orders.

What Monitoring/Oversight Do NRC and the Agreement States Provide for Licensees under Their Control?

Both NRC and Agreement States monitor their licensees by means of periodic inspections. The frequency of inspections depends on the type of license issued to the licensee, and will vary from annual inspections for the larger licensees, such as hospitals, radiopharmaceutical companies, and other large users of byproduct materials, to inspections once every 3-5 years for small licensees who may use only one small radioactive source in a routine and well-established application. The inspections are designed to review the licensee's operation to make sure that it is being conducted safely and in accordance with good practices and the conditions specified on the license. Inspection frequencies may be increased if the NRC or Agreement State believes that the licensee requires closer oversight to implement improvements in their program to raise its standards. In addition, the license may be suspended or revoked if NRC or the Agreement State finds that the licensee's operation does not meet minimum safety standards.

Some facilities may be under the jurisdiction of more than one entity, such as many medical facilities that are licensed by NRC for those parts of their operation that use byproduct materials, and by the state in which they operate for those parts that use accelerator-produced radioactive materials. Most states regulate naturally-occurring and accelerator-produced radioactive materials.

What Causes Discharges Outside of Regulations or License Conditions?

The probable causes of illegal discharges are poor licensee programs, lack of knowledge of the regulations, or deliberate violations. Discharges to the sanitary sewers by NRC or Agreement State licensees must comply with NRC or equivalent Agreement State regulations governing this aspect of the licensee's operation. There are many mechanisms in place to provide reasonable

assurance that licensees will comply with this regulatory requirement. Licenses are issued to licensees only after NRC or the Agreement State is satisfied that the licensee has the qualified staff, equipment, procedures, instrumentation, training programs, and management oversight deemed necessary to operate the proposed program in a safe manner and within the restrictions specified in the license. Any signs of program weaknesses or irregular activities identified during inspection are brought to the licensee's attention for corrective action, and if these are found to be sufficiently serious, the license may be suspended pending completion of corrective actions, or revoked, thereby ending the licensee's use of licensed materials.

All these measures cannot prevent illegal discharges to the sewers, but they help to minimize such a possibility, and they provide an opportunity to identify such illegal activities if they occurred.

What Enforcement Actions Do NRC and Agreement States Take When Licensees Discharge Outside Regulations or License Conditions?

The enforcement actions that could be taken in such cases depend on the specifics of the situation. If the discharge above the limits is found to have been a one-time, inadvertent error in an otherwise sound program, the licensee could be issued a violation and the licensee's management may be called to the NRC or state offices for a meeting with NRC or state management to discuss the incident and the corrective actions the licensee intends to take to prevent recurrence. The NRC or state may also issue a letter to the licensee summarizing the corrective actions to be taken and the completion schedule. Follow-up inspections might be used to confirm completion of the corrective actions and their adequacy. The NRC and some States could also impose monetary penalties.

If, on the other hand, the discharge above the limits is found to be the result of a generally poor program, additional and more escalated enforcement actions could be taken to change the licensee's program. Such changes may involve hiring more competent professionals or managers, retraining of personnel, rewriting operating procedures, and any other measures that may be needed to improve the quality of the program. The program is then monitored closely. In more serious cases, the license could be revoked. In situations where willfulness is found and the matter is under NRC jurisdiction, the matter could be referred to the Department of Justice for appropriate legal action. If the matter is under State jurisdiction, it could be referred to the State Attorney General.

APPENDIX J
RADIOLOGICAL ANALYSIS LABORATORIES

The table below provides a list of laboratories that should be able to provide radiological analyses of sewage sludge samples for POTWs. A list is maintained by the Conference of Radiation Control Program Directors (CRCPD) of laboratories that provide radiological analysis of diverse materials, have quality assurance and quality control programs, and will perform work for both government and private firms. The laboratories listed here are those from the January 2000 CRCPD list that have indicated they perform analyses of sludge samples. The list is available from the CRCPD by phone at 502/227-4543, and is posted to the CRCPD web page, at URL: http://www.CRCPD.org (then go to the "Free Documents" tab, then to "Orphan Source Documents," and then to "Radioassay and TCLP Services"). The list is updated periodically by the CRCPD. The CRCPD does not guarantee that the list is comprehensive, nor is there any certification of the quality of services provided. Thus, the authors of this report provide this list only as a convenience to POTWs in locating laboratories that they may wish to evaluate. The NRC, EPA, and the ISCORS Sewage Sludge Subcommittee do not certify, approve, or endorse these laboratories. Section 5.4.2 of this guidance document provides criteria that POTWs can use to help evaluate laboratories.

Firm	State	Contact person	Phone
Accu-Labs Research, Inc.	Colorado	Karen Schoendaler	303/277-9514
Barringer Laboratories	Colorado	Gerald Ritenour	800/654-0506
Envirotest (nee Core Labs)	Wyoming	Dave Demorest	307/235-5741
Data Chem	Utah	Kevin Griffiths	801/266-7700
Duke Engineering (Yankee Atomic)	Massachusetts	Edward Maher	978/568-2522
General Engineering Labs	South Carolina	J. Westmoreland	843/556-8171
Kentucky Radiation Control Branch	Kentucky	Eric Scott	502/564-8390
Nuclear Technology Service	Georgia	Herman Rao	770/663-0711
Paragon Analytical Inc	Colorado	Lori Pacheco	800/443-1511
Pembroke Laboratory	Florida	Gene Whitney	941/285-8145
Quanterra (multiple labs)	Washington (main office)	Project manager	509/375-3131
Post, Buckley, Schuh & Jernigan	Florida	Tom French	407/277-4443
Rhode Island Nuclear Science Center	Rhode Island	Terry Tehan	401/789-9391
RSA Labs	Connecticut	Jay Dockendorff	860/228-0721
Teledyne-Brown Engineering	New Jersey	Alan Latham	201/664-7070
Teledyne-Brown Engineering	Illinois	Ms. Grob	847/564-0700
ThermoRetech	California	Rod Melgard	510/235-2633
ThermoRetech	Tennessee	Mike McDougal	423/481-0683
ThermoRetech	New Mexico	Ernie Sanchez	505/345-3461
Thornton Laboratories, Inc.	Florida	Drey Taylor	813/223-9702
Univ. of Iowa, State Hygienic Lab	Iowa	Marinea Mehrhoff	319/335-4500
Wisconsin State Hygiene Laboratory	Wisconsin	Lynn West	608/224-6227

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF NEW MEXICO

INTERSTATE NUCLEAR SERVICES, CORP.,

Plaintiff,

v.

No. CIV 98-1224 BB/KBM

THE CITY OF SANTA FE,

Defendant.

AFFIDAVIT OF ELISABETH STETAR

STATE OF TENNESSEE)
) ss
COUNTY OF DAVIDSON)

Elisabeth Stetar, being first duly sworn, deposes and states as follows:

1. My name is Elisabeth Stetar. The matters set forth below are true based on my knowledge, information and belief.

2. I reside in Nashville, Tennessee. My business address is: Performance Technology Group, Inc., 1210 Seventh Avenue North, Nashville, Tennessee 37208-2606.

3. I received my B.S. degree in Biology, Magna Cum Laude, from Middle Tennessee State University in 1983. In 1990, I received a Department of Energy ("DOE") operational health physics fellowship. I received an M.S. in Health Physics in 1992 from Colorado State University.

4. Since 1992, I have been certified by the American Board of Health Physics (comprehensive certification).

5. I have had a Q clearance with the DOE since 1992.

6. I have been employed since 1992 as a health physics consultant for Performance Technology Group, Inc., in Nashville, Tennessee. I provide technical support to governmental

EXHIBIT
B

agencies and private industry in the areas of environmental transport, environmental monitoring, and regulatory compliance for radioactive materials. I have assisted private industries in the development of environmental monitoring and radiation protection programs. Additionally, since 1998, I have been a consultant to the Tennessee Department of Environment and Conservation, providing technical review of the DOE's decontamination and decommissioning of the Oak Ridge Reservation.

7. Prior to my work as a consultant, I was employed by the State of Tennessee's Division of Radiological Health. My work with the Division included managing a statewide environmental monitoring program and performing licensing reviews and compliance inspections for complex radioactive materials facilities — including two of the nation's largest processors of low-level radioactive waste.

8. In 1984, through my work with the Tennessee Division of Radiological Health, I became aware that radioactive materials, when discharged to sanitary sewers, reconcentrate in the sludges that are produced during the sewage treatment process. While I was employed by the Division of Radiological Health, radioactive contamination was discovered in POTWs in Oak Ridge and Erwin, Tennessee. As the State's representative, I worked closely with these municipalities in the technical assessment, analysis, and remediation of their POTWs.

9. I have performed research through the Oak Ridge National Laboratory on the behavior of radionuclides in sanitary sewers and municipal wastewater treatment plants. In 1994, I assisted the Pacific Northwest Laboratory in its development of a report for the Nuclear Regulatory Commission ("NRC") titled, "Reconcentration of Radioactive Material Released to Sanitary Sewers in Accordance with 10 CFR 20," NUREG/CR-6289. A full list of my publications in the area of

reconcentration of radioactive materials in wastewater treatment systems is contained in my curriculum vitae, which is attached hereto as Exhibit ("Ex.") 1.

10. From 1992 through the present, I have provided technical and regulatory compliance assistance to the City of Oak Ridge ("Oak Ridge") on issues involving radioactive material discharges to its POTW. I have participated in Oak Ridge's pretreatment permitting and inspection of radioactive materials dischargers.

11. I have been asked by the City of Santa Fe ("Santa Fe"): (1) to explain the risks to municipalities like Santa Fe presented by radionuclide discharges to their POTWs; (2) to detail the efforts of other municipalities and states to address the problem of reconcentration of radionuclides in POTW systems and POTW effluent and by-products; (3) to assemble and review documentation regarding INS' discharges to municipal POTWs in Vicksburg, Mississippi, Portsmouth, Virginia, and Royersford, Pennsylvania; (4) to analyze the risk to Santa Fe's POTW and sludge by-products resulting from discharges to Santa Fe's POTW from INS' facility; and (5) to render opinions and conclusions on the need for regulation of radionuclide discharges to Santa Fe's POTW to prevent contamination of the POTW and its sludge by-products.

Radionuclide Contamination of POTWs - Risk and Regulatory Status

12. The scientific and regulatory communities have been aware of the problem of reconcentration of radionuclides in sewage sludge in POTWs since the early 1980s. In recent years, elevated levels of radionuclides have been discovered in the biosolids from a number of wastewater treatment plants across the United States that receive radioactive material discharges. By "elevated levels," I mean radionuclide concentrations that are above those that have historically been considered acceptable, by the NRC and Agreement State programs, for soils that are released for

unrestricted use by the public.

13. I am aware that, since the early 1980s, elevated levels of radioactive materials have been discovered, usually inadvertently, in the sludges from a number of POTWs. Some of the documented case histories include the presence of elevated levels of americium-241 in Tonawanda and Grand Island, New York; cobalt-60 and cesium-137 in Oak Ridge; uranium in Erwin; manganese-54 and cobalt-60 in Royersford; thorium-232 in Portland, Oregon; and cobalt-60 in Cleveland, Ohio.

14. At present there are no NRC or Agreement State standards that establish uniform soil clean-up criteria. Instead, soil clean-up levels are usually developed on a case-by-case basis. In some instances, a clean-up level established for the decommissioning of a specific facility has been applied generically to other sites, as was the case at the Northeast Ohio Regional Sewer District in Cleveland.

15. NRC and Agreement State regulations allow facilities licensed by the NRC or Agreement States to discharge radioactive materials to public sewers provided certain criteria are met. For New Mexico, these criteria are contained in 20 NMAC 3.1 § 435, which mirrors the NRC's regulations found at 10 CFR § 20.2003.

16. Radionuclide concentrations are not included in the Environmental Protection Agency's ("EPA's") standards for POTW sludges (40 CFR 503), even though POTWs are required by the federal Clean Water Act to prevent any pollutant, including radioactive materials, from interfering with their treatment systems.

17. The radioactivity issues a POTW must address will depend on the types of radioactive materials that are discharged to the sewer system. Several medical radioisotopes are commonly

discharged to public sewers. Because medical radionuclides are typically short-lived (i.e., they decay quickly into stable materials), they rarely present a problem of reconcentration in biosolids. While such discharges cannot be ignored by POTWs simply because of their typically short-lived half-lives, they do not present the contamination/remediation hazard associated with the longer-lived radionuclides.

18. In the case of radionuclides with long half-lives, the primary concern for municipalities is the potential for these materials to concentrate in the POTW sludge, potentially making it unacceptable for handling and/or disposal by economically feasible methods. The NRC did not consider this potential for reconcentration in developing its original sewer discharge criteria. Additionally, the NRC did not consider the possibility that POTWs would receive radionuclide discharges from more than one licensee.

19. In 1994, the NRC modified its sewage release regulations, now found at 10 CFR § 20.2003, to require that, with the exception of biological materials, radionuclides can be discharged only in soluble form. The modification was motivated by concerns regarding POTW contamination. There are, however, no assurances that the modified regulation will eliminate the reconcentration problem, even if it is enforced. A study I conducted in 1990 demonstrates that even soluble radioactive materials are, to some extent, removed and concentrated in biosolids (Stetar, et al., 1993, Aynesworth, et al. 1994). For example, I found that 30% of the soluble radioactive cobalt that was mixed into raw sewage was removed with solids during treatment (i.e., became incorporated with the sludge). The NRC also modified their regulations to reduce the concentrations of radionuclides that can be discharged to sewers. However, the modified regulation does not reduce the total quantity of materials that can be discharged by a single licensee or the potential for multiple

licensees to discharge to the same POTW. Even if discharges are soluble, the total quantity of long-lived radionuclides discharged to a POTW must be significantly less than the current NRC limit if radionuclide concentrations in the sludge are to be maintained at levels that will ensure the material can be disposed of via traditional sludge disposal methods (e.g., land application and disposal in solid waste landfills).

Local Governmental Efforts to Address Reconcentration Problem

20. In 1984, elevated radiation levels were discovered in Oak Ridge's sewer system (i.e., 5 times the normal background radiation levels) and elevated concentrations of radionuclides were discovered in the POTW sludge. The concentrations of cobalt-60 and cesium-137 in the POTW sludge found at that time were significantly higher than the levels generally considered acceptable for unrestricted soils. For example, the cobalt-60 and cesium-137 concentrations were roughly 45 and 10 times higher, respectively, than the corresponding NRC soil criteria. Additionally, in some locations the radionuclide concentrations in the land application site soils were found to be above the NRC's soil criteria. Because it was deemed to be contaminated, the land disposal site was closed and could no longer be used by the City for sludge disposal. Some of Oak Ridge's contaminated sludge had also been placed in sludge drying beds located next to a city park. The presence of this contaminated sludge prevented Oak Ridge's intended expansion of the park until 1990, when the licensee considered responsible for the contamination removed the material.

21. The Oak Ridge sludge had previously been disposed of by land application (spreading) on DOE property. DOE threatened to prohibit further sludge spreading due to concerns over the potential need for future remediation of the land application site.

22. In response to its sludge contamination problems, Oak Ridge worked with the

dischargers and state regulators to reduce the levels of radionuclides entering the sewer system. These efforts resulted in substantial reductions in the radionuclide concentrations in the sludge. However, despite these reductions, Oak Ridge's ability to dispose of sludge via land application continued to be at risk. In the absence of federal standards that establish safe levels of radionuclides in POTW sludges, the DOE feared that it would face significant remediation costs in the future and, therefore, frequently threatened to terminate the land application program. Thus, the radionuclide discharges were an ongoing interference to Oak Ridge's ability to carry out its wastewater treatment functions.

23. Oak Ridge deemed it necessary to retain a health physics consultant to help them address the impact of radionuclide discharges on their POTW. As a consultant to Oak Ridge, I developed radionuclide concentration limits for land application of the sludge and obtained approval for this approach from the Tennessee Department of Environment and Conservation. The sludge criteria were then used to set site-specific discharge limitations for each industrial discharger of radionuclides.

24. Pursuant to its Clean Water Act authority to prevent interference and pass-through, Oak Ridge currently enforces limits on the quantities of radionuclides that are discharged to the sewer through its industrial pretreatment permitting and inspection program. Oak Ridge's radionuclide quantity limits are more stringent than the NRC or NMED sewer release regulations, (10 CFR § 20.2003/20 NMAC 3.1 § 435), which limit the total quantity discharged for all radionuclides (except tritium and carbon-14) to 1 Ci per year. The Oak Ridge permit program also incorporates limits on discharges of individual radionuclides that are more stringent than the NRC/NMED limitations. For example, the total annual limit for discharges of cobalt-60 for all

dischargers in Oak Ridge, combined, is 0.04 Curies, while the NRC and NMED allow each individual discharger to discharge up to 1 Curie per year.

25. Neither the NRC nor the regulated entities (which include processors of uranium metal and low level radioactive wastes) have objected to the radionuclide discharge limitations imposed by Oak Ridge. The State of Tennessee, an Agreement State, has also been supportive of the Oak Ridge program. When contamination was first discovered in Oak Ridge's POTW, the State added a condition to all radioactive materials dischargers' licenses requiring discharges to meet more restrictive NRC discharge limits than are normally applied to sewage discharges. Subsequently, the State modified its own discharge regulations to reference these more restrictive limits. At present, the State of Tennessee's concentration limits for radioactive discharges are more restrictive than the NRC's.

26. In 1989, the City of Portland, Oregon ("Portland") learned that discharges of thorium oxide from a local titanium casting plant were accumulating in the sewer lines, in the POTW's sludges and in the sediments of the river into which the POTW discharges its liquid effluents. The POTW sludge was composted with other materials and sold directly to the public. In response to this situation, Portland, in conjunction with the Oregon Division of Health, ordered the discharger to install pretreatment facilities, to clean up the contaminated sewers, and to control discharges to ensure that the thorium concentrations in the POTW sludge did not exceed concentrations contained in sludge guidelines developed by the Oregon Division of Health. In July 1990, when it was determined that additional accumulations were occurring within the sewer lines, Portland and the Oregon Division of Health threatened sanctions against the dischargers and entered into a consent agreement with them requiring that the dischargers construct and operate more effective pretreatment

facilities.

27. St. Louis, Missouri has adopted a sewer use ordinance that specifically addresses radioactive materials. A significant aspect of the St. Louis ordinance is that it prohibits the discharge of "any radioactive material except those wastes which are authorized for disposal into sanitary sewers under applicable State and Federal regulations and as **specifically authorized by the Director**" of the sewer district. The St. Louis ordinance also mandates that the total amount of radioactivity from all dischargers not exceed 1 Curie annually, which is more restrictive than the NRC's allowance of a total of 1 Curie discharge for each user.

28. The Northeast Ohio Regional Sewer District in Cleveland regulates discharges of radiological materials to its system by use of questionnaires and permit conditions. The District restricts the concentrations of cobalt-60 that can be discharged to the sewer by a licensee to 100 pCi/l, whereas the NRC sewer discharge limit is 30,000 pCi/l.

Contamination Problems at POTWs That Receive Discharges From INS

29. It has been well documented that elevated levels of radionuclides have been found at several POTWs that have received discharges from INS laundries, including Royersford, Pennsylvania, Vicksburg, Mississippi, and Portsmouth, Virginia.

30. The Royersford POTW had a program of sludge disposal that included the transfer of sludge to farms in the surrounding area to be used as fertilizer. The NRC's investigation of contamination in the Royersford POTW, which is detailed in a 1989 NRC study ("Radiological Impacts of Effluent Releases to the Sanitary Sewer from Interstate Nuclear Services Corporation, Royersford, Pennsylvania"), revealed elevated concentrations of several radionuclides, including cobalt-60 and cesium-137, in the sludge that was being applied as fertilizer. Assuming a 10% solids

content for the liquid sludge, the cobalt-60 levels were as much as 100 times the 8 pCi/g criteria that was later applied by the NRC at Cleveland, Ohio's Southerly facility.

31. In 1988, at the Vicksburg, Mississippi POTW, INS' own sampling revealed concentrations of cobalt-60 up to 11 times the NRC soil release criteria, and concentrations of cesium-137 up to 8 times the NRC value of 15 pCi/g. The sampling data is contained in documents INS provided to the City of Vicksburg.

32. In 1991, in response to the accumulation of INS-discharged radionuclides in Portsmouth, Virginia's wastewater treatment system, the NRC, in a Confirmation of Action Letter, required INS to take several corrective actions, including the reduction of INS' radioactive discharges to concentrations that were 1/100 of the NRC maximum permissible discharge concentrations in place at that time (10 CFR 20).

33. In Springfield, Massachusetts, another municipality that has received INS discharges, INS' 1990 sample of the sewage treatment plant's compost (a mixture of sludge and yard wastes) demonstrated concentrations of cobalt-60 at 8.5 pCi/g, cesium-137 at 2.1 pCi/g, manganese-54 at 2.3 pCi/g, and zinc-65 at 6.55 pCi/g, the combination of which would render this material unacceptable for unrestricted release under NRC soil release guidelines. POTWs frequently make compost directly available to consumers. Thus, it is likely that this material would be expected to meet the criteria considered acceptable in soils available for unrestricted use by the public.

Potential for Radioactive Material Interference at the Santa Fe POTW

34. The current NRC (and NMED) sewage discharge criteria do not adequately protect municipal POTWs, including Santa Fe's, from the potential reconcentration of radionuclides to levels which would trigger NRC requirements for remediation of Santa Fe' sludge and sludge

products. For example, if a facility with discharge volumes comparable to those of the Santa Fe INS facility, were to discharge **soluble** cobalt-60 to the Santa Fe sewer system at the NRC concentration limits specified in 10 CFR § 20.2003, I estimate that the resulting sludge concentrations would be at least 30 pCi/g. Because there are no standards that establish safe levels of radionuclides in sludge, this level of cobalt-60—which is at least 4 times the concentration considered acceptable for soils released for unrestricted use—could jeopardize the City's ability to dispose of this material using traditional, economically feasible disposal methods.

35. The risk of reconcentration of radionuclides in the Santa Fe POTW is heightened by the history of contamination experienced at other POTWs receiving discharges from INS facilities and the fact that neither the existing, nor the proposed Santa Fe INS pretreatment system was designed to preclude the discharge of insoluble radionuclides to the sewer system. Regarding the latter, I have reviewed: (1) the results from sludge samples taken from INS' hold-up tank #2 on March 28, 1996. See *Ex. 2;* (2) a schematic of INS' facility as it existed in 1996, prior to Santa Fe's issuance of an Administrative Order requiring INS to cease its discharges to the POTW, see *Ex. 3;* and (3) official correspondence regarding the NRC's rejection of solubility criteria proposed by INS and NMED's failure to enforce their own regulation regarding solubility. See *Ex. 4.*

36. The sludge samples taken from INS' Santa Fe hold-up tank #2 *(Ex. 2)* indicate levels of cobalt-60 that are 40 times the NRC sewer discharge concentration limit, and levels of cesium-137 that are almost 10 times the NRC release concentration limit. These concentrations are of even greater concern because they are present in sludge, i.e., they would be almost completely insoluble.

37. The schematic *(Ex. 3)* indicates that there were no safeguards in place, prior to INS' shutdown by the City's 1996 Administrative Order, that would prevent the sludge held in INS tank

#2 from entering the sewer system during discharge of the tank's liquid contents. The fact that the sludge discovered in hold-up tank #2 was "the consistency of slimy oatmeal" which the technician was able to "pour" (see *Ex. 4*), would increase the potential for some of the sludge to be released during discharge of the tank.

38. From my review of Ex. 4, I have learned that the NMED previously has not enforced its own amendments mirroring the NRC's 1994 amendments to 10 CFR 20.2003 (20 NMAC 3.1 § 435) prohibiting the discharge of non-soluble radionuclides by INS to the City's POTW.

39. It is my professional opinion that the Santa Fe POTW faced a significant risk for interference from INS' radioactive discharges at the time Ordinance 1997-3 was enacted in light of the following circumstances:

(a) the NMED's non-enforcement of the solubility requirements of 10 CFR § 20.2003/20 NMAC 3.1 § 435;

(b) the high concentrations of radionuclides that were present as sludge in INS' hold-up tank #2;

(c) the continued potential for discharge of insoluble radionuclides from the INS facility to the POTW; and

(d) the complete lack of NRC or NMED standards that establish safe levels for radionuclides in POTW systems and in POTW sludge.

FURTHER AFFIANT SAYETH NOT.

Elisabeth Stetar
Signed

STATE OF TENNESSEE)TN
) ss
COUNTY OF DAVIDSON)Davidson

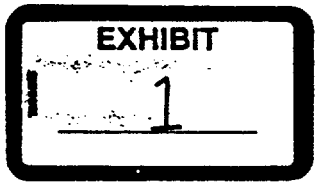
SUBSCRIBED AND SWORN TO before me this 13th day of October, 1999, by Elisabeth Stetar.

S P Crawford
Notary Public

My Commission Expires:
My Commission Expires JAN. 25. 2003

ELISABETH A. STETAR

1210 Seventh Avenue North
Nashville, TN 37208-2606
615-254-7740
Fax: 615-244-2023
email: lstetar@cwixmail.com



EDUCATION

1992—Master of Science, Health Physics
Department of Energy Operational Health
Physics Fellowship
Colorado State University

1983—Bachelor of Science
Major: Biology
Magna cum laude
Middle Tennessee State University

CERTIFICATION AND CLEARANCES

American Board of Health Physics—Comprehensive Certification–1992
Department of Energy—Q Clearance

PROFESSIONAL/TECHNICAL EXPERIENCE

Current
Health Physics Consultant
Performance Technology Group, Inc.
Nashville, TN

Certified health physics consultant specializing in environmental monitoring, regulatory compliance, and radiological risk assessment.

Specific Projects:

Association of Metropolitan Sewerage Agencies—March 1999 to Present

Participate in the development of a dose assessment methodology and calculate dose estimates for members of the public from naturally occurring and man-made radioncuclides present in wastewater treatment plant biosolids.

Tennessee Department of Environment and Conservation—March 1998 to Present

Provide technical review of Department of Energy proposals related to activities on the Oak Ridge Reservation including decontamination and decommissioning, free release of contaminated materials, and re-industrialization of the K-25 Site. Participate in the NRC/State Pilot Program for External Regulation of the Department of Energy. Review radioactive material license applications for major radioactive and mixed-waste processing facilities.

City of Oak Ridge, Tennessee—1992 to Present

Provide technical and regulatory compliance consulting on issues involving radioactive materials. Work to date has included development of radionuclide limits for land application of municipal wastewater treatment plant sludge and development of discharge criteria for releases of radioactive materials to the Oak Ridge sewer system. Participate in pretreatment permitting and inspection of radioactive materials dischargers.

Radiological Assessments Corporation (RAC), 1992 to 1997

Served as a member of the RAC team on projects involving the reconstruction of historical, radiation and chemical doses to the public from environmental releases from Department of Energy Nuclear Weapons Sites. Specific projects included the Savannah River Site Dose Reconstruction Phase I and II and the Rocky Flats Plant Dose Reconstruction Phase II.

M4 Environmental Management, Inc., Oak Ridge, Tennessee—1994 through 1996

Developed procedures for monitoring of effluents from M4 Technology Center which utilizes Quantum Catalytic Processing (Q-CEP™) for treatment of mixed wastes. Also provided technical and regulatory compliance input on M4's radioactive materials license application.

Battelle Pacific Northwest Laboratories—1994

Provided technical assistance and peer review on a study, contracted by the Nuclear Regulatory Commission, to determine the extent to which radioactive materials are reconcentrated by municipal wastewater treatment plants (NUREG/CR-6289, 1994).

Environmental Technology, Inc., Kearsarge Metallurgical Facility Superfund Cleanup—1992

Designed and implemented a radiation protection program and provided radiation protection training for workers involved in the Kearsarge Superfund Site Cleanup. The site was contaminated with naturally occurring radioactive materials (NORM). Also, provided technical and regulatory compliance assistance on issues related to the handling and disposal of the Kearsarge NORM wastes.

ADDITIONAL EXPERIENCE

January 1990–August 1990
Fellowship Practicum
Research
Oak Ridge National Laboratory

Designed and conducted a radiotracer study to determine removal efficiencies for several radionuclides that are routinely present in the Oak Ridge, Tennessee municipal

wastewater treatment system as the result of discharges by medical, research, and industrial facilities. These data were needed to evaluate the current regulations for sewer discharges of radioactive materials and to develop new site-specific criteria.

February 1988 - December 1989
Health Physicist
Licensing Section
Tennessee Division of Radiological Health

Reviewed and evaluated license applications, and performed compliance inspections, for complex radioactive materials facilities, including two of the nation's largest processors of low-level radioactive waste. The activities at these facilities included sorting, compaction, decontamination, volume reduction through smelting, and incineration of radioactively contaminated materials.

February 1984- February 1988
Supervisor
Environmental Radiation Surveillance Program
Tennessee Division of Radiological Health

Managed a statewide environmental monitoring program for radionuclides; developed environmental monitoring procedures and quality assurance plans, and evaluated effluent releases from state-licensed facilities to ensure compliance with state regulations through site-specific monitoring and inspections.

MEMBERSHIPS

National Health Physics Society
Water Environment Federation

PUBLICATIONS

E.A. Stetar, H. L. Boston, I.L. Larsen, and M. H. Mobley. "The Removal of Radioactive Cobalt, Cesium, and Iodine in a Conventional Municipal Wastewater Treatment Plant." *Water Environ. Res.,* 65, 630–639 (1993).

I.L. Larsen, S.Y. Lee, H.L. Boston, and E.A. Stetar. "Discovery of a Cesium-137 Radioactive Particle in Municipal Wastewater Treatment Sludge," *Health Physics*, March 1992.

I.L. Larsen, E.A. Stetar, and K.D. Glass. "In-House Screening for Radioactive Sludge at a Municipal Wastewater Treatment Plant." *Radiation Protection Mgt.*, 12, 29–38 (1995).

C.C. Ainsworth, R.L. Hill, K.J. Cantrell, D.I. Kaplan, M.V. Norton, R.L. Aaberg, E.A. Stetar. Reconcentration of Radioactive Material Released to Sanitary Sewers in Accordance with 10 CFR Part 20. Prepared by the Pacific Northwest Laboratory for the U.S. Nuclear Regulatory Commission. 1994. NUREG/CR-6289.

STATE OF NEW MEXICO DEPARTMENT OF HEALTH
SCIENTIFIC LABORATORY DIVISION
P.O. Box 4700 700 Camino de Salud, NE
Albuquerque, NM 87196-4700 [505]-841-2500
RADIOCHEMISTRY SECTION [505]-841-2574

IHS File

April 29, 1996

ANALYTICAL REPORT
SLD Accession No. RC-96-0129

Distribution
( ) User 55814
(X) Submitter 514
(x) SLD Files

To: William Floyd
ED - Rad. Licensing/Regulation
Haz. & Rad. Materials Bureau
P.O. Box 26110
Santa Fe, NM 87502

From: Radiochemistry Section
Scientific Laboratory Div.
700 Camino de Salud, N.E.
P.O. Box 4700
Albuquerque, NM 87196-4700

APR 3 0 1996

Re: A sludge sample submitted to this laboratory on March 29, 1996

DEMOGRAPHIC DATA

COLLECTION		*LOCATION*
On: 28-Mar-96	*By:* Flo . . .	Holding Tank #2
At: 21:15 hrs.	*In/Near:* Santa Fe	

ANALYTICAL RESULTS

Analysis	Value	Sigma	D. Lmt.	Units	Analyst
Am-241, Alpha Spec.	5.50	0.40	0.50	nCi/L-wet	Ewing
Pu-239+240, Alpha Spec	13.00	0.80	1.40	nCi/L-wet	Ewing
Pu-238, Alpha Spec.	5.00	0.40	1.20	nCi/L-wet	Ewing

Notations & Comments:

Uncertainties, sigmas, are expressed as +- one standard deviation, i.e. one standard error.

Small negative or positive values which are less than two(2) standard deviations should be interpreted as: including 'zero'; as 'not detected'; as 'less than the detection limit (<D. Lmt.)' when reported; or 'less than twice the standard deviation'.

Laboratory Remarks:

Gamma Spectroscopy Report:
==========

A 1 Liter sample of the semi-liquid sludge, as received, was counted in a Marinelli Beaker on 1-Apr-96 by LA Berge.

Nuclide &	T-1/2	Value (pCi/L)	1-Sigma (pCi/L)	MDA (pCi/L)
K-40	1.3 GY	n/d	- -	2,800.
Mn-54	312. D	16,700.	3,000.	690.
Co-57	272. D	1,170.	210.	260.
Co-58	71. D	970.	250.	540.
Co-60	5.27 Y	1,200,000.	190,000.	610.
Ag-110m	250. D	4,030.	650.	370.
Sb-125	2.73 Y	15,800.	2,600.	1,400.
Cs-134	2.06 Y	9,900.	1,600.	340.
Cs-137	30.0 Y	97,000.	16,000.	400.
Ac-228eq	5.75 Y	n/d	- -	2,500.

(Continued on page 2.)

FAX MEMO
YES ✓ DATE 05/03 FAX #
TO Mike Rogers
FROM Bill Floyd
CO. NMED
PH (505) 827-1556 FAX #

EXHIBIT 2

Pb-212eq	1.91 Y	n/d	- -	650.
Bi-212eq	1.91 Y	n/d	- -	7,100.
Tl-208eq	1.91 Y	n/d	- -	440.
Th-234eq	4.5 GY	89,000.	14,000.	2,400.
Ra-226	1.6 kY	n/d	- -	8,000.
Pb-214eq	1.6 kY	n/d	- -	820.
Bi-214eq	1.6 kY	n/d	- -	970.
Pb-210	10.4 Y	n/d	- -	3,500.
U-235	103.8 MY	5,800.	1,000.	490.
Am-241	432.2 Y	6,500.	1,100.	260.

Gross Alpha/Beta Test:
==========
For this sample the requested gross alpha/beta test was canceled per agreement with Bill Floyd, the sample submitter, 9-Apr-96. The gamma spectroscopy measurement had already, clearly, established the presence of beta activity; and, the alpha activity of interest (Am-241 and Pu-238/[239+240]) were to be obtained by specific measurement. It seemed prudent, therefore, not to risk the contamination of an ultra-low level alpha/beta counting system (used for drinking water analysis) by the introduction of this sample material.

Comments Regarding Sample for Am & Pu Analyses:
==========

An attempt to use a 13. mL volume of the semi-liquid sludge, as received, resulted in an unsatisfactory fusion, and a very badly degraded alpha spectrum; but, did confirm the presence of Am-241, Pu-(239+240) and Pu-238 in the sample. The activities of the analytes were at such a level that our routine environmental testing process, which focuses at the picoCurie/Liter level, did not produce quantifiable spectra.

To obtain a smaller sample size, a volume of approximately 12.5 mL (wet weight of 13.5 G) was dried (19-Apr to 22-Apr-96) in a 110 degree C oven, and produced 3.50 G of dry material. The dry material was hand crushed, and used for re-analysis. With increased tracer activity, our routine testing process was successfully performed on ~100 mG aliquotes of the dry material.

The spectrum obtained for the americium fraction contained a small unexpected peak at 5.8 MeV, which we tentatively identified as Cm-244. No attempt was made to quantify this possibly present component.

(Continued on page 3.)

Quality Control Results:
****

QC-Known:
=========

Isotope	Target	Measured
Am-241	1.63 pCi/G	1.81 +- 0.11 pCi/G
Pu-239	0.217 pCi/G	0.30 +- 0.03 pCi/G
Pu-238	0.005 pCi/G	0.02 +- 0.02 pCi/G

QC-Blank:
=========

Isotope	Target	Measured	MDA
Am-241	0.00 pCi	0.10 +- 0.02 pCi	0.05 pCi
Pu-239	0.00 pCi	0.05 +- 0.02 pCi	0.07 pCi
Pu-238	0.00 pCi	-0.01 +- 0.02 pCi	0.11 pCi

QC-Duplicate:
=============

Isotope	Run #1	Run #2	Mean	% Dev From Mea
Am-241	18.0 +- 1.3	21.7 +- 1.5	19.8 +- 1.4 pCi/G	9.5 %
Pu-239	47.0 +- 2.9	45.7 +- 2.8	46.4 +- 2.8 pCi/G	1.5 %
Pu-238	13.1 +- 1.3	22.3 +- 1.7	17.7 +- 1.5 pCi/G	26. %

Transformation from pCi/G-Dry back to Wet Sludge:
****

Using an approximate transformation factor of 0.28 G-dry/mL-wet, 3.50 G-dry were obtained from 12.5 mL wet sludge, the above means transform as:

Isotope	Means, Dry Wt. Based	Means, Wet Sludge
Am-241	19.8 +- 1.4 pCi/G-dry	5,500. +- 400 pCi/L-wet
Pu-239	46.4 +- 2.8 pCi/G-dry	13,000. +- 800 pCi/L-wet
Pu-238	17.7 +- 1.5 pCi/G-dry	5,000. +- 400 pCi/L-wet

Reviewed By: Loren A. Berge
Loren A. Berge, Ph.D. 04/29/96
Supervisor, Radiochemistry Section

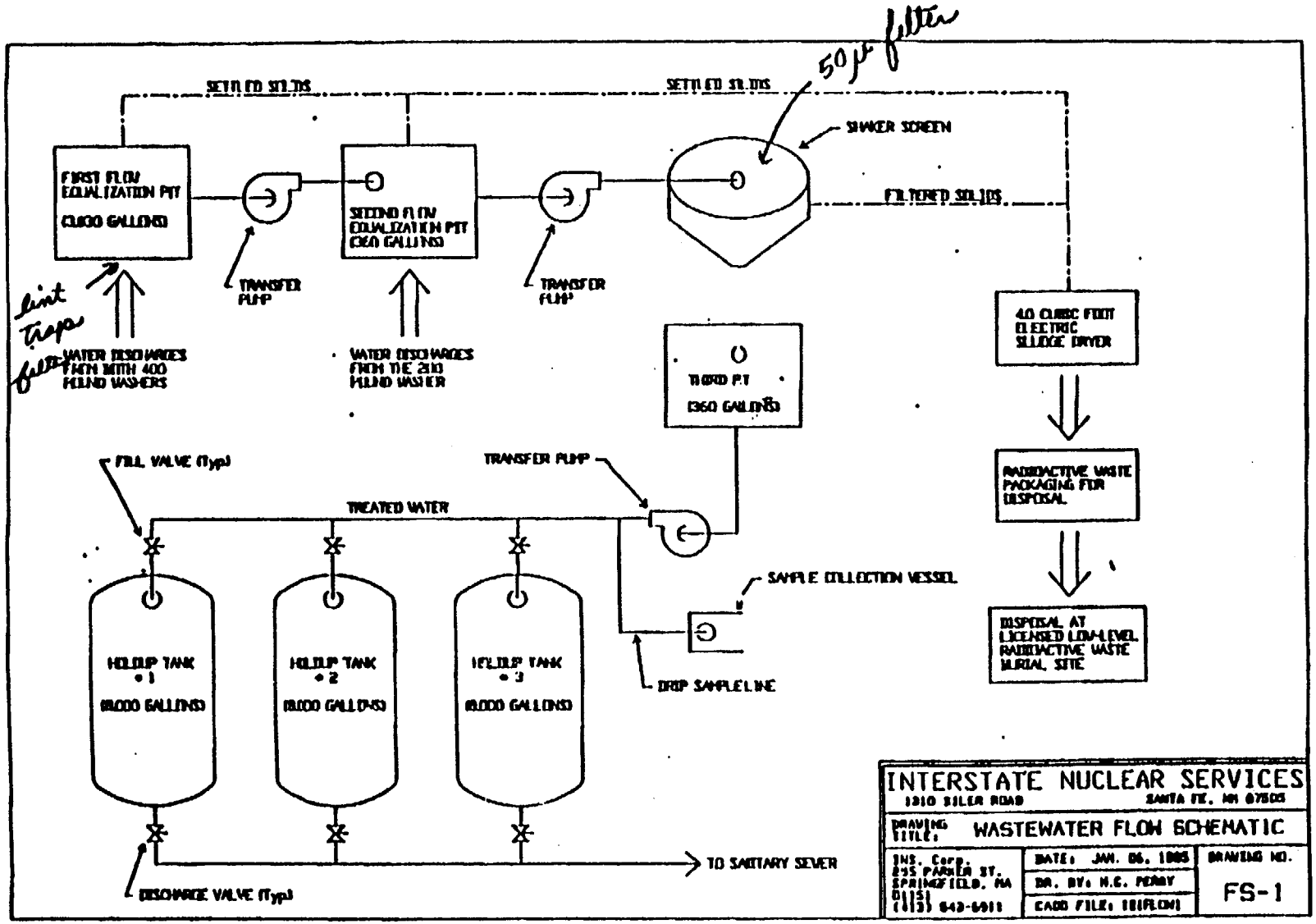

50μ filter
SETTLED SOLIDS
SETTLED SOLIDS
SHAKER SCREEN
FIRST FLOW EQUALIZATION PIT
SECOND FLOW EQUALIZATION PIT
FILTERED SOLIDS
TRANSFER PUMP
TRANSFER PUMP
lint trap
WATER DISCHARGES FROM WITH 400 MICRON WASHERS
WATER DISCHARGES FROM THE 200 MICRON WASHER
THIRD PIT
40 CUBIC FOOT ELECTRIC SLUDGE DRYER
FILL VALVE (Typ)
TRANSFER PUMP
TREATED WATER
RADIOACTIVE WASTE PACKAGING FOR DISPOSAL
SAMPLE COLLECTION VESSEL
HOLDUP TANK #1
HOLDUP TANK #2
HOLDUP TANK #3
DISPOSAL AT LICENSED LOW-LEVEL RADIOACTIVE WASTE BURIAL SITE
DRIP SAMPLE LINE
TO SANITARY SEWER
DISCHARGE VALVE (Typ)
INTERSTATE NUCLEAR SERVICES
1310 SILER ROAD
SANTA FE, NM 87505
DRAWING TITLE: WASTEWATER FLOW SCHEMATIC
INS. Corp. 245 PARKER ST. SPRINGFIELD, MA 01151 (413) 543-6911
DATE: JAN. 06, 1985
DR. BY: M.C. PERRY
CADD FILE: 1B1FLOW1
DRAWING NO. FS-1

EXHIBIT 3

State of New Mexico
ENVIRONMENT DEPARTMENT
Hazardous & Radioactive Materials Bureau
2044 Galisteo
P.O. Box 26110
Santa Fe, New Mexico 87502
(505) 827-1557
Fax (505) 827-1544

GARY E. JOHNSON
GOVERNOR

MARK E. WEIDLER
SECRETARY

EDGAR T. THORNTON, III
DEPUTY SECRETARY

November 12, 1996

Paul H. Lohaus, Deputy Director
Office of State Programs
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Lohaus:

Technical assistance is requested as to whether the enclosed protocol meets the solubility requirement for the release of radionuclides into the sanitary sewer.

It is of utmost importance that we receive a response to this request as soon as possible as the renewal of the radioactive material license for Interstate Nuclear Services (INS) a nuclear laundry located in Santa Fe, depends on whether the solubility question is adequately addressed in this proposed protocol.

Since 10CFR Part 20.2003(a)(1) is a compatibility requirement we believe that the NRC should be able to provide us with a ruling as to adequacy of this proposal.

Also enclosed are the schematics for proposed modifications to the INS Wastewater Treatment System in Santa Fe.

Should you have any questions, please contact me at (505) 827-1564.

Sincerely,

William M. Floyd

William Floyd, Program Manager

WF:lmg

EXHIBIT 4

City of Santa Fe, New Mexico

Debbie Jaramillo, Mayor
David Coss, City Manager

Councilors: Frank Montaño, Mayor Pro Tem, Dist. 3
Larry A. Delgado, Dist. 1
Patti J. Bushee, Dist. 1
Cristopher D. Moore, Dist.2
Molly Whitted, Dist. 2
Art Sanchez, Dist. 3
Amy Manning, Dist. 4
Peso Chavez, Dist. 4

January 13, 1997

Mr. Paul H. Lohaus, Deputy Director
Office of State Programs
US Nuclear Regulatory Commission
Washington, DC 20555

RE: SOLUBILITY CRITERIA FOR LICENSED RADIOACTIVE MATERIALS

Dear Mr. Lohaus:

I just received a copy of the position paper in connection with 20 NMAC 3.1, Section 435.A.1, submitted to Mr. William Floyd (New Mexico Environment Department) two months ago by Dr. James W. Patterson on behalf of Interstate Nuclear Services (INS), and which was transmitted for your approval as a solubility demonstration, on November 12, 1996. In my capacity as the Public Utilities director for the City of Santa Fe, which receives the wastewater from the INS facility, I must inform you that Dr. Patterson's suggested criteria for solubility of radionuclides is grossly inadequate from our municipal perspective.

Pressure filtration has been used in the removal of solids for longer than three decades in the water treatment industry, including applications for the removal of colloidal and organic matter as well as color. Filtration systems are most commonly currently used in combination with state-of-the-art polymer technology to increase the effective reuse of industrial process wastewaters. In fact, the high priority given to resource conservation and reuse nation wide has resulted in the application of cost-effective new technologies such as micro filtration and other membrane application systems. These are being adopted by a wide variety of industries in many different ways which include industrial size clothes laundering and should be adopted in this context.

Dr. Patterson seems to imply that, because the system proposed by INS for their facility in Santa Fe includes pressure filters, it automatically constitutes state-of -the-art technology. Dr. Patterson designed the system in Santa Fe for partial removal of total suspended solids (TSS) to a concentration of 45 mg/l. Dr. Patterson has stated in the past that the proposed system's actual performance remains in question and may not achieve the 45 mg/l standard. The proposed system is based on the use of conventional pressure filtration, as opposed to micro filtration or other membrane-based filtration system. The city's position is that the latter systems are more widely recognized as best available technology and should be adopted as industry standards, particularly for the pretreatment of radionuclide bearing wastewater.

As a municipality, we are concerned about the negative economic impact that the city could potentially experience as a result of radioactive waste discharges into its sewer system. For your information, the city currently uses part of its treated wastewater effluent for irrigation of public recreational grounds, and it is preparing to increase that use to the highest level possible, converting the treated wastewater stream into one of our sources of potable water supply. In addition, our long term plans call for the beneficial use of wastewater biosolids as a soil conditioner on public grounds, in compliance with 40 CFR 503.

Both the actual presence of radioactive matter and the public perception that radioactive waste is contaminating one of these two valuable wastewater treatment by-products will have a dramatic effect upon the city's ability to market them on an unlimited basis. For this reason the city believes that adequate criteria for solubility in reference to 20 NMAC 3.1, Section 435 A.1, must ensure that only the very minimum achievable fraction of radioactive particles enter the wastewater stream.

Furthermore, to best accomplish our goals and protect our economic interests, a new bill will be considered to expand existing municipal regulations and introduce solubility criteria in Chapter 22 of the Santa Fe City Code (SFCC). Thus the city will be able to exercise its local government authority to regulate certain radioactive discharges into the public sanitary sewer system. The Nuclear Regulatory Commission (NRC) has in the past approved of such regulation as consistent with Atomic Energy Act (See attached letter of November 9, 1993 from NRC to City of Laramie, Wyoming)

I look forward to continuing communications with you. Please call me at 505/984-6893 if you have any questions or need additional information from us.

Sincerely,

Patricio Guerrerortiz, P.E.
Public Utilities Department Director

cc: William M. Floyd, Radiation Licensing and Registration, NMED
Mark Basham, City Attorney
Qustandi Kassisieh, Wastewater Management Division, PUD
PUD/File

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

February 5, 1996 7

Mr. William M. Floyd, Program Manager
Radiation, Licensing and Registration
Hazardous and Radioactive Materials Bureau
Environment Department
State of New Mexico
2044 Galisteo Road
P.O. Box 26110
Santa Fe, NM 87502

Dear Mr. Floyd:

The NRC staff has completed its review of your request to determine whether a protocol, submitted to you by Interstate Nuclear Services (INS), meets the solubility requirements in Section 20.2003 of 10 CFR Part 20. The material reviewed consisted of your November 12, 1996 letter to me with attachments, and the December 19, 1996 note to me from Walter Medina enclosing supplemental material, in particular, a December 2, 1996 letter to you from Chriso Petropoulou of Patterson and Associates, Inc.

Based on our review, we do not believe that the information submitted is sufficiently complete to permit a comprehensive licensing review to determine whether or not the system proposed for use by INS at their Santa Fe facility meets the requirements in 10 CFR Part 20 as supplemented by the guidance in the NRC's Information Notice (IN) 94-07, "Solubility Criteria for Liquid Effluent Releases to Sanitary Sewerage Under the Revised 10 CFR Part 20." Although the treatment methods appear to be standard industry practice for treating the wastewater, the INS protocol makes no mention of sewer discharges nor does it mention testing of the discharges for meeting compliance with the regulations. For example, information to confirm system capabilities and specifications and on the testing and quality assurance program that would be performed during operations are areas that should be addressed in the application. The protocol does not address testing of discharges for compliance with regulatory requirements nor compliance with the protocol specifications.

The INS needs to confirm the proposed system capabilities and specifications as well as confirm that proposed operations would continue to meet the specifications necessary to comply with regulatory requirements. Of particular concern is a statement in the INS protocol that indicates that the proposed system would be designed to use a screen shaker with a 44 micron filter pore size, and a wastewater filter capable of removing portions of suspended solids with a size down to 1 micron. One of the recommended procedures referenced in IN 94-07 (ASTM D1888-78, "Standard Test Methods for Particulate and Dissolved Matter, Solids, or Residue in Water") states that a 0.45 micron pore size filter should be used. Thus, it appears radioactive particles with a diameter of less than 44 microns could be contained in the effluent sewer discharge. If so, that radioactive material

In the discharge would not be soluble, per the guidance in IN 94-07. Two other INS facilities, Royerford, PA and Columbia, SC, respectively, are approved for operation with wastewater filter sizes of 20-25 microns. The NRC recognizes that alternative criteria, other than that identified in the IN, may be acceptable on a case-by-case basis, yet INS has provided no supporting documentation to support the use of any alternate criteria for sanitary sewer discharge.

Given that the provided documentation was inadequate for a determination of the solubility requirements per 10 CFR 20.2003, we consider this technical assistance response to fall within the purview of routine technical assistance, and as such, it is not cost reimbursable by New Mexico.

Finally, we are providing copies of this response to Patricio Guerrerortiz, Santa Fe Public Utilities Department Director and to Caron Balkany, Concerned Citizens for Nuclear Safety, who have written to us expressing interest in your technical assistance request.

We trust this responds to your request. If we may be of further assistance, please do not hesitate to contact us.

Sincerely,

Paul H. Lohaus

Paul H. Lohaus, Deputy Director
Office of State Programs

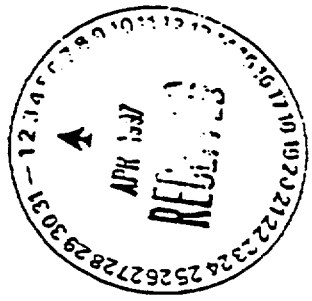
cc:
C. Balkany
P. Guerrerortiz

NMSS
File

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 31, 1997

Mr. Benito Garcia, Chief
Bureau of Hazardous and Radioactive Materials
Water and Waste Management Division
Department of the Environment
2044 Galisteo Road
P.O. Box 26110
Santa Fe, NM 87502



Dear Mr. Garcia:

I have enclosed copies of several documents relating to Interstate Nuclear Services (INS) in Santa Fe, New Mexico. These documents identify a number of concerns and alleged activities relating to INS operations at their Santa Fe facility. While the Nuclear Regulatory Commission (NRC) has no direct regulatory responsibility to assure safe operation of the INS nuclear laundry in Santa Fe, additional INS nuclear laundries are licensed by NRC and Agreement States. Therefore, because a similar situation may also exist at other INS facilities, it is important to communicate any valid Santa Fe facility concerns to all regulatory authorities that have issued licenses to INS.

The alleger has three main concerns with INS:

1. By discharging radionuclides that are not readily soluble in water into the City of Santa Fe sewer system, INS has been violating state law.

2. Repeated illegalities by INS both locally and nationally evidenced by accusations from former INS employees.

3. INS illegally discharging contaminated sludge into the City of Santa Fe's sewer treatment plant.

A more detailed summary of these concerns is enclosed.

We ask that you evaluate these concerns and respond directly to the alleger with your resolution. We have previously notified the alleger that the concerns would be forwarded to you, as the proper regulatory authority, for resolution. (We will cover allegations concerning performance of the New Mexico program as a part of our Integrated Materials Performance Evaluation Program review of the program scheduled in 1997.) Because NRC also licenses an INS nuclear laundry, we request that you inform us of the actions you have taken, as well as any conclusions of your evaluations. We also request that you provide us with a copy of your response(s) to the alleger.

For the same reasons, please describe the results of any State inspections or investigations relating to the alleged activities identified in the enclosed correspondence. In particular, w

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To TOM / KATE	From Gary Sloan	
Co./Dept.	Co.	

INS 00258

request information about whether you have confirmed the statements about alleged improper operations at the INS facility in Santa Fe, attributed to former INS employees, contained in the enclosed summary.

We request an initial response to this letter, with at least a status report on your efforts to resolve these concerns within 30 days of receipt of this letter. If you will need more than 30 days to respond, please let me know. If you believe a meeting to discuss this matter would prove beneficial, NRC representatives will travel to Santa Fe for those discussions. Please contact me at (301) 415-3340, or Paul Lohaus at (301) 415-2326 to discuss this letter.

Sincerely,

Richard L Bangart

Richard L. Bangart, Director
Office of State Programs

Enclosures:
As stated

LIST OF ENCLOSURES

1. Summary of Alleger's Concerns Involving INS (including Composites I, II, & III).
2. December 27, 1996 letter to Cynthia Jones, NRC, from alleger.
3. January 13, 1997 letter from Caron Balkany, President, Concerned Citizens for Nuclear Safety (CCNS) to Paul H. Lohaus, Deputy Director, Office of State Programs (OSP), NRC.
4. January 13, 1997 letter from Patricio Guerrerortiz, Public Utilities Department Director, City of Santa Fe, New Mexico to Paul H. Lohaus, Deputy Director, OSP, NRC.
5. January 22, 1997 letter from Caron Balkany, President, CCNS to Paul H. Lohaus, Deputy Director, OSP, NRC.
6. January 22, 1997 letter from Caron Balkany, President, CCNS to Richard L. Bangart, Director, OSP, NRC.

SUMMARY OF ALLEGER'S CONCERNS INVOLVING INS:

I. INS has been discharging radionuclides into the City of Santa Fe sewer system which are not readily soluble in water, in violation of the law. The New Mexico Environment Department (NMED) has stated that INS should be allowed to continue this activity, while it makes "further study." INS states that rulemaking is required because there is no definition of "readily soluble in water." Composite I contains documents which support this concern. Some specific details follow:

A. INS operations violate Sec. 435 Radiation Protection Regulations (RadRegs).

1. Excerpt of transcript of testimony of William Floyd on behalf of the NMED relicensing program (P. 899-901) that he is required to ensure that INS complies with Sec. 435 RadRegs, which states:

> **A licensee or registrant may discharge licensed or registered material into sanitary sewerage if each of the following conditions is satisfied:**
>
> **The material is readily soluble, or is readily dispersible biological material, in water...**

2. A September 11, 1996 letter from Steve Yanicak, LANL POC, The New Mexico Environment Department, Department of Energy Oversight Bureau, to Caron Balkany, Concerned Citizens for Nuclear Safety, which states that there are additional radionuclides in INS' wastewater stream which are also not readily soluble in water:

> **...americium 241, plutonium, and cesium 137 are not readily soluble in normal waters (pH of 7 under oxidizing conditions at 25 degrees Celsius).**

B. Mr. Floyd, despite the foregoing, recommended that the INS license be renewed while he checked with the NRC for guidance. According to City officials, Mr. Floyd is currently taking the position on behalf of NMED that there is a conflict in the regulations concerning this prohibited discharge, and that INS should be allowed to operate until the conflict is resolved.

II. There is substantial evidence from former employees about repeated illegalities by INS, both locally as well as by national-level corporate management. Composite II contains documents which support this concern. Some specific details follow:

A. Affidavits from A. Leroy Romero, former INS Plant Manager at Santa Fe, detailing a pattern of safety violations and deception, including orders by national-level corporate management to break the law.

1. Orders from national-level corporate management to illegally flush contaminated sludge into the sewer;

2. Orders from national-level corporate management to deceive City and State safety inspectors;

3. Orders from national-level corporate management to falsify compliance reports.

B. Article from local newspaper containing interviews with Mr. Romero.

C. Excerpt of transcript of testimony of Anthony Duran, former INS employee, detailing illegalities, unsafe practices such a direct venting of contaminated exhaust from sludge drying to the outside air and release of contaminated dryer lint in air exhaust to the neighborhood, and also indicating that INS knew when NMED would be coming for inspections.

D. Affidavit of John Nolen, former INS Health Physics Technician, corroborating the testimony of INS illegalities.

E. Romero Exhibit 3 in the NMED hearing corroborates the testimony of two former employees that the INS Santa Fe Plant withheld non-complying water analyses from City officials, diluted and redid water samples before submitting to City officials. The INS City permit requires notification within 24 hours of any non-complying analyses.

1. Michael Bovino, manager of health physics and engineering for INS, nation-wide, signed the required monthly compliance report to the City of Santa Fe for third quarter, 1993. He attached the analysis performed by CEP laboratory dated 9/29/93 showing complying levels for INS for all metals, including copper. A-1

2. Mr. Bovino's oath under penalty of law that the compliance report was "...true and accurate and complete..." when, in fact, it withheld a 9/17/93 report from Scientific Lab showing <u>non-complying</u> copper levels.

3. A 9/17/93 memo from John Nolen, INS health physics technician in Santa Fe, demonstrating that INS corporate headquarters had received a report of the non-complying levels before the false report was sworn to and signed by Mr. Bovino. A-2

III. The City of Santa Fe has determined that INS has been illegally discharging contaminated sludge to the City's sewer treatment plant. INS's sworn testimony on the subject demonstrates a willingness to be deceptive, and a refusal to take responsibility for the problem, increasing the likelihood of repeat problems. Composite III contains documents which support this concern:

A. A copy of the response from the City of Santa Fe to a lawsuit which INS filed against it seeking to force the City to remove an administrative compliance order which has kept the INS facility temporarily closed since May 14th, 1996:

> **...an inspection by the City's Wastewater Treatment Division revealed that INS was discharging contaminated sludge into the City's sewer system in violation of its Permit and the City's Sewer Ordinance. The danger posed by this discharge is real and substantial.**
>
> **• • • •**
>
> **In the professional judgement of the City of Santa Fe's engineers and considering all the evidence, there is no question that sludge in the INS holding tanks was regularly discharged into the City's POTW.**

B. Excepts of testimony from Michael Bovino, INS Corporate Manager of Health Physics, stating an inherently incredible position that he has "no reason to believe or disbelieve" that contaminated sludge[1] in the bottom of three 8,000 gallon settling tanks, each with a 2" gravity drain to the city sewer line, is being discharged into the sewer when the water is released.

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[1] The NMED sludge technician testified that there was 4-6 inches of sludge in the bottom of the tank, that it had the consistency of slimy oatmeal, and that he was able to pour it out of a 500 millimeter beaker in 3 seconds. Composite III.

State of New Mexico
ENVIRONMENT DEPARTMENT
Hazardous & Radioactive Materials Bureau
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GARY E. JOHNSON
GOVERNOR

MARK E. WEIDLER
SECRETARY

EDGAR T. THORNTON, III
DEPUTY SECRETARY

May 7, 1997

Patricio Guerrerortiz, P.E.
Public Utilities Department Director
City of Santa Fe
Post Office Box 909
Santa Fe, NM 87504-0909

Caron Balkany, President
CCNS
107 Cienega
Santa Fe, NM 87501

Re: NMED's Initial Response
Allegations Transmitted by NRC Office of State Programs

Dear Mr. Guerrerortiz and Ms. Balkany:

As requested by Mr. Bangart in his notification and transmittal to me dated March 31, 1997, I am writing this initial response to you to address the allegations you published by letters from Mr. Guerrerortiz dated January 13, 1997 and from Ms. Balkany dated October 30, 1996, December 27, 1996, January 13, 1997, two (2) letters dated January 22, 1997 and February 19, 1997. The October 30, 1996 and February 19, 1997 letters written by Ms. Balkany do not seem to have been included by Mr. Bangart in his transmittal.[1]

As submitted to me by the NRC, the attachments to the letters are packaged topically as *Composite I, II and III* around three issues.[2] I will respond here according to the outline titled ***Summary of Alleger's Concerns Involving INS*** which Mr. Bangart provided with his transmittal.

I. ***INS has been discharging radionuclides into the City of Santa Fe sewer system which are not readily soluble in water, in violation of the law. The New Mexico Environment Department (NMED) has stated that INS should be allowed to continue this activity, while it makes "further study." INS states that rulemaking is required because there is no definition of "readily soluble in water."***

This issue raises questions about the department's approach to enforcement of 20 NMAC 3.1.435 governing discharges of licensed material to publicly owned wastewater treatment works (POTW). In the administrative hearing on INS' license renewal Mr. Floyd

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[1] *See* These are referenced in correspondence dated March 29, 1997 from Mr. Lohaus and April 8, 1997 from Cardelia Maupin for Mr. Lohaus to Ms. Balkany.

[2] *Viz.*, the transmittal includes partial transcript excerpts of testimony by Messrs. Floyd, Duran and Bovino in the department's administrative hearing on INS' license renewal, affidavits from Messrs. Romero and Nolan submitted in the same hearing, selected RadRegs provisions, a *Santa Fe Reporter* article, selections from previous inspection reports for Interstate Nuclear Services (INS) and documents concerning Mr. Romero's dose exposure when he worked at INS.

testified on cross examination by Ms. Balkany that he had not before fully focused on this 1994 amendment to the state RadRegs, which, among other things, prohibits discharge of radionuclides to a POTW unless they are readily soluble in water. Mr. Floyd said he had no guidance on how to enforce the rule and that it seemed to him at first blush that the Table III (Release to Sewers) values in the 20 NMAC 3.1.461 Appendix B list of allowable discharges may conflict with an absolute disallowance on discharges of non-soluble material. Mr. Floyd said he has enforced the effluent discharge limits but had not enforced the solubility parameter.

Mr. Floyd also testified he has repeatedly measured the radioactivity at Santa Fe's POTW, at its sludge field, at the City's NPDES outfall, at the sites the POTW effluent has been land applied;[3] and none of the analytical results indicates elevated levels of any isotope. We are thus reassured that there is no observable public health impact from pre- or post - 1994 discharges from INS. We are also reassured there has been no POTW contamination.

After the administrative hearing we tried to obtain guidance from NRC concerning exactly how we could regulate INS discharges to insure that only soluble radionuclides are discharged. Radionuclide discharges have traditionally been regulated only for maximum levels of radioactivity from a health physics viewpoint. The notion of solubility appears to be a water quality concept, appropriated from the Environmental Protection Agency (EPA) without much analysis as to what it means in the context of allowable radionuclide discharges. I believe that the intent of the solubility regulation was meant to disallow visually observable radionuclide compounds from being discharged. I also believe this instance may be the first time the solubility question has come up explicitly in the case of a licensed discharger where no evidence of contamination exists.

The state's rule was implemented to achieve compatibility with the identical rule promulgated by the NRC as per the New Mexico Agreement State requirements with NRC. The NRC rule, as best we can determine, evolved out of a situation in Ohio where radioactive foils from which numbers were stamped out for watch dials; and the left over foil strips were discharged to the public sewers. Precipitation and concentration of the foil occurred at the POTW and high levels of radioactivity were found in the ash from the POTW's incinerated sludge. The facts are not analogous to INS. For its own reasons, NRC advised that the problem is one for us to solve. Accordingly, now we are soliciting proposals for private

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[3] In the case of the Santa Fe Country Club golf course, land application of the City's POTW effluent has been going on for several decades.

consulting services to provide the assistance we need.

INS has been closed since before the administrative hearing concluded, and therefore, nothing has been discharged since the issue came into focus. Because no observable contamination has resulted from past discharges and given that we as the radioactive materials use and possession regulators are not yet in a position to impose a coherent regulatory approach, we have not gone back on INS to sanction INS for regulatory violations that might have occurred between the date of our solubility regulation and the date the City ordered the facility to shut down. I think we will do better by devoting our resources to development of explicit parameters for determining that insoluble radionuclides are not discharged than we would by chasing after past discharges that were not examined for solubility. This is the most logical regulatory approach.

We are not aware of any statement, as represented by the *summary*, by INS that INS believes the department should go through a rulemaking on the solubility issue. I certainly do not think a rulemaking would be appropriate. NRC underwent rulemaking procedures when the solubility rule was promulgated and we underwent rulemaking in 1994 when we promulgated NRC's solubility rule to meet compatibility requirements. There were no comments on what solubility might mean in the radioactive material context. At this point we must determine what we require so that we can tell INS what it will have to submit to comply with the regulation as written by NRC and adopted by us. Once we have worked out a tentative regulatory position, we will let both of you know that position. In the meantime, if either the City or INS has studies, materials or other data which would be helpful to us, please let Mr. Floyd have them. Mr. Floyd and Mr. Sloan have asked for the scientific basis for CCNS' criticism in the past, but nothing has been provided. Neither do we find any insight on solubility in the letters and materials you have sent to NRC.

II. ***There is substantial evidence from former employees about repeated illegalities by INS, both locally as well as by national-level corporate management.***

The allegations summarized under this heading were all explicitly raised and resolved in the department's administrative hearing on INS' license renewal. I see no point in rehashing them here. No appeal was taken from Secretary Weidler's final decision granting a license renewal with conditions. Mr. Floyd explained our approach to resolving the allegations in the excerpt from his testimony Ms. Balkany already provided. *See*, Composite I, Floyd testimony, p. 853, ls. 6-20. I attach copies of Mr. Duran's cross-examination, Ms. Lopez' post-hearing affidavit and the portion of the last day of hearing which documents Mr. Romero's decision to not testify in the hearing.

III. ***The City of Santa Fe has determined that INS has been illegally discharging contaminated sludge to the City's sewer treatment plant. INS's sworn testimony on the subject demonstrates a willingness to be deceptive, and a refusal to take responsibility for the problem, increasing the likelihood of repeat problems.***

The outline summary here hinges on findings in the City of Santa Fe's cease and desist order and the allegation that Mr. Bovino was disingenuous in his testimony about sludge discharges.

The City's findings have never been tested in an adversary hearing or supported by anything but non-expert opinion testimony.[4] Mr. Englert for the department and Mr. Duran both testified that the sludge formed vertically up the sides of the holding tanks. Mr. Romero testified that it did not. By all accounts, the sludge accumulated over time. Isotopes that had not come through the laundry for more than a year were found in the sludge sample Mr. Englert obtained during ours and the City's inspection.

In sum, the fact and degree of sludge discharge is at best speculative in our opinion. We disagree with the summary of alleger's concerns on this issue that Mr. Bovino's refusal on cross-examination to agree with Ms. Balkany that INS had been discharging sludge for years put him in *"an inherently incredible position"*. In any case, we are satisfied that Mr. Bovino's voluntary agreement to modify the plumbing in the hold-up tanks to eliminate adverse speculation is more important than trying to go back over time and recreate the actual facts. Again, from a public health and safety regulatory perspective, this is the more logical approach.

If either the City of Santa Fe or CCNS has further information needs and if the City or CCNS has information that will help us in our job, please communicate them directly to Mr. Floyd.

Sincerely,

Benito Garcia, Chief
Hazardous and Radioactive Materials Bureau

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[4] See Mr. Duran's testimony, p. 464, l. 22 through p. 468, l. 14. Mr. Duran's was the only testimony on sludge discharges that was subjected to cross-examination. The City seems to take Mr. Duran's opinion as proof of sludge discharges. Mr. Duran believes there were sludge discharges based on the sounds he heard. We are not convinced by Mr. Duran's testimony that he heard sludge being discharged. No one has seen sludge being discharged and no one has presented measurements or dates of what was discharged. Our surveys for radioactivity do not indicate radioactive sludge has reached the City's POTW.

cc: w/ encl. as stated

Hon. Greta Dicus, Commissioner, NRC
Richard L. Bangart, Director, OSP, NRC
Paul H. Lohaus, Dep. Dir., OSP, NRC

w/o encl.

Peter Dwyer, Esq., Office of City of Santa Fe City Attorney
Ed Kelley, Director, Water and Waste Management Division
William Floyd, Mgr., Radioactive Materials Program
Geoffrey Sloan, Esq., Office of General Counsel

METROPOLITAN ST. LOUIS SEWER DISTRICT O R D I N A N C E NO. 8472

This document is downloadable in WordPerfect format.

ORDINANCE NO. 8472

AN ORDINANCE regulating the use of residential and non-residential, public and private sewers, drains, and wastewater pretreatment and treatment systems and the discharge of waters and wastes into the District's wastewater system, stormwater system, drainage facilities, watercourses, and outfalls; and providing penalties for the violation thereof; and repealing Ordinance No. 4786, adopted August 11, 1982.

WHEREAS, it is deemed necessary in the interest of public health and welfare to reasonably regulate the discharge of certain substances, and

WHEREAS, regulation and inspection are necessary because certain substances may damage or interfere with the operation of the District's wastewater and stormwater systems and related appurtenances or interfere with the wastewater treatment processes or pose a hazard to the public or to District employees if discharged into the District's wastewater system, or pass through the treatment facilities and impair water quality of the waters of the State or contaminate the sludge, or impair air quality through emissions of air pollutants, it is deemed necessary, therefore, to preclude or limit certain substances from entering said wastewater and stormwater systems.

BE IT ORDAINED BY THE BOARD OF TRUSTEES OF THE METROPOLITAN ST. LOUIS SEWER DISTRICT:

ARTICLE I - PURPOSE AND OBJECTIVES

Section One - Purpose of Ordinance.

The purpose of this Ordinance is to comply with State and Federal laws and to protect the public health and safety by abating and preventing pollution through the regulation and control of the quantity and quality of residential and nonresidential wastewater, industrial wastes, stormwater, and other wastes discharged into the District's wastewater system, stormwater system and watercourses.

Section Two - Objectives. The objectives of this ordinance are:

A. To prevent the introduction of pollutants into the wastewater and stormwater systems which may damage or interfere with the operation of the systems.

B. To prevent the introduction of pollutants into the wastewater and stormwater systems which may interfere with treatment and pollution control processes.

C. To prevent the introduction of pollutants into the wastewater and stormwater systems which will pass through the systems inadequately treated into watercourses, or the atmosphere, or otherwise be incompatible with the systems.

D. To prevent the introduction of pollutants into the wastewater and stormwater systems which will interfere with sludge and solids management options.

E. To prevent the introduction of pollutants into the wastewater and stormwater systems which will create a hazard to District employees or the public, adversely affect public health and welfare or adversely impact the environment.

F. To prevent the introduction of pollutants into the stormwater system and watercourses which will interfere with beneficial uses and/or achievement of applicable State and Federal water quality standards.

ARTICLE II - DEFINITIONS

Unless the context specifically indicates otherwise, the meaning of terms used in this Ordinance shall be as follows:

1. ASTM means the American Society for Testing and Materials.

2. BOD5 (Biochemical Oxygen Demand) means the quantity of oxygen utilized in 5 days in the biochemical oxidation of carbonaceous and nitrogenous compounds and certain inorganic materials in water or wastewater as determined by Standard Methods and expressed in milligrams per liter.

3. BUILDING SEWER means a sewer extension from a building or an industrial process to the District sewer or other place of disposal.

4. BYPASS means the intentional diversion of waste streams from any portion of a user's sewer system, treatment facility or pretreatment facility or other control facility.

5. CATEGORICAL PRETREATMENT STANDARDS or CPS means any regulation containing pollutant discharge limits or requirements promulgated by the EPA at 40 CFR Chapter One, Subchapter N, Parts 405 through 471 (as amended), in accordance with Section 307(b) and (c) of the Clean Water Act, and which apply to a specific category of industrial user. Users subject to categorical standards are also subject to the general pretreatment standards.

6. CERCLA means the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and all amendments thereto.

7. CFR means Code of Federal Regulations as published by the Office of the Federal Register, National Archives and Records Administration.

8. Clean Water Act or CWA means the Federal Water Pollution Control Act of 1972 and all amendments thereto.

9. COD (Chemical Oxygen Demand) means the quantity of oxygen utilized in the chemical oxidation of organic and oxidizable inorganic matter in water or wastewater as determined by Standard Methods and expressed in milligrams per liter.

10. COMBINED SEWER means a pipe or conduit designed and intended to receive and convey wastewater, stormwater including roof and street drainage, unpolluted water and cooling water.

11. COMBINED SEWER OVERFLOW means a discharge that occurs from a combined sewer into waters of the State when the flow in the combined sewer exceeds the capacity of the combined sewer or flow regulation facility due to wet weather conditions.

12. COMMERCIAL CENTRALIZED WASTE TREATMENT FACILITY or CWT means a facility (other than a landfill or an incinerator) which treats or stores aqueous wastes generated by facilities not located on the site of the CWT and which disposes of these wastes by discharging them into the District's wastewater system.

13. COMPOSITE SAMPLE means a sample made up by combining individual grab samples collected within a 24 hour period. For all pollutants subject to composite sampling requirements, 24 hour flow proportional composite samples shall be obtained when feasible. If the user demonstrates that flow proportional composite samples are not feasible, then the Director may allow collection of time proportional composite samples. In no case may a composite sample be made from fewer than four grab samples. In all cases the individual grab samples must be adequately spaced so as to ensure a sample that is representative of the user's daily operations.

14. COOLING WATER means the water discharged from any system of condensation, air conditioning, cooling, refrigeration, industrial cooling process, or other cooling system which uses or generates water during operation.

15. CSR means Code of State Regulations as published by the Missouri Secretary of State.

16. DAILY AVERAGE VALUE means the result of analysis for a particular

pollutant in a composite sample of a discharge collected within a time period not greater than 24 hours.

17. DIRECTOR means the Executive Director of The Metropolitan St. Louis Sewer District, or his duly authorized representative.

18. DISCHARGE PERMIT means a permit issued by the District to a user for a discharge of wastewater or stormwater into the District's system.

19. DISTRICT means The Metropolitan St. Louis Sewer District.

20. DISTRICT'S SYSTEM or SYSTEM means the entire system of sewers, drainage facilities, combined sewers, sanitary sewers, separate storm sewers, stormwater systems and wastewater systems owned and operated by the District.

21. DRAINAGE FACILITY means any system of artificially constructed drains, including open channels, whether lined or unlined, and separate storm sewers used to convey stormwater, surface water or groundwater. A drainage facility may also convey effluent discharged pursuant to an NPDES permit when such use is approved by the Director.

22. DRY WEATHER FLOW in a combined sewer means flow which is a combination of sanitary flow, industrial flow and infiltration with no contribution from stormwater runoff.

23. EPA means the United States Environmental Protection Agency.

24. GARBAGE means any refuse accumulation of solid animal, fruit or vegetable matter that attends the preparation, use, cooking, dealing in or storing of food and from the handling, storage and sale of produce.

25. GENERAL PRETREATMENT STANDARDS means any regulations containing pollutant discharge limits or requirements applicable to all industrial users, promulgated by EPA in 40 CFR Chapter One, Subchapter N, Parts 401 through 403 (as amended), in accordance with Section 307(b) and (c) of the Clean Water Act.

26. GRAB SAMPLE means an individual sample collected in less than fifteen (15) minutes.

27. GROUNDWATER means any water pertaining to, formed, or occurring underneath the surface of the earth.

28. HAULED WASTE means any waters or liquid wastes which have been removed and transported from any pit, sump, holding tank, septic tank, sewage treatment plant or industrial facility for discharge to the District at designated points as regulated by applicable Ordinances. 29. INDUSTRIAL USER means any person who discharges into the District's wastewater system from any source regulated under Section 307(b), (c) or (d) of the Clean Water Act or from any source listed in Division A, B, D, E or I of the Standard Industrial Classification Manual or from any solid waste disposal operation such as, but not limited to landfills, recycling facilities, solid or hazardous waste handling or disposal facilities, and CWTs.

30. INDUSTRIAL WASTE means the water-borne wastes, including contaminated cooling water, from industrial processes, as distinct from sanitary wastewater.

31. INFECTIOUS WASTE means any waste which contains pathogens with

sufficient virulence and in sufficient quantity so that exposure to the waste by a susceptible host could result in an infectious disease. Such wastes include, but are not limited to: (1) Isolation wastes generated by hospitalized patients who have communicable diseases capable of being transmitted via those wastes; (2) Surgical, dialysis and laboratory wastes contaminated in the process of caring for hospital patients who have communicable diseases capable of being transmitted via those wastes; (3) Cultures and stocks of infectious agents and associated biologicals; (4) Blood and blood products known or suspected to be contaminated with a transmissible infectious agent; (5) All pathology and autopsy wastes, including those from animals contaminated with infectious agents capable of being transmitted to humans; and (6) All discarded sharps including hypodermic needles, syringes, and scalpel blades that have come in contact with material considered infectious.

32. INTERFERENCE means the inhibition or disruption of the District's wastewater system or operations or its processing, use or disposal of sludge, by a user's discharge which alone or in conjunction with other discharges, causes, or contributes to the inhibition or disruption and which: (a) causes a violation of any requirement of the District's NPDES Permit (including an increase in the magnitude or duration of a violation); or (b) prevents the use or disposal of sludge by the District in compliance with any of the following Statutes and Regulations: Section 405 of the Clean Water Act, the Solid Waste Disposal Act (SWDA), the Resource Conservation and Recovery Act (RCRA), the Clean Air Act, the Toxic Substances Control Act (TSCA) or any more stringent State or local regulations. A user contributes to interference when the user: (1) Discharges a pollutant concentration or a daily pollutant loading in excess of that allowed by District Ordinance or permit or by Federal, State, or local law; (2) Discharges wastewater which substantially differs in nature and constituents from the user's normal average discharge; (3) Knows or has reason to know that its discharge, alone or in conjunction with discharges from other users, would result in interference; or (4) Knows or has reason to know that the District is, for any reason, violating its final effluent limitations in its NPDES permit and that the user's discharge either alone or in conjunction with discharges from other users, increases the magnitude or duration of the District's violations.

33. INSTANTANEOUS VALUE means the result of analysis for a particular pollutant in a grab sample.

34. LONG TERM AVERAGE means an average volume or rate of discharge or average mass of pollutant discharge or average rate of production based on actual levels of production or operation over an extended period of time sufficient to capture the normal range of variations in production or operation. A long term average should be based on a minimum of one recent year's historical data, if available, or upon well documented projections if such data are not available.

35. NEW SOURCE means any new building, structure, facility or installation from which there is or may be a discharge of pollutants, the construction of which commenced after the publication of proposed pretreatment standards under Section 307(c) of the CWA which will be applicable to the source if promulgated, provided: (1) Construction is at a site where no other source is located; or (2) Construction totally replaces a process or production equipment that caused a discharge of pollutants at an existing source; or (3) The new production or wastewater generating processes are substantially independent of an existing source at the site. Construction is deemed to have commenced if there has been any placement, assembly or installation of components, significant site preparation work, or entry into binding contractual obligations for the purchase of components which are intended to be used in the new operation within a reasonable period of time. Construction at an existing site results in a modification, not a new source, if it alters, replaces, or adds to existing processes or production equipment, but does not

totally replace them, or if the resulting production or wastewater generating processes are not substantially independent of the existing source.

36. NON-RESIDENTIAL means all property other than residential property, including but not limited to, industrial, commercial and semi-public.

37. NORMAL WASTEWATER means wastewater which, prior to any treatment, contains not more than 350 milligrams per liter of suspended solids and has a BOD5 not greater than 300 milligrams per liter, and a COD not greater than 600 milligrams per liter.

38. NPDES PERMIT means a permit issued under the National Pollutant Discharge Elimination System pursuant to Section 402 of the Clean Water Act for a discharge into waters of the State.

39. OUTFALL means any point of discharge into a watercourse, or other body of surface or groundwater.

40. PASS THROUGH means a discharge of a pollutant from a District treatment plant into waters of the State when such discharge causes a violation of any requirement of the District's NPDES permit, or a violation of a State or Federal water quality standard or increases the magnitude or duration of any violation and which is the result of a user's discharge of the pollutant either alone or in conjunction with other user's discharges of the pollutant into the District's wastewater system. A user contributes to pass through when the user: (1) Discharges a pollutant concentration or a daily pollutant loading in excess of that allowed by District Ordinance or permit or by Federal, State, or local law; (2) Discharges wastewater which substantially differs in nature and constituents from the user's normal average discharge; (3) Knows or has reason to know that its discharge, alone or in conjunction with discharges from other users, would result in pass through; or (4) Knows or has reason to know that the District is, for any reason, violating its final effluent limitations in its NPDES permit and that the user's discharge either alone or in conjunction with discharges from other users, increases the magnitude or duration of the District's violations.

41. PERSON means any individual, firm, proprietorship, partnership, company, association, public or private corporation, joint stock company, trust, estate, political subdivision, or any agency, board, department, or bureau of the State or Federal government, or any other legal entity.

42. pH means the intensity of the basic or acidic condition of a solution as determined by Standard Methods and expressed in standard units (s.u.). A standard unit is the negative logarithm (base 10) of the hydrogen ion activity in a solution at a given temperature.

43. POINT SOURCE means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, vessel, or other floating craft from which pollutants are or may be discharged.

44. POLLUTANT means any substance which, alone or in combination with other substances, if discharged to waters of the State in sufficient quantities, causes or is reasonably certain to cause any alteration of the physical, chemical or biological properties of such waters; or to create a nuisance; or to render such waters harmful, detrimental or injurious to public health, safety or welfare, or to domestic, industrial, agricultural, recreational, or other legitimate beneficial uses or to any organism, aquatic life, plant or animal.

45. PRETREATMENT means the reduction or elimination of pollutants or the alteration of the nature of pollutant properties in wastewater to a more acceptable state prior to discharge to the District's wastewater system.

46. PRIVATE SEWER means a sewer within the boundaries of the District but not owned or controlled by the District.

47. PROBLEM DISCHARGE means any upset, slug discharge, bypass, spill or accident which does or may result in a discharge into the District's system or into a watercourse of a prohibited substance as listed in Articles IV and V; or of a regulated substance in excess of limitations as listed in Article V; or of a regulated substance in excess of limitations established in any permit issued to the user by the District or any NPDES permit issued to the user, and which may: (a) cause interference or pass through; or (b) contribute to a violation of any requirement of the District's NPDES permit; or (c) cause violation of any State or Federal water quality standard.

48. PRODUCTION BASED DISCHARGE LIMITATION means a pollutant limitation which is expressed in terms of allowable mass discharge of pollutant per unit of production. In order to determine compliance with such a limitation, the actual discharge rate and the actual production rate at the time of sampling must be known.

49. RCRA means the Federal Resource Conservation and Recovery Act of 1976 and all amendments thereto.

50. RESIDENTIAL means property used only for human residency and shall include subdivisions, single family dwellings, two family dwellings, and multifamily dwellings.

51. RESPONSIBLE CORPORATE OFFICER means a president, secretary, treasurer or vice president in charge of a principal business function, or any other person who performs similar policy or decision making functions for the corporation, or the manager of one or more manufacturing, production or operation facilities if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

52. SANITARY SEWER means a pipe or conduit designed and intended to receive and convey wastewater as defined herein.

53. SANITARY WASTEWATER means wastewater emanating from the sanitary conveniences, including toilet, bath, laundry, lavatory, and/or kitchen sink, of residential and non-residential sources, as distinct from industrial waste.

54. SEMI-PUBLIC means a governmental, institutional, educational or municipal property.

55. SEPARATE STORM SEWER means a pipe, conduit, conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels or storm drains) designed and intended to receive and convey stormwater, as defined herein and which discharges to waters of the State and which is not part of the combined sewer system. A separate storm sewer may also convey effluent discharged pursuant to an NPDES permit when such use is approved by the Director.

56. SEVERE PROPERTY DAMAGE means substantial physical damage to

property, damage to the treatment facilities which causes them to become inoperable, or substantial or permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

57. SEWER means a pipe or conduit for conveying wastewater, stormwater or cooling water or other disposed wastes.

58. SHALL is mandatory; MAY is permissive.

59. SIGNIFICANT NEW OR INCREASED DISCHARGE means: (1) Any discharge from a new process or facility or a new source. (2) Any increase in volume or rate of discharge from an existing process or facility when the new long term average daily volume or rate of discharge will exceed the previous long term average by 20% or more. (3) Any addition of a priority pollutant or a toxic pollutant not previously present or suspected in the user's discharge. (4) Any addition of a hazardous waste subject to, but not previously reported under the reporting requirements in Article VIII, Section Nine of this Ordinance. (5) Any increase in mass of an existing regulated pollutant when the new long term average daily mass discharge of that pollutant will exceed the previous long term average by 20% or more. (6) Any addition of a new pollutant or any increase in mass of an existing pollutant when the discharge of such pollutant may cause or contribute to interference or pass through. (7) Any new batch discharges when previous discharges from an existing source occurred on a continuous basis.

60. SIGNIFICANT NONCOMPLIANCE means that violations of this Ordinance by a user subject to pretreatment standards meet one or more of the following criteria: (1) Chronic Violation: 66% or more of all measurements taken for the same pollutant during a six month period exceeded (by any magnitude) the applicable daily maximum limit or the applicable average limit; (2) Technical Review Criteria (TRC) Violation: 33% or more of all measurements taken for the same pollutant during a six month period equaled or exceeded the product of the daily average maximum limit or the average limit times the applicable TRC. (For categorical pretreatment limitations the TRC equals 1.4 for BOD, TSS and Oil and Grease; and 1.2 for all other pollutants except pH. For District limitations, the same TRCs apply except there is no TRC for BOD and TSS.); (3) An effluent violation caused interference or pass through or endangered the health of District personnel or the general public; (4) A discharge caused imminent endangerment to human health, welfare or to the environment and resulted in the District exercising its emergency authority under Article IX, Section Three of this Ordinance; (5) Failure to meet a compliance schedule milestone date within ninety (90) days or more after the scheduled date; (6) Failure to submit a required report within thirty (30) days of its due date; (7) Failure to accurately report noncompliance; or (8) Any other violation or group of violations which the Director determines may cause interference or pass through or will adversely affect implementation of the District's pretreatment program.

61. SLUG DISCHARGE means a discharge of a non-routine, occasional nature of any pollutant released at a flow rate and/or concentration which may cause interference as defined herein. A slug discharge may occur as the result of a pollutant release from a batch operation or a spill or any accidental discharge.

62. STANDARD INDUSTRIAL CLASSIFICATION MANUAL or SIC MANUAL means the latest edition of said publication issued by the Executive Office of the President, Office of Management and Budget.

63. STANDARD METHODS means the latest edition of "Standard Methods for the

Examination of Water and Wastewater" as published jointly by the American Public Health Association, The American Water Works Association, and the Water Pollution Control Federation.

64. STATE means the state of Missouri.

65. STORMWATER means rainfall runoff, snow melt runoff and surface runoff and drainage.

66. STORMWATER SYSTEM means the entire system of combined sewers and separate storm sewers, operated by the District, for the collection, storage and treatment of stormwater to serve the needs of the District and its inhabitants and others, including all appurtenances and facilities connected therewith or relating thereto, together with all extensions, improvements, additions and enlargements made thereto or as may be acquired by the District.

67. SURFACE WATER means all water appearing on the land surface as distinguished from groundwater and including water appearing in watercourses, lakes, and ponds.

68. SYSTEM (See definition of District's System).

69. TOTAL OIL AND GREASE means the total of all materials recoverable in a sample as a substance soluble in the procedure solvent using the procedures in Standard Methods and expressed in milligrams per liter. Oil and grease includes fatty acids, soaps, fats, oils, waxes and petroleum products.

70. TOTAL SUSPENDED SOLIDS (TSS) means all matter in water, wastewater, or other liquids; that is retained on a filter as determined by Standard Methods and expressed in milligrams per liter. Total Suspended Solids is also known as Nonfilterable Residue (NFR).

71. TOTAL TOXIC ORGANICS (TTO) means the summation of all quantifiable values greater than .01 mg/l for the applicable toxic organics included in the listing in 40 CFR 401.15 of toxic pollutants identified pursuant to Section 307(a)(1) of the Clean Water Act as determined using the analytical techniques specified in 40 CFR 136 and expressed in milligrams per liter. For discharges subject to categorical pretreatment standards, the list of organics to be included in the TTO is contained in the applicable standard. For the local TTO limit specified in Article V, Section Two, Subsection B of this Ordinance, the organics to be included in the TTO are all of those from the list in 40 CFR 401.15 which are or may be present in the discharge.

72. TOXIC SUBSTANCE means any substance which alone or in combination with other substances, when discharged to a wastewater system, stormwater system or watercourse in sufficient quantities, interferes with any biological wastewater treatment process, or, either through direct exposure or through indirect exposure by ingestion through the food chain, interferes with the normal life processes of any organism, aquatic life, plant or animal or causes adverse human health impacts. Toxic substances include, but are not limited to pollutants listed as toxic in 40 CFR 401.15 pursuant to section 307(a)(1) of the CWA and those listed as toxic in sludge pursuant to section 405(d)(2) of the CWA.

73. TREATMENT means the reduction or elimination of pollutants in wastewater or stormwater prior to discharge to waters of the State.

74. UNPOLLUTED WATER means any water that may be discharged under NPDES regulations into waters of the State without having to be authorized by a

NPDES permit and which will not cause any violations of State or Federal water quality standards.

75. UPSET means an exceptional incident in which there is unintentional and temporary noncompliance with pretreatment or treatment standards because of factors beyond the reasonable control of the user. An upset does not include noncompliance to the extent caused by operational error, improperly designed pretreatment or treatment facilities, lack of preventive maintenance, or careless or improper operation.

76. USER means any person who discharges, or causes the discharge of wastewater into the District's wastewater system or who discharges or causes the discharge of stormwater or any NPDES permit regulated effluent or any other waste into the District's stormwater system or any person served by the District's system.

77. WASTE means any material other than unpolluted water which is accidentally or purposely discarded into the District's system.

78. WASTEWATER means the water-borne wastes, industrial waste and/or sanitary wastewater as defined herein, emanating from residential and non-residential sources together with such groundwater, surface water, or stormwater as cannot be avoided.

79. WASTEWATER SYSTEM means the entire sanitary sewer system, including combined sewers, owned and operated by the District for the collection, storage and treatment of wastewater to serve the needs of the District and its inhabitants and others, including all appurtenances and facilities connected therewith or relating thereto, together with all extensions, improvements, additions and enlargements thereto made or acquired by the District. The District's wastewater system is a Publicly Owned Treatment Works (POTW) as defined at 40 CFR Part 122 and is therefore subject to all provisions of State and Federal regulations applicable to POTWs.

80. WATERCOURSE means a natural or manmade surface drainage channel or body of water (including a lake or pond) in which a flow of water occurs, either continuously or intermittently.

81. WATERS OF THE STATE means all rivers, streams, lakes and other bodies of surface water and groundwater lying within or forming a part of the boundaries of the State which are not entirely confined and located completely upon lands owned, leased or otherwise controlled by a single person or by two or more persons jointly or as tenants in common and includes waters of the United States lying within the State.

82. WET WEATHER FLOW in a combined sewer means flow which is a combination of sanitary flow, industrial flow, infiltration and stormwater runoff.

ARTICLE III - DISTRICT AND NON-DISTRICT WASTEWATER AND STORMWATER SYSTEMS

Section One - Approval Required.

Except as hereinafter provided, no person shall make any connection to the District's system or install any residential or nonresidential wastewater treatment facility, pretreatment facility or other facility intended or used for treatment, pretreatment or control of wastewater or stormwater, without the approval of the Director and subject to the provisions of Article VII of this Ordinance.

Section Two - Connection of New Premise.

Unless prohibited or exempted by other provisions of this Ordinance, any person who develops within the District a property or structure which will produce any wastewater or stormwater which must be disposed of, shall discharge such wastewater or stormwater into the District's system in compliance with this Ordinance and with all rules, regulations and specifications of the District as filed in the office of the Secretary-Treasurer of the District.

Section Three - Connection of Existing System.

Within ninety (90) days after a District sanitary sewer becomes available to a property served by an existing residential or non- residential wastewater system a direct connection shall be made to the District sewer in compliance with this Ordinance and with all rules, regulations and specifications of the District as filed in the office of the Secretary-Treasurer of the District. A sanitary sewer shall be considered available if it is within two hundred (200) feet of any legal boundary of the property to be connected to the sewer and if the sewer and receiving treatment plant can, by design, properly convey and treat the wastes to be discharged. Any septic tank, cesspool, lagoon, or other residential, or non-residential wastewater treatment facility shall be abandoned and filled with suitable material as per applicable District Ordinances and/or State or local regulations or shall be removed unless such system is to be used for pretreatment or control of wastewater prior to discharge to the District's wastewater system.

Section Four - Non-District System Required.

When connection to a District sanitary sewer is prohibited by other provisions of this Ordinance or when the Director determines that connection to a sanitary sewer is not feasible or when a District sanitary sewer is not available under the provisions of this Ordinance, the building sewer shall be connected to a residential, or non-residential pollution control system approved by the Director and complying with the provisions of this Ordinance and with applicable local, State and Federal regulations.

ARTICLE IV - CONTROL OF POLLUTANT DISCHARGES TO SEPARATE STORM SEWERS AND WATERCOURSES

Discharges to the District's separate storm sewers enter waters of the State directly or after conveyance through the District's system and are subject to NPDES permit regulations. All users shall comply with the provisions of this article to ensure that discharges from the District's separate storm sewers do not violate conditions of any of the District's NPDES permits or of any NPDES permit regulations, including stormwater discharge regulations, or cause any violations of State or Federal water quality standards.

Section One - Prohibited Discharges to Separate Storm Sewers and Watercourses.

A. No person shall discharge any wastewater treatment plant effluent, cooling water, stormwater or unpolluted water into any separate storm sewer or watercourse unless such discharge is authorized by an NPDES permit or is exempt from NPDES permit regulations and is not otherwise prohibited by this Ordinance.

B. No person shall discharge or cause to be discharged into any separate storm sewer any stormwater associated with industrial activity as defined in 40 CFR 122.26(b) unless the discharge is in compliance with all applicable provisions of the NPDES stormwater regulations in 40 CFR 122.26 and any applicable State regulations and is in compliance with the terms and conditions of any system- wide stormwater discharge permit issued to the District pursuant to those regulations.

C. No user shall initiate a significant new or increased discharge above the levels contained in the authorization to discharge to any separate storm sewer or watercourse without first complying with the reporting provisions of Article VIII, Section Six and until having received approval from the Director subject to the provisions of Article VI, of this Ordinance.

D. A user shall report to the Director, in accordance with the provisions of Article VIII, Section Eight of this Ordinance, any problem discharges as defined in this Ordinance or any other discharges to a separate storm sewer or watercourse that are not in compliance with NPDES or District permit conditions.

Section Two - Flow Obstruction Prohibited.

A. No person shall place any dam or other flow restricting structure or device in any drainage facility or watercourse without first having obtained approval from the Director.

B. No person shall place or deposit into any outfall, drainage facility, storm sewer or watercourse within the District any garbage, trash, yard waste, soil, rock or similar material, or any other substance which obstructs flow in the system or damages the system or interferes with the proper operation of the system or which constitutes a nuisance or a hazard to the public. In the event that such an obstruction occurs, the Director may cause such obstruction to be removed or cause such damage to be repaired and to recover applicable costs pursuant to the provisions of Article IX, Section Six of this Ordinance.

ARTICLE V - CONTROL OF POLLUTANT DISCHARGES TO SANITARY AND COMBINED SEWERS

Pollutants which are discharged to the District's sanitary or combined sewers enter waters of the State from District treatment plant outfalls or combined sewer overflow outfalls after conveyance through the District's system and are therefore subject to NPDES permit regulations. All users of the system shall comply with the prohibitions and standards of this article to ensure that discharges from the District's outfalls do not violate conditions of the District's NPDES permits, or cause any violations of State or Federal water quality standards.

Section One - Prohibited Substances.

A. No person shall discharge or cause to be discharged into any sanitary or combined sewer any of the following substances:

1. Any substance in a quantity or concentration which may cause interference or pass through as those terms are defined in Article II of this Ordinance, or cause violations of State or Federal water quality standards in a receiving watercourse, or may otherwise endanger life, limb, or property or constitute a public nuisance.

2. Any flammable or explosive substance which creates an atmosphere within the wastewater system which exceeds ten percent of the Lower Explosive Limit (LEL) as designated by the National Fire

Protection Association; or which causes the discharge into the District's sewer to have a closed cup flashpoint of less than 140 degrees Fahrenheit (60 degrees Celsius). Closed cup flashpoints shall be determined using the test methods specified in 40 CFR 261.21.

3. Any wastes which can create corrosive conditions capable of causing damage or hazard to structures, equipment or personnel of the wastewater system. Such wastes include, but are not limited to: (1) Those which cause the pH of a discharge to be less than 5.5 , unless the user can show that all parts of the District's system which will be subject to the lower pH are designed to accommodate such discharge and the discharge will not cause violations of other prohibitions in this section and except for excursions allowed pursuant to the continuous monitoring provision in Article X, Section Two, Subsection C); and (2) Those wastes which contain oxidizable chemical compounds (such as sulfide, sulfite and nitrite) in sufficient quantities to create corrosive conditions in the system.

4. Any solids or any substances that will solidify or become discernibly viscous at temperatures between 32 and 150 degrees Fahrenheit (0 and 65 degrees Celsius) or any other substances in quantities capable of causing obstruction to flow within the District's treatment plants or sewers, including any obstruction within the combined sewer system which causes or contributes to a combined sewer overflow.

5. Any garbage containing particles larger than one-half inch in any dimension or particles which will not be carried freely under the flow conditions of the sewer.

6. Any pollutant released at a flow rate and/or concentration which will cause interference with the operation of the wastewater system.

7. Heat in amounts which will cause interference with the operation or maintenance of the wastewater system, but in no case heat in such quantities that the temperature at the headworks of the District's treatment plant exceeds 40 degrees Celsius (104 degrees Fahrenheit).

8. Any water or waste which by itself or by interaction with other materials, emits toxic gases, vapors or fumes into the atmosphere of any area of the wastewater system at levels in excess of Threshold Limit Values (TLV) established for air-borne contaminants by the American Conference of Governmental Industrial Hygienists (ACGIH) or the Occupational Safety and Health Administration (OSHA).

9. Any trucked or hauled wastes except as authorized by District Ordinance, and in compliance with the provisions of this Ordinance. In no case may trucked or hauled wastes include any hazardous wastes as defined in 40 CFR Part 261 or in 10 CSR 25-4.261.

10. Any wastes which are highly colored, such as, but not limited to concentrated dye wastes, tannin or spent tanning solutions at concentrations which cause discoloration of District equipment or which cause the effluent from the District's plant to have an objectionable color. 11. Any petroleum based oil or grease, nonbiodegradable cutting oil or product of mineral oil origin except those which unavoidably enter the user's waste stream as a normal constituent of wastewater from processes or equipment which use or process such materials or through contact with areas contaminated with such materials. In no case may such materials be discharged in quantities or concentrations which will cause interference or pass through.

12. Any infectious wastes, except those wastes which are authorized for disposal into sanitary sewers under State regulations 10 CSR 80-7.010 and 19 CSR 30-20.011 or more stringent local regulations.

13. Any radioactive material, except those wastes which are authorized for disposal into sanitary sewers under applicable State and Federal regulations and as specifically authorized by the Director. The aggregate of all radioactive materials discharged from all users to the sewers tributary to each of the District's treatment plants shall be limited to one (1) curie per year. Excreta from individuals undergoing medical diagnosis or treatment with radiological materials shall be exempt from this prohibition. Any radioactive material discharged to the wastewater system must be readily soluble or dispersible in water.

14. Any substance in quantities which either alone or in combination with other wastes results in the

formation within the wastewater system of any malodor, foam, or other condition which is capable of creating a public nuisance or hazard to life or interferes with operation and maintenance of the system.

Section Two - Discharge Limitations.

The limitations for quantities and/or concentrations of pollutants contained in this section apply to all users who discharge to the District's wastewater system.

A. Categorical Pretreatment Standards:

Any industrial user having process waste streams which are subject to any Federal categorical pretreatment standards either currently in effect or promulgated or modified after the effective date of this ordinance shall comply with the requirements of such standards. All categorical pretreatment standards established pursuant to 40 CFR Chapter One, Subchapter N, are hereby incorporated by reference and are fully enforceable under this Ordinance the same as if fully set out herein. Limitations established in such standards shall apply to the treated effluents or, if no treatment is provided, to the untreated effluents from the processes regulated by the standard, unless otherwise specified by the standard. When the limits in a categorical pretreatment standard are production based, the Director may convert the limits to equivalent mass or concentration for purposes of calculating effluent limitations applicable to individual users. Where regulated process effluents can not be sampled prior to mixing with other wastestreams, alternative limits for the mixed effluent may be established by the Director using the combined waste stream formula subject to the provisions of 40 CFR 403.6(e). All users subject to categorical pretreatment standards are also obligated under Federal law to comply with the District's discharge limitations specified in subsection B of this section. When a pollutant in a user's discharge is subject to both a limit from a categorical pretreatment standard and a District limit at the same sampling point, the most strict limit shall apply.

B. District Limitations:

At the point of discharge from the user's property to the District's wastewater system, all users shall comply with the following limitations. Separate limitations apply for discharges to the District's plants with outfalls to the Mississippi and Missouri Rivers (Large Rivers) and for plants with outfalls to all other streams (Small Rivers).

Parameter*	Daily Average Limit**		Instantaneous Limit**	
	Large Riv.	Small Riv.	Large Riv.	Small Riv.
Antimony	0.5	0.5	1.5	1.5
Arsenic	0.4	0.3	1.2	0.9
Barium	10.0	10.0	30.0	30.0
Beryllium	0.4	0.1	1.2	0.3
Cadmium	0.7	0.4	1.2	1.2
Chromium	5.0	5.0	15.0	15.0
Copper	2.7	1.5	4.5	4.5
Cyanide, Amenable	0.4	0.1	1.2	0.3

Iron 150. 25.0 450.0 75.0

Lead 0.4 0.2 0.6 0.6

Mercury 0.01 0.01 0.03 0.03

Nickel 2.3 1.0 4.1 3.0

Oil & Grease 200 200 200 200

Phenolic Compounds 7.0 0.05 21.0 0.15

Selenium 0.2 0.2 0.6 0.6

Silver 0.5 0.01 1.5 0.03

Zinc 3.0 3.0 9.0 9.0

Total Toxic Organics Shall not exceed 5.52 mg/l at any time.

Temperature Shall not exceed 140øF (60øC) at any time.

*** pH Shall be in the range of 5.5 to 11.5 s.u. at all times.

*** * Total substance (dissolved plus suspended).

** All units are milligrams per liter unless otherwise noted.

*** Excursions may be allowed pursuant to the continuous monitoring provisions of Article X, Section Two, Subsection C.

C. More Restrictive Standards:

The Director shall establish limits on the volume and concentration of contributions from users which are more strict than those specified in this Section when the Director determines such action is necessary to ensure that the aggregate discharges to the sewers tributary to any segment of the District's system do not cause: (1) Interference or pass through, (2) Violations of the District's NPDES permit conditions, (3) Violations of any State or Federal water quality standards, (4) Danger to life, limb or property, (5) Local nuisance conditions, or (6) Air emissions or any other environmental releases from the District's system in excess of the limits and requirements of applicable State, Federal and local regulations. When the Director determines it is necessary to establish more strict limits under the provisions of this subsection, the Director shall advise the users affected by the change and shall require the users to develop within a reasonable period of time, compliance schedules or management plans or to take such other action as may be necessary to achieve the goals of this subsection.

Section Three - Restrictions.

A. New or Increased Discharges. A user shall not initiate a significant new or increased discharge without first complying with the reporting provisions of Article VIII, Section Six and until having received approval from the Director subject to the provisions of Article VI, of this Ordinance.

B. Upsets. In the event of an upset, as defined in this Ordinance, the user shall take all feasible steps to control production or discharges so as to minimize the extent or duration of any noncompliance until the condition causing the upset is mitigated or an alternative method of maintaining compliance approved

by the Director is provided. The user shall also comply with the reporting requirements of Article VIII, Section Eight of this Ordinance.

C. Dilution Prohibited. Except where expressly authorized to do so by an applicable categorical pretreatment standard or requirement, no user shall increase the use of potable or process water in any way for the purpose of diluting a discharge as a partial or complete substitute for pretreatment required to comply with the provisions of this Ordinance.

D. Bypassing. No industrial user may bypass any portion of its pretreatment facilities except when necessary to perform essential maintenance and then only if the bypass will not result in a violation of applicable pretreatment standards or requirements. Any other pretreatment facility bypass is prohibited unless: (1) The bypass is unavoidable to prevent loss of life, personal injury or severe property damage; (2) There are no feasible alternatives to the bypass; and (3) In the event of an anticipated bypass, advance notice is provided to the Director. Any pretreatment facility bypass shall be reported to the Director in accordance with the provisions of Article VIII, Section Eight of this Ordinance.

E. Prohibited Discharges to Sanitary Sewers: No person shall discharge or cause to be discharged into any sanitary sewer any: (1) Stormwater, surface water, or groundwater, (2) Roof runoff, (3) Cooling water which is from a non-contact once-through operation and which is not treated prior to or during use, or (4) Unpolluted water, except that; (a) any water listed above which contains pollutants regulated by this Ordinance may be discharged when approved by the Director subject to any pretreatment, flow control or other control measures and monitoring procedures as determined by the Director, and, (b) small volumes of otherwise excluded cooling water may be discharged provided such discharge does not violate any other provisions of this Ordinance.

F. Open Connections Prohibited. No person constructing or repairing a sanitary sewer, or any building sewer connected to a sanitary sewer shall leave such sewer open, unsealed, or incomplete in a manner which will permit stormwater, groundwater, or surface water to enter any District sanitary sewer. All such openings shall be tightly sealed at all points whenever work is not actually in progress on such sewer or connection.

ARTICLE VI - AUTHORITY TO PROHIBIT OR REGULATE DISCHARGES

Section One - Control Alternatives.

A. If any wastewater or stormwater is discharged or is proposed to be discharged into the District's system, the Director, in order to ensure compliance with the provisions of this Ordinance or with State or federal regulations, may take one or more of the following actions: 1. Prohibit the discharge, 2. Require pretreatment to a condition acceptable for discharge into the wastewater system, 3. Require treatment to a condition acceptable for discharge into a separate storm sewer, drainage facility or watercourse. 4. Require controls on the quantities and rates of discharge, 5. Require payment to cover added costs of handling and treating the wastes not covered by existing fees or user charges, 6. Require the development of compliance schedules for meeting any applicable treatment or pretreatment standard, or stormwater discharge standard or any requirement of this Ordinance, 7. Require the submission of reports necessary to assure compliance with any applicable treatment or pretreatment standard, or stormwater discharge standard, or any requirement of this Ordinance, 8. Require the user to obtain a discharge permit from the District. 9. Carry out all inspections, surveillance, and monitoring necessary to determine compliance with any applicable treatment or pretreatment standard, stormwater discharge standard or any requirement of this Ordinance, 10. Require submission of management plans for the control of accidental discharges or slug discharges, 11. Require submission of management plans to control pollutants entering the wastewater and/or separate stormwater system, 12. Require sampling and analysis of discharges and reporting of the results, 13. Seek remedies for noncompliance by any user as provided in Article IX of this Ordinance, and/or 14. Terminate service.

B. When considering the above alternatives, the Director shall ensure that the District is in compliance

with all State and Federal requirements and limitations. The Director shall also take into consideration the cost effectiveness, economic impact of each alternative on the user and the District, and any other factors relevant to the situation.

Section Two - Variances.

A. Categorical Pretreatment Standards: Requests for variances from categorical pretreatment standards shall be made directly to the Missouri Department of Natural Resources (MDNR) in accordance with the provisions of 40 CFR 403.13. One copy of such a variance application and its supporting documentation shall be provided to the Director no later than the date of submittal to MDNR.

B. District Standards: Requests for variances from the District's limitations or requirements contained in this Ordinance shall be made in writing to the Director on a form provided by the Director. The Director may approve or deny a variance application in full or in part and shall set time limits for the duration of the variance. No variance may be approved for a time period longer than three (3) years. Variances shall contain such conditions as the Director determines necessary to ensure compliance with this Ordinance and with any State or Federal regulations. The Director will notify the applicant in writing of his decision within sixty (60) days of receipt of a completed application. Variances from District standards may be approved only where: (1) The alternative limit is no less stringent than justified by the factors presented for consideration; and (2) The alternative limit will not result in a violation of the prohibitions in Article V, Section One; and (3) The alternative limit will not result in an adverse non- water quality environmental impact; and (4) The alternative limit will not violate any applicable State, Federal or local regulations; and (5) Compliance with the standard would result in either (a) a removal cost that can not be justified for the size and/or nature of the discharge, or (b) an adverse non-water quality environmental impact.

C. Hauled Wastes: When a variance from a District limitation is sought for discharge of a hauled waste subject to the provisions of applicable District Ordinances, the Director may approve or deny the request solely on the basis of the information contained in the application for special discharge and an analysis of the waste to be hauled using the criteria in subsection B above.

D. Variance Modification or Revocation: The Director may revoke a variance after thirty (30) days notice to the user for cause including, but not limited to, the following causes: (1) A violation of any term or condition of the variance. (2) A misrepresentation or failure to fully disclose all relevant facts in obtaining a variance. (3) A determination by the Director based upon additional information, that a variance is no longer appropriate. The Director may modify a variance after thirty (30) days notice to the user following a determination by the Director that the circumstances under which the variance was granted have changed and a modification is necessary to ensure compliance with the conditions stated in subsection B of this Section.

Section Three - Discharge Permits.

A. Permit Required: The Director may require that a user obtain a permit to discharge into the District's wastewater system or stormwater system. Such judgment shall be made based upon data contained in the User Questionnaire or in other reports required pursuant to Article VIII of this ordinance or resulting from sampling or investigations performed by the District or as required by State or Federal regulations. 1. Within 60 days of being notified by the Director that a permit is required, the user shall submit a permit application on a form provided by the Director complete with all supplementary information as specified on the application form and as specified in the Director's notification. The Director shall promptly review the application and shall advise the applicant of any deficiencies. The Director shall issue or deny the permit within 90 days of receipt of a complete application, including all supplementary information required. Should the applicant fail to correct application deficiencies within a reasonable period of time, the Director may proceed to issue or deny the permit within 90 days of his last request

for information. 2. Any user who has been issued a discharge permit shall apply for renewal of that permit at least 180 days prior to the expiration date contained therein. The District shall process permit renewal applications on the same basis as a first time application. Any user who fails to submit a timely application for permit renewal will be subject to enforcement action as provided in Article IX of this ordinance. 3. No user who has been required to submit a permit application may continue to discharge into the District's system after the date of a permit denial. 4. The terms and conditions of a permit are automatically continued past its expiration date and remain fully enforceable pending issuance of a new permit if: (a) The permittee has submitted a timely and sufficient application for renewal; and (b) The District is unable, through no fault of the permittee, to issue a new permit before the expiration date of the previous permit; and (c) The permittee is not in significant noncompliance with the terms and conditions of the previous permit on its expiration date.

B. Change in or Termination of Discharge:

1. A permittee shall not significantly increase the average daily volume, or flow rate of discharge or add any significant new pollutants or significantly increase the discharge of existing pollutants set forth in a permit without first having secured an amendment to the permit unless the permit conditions authorize such increase or additions without an amendment. A permittee shall notify the Director of any proposed significant new or increased discharge in accordance with the provisions of Article VIII, Section Six. If required by the Director, the permittee shall submit a new permit application for the discharge and shall not commence the new or increased discharge until a revised permit has been issued.

2. Whenever any discharge covered by a permit is permanently eliminated, the existing permit will be terminated or modified upon verification by the Director.

C. Permits not Transferrable:

A permit may not be transferred or reassigned. When a property covered by a discharge permit is sold or otherwise transferred to a new owner, the new owner shall apply for a new permit at least ten (10) days prior to the transfer and shall agree to abide by all of the conditions and terms of the previous owner's permit until the Director issues a new permit or denies the application. D. Permit Conditions: The Director shall include conditions and terms in each permit to ensure compliance with the provisions of this Ordinance and with applicable State and federal regulations. Conditions may include, but are not limited to:

1. Limits on rate, time, and characteristics of discharge or requirements for flow regulation and equalization;

2. Installation and maintenance of inspection, flow measurement, and sampling facilities, including access to such facilities;

3. Specifications for monitoring programs which may include flow measurement, sampling, chemical and biological tests, recording of data, and reporting schedule;

4. Treatment or pretreatment standards and requirements;

5. Schedules for development and/or implementation of management plans, drawings and specifications, construction of necessary facilities or process changes, including schedules for reporting progress toward meeting these requirements;

6. Submission of self-monitoring reports and other reports as required pursuant to this Ordinance;

7. Effective date and termination date. No permit will be issued for a time period longer than five (5) years.

8. Special service charges or fees pursuant to applicable Ordinances;

9. Any other conditions to ensure compliance with this Ordinance and with applicable requirements of State and Federal regulations.

10. Authority to revoke for cause. E. Permit Modification or Revocation: The Director may revoke a permit after thirty (30) days notice to the user for cause including, but not limited to, the following causes: (1) A violation of any term or condition of the permit. (2) A misrepresentation or failure to fully disclose all relevant facts in obtaining a permit. The Director may modify a permit after thirty (30) days notice to the user following promulgation of new State, Federal or local regulations to ensure compliance with the effective dates contained in any such new regulations.

Section Four - Special Agreements.

When necessary to provide for proper treatment of wastewater or stormwater, the Director may enter into special agreements or arrangements with a user to accept wastewater or stormwater into the District's system at other than the usual discharge points or to accept wastewater or stormwater of unusual strength or character for special treatment, subject to any special discharge conditions or payments or user charges as may be applicable.

ARTICLE VII - TREATMENT, PRETREATMENT AND DISCHARGE CONTROL FACILITIES

Section One - Facilities Required.

A. Treatment, pretreatment or discharge control facilities shall be provided for discharges to the District's system when required by State or Federal regulations or when, in the judgement of the Director, such facilities are necessary to ensure compliance with the provisions of Articles III through VI of this Ordinance or for the control of pollutants which are contained or may be contained in any of the user's discharges or for the prevention or control of slug discharges or spills. All such facilities shall be located so as to be readily accessible for maintenance and inspection.

B. Interceptors or traps for oil, grease, grit, or other harmful or flammable substances which can be trapped, shall be provided when required by the Director. Such interceptors or traps shall not be required for private dwelling units. Degreasers, enzymes and similar substances which act to temporarily emulsify or suspend oil or grease shall not be introduced into any trap designed to capture and retain oil and grease. All traps shall be maintained in a manner which prevents the trapped substances from being discharged into the wastewater system, stormwater system, or any watercourse.

C. Spill containment facilities shall be provided when required by State or Federal regulations or when, in the judgement of the Director, such facilities are necessary for the containment of any raw materials, products, wastes or other potential pollutants used or stored on the user's premises in such locations that a spill of the material may enter into the District's system or a watercourse and cause interference or pass through or cause violations of the District's NPDES permit or cause violations of State or Federal water quality standards.

D. Stormwater treatment or control facilities shall be provided when required by State or Federal regulations or when, in the judgement of the Director, such facilities are necessary for the treatment or control of stormwater which has or may come into contact with any raw materials, products, wastes or other potential pollutants used or stored on the user's premises in such locations that stormwater flowing through or running off the user's premises may contact such materials and may convey pollutants therefrom into the District's system or a watercourse and cause interference or pass through or cause violations of the District's NPDES permit or cause violations of State or Federal water quality standards. Section Two - Drawings and Specifications. Drawings, specifications, and any other pertinent

engineering data relating to proposed wastewater treatment or pretreatment facilities, holding tanks, grease, oil and grit interceptors, spill control or containment facilities or other facilities to be utilized in the treatment, pretreatment, or control of wastewater or stormwater discharged to any sewer or watercourse within the District, shall be submitted to the Director for approval. All plans and specifications shall be prepared by a registered professional engineer, licensed in the State of Missouri, except this requirement may be waived on a case by case basis by the Director for facilities which will not become part of the system owned or operated by the District. Construction of facilities shall not be started until said drawings and specifications have been approved by the Director through issuance of a construction permit or other written approval.

Section Three - Construction Approvals.

A. Construction Permit: Before starting construction of any residential, or non-residential wastewater system, treatment facility, or drainage facility or any connection to the District's system, the owner thereof shall first obtain a construction permit from the Director. The application for such permit shall be made on a form furnished by the Director. Fees for plan review, connection, permits and inspections shall be paid to the District in accordance with applicable Ordinances. The Director shall either issue or deny the requested permit within 90 days after submittal of the application.

B. Construction Approval: Before starting construction of any pretreatment facility or any other facility not included under Subsection A of this Section for the control of wastewater or stormwater discharges or for spill control or containment, the user shall first obtain written approval from the Director. The Director shall either approve or reject a pretreatment or other facility design within 90 days after its submittal.

Section Four - Construction Inspections.

The Director shall have the right to inspect the work at any stage of construction of any facility required pursuant to Section One of this Article, or any connection to the District's system. The owner or contractor shall notify the Director before any underground portions are covered, and when the work is ready for final inspection. Inspections shall be made within two (2) working days following receipt of such notice by the Director unless the owner or contractor agrees to a later time for the inspection.

Section Five - Management Plans Required.

A. Management plans for the control of accidental discharges or slug discharges shall be provided when required by State or Federal regulations or when, in the judgement of the Director, such plans are necessary for the control of slug discharges or for the control of pollutants that could be discharged to the District's system during an accidental discharge on the user's premise. When required such plans shall include, as a minimum, the following elements:

1. Description of discharge practices, including non-routine batch discharges.

2. Description of stored chemicals.

3. Procedures for notifying the District of any accidental discharges or slug discharges pursuant to Article VIII, Section Eight of this Ordinance.

4. Procedures to prevent accidental discharges or slug discharges.

5. Procedures for containing spills that occur.

6. Measures for controlling toxic organic pollutants.

7. Procedures and equipment for emergency response.

8. Follow up practices to limit damage to the District's system and the environment. When a user has developed a similar plan under RCRA, CERCLA, or other statutes and such plan provides adequate protection for the District's system and the environment, the Director may accept that plan as fulfilling the requirements of this subsection.

B. Solvent management plans shall be provided when required by the Director or by any State or Federal regulation.

C. Stormwater management plans shall be provided when required by the Director or by any State or Federal regulation.

D. Any other management plans shall be provided when required by the Director for the control of discharges or for the control or containment of any raw materials, products, wastes or any other substances which are potential pollutants if discharged into the District's system or into a watercourse.

Section Six - Compliance Schedules.

When required pursuant to the provisions of Article VI, Section One or Section Three of this Ordinance, or when in the judgement of the Director, a schedule is required to ensure compliance with any provision of this Ordinance, a user shall develop a compliance schedule which contains increments of progress toward meeting applicable treatment or pretreatment standards, or stormwater discharge requirements or any provisions of this Ordinance. The increments shall be in the form of dates for commencement and completion of major events leading to the construction and operation of treatment or pretreatment facilities or process changes. No increment shall exceed nine months. The schedule shall provide for the shortest period of time practicable for completion of necessary facilities or process changes. When the schedule is for compliance with newly promulgated categorical pretreatment standards, the final date for compliance may not be later than the compliance date contained in the standard. Section Seven - Pollution Control Operations. All facilities for the treatment, pretreatment, or control of wastewater, cooling water or storm water or for spill containment shall be maintained continuously in satisfactory and effective operation by the user at the user's expense and shall be subject to inspection as deemed necessary by the Director. The user shall maintain operating records and shall submit all reports as stipulated in Article VIII, and Article X, of this Ordinance. Sludges, floatables and all other residuals removed during treatment or pretreatment operations or from grease, oil and grit traps or from spill containment facilities or from accidental discharge remediation activities, shall be disposed of in accordance with applicable local, State and Federal regulations.

Section Eight - Provisions for Monitoring.

A. When required by the Director, the user shall provide a suitable manhole or other appurtenance in each building sewer and in each regulated process discharge or at other suitable locations determined necessary by the Director, to facilitate observation, sampling, and measurement of all wastewater discharged from regulated processes and all wastewater, cooling water or stormwater discharged from the user's premise into the District's system. Such sampling points shall be located so as to ensure the ability to collect samples which are representative of the user's daily operations. All sampling points shall be designed and constructed in a manner approved by the Director and shall be provided and maintained by the user at the user's expense and shall be safe and accessible at all times.

B. Whenever the Director determines that a public safety hazard may exist due to the nature of a user's

discharge, the Director shall require the user to install and maintain at the user's expense suitable monitoring devices to detect the presence of hazardous conditions.

Section Nine - Safeguards Against Accidental/Slug Discharges.

Each user shall provide safeguards against accidental discharges to the District's system of prohibited substances or of regulated substances in excess of limitations and of slug discharges. Facilities to prevent accidental discharges and slug discharges shall be provided and maintained at the user's expense. The user shall report all accidental discharges and slug discharges to the Director in accordance with the provisions of Article VIII, Section Eight of this Ordinance. Costs incurred by the District during mitigation of accidental or slug discharge events may be charged to the responsible person as provided in Article IX, Section Six.

Section Ten - Employee Emergency Advisory.

Emergency notification procedures shall be permanently posted by the user on bulletin boards or in other prominent places advising employees whom to call in the event of an upset, accidental discharge or slug discharge. At a minimum, notification shall be made to the District's emergency response number. Other agencies shall be notified as per applicable laws and regulations. Users shall make certain that all employees who may be in a position to cause or observe such incidents are advised of the emergency notification procedures. Section Eleven - Local Approvals. Users who are required to construct or operate facilities under the provisions of this Ordinance may be subject to local health and building codes. It is the user's responsibility to ensure that all such requirements are met.

ARTICLE VIII - USER REPORTS AND MONITORING

Section One - User Questionnaire.

When required by the Director any user as identified below shall submit applicable User Questionnaires to the Director on forms provided by the Director. (1) Any user who discharges wastewater to the District's wastewater system, or stormwater system or to a watercourse, and who consumes at least fifty thousand (50,000) cubic feet of water in a six month period. (2) Any user who discharges or may discharge toxic substances. (3) Any user subject to Federal Categorical Pretreatment Standards. (4) Any user required to pretreat wastewater in accordance with Article VI. (5) Any user who discharges radioactive materials. (6) Any user who discharges stormwater associated with industrial activity as defined in 40 CFR 122.26(b) or any user who the Director determines is or may be contributing a substantial pollutant loading to the District's stormwater system. (7) Any other user not previously listed when the Director determines that such information is required to ensure the District's compliance with any State or Federal regulation or with the provisions of this Ordinance. Any user who has previously submitted a User Questionnaire may be required to submit a new questionnaire at any time the Director determines such information is necessary to ensure the District's compliance with any State or Federal regulations or with any provisions of this Ordinance. Unless so requested by the Director, a user who submitted a questionnaire prior to enactment of this Ordinance, is not required to submit a new questionnaire.

Section Two - Baseline Monitoring Report.

Any existing industrial user subject to a newly promulgated categorical pretreatment standard or a new source or any source that becomes subject to the standard after the promulgation of an applicable categorical standard, shall submit a report to the Director which contains the information required by 40 CFR 403.12(b). Existing users shall submit the report within 180 daysof promulgation of the standard. New sources and sources that become subject to the standard after promulgation shall submit the report at least 90 days before initiating discharge. The report shall indicate whether or not applicable pretreatment standards are being met on a consistent basis; and, if not, whether additional operation and maintenance and/or additional pretreatment is required for the user to meet applicable pretreatment standards and requirements. If additional pretreatment and/or operation and maintenance will be required to meet the standards, a schedule shall be developed by the user, with the approval of the Director, to indicate when the user will provide such additional pretreatment. The completion date in the schedule shall not be later than the compliance date established for the applicable pretreatment standards.

Section Three - 90 Day CPS Compliance Report.

When required by the Director, within 90 days following the date for final compliance with applicable categorical pretreatment standards (CPS) or following commencement of introduction of wastewater from a new source into the District, any industrial user subject to the standards shall submit a report to the Director which contains the information required by 40 CFR 403.12(b).

Section Four - Self-Monitoring Reports.

A. When required by the Director or by State or Federal regulations, any user who discharges any wastewater or stormwater to the District's system shall submit to the Director self- monitoring reports identifying the nature and concentration or mass of prohibited or regulated substances in discharges from regulated processes or from the user's premises. The results shall be reported as concentration if the pollutant limits are given in concentration terms and shall be reported as mass if the pollutant limits are given as mass. The report shall include a record of all measured or estimated average and maximum daily flows during the reporting period. Other information may be required based upon applicable State and Federal regulations. The reporting period shall be determined by the Director based upon the quantity or characteristics of the discharge or the requirements of the State or Federal regulations. All sampling and analyses performed to satisfy this monitoring requirement shall be performed in accordance with the provisions of Article X, Section Two of this Ordinance.

B. If a user performs monitoring using the methods specified in Article X, Section Two, more often than required by the Director, the results of all such additional monitoring and any additional flow measurements shall be reported to the Director at least quarterly.

C. If any sampling performed by a user using the methods specified in Article X, Section Two indicates a violation of any pretreatment limitation the user shall notify the Director within one business day of becoming aware of the violation. The user shall resample the discharge and shall submit the results of the resampling to the Director within thirty (30) days of becoming aware of the violation.

Section Five - Production Reports.

A. All users subject to production based discharge limitations shall submit to the Director periodic reports on production rates. The first report shall be submitted within 90 days following the date for final compliance with applicable categorical pretreatment standards or following commencement of discharge from a new source into the District. Thereafter, the reports shall be submitted semi-annually at the times specified by the Director. Users for which equivalent mass or concentration limits have been established by the Director in accordance with Article V, Section Two, subsection A, shall report a reasonable

measure of the user's long term average daily production rate. For the initial report, the long term average daily production rate should be based upon a minimum of one recent year's historical data, if available, or upon well documented projections if such data are not available. Subsequent reports shall contain actual average daily production rates during the reporting period. All other users subject to production based discharge limitations shall report the actual daily production rates during the reporting period.

B. Any user for which the Director has converted production based discharge limitations to equivalent mass or concentration limits shall notify the Director within two (2) business days after the user has a reasonable basis to know that the average daily production rate will significantly change within the next calendar month.

Section Six - Reports of New/Increased Discharge.

Any user planning a significant new or increased discharge, shall notify the Director at least ten (10) business days prior to the date of the planned increase or addition. The Director may exercise the authority granted in Article VI, Section One to impose conditions on the proposed increase or addition.

Section Seven - Compliance Schedule Progress Reports.

Any user for which a compliance schedule has been established pursuant to the provisions of this Ordinance, shall submit a report of progress to the Director not later than fourteen (14) business days following each date in the schedule and the final date for compliance or at such frequency as the Director has determined necessary. Each report shall state the status of compliance with the progress increment due and shall explain the reasons for any delays, actions being taken to return to schedule and the expected date the missed increment will be completed.

Section Eight - Notification of Problem Discharge.

A. Unanticipated Discharge: In the event of any problem discharge into the District's system, the user shall immediately notify the Director by telephone of the incident and shall provide such information as the Director may require at that time in order to assess the impact of the incident on the District's system or on water quality. Within five (5) business days following any such incident, the user shall submit to the Director a detailed written report which contains a description of the incident and its cause, location within the user's facility, exact dates and times of the period of problem discharge and, if not yet corrected, the anticipated time the incident is expected to continue, and steps taken or planned to correct the current incident and to reduce, eliminate and prevent occurrences of future such incidents. Such notification shall not relieve the user of any expense, loss, damages, or other liability which may be incurred as a result of damage to the District's system, fish kills, or any other damage sustained by any person or property; nor shall such notification relieve the user of any fines, criminal or civil penalties, or other liability which may be imposed by this Ordinance or other applicable law.

B. Anticipated Discharge: If a user anticipates a need for a pretreatment facility or treatment facility bypass which may cause pretreatment or treatment standards or requirements to be violated, the user shall notify the Director prior to commencing the bypass. An anticipated bypass will be allowed only when the conditions specified in Article V, Section Three, subsection D are met.

Section Nine - Hazardous Waste Discharge Report.

Any user who discharges to the District's wastewater system any substance which, if otherwise disposed, is a listed or characteristic waste in 40 CFR 261, shall submit to the Director a report pursuant to the provisions in 40 CFR 403.12(p). Pollutants already being reported to the Director pursuant to the provisions of Section Four of this Article do not have to be included in this report. Users who are initially exempt from this reporting requirement because they do not discharge applicable quantities of hazardous wastes are subject to the reporting requirements of Section Six of this Article if they subsequently initiate discharge of such wastes.

Section Ten - Non-District Operated Facilities Reports.

Any person who operates a wastewater system or wastewater treatment facility or who discharges any wastewater, cooling water, storm water or unpolluted water into any watercourse within the District shall furnish such reports as may be required by the Director for ascertaining compliance with this Ordinance.

Section Eleven - Stormwater Reports.

When required by the Director, any user who discharges stormwater to the District's stormwater system shall submit a report to the Director which includes the following information: (1) Name and address of the facility and name and telephone number of a contact person. (2) Location of the discharge on the user's property. (3) Description, including SIC, which best reflects the principal products or services provided by the facility. (4) Any existing NPDES number for the discharge. (5) Any of the information specified in 40 CFR 122.26(c)(1)(i)(A) through (E) which the Director determines is necessary. (6) Any other information the Director determines is necessary to evaluate compliance with this Ordinance and with NPDES stormwater regulations. Any user who plans a new discharge of stormwater associated with industrial activity, as defined in 40 CFR 122.26(b)(14) shall submit such report at least 180 days before initiating the discharge, except that dischargers included under 122.26(b)(14)(x) shall submit such report at least 90 days before initiating construction. All other users who discharge stormwater shall submit such reports at the times specified by the Director.

Section Twelve - Other Reports.

Users shall submit any other reports required by the Director to ensure compliance with the provisions of this Ordinance and with applicable State and Federal regulations.

ARTICLE IX - ENFORCEMENT

Section One - Notification of Violation.

Whenever any user is found to have violated or to be violating any provision of this Ordinance or a discharge permit or order issued pursuant to this Ordinance, the Director shall provide the user with a notification of the nature of the violation and direct that actions be taken to remedy the noncompliance. Within thirty (30) days after receipt of the notice, unless a shorter time is specified in the notice, a plan for the satisfactory correction thereof shall be submitted by the user to the Director.

A. Verbal Notice:For a violation which involves the discharge or imminent threat of discharge of

pollutants by a user and which presents or appears to present an immediate danger to the health or welfare of humans, the Director may notify the user by telephone or visit to take immediate action to discontinue or reduce the discharge to safe levels or, in the case of an imminent threat, to take appropriate actions to eliminate the threat within a reasonable amount of time as established by the Director. Such verbal notice shall be followed within five days by a written notice.

B. Written Notice: For any violation other than one requiring immediate action, the Director may notify the user by letter or by order as provided in Section two of this Article of the nature of the violation and require the user to take action to remedy the noncompliance.

Section Two - Administrative Orders.

The Director is authorized to issue the following administrative orders at any time he deems such action appropriate to secure timely and effective compliance with this Ordinance or a discharge permit or order issued pursuant to this Ordinance, whether or not any previous notifications of violation have been provided to the user.

A. Cease and Desist Order: The Director may issue an order to cease and desist a violation or an action or inaction which threatens a violation and to direct the user to comply forthwith or to take such appropriate remedial or preventive action as may be needed to properly address the violation or threatened violation, including halting operations and terminating the discharge.

B. Compliance Order: The Director may issue an order requiring a user to provide within a specified period of time, such treatment, pretreatment or discharge control facilities or related appurtenances as are necessary to correct a violation or to prevent a threatened violation. A compliance order may also direct that a user provide improved operation and maintenance of existing discharge facilities, conduct additional self-monitoring or submit appropriate reports or management plans.

C. Show Cause Order: The Director may issue an order to show cause why a proposed enforcement action should not be taken. Notice shall be served on the user specifying the time and place for a meeting, the proposed enforcement action and the reasons for such action, and a request that the user show cause why the proposed enforcement action should not be taken. Whether or not a duly notified user appears as noticed, additional enforcement action may be initiated.

D. Consent Order: The Director may enter into consent orders, assurances of voluntary compliance, or other similar documents establishing an agreement with a user. Such orders shall include specific actions to be taken by the user and specific time frames to correct a violation or to remove the threat of a violation.

Section Three - Emergency Action.

When a user has failed to take action within the time established in a notice or order to eliminate an imminent threat to humans or to the environment or to the effective operation of District facilities, the Director may take such action as deemed necessary, including work by District personnel to eliminate the threat or to mitigate the impact on the District's system or the environment. The Director shall attempt to notify the user of the intended action, but if unable to do so within a reasonable period of time, shall proceed with the action.

Section Four - Legal Action and Penalties.

As an alternative to, or in addition to, the procedures set forth in Sections One through Three of this

Article, the Director may initiate through counsel litigation for appropriate legal and/or equitable relief in the City or County Courts having jurisdiction.

A. Injunctive Relief: Injunctive relief may be sought to restrain a violation or threatened violation of any of the provisions of this Ordinance.

B. Consent Decree: When deemed appropriate, the District may enter into a consent decree with any person accused of a violation of this Ordinance, prior to a full hearing on the issues.

C. Penalties: Any person who pleads or is found guilty of a violation of this Ordinance shall be fined not more than One Thousand Dollars ($1000.00) or be imprisoned for a period of not more than one year, or both such fine or imprisonment, for each violation. Each day in which any such violation shall continue shall be deemed a separate offense.

Section Five - Liability Due to Violations.

A. Any person who violates any provisions of this Ordinance shall be liable to the District for any expense, loss, or damage incurred by the District due to such violation and for any penalties assessed against the District by reason of such violation.

B. Actions taken by a user in response to notifications, orders or enforcement activities initiated by the District pursuant to Sections One through Three of this Article in no way relieve the user of liability for any violations occurring before or after the District's action.

Section Six - Recovery of Costs.

The Director shall bill the user for the costs incurred by the District for any work undertaken pursuant to the provisions of Section Three of this Article. The Director may also bill the user for work undertaken pursuant to the provisions of Article IV, Section Two and Article VII, Section Nine of this Ordinance. Failure to pay any such assessed costs within thirty (30) days after demand has been made shall constitute a violation of this Ordinance, enforceable under the provisions of this Article, or notice may be filed in the Office of the Recorder of Deeds of the City or County having jurisdiction, as the case may be, whereupon such bill shall become a lien against the property involved. Section Seven - False Statements. Any person who knowingly makes any false statements, representation or certification in any application, questionnaire, record, report, plan, drawing or other document filed or required to be maintained pursuant to this Ordinance, or who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method shall, upon conviction, be subject to the penalties stipulated in Section Four of this Article. Section Eight - Publication of Violators. A list of the users who have experienced significant noncompliance of the pretreatment limitations or requirements of this Ordinance during the previous twelve (12) months shall be published annually by the Director in the largest daily newspaper published in the District's service area. The notification shall also summarize any enforcement action taken against the user during the same period.

ARTICLE X - GENERAL PROVISIONS

Section One - Records Retention.

All persons subject to this Ordinance shall retain and preserve, for not less than three (3) years, all records, books, documents, memoranda, reports, sample analysis results, correspondence and any and all summaries thereof relating to the monitoring, sampling and chemical analyses of their discharge made by or on their behalf. All records which pertain to matters which are the subject of administrative action

or any other enforcement or litigation activities brought by the District shall be retained and preserved by such persons until all enforcement activities have been concluded and all periods of limitation with respect to appeals have expired.

Section Two - Analytical Procedures.

All sampling and analyses performed to satisfy the monitoring and reporting requirements of this Ordinance shall be performed in accordance with the techniques prescribed in 40 CFR 136 and amendments thereto unless other techniques are prescribed for specific parameters.

A. Sampling of discharges subject to categorical standards and sampling of discharges to the District's wastewater system shall be conducted in such a manner as to ensure that the results of individual samples (whether grab or composite) are representative of daily operations and that the results of all samples during the reporting period are representative of the conditions during the reporting period.

B. Sampling of discharges to a separate storm sewer shall be conducted in accordance with 40 CFR 122.21(g)(7) and 122.26(d)(2) or as specified in any NPDES permit issued for such discharges.

C. When a user employs continuous monitoring techniques for temperature or pH and maintains records of the temperature or pH continuously monitored, the user shall meet the temperature and pH prohibitions and limitations specified in Article V of this Ordinance and in any applicable categorical standard, except that unintentional and temporary excursions above the temperature and upper pH values and below the lower pH values are allowed so long as: (1) The total time during which values for each parameter are outside the prohibition or limitation levels does not exceed Eight (8) hours in any calendar month; (2) No individual excursion exceeds sixty (60) minutes in length; and (3) No excursion results in or contributes to violations of the prohibitions in Article V, Section One, Subsections A.1, A.8 or A.14 or otherwise endangers life, limb or property or causes a public nuisance. When the Director determines that a sixty minute excursion by any user will or may result in a violation as described in (3) above, the Director may establish a shorter allowable duration for that discharger.

Section Three - Certifications on Applications and Reports.

A. All reports, questionnaires or applications required to be submitted to the Director pursuant to the provisions of this Ordinance shall contain the following certification statement: "I certify under penalty of Law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

B. All reports, questionnaires and applications must be signed as follows: 1. By a responsible corporate officer if the user is a corporation. 2. By a general partner if the user is a partnership. 3. By the proprietor if the user is a sole proprietorship. 4. By a duly authorized representative of the individual designated in 1, 2 or 3 if that individual submits a written authorization to the Director and the authorization specifies a person or position having responsibility for the overall operation of the facility from which the discharge originates, such as a plant manager, or overall responsibility for environmental matters at the company. A new authorization must be submitted to the Director anytime the person or position changes.

Section Four - Data Verification.

When the Director determines it is necessary to verify any data reported on any application or any User

Questionnaire or any other reports submitted pursuant to the provisions of this Ordinance, the Director may sample wastewater or stormwater discharges or potential sources of pollutant discharges from an applicant or a user. Samples may be collected by the District on a periodic or continuous basis as required to verify reported data. The analytical information obtained from such sampling, if substantially different from reported data, may be used in lieu of the information reported by the applicant or user. If deemed necessary, an extended, comprehensive sampling program may be conducted after notice to the user by the Director to obtain additional discharge or source data necessary for verification of reported data. The analytical results obtained from said program may also be used in lieu of reported values for each source or potential source of pollutant discharge. If a comprehensive sampling program is deemed necessary, all equipment installation, sampling, and analysis costs shall be borne by the user in accordance with applicable ordinances. If the user elects to make the sampling or monitoring installations with the user's own personnel, each installation shall be of a type and configuration acceptable to the Director. The hours of operation of any gauging or sampling station shall be the time required, as approved by the Director, to obtain representative samples of the effluent discharged and to conduct necessary analytical examinations of the samples collected.

Section Five- Right of Entry.

In order to ensure compliance with the provisions of this Ordinance and applicable State and Federal regulations, District representatives may inspect a user's treatment, pretreatment or discharge control facilities, or any process or any area of the user's premise which may be a source of any discharge or a source of any pollutants contained in any discharge into the District's wastewater or stormwater system or any watercourse; conduct sampling of such facilities, processes or areas; and examine or copy any user's records related to such discharges. Any duly authorized representative of the District upon presentation of proper credentials and after execution of appropriate confidentiality agreements shall be permitted access to appropriate areas of a user's premises without prior notice for these purposes. A representative of the user shall, if appropriate, accompany the District representative while the work is being performed and shall assure that all applicable safety rules are being observed by the District's representative.

Section Six- More Stringent State and Federal and Local Regulations.

A. In any instance in which the State government or Federal government modifies an existing regulation or promulgates a new regulation which establishes treatment, pretreatment or discharge standards or requirements for new or existing users which are more stringent than those contained in this Ordinance, such State or Federal requirements shall, on the effective date of the new regulations, supersede the less stringent provisions of this Ordinance and shall be fully enforceable under this Ordinance as if fully set out herein.

B. In any instance in which a State, Federal or local government agency imposes restrictions or limitations on the use of or discharges to any facilities regulated by this Ordinance which are more stringent than the provisions of this Ordinance, such restrictions or limitations shall take precedence within the jurisdictional area of the State, Federal or local government agency.

Section Seven - Applicable Charges and Fees.

A. All users shall pay the sewer use charges and capital improvement surcharges authorized by applicable District Ordinances. Nonresidential users who discharge wastewater containing BOD5, COD or TSS in excess of the concentrations of those substances in normal wastewater may be subject to extra strength surcharges as authorized by applicable District Ordinances.

B. Charges or fees to provide for the recovery of costs associated with implementation and enforcement of this Ordinance shall be as stated in the applicable District ordinances. These fees shall be in addition to the normal sewer use charges. Charges and fees may include:

1. Fees for monitoring, inspections and surveillance;

2. Fees for laboratory analyses.

3. Fees for permit applications

4. Appeal fees;

5. Charges for emergency actions or repairs;

6. Other fees necessary to carry out the requirements stipulated herein.

Section Eight - Damage to Property.

No person shall willfully damage, destroy, uncover, deface, alter, or tamper with any structure, appurtenance, sampling equipment, flow monitoring equipment, or equipment which is a part of the District's system. Any person who willfully or negligently damages any structure, appurtenance, or equipment which is a part of the District's system shall be liable to the District for all loss and expense.

Section Nine - Conflicting Ordinances.

Ordinance 4786, adopted August 11, 1982 and all other ordinances or parts of ordinances in conflict herewith are hereby repealed. Section Ten - Liability Under Previous Ordinances. Nothing contained in this Ordinance shall be construed as abating any action now pending under or by virtue of Ordinance 4786 herein repealed; or as discontinuing, abating, modifying or altering any penalty accrued or to accrue, or as affecting the liability of any person, firm or corporation, or as waiving any right of the District under the provisions of Ordinance 4786. Section Eleven - Severability.

The invalidity of any section, clause, sentence, or provision of this Ordinance shall not affect the validity of any other part of this Ordinance which can be given effect without such invalid part.

Section Twelve - Right to Confidentiality.

Information and data obtained from applications, questionnaires, permits, monitoring programs and inspections and any other required reports or documents shall be available for inspection by the public or any government agency without restriction, unless a user specifically states that the release of such information would divulge information, processes, or methods of production entitled to protection as trade secrets of the user. Any information submitted to the Director may be claimed as confidential in accordance with applicable Federal regulations. Any claim of confidentiality must be made at the time of submittal by stamping the words "Confidential Business Information" on each page containing such information. When requested by the user furnishing the report, the portion of a report which might disclose trade secrets or secret processes shall not be made available for inspection by the public, but shall be made available upon written request to governmental agencies for uses related to regulation of the user's discharge; subject however to the confidentiality provisions of 40 CFR, Part 2 which are incorporated by this reference as applicable to the District to the same extent Part 2 is applicable to EPA, or any applicable Missouri law. In the event that a party to any judicial or administrative proceeding or any court or any administrative agency (except as specified above) demands or subpoenas or orders the

production of any such confidential information, the District shall immediately notify the person who supplied such information so that person shall have the opportunity to secure judicial or administrative relief to preserve such confidentiality. Unless such person gets such relief, the District will comply with such demand, subpoena or order if it is legally required so to do. Wastewater constituents and characteristics will not be recognized as confidential information. Persons, other than authorized representatives of the United States Environmental Protection Agency or the Missouri Department of Natural Resources, requesting to review information and data must do so in writing and must pay all applicable costs associated with the preparation and copying of such information and data.

Section Thirteen - Right to Amend Ordinance.

The District reserves the right to amend this Ordinance in any manner and to establish more stringent limitations or requirements where deemed necessary to comply with the objectives set forth in Article I, Section Two of this Ordinance.

Section Fourteen - Appeals.

Any user who claims to be aggrieved by an act of, or failure to act by, the Director may appeal to the District's Board of Trustees or may take such other action as provided for within the MSD Plan. A written petition of appeal may be filed with the Board within thirty (30) days of the Director's act or failure to act. At its next regularly scheduled meeting the Board shall set a time for hearing the appeal and shall give written notice to the parties, stating the time and place for the hearing. The hearing shall be set for a date not later than sixty (60) days from the date of the Board meeting. The Board shall decide the appeal within 30 days after the hearing and shall notify the parties in writing of its decision.

The foregoing Ordinance was adopted August 14, 1991.