RADIOACTIVE AND NONRADIOACTIVE WASTE CHARACTERIZATION AT THE ROCKY FLATS PLANT

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ABSTRACT

The Waste Stream and Residue Identification and Characterization (WSRIC) program, conducted during 1990 by EG&G Rocky Flats, Inc., at the Department of Energy (DOE) Rocky Flats Plant (RFP), was designed to provide complete and accurate characterizations of all process outputs, including wastes, products, and residues. The WSRIC program provides the fundamental information required by the RFP for effective management of its nonhazardous, hazardous, and mixed wastes, in addition to management of its residues.

This paper reviews how the WSRIC program obtained data to characterize waste and residue streams. The WSRIC program consisted of two phases. The first phase provided field identification, evaluation, validation, and verification of current RFP processes, wastes or residue streams, and waste management units. Utilizing this process knowledge and associated assumptions, waste and residue streams were characterized to determine their regulatory status under 40 CFR 261 and the Colorado Code of Regulations (6 CCR 1007-3 Part 261). Such knowledge was also used to determine which wastes were subject to Land Disposal Restriction (LDR) regulations under 40 CFR 268 and 6 CCR 1007-3 Part 268.

The second phase of WSRIC established and implemented a sampling/analysis program to verify and augment the results of the initial process characterization effort. The sampling/analysis program utilized waste stream information generated in the first phase and prioritized each waste stream for sampling and analysis. Data derived from this effort supplemented the determinations made through process knowledge and assisted in the characterization of wastes characterized as *unknown* in the initial effort. The sampling/analysis program required the resolution of several unique issues, some of which are not yet resolved.

EG&G's successful management of the WSRIC program resulted in meeting all 1990 program objectives and all Environmental Protection Agency (EPA) and Colorado Department of Health (CDH) reporting schedules and requirements associated with this program. The efforts involved in achieving some of the objectives in the 1990 WSRIC program are ongoing in 1991 and will probably continue throughout the life of the facility. The WSRIC program expanded in 1991 to include characterization of all plant waste streams, refinement of existing waste characterizations, upgrade of the sampling/analytical program, and the management/documentation of off-site waste shipments.

INTRODUCTION

The RFP is located in northern Jefferson County, Colorado, approximately 16 miles northwest of Denver. The RFP consists of approximately 6550 acres of Federally-owned land. Within the RFP is a 400-acre restricted area referred to as the Protected Area (PA), where all major plutonium processing and recovery operations are located. The RFP is a government-owned, contractor-operated facility that is part of the nationwide nuclear weapons production complex.

The primary RFP mission is to produce components for nuclear weapons. Parts containing plutonium, uranium, beryllium, and stainless steel are fabricated at the RFP and shipped off-site for final assembly. Additional activities include chemical processing to recover plutonium from by-product material, metallurgical research and development, machining, assembly, nondestructive testing, and remote engineering. Waste-handling operations at the RFP include treatment, packaging, transport, and storage of waste materials.

The types of waste managed include nonhazardous, hazardous, Low-Level Radioactive Waste (LLW), Transuranic (TRU) Waste, Low-Level Radioactive Mixed Waste (LLMW), and TRU Mixed Waste. LLW contains radioactive elements, such as depleted uranium at any concentration and plutonium at concentrations of less than 100 nCi/gram. TRU waste contains alpha-emitting radionuclides with atomic numbers greater than 92 and half-lives greater than 20 years, at concentrations above 100 nCi/gram. Mixed waste contains either LLW or TRU waste and chemical constituents defined as hazardous by the Resource Conservation and Recovery Act (RCRA).

Current waste-handling practices involve on-site and off-site recycling of hazardous materials, on-site storage of hazardous and mixed wastes, on-site treatment of radioactive and mixed wastes, on-site disposal of nonhazardous and nonradioactive wastes in the Rocky Flats landfill, and off-site treatment or disposal of hazardous and radioactive materials shipped to other DOE facilities.

REGULATORY BACKGROUND

A series of four compliance agreements negotiated among the DOE, the CDH, and the EPA resulted in the WSRIC program at the RFP. In July 1986, the DOE, the CDH, and the EPA implemented a compliance agreement in response to a CDH rejection of the RFP hazardous waste permit application submitted for RCRA compliance. The hazardous waste permit application was rejected on the basis that it contained insufficient information on the identity, character, and quantity of wastes treated, stored, or disposed of at the

RFP. The 1986 compliance agreement stipulated that a technical program be implemented to provide supplemental information regarding waste generation and management at the RFP.

The Agreement in Principle (AIP) between the DOE and the State of Colorado was entered into on June 28, 1989. It required that DOE provide the State of Colorado additional technical and financial support for environmentally-related State activities to accelerate certain waste treatment activities and also to update/revise the RFP waste characterization plan. It specifically requires the expansion and provision of more details on the nature, quantities, and hazards associated with all hazardous, mixed, and radioactive wastes at the RFP. This information was first provided in the form of a draft report in September 1990, and periodic revisions will follow.

A Federal Facility Compliance Agreement (FFCA) among the EPA, the State of Colorado, and the DOE was entered into September 19, 1989. This agreement provided a 1-year period for DOE to achieve compliance at the RFP with Land Disposal Restriction (LDR) regulations under RCRA which are codified in 40 CFR Part 268. During this 1-year period, the DOE was required to take action ensuring the accurate identification, safe storage, and minimal impact of hazardous and mixed wastes. The terms of this agreement required the DOE to submit a comprehensive Waste Characterization Report to the EPA and the State of Colorado before September 1990 (Compliance Requirement No. A(6)). The report was to provide characterizations of all wastes stored at the RFP and all waste streams generated at the RFP. Also, it was to provide all information necessary to confirm which wastes are subject to LDR.

The Residue Compliance Agreement (RCA), signed November 3, 1989, between the DOE and the CDH, requires a residue characterization, together with the waste characterization effort called for in the AIP and FFCA. Residues are defined as materials that contain recoverable amounts of plutonium, enriched uranium, neptunium, or americium. The primary effects of this agreement were to require residue characterizations based on process knowledge and to characterize outputs as hazardous or nonhazardous waste, where appropriate.

WSRIC PROGRAM OVERVIEW

The objective of the WSRIC program is to validate, modify, and update the existing waste characterization database. Emphasis is placed on the addition of new and modified hazardous waste generating processes, the initial characterization of TRU mixed waste streams and residues, and the recharacterization of all known, potentially hazardous, and LLMW streams generated or stored at the RFP. Data from the WSRIC program is utilized in a number of forms and for differing purposes at the RFP. The WSRIC data flow is shown in Fig. 1.

During implementation of the WSRIC program, generated information has been entered into the Waste and Environmental Management System (WEMS) database to obtain a current, complete record of waste and residue generating processes, streams, and stored inventories at the RFP. The WEMS database is periodically updated to reflect the current configuration of waste/residue generation and storage at the RFP. Update data is generated during the annual recharacterization required by the RCRA Part B Permit and

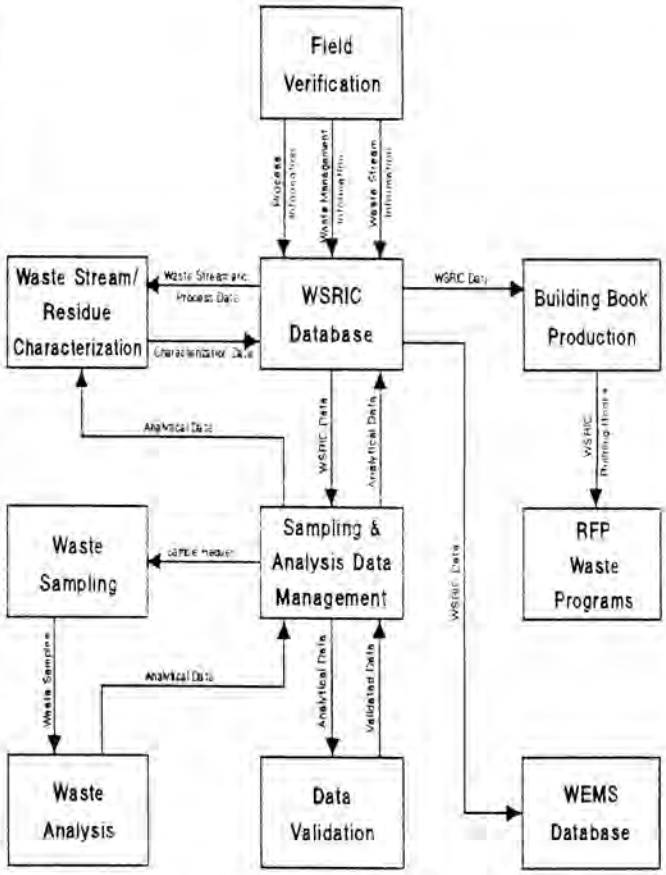

Fig. 1. Waste stream and residue indentification and characterization data flow.

described in the *Generator Waste Analysis Plan*. Data from the WSRIC recharacterization effort is used to specify wastes that warrant continued sampling and analysis, the appropriate sampling frequencies, and the target analytes.

The WSRIC program consists of two phases. The first is to conduct field evaluation, validation, and verification of current RFP processes, wastes, and waste management units. This phase provides reliable updates and supplemental information to existing data/process knowledge to identify and characterize the RFP waste generating processes, waste/residue streams, and waste management units. This information is also used to determine the sampling and analysis strategy used in the program and to validate any new analytical data with process or waste generation knowledge gathered in the field.

Based on preliminary field verification findings, the second phase is to establish and implement a sampling/analysis program to characterize all known and potentially hazardous and mixed wastes and residues. Subsequent sampling and analysis plans will be developed to provide the required supplemental identification and characterization of hazardous wastes, mixed wastes (both LLMW and TRU mixed waste), and residues being generated, treated, or stored inside the PA. The added emphasis placed on the residue portion of the WSRIC program, as a result of the RCA, focuses most of the current effort on field evaluation, validation, and verification of residue streams.

BUILDING SELECTION AT RFP

Of the approximately 200 structures and over 60 associated trailers at the RFP, 98 buildings and 3 trailer groups were included in the 1990 WSRIC program. The list of buildings included all those within the PA and all other buildings of interest to the CDH and the EPA. The buildings not included in the 1990 WSRIC report were predominantly contractor trailers, administrative offices, and storage areas. These areas had little relationship to the generation of RCRA hazardous or radioactive wastes. The remaining buildings are scheduled to be evaluated and documented with succeeding WSRIC programs.

FIELD INVESTIGATION PROCEDURES

The WSRIC field verification effort began in January 1989, and was completed in August 1990. A total of 101 buildings were evaluated as including approximately 500 active processes, generating more than 4000 output streams. The processes were sufficiently detailed to support effective management of their associated wastes/residues, ensure compliance with applicable regulations, and adequately characterize each waste/residue stream. The field investigation included the following tasks,

- Identifying processes located in each building, including the process inputs and outputs
- Describing the processes sufficiently to allow accurate waste stream characterization based on process knowledge
- Identifying process or waste management actions that result in nonhazardous or nonradioactive material becoming, respectively, hazardous or radioactive
- Determining approximate generation rates of hazardous and radioactive output streams, if possible
- Identifying the management of output streams, including their collection locations or destinations

A *process* is defined as a group of common or related activities. Most of these related activities are located within a single building. However, several *support* processes cross building borders (for instance, maintenance functions, some machining processes, or storage areas). Inactive processes are not investigated or verified. Assuming the plant is in full production, each building manager or other cognizant operations personnel lists the active processes for each building. Office-related or custodial areas/processes are not generally field verified because these operations typically do not generate radioactive or hazardous outputs.

WASTE/RESIDUE CHARACTERIZATION PROCEDURES

The characterization of waste streams is based upon evaluation of the stream-specific information and process knowledge collected in the field. The use of the terms *hazardous* or *nonhazardous* refers to whether or not a waste or residue is subject to RCRA hazardous waste regulations. Wastes and other outputs from the various processes defined as hazardous according to other laws, such as the Toxic Substances Control Act (TSCA) and the Atomic Energy Act, are designated as nonhazardous. It is possible a substance known to pose hazards to human health or the environment is characterized as nonhazardous in accordance with RCRA regulations.

Waste characterization worksheets document solid and hazardous waste determinations, as well as those for residues and radioactive wastes. Such determinations are particularly important for residues that consist solely of special nuclear material or are characteristic by-products being reclaimed, because such materials are excluded from the definition of RCRA solid wastes and hazardous wastes. For nonresidue buildings, the wastes generally meet the definition of RCRA solid wastes and, therefore, the emphasis is placed on solid and hazardous waste determinations.

Solid waste determinations for residue streams are required by the RCA. This agreement defines residues as materials considered by the DOE to contain recoverable amounts of plutonium, enriched uranium, americium, or neptunium. Two types of residues are generated at the RFP, low-content and high-content residues.

1. Low-content residues: Residues that contain economically recoverable quantities of plutonium, enriched uranium, americium, or neptunium, and for which an economic discard limit (EDL) is calculated. The EDL is the concentration of plutonium (expressed as grams per gram-bulk-weight) required in a material for the recovery costs to equal the newly-produced plutonium value. A separate EDL must be calculated for each residue. The residue itself is then assayed to determine whether it exceeds the EDL and, therefore, qualifies as a low-content residue. Low-content residues include materials that become radioactively contaminated during the production or processing of nuclear materials.
2. High-content residues: Residues that contain such high concentrations of plutonium, enriched uranium, americium, or neptunium, that an EDL calculation has never been necessary. High-content residues include highly concentrated nuclear materials and intermediate recovery products generated during plutonium processing. Examples are impure/reject metals, oxides, alloys, hydrides, and other plutonium compounds.

Wastes produced in the remaining nonresidue buildings were not subjected to formal solid waste evaluation because these wastes are never generated as residues (that is, they never contain plutonium at levels above EDL). Furthermore, all of these nonresidue wastes generally meet the definition of RCRA solid wastes because they are discarded materials. For this reason, solid waste evaluations for nonresidue buildings were limited primarily to identifying the applicable regulation exclusions. For example, uncontained gases and process products are not defined as solid wastes, and so are not hazardous wastes. The processes for identifying and characterizing solid wastes, hazardous wastes, radioactive wastes, and residues are summarized in the data flow diagrams presented in Figs. 2, 3, and 4.

All process outputs characterized as hazardous wastes are conservatively identified as being subject to the LDR regulations in 40 CFR Part 268 and 6 CCR 1007-3 Part 268 until adequate statistical analysis data is obtained. The only exceptions to this policy are those hazardous wastes that contain recyclable materials.

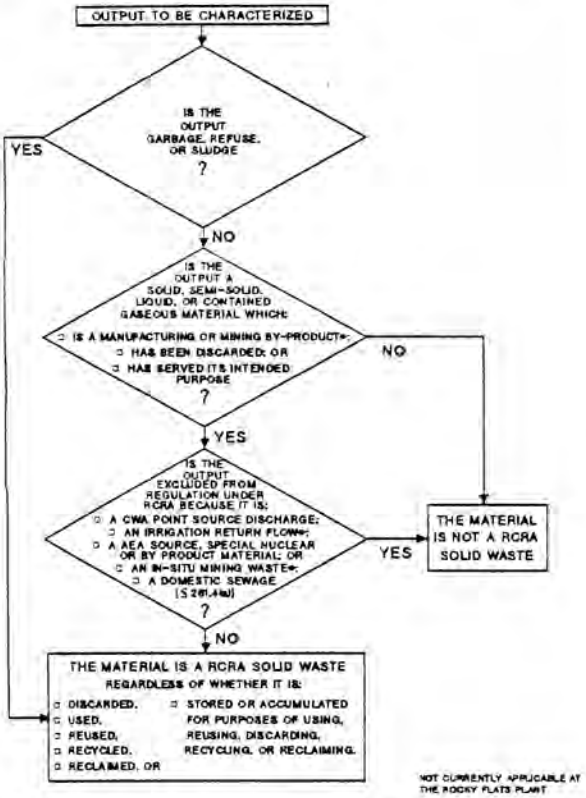

Fig. 2. Process for decision element 1 (6 CCR 1007-3 Part 261) data flow.

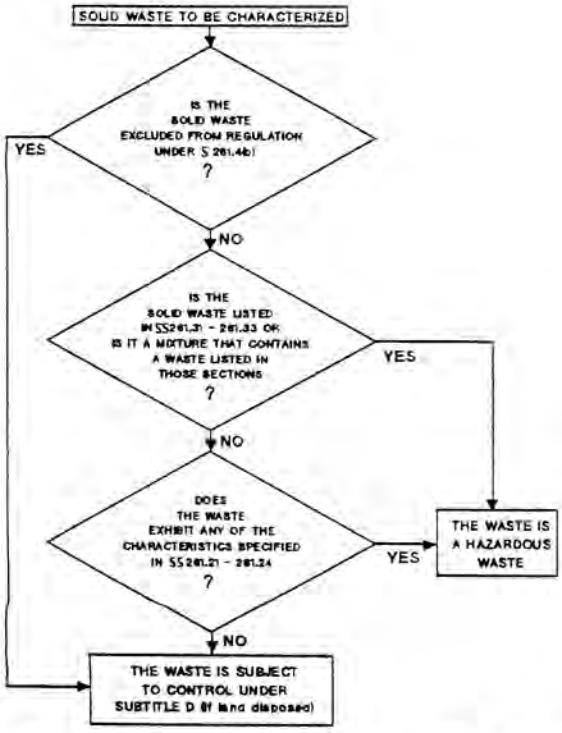

Fig. 3. Process for decision element 2 (6 CCR 1007-3 Part 261).

Hazardous wastes are prohibited from land disposal until the generator demonstrates the waste meets specified *treatment standards*. The standard may exist as either performance levels (concentrations in the waste or waste extract that must be achieved) or as actual methods of required treatment, such as incineration. Those hazardous wastes currently designated as LDR regulated, but not definitely known to exceed LDR specified limits, are included in the sampling and analysis program currently underway. Specific analytical methods are employed on either the total waste or the extract, depending on the applicable LDR treatment standards.

Because very little analytical data exists for the various outputs generated at RFP, virtually all waste stream characterizations performed to date are based on process knowledge. This fact and the large number of outputs requiring characterization necessitates certain assumptions. For example, only high-content residues were subject to plutonium recovery during normal operations at RFP. As a result, low-content residues were designated as solid wastes because they were accumulating speculatively [40 CFR 261.2(c)(4)]. Following cessation of normal operations at the RFP (including plutonium recovery), the assumption is that high-content residues are also accumulating speculatively, and that they are solid wastes as well.

Hazardous waste determinations also required some assumptions. Two examples are used oils and Ful-Flo filters. Used oils have been designated as unknown, with respect to their Subtitle C status, unless analytical data are available to justify hazardous or nonhazardous designation. In addition, characterization assumed that used Ful-Flo filters retain sufficient quantities of liquids to fail the Paint Filter Liquids Test for free liquids. Therefore, these outputs have been designated as nonhazardous, if filtering a nonhazardous waste stream, or hazardous, if filtering a hazardous waste stream.

In at least one case, process knowledge, based on waste stream analytical data, was used to make hazardous waste determinations. In this case, analysis of leaded glovebox glass indicated TCLP toxic levels of lead and barium. As a result, all waste leaded glovebox glass was assumed hazardous.

Additional assumptions used to characterize RFP process outputs apply primarily to the classification of residues and radioactive wastes generated within the residue buildings and certain nonresidue buildings that handle neptunium, plutonium, americium, or uranium. These assumptions are necessary because the RFP nuclear accountability system, the Safeguards Accountability Network, does not trace a container of waste/residue to a specific generating process. Instead, containers are traced to a Material Balance Area (MBA) which may receive drums containing waste from several different processes. As a result, the individual process streams could not be associated directly with any of the site's nuclear material databases. For this reason, no actual residue status or actinide/radioactivity levels on specific process output streams were obtainable.

Another complicating factor in establishing residue status or radioactivity levels is that process output materials cannot be identified as waste or residue until they are determined as such by assay/counter. The same process may generate residue, TRU waste, or low-level waste at any given time, depending on the plutonium content within the container at the point of assay.

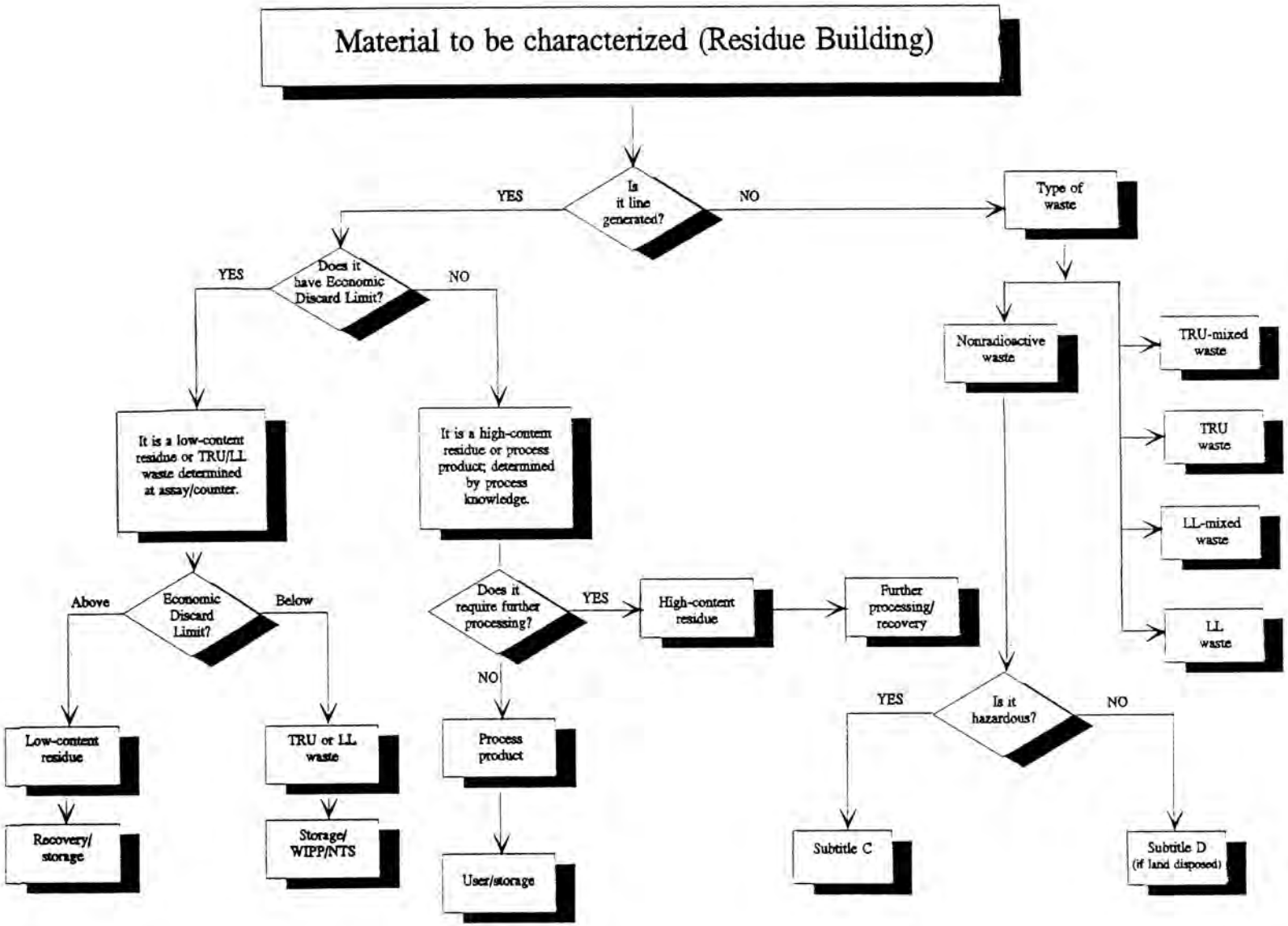

Fig. 4. Residue/radioactive waste determination.

The rationale for characterizing an output, considering residue status or the radioactivity level involved, utilized the following five assumptions.

- Only those process outputs associated with Item Description Code (IDC) numbers for high-content residues, generated from known residue inputs, or assayed and determined to be above EDL during a process are identified strictly as residues. (IDCs are part of a numerical system used at the RFP to identify those wastes resulting from a production process.)
- Process products, such as plutonium parts, are designated as products rather than residues. Residues are limited to those outputs containing such high concentrations of plutonium, enriched uranium, americium, or neptunium that an EDL calculation has never seemed necessary, or outputs that are known always to rate above EDL. Also, residues are never intended for discard. Residues differ from products because they require additional chemical purification/alteration before they can be considered as effective substitutes for raw materials or for commercial chemical products.
- Any line-generated materials (those produced within a glovebox or transfer line/tank) from a residue building, other than high-content residues and process products, are assumed to be either low-content residues or wastes. As a result, those process outputs are designated as residue, TRU waste, and low-level waste.
- Nonline-generated outputs generated in residue buildings are always wastes and are designated as TRU, low-level, and nonradioactive waste. This determination is made at assay/counter.
- Nonline outputs generated in nonresidue buildings are always wastes and are designated as TRU, low-level, and nonradioactive waste as specified on the field verification worksheet. Exceptions to this specification were instituted for nonresidue buildings/processes that handle plutonium or uranium.

These assumptions are used where appropriate only to indicate potential radioactivity levels for process outputs. Where information indicates otherwise, specific processes/outputs are identified as nonradioactive.

CONCLUSION

The identification and characterization of RFP wastes is a complex task due to the broad nature of waste tracking categories and the interrelationships between these categories. As a result of the WSRIC program, mechanisms for categorizing these wastes and for accurately characterizing the wastes in accordance with federal and state hazardous waste regulations has been developed. The program is currently being expanded to include:

- Characterizing additional waste streams,
- Refining existing waste characterization process,
- Upgrading the sampling and analysis program,
- Managing and documenting off-site waste shipments.