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Civilian Radioactive Waste Management System
Management and Operating Contractor

Waste Treatment Building
Interim Design Study for FY 1995

Document No. BCB000000-01717-5705-00007, REV. 00

September 28, 1995

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EXECUTIVE SUMMARY

This report presents interim results of the conceptual design effort for the Civilian Radioactive Waste Management System (CRWMS) Waste Treatment Building (WTB). The WTB is located within the Radiologically Controlled Area (RCA) of the Repository surface facilities and will process and/or package secondary wastes generated as a result of normal and certain abnormal repository operations. This waste will be transported and disposed of in compliance with applicable regulatory requirements. Secondary wastes include LLW (LLW), hazardous waste (HW) and low level mixed waste (LLMW).

The conceptual design information contained in this report is based on preliminary information of indeterminate quality. For this reason, this report has been designated as to-be-verified (TBV), and assigned an overall tracking identification number of TBV-090-DD, per Nevada Line Procedure (NLP)-3-15 as required by Quality Administrative Procedure (QAP)-3-5.

Preparation of the FY 1995 WTB conceptual design proceeded in two phases, and in advance of development and definition of secondary waste-producing areas in other surface and subsurface facilities. The conceptual design was prepared in a stepwise manner.

The steps accomplished in the first phase consisted of: 1) preparation of estimated secondary waste generation rates for surface and subsurface facilities, 2) assessment of potential waste treatment technology, 3) preparation of six candidate processing configurations for liquid LLW processing and another five candidate processing configurations for solid LLW processing, 4) screening of these 11 cases down to two cases each for solid and liquid LLW processing using a Kepner-Tregoe (KT) style decision analysis, and 5) assessment of HW and LLMW processing alternatives given the volume of these wastes estimated in the first step. The results of these activities were presented in the reports entitled Hazardous and Low Level Mixed Waste Treatment Analysis Report (Ref. 12) and Low Level Waste Treatment Analysis Report (Ref. 9).

The second phase of the WTB conceptual design effort was based on the first-stage results and included the following primary tasks: 1) reassessment of waste generation rates (to capture advances in facility design since completion of the previous work), 2) screening of the previous four candidate LLW processing configurations down to one final case each for solid and LLW processing, using Life Cycle Cost Analysis (LCCA), and 3) preparation of the conceptual design for the WTB based on the selected technologies.

Based on commercial practice, the quantity of HW estimated to be generated at the Repository facilities appears to be too low to justify licensing, construction and operation of an on-site Resource Conservation and Recovery Act (RCRA) processing facility. Further, based on Department of Energy (DOE) Memorandum (Ref. 20), it can be concluded that on-site disposal of RCRA hazardous waste, at the Repository, is undesirable. For these reasons, off-site treatment and disposal of HW is recommended and assumed. HW, or waste materials likely to be classified as HW in the state of Nevada, in the future, is collected at the source of generation at the Repository and staged, in sheds located in the Balance of Plant (BOP) and RCA areas of the surface facilities. Storage time in these sheds will be limited such that a RCRA permit will not be required, although the sheds will be designed to RCRA standards. The BOP shed is also used to stage underground wastes in this category. The WTB contains no provision for the processing of HW or LLMW.

LLMW is not anticipated to be produced as a result of normal Repository operations, due primarily to proper selection and segregation of materials used at the repository. To arrive at an estimate of the LLMW generation rate, a series of improbable events has been postulated. The LLMW generation rate resulting from this estimate is significantly lower than the estimated HW generation rate . For this reason, this report assumes that LLMW generated at the repository, if any, will be shipped off-site for treatment and disposal. Due to unresolved regulatory requirements for the processing of LLMW, the exact on-site WTB requirements for packaging/shipping of this material remain to be determined (TBD). The WTB conceptual design includes a small interim staging area for LLMW.

The LCCA performed on the LLW processing cases shows a liquid waste processing configuration consisting of filtration, evaporation and ion-exchange treatment of recyclable water to have a significantly lower Life Cycle Cost (LCC) than the other process option which consisted of grouting of all LLW water. In addition, the cost savings appears to increase, as would be expected, with increasing grouted waste disposal (burial) cost over the range of 5 to 49 $\$/ft^3$ The recycle processing system was selected as the basis for the conceptual design. Any LLW water which is judged or proven to be unsuitable for recycle is grouted, as is spent dewatered ion-exchange resin and evaporator bottoms.

Analysis of the two solid LLW processing options showed a system consisting of shredding, compaction and supercompaction steps to present a significant LCC savings over the competing system which does not include the supercompaction step. As was the case with the liquid LLW, the magnitude of the LCC savings increases with increased grouted waste disposal (burial) cost, in the range of 5 to 49$/ cu.ft. The WTB conceptual design includes a solid waste treatment system with the supercompaction step.

The conclusions reached in the LCCA of these cases is that: 1) operating costs appear to be the primary driver of LCC and 2) processing options that reduce waste volume, without increasing operating costs, are recommended.

The WTB conceptual design presented in this report includes flow diagrams, material balances, process descriptions, summary tables listing utility and operating requirements,
a description of the arrangement of the WTB, and an equipment/specification listing.

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1. INTRODUCTION

In 1982, Congress enacted the Nuclear Waste Policy Act (NWPA) that sets forth the requirements for the permanent disposal of the nation's high-level nuclear waste. The deep-mined geologic Repository required by this legislation will be designed to receive, package, and dispose of spent nuclear fuel (SNF) from nuclear utility facilities, defense high-level waste (HLW) and West Valley HLW. In 1987, Congress amended the 1982 law by enacting the Nuclear Waste Policy Amendments Act (NWPAA), which necessitated the study of a potential Repository only at the Yucca Mountain site in Nevada.

The production of secondary wastes, with the exception of Low Level Mixed Waste (LLMW), is anticipated as a result of normal Repository operations. These wastes consist of low level waste (LLW), Hazardous Waste (HW) and LLMW. A Waste Treatment Building (WTB) will be provided in the Radiologically Controlled Area (RCA) of the Repository surface facilities to process LLW for disposal, to collect HW for delivery to an off-site disposal facility, and to temporarily stage any LLMW generated, prior to transport off-site to a facility licensed to receive, treat (if necessary) and dispose of this waste. This report describes the conceptual design of the WTB.

1.1 PURPOSE

The purpose of this report is to present the results of WTB conceptual design activities performed in the later part of FY 1995. These activities included a LCCA of two candidate processing options each for liquid and solid LLW, assessment of processing requirements for HW and LLMW processing and preparation of this design report which includes WTB Flow Diagrams (FDs), Process Descriptions, an Equipment/Construction Specification Institute (CSI) List, an Operating Requirements Summary, a Utility Requirements Summary, a Heating Ventilating and Air Conditioning (HVAC) System Description as well as a Building Description. The conceptual design effort also included a revised estimate of waste generation rates at the repository. The conceptual design effort is based on the results of preliminary WTB process screening activities presented in the Low Level Waste Treatment Analysis Report (Ref. 9) and the Hazardous and Low Level Mixed Waste Treatment Analysis Report (Ref. 12) issued in January, 1995.

1.2 BACKGROUND

A High-Level Nuclear Waste Repository is to be constructed to satisfy the requirements of Section 113 of the NWPA. This deep-mined geologic Repository will be designed to receive, package, and dispose of SNF from nuclear utility facilities, defense HLW, and West Valley HLW. In 1987, the NWPAA necessitated the study of a potential Repository only at the Yucca Mountain site in Nevada. Currently, feasibility studies are being conducted to assess the suitability of the site for construction of a geologic Repository for disposal of highly radioactive nuclear waste and conceptual designs for selected surface facilities are being developed.

Repository operations are divided into discrete phases including Emplacement, Caretaker and Decommissioning and Demolition (D&D). During the Emplacement phase, the waste Repository will receive and process approximately 69,000 short tons (63,000 MTU) of SNF and 7,700 short tons (7,000 MTU) of HLW. As a result of normal Repository operations carried out in the RCA, secondary waste will be generated. This site-generated waste must be processed to make it suitable for disposal. The primary function of the WTB (WTB) described in this report is processing and packaging of LLW. The low estimated volumes of HW and LLMW indicate that off-site processing and disposal of these wastes is recommended.

The results of previously conducted waste treatment technology evaluations and screening efforts (Ref. 9 and 12), particularly Reference 9, accomplished several tasks important to the WTB design. These tasks included: (1) assessment of the generation rates of LLW, (2) analysis of available waste treatment processes, (3) identification of candidate LLW processing configurations, and (4) screening of these configurations down to two candidates each for liquid and solid wastes. The sources of waste generation were also identified along with waste quantities. A KT-style screening analysis was used in the previous work to narrow the field of eleven 11 process configurations down to two candidates each for solid and liquid LLW processing.

This report presents the results of conceptual design activities which are based upon the results from the previous work. Prior to development of the conceptual design, it was necessary to: 1) re-evaluate waste generation rates (to capture changes in surface facility design since the previous work), and 2) select a final processing configuration for both solid and liquid LLW.

Since the design of certain surface facilities important to WTB design is not as advanced as the conceptual design of the WTB, waste generation rates were reassessed based on an evaluation of HLW processing steps likely to generate LLW. HW generation rates were developed based primarily on the type and quantity of equipment items located in both aboveground and underground facilities. LLMW generation rates were estimated based on postulated events resulting in contamination of HW with LLW.

Following the reassessment of waste generation rates, a LCCA was utilized to select process configurations upon which to base the conceptual design. This approach involved development of each of the candidate case concepts to a level sufficient to estimate capital, operating and D&D costs. A LCCA was subsequently performed for each of the four cases and a final processing configuration selected for solid and liquid processing based on the lowest total Life Cycle Cost (LCC).

1.3 SCOPE

This report is limited to conceptual design of a stand-alone WTB for support of solid and liquid LLW handling, treatment and temporary storage operations conducted at the waste repository. LLW disposal (burial) facilities are beyond the scope of this report, and are to be evaluated at a later date. The secondary wastes processed in the WTB are limited to LLW, with minimal capacity to inventory/stage/ship solid or liquid LLMW. Gas and vapor wastes, including those wastes produced in the WTB, are assumed to be processed at the source of generation.

HW, due to the low volume generated, is assumed to be processed at the point of generation for shipment to an commercial, RCRA licensed disposal facility. Underground generated HW is assumed to be staged in the Balance of Plant (BOP) area of the Repository in order to minimize the potential for formation of LLMW within the RCA. LLMW is assumed to be shipped from the WTB to a disposal facility.

2. DESIGN INPUTS

The WTB receives and processes site-generated LLW and LLMW from facilities located within the RCA during the Emplacement and Caretaker phases of mined Geologic Depository System (MGDS) operations. These wastes, after processing, are shipped to a facility. The types and forms of these wastes were detailed in the previous Low-Level Waste Treatment Analysis Report (Ref. 9), and companion Hazardous and Mixed Waste Treatment Analysis Report (Ref. 12).

Ref. 9 developed six process configurations for liquid LLW processing and another five cases for solid LLW processing. These cases were subsequently screened down to two cases each for liquid and solid LLW using a KT-style analysis. This conceptual design report is based on the previous work, by screening the previous four process configurations down to one for each LLW phase (solid & liquid) using LCCA. Therefore, the screened process configurations from the previous report (Ref. 9) provided input to this report.

Another input, used in re-evaluation of secondary waste generation rates, was the Transportation Cask shipment schedule (Ref. 15). The general methodology employed to re-estimate waste quantities is discussed in Sections 2.3.1.1 and 2.3.1.2 of this report.

HW generation rates , which were also re-estimated for this conceptual design effort, required input from the Sub-Surface Group. This input consisted of a listing of sub-surface sources of waste oils as well as review comments on waste generation rates derived from this raw data (Ref. 16).

All other input to this conceptual design was internally generated.

2.1 FUNCTIONAL REQUIREMENTS

The primary functions of the WTB are liquid and solid LLW treatment, HW collection and handling, LLMW interim staging, as well as shipping and receiving of secondary wastes.

LLW generated on-site will require waste stream segregation at the source of generation, volume reduction, stabilization, packaging and labeling prior to disposal. The final waste disposal drums will conform to the applicable regulations. The WTB will be constructed and operated in accordance with applicable laws and regulations. The WTB should be able to process a wide variety of radioactively contaminated wastes produced in either liquid or solid form, with varying levels of contamination. However, TRU wastes and HLW will not be processed by the WTB.

HW generated within the WTB is collected in standard 55-gallon drums meeting Department of Transportation (DOT) specifications for commercial transport. Once the waste drums are filled, they are transferred to a covered shed or self-contained storage and containment building located outside of the WTB. The shed or building will be designed to RCRA standards. Storage time inside this shed will be limited such that a RCRA permit will not be required. The HW accumulates in the shed prior to transportation to a RCRA-licensed HW management facility for final disposal.

LLMW is managed in a similar manner to HW except that it is temporarily staged in a confined area inside the WTB prior to its shipment for disposal. As was the case with HW, storage time of LLMW will be such that a RCRA permit will not be required.

2.2 REGULATORY REQUIREMENTS

The management of radioactive LLW generated at the RCA facilities is subject to, and must be conducted within, an extensive framework of federal and state regulations. These regulations govern all aspects of waste generation, treatment, packaging, transport and disposal. Regulations that affect the Civilian Radioactive Waste Management System (CRWMS) project involve the U.S. Nuclear Regulatory Commission (NRC), the U.S. Environmental Protection Agency (EPA), and the U.S. DOE.

The WTB is designed to be consistent with the requirements of General Design Criteria contained in the Code of Federal Regulations [10 CFR 60.132(d)] and program documents, orders, and directives in the Requirements Document Repository Design (RDRD). A detailed listing of federal and state regulations is provided in Appendix A of the previously issued Low-Level Waste Treatment Analysis Report (Ref. 9). Requirements contained in the RDRD (Ref. 17) and relevant to the WTB, are listed in Section 3.7.3.9 of that document, Site Generated Waste Treatment, Items A through E.

The HW and LLMW generated by nuclear waste Repository operations must also be managed in compliance with applicable federal, state and local regulations. These regulations provide guidelines for the treatment, storage, and disposal of HW, but are unresolved for LLMW. A detailed listing of Federal and State regulations is provided in Appendix B of the previously issued Hazardous and Low-Level Mixed Wastes Treatment Analysis Report (Ref. 12).

The following sections provide a summary of the regulations applicable to LL, HW and LLMW to identify applicable design requirements.

2.2.1 Low-level Waste

The following section provides an overview of the regulatory requirements for the treatment, storage and disposal of LLW.

2.2.1.1 Federal Environmental Requirements

The major environmental laws that were reviewed to determine their applicability to the WTB include:

A. The Atomic Energy Act of 1954, as amended;

B. The Clean Air Act of 1977, as amended;

C. The Clean Water Act of 1977, as amended;

D. The Coastal Zone Management Act of 1972, as amended;

E. The Endangered Species Act of 1973, as amended;

F. The Fish and Wildlife Coordination Act of 1934, as amended; and

G. The National Historic Preservation Act of 1966, as amended.

The Atomic Energy Act of 1954, as Amended

The Atomic Energy Act of 1954 provides that the U.S. Atomic Energy Commission (succeeded by the U.S. DOE for conducting nuclear defense, as well as research and development activities) is authorized to develop and implement regulations to govern activities related to the design, location, and operation of U.S. DOE facilities to protect health, and minimize danger to life or property. LLMW (waste containing both dangerous chemicals and radioactive materials) must be regulated both by the Atomic Waste Energy Act and RCRA. The nonradioactive, chemically hazardous portion of a nuclear waste is subject to regulation under RCRA; the radioactive component of the waste is regulated under the authority of the Atomic Energy Act of 1954 by the NRC.

The DOE has issued orders to govern the activities of its facilities and to manage health protection aspects of LLMW. These orders provide for a consistent approach to managing waste that results from U.S. DOE activities. The orders set radiation exposure limits and concentration guides to minimize exposure to radiation, and exposure standards and procedures for managing LLMW. The Repository and WTB will be operated in accordance with these orders.

The Clean Air Act of 1977, as Amended

The Clean Air Act of 1977 establishes national ambient air quality standards (NAAQS), and sets standards for abating air pollution and preventing further deterioration of air quality. These guidelines are implemented by federal, state and local requirements to control and abate air pollution. The applicable regulations include National Air Emission Standards for Hazardous Air Pollutants (NESHAP)(40 CFR Part 61) and National Emission Standard for Radionuclide Emissions from U.S. DOE facilities (40 CFR Part 61, Subpart H). The final Environmental Impact Statement (EIS) for the Yucca Mountain site will include calculated expected emissions from the Repository and the surface facilities (including the WTB) in an evaluation of the air quality impacts of Repository operations.

The Clean Water Act of 1977, as Amended

Operation of the WTB is not anticipated to result in the discharge of liquid effluents, however a National Pollutant Discharge Elimination System (NPDES) permit may be required.

The Coastal Zone Management Act of 1972, as Amended

The WTB will not be located in a coastal zone or shoreline as defined by this statute. Therefore, no permits or reviews pursuant to this statute are applicable.

The Endangered Species Act of 1973, as Amended

The location of the WTB has not been determined. Therefore, a review of the permitting requirements cannot be conducted at this time. Once identified, the location of the WTB will constitute a small fraction of the Yucca Mountain site and, hence, does not play a significant role in the ecology of the site. No listed, or proposed, endangered or threatened species or their habitats are expected to be affected by the WTB activities.

The Fish and Wildlife Coordination Act of 1934, as Amended

The WTB will not involve the impoundment, diversion, control or modification of any body of water. Therefore, no permits or reviews pursuant to this statute are applicable.

The National Historic Preservation Act of 1966, as Amended

The WTB may affect areas that are eligible for nomination to the National Register of Historic Places. In addition, the area was reviewed for cultural resources. A total of 178 prehistoric aboriginal sites have been identified at the Yucca Mountain site. Therefore, the Yucca Mountain site has been recorded as an archaeological site.

During the construction phase, the site will be monitored for the presence of archaeological resources in accordance with regulations issued pursuant to the following legislation: the American Antiquities Preservation Act of 1906; the American Indian Religious Freedom Act of 1978; the Historic Sites, Buildings and Antiquities Act of 1935; the Archaeological and Historic Preservation Act of 1960; and the Archaeological Protection Act of 1979.

2.2.1.2 Federal Design Requirements

Development of the engineering concepts for the WTB design must be consistent, as a minimum, with the following regulations:

A. 10 CFR Part 20, "Standards for Protection Against Radiation";

B. 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste";

C. The Low-Level Radioactive Waste Policy Amendment Act (LLRWPAA) of 1985, as amended;

D. DOE Order 5820.2A, " Radioactive Waste Management," (DOE, 1988);

E. DOE Order 5480.1b, " Environmental, Safety, and Health Program for Department of Energy Operations", (DOE, 1986);

F. DOE Order 5480.4, "Environmental Protection, Safety, and Health Protection Standards" (DOE, 1984b); and

G. DOE Order 6430.1A, "General Design Criteria" (DOE, 1989).

10 CFR Part 20

The regulations covered under 10 CFR, Part 20 were issued under the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended. This Part establishes the standards for protection from radiation for workers and the public of NRC-licensed facilities. The WTB must adhere to the same (as applicable) licensing requirements as the Repository and will, therefore, be included as part of the License Application (LA). This Part addresses the control, receipt, possession, use transfer, and disposal of licensed material in such a manner that the total occupational or offsite dose does not exceed the standards of protection for safety described in this Part. The design of the WTB must provide the appropriate shielding and/or mitigation features that will preclude the release of radionuclides at levels exceeding these standards. A Preliminary Hazard Analysis (PHA) and Design Basis Accident Analysis (DBAA) must be performed during future design efforts in order to determine the required mitigative design features required for the WTB.

10 CFR Part 61

The procedures, criteria, as well as terms and conditions for NRC licensing of near-surface disposal of radioactive LLW are provided by 10 CFR, Part 61 as defined in the LLRWPAA. This Part identifies the terms and conditions by which the Commission issues a license for disposal of radioactive wastes containing by-product, source and special nuclear material (SNM) received from other persons and/or entities.

NRC regulation 10 CFR Part 61, establishes a classification system and a set of corresponding waste-form-acceptance criteria for land burial of LLW at commercial sites. Existing DOE regulations have not been modified; therefore, 10 CFR Part 61, will be followed for this application, unless directed otherwise by the DOE.

According to 10 CFR, Part 61, LLW can be classified as either A, B, or C as determined by the concentrations of different radionuclides. The radioactivity of the three classes is related by the inequality: $A < B < C$. Disposal regulations are also contained in 10 CFR, Part 61. Shallow land burial (SLB), the recommended disposal option, is permitted only for Classes A, B, and C. The "greater than C" wastes require a higher degree of confinement (e.g., the repository).

The Low-Level Radioactive Waste Policy Act

This law delegates to the states the responsibility for disposing of Class A, B, and C wastes to the states in accordance with 10 CFR Part 61.

DOE Order 5820.2A, Radioactive Waste Management

This Order establishes the policies and guidelines for the management of DOE HLW, LLW, LLMW and TRU Waste. These policies comply with the requirements of the Atomic Waste Energy Act of 1954, as amended, the EPA and the NRC. This Order addresses performance analysis/assessment, waste generation/minimization, characterization; waste acceptance criteria; and waste treatment, shipment, storage and disposal.

In accordance with DOE Order 5820.2A, the LLW that will be treated and stored on a long-term basis at the Yucca Mountain site must, as a minimum, adhere to the following objectives:

A. Waste must be treated by appropriate methods to ensure that the disposal site meets the performance objectives.

B. Waste treatment techniques such as incineration, shredding, and compaction must be used to reduce volume and provide more stable waste forms.

C. LLW shall be stored by appropriate methods to achieve the required performance objectives.

2.2.1.3 State Requirements

State of Nevada requirements that will also need to be considered include water and air quality laws, safety and fire protection regulations and any regulations pertaining to wildlife. Nevada State regulations include, but are not limited to, the following:

A. Nevada Revised Statutes (NRS) Title 40, Chapter 444, Public Health and Safety: Sanitation 1986, Standards for Solid Waste Disposal.

B. NRS, Title 40, Chapter 445, Public Health and Safety; Water Controls, Air Pollution, 1985, Standards for Air Quality.

C. NRS, Title 40, Chapter 459, Public Health and Safety; Hazardous Materials, Radioactive Waste, 1985, Standards for Hazardous and Radioactive Waste Management.

D. NRS, Title 45, Chapter 501, Wildlife; Administration and Enforcement, 1985, Standards for Wildlife Protection.

The regulations applicable to the aboveground facilities at the MGDS have been listed in Section 2.2.1 of this report. These regulations cited in Section 2.2.1 have been interpreted to require the following at the MGDS above-ground facilities:

A. Liquid LLW must either be treated and packaged into a solid form or packed with materials capable of absorbing twice the amount of liquid.

B. Free liquid or noncorrosive liquid in the solidified LLW must be reduced to as little as reasonably achievable, but may not exceed 1 percent of the volume of the waste.

C. Packaged waste must not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes.

D. Disposal containers may not be made up of flammable material such as cardboard or fiberboard.

E. Packaged waste must not be capable of igniting. All combustible radioactive waste must be reduced to noncombustible form unless it can be demonstrated that the waste packages containing combustible material, upon "catching on fire", will not compromise the integrity of other waste packages.

F. Waste packages must exhibit structural stability under the expected disposal conditions such as the weight of overburden and compaction equipment, the presence of moisture, microbial activity, and internal factors such as radiation effects and chemical changes.

G. Void spaces within the waste must be reduced to the maximum extent practicable.

2.2.2 Hazardous Waste

HW must be managed in accordance with the following federal regulatory requirements: 40 CFR Part 260, 40 CFR Part 261, 40 CFR Part 262, 40 CFR Part 264, 40 CFR Part 265, and 40 CFR Part 268. Containers that are used for collection of HW must comply with the requirements of 49 CFR Part 173 and 49 CFR Part 178. Acceptable storage containers include 55-gallon drums, 30-gallon drums, and 5-gallon drums meeting DOT specifications. HW may be accumulated on-site, in interim storage, for a limited time without requiring a RCRA storage permit.

The principal requirements of the federal regulations pertinent to the management of HW stored in containers are:

A. HW storage areas must be furnished with a containment system to contain leaks, spills, and accumulated precipitation.

B. The containment system must have capacity sufficient to hold 10 percent of the total volume of all of the contents or the volume of the largest container, whichever is greater.

2.2.3 Low-Level Mixed Waste

LLMW management is subject to the following federal regulatory requirements: DOE order 5820.2A, 40 CFR Part 260, 40 CFR Part 261, 40 CFR Part 262, 40 CFR Part 264, 40 CFR Part 265, 40 CFR Part 268, and the Federal Facility Compliance Act. Containers used for long-term staging of LLMW must comply with the requirements of 49 CFR Part 173 and 49 CFR Part 178. Acceptable storage containers include those specified for HW plus bins meeting DOT specifications.

Existing regulations concerning LLMW management may be interpreted to require the following:

A. Regulations related to treatment and disposal of LLMW are currently unresolved. It is assumed that these regulations will be available in the future and, due to the low volume of LLMW anticipated, these wastes will be shipped off-site for treatment and disposal. The WTB is equipped with a small LLMW staging room for this purpose.

B. A staging facility must be equipped with a containment system to confine spills or leaks.

C. LLMW staging must be provided in an enclosed building in which airlocks and confinement ventilation systems are furnished.

2.3 WASTE DATA

Previous reports (Ref. 7 and 8) estimated waste volume generation rates for aboveground Repository operations. In order to capture advances in the conceptual design of other facilities, the generation rate of secondary wastes has been re-examined. These new rates form the basis for the WTB conceptual design. This report section presents the new waste generation volumes, and documents the methodology by which these new values were obtained.

2.3.1 Low-Level Waste

The amount of site-generated LLW was previously estimated (Ref. 9) based on a projected schedule of transportation cask shipments to the MGDS. Based on recent changes in this cask shipment schedule, as well as refinement of cask decontamination philosophy, the volume of LLW generation was re-estimated.

This section presents the methodology used to re-estimate the generation of solid and liquid LLW by facilities within the RCA. The actual results of this effort are given in Section 4.1.2.

2.3.1.1 Liquid Low-Level Waste

Liquid LLW can be subdivided into recyclable liquid Waste, which is predominantly aqueous with only trace amounts of dissolved chemicals, and chemical waste (which is non-recyclable). The various activities that generate these two waste streams are listed below:

Recyclable Liquid Waste

A. Floor washdown
B. Loaded transportation cask exterior decontamination
C. Unloaded transportation cask exterior decontamination
D. Waste package washing
E. Small equipment/tool decontamination

Chemical Waste

A. Floor washdown
B. Loaded transportation cask exterior decontamination
C. Unloaded transportation cask exterior decontamination
D. Small equipment/tool decontamination

The methodology used to estimate the liquid waste volumes produced is presented below, by waste type:

Recyclable Liquid Waste

Floor Drains:

The periodic washdown of floors and equipment in the Waste Handling Building (WHB), the Cask Maintenance Facility (CMF), and the WTB will generate both a spent aqueous stream suitable for recycling, and a separate, nonrecyclable liquid stream containing detergents and other chemicals. It is estimated that the WHB and the CMF will be washed down twice per year, while the WTB will be washed down only once yearly. Based on engineering judgement, it is estimated that each washdown will consume a fixed volume of wash liquid per unit of floor area, and that the recyclable water stream will constitute 60 percent of the total floor wash waste fluid. The annual generation rate of waste recyclable water from this source can, therefore, be calculated by multiplying (1) the building floor space by (2) the annual washdown frequency by (3) the total volume of wash liquids per unit area by (4) the volume percentage of a specific wash stream.

Loaded Transportation Cask Exterior Decontamination:

The report Waste Handling Building Layout for MPC Implementation (Ref. 7) indicates that approximately 8 percent of the incoming transportation casks may exhibit "weeping", and, therefore, require some degree of exterior decontamination. (The original source of the cask "weeping" information is the report: Transportation Cask Contamination Weeping, (Ref. 19).) The specific decontamination procedure used will depend on the extent of contamination and the difficulty experienced in its removal. The frequency with which each of the available decontamination procedures will be needed has been assumed to be as follows:

30 Percent	Wiping
70 Percent	Soapy water wash/water rinse
10 Percent	Hot Alkaline Permanganate (AP)/ Citric Acid and Oxalic Acid (CITROX/water rinse (i.e.,chemical wash)

Of these decontamination techniques, only the chemical wash procedure will produce recyclable liquid waste. Therefore, the total volume of recyclable liquid waste generated by this activity can be estimated by multiplying (1) the total incoming cask exterior surface area by (2) the percentage of casks requiring decontamination by (3) the percentage of cases in which the chemical wash procedure is used by (4) the volume of rinse water used per unit of surface area by the particular chemical wash procedure. The final term in this equation is estimated using engineering judgement.

Unloaded Transportation Cask Exterior Decontamination:

The need to decontaminate the exteriors of unloaded transportation casks arises from periodic cask maintenance activities, and is not related to any external contamination found on the incoming loaded casks. It is first assumed that a fixed inventory of transportation casks (85 casks) will serve the Repository surface facilities. It is further assumed that each of these casks must undergo Testing/ Inspection/ Maintenance/ Repair (TIMR) at least three times per year. In the course of TIMR, an unloaded, open cask is immersed in a water-filled cask maintenance pool located in the CMF. This process causes any contamination present on the cask interior surface to enter the water. Even though the water bath is continuously circulated through an ion-exchange bed, some of the contamination released from the cask interior will redeposit on the exterior. Therefore, each cask must undergo exterior decontamination after its removal from the maintenance pool.

The procedures available for unloaded cask exterior decontamination are the same as those procedures identified previously for loaded cask exterior decontamination. It was assumed that the frequency of use for each of these decontamination procedures will be unchanged from the loaded cask case. It is again noted that only the chemical wash procedure will produce recyclable liquid waste. Therefore, the total volume of recyclable liquid waste generated by this activity can be estimated by multiplying (1) the total external surface area of the cask inventory, by (2) three external decontaminations per year for each cask in the inventory by, (3) the percentage of cases in which the chemical wash procedure is used by (4) the volume of rinse water used per unit of surface area by the particular chemical wash procedure. Again, the final term in this equation is estimated using engineering judgement.

Waste Package Wash:

After the incoming transportation casks are opened in the WHB, their contents are removed and placed inside waste packages. These waste packages are then welded closed and ultimately sent to the Repository. In order to provide adequate recyclable liquid waste handling capacity, it is assumed that 1 percent of the sealed waste packages will require an external water wash. Therefore, the total volume of liquid waste generated by this activity is estimated by multiplying (1) the total waste package external surface area by (2) one percent by (3) the wash water usage per unit of surface area, as determined by engineering judgement.

Small Equipment/Tool Decontamination:

Small equipment and tools might be periodically decontaminated for re-use by successively soaking them in hot AP, CITROX, and finally a water rinse. It is assumed that an average of 50 gallons of each soak liquid will be used every week. The spent rinse water will be designated as recyclable liquid waste.

Truck/Rail Carriage Wash:

In the unlikely event that a truck/rail carriage becomes contaminated, provision must be made for receiving, decontaminating, and returning it to service. This report assumes that truck/rail carriages will be washed on an "as required" basis in a truck/rail carriage washdown area. The quantity of water used for washing truck/rail carriages is estimated based on the assumption that only one large (approximately 1,000 ft^2) rail carriage will be washed yearly. The total area washed per year is calculated by multiplying the total surface area of the carriage by the annual wash frequency. The wash water volume per unit of surface area was estimated based on engineering judgement. The total annual volume of truck/rail carriage wash waste water is calculated by multiplying (1) the total square footage of area washed per year by (2) the estimated wash water volume used per unit area.

Chemical Waste

Floor Drains:

The general discussion of floors and equipment washdowns given above under "Recyclable Liquid Waste" is also applicable to chemical waste generation. Based on engineering judgement, it is estimated that 60 percent of the fixed volume of wash water used per unit of floor area will be recyclable water, while the remaining 40 percent will be chemical waste. The yearly volume of chemical waste generated by this activity can, therefore, be estimated by multiplying (1) the building floor space by (2) the washdown frequency by (3) the total volume of wash liquids per unit area by (4) the volume percentage (40 percent) represented by chemical waste.

Loaded Transportation Cask Exterior Decontamination

The general discussion of this activity given above under "Recyclable Liquid Waste" is also applicable to chemical waste generation. Of the three identified decontamination procedures, only soapy water wash/ water rinse and chemical wash are likely to produce spent, nonrecyclable (chemical) wastewater. Therefore, the total chemical waste volume attributable to each of these two procedures can be estimated by multiplying (2) the total incoming cask exterior surface area by (2) the percentage of casks requiring decontamination by (3) the percentage of contaminated casks requiring a particular decontamination procedure by (4) the volume of chemical wastewater generated per unit of surface area by the selected procedure. The sum of the chemical waste volumes produced by the two decontamination procedures represents the total chemical wastewater for this activity.

Unloaded Transportation Cask Exterior Decontamination

The general discussion of this activity given above under "Recyclable Liquid Waste" is also applicable to chemical waste generation. Only two of the decontamination procedures identified - soapy water wash/ water rinse and chemical wash will produce spent, non-recyclable chemical wastes. Therefore, the total chemical waste volume attributable to each of these two procedures can be estimated by multiplying (1) the total surface area of the cask inventory, by (2) three external decontaminations per year for each cask in the inventory by (3) the percentage of the casks requiring a particular decontamination procedure by (4) the volume of chemical waste generated per unit of surface area by the selected procedure. The sum of the chemical waste volumes produced by the two procedures represents the total for this activity.

Small Equipment/Tool Decontamination Solution

Small equipment and tools are periodically decontaminated for re-use by successively soaking them in hot AP, CITROX, and, finally, rinse water. It is assumed that an average of 50 gallons of each soak liquid will be used per week. The spent AP and CITROX solutions will be designated as nonrecyclable chemical waste.

2.3.1.2 Solid Low-Level Waste

Compactible Solid LLW

The yearly generation of compactible solid LLW is determined partly by the total number of cask decontaminations performed and partly by the number of operating personnel working in the radioactive area.

Cask decontamination activities produce waste paper and cloth that are classified as compactible solid LLW. Referring to the preceding section on liquid LLW, the total number of cask decontaminations can be found by summing the numbers of loaded and unloaded transportation cask exterior decontaminations. It is estimated that each cask decontamination will generate approximately 20 cubic feet of combined paper and cloth. Further, it is assumed that various other decontamination operations, such as floor or equipment wipedowns, can be indirectly attributed to the cask decontaminations. Accordingly, the volume of paper and cloth generated by these other activities is estimated to be 50 percent of the waste directly attributable to cask handling. The total for cask decontamination compactible waste material is, therefore, equal to the sum of the direct and indirect sources.

Operating personnel working in the radioactive area will generate plastic waste of various types, which is also classified as compactible solid LLW. The volume of this material is estimated by multiplying the number of operators by an assumed waste generation rate per person.

Based on published information, the two types of waste material - plastics and paper/cloth - should collectively represent a large fraction of the total compactible solid LLW. It is assumed that these two wastes, in combination, will constitute the same volume percentage of the total compactible waste stream as they do in solid waste from domestic Pressurized Water Reactors (PWR), as reported by the Electric Power Research Institute (EPRI) (Ref. 14, Figure 2-1). This assumption permits the calculation of the total compactible solid LLW stream from the previously determined rates for waste plastic and paper/cloth.

Noncompactible Solid LLW

The yearly generation rate of metallic, noncompactible solid LLW has been determined partly by the estimated volume of spent HEPA filter elements discharged from radioactive service, and partly by the number of unloaded cask TIMR operations performed. The total volume of noncompactible solid LLW was found by assuming that metal constitutes a fixed volume percentage of the total stream.

The total volume of spent filter elements is found by multiplying (1) the number of each type of filter installed in radioactive service by (2) the corresponding element replacement frequency for each installed filter unit by (3) the corresponding volume of each type of filter element. The final volume of spent filter elements was then increased by 50 percent to account for filter frames and other miscellaneous appurtenances.

As described in the preceding section on liquid LLW, TIMR is periodically performed on each of the transportation casks serving the Repository surface facilities. TIMR operations are expected to generate valves, fittings, pipes, bolts and various other metallic scrap classified as noncompactible solid LLW. The total volume of this stream is found by multiplying (1) the number of unloaded transportation casks undergoing TIMR each year, by (2) the assumed volume of metal waste generated per TIMR operation.

As was the case for compactible solid LLW, the two types of metal waste material thus far identified (spent ion-exchange resin and cask TIMR metal waste) should collectively represent a significant fraction of the total noncompactible solid LLW. It is assumed that these two wastes, in combination, will constitute the same volume percentage of the total noncompactible waste stream as they did in the solid waste from domestic PWRs, as reported by EPRI (Ref. 14, Figure 2-2). This assumption permits the calculation of the total noncompactible solid LLW stream from the previously determined rates for metal waste.

Spent Ion-Exchange Resin

Spent ion-exchange resin volume was calculated by multiplying the estimated resin volume of each demineralizer unit by the estimated changes per year. All estimated quantities are based on engineering judgement.

2.3.2 Hazardous Waste

Liquid Hazardous Waste

The Repository surface facilities will generate a number of streams classified as liquid HW, such as shielding oil, hydraulic oil, lubricants, fluids and solvents. Although waste oils are generally not classified as HW in Nevada, these streams are presumed to be HW for the purposes of this conceptual design. The volume of each of these streams can be estimated by multiplying (1) the number of source items containing a particular type of hazardous liquid by (2) the liquid capacity of each source item by (3) the liquid change-out frequency of each source item. The sum of the individual liquid streams represents the total liquid HW generation rate.

Solid Hazardous Waste

The Repository surface facilities may also have the potential to produce solid HW, although specific mechanisms of generation have not yet been identified. It is conservatively assumed that the volumetric ratio of solid to liquid HW produced by the Repository surface facilities will be the same as the ratio of solid to liquid LLMW from domestic nuclear facilities, as reported in the report entitled, "Locations, Volumes, and Characteristics of DOE's Mixed Low-Level Wastes" (Ref. 4).

2.3.3 Low-Level Mixed Waste

Liquid Low-Level Mixed Waste

Liquid HW may become liquid LLMW if it becomes contaminated with radionuclides. It is conservatively assumed that certain liquid HW streams will, at some frequency, be transformed into LLMW by inadvertent cross-contamination.

Solid Low-Level Mixed Waste

The Repository surface facilities may also have the potential to produce solid LLMW, although specific mechanisms of generation have not yet been identified. It is conservatively assumed that the volumetric ratio of solid to liquid LLMW produced by the Repository surface facilities will be the same as the ratio experienced by domestic nuclear facilities, as reported in Ref. 4.

3. ASSUMPTIONS

The conceptual design information contained in this report is based on preliminary information of indeterminate quality. For this reason, this report has been designated as TBV, and assigned an overall tracking identification number of TBV-090-DD, per NLP -3-15 as required by QAP-3-5.

Controlled Design Assumptions (CDAs) and Design Concept Assumptions (DCAs), relevant to conceptual design of the WTB, air listed below. In general, the version of these assumptions in effect at the start of this WTB design effort, is the version utilized.

CDAs: Key 001, 003, 012 and 024

DCAs: DCS 010, 011, 012 and 013

Numerous other assumptions were made in order to develop a conceptual processing plan for secondary wastes. These assumptions are listed below:

A. A suitable binding agent, such as Portland cement, is available that, when mixed with liquid LLW, will produce a solid possessing satisfactory disposal characteristics, including leachability and combustibility.

B. LLW, generated during the Caretaker and D&D phases will have no impact on the WTB design.

C. LLW is not generated by subsurface waste emplacement area operations. Wastes, dirt and other material transferred from the subsurface facility will not be radiologically contaminated.

D. No secondary TRU or HLW streams will be processed in the WTB.

E. Provisions will be made to wash incoming truck/rail carriages, although the location of such a facility has yet to be determined.

F. Treated liquid low level wastewater may not be discharged on-site and, therefore, must be recycled and/or solidified prior to disposal.

G. Final LLW packages must meet predetermined leachability criteria.

H. The estimated quantities of site-generated waste are based on normal Repository operations. Variations in the quantity of LLW generated due to process upsets are insignificant and not addressed in this report.

I. Operations performed in the WHB will not be simultaneous with those operations conducted in the Performance Confirmation Building (PCB). Therefore, the WTB does not need to be designed to simultaneously process wastes from both WHB and PCB operations.

J. Gaseous process waste and HVAC streams leaving either radioactive or potentially radioactive operations will be decontaminated by high-efficiency filtration before release to the atmosphere, and will be continuously monitored for radiological activity.

K. Recyclable liquid LLW and chemical liquid LLW will be segregated at their point of generation and also during subsequent processing inside the WTB.

L. The WTB design is based on a single shift operation, with six effective working hours per operating day, 235 days per year.

M. The number of stages of High-Efficiency Particulate Air (HEPA) filtration shown on flow diagrams (FD) are to be verified during detailed design.

N. HW from the RCA and BOP area will be collected and handled separately from low-level radioactive wastes in order to minimize to possible formation of LLMW.

O. HW will be handled in its as-received condition at the source of generation and prepared for transportation to an off-site, RCRA licensed, HW management facility.

P. Pending resolution of regulatory requirements and treatment technology, LLMW is to be collected, packaged and stored, as-received, in containers at a transfer point in the WTB. The LLMW containers are to be transferred to a suitable off-site facility for final disposal.

Q. A remote centralized chilled water system is assumed to provide service to the WTB HVAC system.

R. The shipping and receiving area of the WTB is assumed to be a contamination-free area for HVAC purposes.

S. The inventory of transportation casks is assumed to be 85, as indicated in the report: Monitored Retrievable Storage Facility Cask Maintenance Facility Design Study Report, February 28,1993, CRWMS M&O Document Number MRSR-0001, (Ref. 18).

T. An unloaded transportation cask is assumed to enter the CMF pool for TIMR operations three times annually.

U. Only LLW resulting from unloaded transportation cask exterior decontamination, in the CMF, will be routed to the WTB for processing.

V. The volumetric ratio of solid to liquid HW produced by Repository surface facilities is assumed to be the same as that derived from the report: "Locations, Volumes and Characteristics of DOE's Mixed Low-Level Waste" (Ref. 4).

4. DESIGN DESCRIPTION

This section presents details of the WTB design and is divided into subsections addressing LLW HW and LLMW processing.

4.1 LOW-LEVEL WASTE PROCESSING

4.1.1 General

The nuclear industry, since its inception, has practiced a variety of methods for treating and handling LLW. Such waste ranges from dry trash, paper, plastic, glass, clothing, and discarded equipment to wet sludges and aqueous, or organic, liquids. These wastes may be derived from any operation involving radioactive material.

In the WTB, secondary LLW generated by RCA operations are processed and converted into a stable form to permit disposal. This section of the report presents an overview of the WTB operations, equipment, utility and operating requirements, and HVAC system concepts. The WTB receives both liquid and solid LLW.

Liquid LLW is comprised of fluids which are contaminated with radioactive materials. This LLW typically contains a relatively low concentration of insoluble solids, generally less than 1 percent. Liquid LLW is generated by decontamination and maintenance activities as well as by other operations performed in the RCA. LCCA indicates that reduction of waste volume is a primary factor in reducing the costs associated with waste treatment and disposal. One of the more effective means of achieving this objective with aqueous waste is through recycle, with evaporation being the primary purification step of purifying the recycled stream. Therefore, segregation of aqueous waste streams at their source of generation into recyclable and nonrecyclable (chemical) wastes is assumed, and forms the basis for the WTB conceptual design.

The solid LLW must be processed for several purposes: (1) to segregate wet solids, compactible solids, noncompactible solids and oversized equipment/tools that require mechanical disassembly, (2) to reduce the volume of the compactible solids to the maximum extent possible and (3) to reduce the mobility of the wastes during prolonged storage. The treatment technology is, in general, the same for any level of radioactivity below the upper radiological limit for LLW. Each category of solid waste must be processed in a manner which produces an immobile product suitable for disposal.

The waste treatment cases developed in the previous report (Ref. 9) represent a range of possible technology configurations. These cases were screened down to two cases each for solid and liquid LLW treatment using a KT style analysis. The candidate cases identified in the screening effort were evaluated further, using a LCCA, in the subsequent phase of the conceptual design effort. The results of this work are presented in Section 5 of this report. A single LLW treatment system process configuration, for both solid and liquid LLWs, was then selected on the basis of lowest LCC. These proposed configurations formed the basis for development of the WTB conceptual design.

4.1.2 Waste Volume

The volume of secondary waste generated has been re-estimated, based on recent revisions to the SNF and HLW shipment schedule and on comments on the previously issued Low-Level Waste Treatment Analysis Report (Ref. 9) and subsequent technical discussions. The general estimating methodology was described in Section 2.3.1 of this report.

Site-generated waste may take the form of gases, vapors, liquids or solids. The WTB receives and processes solid and liquid LLW only, while gas or vapor process or HVAC streams are treated at, or near, their points of generation before release to the atmosphere. Contaminants present in the gas as entrained particulates may be removed from the gas by scrubbing or by the use of HEPA filtration techniques.

4.1.2.1 Liquid Low-Level Waste

Liquid LLW is generated as a result of SNF and HLW handling operations, decontamination operations, housekeeping, and maintenance activities performed within the RCA. Table 1 lists the calculated annual volumes of both chemical and recyclable aqueous liquid wastes generated within the RCA. These waste volumes are summarized by the three main areas of the RCA: 1) WHB, 2) CMF and 3) WTB. Due to the early stage of conceptual design development of the RCA, some potential secondary waste producing facilities have been assumed to exist, and waste generation rates estimated for them. An example of this is the truck/rail washdown area, the need for which has yet to be determined. For this reason, the volume of wash liquid from this area is shown as a separate entry in Table 1. The stream numbers shown in Table 1 are keyed to WTP-SK-001 - 011. Process stream flow rates and properties are provided in the material balance table shown on WTP-SK-020. In general, the liquid LLW volumes presented in Table 1 are lower than those previously presented in the Low-Level Waste Treatment Analysis Report (Ref. 9), due largely to refinement in decontamination concepts.

Table 1. Summary of Liquid LLW Generation Rates

Source Facility	Category	Stream Number	Recyclable Liquid Gallons/yr	Chemical Liquid Gallons/yr
WHB	Floor Drains	111		20.200
	Floor Drains	103	30,300	
	Waste Package Wash	105	1,600	
	Small Equip./Tools Decon Water	113		6,200
	Small Equip./Tools Decon Solution	106	3,100	
	Total		35,000	26,400
	Truck/Rail Carriage Wash Area Solution	1078	1,100	
	Total		1,100	
CMF	Cask Decon Solution	112		21,500
	Floor Drains	102	21,100	
	Floor Drains	110		14,100
	Cask Decon Water	104	12,700	
	Total		33,800	35,600
WTB	Floor Drains	109		3,400
	Floor Drains	101	5,200	
	Total		5,200	3,400
Grand Total			75,100	29,800

4.1.2.2 Solid Low-Level Waste

Solid LLW is also generated as a result of SNF and HLW handling operations, decontamination operations, house-keeping activities, and maintenance activities conducted within the RCA. Table 2 lists the estimated annual volumes of both compactible and noncompactible wastes generated within the RCA. The major sources of solid LLW are the WHB and the CMF. Solid LLW is generated in the WTB and Carrier Staging Shed (CSS). It has been assumed that the WTB will not receive any TRU site-generated waste.

The total quantity of solid LLW presented in Table 2 was re-estimated (Ref. 11), based on recent information concerning RCA operations, resulting from conceptual design advancement. The estimating methodology was described in Section 2.3.1.2. The stream numbers shown in Table 2 are keyed to WTP-SK-012 through 019. In general, the solid LLW volumes presented in Table

2 are slightly lower than those presented in the Low-Level Waste Treatment Analysis Report (Ref. 9).

Table 2. Summary of Solid LLW Generation Rates

Source Facilities	Category	Stream Number	Quantity ft^3/ yr
WHB CMF WTB CSS	Compactible	202	26,790
	Noncompactible	201	8,986
	Spent Resin Slurry	203	1,545
	Total		37,321

4.1.3 Technology Selection

The previously issued Low-Level Waste Treatment Analysis Report (Ref. 9) identified six competing process configurations for the treatment of liquid LLW, and an additional 5 configurations for the treatment of solid LLW. A KT analysis was then performed to screen the process configurations further to two each for the treatment of solid and liquid LLW. The K-T analysis considered such factors as safety, operability, commercial experience, waste volume reduction, regulatory compliance, maintainability, chemical consumption, secondary waste generation, process flexibility and reliability. The configurations are listed below:

Liquid LLW Processing:

L-1 Filtration/ Evaporation/ Ion-Exchange/ Recycle
L-6 Solidification

Solid LLW Processing:

S-1 Shredding/ Compaction/ Supercompaction/ Grouting
S-2 Shredding/ Compaction/ Grouting

This conceptual design effort continued the technology screening process by selecting final configurations based on LCCA. The LCCA effort involved: (1) developing each of the four candidate process configurations sufficiently far to determine equipment requirements, (2) developing capital costs, and (3) estimating operating requirements and costs. The result of these analyses are summarized in Table 3, which expresses all life-of-plant costs in 1995 dollars.

Table 3. WTB Life Cycle Cost Breakdown

Description	Case L-1 (Million $)	Case L-6 (Million $)	Case S-1 (Million $)	Case S-2 (Million $)
Capital Cost	8.09	6.11	9.39	8.40
Operating Cost				
Labor	8.38	3.3	5.99	5.08
Operating supplies	7.16	15.22	10.29	13.71
Disposal	21.63	45.93	17.68	26.41
Maintenance	1.33	1.01	1.55	1.38
Utilities	0.87	0.52	0.55	0.47
Total Operating Cost	39.38	65.98	36.06	47.06
Decon. & Decom.	0.23	0.17	0.27	0.24
WTB Life Cycle Cost	47.70	72.27	45.71	55.69

Cases L-1 and S-1 present the lowest life cycle cost for liquid and solid LLW processing, respectively, and are recommended. Accordingly, this report presents a WTB conceptual design including flow diagrams, heat and material balances, process descriptions as well as utility and miscellaneous consumable requirements for these two recommended configurations.

The analyses of each of the cases is presented in the following Appendices to this report:

Case	Appendix
L-1	C
L-6	D
S-1	E
S-2	F

The LCCAs were based on the postulated breakdown of plant life presented below:

Engineering and Construction	5 years	(1995-1999)
Startup	1 year	(2000)
Emplacement Phase	24 years	(2001-2024)
Caretaker Phase	26 years	(2025-2050)
D&D Phase	1 year	(2051)

The duration of the various phases of plant life are representative of planning data available at the time the LCCAs were performed. Since the purpose of these LCCAs was comparison of alternatives, results are unlikely to be impacted by revised durations or start/ stop dates.

All life-of-plant costs and expenditures were translated into 1995 dollars, using the following bases and assumptions:

A. Start-up cost, $ = 30% of the annual operating cost
B. D&D cost, $ = 20% of Total Capital Cost
C. Real interest rate = 7% for the duration of the 50-year life cycle
D. Average inflation rate = 3.2% for the duration of the 50-year life cycle
E. Life-of-Plant maintenance cost, $ = 40% of the Total Capital Cost
F. 55-gallon steel drum = $75 per drum
G. 85-gallon steel drum = $188 per drum
H. Cement dry mix cost = $0.06 per pound
I. LLW disposal cost = $49 per ft^3
J. Electricity cost = $0.056 per Kwh
K. Natural gas cost = $0.002 per ft^3
L. The annual operating cost during Caretaker operations was assumed to be 1/52nd of the yearly Emplacement Phase operating cost.

In order to judge the impact of treated LLW disposal cost on life cycle cost, a series of sensitivity cases were calculated using variable disposal costs of 15 and 5 $\$/ft^3$. The disposal cost used in the base LCCA was 49 $\$/ft^3$ and was estimated. The results of these additional evaluations are presented in Table 4. Detailed calculation summary sheets are presented in Appendix G. From the table it can be seen that the recommended process configurations remain the same even as the per unit disposal cost is reduced, although by a decreasing margin. In other words, the cost advantage of achieving greater disposed waste volume reduction decreases as the per unit disposal cost decreases. By inspection, disposal costs higher than 49 $\$/ft^3$ would probably favor the recommended process configurations by an even larger margin.

Table 4. WTB Life Cycle Cost Comparison (Million $)

Case No.	LLW Disposal Cost		
	49 $\$/ft^3$	15 $\$/ft^3$	5 $\$/ft^3$
L-1	47.70	32.69	28.28
L-6	72.27	40.40	31.03
S-1	45.71	33.45	29.84
S-2	55.69	37.37	31.98

This comparison of total life cycle costs as a function of per unit disposal cost is also presented graphically in Figures 1 and 2. These figures also breakdown the total costs into capital, operating, and D&D components.

Figure 1 demonstrates the sensitivity of LCC to unit disposal costs. The cost differential between cases decreases from 24.6 million dollars to about 7.7 million dollars when a lower disposal cost of 15 $\$/ft^3$ is used in the analysis, and to about 2.8 million dollars when a disposal cost of 5 $\$/ft^3$ is used.

The two solid LLW processing alternatives, again from the "Low-Level Waste Treatment Analysis Report" (Ref. 9) are Case S-1, which consists of shredding/ compaction/ supercompaction and Case S-2, which consists of shredding/ compaction. Case S-1 represents a significant reduction in waste volume, when compared to Case S-2, due to the supercompaction step. The LCC for these cases, along with backup information, are presented in Appendices E and F. As was the case with liquid waste, the lower waste volume case, Case S-1, presents a LCC about 18 percent (10 million $) lower than Case S-2. The difference in LCC between the two solid cases is lower, in comparison to the two liquid cases, due to the significant waste volume reduction achieved in Case L-1 resulting from the recycle of treated water. A comparison of the LCC of the solid waste cases is presented on Figure 2. Case S-1 is the preferred treatment option at a waste disposal cost of 49 $\$/ft^3$.

Figure 2 also shows the sensitivity of LCC to unit disposal cost. The cost differential between Cases S-1 and S-2 decreases from 10 million dollars to about 4 million dollars when a lower disposal cost of 15 $\$/ft^3$ is used in the analysis, and to about 2 million dollars when a disposal cost of 5 $\$/ft^3$ is used.

The WTB conceptual design presented in this report is based upon the lowest LCC cases evaluated, namely case S-1 for solid LLW and case L-1 for liquid LLW.

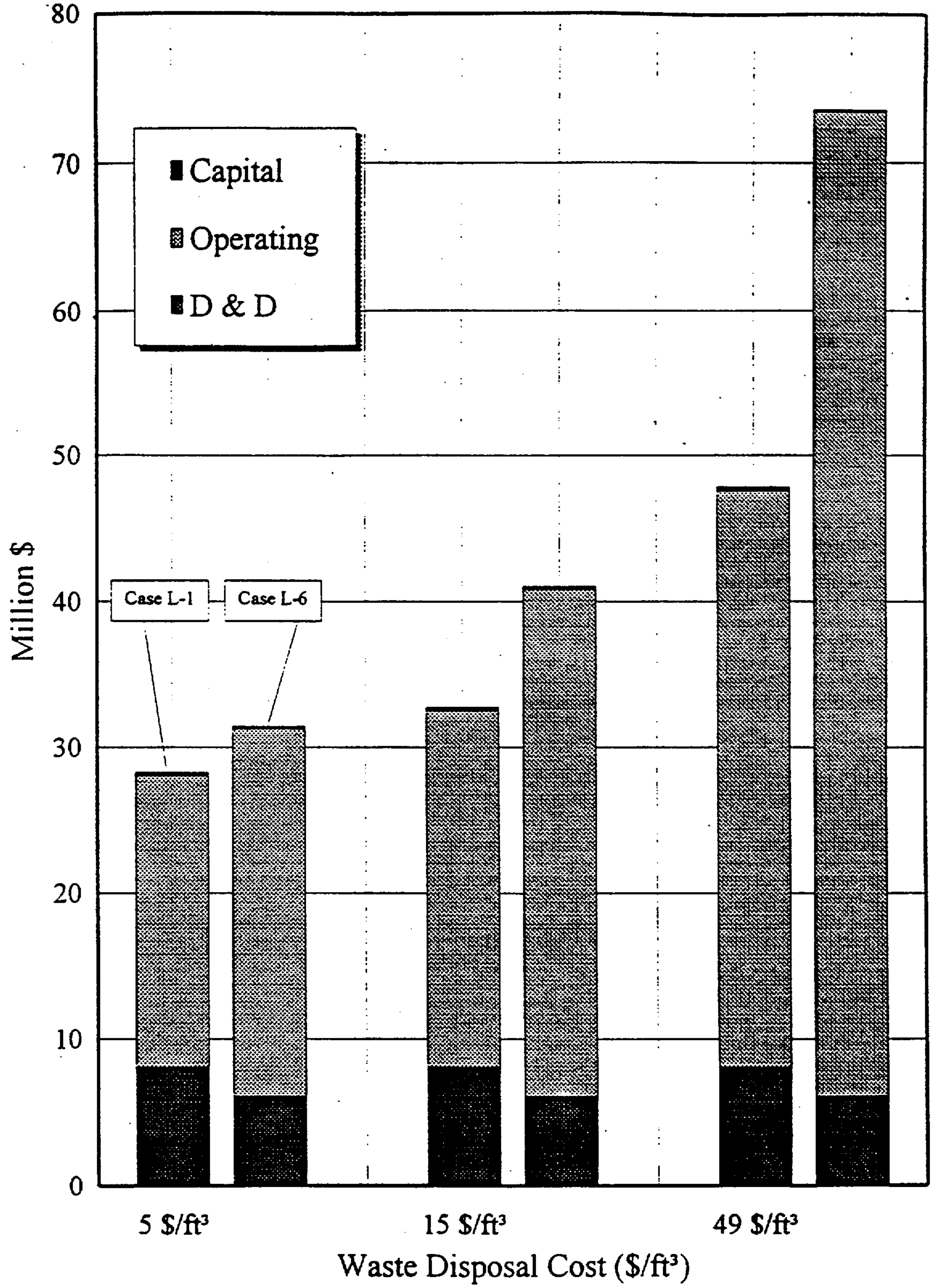

Figure 1. Life Cycle Cost Comparison - Liquid LLW (Cases L-1 & L-6)

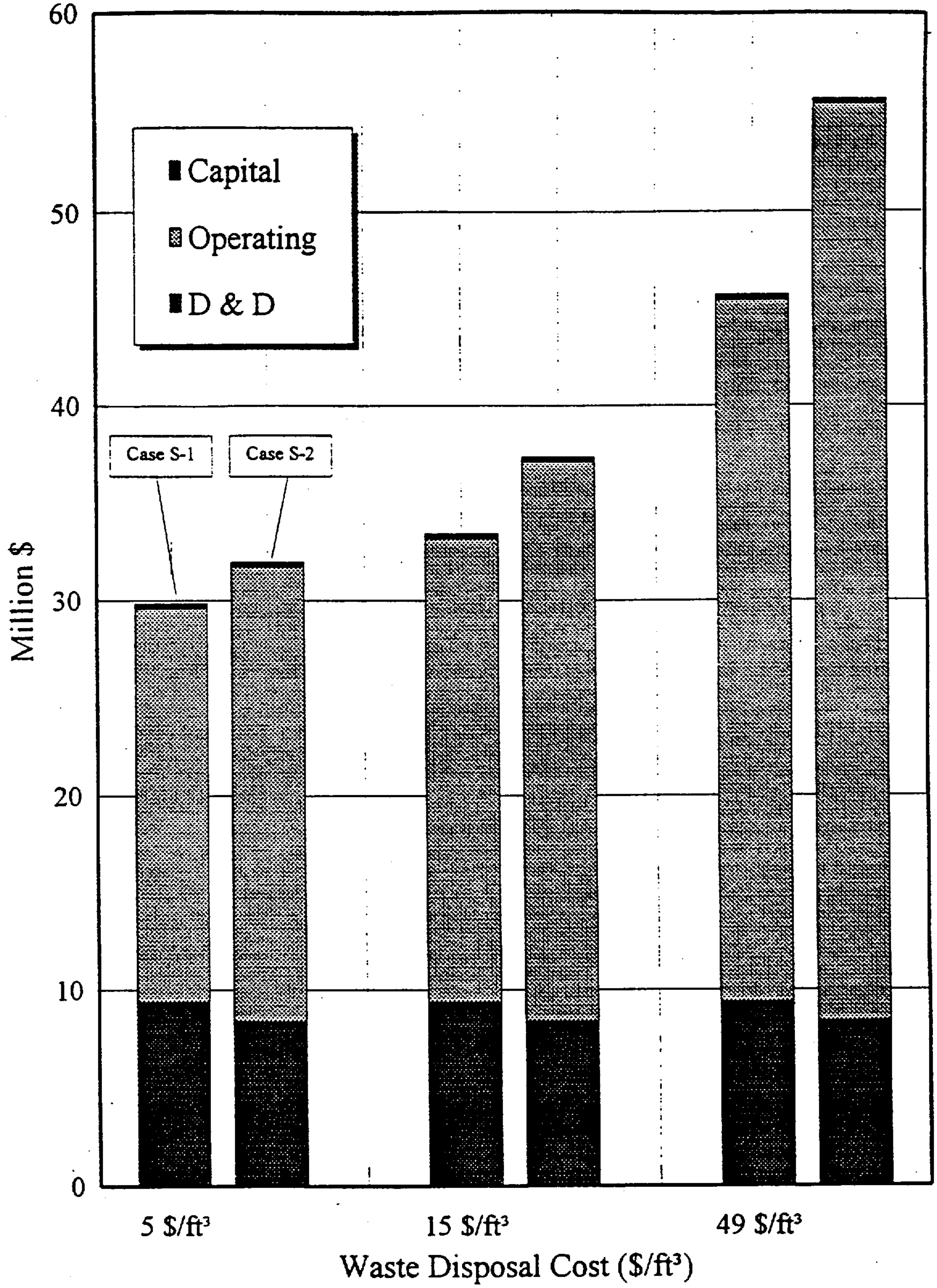

Figure 2. Life Cycle Cost Comparison - Solid LLW (Cases S-1 & S-2)

4.1.4 Process Description

The following process description addresses the handling and treatment of solid and liquid LLW generated by operations conducted within the RCA. This section also references a series of Fds starting with the prefix WTP-SK, and contained in Appendix H. Of these diagrams, Fds 001 through 011 depict liquid waste processing, while Fds 012 through 019 show solid waste processing. FD 020 gives material balance tables for both operations. For some of the intermittently-flowing liquid streams, instantaneous volumetric rates are given, in gallons per minute (gpm).

4.1.4.1 Liquid LLW Processing

Spent chemical and aqueous LLW is generated by operations conducted within the WTB and other surface facilities inside the RCA. These liquids are segregated, and are routed to the Chemical Liquid LLW Collection Tank (TNK-101) and the Recyclable Liquid LLW Collection Tank (TNK-102), respectively. The nominal 10,000 gallon capacity of each tank equals approximately 30-days production of each type of waste at the average throughput rate. This permits each tank to be used as a surge volume to even out the throughput of downstream operations. Both tanks are located inside the WTB, and are vented to a system consisting of heaters, HEPA filters, and blowers. The other process equipment items that handle liquid LLW and that require ventilation are also served by this same system.

The WTB design is based on single-shift operation of equipment downstream of the Chemical Liquid Collection Tank (TNK-101) and the Recyclable Liquid LLW Collection Tank (TNK-102) for 235 days per year. For about one hour during each operating day, aqueous waste is withdrawn at a net forward rate of 5.4 gpm from the Recyclable Liquid LLW Collection Tank (TNK -102) by the top-mounted Recyclable Waste Feed Pump (P-102 A or B). This 320 gallon batch transfer passes first through the Cartridge Filter (FLT-101 A&B) before filling the Evaporator Feed Tank (TNK-103). The provision of two parallel, 100 percent capacity filters permits the diversion of the liquid stream to the second unit if the first filter becomes plugged with solids. The rejection of these solids is accomplished by removing the loaded filter element and discarding it to the compactible, solid LLW stream. This operation is performed after completion of the batch liquid transfer. In the unlikely event that both parallel filters become plugged during the course of a single transfer, the installed capability is provided to backflush the elements with solids-free water pumped from the Recyclable Water Storage Tanks (TNK-107 A&B). The solids-rich backflush stream is returned to the Recyclable Liquid LLW Collection Tank.

The 480 gallon nominal capacity Evaporator Feed Tank (TNK-103) is filled and emptied once each operating day. After the tank liquid rises to a minimum level, the top-mounted Evaporator Feed Pump (P-103 A&B) can initiate a controlled transfer to the Evaporator Package (EVP-101). This 318 gallon batch transfer typically takes place over about 3 hours at an average rate of 1.6 gpm. The Evaporator Feed Tank (TNK-103) is located in the WTB and is also served by the vent system previously mentioned.

The Evaporator Package (EVP-101) consists of a vertical, cylindrical tank with a bladed agitator and a transfer pump mounted on top of the tank, a submerged four element electric heater element rated at 125 Kw and a water-cooled cooling coil. The agitator blades, heating element and cooling coil must be submerged when in operation. At the start of each daily operating cycle, the heating element warms the agitated bottoms liquid to near boiling. Shortly after commencement of the 318 gallon controlled transfer from the Evaporator Feed Tank (TNK-103), the heating element power output increases to initiate boiling. The boiling operation continues for approximately three hours, at a rate slightly less than that of the incoming feed liquid.

Water vapor and possibly air or other noncondensibles pass overhead from the Evaporator Package (EVP-101) and enter the shellside of the water-cooled Condenser (CND-101), which is rated at 1.085 MM Btu/hr. The newly-formed aqueous condensate gravity drains from the Condenser (CND-101) liquid outlet to the Condensate Collection Tank (TNK-104) at an average rate of 1.4 gpm. A total of 303 gallons of condensate is typically produced from a 318 gallon batch of Evaporator Package (EVP-101) feed liquid. Water-saturated noncondensibles exit through the Condenser (CND-101) vapor outlet and are drawn by suction to the previously described vent system.

The Evaporator Package (EVP-101 bottoms experience a net accumulation of 26 gallons over the course of a typical boiloff cycle. The daily purge of this excess is achieved at the end of the evaporation cycle by first turning off the heating element and then initiating water flow through the cooling coil. The top-mounted transfer pump may be activated as soon as the bottoms temperature falls low enough to avoid cavitation. The 26 gallon batch transfer is discharged to the Ph Adjustment Tank (TNK-108) for further processing. The cooling coil can continue to operate until the remaining bottoms liquid falls to near ambient temperature.
For about 3 hours during every operating day, the 480-gallon Condensate Collection Tank (TNK-104) receives aqueous condensate at an average rate of 1.4 gpm. After about 30 minutes, when the tank liquid rises to a minimum level, the top-mounted Ion-Exchange Unit Feed Pump (P-104 A&B) can initiate a controlled transfer to the Ion-Exchange Columns. This 303-gallon batch transfer typically takes place over about 3 hours at an average rate of 1.7 gpm. As is the case with the other process tanks, the Condensate Collection Tank (TNK-104) is served by the vent system previously described.

The Ion-Exchange Unit (INX-101) contains three functionally interchangeable ion-exchange columns. For approximately 3 hours in each operating day, the unit receives a 1.7 gpm feed of aqueous condensate. Upon entering the lead column, this liquid flows downward through a bed of nonregenerable cation exchange resin. In the second column, the condensate flows downward through nonregenerable anion exchange resin. Leaving this second column, the now polished and decontaminated condensate proceeds to one of the two parallel Recyclable Water Storage Tanks (TNK-107 A&B). Meanwhile, the third (or standby) column may be undergoing resin changeout, as described below.

The clean condensate from the Ion-Exchange Unit (INX-101) is continuously monitored to verify that it has been adequately decontaminated. An unacceptable radiation dose indicates the need for replacement of one or both of the resin beds. Immediately after the detection of unacceptable resin performance, the Ion-Exchange Unit (INX-101) feed stream must be stopped. If the standby column already contains a fresh charge of that same resin, then the unit valving can be quickly changed to permit the standby column to replace the failed column. Feed to the Ion-Exchange Unit (INX-101) may then be resumed.

The failed column is placed in the standby mode. It must undergo resin change-out before being returned to service. The first step in this operation requires that the top outlet line be opened while a high flow of clean water from the Recyclable Water Storage Tank (TNK-107 A&B) is admitted to the bottom of the column. As the water level rises through the column, it fluidizes the resin particles and carries them overhead to the 310-gallon Spent Resin Catch Tank (TNK-106) where, a top-mounted agitator maintains the slurried resin in suspension.

The Spent Resin Transfer Pumps (P-106 A&B) periodically move the slurried resin from the Spent Resin Catch Tank (TNK-106) to the Spent Resin Drum Filling Station (MIS-102). This Filling Station is expected to be a packaged unit consisting of an airtight chamber with an access door and internal components. Based on the preliminary design work performed thus far, it is anticipated that empty, open-topped 55-gallon drums will first be introduced to the Filling Station through the access door. These drums are designed with thick walls to provide radiation shielding against the contaminated resin. Inside the Filling Station, a hydraulic system positions a specially-designed lid over the open top of the drum. This lid is fitted with a fill connection that is joined to the Spent Resin Transfer Pump (P-106 A&B) discharge line by a flexible hose, as well as a separate vent connection. During resin transfer, the operating Spent Resin Transfer Pump (P-106 A&B) discharges the resin slurry through a recirculation line that empties back into the Spent Resin Catch Tank (TNK-106). A slipstream drawn from this recirculation loop is sent to the Spent Resin Drum Filling Station (MIS-102) where it passes through a volumetric metering device before emptying into the drum. The metering device automatically terminates the forward-flowing slipstream once the drum is filled. Air displaced from the drum exits through the top lid vent connection. This air may be filtered inside the Filling Station chamber before being routed to the same system that handles process tank vents.

Following completion of the fill cycle, the hydraulic device inside the Filling Station retracts the specially-designed lid from the top of the drum. It is then necessary to secure a more conventional solid lid to the top of the drum. Depending on the automatic capabilities of the Filling Station, a plant operator fully suited in protective gear may be needed to secure a drum lid. Once the solid lid is firmly in place, the filled drum is removed from the Filling Station by a forklift and carried to the Drum Lifter (DPR-201). Working off the contents of a full Spent Resin Catch Tank (TNK-106) requires that several such drums be filled. The final dispositioning of spent resin is discussed in the section on Solid LLW Processing.

The next step in a standby column resin changeout is the addition of fresh resin. To prepare for this changeout, a measured volume of decontaminated water from the available Recycle Water Storage Tank (TNK-107 A&B) is first transferred to the 310-gallon Resin Feed Tank (TNK-105). A drum of fresh resin is then made accessible to the top of this tank by a forklift while the tank agitator is activated. Standing on a platform adjacent to the tank, a plant operator next opens the tank loading hatch and manually adds the required amount of fresh resin from the drum. Resin transfer is accomplished by opening a top inlet line on the standby column and starting one of the double-diaphragm type Resin Transfer Pumps (P-105 A&B). Once inside the column, the slurried resin particles are retained by a porous support media to form a bed. The transfer water flows down through both the bed and the support media before exiting the bottom of the column and proceeding to the Recyclable Liquid LLW Collection Tank (TNK-102). Upon completion of the resin transfer, the associated column inlet line is closed. The standby column is then ready to be returned to service.

As previously noted, the 1.7 gpm intermittent stream of decontaminated aqueous condensate from the Ion-Exchange Unit (INX-101) is routed to one of the two Recyclable Water Storage Tanks (TNK-107 A&B). These 3,240-gallon tanks operate in parallel on staggered cycles, alternating between fill and delivery modes. At an average fill rate of 303 gallons per plant operating day, a single tank is completely filled in eight or nine operating days. At that point, the condensate feed stream must be diverted to the second tank. The liquid in a filled tank is immediately sampled and analyzed to confirm its acceptability for reuse. Unacceptable levels of contamination require that the tank contents be drained to the Floor Drain Collection Tank (TNK-109) and then be reprocessed. Acceptable test results permit the tank to be placed in the delivery mode. It then acts as an "on-demand" source of clean recycle water for miscellaneous uses within the plant.

With regard to the handling and treatment of chemical LLW, the 480-gallon Ph Adjustment Tank (TNK-108) receives one batch transfer from the Chemical Liquid LLW Collection Tank (TNK-101) and a second batch transfer of aqueous bottoms liquid from the Evaporator Package (EVP-101) each operating day. The volumes of these daily transfers are 278 gallons and 26 gallons respectively, for a total of 304 gallons. The liquid mixture in the filled Ph Adjustment Tank (TNK-108) is homogenized by agitation before its Ph is measured. In preparation for the downstream processing of this liquid into grout, its Ph is then adjusted to an acceptable value by a metered addition from either the Caustic Injection Skid (MIS-105) or the Acid Injection Skid (MIS-106), as appropriate.

The pH Adjustment Tank (TNK-108) is emptied each operating day by as many as 20, 16.4-gallon pumped batch transfers to the Chemical Waste Drum Filling Station (MIS-103). As with the Spent Resin Drum Filling Station described above, the Chemical Waste Drum Filling Station (MIS-103) is expected to be a packaged unit consisting of an airtight chamber with an access door and internal components. It is currently anticipated that empty, open-topped 55-gallon drums will first be introduced to the Filling Station through the access door where a hydraulic system positions a specially-designed lid over the top of the drum. This lid is fitted with a fill connection that is joined to the Treated Chemical Waste Transfer Pump (P-109 A&B) discharge line by a flexible hose, as well as a separate vent connection. During a batch transfer, the incoming chemical waste passes through a volumetric metering device that automatically stops the flow once the specified 16.4 gallons has been delivered to the drum. Air displaced from the drum exits through the top lid vent connection. This air may be filtered inside the Filling Station before being routed to the same system that handles process tank vents.

Following completion of the fill cycle, the hydraulic device inside the Filling Station retracts the specially-designed lid from the top of the drum. It is then necessary to secure a more conventional solid lid to the top of the drum. Depending on the automatic capabilities of the Filling Station, a plant operator fully suited in protective gear may be needed to secure the drum lid. Once the solid lid is firmly in place, the partially filled drum is removed from the Filling Station by a forklift and carried to the Cement Feeder Package (MIS-108). The metered addition of dry cement to these partially filled drums is performed by the combined operation of the Cement Storage Silo Package (MIS-107), the Rotary Feeder (FED-101) and the Cement Feeder Package (MIS-108). The vertical Cement Storage Silo Package is located outside, but immediately adjacent to, the WTB. It consists of a storage silo, a vent filter and an exhaust blower discharging to the atmosphere. The 740 ft^3 silo is refilled once every five operating days by pneumatic transfer from a delivery truck.

The Cement Feeder Package (MIS-108) consists of a feed hopper located outside the WTB, a screw feeder that penetrates the WTB wall, and a chamber where dry grout formers are added to partially filled chemical waste drums. The drums enter this chamber individually through an access door. Once inside, the solid drum lids must be removed. Dry grout formers are then transferred from the feed hopper to the open drum by the screw feeder. A load cell on the feed hopper automatically terminates this transfer upon delivery of the specified solid mass. Chamber vent gases are filtered before leaving the Cement Feeder Package (MIS-108) before entering the previously described vent system. The variable speed Rotary Feeder (FED-101) periodically refills the feed hopper from the storage silo by gravity flow.

Once a drum is filled, its solid lid is reinstalled to permit its removal from the chamber by a forklift. The current material balance calls for each filled drum to contain 143 pounds of chemical waste (originally in liquid form) plus 650 pounds of dry grout formers, for a total of 794 pounds. Based on this, and the total volume of chemical waste that must be processed, it is estimated that about 18 grout-filled drums will be produced every operating day. Assuming that Cement Feeder Package (MIS-108) operates for 6 hours per day, a filled drum must be produced once every 20 minutes.

The filled chemical waste drums are transferred by forklift to the two, parallel operated Cement Mixing Stations (MIX-104 A&B). Most of the operating equipment associated with each station is housed inside an airtight chamber. An incoming drum enters the chamber through an access door and is placed on a roller conveyor. Following removal of the drum lid, the access door is closed and the conveyor moves the drum horizontally to a support platform. A hydraulic device then raises the support platform. This operation causes variable speed, fixed-in-place mixing blades mounted above to be submerged in the drum contents. It also causes a dust hood to seal off the open top of the drum. The mixing blades are rotated for as long as necessary to form a homogeneous grout paste or slurry. Vent gases and entrained particulates from the drum are confined by the dust hood. This gas stream is filtered by the Cement Mixing Station (MIX-104 A&B) before being discharged to the previously described vent system for further treatment.

Following completion of the mixing step, the hydraulically-operated support platform lowers the filled drum. A drain pan must then be rotated into position to catch any grout slurry dripping from the mixing blades. At the end of each operating day, the mixing blades are washed with clean recycled water. All recaptured drips and wash liquids drain to the Floor Drain Collection Tank (TNK-109), where they are periodically recycled to the Chemical Liquid LLW Collection Tank (TNK-101), or possibly to the Recyclable Liquid LLW Collection Tank (TNK-102) for reprocessing. Each filled drum is moved along the roller conveyor to the chamber access door, where the solid drum lid is again fixed in place. This operation may require the assistance of a fully suited plant operator. Assuming that both Cement Mixing Stations (MIX-104 A&B) are in service for six hours out of each operating day, the time available to process each drum is estimated to be 40 minutes.

Following closure, the filled drums are moved by forklift to an interim storage area. After a specified curing period, the solidified grout is inspected and tested to verify its quality. Acceptable drums are finally packaged and moved to the disposal area.

Floor drains from both the solid and the liquid LLW processing areas, as well as drips and spent wash liquids from the two Cement Mixing Stations (MIX-104 A&B), flow by gravity to the Floor Drain Collection Tank (TNK-109). This 2,070-gallon tank is located inside an underground sump and is used for interim storage. Following sampling and analysis, the tank contents are periodically pumped out to either the Chemical Liquid LLW Collection Tank (TNK-101) or the Recyclable Liquid LLW Collection Tank (TNK-102), as appropriate. Any leaks from the Floor Drain Collection Tank (TNK-109) or its top-mounted transfer pumps are captured by the 5,940-gallon Sump (SMP-101). From this sump these leaks are transferred to the Chemical Liquid LLW Collection Tank (TNK-101).

As previously noted, a vent system is provided to decontaminate effluent gases from process equipment in the liquid LLW processing area. This vent system consists of a collection header feeding into two parallel, 100 percent capacity gas processing trains. Inside the operating train, the combined vent gases are first warmed by a Heater (HTR-101 A or B) to prevent the downstream condensation of water vapor. The gases then successively pass through a Roughing Filter (FLT-102 A or B) and at least one HEPA Filter (FLT-103 A or B) where entrained particulates are removed. The filtered gases are drawn by suction to the inlet of the Vent Blower (BLO-101 A or B) where they are discharged to the HVAC plenum.

4.1.4.2 Solid LLW Processing

Both compactible and noncompactible solid LLW is generated by the WTB and by other Repository surface facilities inside the RCA. This unsorted waste is first loaded into specially-designed shielded drums at their points of generation. Once the drums are filled, they are sealed closed and delivered by forklift to an area near the Waste Type Sorting Station (MIS-201). the Waste Type Sorting Station (MIS-201), located inside the WTB, is an airtight chamber equipped with multiple access doors and gloveports, an internal sorting table, a barrel lifter with movable crane, and a HEPA filter and exhaust blower. The Waste Type Sorting Station (MIS-201) performs the function of separating compactible material from noncompactible material, and then reloading these wastes into separate drums.

After receipt by the Waste Type Sorting Station (MIS-201), an incoming filled drum is first fitted near the top with an external, circumferential adapting collar. The Waste Type Sorting Station (MIS-201) exterior containment door is then opened to reveal a containment collar that will later mate up to the drum adapting collar. Meanwhile, the Sorting Station interior containment door remains closed to prevent the spread of contamination. The drum is next connected to the barrel lifter, which raises it vertically and swivels it into a horizontal position. This movement permits the drum adapting collar to be engaged to the aforementioned containment collar.

Working through the gloveports, operating personnel remove the interior containment door and the drum lid before unloading the drum contents. The gloveports and shielded viewing windows are then used to manually sort the solid waste, with compactible and noncompactible material being dropped through separate discharge ports in the floor of the Waste Type Sorting Station (MIS-201). A 55-gallon drum is securely mounted below each of these discharge ports to receive the waste. Once the drums are filled, they are sealed closed before being disengaged from the Waste Type Sorting Station (MIS-201). Similarly, the empty waste delivery drums are sealed closed and removed from the Waste Type Sorting Station (MIS-201) for reuse.

Confinement of contamination is aided by an exhaust blower that maintains a negative gauge pressure inside the Waste Type Sorting Station (MIS-201). The vent gases are filtered through a HEPA filter and are then discharged to the vent system serving the solid LLW process equipment.

Over-sized solid waste items, such as possibly discarded HEPA filter elements, are enclosed inside shielded, 100 ft^3 boxes and sent to the Mechanical Disassembly Station. The Mechanical Disassembly Station is a sealed room containing a press and a Cutter (CUT-201) and served by an exhaust blower and a HEPA filter. Working inside this room, an operator fully suited in protective gear opens the incoming boxes and removes the solid waste. The operator then uses a press and/or Cutter (CUT-201) to reduce the size of the waste items into pieces small enough to fit into 55-gallon drums. The operator also sorts these pieces by placing the compactible material and the noncompactible material into separate drums. At the end of this operation, the waste delivery box is sealed closed and made available for reuse. The filled waste drums are also sealed closed and removed from the Mechanical Disassembly Station.

Drums of compactible solid LLW from the Waste Type Sorting Station (MIS-201) and the Mechanical Disassembly Station are delivered by forklift to the Waste Size Sorting Station (MIS-203). At this station the feed drums are opened and the contents are divided into undersized and oversized streams before being loaded into separate product drums. This sorting and the subsequent shredding of oversized items improves the efficiency of downstream waste compaction. The Waste Size Sorting Station (MIS-203) is designed and operated in the same manner as the above-described Waste Type Sorting Station (MIS-201). The emptied waste feed drums can be recycled to an upstream point for reuse. Alternately, these drums can be used to receive the size-classified solid waste product streams discharged from the bottom of Waste Size Sorting Station (MIS-203).

A Drum Handler (DHR-201 A&B) and a forklift are used to remove and transport the filled product drums from the Waste Size Sorting Station (MIS-203).. The drums containing under-sized pieces of waste are sent directly to the In-Drum Compactor (MIS-205), while those drums filled with over-sized material are first processed through the Shredding Station (MIS-204). It is anticipated that the Shredding Station (MIS-204) will be a specially-designed, packaged unit. There, incoming drums are first loaded onto a drum lifter. Following removal of the drum lid, the drum lifter positions a funnel-shaped transition piece over the open top of the drum. The drum lifter then raises the drum, turns it upside down, and places the outlet of the drum transition piece over a compatible fitting on top of the shredder. The solid waste falls from the inverted drum at a controlled rate, enters the shredder, and is ripped into smaller pieces by cutting wheels attached to two, low-speed, counter-rotating shafts. The shredded material drops through a bottom discharge port and enters a 55-gallon product drum. Shredding Station (MIS-204) vent gases pass through a HEPA filter and an exhaust blower before being discharged for further cleanup downstream. Emptied feed drums can be recycled to an upstream point, or used to receive the shredded product material.

The drummed waste from the Shredding Station (MIS-204) joins the under-sized material from the Waste Size Sorting Station (MIS-203) en route to the In-Drum Compactor (MIS-205), which is housed within an airtight chamber. Inside this chamber, the drum lids are again removed and the drums are positioned in the In-Drum Compactor (MIS-205) frame. After closure of the chamber door, the In-Drum Compactor (MIS-205) lowers a hydraulically-operated steel ram into the top of the open drum, causing compaction of the solid waste to an average density of approximately 40 lbs/ft^3. The bottom of the drum is supported from below by a solid, contoured plate during this operation. The drum lid is replaced following retraction of the hydraulic ram. Post-compaction drums containing more than a specified void space are returned to the Shredding Station (MIS-204) or to the Waste Size Sorting Station (MIS-203) to receive additional waste. These drums undergo as many refill/compaction cycles as necessary to reduce the residual void space to an acceptable level. Once this objective has been achieved, the drums are again sealed closed before transfer to the Supercompactor (MIS-206). Vent gases from the In-Drum Compactor (MIS-205) pass through a HEPA filter and an exhaust blower upstream of the solid waste vent system.

The Supercompactor (MIS-206) receives sealed drums filled with compacted, solid waste from the In-Drum Compactor (MIS-205). The incoming drums enter an airtight chamber and are mounted in the cylindrical, Supercompactor (MIS-206) drum mold. During compaction, a hydraulically-operated metal ram exerts very high force on the top of the drum, while the surrounding mold maintains its outer diameter. This causes the drum and its contents to deform into a short disk, measuring about 24 inches in diameter and 9 inches height and weighing approximately 284 pounds. The density of this disk is estimated to be 127 lbs/ft^3. If this crushing operation causes the drum wall to breach, some of the contents may escape and contaminate the inside of the Supercompactor (MIS-206) . For this reason, recyclable water can be used to wash down the Supercompactor (MIS-206), as necessary. Spent wash water is then drained to the Floor Drain Collection Tank (TNK-109). Vent gases from the Supercompactor (MIS-206) pass through a HEPA filter and an exhaust blower upstream of the solid waste vent system.

The high-density solid waste disks are lifted from the Supercompactor (MIS-206). These disks are then divided into groups of three disks each prior to being loading into 85-gallon disposal drums. The current design anticipates that empty disposal drums will first receive about 3 inches of grout slurry poured from the Drum Lifter (DPR-202). Following solidification of the grout, the partially filled disposal drums are carried to the Supercompacter (MIS-206) and loaded with three disks, stacked on top of each other. Each drum is then sealed closed and moved by forklift back to an area accessible to the Drum Lifter (DPR-202)2. After removal of the drum lid, the

Drum Lifter (DPR-202) pours grout slurry into the drum to fill all of the remaining void space. The lid is then replaced and the filled disposal drum moved to the Curing/Inspection/Packaging/Certification and Interim Storage Room. An alternate approach would be to place a spacer in the bottom of each disposal drum prior to loading of the disks. A single grout pour would then be needed to completely fill all of the internal void space, including the space below the bottom disk. This technique would reduce drum handling and minimize fissures in the solidified grout encasement.

The preparation of fresh grout slurry is achieved by the combined operation of the Cement Storage Silo Package (MIS-207), the Rotary Feeder (FED-201), the Cement Feeder (MIS-208), and the Drum Mixing Station (MIX-201). The vertical Cement Storage Silo Package (MIS-207) is located outside, but immediately adjacent to, the WTB. This package consists of a storage silo, a vent filter and an exhaust blower discharging to the atmosphere. The 330 ft^3 silo is refilled once every five operating days by pneumatic transfer from a delivery truck. The Loss of Weight Feeder Package (MIS-208) consists of a feed hopper located outside the WTB and a screw feeder that penetrates the WTB wall and discharges into the Drum Mixing Station (MIX-201).

Empty 55-gallon grout preparation drums are loaded, as necessary, into the Drum Mixing Station (MIS-201). A measured volume of clean recycled water is then added to each drum. Dry cement is then transferred to each drum by the Cement Feeder (MIS-208). A load cell on the feed hopper automatically terminates this transfer upon delivery of the specified solid mass. The variable speed Rotary Feeder (FED-201) periodically refills the feed hopper from the storage silo.

The filled, open top drums are raised by a hydraulic device built into the Drum Mixing Station (MIX-201). Variable-speed, fixed-in-place mixing blades mounted above the station are submerged in the water and cement. A built-in hood also seals the top of the drum to prevent the spread of dust. After the mixing blades are rotated to produce a grout slurry having the desired consistency, the drum is lowered and removed from the Drum Mixing Station (MIX-201). The mixing blades can then be cleaned, as necessary, by a spray of recycle water. The resulting drain-off can be collected in another 55-gallon drum that will then be used to prepare the next batch of grout. These drips may alternately be drained to the Floor Drain Collection Tank (TNK-109).

A forklift is used to move slurry-filled drums from the Drum Mixing Station (MIX-201) to the Drum Lifter (DPR-202). The Drum Lifter then raises each drum and pours the grout to fill in the void space of a receiving, 85-gallon waste disposal drum. As described above, some of these disposal drums contain high-density disks of compacted waste from the Supercompactor (MIS-206). Other disposal drums contain the smaller, 55-gallon drums from the Waste Type Sorting Station (MIS-201) and the Mechanical Disassembly Station that are filled with solid, noncompactible LLW. Finally other disposal drums contain smaller drums of de-watered, spent ion-exchange resin. The upstream handling of these drums and resin is described below.

Shielded transport drums containing aqueous slurries of spent resin from either the Spent Resin Drum Filling Station (MIS-102) or from Repository surface facilities outside the WTB are carried by forklift to the Drum Lifter (DPR-202). Following removal of its lid, each drum is mounted in the Drum Lifter (DPR-202), causing a built-in pour spout to clamp over the open top of the drum. The Drum Lifter (DPR-202) then raises and tilts the drum such that the pour spout discharges to a compatible connection on the airtight chamber housing the Gravity Filtration System (MIS-202). As the resin slurry pours from the drum at a controlled rate, it first enters a horizontal filter feed trough. A continuous belt filter moves along the bottom of the trough, from side to side. The liquid phase drains by gravity through the belt filter and is accumulated in a bottom reservoir, where this contaminated water is periodically returned to the Recyclable Liquid LLW Collection Tank (TNK-102) by the externally-mounted Filtrate Transfer Pump (P-201 A&B). Meanwhile, the resin particles form a bed on top of the moving belt filter. Additional dewatering occurs as the belt rises out of the feed pool along a gradual incline. As the dewatered resin is released from the belt filter, it can fall either into a hopper or directly into a waiting 55-gallon drum. Once the drum is filled, this drum is sealed closed and moved by forklift to a suitable point for loading into an 85-gallon waste disposal drum. At the same time, the emptied shielded transport drums may be returned to their points of origin for reuse. Vent gases from the gravity filtration system pass through a HEPA filter and an exhaust filter before being discharged to the solid waste vent system.

Filled waste disposal drums, containing solid LLW encased in freshly poured grout, are moved by forklift from the Drum Lifter (DPR-202) pouring area to the Curing/Inspection/Packaging/Certification and Interim Storage Room. The yearly production of these drums, broken down by waste type, is estimated to be as follows:

Waste Type	Drums/year
Noncompactible, solid LLW	1,528
Compacted disks of solid LLW	381
Spent ion-exchange resin	96
Total	2,005

The waste disposal drums remain in interim storage for about three days while the grout hardens and cures. If necessary, quality tests can then be performed on the solidified grout. The drums are then labelled and their lids are permanently secured in place. The sealed waste disposal drums are finally moved to the disposal area.

A vent system is provided to decontaminate effluent gases from process equipment in the solid LLW processing area. This vent system consists of a collection header feeding into two parallel, 100 percent capacity gas processing trains. Inside the operating train, the combined vent gases are first warmed by a Heater (HTR-201 A or B) to prevent the downstream condensation of water vapor. The gases then successively pass through a Roughing Filter (FLT-202 A or B) and at least one HEPA Filter (FLT-203 A or B) where entrained particulates are removed. The filtered gases are drawn by suction to the inlet of the Vent Blower (BLO-202 A or B) where they are discharged to the HVAC plenum.

4.1.5 Equipment Requirements

Table 5 lists the equipment items associated with the solid and liquid LLW treatment systems and also provides the following information:

A. Equipment Tag/ CSI Number
B. Equipment Description
C. Equipment Capacity
D. Remarks
E. Flow Diagram Sheet Number

Equipment tag numbers shown in the equipment list are keyed to Flow Diagrams, WTP-SK-001 through 019, contained in Appendix H.

Pumps in radioactive service are provided with installed, 100 percent capacity spares. Whenever possible, failed equipment will be decontaminated, repaired, and returned to service. Items that cannot be repaired must be disassembled inside the WTB before disposal as solid LLW.

Table 5. LLW Processing Annotated Equipment/ CSI Specification List

Tag No.	Equipment Description	Capacity	FD Sheet No.	CSI Spec. No.	Remarks
LIQUID LLW PROCESSING EQUIPMENT					
Pumps					
P-101 A&B	Chemical waste feed pumps	20 gpm	01	15160	Mounted on TNK-101 submerged
P-102 A&B	Recyclable waste feed pumps	20 gpm	01	15160	Mounted on TNK-102 submerged
P-103 A&B	Evaporator feed pumps	10 gpm	02	15160	Mounted on TNK-103 submerged
P-104 A&B	Ion-exchange unit feed pumps	10 gpm	03	15160	Mounted on TNK-104 submerged
P-105 A&B	Resin transfer pumps	20 gpm	04	15160	Double diaphragm
P-106 A&B	Spent resin transfer pumps	20 gpm	04	15160	Double diaphragm

Table 4 LLW Processing Annotated Equipment/CSI Specification List (Continued)

Tag No.	Equipment Description	Capacity	FD Sheet No.	CSI Spec. No.	Remarks
P-107 A&B	Recycle water supply pumps	100 gpm	05	15160	Centrifugal
P-108 A&B	Recycle water supply pumps	100 gpm	05	15160	Centrifugal
P-109 A&B	Treated chemical waste transfer pumps	10 gpm	06	15160	Mounted on TNK-108 submerged
P-110 A&B	Floor drain transfer pumps	10 gpm	10	15160	Mounted on TNK-109 submerged
P-111	Sump pump	10 gpm	10	15160	Double diaphragm
Tanks/ Vessels					
TNK-101	Chemical liquid LLW collection tank	10,100 gallons	01	13205	30 days storage
TNK-102	Recyclable liquid LLW collection tank	10,100 gallons	01	13205	30 days storage
TNK-103	Evaporator feed tank	480 gallons	02	13205	1 Batch
TNK-104	Condensate collection tank	480 gallons	03	13205	1 Batch
TNK-105	Resin feed tank	310 gallons	04	13205	1 Batch
TNK-106	Spent resin catch tank	310 gallons	04	13205	1 Batch
TNK-107A&B	Recyclable water storage tanks	3,240 gallons	05	13205	8-9 days storage per tank
TNK-108	Ph adjustment tank	480 gallons	06	13205	Same as TNK-103
TNK-109	Floor drain collection tank	2,070 gallons	10	13205	

Table 4 LLW Processing Annotated Equipment/CSI Specification List (Continued)

Tag No.	Equipment Description	Capacity	FD Sheet No.	CSI Spec. No.	Remarks
Heaters					
HTR-101A&B	Heaters	68,260 BTU/hr	11	16881[1]	
Exchangers					
CND-101	Condenser	1.085 MM BTU/hr	03	15755	
Miscellaneous Process Equipment					
BLO-101A&B	Vent blowers	1,500 cfm	11	15860	
EVP-101	Evaporator Package	1.142 MM BTU/hr	03	15756[1]	
FED-101	Rotary feeder	2.35 cfm	08	14570	Located in Bottom of MIS-107
FLT-101A&B	Cartridge filters	5.3 gpm	02	11361[1]	
FLT-102A&B	Roughing filters	1,500 cfm	11	15885	Enclosed in a common housing
FLT-103A&B	HEPA filters				
INX-101	Ion exchange columns	3.5 gpm	04	11250	
MIS-102	Spent resin drum filling station		04	13095[1]	
MIS-103	Chemical waste drum filling station		07	13095[1]	
MIS-104A&B	Cement mixing station		09	11220	
MIS-105	Caustic injection skid	2 gpm	06	11240	

Table 4 LLW Processing Annotated Equipment/CSI Specification List (Continued)

Tag No.	Equipment Description	Capacity	FD Sheet No.	CSI Spec. No.	Remarks
MIS-106	Acid injection skid	2 gpm	06	11240	
MIS-107	Cement storage silo package	740 ft^3	08	11173	
MIS-108	Cement feeder package	1.38 cfm	08	14570	
MIX-101	TNK-101 mixer	50 HP	01	11220	
MIX-102	TNK-102 mixer	50 HP	01	11220	
MIX-103	TNK-105 mixer	5 HP	04	11220	
MIX-104	TNK-106 mixer	5 HP	04	11220	
MIX-105	TNK-108 mixer	3 HP	06	11220	
MIX-106	TNK-109 mixer	10 HP	10	11220	
Miscellaneous Equipment					
FKL-101	Forklift (battery-operated)		08	14511(1)	
SMP-101	TNK-109 containment sump	5,940 gallons	10	13216(1)	
SOLID LLW PROCESSING EQUIPMENT					
Pumps					
P-201 A&B	Filtrate transfer pumps	10 gpm	13	15160	Mounted on FLT-202 submerged
Heaters					

Table 4 LLW Processing Annotated Equipment/CSI Specification List (Continued)

Tag No.	Equipment Description	Capacity	FD Sheet No.	CSI Spec. No.	Remarks
HTR-201A&B	Heaters	68,260 BTU/hr	19	16881[1]	
Miscellaneous Process Equipment					
BLO-201	Blower	500 cfm	12	15860	
BLO-202A&B	Vent blowers	2,000 cfm	19	15860	
DPR-201	Drum lifter		13	14610	-
DPR-202	Drum lifter		17	14610	-
FED-201	Rotary feeder	0.7 cfm	16	14570	
FLT-201	HEPA filter	500 cfm	12	15885	
FLT-202A&B	Roughing filters	2,000 cfm	19	15885	Enclosed in a common housing
FLT-203A&B	HEPA filters				
MIS-201	Waste Type Sorting Station	9 drums/hr	12	11181[1]	
MIS-202	Dewatering station		13	11362[1]	
MIS-203	Waste size sorting station	6 drums/hr	14	11181[1]	
MIS-204	Size reduction station		14	11182[1]	
MIS-205	In-drum compactor	88 psi	15	11172	
MIS-206	Supercompact-or	10,000 psi	15	11172	

Table 4 LLW Processing Annotated Equipment/CSI Specification List (Continued)

Tag No.	Equipment Description	Capacity	FD Sheet No.	CSI Spec. No.	Remarks
MIS-207	Cement storage silo package	330 ft^3	16	11173	
MIS-208	Cement feeder	0.44 cfm	16	14570	
MIX-201	Drum mixing station	15 HP	17	11220	
Miscellaneous Equipment					
CRN-201	Small portable crane		14	14680	
CUT-201	Cutter		12	14590(1)	Inside a cell
DHR-201A&B	Drum handler		14	14512(1)	Portable, to move 55- gal/ 85-gal drums
FLK-201	Forklift (battery-operated)		12	14511(1)	

Note: (1) A CSI specification number does not exist for this item; therefore, the number shown has been assigned.

4.1.6 Utility Requirements

The WTB and the operations performed in this building will require the support of the following utility systems. Equipment items used to provide these utilities are located outside the WTB.

A. Cooling water
B. Electricity
C. Compressed (instrument) air
D. Breathing air
E. Fire water
F. Sanitary water
G. Chilled water (HVAC system only)

The estimated normal operating demands for cooling water, chilled water and electric power are listed in Table 6.

Table 6. Utility Requirements

Description	Process	HVAC	Total
Cooling Water, gpm	350[1]	-	350
Chilled Water, BTU/hr	-	2,187,000	2,187,000
Electricity, Kw	844	1,253	2,097

Note:
(1) This consumption includes a 20 percent safety factor to account for peak process demand.

4.1.7 Operating Requirements

The following operating requirements are miscellaneous consumable items and chemicals needed to support normal WTB operations:

A. Empty 55-gallon drums
B. Empty 85-gallon drums
C. Cement
D. Ion-Exchange Resin
E. Acid
F. Caustic

As shown on WTP-SK, sheets 1-19, empty 55-gallon drums are used to contain dewatered, spent ion-exchange resin and noncompactible solid LLW. These drums also receive compactible solid LLW before they are pressed into disks by the Supercompactor (MIS-206). All 55-gallon drums and reduced-size disks are overpacked into 85-gallon drums. The void space inside these larger drums is then filled with a grout made from clean recycle water and cement. Cement is also used as a solidification agent for liquid LLW. Ion-exchange resin is used to remove trace quantities of dissolved radionuclides from overhead condensates generated by the evaporation of recyclable liquid LLW. Finally, acid and caustic are used, as necessary, to adjust the Ph of chemical liquid LLW upstream of grout formation.

The total estimated operating requirements are listed in Table 7.

Table 7. Operating Requirements

Description	Quantity/ year
55-gallon drums	7,134 drums/year
85-gallon drums	2,005 drums/year
Cement	3,668,000 lbs/year
Ion Exchange Resin	400 ft^3/year
Acid	18 gallons/year (100% H_2SO_4)
Caustic	41 gallons/year (25 wt% NaOH)

4.2 HAZARDOUS AND LOW-LEVEL MIXED WASTE PROCESSING

4.2.1 General

In addition to LLW, secondary waste (in the form of HW and LLMW) is also generated by normal nuclear waste handling and disposal operations at the Repository. These site-generated wastes are collected and handled at the source of generation in the RCA and BOP areas of the Repository. Since the handling of nuclear wastes is restricted to the RCA, only the RCA has the theoretical potential to produce LLMW. However, HW is generated in both the RCA and the BOP area of the Repository. HW from the RCA is handled separately from HW generated by the BOP area of the Repository. Segregation of the HW is practiced to minimize the potential for generation of LLMW from cross-contamination of BOP HW with radionuclides. Following collection and handling in 55-gallon drums, HW is shipped to a staging shed, one each in the RCA and BOP areas of the Repository, prior to shipment for final treatment and disposal at an , commercial, RCRA-licensed facility. LLMW is collected at the points of generation in the RCA and placed into drums. These drums are then sent to the WTB for interim staging prior to shipment for final treatment and disposal. Resolution of regulatory requirements governing LLMW management will be needed to define the on-site processing requirements for this material.

4.2.2 Waste Volume

4.2.2.1 Hazardous Waste

WTP-SK-050 provides a schematic overview of the generation of liquid and solid HW in the RCA and BOP areas of the Repository. The facilities in the RCA that generate HW have been identified to be the WHB, PCB, CMF, WTB, and WOG. From the BOP area, the Motor Pool and Medical Center generate HW. Any HW generated from sub-surface operations will be delivered to and processed in the BOP area to prevent the accidental generation of LLMW.

4.2.2.2 Liquid Hazardous Waste

Liquid HW generated in the RCA and BOP facilities is collected and packaged at the source of generation. The liquid HW may be categorized as waste oil, antifreeze coolant, spent solvents, and medical waste. Waste oil is comprised of hydrocarbon-based oils such as lubricating oil, shielding window oil, and hydraulic oil, etc. The source of waste oils is generally site vehicles and other transport equipment. Antifreeze coolant and spent solvents are generated from regular maintenance of site vehicles in the WOG and Motor Pool. Finally, medical waste is only generated only in the Medical Center in the BOP area of the Repository.

The methodology used to estimate the generation of HW by the identified sources was described in Section 2.3.2.

Table 8 presents the estimated yearly volumes of liquid HW from the RCA and the BOP, broken down by source facility (Ref. 6). Although, in general, Nevada does not classify waste oils as HW, these streams have been assumed to be HW for the purpose of this conceptual design. The total liquid volumes from these two areas correspond to 13 and 221 filled 55-gallon drums per year, respectively.

Table 8. Summary of Estimated Liquid Hazardous Waste Generation Rates

Area	Facility	Stream No.	Type of Waste	Gallons/yr
RCA	WHB	501	Waste Oil	486
	PCB	502	Waste Oil	6.2
	CMF	503	Waste Oil	1.6
	WTB	504	Waste Oil	13
	WOG	505	Waste Oil	8.7
	WOG	506	Antifreeze Coolant	4.8
	WOG	507	Spent Solvents	72
	Total Estimated RCA Liquid Hazardous Waste			600
BOP	Subsurface	508	Waste Oil	11,816
	Motor Pool	509	Waste Oil	34
	Motor Pool	510	Antifreeze Coolant	27
	Motor Pool	511	Spent Solvents	72
	Medical Center	512	Medical Waste	12
	Total Estimated BOP Liquid Hazardous Waste			12,000

4.2.2.3 Solid Hazardous Waste

WTP-SK-050 presents an overview of the RCA and BOP facilities that may generate solid HW. The specific RCA facilities include the WHB, WTB, PCB, WOG, and CMF, while the BOP facilities include the Motor Pool, Maintenance Shops, subsurface operations, and Medical Center.

The methodology used to estimate the generation of HW by the identified sources was discussed in Section 2.3.2.

Table 9 presents the estimated yearly volumes of solid HW from the RCA and the BOP, broken down by source facility (Ref. 6). The total solid volumes from these two areas are 27 and 510 filled 55-gallon drums per year, respectively.

Table 9. Summary of Estimated Solid Hazardous Waste Generation Rates

Area	Facility	Stream No.	ft^3/yr
RCA	WHB	601	154
	PCB	602	2
	CMF	603	0.5
	WTB	604	4
	WOG	605	27
Total RCA Solid Hazardous Waste			187
Total BOP Solid Hazardous Waste		606	3,743
Total Solid Hazardous Waste			3,930

4.2.2.4 Low-Level Mixed Waste

LLMW is defined as waste material that exhibits the characteristics of both HW and LLW. Currently, regulations relating to treatment of LLMW are unresolved. Due to the low volume of LLMW anticipated to be generated at the Repository, and the assumption that regulatory requirements will be resolved in the future, it is assumed that LLMW will be shipped for treatment and disposal. Packaging requirements for this material remain to be determined (TBD).

WTP-SK-060 presents an overview of the handling of liquid and solid LLMW that is generated in the RCA. The LLMW is collected at the source of generation, in shielded areas segregated from the handling of HW and LLW. Following collection, the LLMW is packaged, as received, in standard 55-gallon drums. The drums are then sealed closed and loaded onto site vehicles for transfer to the WTB for interim staging. The LLMW is then sent to a suitable facility for final treatment and disposal. Since the handling of radioactive material is restricted to facilities within the RCA, the possibility of LLMW being generated by BOP facilities is considered to be negligible.

4.2.2.5 Liquid Low-Level Mixed Waste

The methodology used to estimate the generation rate of liquid LLMW was described in Section 2.3.3.

The average yearly volume of this liquid, in the form of waste oil, is estimated to be 32 gallons or one (1) 55-gallon drum per year.

4.2.2.6 Solid Low-Level Mixed Waste

The methodology used to estimate the generation of solid LLMW was described in Section 2.3.3. The average yearly volume of this solid is estimated to be 11 ft^3 or two (2) 55-gallon drums per year.

4.2.3 Waste Handling

Hazardous and LLMW are collected and handled at the source of generation at the Repository. HW in the RCA is handled separately from BOP HW to minimize the potential generation of LLMW from contamination of HW generated or staged in the BOP facilities with radionuclides. Following collection and packaging of HW at the source within the RCA, the waste is temporarily stored in the RCA HW Staging Shed, for a limited period of time prior to shipment to a commercial, , RCRA licensed facility for final treatment and disposal. LLMW is collected at the points of generation in the RCA and placed into drums. These drums are then sent to the WTB for interim staging prior to shipment for final treatment and disposal. Further clarification of the regulatory requirements governing LLMW management will be needed to define the facility receiving this material.

4.2.3.1 Hazardous Waste Handling

The volume of liquid and solid HW generation are discussed in Sections 4.2.2.2 and 4.2.2.3 of this report. At these low generation rates, it is more economical to prepare HW for treatment and disposal at an , RCRA-licensed, commercial HW management facility. This practice minimizes the burden of having to license, operate, and manage a RCRA HW treatment facility at the Repository. The following sections discuss the movement of liquid and solid HW through the Repository RCA and BOP facilities.

4.2.3.2 Liquid Hazardous Waste

As shown on WTP-SK-050, liquid HW generated in the RCA and BOP facilities are first collected and loaded into 55-gallon drums at their points of generation. These liquids can be classified as oil-based, water-based, organic (i.e. spent solvents), and medical HW. The HW from the RCA and the BOP facilities are handled separately to avoid the potential exposure of waste from the unrestricted BOP area to radionuclide contamination.

Since a significant portion of the liquid HW is generated in the WOG and Maintenance Shops areas of the Repository , respectively, a dedicated materials storage area for empty drums will be provided at each of these locations. Empty drums are distributed, as needed, to the Repository facilities where HW is generated.

The drums containing the HW generated in the RCA are moved by vehicles to a covered staging shed located in the RCA, for interim storage. The shed is equipped with a perimeter dike and a spill containment system, and will be surrounded by a chain-link fence. A similar staging shed will be provided in the BOP area of the Repository to handle HW collected in that area and from subsurface. These sheds will store the filled drums for a limited time prior to shipment to a RCRA licensed , commercial HW management facility. This staging will not require a RCRA license.

4.2.3.3 Solid Hazardous Waste

Solid HW from the RCA and BOP facilities is handled at its source of generation in a manner similar to that of liquid HW. To prevent the cross contamination of HW generated or stored in the BOP area of the Repository with radionuclides, the solid HW in the BOP area is prepared and handled independently from the HW generated in the RCA area of the Repository.

Preparation and handling of solid HW will be performed at the source of generation. If necessary, a portable shearing unit may be used for reduction of oversized waste material prior to packaging. In addition, an absorbent material may be added to the bottom of the solid HW container to absorb any free liquid which might be present. Fresh absorbent material and clean storage containers may share storage space with the empty drums designated to contain liquid HW. Standard 55-gallon drums or other suitable containers meeting DOT specifications may be used to store and transport solid HW. Partially-filled waste containers will be sequestered in one of several accumulation areas located near the points of waste generation. Once the containers are filled with waste, each container will be sealed closed and transferred by site vehicle to the RCA or BOP staging shed, as appropriate. Storage of the HW will be limited such that a RCRA permit is not required. Following interim storage, HW is transported to an RCRA licensed treatment and disposal facility.

4.2.3.4 Low-Level Mixed Waste Handling

LLMW is not anticipated to be generated at the Repository as a result of normal operations. Liquid and solid LLMW is produced when HW is contaminated with radionuclides. The volume of solid and liquid LLMW which has been estimated, is based on the periodic occurrence of improbable postulated events, and are very small. LLMW generation is not anticipated in the BOP area, since this is an unrestricted support area, without any radioactive waste handling or processing operations. Pending resolution of NRC and EPA regulatory requirements concerning the disposition of LLMW, this material has been assumed to be packaged in an as-received condition for on-site interim staging, and then transported to an facility for final treatment and disposal.

4.2.3.5 Liquid Low-Level Mixed Waste

The liquid LLMW from the RCA area of the Repository are segregated into oil-based, water-based, or hydrocarbon-based streams. This LLMW is collected at the source of generation, in shielded areas isolated from areas handling HW and LLW. Following collection, the liquid LLMW are packaged, as received, in drums (i.e., 55-gallon capacity) suitable for handling and storage of LLMWs. The filled waste drums are then sealed closed and loaded onto site vehicles for transfer to the LLMW transfer point inside the WTB. From this location, the drums will be shipped to an appropriate facility for treatment and disposal.

4.2.3.6 Solid Low-Level Mixed Waste

Solid LLMW generated in the RCA is handled in the same manner as liquid LLMW. Solid materials that are contaminated with hazardous constituents and radioactive nuclides are collected at the source of generation. The solid LLMW will be allowed to accumulate in storage containers, such as 55-gallon drums. Once the drums are filled with LLMW, they are transported by site vehicles to the WTB, where a LLMW transfer point is provided to accumulate the drums. The LLMW is transferred to an off-site facility for final treatment and disposal.

4.3 BUILDING DESCRIPTION

4.3.1 Building Design

The WTB will house the equipment and support systems required for the processing and staging of LLW and LLMW. HW is processed at the source of generation, and a separate staging shed is provided in the RCA to collect this waste pending shipment. Details of the WTB are presented on Drawing WTA-SK-001 through 006, in Appendix I.

The WTB is located in the RCA adjacent to the WHB. The WTB is a two-story prefabricated metal building with a gable roof supporting a 33,024 ft^2 building footprint. Concrete shielding walls are provided around the inner perimeter of the building as well as in the waste movement and storage areas. The total enclosed work space, including the second-floor HVAC area, is 46,408 ft^2. The outer building dimensions are approximately 194 feet by 174 feet with a maximum eave height of 36 feet. This two-story structure will include area for solid and liquid LLW processing, LLMW staging and for administrative offices and support. HVAC system equipment is housed on the second floor above the general administrative side of the building. The WTB area consists of 8,928 ft^2 for solid LLW processing, 15,840 ft^2 for recyclable and chemical liquid LLW processing, 624 ft^2 for LLMW staging and 7,632 ft^2 for administrative offices, breakroom, men's and women's toilet/locker facilities, loading/unloading truck bay, and temporary/interim waste storage areas. The remaining support systems such as the cooling tower, , plant air, and chilled water systems are assumed to be located in a separate centralized utility building, serving all Repository surface facilities, including the WTB.

Each liquid and solid LLW processing area is sized to accommodate estimated functional space requirements. The liquid LLW processing area is further divided into two sections: a recyclable liquid LLW processing area and a chemical waste processing area. A common 4 meter wide forklift aisle separates these areas. Pipe racks and HVAC ducts as well as vent gas filtration equipment is located above the forklift aisle. The solid LLW processing area is adjacent to the recyclable liquid LLW processing area and separated from it by a partition wall. The administration and support area is separated from the LLW processing area by a corridor and airlocks. The administration and support areas include an administrative office, general office, health physics room, breakroom, men's and women's toilet/ locker facilities, quality assurance (QA) office, inventory control office, temporary storage area and the truck loading/unloading bay. HVAC equipment occupies space above the administration area and a portion of the LLW processing area on the second floor.

The recyclable liquid LLW processing area is 6,912 ft^2 which provides space for process tanks with a dike wall, as well as the other process equipment. The area also provides space for the system piping, pumps, pipeway, control panels, maintenance operations and operating personnel. A 6,912 ft^2 area is also provided to house equipment to process chemical waste, which is not suitable for recycle, and interim drum storage. An interim drum storage area is sized to accommodate empty and solidified chemical waste drums for curing, inspection and certification purposes. A forklift corridor of 2,016 ft^2 divides these two sections, and brings the total floor space occupied by these LL liquid waste processing functions to 15,840 ft^2.

Solid LLW is packaged into 55-gallon drums and 100 ft^3 boxes for on-site transfer at the source of generation and is transferred to the WTB using site vehicles. Solid LLW drums and boxes are unloaded using the truck bay. A 6,912 ft^2 area will provide space for the equipment needed for sorting, shredding, compacting and stabilizing the waste in cement grout. A forklift corridor of 2,016 ft^2 will also be provided for material movement. The packaged drums are sent for disposal using the same truck bay. An inventory control room will be provided adjacent to the truck bay.

The architectural design of the WTB is in accordance with state and local building codes as well as directives contained in the RDRD.

4.3.2 HVAC Systems

4.3.2.1 General Design Description

The ventilation system for the WTB provides proper environmental conditions for the equipment used in this facility as well as for the health, safety, and comfort of operating personnel. Details of the WTB HVAC system are presented on drawings WTH-SK-101, 102 and 103A through E in Appendix J.

The ventilation system is comprised of three separate, independent subsystems. The first is a HEPA filtered subsystem that mainly serves the waste treatment area. The second subsystem serves the shipping and receiving area. The third subsystem serves the offices and other miscellaneous rooms.

4.3.2.2 Design Criteria

The ventilation system is designed to comply with the requirements of General Design Criteria (DOE Order 6430.1A) and program documents, orders, and directives contained in the (RDRD). The following material provides additional design criteria for the WTB ventilation system:

Confinement

The ventilation system is designed to confine radioactive and hazardous materials within the waste treatment area as close to the point of origin as practicable and also prevents uncontrolled releases to rooms and areas normally occupied by personnel. The WTB ventilation confinement zones are:

Primary Confinement Zone:

Process enclosures (tanks, drums, and other miscellaneous process items), process off-gas vent system shown on drawings WTP-SK-011 and WTP-SK-019 (Appendix H), and the associated final exhaust HEPA filters.

Secondary Confinement Zone:

Enclosures/Rooms that contain potentially contaminated items of process equipment or rooms supporting primary confinement functions. Examples of areas that are classified as secondary confinement zones include the chemical liquid LLW area, recyclable liquid LLW area, solid LLW area, LLMW interim storage, forklift battery charger, temporary storage, and associated HEPA-filtered final exhaust air system.

The other areas of the facility are normally clean and provisions are made to prevent these areas from becoming more negative than any adjacent potentially contaminated area.

The adequacy of the confinement system to effectively perform its required function shall be confirmed later by safety analysis.

Ambient Design Conditions

The ambient temperature used is that of the DOE Nevada Test Site. The application of the weather data is in accordance with the requirements specified in DOE Order 6430.1A, Section 1550-1.3 unless otherwise indicated by the program.

Indoor Design Conditions

Offices and Change Rooms	72 °FDB/72 °FDB (Summer/Winter)
Normally occupied process areas	72 °FDB/72 °FDB (Summer/Winter)
Normally unoccupied areas	85 °FDB/60 °FDB (Summer/Winter)
Winter humidification	Not provided

HVAC equipment is selected for operation at an elevation of 5000 feet above sea level and sized for an entering air temperature of -20 °FDB to protect against freezing.

4.3.2.3 System Description

The WTB HVAC system consists of the following three separate and independent subsystems:

Waste Treatment Areas HVAC Subsystem

The Waste Treatment Areas HVAC Subsystem is a separate, independent ventilation subsystem designed to: operate continuously; maintain proper environmental conditions for the health, safety, and comfort of personnel; maintain design conditions for the equipment; and provide contamination confinement.

The waste treatment process vents are discharged to the outside environment by a dedicated HEPA unit with two testable stages of HEPA filters and through the stack by the secondary confinement final exhaust fans. The confinement negative pressure in the process vent system is maintained by the process vent blowers. Corrosive vapors, noxious gases or vapors, and flammable (or combustible) gases are not anticipated from these vents.

The waste treatment area ventilation subsystem is a once-through concept consisting of supply air handling units for room ventilation and filtered exhaust with two testable stages of HEPA filtration, exhaust fans, and a stack. The subsystem is not safety class-qualified. The nonsafety classification shall be confirmed by safety analysis.

The waste treatment area is classified as a secondary confinement ventilation zone and maintained at a negative pressure of -0.15" wg with respect to the outside atmosphere. The WTB processing areas will be equipped with Continuous Air Monitoring (CAM) systems.

The waste treatment area ventilation subsystem is provided with backup units to meet redundancy requirements for maintenance only. This subsystem does not have emergency power. Process vents will be evaluated during a later design phase to determine safety classification, and confirmed by safety analysis.

Receiving and Shipping Room HVAC Subsystem

The Receiving and Shipping Room HVAC Subsystem is designed to operate continuously, maintain space design conditions, and ensure proper indoor air quality.

The Receiving and Shipping Room HVAC Subsystem and associated/independent HVAC equipment room are not classified as confinement zones. No redundancy or emergency power is required.

The Receiving and Shipping Room HVAC Subsystem is of the recirculation type designed to operate normally with approximately 10 percent outside air. The subsystem is also capable of operating once-through as required for removing diesel fumes discharged by truck exhaust. This subsystem consists of a supply air handling unit and a recirculation/exhaust fan.

The truck door is provided with air curtains to prevent excessive inlet of dust or loss of treated air.

Offices and Other Miscellaneous Rooms HVAC Subsystem

The offices and miscellaneous rooms HVAC subsystem is similar to the Receiving and Shipping Room HVAC subsystem except that the change rooms are provided with a single stage of HEPA filtration and diesel fumes exhaust operating mode is not required.

4.3.2.4 HVAC Equipment Description

The major pieces of HVAC equipment are as follows:

The HVAC equipment for the waste treatment area subsystem is of nuclear-grade quality comprised of air handling units, fans, pumps, air distribution equipment, and control instrumentation. The exhaust is provided with two testable stages of HEPA filtration. Electric heaters provide the necessary preheating and reheating. The ductwork is of welded carbon steel constructed in accordance with Sheet Metal and Air-conditioning Contractors National Association (SMACNA) high-pressure standards.

The remaining two HVAC subsystems are of industrial-grade quality and are comprised of air handling units, fans, pumps, air distribution, and control instrumentation. The filters are 30 and 90 percent efficiency filters. Electric heaters provide the necessary preheating and/or reheating. The ductwork is of galvanized steel construction in accordance with SMACNA low-pressure standards.

4.3.2.5 HVAC Control System

The HVAC control system will be provided with the latest, state-of-the-art system to control, monitor, and provide sufficient data acquisition and retention for a documented history of the HVAC operations.

The HVAC control system will be designed such that a loss of control functions shall not degrade the confinement function of the ventilation system. All controls shall be designed to assume a safe position or mode in case of failure.

5. CONCLUSIONS AND RECOMMENDATIONS

This report has been developed to support the conceptual design of the WTB. Within the scope of this report, the WTB design is expected to meet NRC, DOE and other federal, state and requirements. The WTB processes liquid and solid LLW generated within this facility using proven technology that is currently being employed by nuclear and related facilities. The following design recommendations need to be considered as part of future WTB design efforts.

Repository Design Requirements Document (RDRD)

The RDRD needs to be expanded further to establish a more relevant basis for design of the WTB. Information currently contained in the RDRD is too general to adequately define WTB design requirements. Some of the specific design requirements which require resolution are:

A. Identification of the type, location and waste acceptance criteria for the LLW disposal facility.

B. Determination of operations required and timing for the Performance Confirmation function within the RCA. This criteria is required in order to determine potential impact on the WTB design.

C. Requirements for processing of non-RCRA recyclable waste, such as spent oils, for the Repository as a whole.

D. A radiological design basis is required for LLW generated within the Repository and processed in the WTB.

E. The utility system interfaces in the RDRD, Section 3.2.3.4 need to be developed further to be useful.

Recommendations and conclusions relative to LLW, HW and LLMW follow:

Low-Level Waste:

A. It is recommended that additional emphasis be placed on the conceptual design development of the secondary waste-producing areas, such as decontamination, waste collection and handling, etc., within the RCA.

B. A parallel effort to WTB design needs to be undertaken to identify the LLW disposal facility.

C. An effort should be undertaken to characterize the probable radiological characteristics of the secondary LLW generated within the RCA.

D. A liquid LLW processing configuration consisting of filtration/ evaporation/ ion-exchange/ recycle has been shown to present an economic advantage over other configurations investigated, based on LCC, and is recommended.

E. A solid LLW processing configuration consisting of compaction/ shredding/ supercompaction has been shown to have an economic advantage over competing systems, based on LCC, and is recommended.

F. The LCCAs performed as part of the WTB conceptual design effort documented in this report should be reconfirmed, in the future, in order to capture the Total System Life Cycle Cost (TSLCC) work performed in FY 1995.

Hazardous Waste:

Current estimates indicate that the volumes of solid and liquid HW generated by Repository operations will not be negligible. At 80 percent of the total HW volume, subsurface operations account for the greatest quantity of HW among the Repository facilities. Even though the HW generation from sub-surface operation has increased from previous estimates, based on commercial experience the total waste volume still appears to be too low to justify on-site treatment and disposal in a RCRA licensed facility. Also, based on DOE memorandum, (Ref. 20) it can be concluded that on-site disposal of RCRA hazardous waste material at the Repository is undesirable. Instead, management of the HW by a commercial HW treatment and disposal facility offers potential cost savings and flexibility, and is recommended.

Low-Level Mixed Waste

At this time, regulatory criteria for the treatment, storage, and disposal of LLMW have not been established. Pending resolution of these criteria and development of a National Compliance Plan to establish treatment capacity and technology for LLMW, it is recommended that LLMW be handled and staged in its as-received condition, in containers meeting DOT specifications. Any attempt to process or treat these wastes on-site at this time could lead present problems when regulatory requirements are resolved. In addition, it is recommended that, since LLMW is not anticipated to be produced as the result of normal operations at the Repository, any LLMW produced be processed and disposed of at an off-site facility.

6. INTERFACES

This section identifies interface requirements for the WTB. Related information is contained in Design Inputs, Section 2 of this report.

The interface requirements for Repository surface facilities, which include the WTB, are listed in the RDRD (Ref. 17). RDRD requirements are derived from higher level documents such as the MGDS Requirements Documents and applicable CFRs.

The RDRD interfaces applicable to the WTB are listed in Section 3.2.3.4 of the RDRD (Ref. 17). All of these requirements relate to utilities and are indicated as either TBV or to-be-determined (TBD). Since they are undefined at this time, they have not been incorporated into this conceptual design.

As discussed in Section 2 of this report, there are three other prime Interface areas, exclusive of the RDRD, which impact the WTB design.

The first primary interface information required for conceptual design of the WTB is data on the generation rate of secondary waste produced by the various buildings within the RCA of the Repository surface facilities. This data would normally be expected to be produced, by the Surface Facilities group as a result of design activities for these buildings. Due to the early stage of design development of RCA facilities, little, if any, data on secondary waste generation systems or rates was available to support this WTB conceptual design effort.

For this reason, the conceptual design presented in this report is based on conceptualized secondary waste producing mechanisms and rates, for buildings within the WTB. The estimated rates are based largely on a limited amount of input information regarding the physical size and delivery schedule of loaded transportation casks processed at the Repository. The waste delivery schedule, (Ref. 15) was provided by the Waste Acceptance Interface and has been designated as TBV. The second primary interface information, data on the physical size of transportation casks, is based on information taken from the report Multi-Purpose Canister System Evaluation (Ref. 10) and is of indeterminate quality.

The third primary interface is from the Repository Sub-Surface Design Interface and consists of data on the potential volume of HW liquid generated sub-surface and delivered aboveground (Ref. 16), and is of indeterminate quality

7. QUALITY ASSURANCE

7.1 QAP-2-0 CLASSIFICATION

This report has been prepared to support development of the Repository Advanced Conceptual Design (ACD). The WTB is on the "Q" list, and, therefore, the QA program applies to this technical document.

7.2 COMPUTER PROGRAMS

No software requiring verification or validation has been used in the preparation of this conceptual design.

8. REFERENCES

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31. Title 40 CFR Part 265, *Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*

APPENDIX A

ACRONYMS

ACRONYM LIST

ACD	Advanced Conceptual Design
AP	Alkaline Permanganate
BOP	Balance of Plant
CFR	Codes of Federal Regulations
CITROX	Citric Acid and Oxalic Acid
CMF	Cask Maintenance Facility
CRWMS	Civilian Radioactive Waste Management System
CSI	Construction Specification Institute
CSS	Carrier Staging Shed
D&D	Decommissioning and Demolition
DBA	Design Basis Accident
DOE	Department of Energy
DOT	Department of Transportation
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
FD	Flow Diagram
GPM	Gallons per Minute
HEPA	High-Efficiency Particulate Air
HLW	High-Level Waste
HVAC	Heating, Ventilating and Air Conditioning
HW	Hazardous Waste
KT	Kepner-Tregoe
LA	License Application
LAD	License Application Design
LCC	Life Cycle Cost
LCCA	Life Cycle Cost Analysis
LLMW	Low-Level Mixed Waste
LLRWPAA	Low-Level Radioactive Waste Policy Amendment Act
LLW	Low-Level Waste
MGDS	Mined Geologic Disposal System
NAAQS	National Ambient Air Quality Standards

NPDES	National Pollutant Discharge Elimination System
NESHAP	National Air Emission Standards for Hazardous Air Pollutants
NRC	Nuclear Regulatory Commission
NRS	Nevada Revised Statutes
NWPA	Nuclear Waste Policy Act
NWPAA	Nuclear Waste Policy Amendments Act
OCRWM	Office of Civilian Radioactive Waste Management
PCB	Performance Confirmation Building
PHA	Preliminary Hazard Analysis
PWRs	Pressurized Water Reactors
QA	Quality Assurance
QAP	Quality Administrative Procedure
QARD	Quality Assurance Requirements and Description
RCA	Radiologically Controlled Area
RCRA	Resource Conservation and Recovery Act
RDRD	Repository Design Requirements Document
SLB	Shallow Land Burial
SMACNA	Sheet Metal and Air-conditioning Contractors National Association
SNF	Spent Nuclear Fuel
SNM	Special Nuclear Material
TBD	To be determined
TBV	To be verified
TIMR	Testing/ Inspection/ Maintenance/ Repair
TRU	Transuranic
TSLCC	Total System Life Cycle Cost
WHB	Waste Handling Building
WOG	Waste Operations Garage
WTB	Waste Treatment Building
YMSCP	Yucca Mountain Site Characterization Project

APPENDIX B

DEFINITIONS

DEFINITIONS

ADVANCED CONCEPTUAL DESIGN: A level of design used to explore design alternatives and fix the design criteria resulting in a concept to be made final in later design:This design includes life cycle cost analysis, preliminary drawings, and construction schedules etc.

AIR LOCK: A system of doors arranged to allow movement of persons and/or vehicles through it without permitting appreciable airflow.

CARETAKER PERIOD: The period of repository operation that begins with the emplacement of the last waste package and extends through the performance confirmation of the waste packages.

CARRIER: A truck or railcar used by shippers for the transportation of highly radioactive materials from the point of origin to the nuclear waste repository.

CARTRIDGE FILTER: An on-line filter with a replaceable cartridge used to remove solid particles from a process fluid.

CASK: A cylindrical receptacle that houses highly radioactive materials in the form of fuel assemblies, canisters, or disposal containers during transportation or storage.

CASK MAINTENANCE FACILITY (CMF): The primary functions of this building are decontamination, inspection, maintenance and repair, and recertification of shipping casks.

CUTTER: A machine used to mechanically reduce the size of oversized, primarily metal, objects.

DECONTAMINATION: The removal of radioactive material deposited on the internal and external surfaces of equipment and materials by chemical or physical processes.

DEFENSE HIGH-LEVEL WASTE (HLW): High-level radioactive waste generated by activities related to the national defense program, including the manufacture of nuclear weapons and research and development on nuclear weapons at government laboratories.

DISPOSAL: The management of Repository generated waste in such a way that it presents no potential hazard to human health or to the environment.

EMPLACEMENT: The act of placing high-level waste disposal containers in underground storage positions.

FACILITIES: Buildings in which equipment is housed to perform primary and supporting Repository operations.

FUEL ASSEMBLY: A unit consisting of fuel rods held together by mechanical support.

GROUT: A mixture of cement, water and/or chemicals to solidify LLW.

HAZARDOUS WASTE: A solid waste that is either listed as a HW in Subpart D of 40 CFR part 261 or exhibits any of the characteristics for HW identified in Subpart C of 40 CFR part 261.

HEALTH PHYSICS: A science concerned with recognition, evaluation, and management of hazards from radiation exposure.

HIGH-EFFICIENCY PARTICULATE AIR (HEPA) FILTER: A filter capable of removing at least 99.97% of the particulate material as small as 0.3 micron in size from an air stream.

ION EXCHANGE: The exchange of undesirable ions in a liquid waste stream with replacement ions residing in a resin material. The resin usually has selective affinities for particular types of exchangeable ions.

LOW-LEVEL MIXED WASTE: Waste that satisfies the definition of both hazardous and low-level radioactive waste.

LOW-LEVEL RADIOACTIVE WASTE: Waste that satisfies the definition of radioactive waste subject to the Atomic Energy Act of 1954 and is not classified as spent fuel from commercial nuclear power plants, or defense high-level radioactive waste from weapons production.

MINED GEOLOGIC DISPOSAL SYSTEM (MGDS): A system requiring licensing by the Nuclear Regulatory Commission for the disposal of high-level radioactive waste in excavated geologic media.

NORMAL OPERATION: An operation expected to be performed most of the time on a routine basis.

NUCLEAR WASTE POLICY ACT (NWPA): A federal law enacted by congress in 1982 to provide for the development of repositories for the disposal of the nation's high-level nuclear waste, spent nuclear fuel, and defense high-level waste.

OVERPACK: Secondary external containment for packaged nuclear waste.

PACKAGED WASTE: The disposal container and its waste contents.

REPOSITORY: A system licensed by Nuclear Regulatory Commission designed for the disposal of high-level radioactive waste in excavated geologic media.

ROUGHING FILTER: A filter used to remove relatively large particulates from an air stream prior to entering a HEPA filter.

SHIELDING: A material placed between a source of radiation and personnel to protect against radiation exposure.

SHREDDER: A device which utilizes counter rotating shafts and cutting wheels to reduce large items to smaller pieces.

SOLIDIFICATION: A process of converting liquid radioactive waste to a dry, stable solid.

SPENT NUCLEAR FUEL (SNF): Fuel rods that have been removed from a nuclear reactor from commercial nuclear power plants following irradiation.

SUPERCOMPACTOR: A device that operates a press with hydraulic pressure ranging from 4,000 to 22,000 psi for volume reduction of solid waste materials.

TRANSPORTATION CASK: A cask designed for the movement of spent nuclear fuel and high-level radioactive waste to the Repository in compliance with federal nuclear materials transportation regulations.

WASTE HANDLING BUILDING (WHB): A building in which SNF and HLW are received and repackaged as required into disposal containers for emplacement. The building also conducts periodic performance confirmation of waste packages during the caretaking period of the repository.

WASTE TREATMENT BUILDING (WTB): A building in which site-generated secondary waste such as LLW, HW, and LLMW is prepared and/or processed prior to shipment for disposal.

APPENDIX C

LCCA OF CASE L-1

LCCA OF CASE L-1

Appendix C contains the Figure and Tables listed below. This data represents the results of the Life Cycle Cost Analyses for one of the LL Waste Treatment Options, Case L-1, Filtration/Evaporation/Ion Exchange Process.

Block Flow Diagram

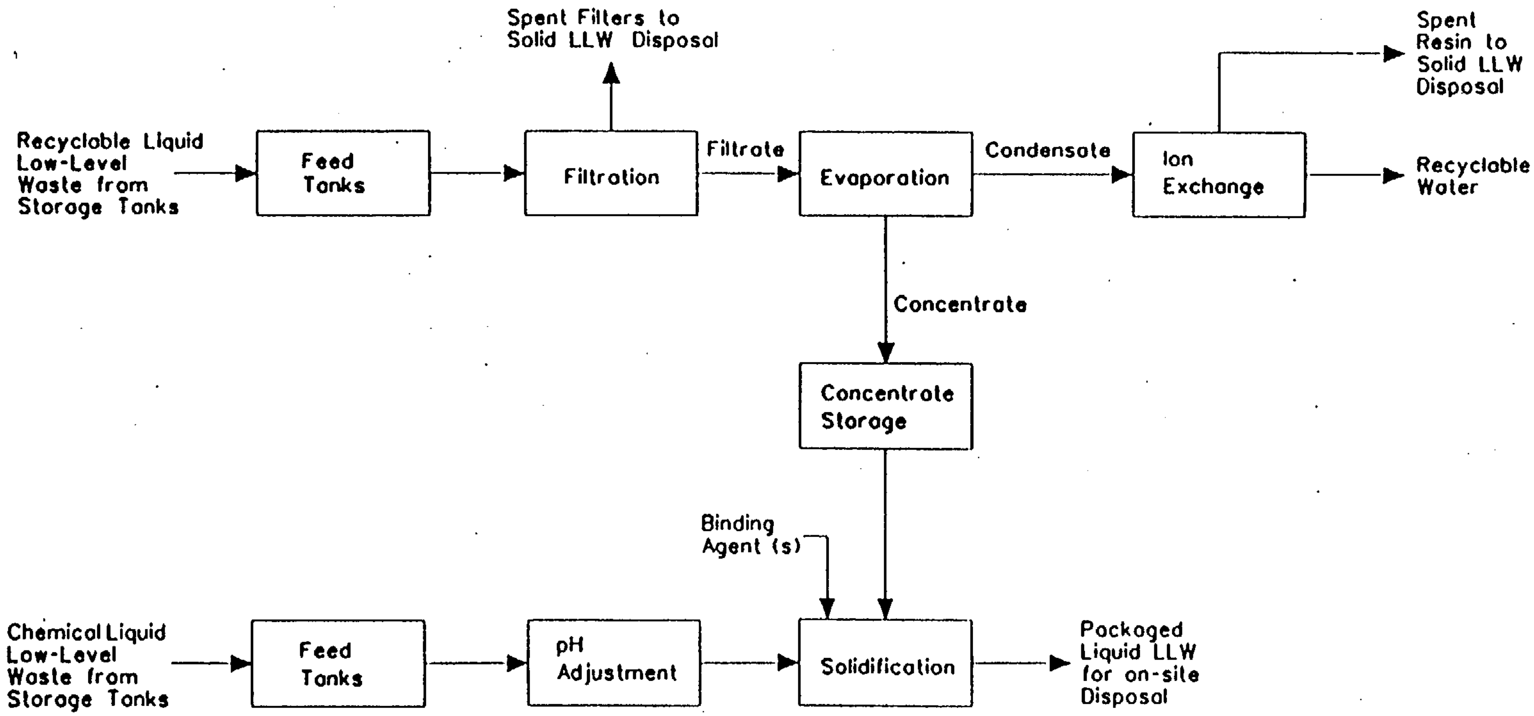
Cost Summary

LCCA Breakdown (1995-2007)
LCCA Breakdown (2008-2022)
LCCA Breakdown (2023-2038)
LCCA Breakdown (2039-2051)

Annual Operating Cost (1995-2008)
Annual Operating Cost (2008-2022)
Annual Operating Cost (2023-2038)
Annual Operating Cost (2039-2051)

Basis

Input Data



BLOCK FLOW DIAGRAM

CASE : L-1

LIQUID LOW-LEVEL WASTE FILTRATION / EVAPORATION / ION EXCHANGE PROCESS

FIGURE 6 - 1

BY : M. PATEL
CHK'D : QBN 8/1/95

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : L-1 (FILTRATION / EVAPORATION / ION EXCHANGE PROCESS)

SUMMARY

(COSTS IN MILLION $)

MODE OF MGDS OPERATION YEAR	ENG. & CONS. 1995 to 1999	START-UP 2000	EMPLACEMENT 2001 to 2024	CARETAKER 2025 to 2050	D & D 2051	TOTAL
COST COMPONENT						
Capital Cost	8.09					8.09
Operating Cost						
Labor	0.00	0.16	8.15	0.07		8.38
Operating Supplies	0.00	0.13	6.78	0.26		7.16
Disposal	0.00	0.39	20.47	0.77		21.63
Maintenance	0.00	0.02	0.91	0.40		1.33
Utilities	0.00	0.02	0.85	0.00		0.87
Total Operating Cost	0.00	0.71	37.17	1.50		39.38
Decon. & Decom.					0.23	0.23
WTB Life-Cycle Cost	**8.09**	**0.71**	**37.17**	**1.50**	**0.23**	**47.70**

Appendix C

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : L-1 (FILTRATION / EVAPORATION / ION EXCHANGE PROCESS)

LCCA BREAKDOWN (1995-2007)

(COSTS IN MILLION $)

	ENGINEERING & CONSTRUCTION					START-UP	EMPLACEMENT						
YEAR (BASE YR = 1995)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
COST COMPONENT													
Initial Capital Cost	1.74	1.68	1.62	1.56	1.50								
Operating Cost													
Labor	0.00	0.00	0.00	0.00	0.00	0.16	0.50	0.48	0.46	0.45	0.43	0.42	0.40
Operating Supplies	0.00	0.00	0.00	0.00	0.00	0.13	0.42	0.40	0.39	0.37	0.36	0.35	0.33
Disposal	0.00	0.00	0.00	0.00	0.00	0.39	1.25	1.21	1.17	1.12	1.08	1.05	1.01
Maintenance	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.05	0.05	0.05	0.05	0.05	0.05
Utilities	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.05	0.05	0.05	0.05	0.04	0.04
Total Operating Cost	0.00	0.00	0.00	0.00	0.00	0.71	2.28	2.19	2.12	2.04	1.97	1.90	1.83
Decon. & Decom.													
WTB Life-Cycle Cost	1.74	1.68	1.62	1.56	1.50	0.71	2.28	2.19	2.12	2.04	1.97	1.90	1.83

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LCCA BREAKDOWN (2008-2022)

YEAR (BASE YR = 1995)	EMPLACEMENT														
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
COST COMPONENT															
Initial Capital Cost															
Operating Cost															
Labor	0.39	0.37	0.36	0.35	0.34	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.24	0.23
Operating Supplies	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.24	0.23	0.22	0.22	0.21	0.20	0.19
Disposal	0.97	0.94	0.90	0.87	0.84	0.81	0.78	0.76	0.73	0.70	0.68	0.65	0.63	0.61	0.59
Maintenance	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Utilities	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
Total Operating Cost	1.77	1.70	1.64	1.58	1.53	1.47	1.42	1.37	1.32	1.28	1.23	1.19	1.14	1.10	1.06
Decon. & Decom.															
WTB Life-Cycle Cost	1.77	1.70	1.64	1.58	1.53	1.47	1.42	1.37	1.32	1.28	1.23	1.19	1.14	1.10	1.06

Appendix C

LCCA BREAKDOWN (2023-2038)

	EMPLACEMENT		CARETAKER													
YEAR (BASE YR = 1995)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
COST COMPONENT																
Initial Capital Cost																
Operating Costs																
Labor	0.23	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Operating Supplies	0.19	0.18	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Disposal	0.57	0.55	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Maintenance	0.09	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01
Utilities	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Operating Cost	1.03	0.99	0.09	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.05
Decon & Decomm																
WTB Life-Cycle Cost	1.03	0.99	0.09	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.05

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C-8

<u>LCCA BREAKDOWN (2039-2051)</u>

YEAR (BASE YR = 1995)	CARETAKER 2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	D & D 2051	TOTAL
COST COMPONENT														
Initial Capital Cost														[illegible]8.09
Operating Cost														[illegible]
Labor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		8.38
Operating Supplies	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		[illegible]
Disposal	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02		21.63
Maintenance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		1.33[illegible]
Utilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.87
Total Operating Cost	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04		[illegible]
Decon. & Decom.													0.23	[illegible]
WTB Life-Cycle Cost	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.23	47.70

Appendix C

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : L-1 (FILTRATION / EVAPORATION / ION EXCHANGE PROCESS)

ANNUAL OPERATING COST (1995-2008)

	ENGINEERING & CONSTRUCTION					STARTUP	EMPLACEMENT							
YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Labor, $						186,000	620,000	620,000	620,000	620,000	620,000	620,000	620,000	620,000
Operating Supplies														
Containers														
55-gal, $						97,200	324,000	324,000	324,000	324,000	324,000	324,000	324,000	324,000
Solidification														
Cement, $						57,456	191,520	191,520	191,520	191,520	191,520	191,520	191,520	191,520
Chemicals														
Acid, $						8	26	26	26	26	26	26	26	26
Caustic, $						25	83	83	83	83	83	83	83	83
Sub-total, $						164,688	515,628	515,628	515,628	515,628	515,628	515,628	515,628	515,628
Waste Disposal														
Low-Level, $						466,941	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471
Maintenance, $						20,856	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520
Utilities														
Electricity, $						11,034	36,780	36,780	36,780	36,780	36,780	36,780	36,780	36,780
Natural Gas, $						8,400	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000
Sub-total, $						19,434	64,780	64,780	64,780	64,780	64,780	64,780	64,780	64,780
Operating Supplies														
Containers														
55-gal.							4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320
Solidification														
Cement							3,192,000	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000
Chemicals														
Acid							0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Caustic							0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Waste Disposal														
Low-Level Waste drums							4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320
Utilities														
Electricity							660,000	660,000	660,000	660,000	660,000	660,000	660,000	660,000
Natural Gas							14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000

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ANNUAL OPERATING COST (2009-2024)

YEAR	EMPLACEMENT															
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Labor, $	620,000	620,000	620,000	620,000	620,000	620,000	620,000	620,000	620,000	620,000	620,000	620,000	620,000	620,000	620,000	620,000
Operating Supplies																
Containers																
55-gal, $	324,000	324,000	324,000	324,000	324,000	324,000	324,000	324,000	324,000	324,000	324,000	324,000	324,000	324,000	324,000	324,000
Solidification																
Cement, $	191,520	191,520	191,520	191,520	191,520	191,520	191,520	191,520	191,520	191,520	191,520	191,520	191,520	191,520	191,520	191,520
Chemicals																
Acid, $	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
Caustic, $	83	83	83	83	83	83	83	83	83	83	83	83	83	83	83	83
Sub-total, $	515,628	515,628	515,628	515,628	515,628	515,628	515,628	515,628	515,628	515,628	515,628	515,628	515,628	515,628	515,628	515,628
Waste Disposal																
Low-Level, $	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471	1,556,471
Maintenance, $	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520
Utilities																
Electricity, $	36,780	36,780	36,780	36,780	36,780	36,780	36,780	36,780	36,780	36,780	36,780	36,780	36,780	36,780	36,780	36,780
Natural Gas, $	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000
Sub-total, $	64,780	64,780	64,780	64,780	64,780	64,780	64,780	64,780	64,780	64,780	64,780	64,780	64,780	64,780	64,780	64,780
Operating Supplies																
Containers																
55-gal.	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320
Solidification																
Cement	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000	3,192,000
Chemicals																
Acid	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Caustic	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Waste Disposal																
Low-Level Waste drums	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320	4,320
Utilities																
Electricity	660,000	660,000	660,000	660,000	660,000	660,000	660,000	660,000	660,000	660,000	660,000	660,000	660,000	660,000	660,000	660,000
Natural Gas	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000

Appendix C

ANNUAL OPERATING COST (2025-2039)

YEAR	CARETAKER														
	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Labor, $	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Operating Supplies															
Containers															
55-gal, $	27,750	27,750	27,750	27,750	27,750	27,750	27,750	27,750	27,750	27,750	27,750	27,750	27,750	27,750	27,750
Solidification															
Cement, $	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224
Chemicals															
Acid, $	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caustic, $	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-total, $	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974
Waste Disposal															
Low-Level, $	133,309	133,309	133,309	133,309	133,309	133,309	133,309	133,309	133,309	133,309	133,309	133,309	133,309	133,309	133,309
Maintenance, $	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520
Utilities															
Electricity, $	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61
Natural Gas, $	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
Sub-total, $	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108
Operating Supplies															
Containers															
55-gal.	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370
Solidification															
Cement	270,400	270,400	270,400	270,400	270,400	270,400	270,400	270,400	270,400	270,400	270,400	270,400	270,400	270,400	270,400
Chemicals															
Acid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Caustic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste Disposal															
Low-Level Waste drums	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370
Utilities															
Electricity	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Natural Gas	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333

ANNUAL OPERATING COST (2040-2050)

YEAR	CARETAKER 2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Labor, $	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Operating Supplies											
Containers											
55-gal., $	27,750	27,750	27,750	27,750	27,750	27,750	27,750	27,750	27,750	27,750	27,750
Solidification											
Cement, $	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224	16,224
Chemicals											
Acid, $	0	0	0	0	0	0	0	0	0	0	0
Caustic, $	0	0	0	0	0	0	0	0	0	0	0
Sub-total, $	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974	43,974
Waste Disposal											
Low-Level, $	133,309	133,309	133,309	133,309	133,309	133,309	133,309	133,309	133,309	133,309	133,309
Maintenance, $	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520	69,520
Utilities											
Electricity, $	61	61	61	61	61	61	61	61	61	61	61
Natural Gas, $	47	47	47	47	47	47	47	47	47	47	47
Sub-total, $	108	108	108	108	108	108	108	108	108	108	108
Operating Supplies											
Containers											
55-gal.	370	370	370	370	370	370	370	370	370	370	370
Solidification											
Cement	270,400	270,400	270,400	270,400	270,400	270,400	270,400	270,400	270,400	270,400	270,400
Chemicals											
Acid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Caustic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste Disposal											
Low-Level Waste drums	370	370	370	370	370	370	370	370	370	370	370
Utilities											
Electricity	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Natural Gas	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333

LIFE-CYCLE COST ANALYSES OF LOW-LEVEL WASTE TREATMENT ALTERNATIVE

CASE : L-1 (FILTRATION / EVAPORATION / ION EXCHANGE PROCESS)

BASIS

1.	Startup cost, $	=	30%	of the annual operating cost.
2.	D & D Cost , $	=	20%	of Total Capital Cost.
3.	Real interest rate	=	7.00%	for the duration of 50-year life cycle.
4.	Average inflation rate	=	3.20%	for the duration of 50-year life cycle.
5.	Maintenance cost , $	=	40%	of the Total Capital Cost.
6.	55-gallon steel drum	=	$75	per drum.
7.	Cement dry mix cost	=	$0.06	per pound.
8.	Acid cost, $	=	$85	per ton.
9.	Caustic Cost, $	=	$165	per ton.
10.	LLW Disposal cost	=	$49	per ft^3
11.	Electricity cost, $	=	$0.056	per kw-hr
12.	Natural Gas cost, $	=	$0.002	per ft^3.
13.	Caretaker operations assumed to be 1 week / year.			

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : L-1 (FILTRATION / EVAPORATION / ION EXCHANGE PROCESS)

INPUT DATA

Description	Construction Period	Emplacement Period	Caretaker Period
Total Capital Costs, $ Mil. =	8.69		
55-gallon drum consumption, Drums/year =		4,320	370
Cement consumption, Pounds/year =		3,192,000	270,400
Acid consumption, tons/year =		0.3	
Caustic consumption, tons/year =		0.5	
Electricity consumption, KWH/year =		660,000	1,100
Natural Gas consumption , ft^3/year =		14,000,000	
Operating Labor, $/year =		$620,000	$12,000

APPENDIX D

LCCA OF CASE L-6

LCCA OF CASE L-6

Appendix D contains the Figure and Tables listed below. This data represents the results of the Life Cycle Cost Analyses for one of the LL Waste Treatment Options, Case L-6, Solidification Process.

Block Flow Diagram

Cost Summary

LCCA Breakdown (1995-2007)
LCCA Breakdown (2008-2022)
LCCA Breakdown (2023-2038)
LCCA Breakdown (2039-2051)

Annual Operating Cost (1995-2008)
Annual Operating Cost (2008-2022)
Annual Operating Cost (2023-2038)
Annual Operating Cost (2039-2051)

Basis

Input Data

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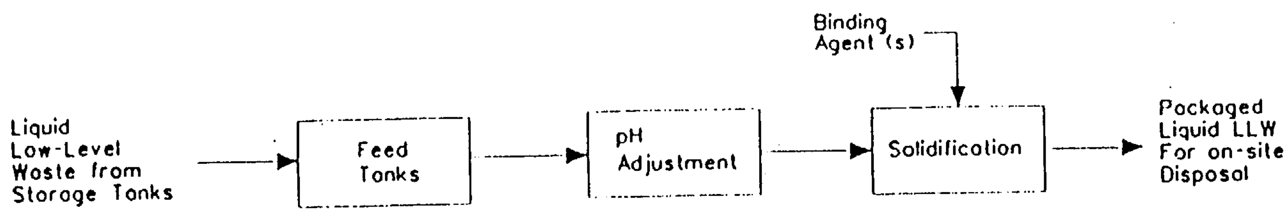
D-3



BLOCK FLOW DIAGRAM

CASE : L-6

LIQUID LOW-LEVEL WASTE SOLIDIFICATION

FIGURE 6 - 6

BY : M. PATEL
CHK'D : QBN 8/1/95

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : L-6 (SOLIDIFICATION PROCESS)

SUMMARY

(COSTS IN MILLION $)

MODE OF MGDS OPERATION YEAR	ENG. & CONS. 1995 to 1999	START-UP 2000	EMPLACEMENT 2001 to 2024	CARETAKER 2025 to 2050	D & D 2051	TOTAL
COST COMPONENT						
Capital Cost	6.11					6.11
Operating Cost						
Labor	0.00	0.06	3.21	0.03		3.30
Operating Supplies	0.00	0.27	14.37	0.58		15.22
Disposal	0.00	0.83	43.35	1.76		45.93
Maintenance	0.00	0.01	0.69	0.30		1.01
Utilities	0.00	0.01	0.51	0.00		0.52
Total Operating Cost	0.00	1.18	62.13	2.67		65.98
Decon. & Decom.					0.17	0.17
WTB Life-Cycle Cost	**6.11**	**1.18**	**62.13**	**2.67**	**0.17**	**72.27**

Appendix D

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : L-6 (SOLIDIFICATION PROCESS)

LCCA BREAKDOWN (1995-2007)

(COSTS IN MILLION $)

	ENGINEERING & CONSTRUCTION					START-UP	EMPLACEMENT						
YEAR (BASE YR = 1995)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
COST COMPONENT													
Initial Capital Cost	1.31	1.27	1.22	1.18	1.14								
Operating Cost													
Labor	0.00	0.00	0.00	0.00	0.00	0.06	0.20	0.19	0.18	0.18	0.17	0.16	0.16
Operating Supplies	0.00	0.00	0.00	0.00	0.00	0.27	0.88	0.85	0.82	0.79	0.76	0.73	0.71
Disposal	0.00	0.00	0.00	0.00	0.00	0.83	2.65	2.56	2.47	2.38	2.30	2.21	2.14
Maintenance	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.04	0.04	0.04	0.04	0.04	0.03
Utilities	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total Operating Cost	0.00	0.00	0.00	0.00	0.00	1.18	3.80	3.67	3.54	3.41	3.29	3.17	3.06
Decon & Decom													
WTB Life-Cycle Cost	1.31	1.27	1.22	1.18	1.14	1.18	3.80	3.67	3.54	3.41	3.29	3.17	3.06

LCCA BREAKDOWN (2008-2022)

	EMPLACEMENT														
YEAR (BASE YR = 1995)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
COST COMPONENT															
Initial Capital Cost															
Operating Cost															
Labor	0.15	0.15	0.14	0.14	0.13	0.13	0.12	0.12	0.11	0.11	0.11	0.10	0.10	0.10	0.09
Operating Supplies	0.68	0.66	0.64	0.61	0.59	0.57	0.55	0.53	0.51	0.49	0.46	0.46	0.44	0.43	0.41
Disposal	2.06	1.99	1.92	1.85	1.78	1.72	1.66	1.60	1.54	1.49	1.44	1.38	1.33	1.29	1.24
Maintenance	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Utilities	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01
Total Operating Cost	2.95	2.85	2.75	2.65	2.56	2.46	2.38	2.29	2.21	2.13	2.06	1.98	1.91	1.85	1.78
Decon. & Decom.															
WTB Life-Cycle Cost	2.95	2.85	2.75	2.65	2.56	2.46	2.38	2.29	2.21	2.13	2.06	1.98	1.91	1.85	1.78

LCCA BREAKDOWN (2023-2038)

	EMPLACEMENT		CARETAKER													
YEAR (BASE YR = 1995)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
COST COMPONENT																
Initial Capital Cost																
Operating Cost																
Labor	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Operating Supplies	0.40	0.38	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
Disposal	1.20	1.16	0.10	0.10	0.10	0.09	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.06
Maintenance	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Utilities	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Operating Cost	1.72	1.66	0.16	0.15	0.14	0.14	0.13	0.13	0.13	0.12	0.12	0.11	0.11	0.10	0.10	0.10
Decon & Decom.																
WTB Life-Cycle Cost	1.72	1.66	0.16	0.15	0.14	0.14	0.13	0.13	0.13	0.12	0.12	0.11	0.11	0.10	0.10	0.10

LCCA BREAKDOWN (2039-2051)

YEAR (BASE YR = 1995)	CARETAKER 2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	D & D 2051	TOTAL
COST COMPONENT														
Initial Capital Cost														6.11
Operating Cost														
Labor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		3.30
Operating Supplies	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01		15.22
Disposal	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04		45.93
Maintenance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		1.01
Utilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.52
Total Operating Cost	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.06		65.98
Decon. & Decom.													0.17	0.17
WTB Life-Cycle Cost	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.06	0.17	72.27

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : L-6 (SOLIDIFICATION PROCESS)

ANNUAL OPERATING COST (1995-2008)

YEAR	ENGINEERING & CONSTRUCTION 1995	1996	1997	1998	1999	STARTUP 2000	EMPLACEMENT 2001	2002	2003	2004	2005	2006	2007	2008
Labor, $						73,200	244,000	244,000	244,000	244,000	244,000	244,000	244,000	244,000
Operating Supplies														
Containers														
55-gal, $						205,875	686,250	686,250	686,250	686,250	686,250	686,250	686,250	686,250
Solidification														
Cement, $						121,842	406,140	406,140	406,140	406,140	406,140	406,140	406,140	406,140
Chemicals														
Acid, $						8	26	26	26	26	26	26	26	26
Caustic, $						25	83	83	83	83	83	83	83	83
Sub-total, $						327,749	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498
Waste Disposal														
Low-Level, $						989,007	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691
Maintenance, $						15,751	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504
Utilities														
Electricity, $						3,344	11,146	11,146	11,146	11,146	11,146	11,146	11,146	11,146
Natural Gas, $						8,400	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000
Sub-total, $						11,744	39,146	39,146	39,146	39,146	39,146	39,146	39,146	39,146
Operating Supplies														
Containers														
55-gal.							9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150
Solidification														
Cement							6,769,000	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000
Chemicals														
Acid							0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Caustic							0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Waste Disposal														
Low-Level Waste drums							9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150
Utilities														
Electricity							200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000
Natural Gas							14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000

Appendix D

ANNUAL OPERATING COST (2009-2024)

YEAR	EMPLACEMENT															
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Labor, $	244,000	244,000	244,000	244,000	244,000	244,000	244,000	244,000	244,000	244,000	244,000	244,000	244,000	244,000	244,000	244,000
Operating Supplies																
Containers																
55-gal, $	686,250	686,250	686,250	686,250	686,250	686,250	686,250	686,250	686,250	686,250	686,250	686,250	686,250	686,250	686,250	686,250
Solidification																
Cement, $	406,140	406,140	406,140	406,140	406,140	406,140	406,140	406,140	406,140	406,140	406,140	406,140	406,140	406,140	406,140	406,140
Chemicals																
Acid, $	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
Caustic, $	83	83	83	83	83	83	83	83	83	83	83	83	83	83	83	83
Sub-total, $	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498	1,092,498
Waste Disposal																
Low-Level, $	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691	3,296,691
Maintenance, $	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504
Utilities																
Electricity, $	11,146	11,146	11,146	11,146	11,146	11,146	11,146	11,146	11,146	11,146	11,146	11,146	11,146	11,146	11,146	11,146
Natural Gas, $	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000
Sub-total, $	39,146	39,146	39,146	39,146	39,146	39,146	39,146	39,146	39,146	39,146	39,146	39,146	39,146	39,146	39,146	39,146
Operating Supplies																
Containers																
55-gal.	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150
Solidification																
Cement	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000	6,769,000
Chemicals																
Acid	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Caustic	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Waste Disposal																
Low-Level Waste drums	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150	9,150
Utilities																
Electricity	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000
Natural Gas	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000

ANNUAL OPERATING COST (2025-2039)

YEAR	CARETAKER														
	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Labor, $	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Operating Supplies															
Containers															
55-gal., $	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000
Solidification															
Cement, $	37,380	37,380	37,380	37,380	37,380	37,380	37,380	37,380	37,380	37,380	37,380	37,380	37,380	37,380	37,380
Chemicals															
Acid, $	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caustic, $	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-total, $	100,380	100,380	100,380	100,380	100,380	100,380	100,380	100,380	100,380	100,380	100,380	100,380	100,380	100,380	100,380
Waste Disposal															
Low-Level, $	302,647	302,647	302,647	302,647	302,647	302,647	302,647	302,647	302,647	302,647	302,647	302,647	302,647	302,647	302,647
Maintenance, $	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504
Utilities															
Electricity, $	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Natural Gas, $	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
Sub-total, $	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Operating Supplies															
Containers															
55-gal.	840	840	840	840	840	840	840	840	840	840	840	840	840	840	840
Solidification															
Cement	623,000	623,000	623,000	623,000	623,000	623,000	623,000	623,000	623,000	623,000	623,000	623,000	623,000	623,000	623,000
Chemicals															
Acid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Caustic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste Disposal															
Low-Level Waste drums	840	840	840	840	840	840	840	840	840	840	840	840	840	840	840
Utilities															
Electricity	333	333	333	333	333	333	333	333	333	333	333	333	333	333	333
Natural Gas	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333

ANNUAL OPERATING COST (2040-2050)

YEAR	CARETAKER 2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Labor, $	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Operating Supplies											
Containers											
55-gal., $	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000
Solidification											
Cement, $	37,380	37,380	37,380	37,380	37,380	37,380	37,380	37,380	37,380	37,380	37,380
Chemicals											
Acid, $	0	0	0	0	0	0	0	0	0	0	0
Caustic, $	0	0	0	0	0	0	0	0	0	0	0
Sub-total, $	100,380	100,380	100,380	100,380	100,380	100,380	100,380	100,380	100,380	100,380	100,380
Waste Disposal											
Low-Level, $	302,647	302,647	302,647	302,647	302,647	302,647	302,647	302,647	302,647	302,647	302,647
Maintenance, $	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504	52,504
Utilities											
Electricity, $	19	19	19	19	19	19	19	19	19	19	19
Natural Gas, $	47	47	47	47	47	47	47	47	47	47	47
Sub-total, $	65	65	65	65	65	65	65	65	65	65	65
Operating Supplies											
Containers											
55-gal.	840	840	840	840	840	840	840	840	840	840	840
Solidification											
Cement	623,000	623,000	623,000	623,000	623,000	623,000	623,000	623,000	623,000	623,000	623,000
Chemicals											
Acid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Caustic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste Disposal											
Low-Level Waste drums	840	840	840	840	840	840	840	840	840	840	840
Utilities											
Electricity	333	333	333	333	333	333	333	333	333	333	333
Natural Gas	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333

LIFE-CYCLE COST ANALYSES OF LOW-LEVEL WASTE TREATMENT ALTERNATIVE

CASE : L-6 (SOLIDIFICATION PROCESS)

BASIS

1.	Startup cost, $	=	30%	of the annual operating cost.
2.	D & D Cost, $	=	20%	of Total Capital Cost.
3.	Real interest rate	=	7.00%	for the duration of 50-year life cycle.
4.	Average inflation rate	=	3.20%	for the duration of 50-year life cycle.
5.	Maintenance cost, $	=	40%	of the Total Capital Cost.
6.	55-gallon steel drum	=	$75	per drum.
7.	Cement dry mix cost	=	$0.06	per pound.
8.	Acid cost, $	=	$85	per ton.
9.	Caustic Cost, $	=	$165	per ton.
10.	LLW Disposal cost	=	$49	per ft^3
11.	Electricity cost, $	=	$0.056	per kw-hr
12.	Natural Gas cost, $	=	$0.002	per ft^3.

13. Caretaker operations assumed to be 1 week / year.

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : L-6 (SOLIDIFICATION PROCESS)

INPUT DATA

Description	Construction Period	Emplacement Period	Caretaker Period
Total Capital Costs, $ Mil. =	6.563		
55-gallon drum consumption, Drums/year =		9,150	840
Cement consumption, Pounds/year =		6,769,000	623,000
Acid consumption, tons/year =		0.3	
Caustic consumption, tons/year =		0.5	
Electricity consumption, KWH/year =		200,000	
Natural Gas consumption , ft^3/year =		14,000,000	
Operating Labor, $/year =		$244,000	$5,000

APPENDIX E

LCCA OF CASE S-1

LCCA OF CASE S-1

Appendix E contains the Figure and Tables listed below. This data represents the results of the Life Cycle Cost Analyses for one of the LL Waste Treatment Options, Case S-1, Shredding/Compaction/Supercompaction Process.

Block Flow Diagram

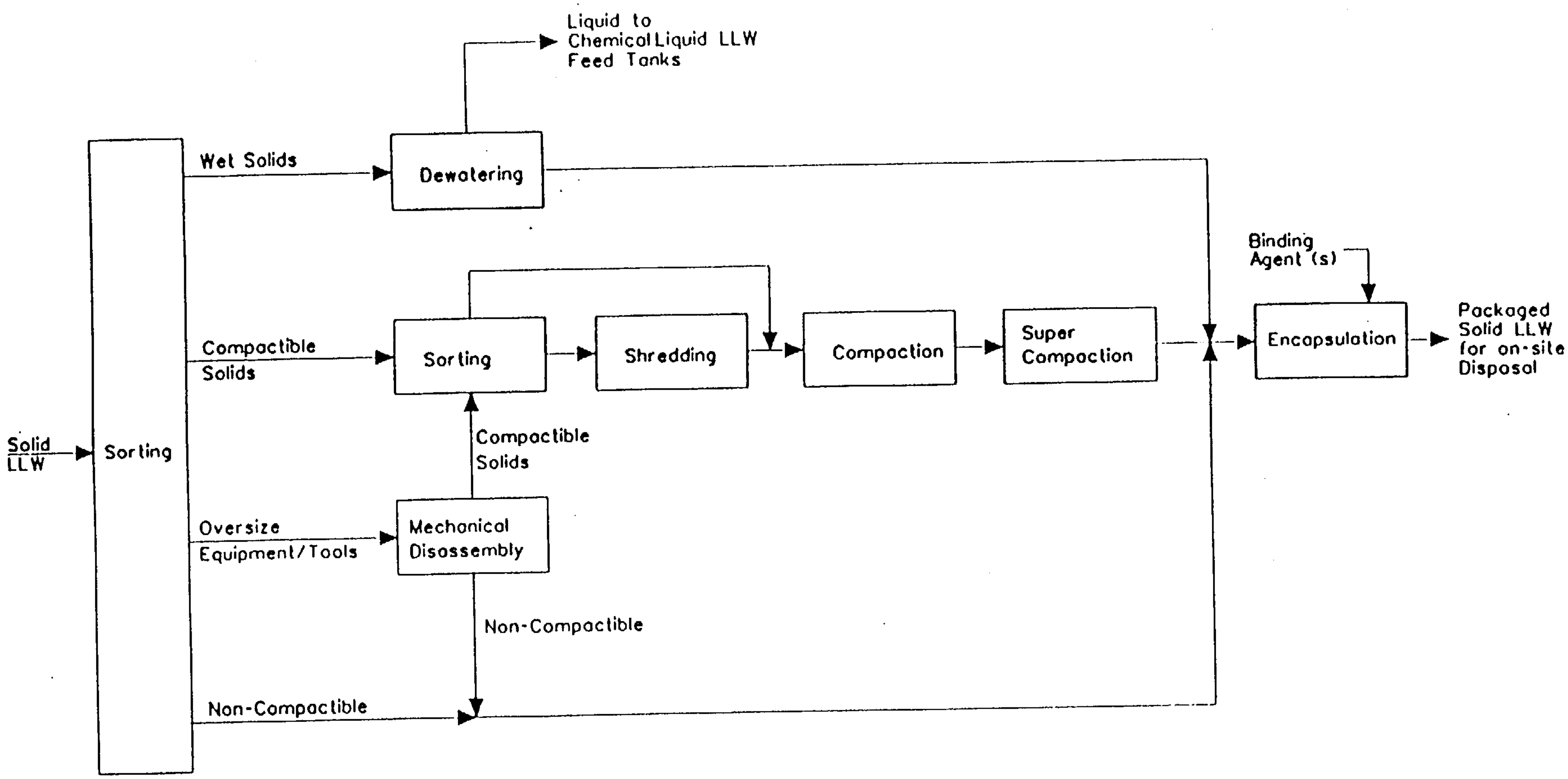
Cost Summary

LCCA Breakdown (1995-2007)
LCCA Breakdown (2008-2022)
LCCA Breakdown (2023-2038)
LCCA Breakdown (2039-2051)

Annual Operating Cost (1995-2008)
Annual Operating Cost (2008-2022)
Annual Operating Cost (2023-2038)
Annual Operating Cost (2039-2051)

Basis

Input Data



BLOCK FLOW DIAGRAM

CASE : S-1

SOLID LOW-LEVEL WASTE /
SHREDDING / COMPACTION /
SUPERCOMPACTION PROCESS

FIGURE 6 - 7

BY : M. PATEL
CHK'D : QBN 8/1/95

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : S-1 (SHREDDING/COMPACTION/SUPERCOMPACTION PROCESS)

SUMMARY

(COSTS IN MILLION $)

MODE OF MGDS OPERATION YEAR	ENG. & CONS. 1995 to 1999	START-UP 2000	EMPLACEMENT 2001 to 2024	CARETAKER 2025 to 2050	D & D 2051	TOTAL
COST COMPONENT						
Capital Cost	9.39					9.39
Operating Cost						
Labor	0.00	0.11	6.83	0.06		5.99
Operating Supplies	0.00	0.19	10.02	0.08		10.29
Disposal	0.00	0.33	17.21	0.15		17.68
Maintenance	0.00	0.02	1.06	0.47		1.55
Utilities	0.00	0.01	0.54	0.00		0.55
Total Operating Cost	0.00	0.66	34.65	0.75		36.06
Decon & Decom					0.27	0.27
WTB Life-Cycle Cost	**9.39**	**0.66**	**34.65**	**0.75**	**0.27**	**45.71**

Appendix E

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : S-1 (SHREDDING/COMPACTION/SUPERCOMPACTION PROCESS)

LCCA BREAKDOWN (1995-2007)

(COSTS IN MILLION $)

	ENGINEERING & CONSTRUCTION					START-UP	EMPLACEMENT						
YEAR (BASE YR = 1995)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
COST COMPONENT													
Initial Capital Cost	2.02	1.94	1.88	1.81	1.74								
Operating Cost													
Labor	0.00	0.00	0.00	0.00	0.00	0.11	0.36	0.34	0.33	0.32	0.31	0.30	0.29
Operating Supplies	0.00	0.00	0.00	0.00	0.00	0.19	0.61	0.59	0.57	0.55	0.53	0.51	0.49
Disposal	0.00	0.00	0.00	0.00	0.00	0.33	1.05	1.02	0.98	0.95	0.91	0.88	0.85
Maintenance	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.06	0.06	0.06	0.06	0.05	0.05
Utilities	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total Operating Cost	0.00	0.00	0.00	0.00	0.00	0.66	2.12	2.05	1.97	1.90	1.84	1.77	1.71
Decon. & Decom.													
WTB Life-Cycle Cost	2.02	1.94	1.88	1.81	1.74	0.66	2.12	2.05	1.97	1.90	1.84	1.77	1.71

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E-6

Appendix E

LCCA BREAKDOWN (2008-2022)

	EMPLACEMENT														
YEAR (BASE YR = 1995)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
COST COMPONENT															
Initial Capital Cost															
Operating Cost															
Labor	0.28	0.27	0.26	0.25	0.24	0.23	0.22	0.21	0.21	0.20	0.19	0.19	0.18	0.17	0.17
Operating Supplies	0.48	0.46	0.44	0.43	0.41	0.40	0.38	0.37	0.36	0.34	0.33	0.32	0.31	0.30	0.29
Disposal	0.82	0.79	0.76	0.73	0.71	0.68	0.66	0.63	0.61	0.59	0.57	0.55	0.53	0.51	0.49
Maintenance	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03
Utilities	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0 02	0.02	0.02	0.02	0.02	0.02
Total Operating Cost	1.65	1.59	1.53	1.48	1.42	1.37	1.33	1.28	1.23	1.19	1.15	1.11	1.07	1.03	0.99
Decon. & Decom.															
WTB Life-Cycle Cost	1.65	1.59	1.53	1.48	1.42	1.37	1.33	1.28	1.23	1.19	1.15	1.11	1.07	1.03	0.99

LCCA BREAKDOWN (2023-2038)

YEAR (BASE YR = 1995)	EMPLACEMENT		CARETAKER													
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
COST COMPONENT																
Initial Capital Cost																
Operating Cost																
Labor	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Operating Supplies	0.28	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Disposal	0.48	0.46	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
* Maintenance	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Utilities	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Operating Cost	0.96	0.92	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	[illegible]	0.03	[illegible]
Decon. & Decom.																
WTB Life-Cycle Cost	0.96	0.92	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03

LCCA BREAKDOWN (2039-2051)

YEAR (BASE YR = 1995)	CARETAKER												D & D	TOTAL
	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	
COST COMPONENT														
Initial Capital Cost														[illegible]8.39
Operating Cost														[illegible]
Labor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		5.99
Operating Supplies	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		10.28
Disposal	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		17.68
Maintenance	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		[illegible]
Utilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.55
Total Operating Cost	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02		[illegible]36.06
Decon. & Decom.													0.27	[illegible]
WTB Life-Cycle Cost	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.27	45.71

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : S-1 (SHREDDING/COMPACTION/SUPERCOMPACTION PROCESS)

ANNUAL OPERATING COST (1995-2008)

YEAR	ENGINEERING & CONSTRUCTION					STARTUP	EMPLACEMENT							
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Labor, $						132,900	443,000	443,000	443,000	443,000	443,000	443,000	443,000	443,000
Operating Supplies														
Containers														
55-gal., $						78,975	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250
85-gal., $						132,188	440,625	440,625	440,625	440,625	440,625	440,625	440,625	440,625
Solidification														
Cement, $						17,348	57,828	57,828	57,828	57,828	57,828	57,828	57,828	57,828
Sub-total, $						228,511	761,703	761,703	761,703	761,703	761,703	761,703	761,703	761,703
Waste Disposal														
Low-Level, $						392,557	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523
Maintenance, $						24,197	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656
Utilities														
Electricity, $						3,845	12,817	12,817	12,817	12,817	12,817	12,817	12,817	12,817
Natural Gas, $						8,400	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000
Sub-total, $						12,245	40,817	40,817	40,817	40,817	40,817	40,817	40,817	40,817
Operating Supplies														
Containers														
55-gal.							3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510
85-gal.							2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350
Solidification														
Cement, Lbs.							963,800	963,800	963,800	963,800	963,800	963,800	963,800	963,800
Waste Disposal														
Low-Level Waste drums							2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350
Utilities														
Electricity							230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000
Natural Gas							14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000

ANNUAL OPERATING COST (2009-2024)

YEAR	EMPLACEMENT															
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Labor, $	443,000	443,000	443,000	443,000	443,000	443,000	443,000	443,000	443,000	443,000	443,000	443,000	443,000	443,000	443,000	443,000
Operating Supplies																
Containers																
55-gal., $	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250
85-gal., $	440,625	440,625	440,625	440,625	440,625	440,625	440,625	440,625	440,625	440,625	440,625	440,625	440,625	440,625	440,625	440,625
Solidification																
Cement, $	57,828	57,828	57,828	57,828	57,828	57,828	57,828	57,828	57,828	57,828	57,828	57,828	57,828	57,828	57,828	57,828
Sub-total, $	761,703	761,703	761,703	761,703	761,703	761,703	761,703	761,703	761,703	761,703	761,703	761,703	761,703	761,703	761,703	761,703
Waste Disposal																
Low-Level, $	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523	1,308,523
Maintenance, $	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656
Utilities																
Electricity, $	12,817	12,817	12,817	12,817	12,817	12,817	12,817	12,817	12,817	12,817	12,817	12,817	12,817	12,817	12,817	12,817
Natural Gas, $	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000
Sub-total, $	40,817	40,817	40,817	40,817	40,817	40,817	40,817	40,817	40,817	40,817	40,817	40,817	40,817	40,817	40,817	40,817
Operating Supplies																
Containers																
55-gal.	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510
85-gal.	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350
Solidification																
Cement, Lbs.	963,800	963,800	963,800	963,800	963,800	963,800	963,800	963,800	963,800	963,800	963,800	963,800	963,800	963,800	963,800	963,800
Waste Disposal																
Low-Level Waste drums	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350
Utilities																
Electricity	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000
Natural Gas	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000

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ANNUAL OPERATING COST (2025-2039)

	CARETAKER														
YEAR	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Labor, $	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000
Operating Supplies															
Containers															
55-gal., $	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063
85-gal., $	8,474	8,474	8,474	8,474	8,474	8,474	8,474	8,474	8,474	8,474	8,474	8,474	8,474	8,474	8,474
Solidification															
Cement, $	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112
Sub-total, $	14,648	14,648	14,648	14,648	14,648	14,648	14,648	14,648	14,648	14,648	14,648	14,648	14,648	14,648	14,648
Waste Disposal															
Low-Level, $	25,164	25,164	25,164	25,164	25,164	25,164	25,164	25,164	25,164	25,164	25,164	25,164	25,164	25,164	25,164
Maintenance, $	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656
Utilities															
Electricity, $	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
Natural Gas, $	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
Sub-total, $	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
Operating Supplies															
Containers															
55-gal.	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
85-gal.	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Solidification															
Cement, Lbs	18,535	18,535	18,535	18,535	18,535	18,535	18,535	18,535	18,535	18,535	18,535	18,535	18,535	18,535	18,535
Waste Disposal															
Low-Level Waste drums	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Utilities															
Electricity	383	383	383	383	383	383	383	383	383	383	383	383	383	383	383
Natural Gas	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333

Appendix E

ANNUAL OPERATING COST (2040-2050)

YEAR	CARETAKER										
	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Labor, $	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000
Operating Supplies											
Containers											
55-gal., $	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063
85-gal., $	8,474	8,474	8,474	8,474	8,474	8,474	8,474	8,474	8,474	8,474	8,474
Solidification											
Cement, $	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112
Sub-total, $	14,648	14,648	14,648	14,648	14,648	14,648	14,648	14,648	14,648	14,648	14,648
Waste Disposal											
Low-Level, $	25,164	25,164	25,164	25,164	25,164	25,164	25,164	25,164	25,164	25,164	25,164
Maintenance, $	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656	80,656
Utilities											
Electricity, $	21	21	21	21	21	21	21	21	21	21	21
Natural Gas, $	47	47	47	47	47	47	47	47	47	47	47
Sub-total, $	68	68	68	68	68	68	68	68	68	68	68
Operating Supplies											
Containers											
55-gal.	68	68	68	68	68	68	68	68	68	68	68
85-gal.	46	45	46	46	45	46	45	45	46	45	46
Solidification											
Cement, Lbs.	18,635	18,536	18,635	18,635	18,536	18,635	18,536	18,635	18,635	18,536	18,635
Waste Disposal											
Low-Level Waste drums	0	0	0	0	0	0	0	0	0	0	0
Utilities											
Electricity	383	383	383	383	383	383	383	383	383	383	383
Natural Gas	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333

LIFE-CYCLE COST ANALYSES OF LOW-LEVEL WASTE TREATMENT ALTERNATIVE

CASE : S-1 (SHREDDING/COMPACTION/SUPERCOMPACTION PROCESS)

BASIS

1.	Startup cost, $	=	30%	of the annual operating cost.
2.	D & D Cost , $	=	20%	of Total Capital Cost.
3.	Real interest rate	=	7.00%	for the duration of 50-year life cycle.
4.	Average inflation rate	=	3.20%	for the duration of 50-year life cycle.
5.	Maintenance cost , $	=	40%	of the Total Capital Cost.
6.	55-gallon steel drum	=	$75	per drum.
7.	85-gallon steel drum	=	$188	per drum.
8.	Cement dry mix cost	=	$0.06	per pound.
9.	LLW Disposal cost	=	$49	per ft^3
10.	Electricity cost, $	=	$0.056	per kw-hr
11.	Natural Gas cost, $	=	$0.002	per ft^3.

12. Caretaker operations assumed to be 1 week / year.

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : S-1 (SHREDDING/COMPACTION/SUPERCOMPACTION PROCESS)

INPUT DATA

Description	Construction Period	Emplacement Period	Caretaker Period
Total Capital Costs, $ Mil. =	10.082		
55-gallon drum consumption, Drums/year =		3,510	
85-gallon drum consumption, Drums/year =		2350	
Cement consumption, Pounds/year =		963,800	
Electricity consumption, KWH/year =		230,000	
Natural Gas consumption , ft^3/year =		14,000,000	
Operating Labor, $/year =		$443,000	$9,000

APPENDIX F

LCCA OF CASE S-2

LCCA OF CASE S-2

Appendix F contains the Figure and Tables listed below. This data represents the results of the Life Cycle Cost Analyses for one of the LL Waste Treatment Options, Case S-2, Shreeding/Compaction Proceess.

Block Flow Diagram

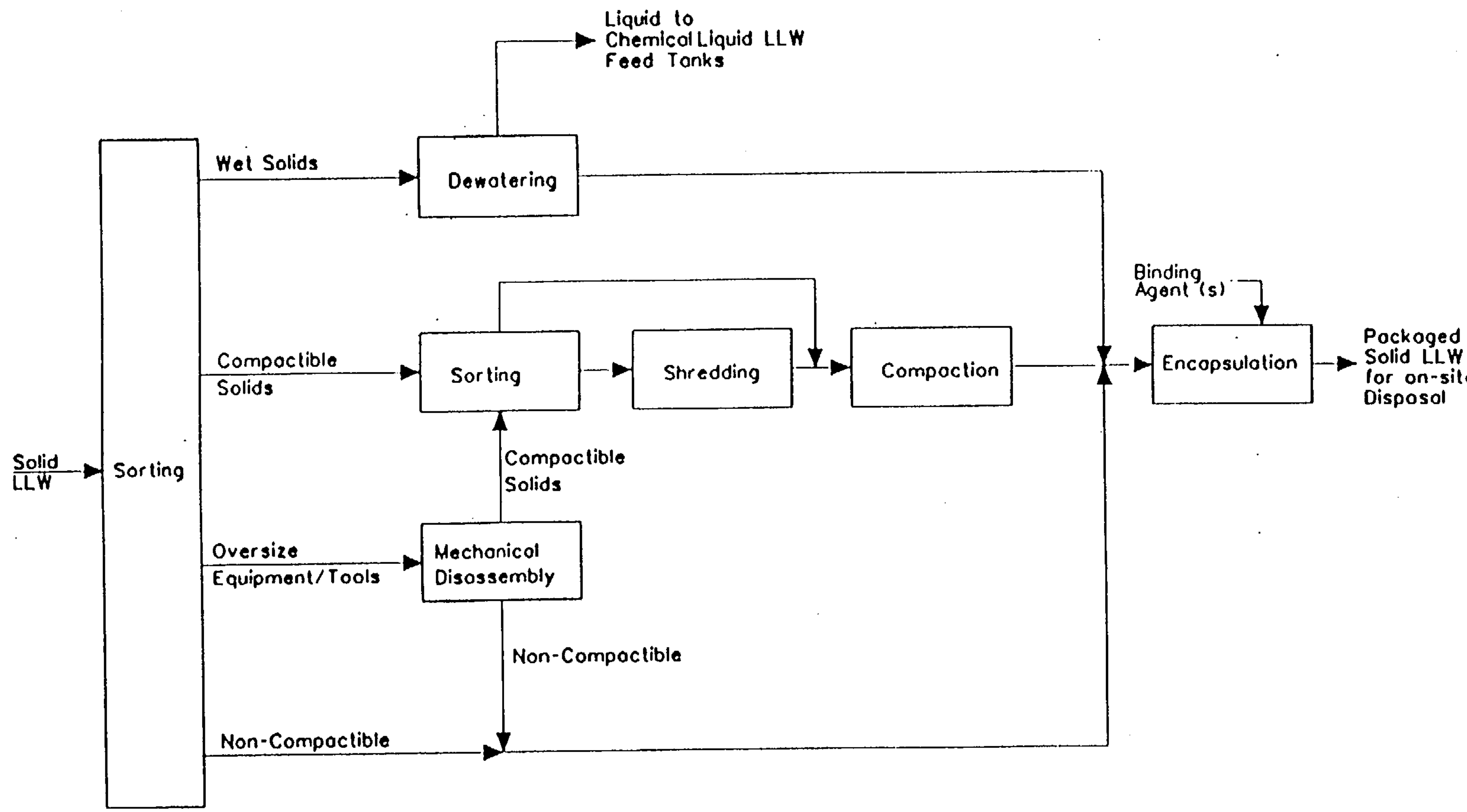
Cost Summary

LCCA Breakdown (1995-2007)
LCCA Breakdown (2008-2022)
LCCA Breakdown (2023-2038)
LCCA Breakdown (2039-2051)

Annual Operating Cost (1995-2008)
Annual Operating Cost (2008-2022)
Annual Operating Cost (2023-2038)
Annual Operating Cost (2039-2051)

Basis

Input Data



BLOCK FLOW DIAGRAM

CASE : S-2

SOLID LOW-LEVEL WASTE SHREDDING / COMPACTION / PROCESS

FIGURE 8 - 8

BY : M. PATEL
CHK'D : QBN 8/1/95

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : S-2 (SHREDDING/COMPACTION PROCESS)

SUMMARY

(COSTS IN MILLION $)

MODE OF MGDS OPERATION YEAR	ENG. & CONS. 1995 to 1999	START-UP 2000	EMPLACEMENT 2001 to 2024	CARETAKER 2025 to 2050	D & D 2051	TOTAL
COST COMPONENT						
Capital Cost	8.40					8.40
Operating Cost						
Labor	0.00	0.09	4.94	0.04		5.08
Operating Supplies	0.00	0.25	13.35	0.11		13.71
Disposal	0.00	0.49	25.70	0.22		26.41
Maintenance	0.00	0.02	0.95	0.42		1.38
Utilities	0.00	0.01	0.46	0.00		0.47
Total Operating Cost	0.00	0.86	45.40	0.79		47.06
Decon & Decom					0.24	0.24
WTB Life-Cycle Cost	**8.40**	**0.86**	**45.40**	**0.79**	**0.24**	**55.69**

Appendix F

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : S-2 (SHREDDING/COMPACTION PROCESS)

LCCA BREAKDOWN (1995-2007)

(COSTS IN MILLION $)

	ENGINEERING & CONSTRUCTION					START-UP	EMPLACEMENT						
YEAR (BASE YR = 1995)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
COST COMPONENT													
Initial Capital Cost	1.80	1.74	1.68	1.62	1.56								
Operating Cost													
Labor	0.00	0.00	0.00	0.00	0.00	0.09	0.30	0.29	0.28	0.27	0.26	0.25	0.24
Operating Supplies	0.00	0.00	0.00	0.00	0.00	0.25	0.82	0.79	0.76	0.73	0.71	0.68	0.66
Disposal	0.00	0.00	0.00	0.00	0.00	0.49	1.57	1.52	1.46	1.41	1.36	1.31	1.27
Maintenance	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.06	0.05	0.05	0.05	0.05	0.05
Utilities	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.03	0.03	0.03	0.02	0.02	0.02
Total Operating Cost	0.00	0.00	0.00	0.00	0.00	0.86	2.78	2.68	2.59	2.49	2.41	2.32	2.24
Decon & Decom													
WTB Life-Cycle Cost	1.80	1.74	1.68	1.62	1.56	0.86	2.78	2.68	2.59	2.49	2.41	2.32	2.24

LCCA BREAKDOWN (2008-2022)

YEAR (BASE YR = 1995)	EMPLACEMENT														
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
COST COMPONENT															
Initial Capital Cost															
Operating Cost															
Labor	0.23	0.23	0.22	0.21	0.20	0.20	0.19	0.18	0.18	0.17	0.16	0.16	0.15	0.15	0.14
Operating Supplies	0.63	0.61	0.59	0.57	0.55	0.53	0.51	0.49	0.47	0.46	0.44	0.43	0.41	0.40	0.38
Disposal	1.22	1.18	1.14	1.10	1.06	1.02	0.98	0.95	0.91	0.88	0.85	0.82	0.79	0.76	0.74
Maintenance	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Utilities	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
Total Operating Cost	2.16	2.08	2.01	1.94	1.87	1.80	1.74	1.68	1.62	1.56	1.50	1.45	1.40	1.35	1.30
Decon. & Decom.															
WTB Life-Cycle Cost	2.16	2.08	2.01	1.94	1.87	1.80	1.74	1.68	1.62	1.56	1.50	1.45	1.40	1.35	1.30

LCCA BREAKDOWN (2023-2038)

YEAR (BASE YR = 1995)	EMPLACEMENT		CARETAKER													
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
COST COMPONENT																
Initial Capital Cost																
Operating Cost																
Labor	0.14	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Operating Supplies	0.37	0.36	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Disposal	0.71	0.68	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Maintenance	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Utilities	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Operating Cost	1.25	1.21	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03
Decon. & Decom.																
WTB Life-Cycle Cost	1.25	1.21	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03

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LCCA BREAKDOWN (2039-2051)

YEAR (BASE YR = 1995)	CARETAKER												D & D	TOTAL
	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	
COST COMPONENT														
Initial Capital Cost														8.40
Operating Cost														[illegible]
Labor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		5.08
Operating Supplies	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		13.71
Disposal	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		26.41
Maintenance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		1.38
Utilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.47
Total Operating Cost	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02		47.06
Decon. & Decom.													0.24	0.24
WTB Life-Cycle Cost	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.24	55.69

Appendix F

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : S-2 (SHREDDING/COMPACTION PROCESS)

ANNUAL OPERATING COST (1995-2008)

	ENGINEERING & CONSTRUCTION					STARTUP	EMPLACEMENT							
YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Labor, $						112,800	376,000	376,000	376,000	376,000	376,000	376,000	376,000	376,000
Operating Supplies														
Containers														
55-gal, $						78,975	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250
85-gal, $						197,438	658,125	658,125	658,125	658,125	658,125	658,125	658,125	658,125
Solidification														
Cement, $						28,062	93,540	93,540	93,540	93,540	93,540	93,540	93,540	93,540
Sub-total, $						304,475	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915
Waste Disposal														
Low-Level, $						586,330	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432
Maintenance, $						21,638	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128
Utilities														
Electricity, $						2,173	7,245	7,245	7,245	7,245	7,245	7,245	7,245	7,245
Natural Gas, $						8,400	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000
Sub-total, $						10,573	35,245	35,245	35,245	35,245	35,245	35,245	35,245	35,245
Operating Supplies														
Containers														
55-gal.							3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510
85-gal.							3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510
Solidification														
Cement, Lbs.							1,559,000	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000
Waste Disposal														
Low-Level Waste drums							3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510
Utilities														
Electricity							130,000	130,000	130,000	130,000	130,000	130,000	130,000	130,000
Natural Gas							14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000

ANNUAL OPERATING COST (2009-2024)

YEAR	EMPLACEMENT															
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Labor, $	376,000	376,000	376,000	376,000	376,000	376,000	376,000	376,000	376,000	376,000	376,000	376,000	376,000	376,000	376,000	376,000
Operating Supplies																
Containers																
55-gal, $	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250	263,250
85-gal, $	658,125	658,125	658,125	658,125	658,125	658,125	658,125	658,125	658,125	658,125	658,125	658,125	658,125	658,125	658,125	658,125
Solidification																
Cement, $	93,540	93,540	93,540	93,540	93,540	93,540	93,540	93,540	93,540	93,540	93,540	93,540	93,540	93,540	93,540	93,540
Sub-total, $	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915	1,014,915
Waste Disposal																
Low-Level, $	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432	1,954,432
Maintenance, $	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128
Utilities																
Electricity, $	7,245	7,245	7,245	7,245	7,245	7,245	7,245	7,245	7,245	7,245	7,245	7,245	7,245	7,245	7,245	7,245
Natural Gas, $	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000
Sub-total, $	35,245	35,245	35,245	35,245	35,245	35,245	35,245	35,245	35,245	35,245	35,245	35,245	35,245	35,245	35,245	35,245
Operating Supplies																
Containers																
55-gal.	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510
85-gal.	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510
Solidification																
Cement, Lbs.	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000	1,559,000
Waste Disposal																
Low-Level Waste drums	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510
Utilities																
Electricity	130,000	130,000	130,000	130,000	130,000	130,000	130,000	130,000	130,000	130,000	130,000	130,000	130,000	130,000	130,000	130,000
Natural Gas	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000

ANNUAL OPERATING COST (2025-2039)

YEAR	CARETAKER														
	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Labor, $	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
Operating Supplies															
Containers															
55-gal., $	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063
85-gal., $	12,656	12,656	12,656	12,656	12,656	12,656	12,656	12,656	12,656	12,656	12,656	12,656	12,656	12,656	12,656
Solidification															
Cement, $	1,799	1,799	1,799	1,799	1,799	1,799	1,799	1,799	1,799	1,799	1,799	1,799	1,799	1,799	1,799
Sub-total, $	19,518	19,518	19,518	19,518	19,518	19,518	19,518	19,518	19,518	19,518	19,518	19,518	19,518	19,518	19,518
Waste Disposal															
Low-Level, $	37,585	37,585	37,585	37,585	37,585	37,585	37,585	37,585	37,585	37,585	37,585	37,585	37,585	37,585	37,585
Maintenance, $	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128
Utilities															
Electricity, $	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Natural Gas, $	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
Sub-total, $	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59
Operating Supplies															
Containers															
55-gal.	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
85-gal.	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
Solidification															
Cement, Lbs.	29,981	29,981	29,981	29,981	29,981	29,981	29,981	29,981	29,981	29,981	29,981	29,981	29,981	29,981	29,981
Waste Disposal															
Low-Level Waste drums	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
Utilities															
Electricity	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217
Natural Gas	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333

ANNUAL OPERATING COST (2040-2050)

YEAR	CARETAKER 2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Labor, $	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
Operating Supplies											
Containers											
55-gal, $	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063	5,063
85-gal, $	12,656	12,656	12,656	12,656	12,656	12,656	12,656	12,656	12,656	12,656	12,656
Solidification											
Cement, $	1,799	1,799	1,799	1,799	1,799	1,799	1,799	1,799	1,799	1,799	1,799
Sub-total, $	19,518	19,518	19,518	19,518	19,518	19,518	19,518	19,518	19,518	19,518	19,518
Waste Disposal											
Low-Level, $	37,585	37,585	37,585	37,585	37,585	37,585	37,585	37,585	37,585	37,585	37,585
Maintenance, $	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128	72,128
Utilities											
Electricity, $	12	12	12	12	12	12	12	12	12	12	12
Natural Gas, $	47	47	47	47	47	47	47	47	47	47	47
Sub-total, $	59	59	59	59	59	59	59	59	59	59	59
Operating Supplies											
Containers											
55-gal.	68	68	68	68	68	68	68	68	68	68	68
85-gal.	68	68	68	68	68	68	68	68	68	68	68
Solidification											
Cement, Lbs.	29,981	29,981	29,981	29,981	29,981	29,981	29,981	29,981	29,981	29,981	29,981
Waste Disposal											
Low-Level Waste drums	68	68	68	68	68	68	68	68	68	68	68
Utilities											
Electricity	217	217	217	217	217	217	217	217	217	217	217
Natural Gas	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333	23,333

LIFE-CYCLE COST ANALYSES OF LOW-LEVEL WASTE TREATMENT ALTERNATIVE

CASE : S-2 (SHREDDING/COMPACTION PROCESS)

BASIS

1.	Startup cost, $	=	30%	of the annual operating cost.
2.	D & D Cost, $	=	20%	of Total Capital Cost.
3.	Real interest rate	=	7.00%	for the duration of 50-year life cycle.
4.	Average inflation rate	=	3.20%	for the duration of 50-year life cycle.
5.	Maintenance cost, $	=	40%	of the Total Capital Cost.
6.	55-gallon steel drum	=	$75	per drum.
7.	85-gallon steel drum	=	$188	per drum.
8.	Cement dry mix cost	=	$0.06	per pound.
9.	LLW Disposal cost	=	$49	per ft^3
10.	Electricity cost, $	=	$0.056	per kw-hr
11.	Natural Gas cost, $	=	$0.002	per ft^3.

12. Caretaker operations assumed to be 1 week / year.

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : S-2 (SHREDDING/COMPACTION PROCESS)

INPUT DATA

Description	Construction Period	Emplacement Period	Caretaker Period
Total Capital Costs, $ Mil. =	9.016		
55-gallon drum consumption, Drums/year =		3,510	
85-gallon drum consumption, Drums/year =		3510	
Cement consumption, Pounds/year =		1,559,000	
Electricity consumption, KWH/year =		130,000	
Natural Gas consumption, ft^3/year =		14,000,000	
Operating Labor, $/year =		$376,000	$7,000

APPENDIX G

SUMMARY OF LCCAs FOR SENSITIVITY CASES

SUMMARY OF LCCAs FOR SENSITIVITY CASES

Appendix G contains the cost summary tables for each of the following LL Waste Treatment Sensitivity Cases for waste disposal costs of $5/ft^3 and $15/ft^3.

Case L-1, Filtration/Evaporation/Ion Exchange Process at $5/ft^3
Case L-1, Filtration/Evaporation/Ion Exchange Process at $15/ft^3
Case L-6, Solidification Process at $5/ft^3
Case L-6, Solidification Process at $15/ft^3
Case S-1, Shredding/Compaction/Supercompaction Process at $5/ft^3
Case S-1, Shredding/Compaction/Supercompaction Process at $15/ft^3
Case S-2, Shreeding/Compaction Proceess at $5/ft^3
Case S-2, Shreeding/Compaction Proceess at $15/ft^3

BY : M. PATEL
CHK'D :

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : L-1 (FILTRATION / EVAPORATION / ION EXCHANGE PROCESS)

SUMMARY

(COSTS IN MILLION $)

MODE OF MGDS OPERATION YEAR	ENG. & CONS. 1995 to 1999	START-UP 2000	EMPLACEMENT 2001 to 2024	CARETAKER 2025 to 2050	D & D 2051	TOTAL
COST COMPONENT						
Capital Cost	8.09					8.09
Operating Cost						
Labor	0.00	0.16	8.15	0.07		8.38
Operating Supplies	0.00	0.13	6.78	0.26		7.16
Disposal (1)	0.00	0.04	2.09	0.08		2.21
Maintenance	0.00	0.02	0.91	0.40		1.33
Utilities	0.00	0.02	0.85	0.00		0.87
Total Operating Cost	0.00	0.36	18.79	0.81		19.95
Decon. & Decom.					0.23	0.23
WTB Life-Cycle Cost	8.09	0.36	18.79	0.81	0.23	28.28

Note:
(1) Disposal cost = $5/ ft³

BY : M. PATEL
CHK'D :

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : L-1 (FILTRATION / EVAPORATION / ION EXCHANGE PROCESS)

SUMMARY

(COSTS IN MILLION $)

MODE OF MGDS OPERATION YEAR	ENG. & CONS. 1995 to 1999	START-UP 2000	EMPLACEMENT 2001 to 2024	CARETAKER 2025 to 2050	D & D 2051	TOTAL
COST COMPONENT						
Capital Cost	8.09					8.09
Operating Cost						
Labor	0.00	0.16	8.15	0.07		8.38
Operating Supplies	0.00	0.13	6.78	0.26		7.16
Disposal (1)	0.00	0.12	6.27	0.24		6.62
Maintenance	0.00	0.02	0.91	0.40		1.33
Utilities	0.00	0.02	0.85	0.00		0.87
Total Operating Cost	0.00	0.44	22.96	0.97		24.37
Decon. & Decom.					0.23	0.23
WTB Life-Cycle Cost	8.09	0.44	22.96	0.97	0.23	32.69

Note:
(1) Disposal cost = $15/ ft³

BY : M. PATEL
CHK'D :

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : L-6 (SOLIDIFICATION PROCESS)

SUMMARY

(COSTS IN MILLION $)

MODE OF MGDS OPERATION YEAR	ENG. & CONS. 1995 to 1999	START-UP 2000	EMPLACEMENT 2001 to 2024	CARETAKER 2025 to 2050	D & D 2051	TOTAL
COST COMPONENT						
Capital Cost	6.11					6.11
Operating Cost						
Labor	0.00	0.06	3.21	0.03		3.30
Operating Supplies	0.00	0.27	14.37	0.58		15.22
Disposal (1)	0.00	0.08	4.42	0.18		4.69
Maintenance	0.00	0.01	0.69	0.30		1.01
Utilities	0.00	0.01	0.51	0.00		0.52
Total Operating Cost	0.00	0.44	23.20	1.10		24.74
Decon. & Decom.					0.17	0.17
WTB Life-Cycle Cost	**6.11**	**0.44**	**23.20**	**1.10**	**0.17**	**31.03**

Note:
(1) Disposal cost = $5/ft^3$

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Appendix G

LCC_L6_1.WK4

08/03/95

BY : M PATEL
CHK'D :

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : L-6 (SOLIDIFICATION PROCESS)

SUMMARY

(COSTS IN MILLION $)

MODE OF MGDS OPERATION YEAR	ENG. & CONS. 1995 to 1999	START-UP 2000	EMPLACEMENT 2001 to 2024	CARETAKER 2025 to 2050	D & D 2051	TOTAL
COST COMPONENT						
Capital Cost	6.11					6.11
Operating Cost						
Labor	0.00	0.06	3.21	0.03		3.30
Operating Supplies	0.00	0.27	14.37	0.58		15.22
Disposal (1)	0.00	0.25	13.27	0.54		14.06
Maintenance	0.00	0.01	0.69	0.30		1.01
Utilities	0.00	0.01	0.51	0.00		0.52
Total Operating Cost	0.00	0.61	32.05	1.45		34.11
Decon. & Decom.					0.17	0.17
WTB Life-Cycle Cost	6.11	0.61	32.05	1.45	0.17	40.40

Note:
(1) Disposal cost = $15/ft^3$

BY : M. PATEL
CHK'D :

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : S-1 (SHREDDING/COMPACTION/SUPERCOMPACTION PROCESS)

SUMMARY

(COSTS IN MILLION $)

MODE OF MGDS OPERATION YEAR	ENG. & CONS. 1995 to 1999	START-UP 2000	EMPLACEMENT 2001 to 2024	CARETAKER 2025 to 2050	D & D 2051	TOTAL
COST COMPONENT						
Capital Cost	9.39					9.39
Operating Cost						
Labor	0.00	0.11	5.83	0.05		5.99
Operating Supplies	0.00	0.19	10.02	0.08		10.29
Disposal (1)	0.00	0.03	1.76	0.01		1.80
Maintenance	0.00	0.02	1.06	0.47		1.55
Utilities	0.00	0.01	0.54	0.00		0.55
Total Operating Cost	0.00	0.37	19.19	0.62		20.18
Decon. & Decom.					0.27	0.27
WTB Life-Cycle Cost	9.39	0.37	19.19	0.62	0.27	29.84

Note:
(1) Disposal cost = $5/ft³

BY : M. PATEL
CHK'D :

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : S-1 (SHREDDING/COMPACTION/SUPERCOMPACTION PROCESS)

SUMMARY

(COSTS IN MILLION $)

MODE OF MGDS OPERATION YEAR	ENG. & CONS. 1995 to 1999	START-UP 2000	EMPLACEMENT 2001 to 2024	CARETAKER 2025 to 2050	D & D 2051	TOTAL
COST COMPONENT						
Capital Cost	9.39					9.39
Operating Cost						
Labor	0.00	0.11	5.83	0.05		5.99
Operating Supplies	0.00	0.19	10.02	0.08		10.29
Disposal (1)	0.00	0.10	5.27	0.04		5.41
Maintenance	0.00	0.02	1.06	0.47		1.55
Utilities	0.00	0.01	0.54	0.00		0.55
Total Operating Cost	0.00	0.43	22.71	0.65		23.79
Decon. & Decom.					0.27	0.27
WTB Life-Cycle Cost	**9.39**	**0.43**	**22.71**	**0.65**	**0.27**	**33.45**

Note:
(1) Disposal cost = $15/ft^3$

Appendix G

BY : M. PATEL
CHK'D :

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : S-2 (SHREDDING/COMPACTION PROCESS)

SUMMARY

(COSTS IN MILLION $)

MODE OF MGDS OPERATION YEAR	ENG. & CONS. 1995 to 1999	START-UP 2000	EMPLACEMENT 2001 to 2024	CARETAKER 2025 to 2050	D & D 2051	TOTAL
COST COMPONENT						
Capital Cost	8.40					8.40
Operating Cost						
Labor	0.00	0.09	4.94	0.04		5.08
Operating Supplies	0.00	0.25	13.35	0.11		13.71
Disposal (1)	0.00	0.05	2.62	0.02		2.69
Maintenance	0.00	0.02	0.95	0.42		1.38
Utilities	0.00	0.01	0.46	0.00		0.47
Total Operating Cost	0.00	0.43	22.32	0.59		23.34
Decon. & Decom.					0.24	0.24
WTB Life-Cycle Cost	8.40	0.43	22.32	0.59	0.24	31.98

Note:
(1) Disposal cost = $5/ft^3$

LCC_S2_1.WK4

08/03/95

BY : M. PATEL
CHK'D :

LIFE CYCLE COST ANALYSES OF LL WASTE TREATMENT OPTIONS

CASE : S-2 (SHREDDING/COMPACTION PROCESS)

SUMMARY

(COSTS IN MILLION $)

MODE OF MGDS OPERATION YEAR	ENG. & CONS. 1995 to 1999	START-UP 2000	EMPLACEMENT 2001 to 2024	CARETAKER 2025 to 2050	D & D 2051	TOTAL
COST COMPONENT						
Capital Cost	8.40					8.40
Operating Cost						
Labor	0.00	0.09	4.94	0.04		5.08
Operating Supplies	0.00	0.25	13.35	0.11		13.71
Disposal (1)	0.00	0.15	7.87	0.07		8.08
Maintenance	0.00	0.02	0.95	0.42		1.38
Utilities	0.00	0.01	0.46	0.00		0.47
Total Operating Cost	0.00	0.52	27.57	0.64		28.73
Decon. & Decom.					0.24	0.24
WTB Life-Cycle Cost	8.40	0.52	27.57	0.64	0.24	37.37

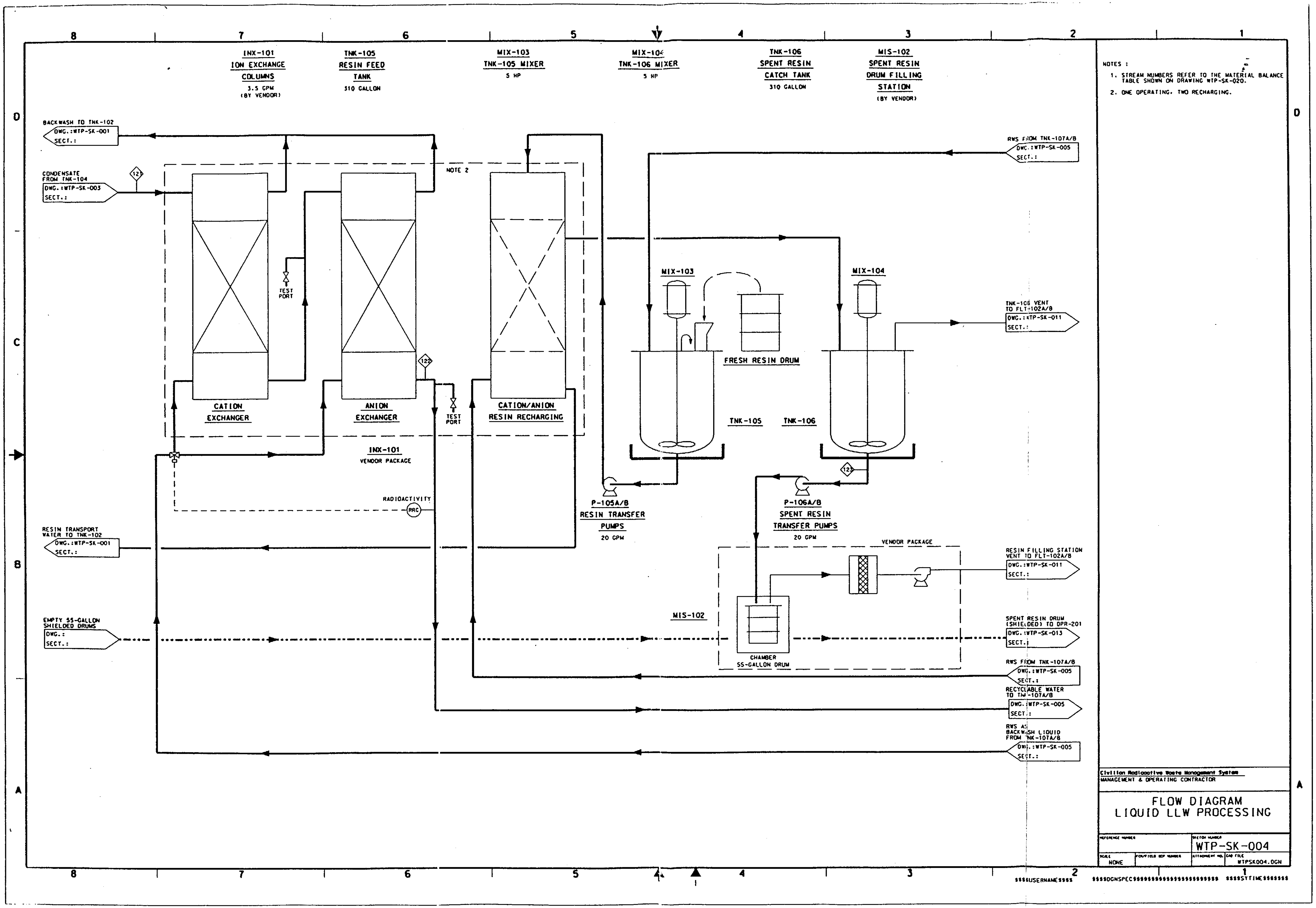
Note:
(1) Disposal cost = $15/ft³

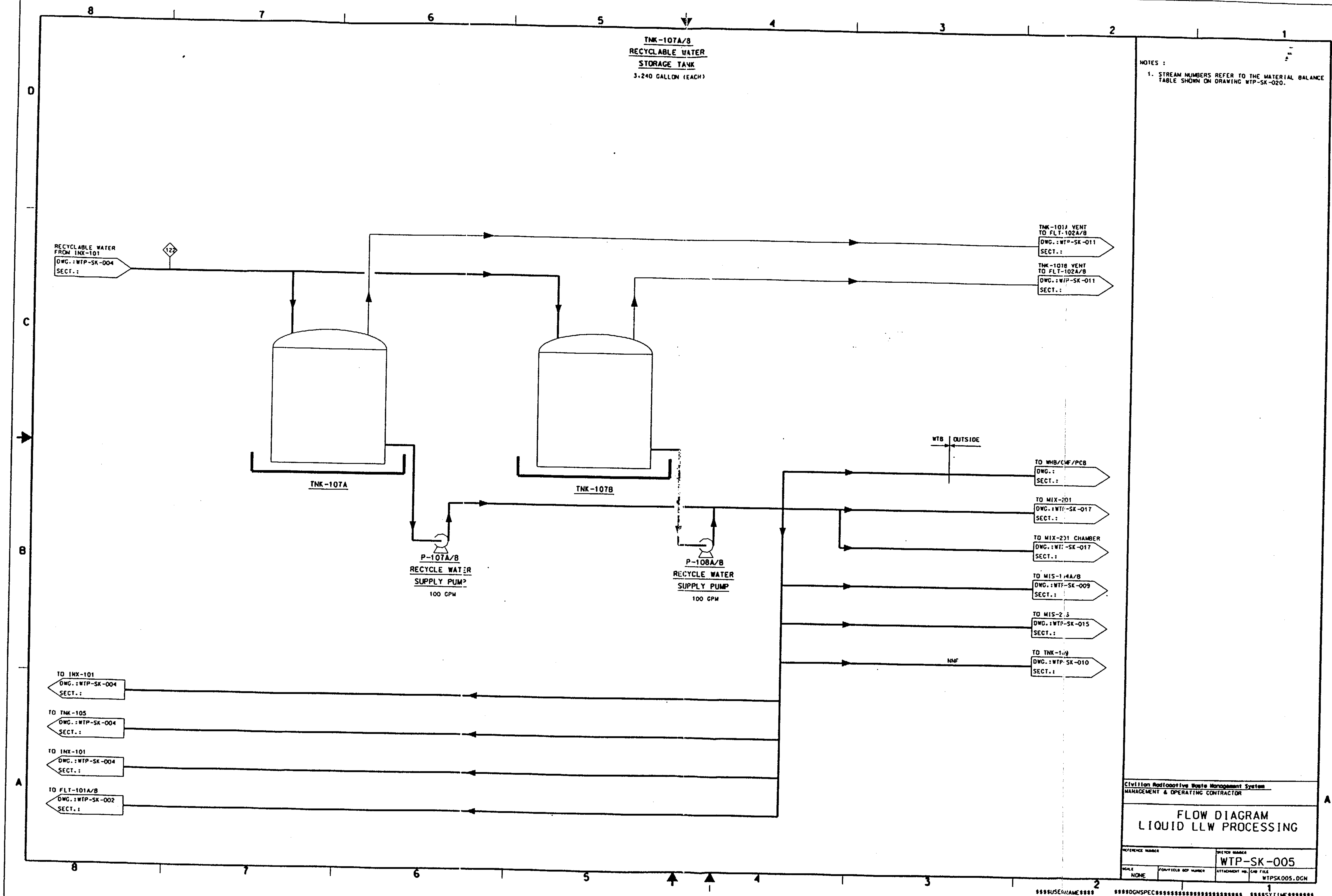
APPENDIX H

FLOW DIAGRAMS

FLOW DIAGRAMS

Title	Sketch Numbers
Liquid LLW Processing	WTP-SK-001 through -011
Solid LLW Processing	WTP-SK-012 through -019
Liquid and Solid LLW Processing Material Balance Diagram	WTP-SK-020
Hazardous Waste Handling	WTP-SK-050 and 051
Liquid and Solid Hazardous Waste Material Balance Diagram	WTP-SK-052
Low-Level Mixed Waste Handling	WTP-SK-060
Solid and Liquid Low-Level Mixed Waste Material Balance Diagram	WTP-SK-061


INX-101
ION EXCHANGE COLUMNS
3.5 GPM
(BY VENDOR)
TNK-105
RESIN FEED TANK
310 GALLON
MIX-103
TNK-105 MIXER
5 HP
MIX-104
TNK-106 MIXER
5 HP
TNK-106
SPENT RESIN CATCH TANK
310 GALLON
MIS-102
SPENT RESIN DRUM FILLING STATION
(BY VENDOR)
NOTES :
1. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-020.
2. ONE OPERATING, TWO RECHARGING.
BACKWASH TO TNK-102
DWG.:WTP-SK-001
SECT.:
CONDENSATE FROM TNK-104
DWG.:WTP-SK-003
SECT.:
NOTE 2
TEST PORT
CATION EXCHANGER
ANION EXCHANGER
CATION/ANION RESIN RECHARGING
INX-101
VENDOR PACKAGE
RADIOACTIVITY
RRC
RWS FROM TNK-107A/B
DWG.:WTP-SK-005
SECT.:
MIX-103
MIX-104
FRESH RESIN DRUM
TNK-105
TNK-106
TNK-106 VENT TO FLT-102A/B
DWG.:WTP-SK-011
SECT.:
P-105A/B
RESIN TRANSFER PUMPS
20 GPM
P-106A/B
SPENT RESIN TRANSFER PUMPS
20 GPM
RESIN TRANSPORT WATER TO TNK-102
DWG.:WTP-SK-001
SECT.:
VENDOR PACKAGE
RESIN FILLING STATION VENT TO FLT-102A/B
DWG.:WTP-SK-011
SECT.:
EMPTY 55-GALLON SHIELDED DRUMS
DWG.:
SECT.:
MIS-102
CHAMBER
55-GALLON DRUM
SPENT RESIN DRUM (SHIELDED) TO DPR-201
DWG.:WTP-SK-013
SECT.:
RWS FROM TNK-107A/B
DWG.:WTP-SK-005
SECT.:
RECYCLABLE WATER TO TNK-107A/B
DWG.:WTP-SK-005
SECT.:
RWS AS BACKWASH LIQUID FROM TNK-107A/B
DWG.:WTP-SK-005
SECT.:
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
FLOW DIAGRAM
LIQUID LLW PROCESSING
WTP-SK-004
NONE
WTPSK004.DGN
$$$$USERNAME$$$$
$$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$$$
$$$$SYTIME$$$$$$$



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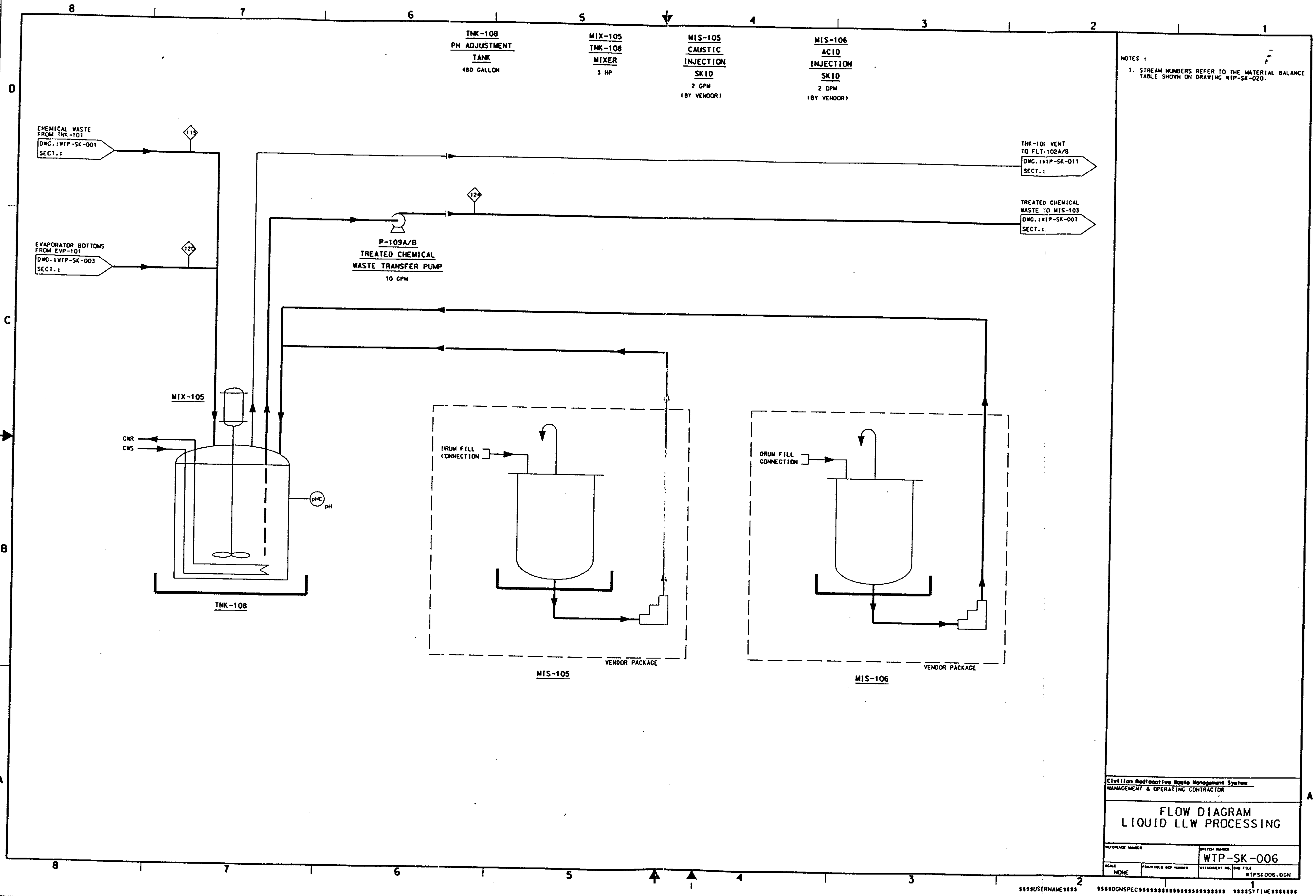

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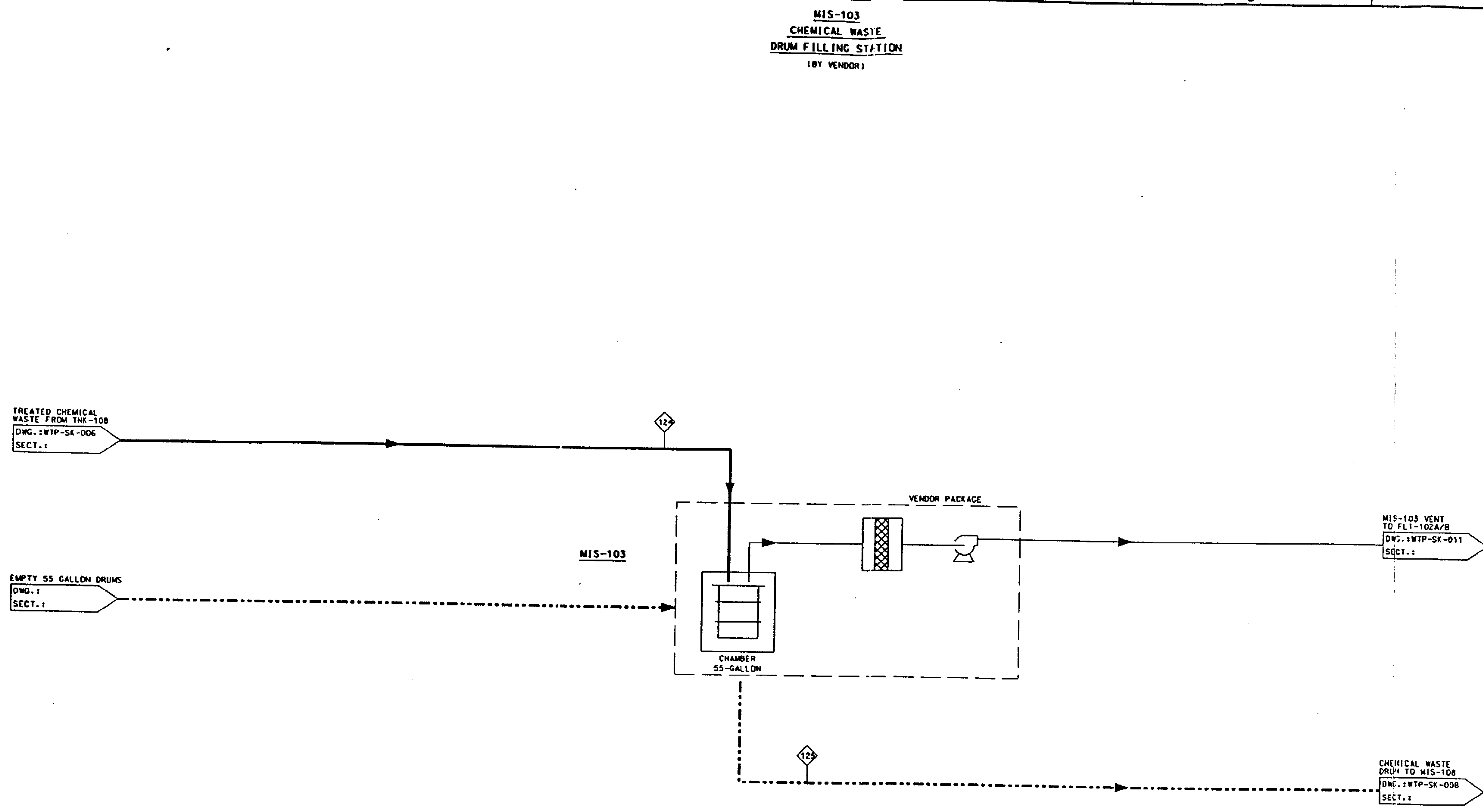


NOTES :

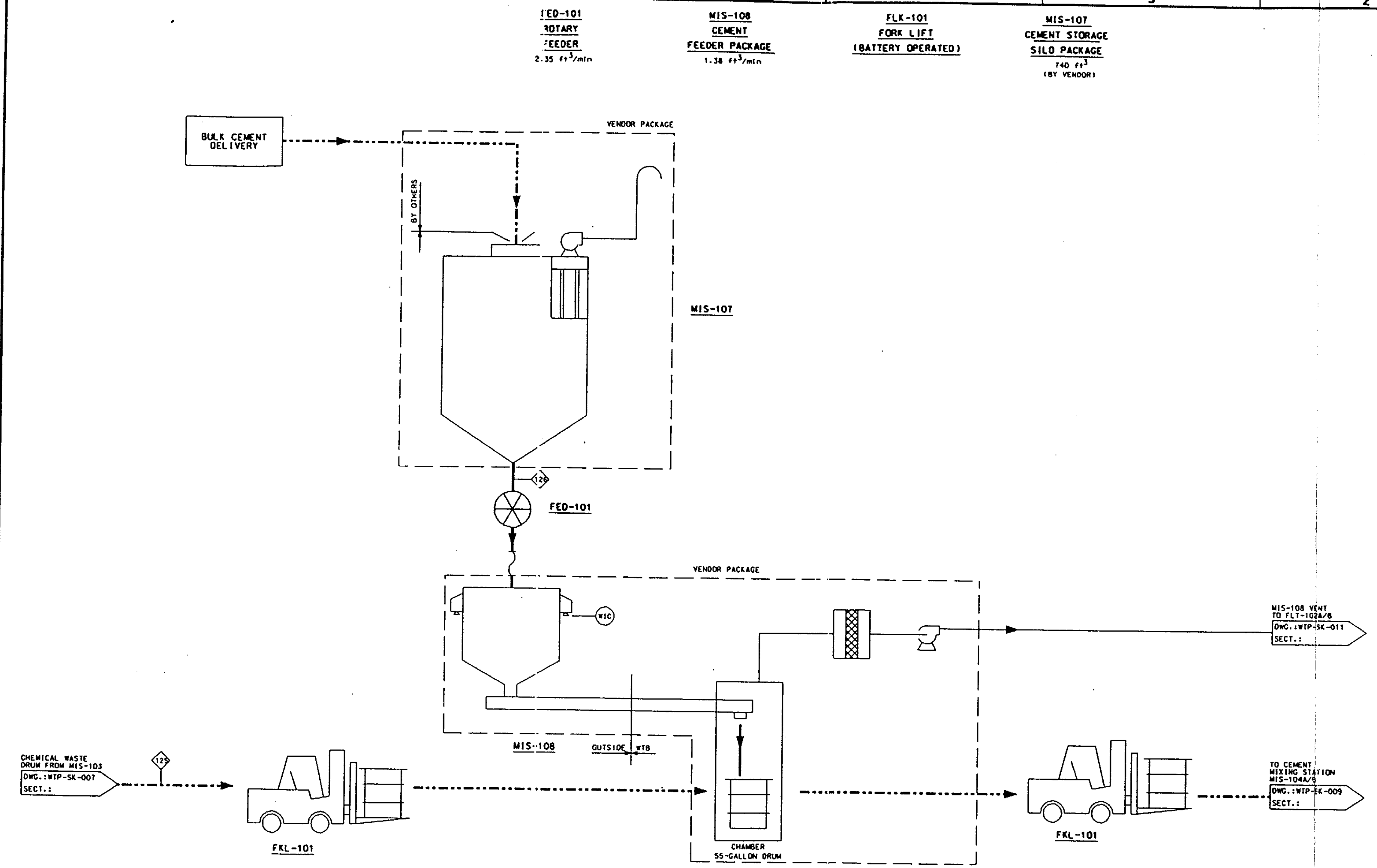
1. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-020.

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

FLOW DIAGRAM
LIQUID LLW PROCESSING

REFERENCE NUMBER		SKETCH NUMBER	
		WTP-SK-007	
SCALE: NONE	FOV/FIELD DCP NUMBER	ATTACHMENT NO.	CAD FILE: WTPSK007.DGN

$$$$USERNAME$$$$ $$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$



NOTES :

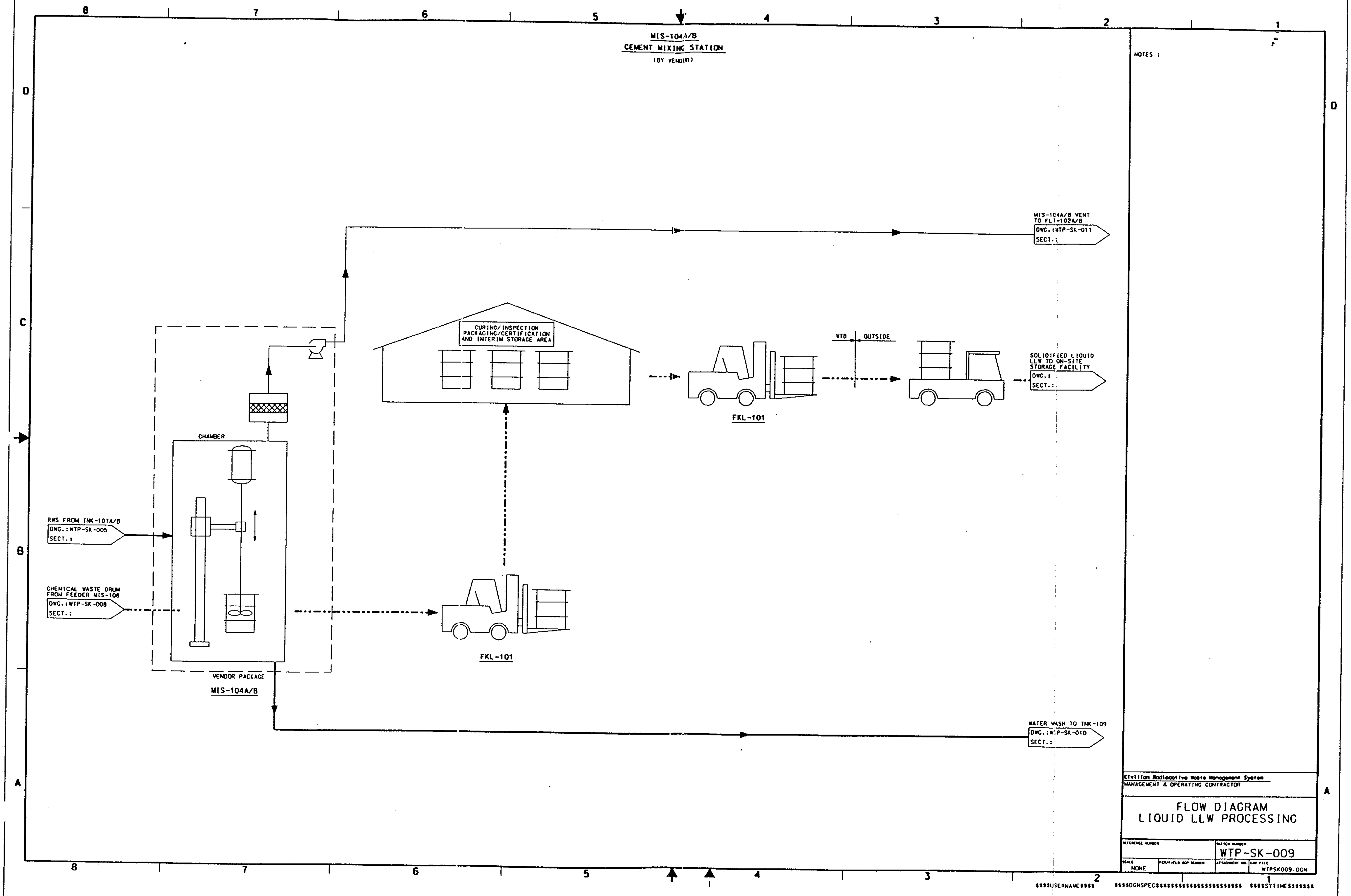
1. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-020.

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

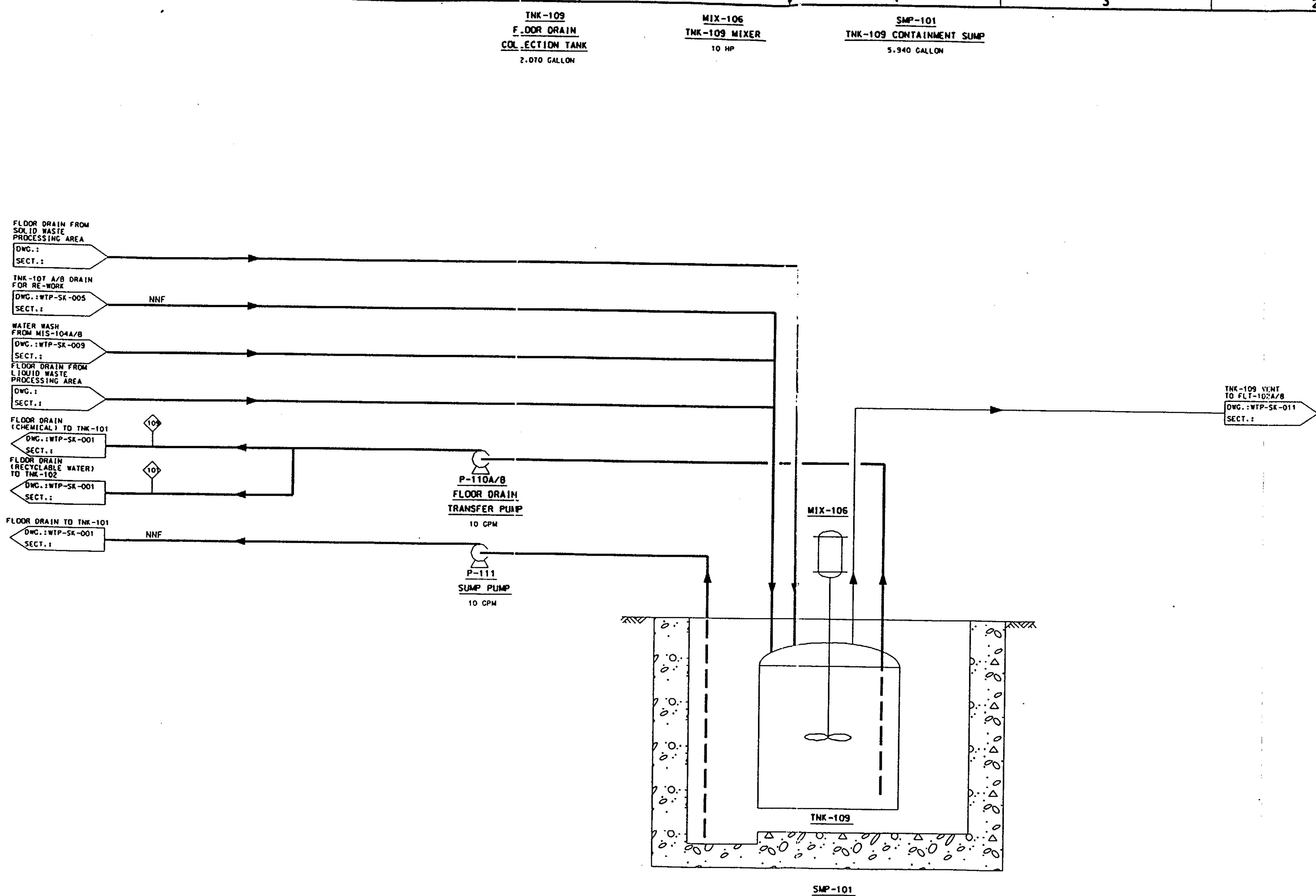
FLOW DIAGRAM
LIQUID LLW PROCESSING

REFERENCE NUMBER	SKETCH NUMBER WTP-SK-008
SCALE NONE	FOR/FIELD BCP NUMBER
ATTACHMENT NO.	CAD FILE WTPSK008.DGN

$$$$USERNAME$$$$ $$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$



BCB000000-01717-5705-00007 REV 00



NOTES :

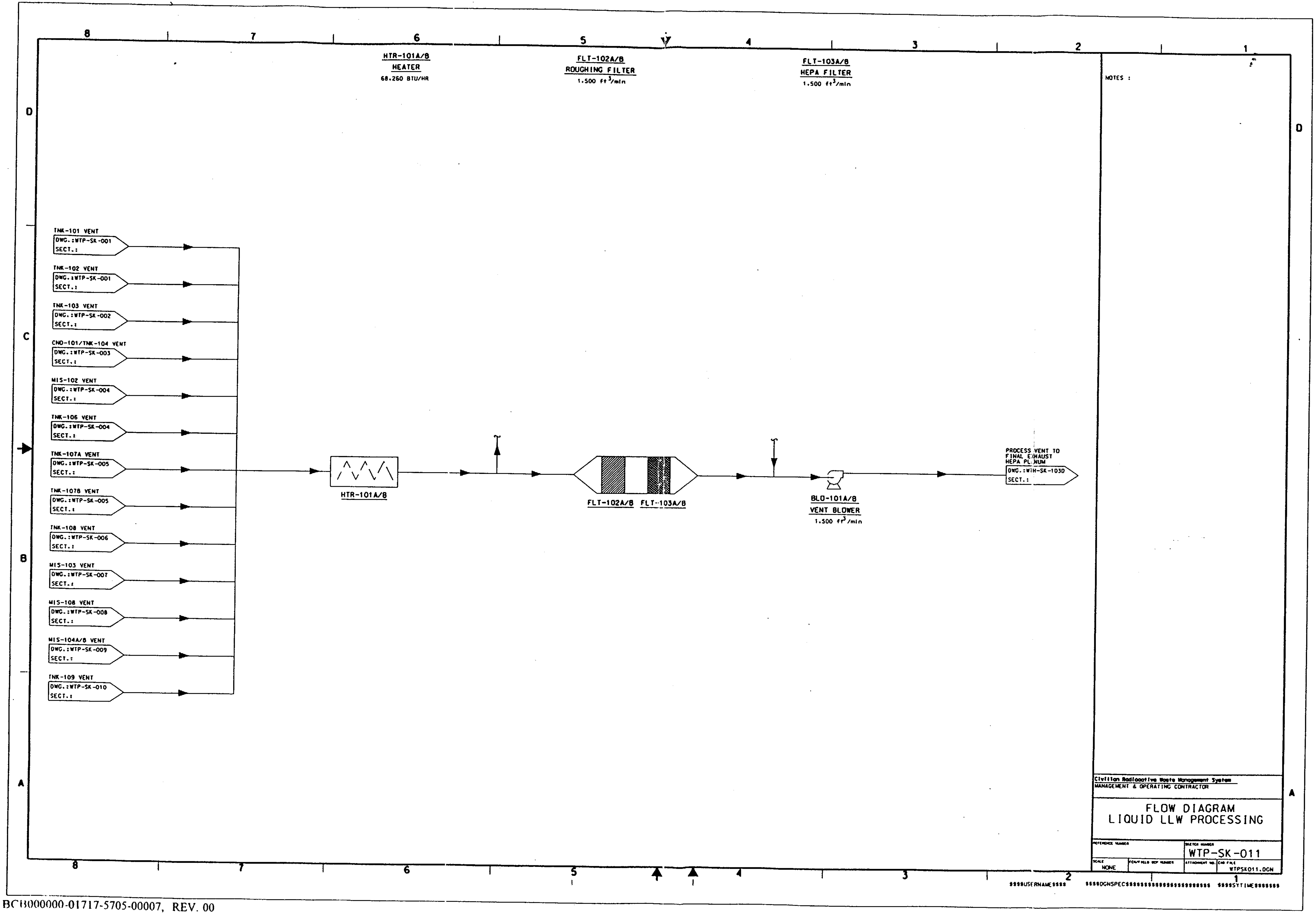
1. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-020.

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

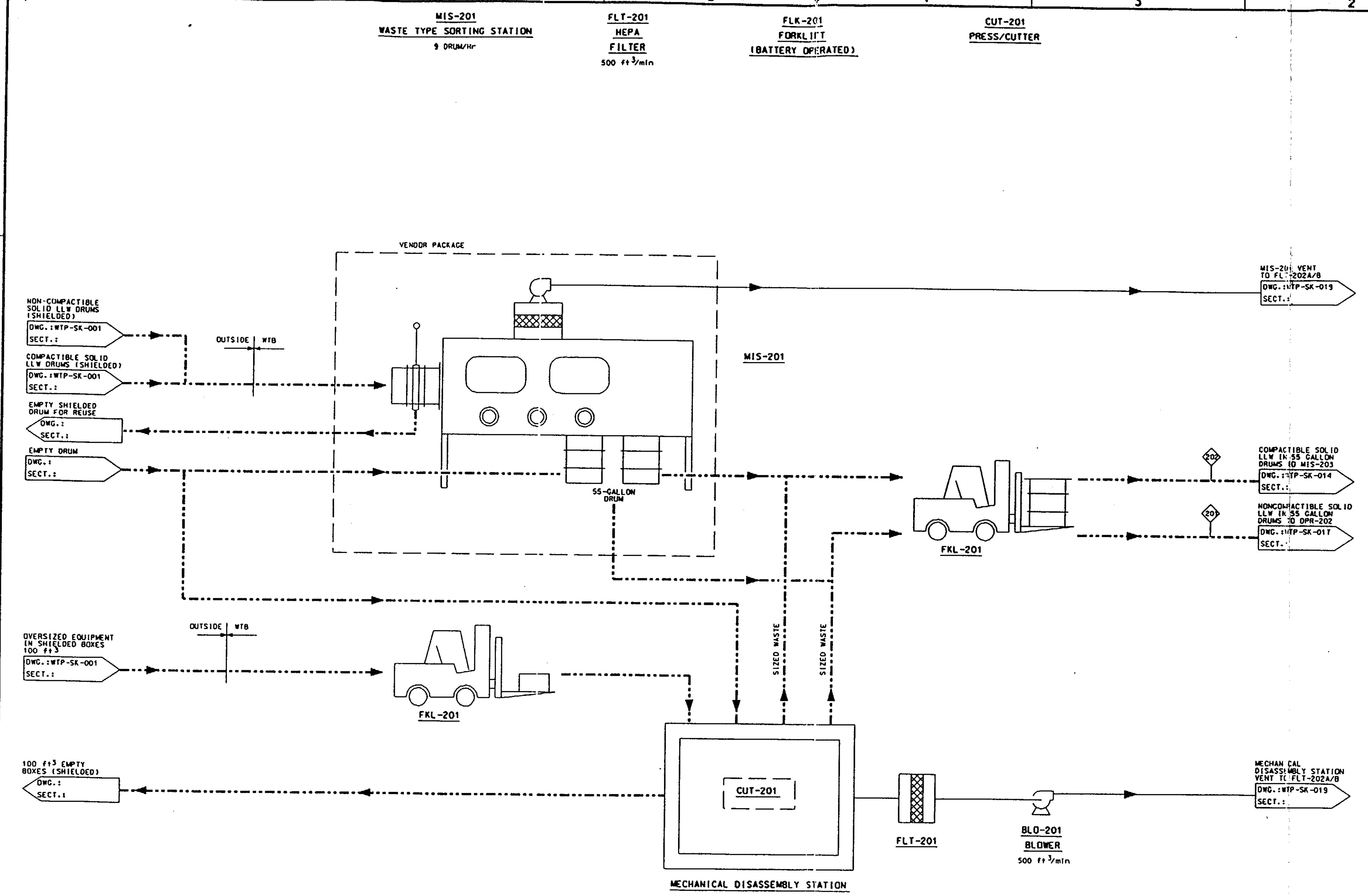
FLOW DIAGRAM
LIQUID LLW PROCESSING

REFERENCE NUMBER	SKETCH NUMBER WTP-SK-010
SCALE NONE	CAD FILE WTPSK010.DGN

$$$$USERNAME$$$$ $$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$



HTR-101A/B
HEATER
68,260 BTU/HR
FLT-102A/B
ROUGHING FILTER
1,500 ft³/min
FLT-103A/B
HEPA FILTER
1,500 ft³/min
NOTES :
TNK-101 VENT
DWG.:WTP-SK-001
SECT.:
TNK-102 VENT
DWG.:WTP-SK-001
SECT.:
TNK-103 VENT
DWG.:WTP-SK-002
SECT.:
CNO-101/TNK-104 VENT
DWG.:WTP-SK-003
SECT.:
MIS-102 VENT
DWG.:WTP-SK-004
SECT.:
TNK-106 VENT
DWG.:WTP-SK-004
SECT.:
TNK-107A VENT
DWG.:WTP-SK-005
SECT.:
TNK-107B VENT
DWG.:WTP-SK-005
SECT.:
TNK-108 VENT
DWG.:WTP-SK-006
SECT.:
MIS-103 VENT
DWG.:WTP-SK-007
SECT.:
MIS-108 VENT
DWG.:WTP-SK-008
SECT.:
MIS-104A/B VENT
DWG.:WTP-SK-009
SECT.:
TNK-109 VENT
DWG.:WTP-SK-010
SECT.:
HTR-101A/B
FLT-102A/B
FLT-103A/B
BLO-101A/B
VENT BLOWER
1,500 ft³/min
PROCESS VENT TO
FINAL EXHAUST
HEPA PLENUM
DWG.:WIH-SK-103D
SECT.:
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
FLOW DIAGRAM
LIQUID LLW PROCESSING
WTP-SK-011
NONE
WTPSK011.DGN



NOTES :

1. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-020.

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

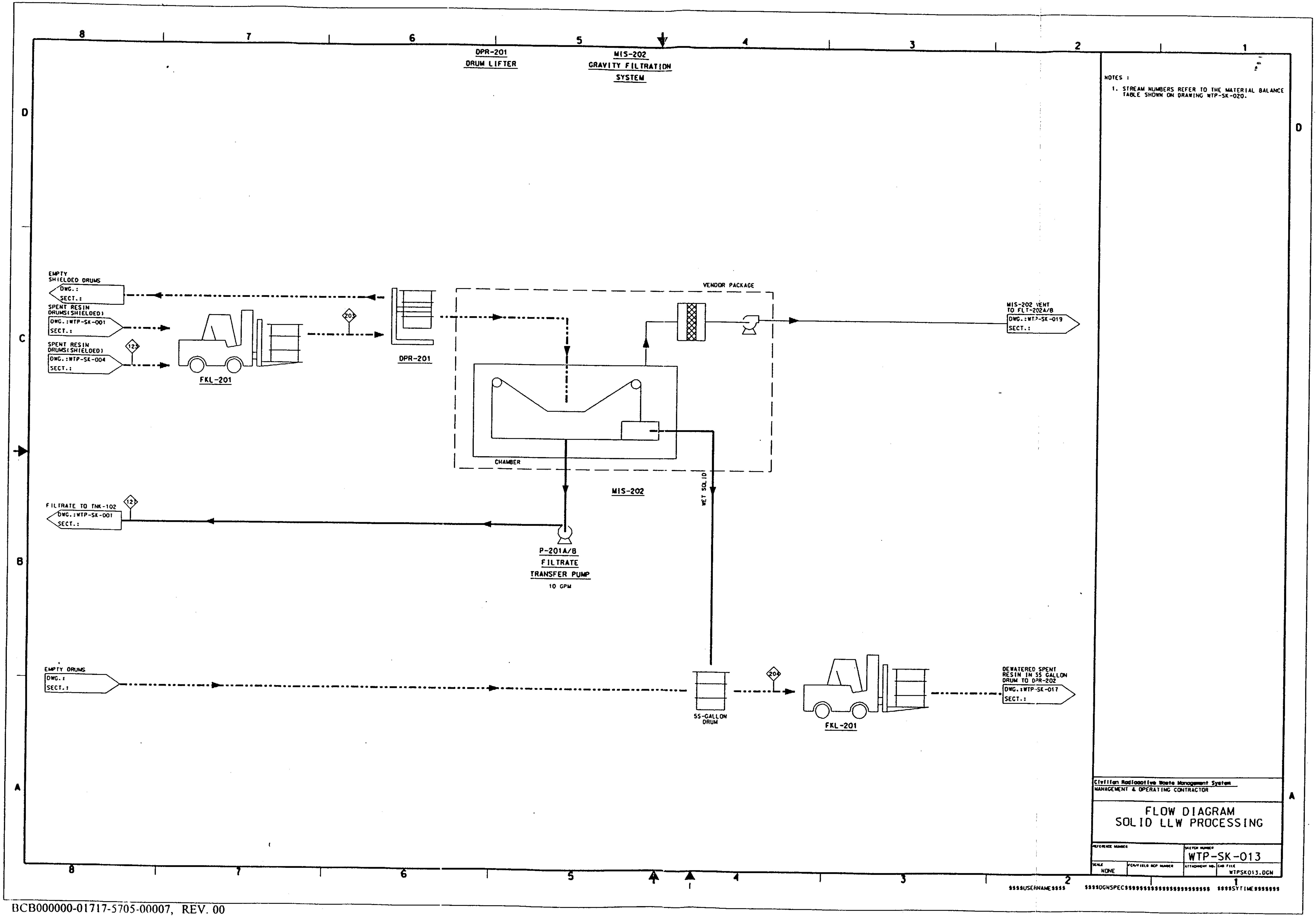
FLOW DIAGRAM
SOLID LLW PROCESSING

SKETCH NUMBER: WTP-SK-012

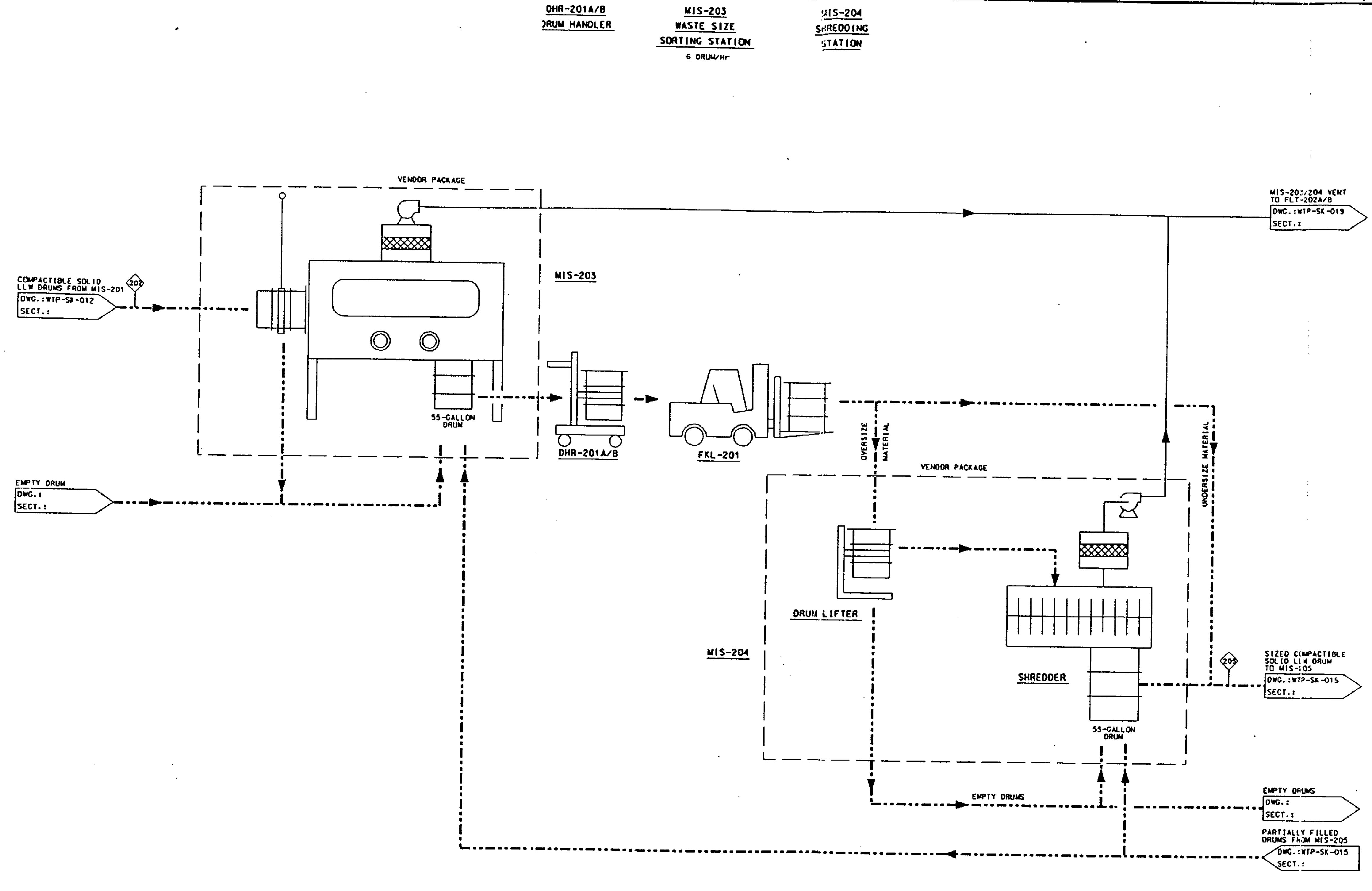
SCALE: NONE

CAD FILE: WTPSK012.DGN

$$$$USERNAME$$$$ $$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$



DPR-201
DRUM LIFTER
MIS-202
GRAVITY FILTRATION
SYSTEM
NOTES :
1. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-020.
EMPTY SHIELDED DRUMS
DWG.:
SECT.:
SPENT RESIN DRUMS(SHIELDED)
DWG.:WTP-SK-001
SECT.:
SPENT RESIN DRUMS(SHIELDED)
DWG.:WTP-SK-004
SECT.:
123
FKL-201
DPR-201
VENDOR PACKAGE
MIS-202 VENT TO FLT-202A/B
DWG.:WTP-SK-019
SECT.:
CHAMBER
MIS-202
WET SOLID
FILTRATE TO TNK-102
DWG.:WTP-SK-001
SECT.:
P-201A/B
FILTRATE
TRANSFER PUMP
10 GPM
EMPTY DRUMS
DWG.:
SECT.:
55-GALLON DRUM
204
FKL-201
DEWATERED SPENT RESIN IN 55 GALLON DRUM TO DPR-202
DWG.:WTP-SK-017
SECT.:
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
FLOW DIAGRAM
SOLID LLW PROCESSING
WTP-SK-013
NONE
WTPSK013.DGN



NOTES :

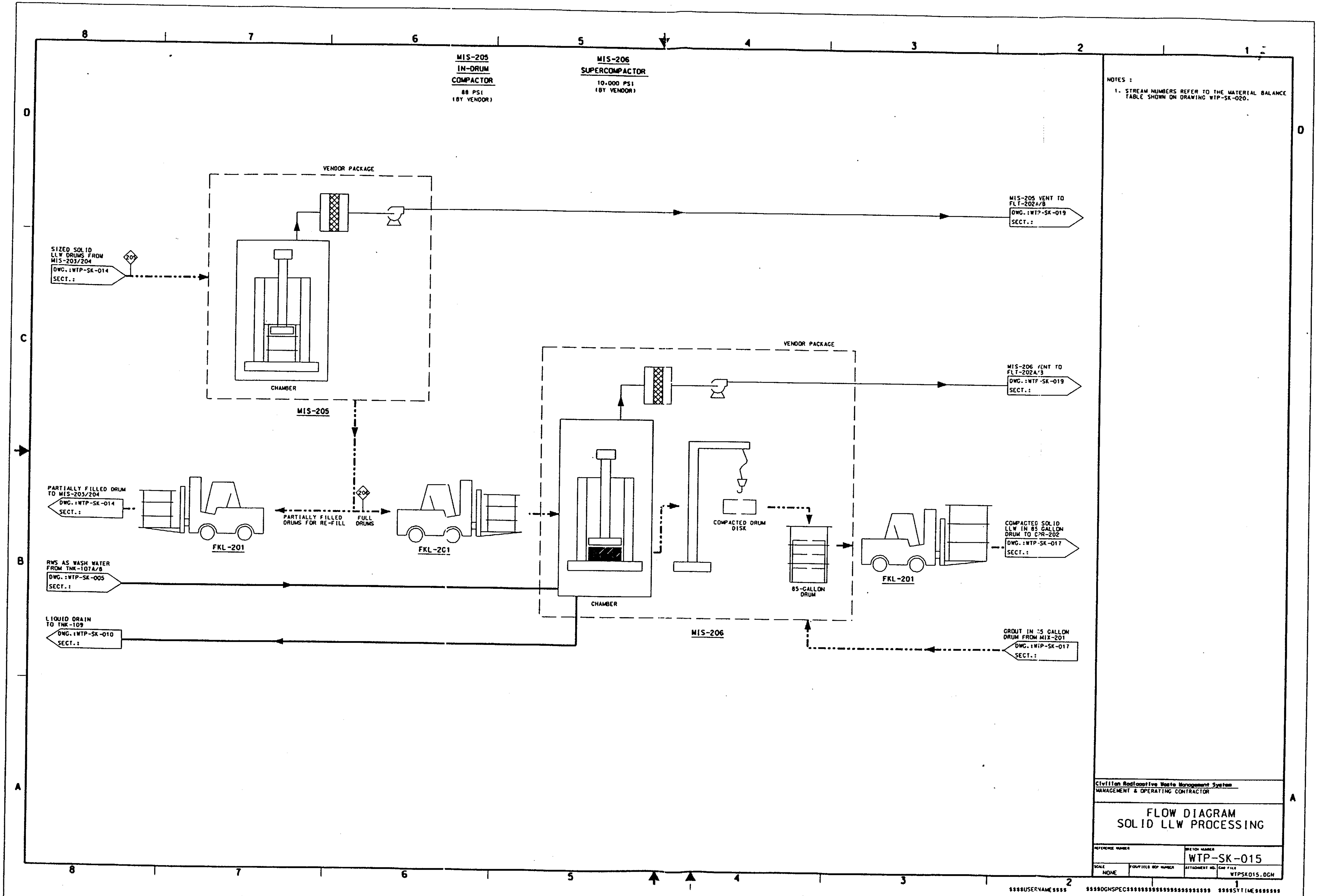
1. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-020.

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

FLOW DIAGRAM SOLID LLW PROCESSING

REFERENCE NUMBER		SKETCH NUMBER	
		WTP-SK-014	
SCALE	FOR/FIELD SCP NUMBER	ATTACHMENT NO.	CAD FILE
NONE			WTPSK014.DGN

$$$$USERNAME$$$$ $$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$



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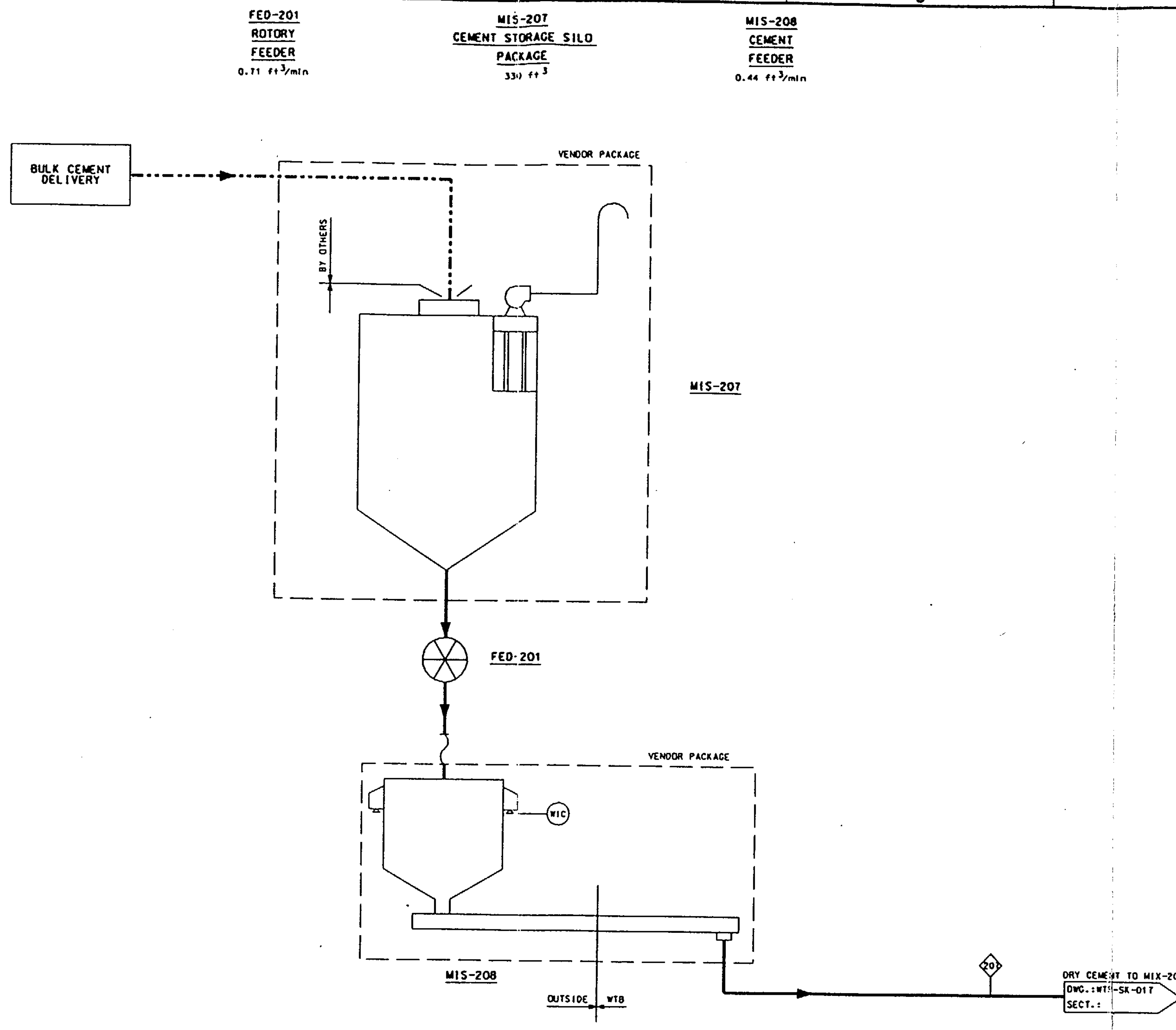


NOTES :

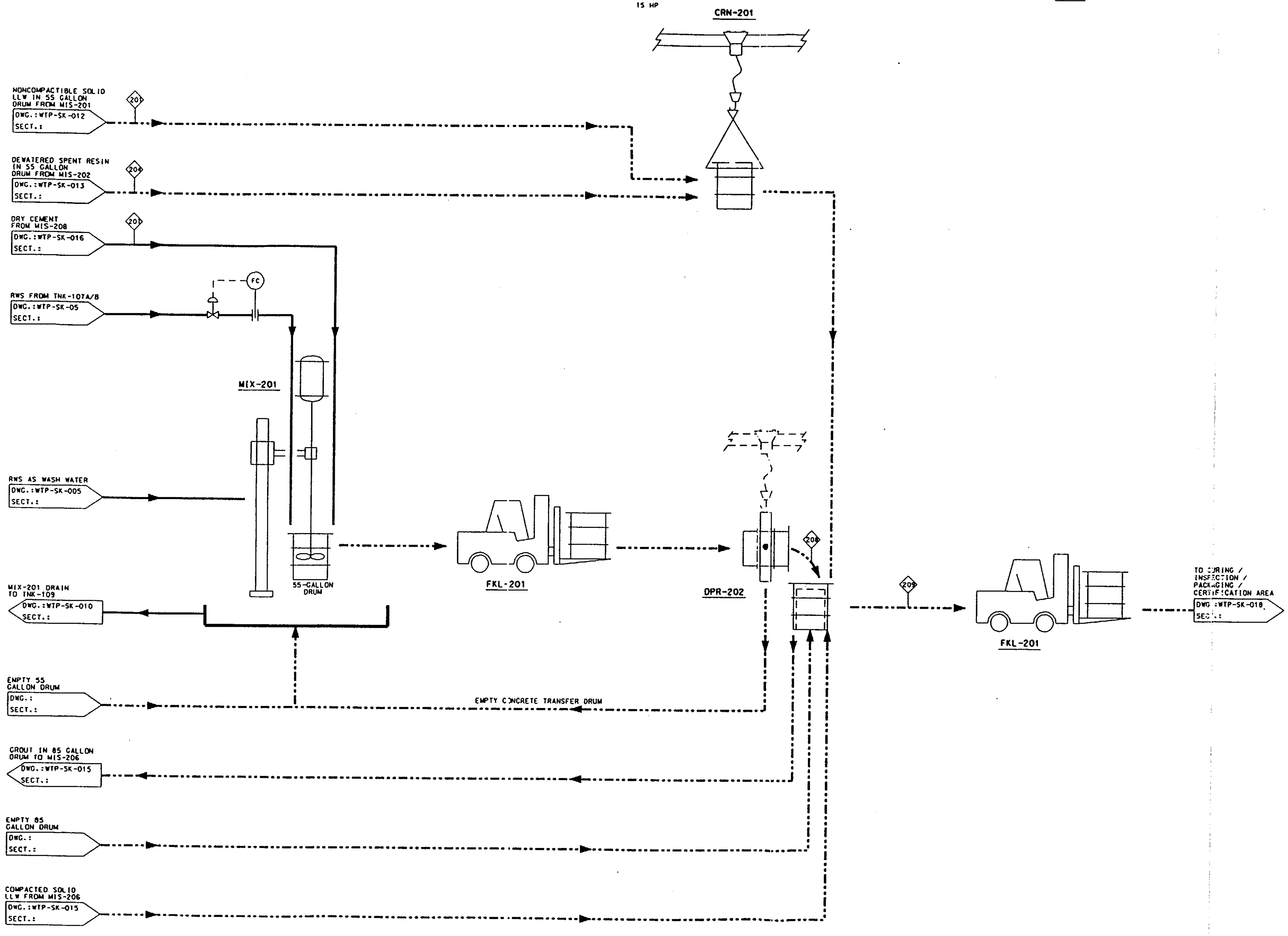
1. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-020.

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

FLOW DIAGRAM
SOLID LLW PROCESSING

REFERENCE NUMBER		SKETCH NUMBER	
		WTP-SK-016	
SCALE NONE		ATTACHMENT NO.	CAD FILE WTPSK016.DGN

$$$$USERNAME$$$$ $$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$



NOTES :

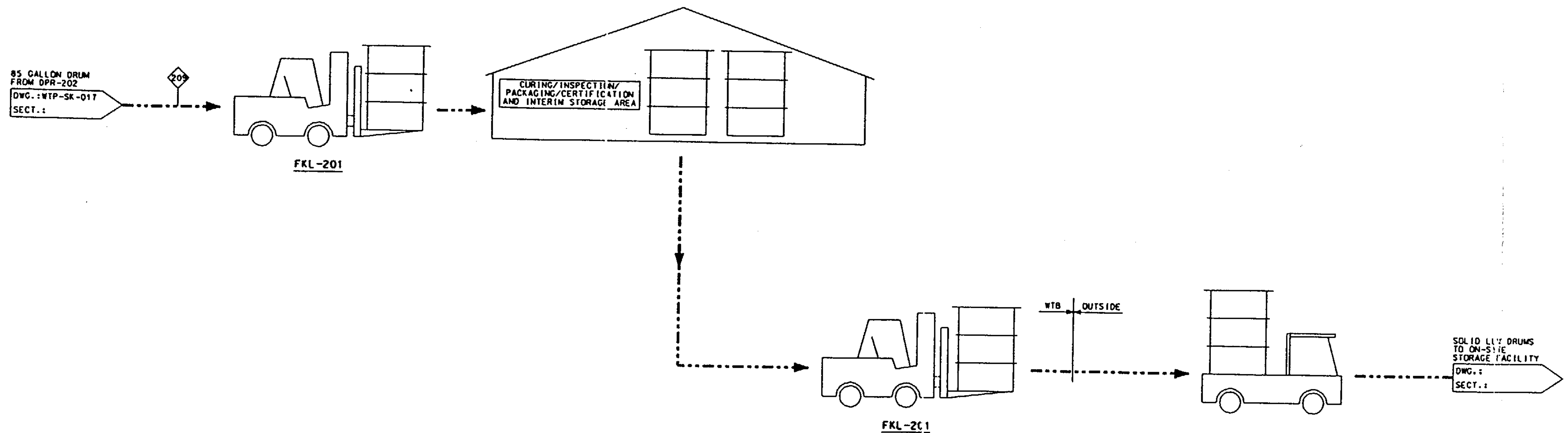
1. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-020.

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

FLOW DIAGRAM SOLID LLW PROCESSING

REFERENCE NUMBER		SKETCH NUMBER	
		WTP-SK-017	
SCALE NONE	FCN/FIELD BOP NUMBER	ATTACHMENT NO.	CAD FILE WTPSK017.DGN

$$$USERNAME$$$$ $$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$



NOTES :

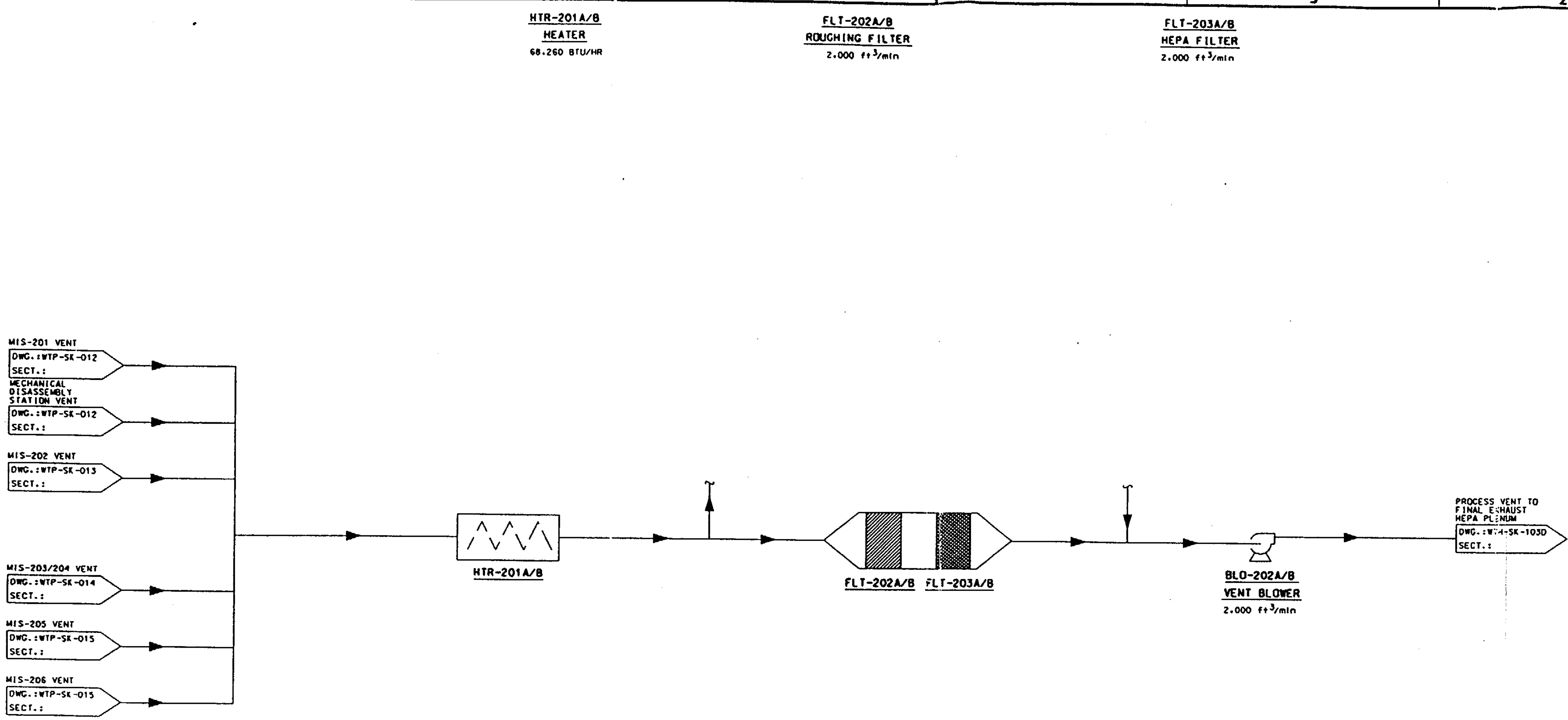
1. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-020.

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

FLOW DIAGRAM
SOLID LLW PROCESSING

REFERENCE NUMBER	SKETCH NUMBER: WTP-SK-018
SCALE: NONE	CAD FILE: WTPSK018.DGN

$$$$USERNAME$$$$ $$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$



Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

FLOW DIAGRAM
SOLID LLW PROCESSING

REFERENCE NUMBER		SKETCH NUMBER	
		WTP-SK-019	
SCALE: NONE	FOR/FIELD DCP NUMBER	ATTACHMENT NO.	CAD FILE: WTPSK019.DGN

$$$$USERNAME$$$$ $$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$

LIQUID LLW PROCESSING

STREAM NO.	101	102	103	104	105	106	107	108	109	110	111	112	113	114
DESCRIPTION	FLOOR DRAIN (RECYCLABLE) FROM TNK-109	FLOOR DRAIN (RECYCLABLE) FROM CMF	FLOOR DRAIN (RECYCLABLE) FROM WHB	CASK DECON. WATER WASH FROM CMF	WASTE PACKAGE WASH FROM WHB	SMALL EQUIP./ TOOL DECON. WATER FROM WHB	TRUCK/RAIL CARRIAGE WASH	TOTAL RECYCLABLE LIQUID LLW	FLOOR DRAIN (CHEMICAL) FROM TNK-109	FLOOR DRAIN (CHEMICAL) FROM CMF	FLOOR DRAIN (CHEMICAL) FROM WHB	CASK DECON. CHEMICAL WATER WASH FROM CMF	SMALL EQUIP./ TOOLS DECON. SOLUTION FROM WHB	TOTAL CHEMICAL LIQUID LLW
GALLONS/YEAR	5,200	21,100	30,300	12,700	1,600	3,100	1,100	75,100	3,400	14,100	20,200	21,500	6,200	65,400
GALLONS/BATCH	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DRUMS/YEAR (55 GALLON)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
lb/DRUM	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BULK DENSITY, lb/ft^3	66.5	66.5	66.5	66.5	66.5	66.5	66.5	66.5	64	64	64	64	64	64
PRESSURE, PSIG	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
TEMPERATURE, °F	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT
GPM	—	—	—	—	—	—	—	—	—	—	—	—	—	—

STREAM NO.	115	116	117	118	119	120	121	122	123	124	125	126	127
DESCRIPTION	CHEMICAL WASTE TO TNK-108	RECYCLABLE LIQUID WASTE TO FLT-101A/B	FILTRATE FROM FLT-101A/B	EVAPORATOR FEED TO EVP-101	EVAPORATOR OVERHEAD CONDENSATE	EVAPORATOR BOTTOMS	ION EXCHANGE FEED	RECYCLABLE WATER TO TNK-107A/B	SPENT RESIN SLURRY	CHEMICAL WASTE FROM TNK-108	DRUM CONTAINING CHEMICAL WASTE	CEMENT ADDITION TO DRUM	WATER FROM SPENT RESIN DEWATERING MIS-202
GALLONS/YEAR	65,400	75,100	—	—	—	—	—	—	1,728	—	—	—	7,011
GALLONS/BATCH	278	320	318	318	303	26	303	303	144	304	—	—	—
DRUMS/YEAR (55 GALLON)	—	—	—	—	—	—	—	—	—	—	4,370	4,370	—
lb/DRUM	—	—	—	—	—	—	—	—	—	—	143	651	—
BULK DENSITY, lb/ft^3	64	66.5	65.3	65.3	62.4	80.9	62.4	62.4	50	65.2	65.2	94	62.4
PRESSURE, PSIG	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	ATM	ATM	TBD
TEMPERATURE, °F	AMBIENT	AMBIENT	AMBIENT	AMBIENT	107	176	107	107	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT
GPM	9.3	5.3	5.3	1.6	1.4	5	1.7	1.7	5	3.4	—	—	5

SOLID LLW PROCESSING

STREAM NO.	201	202	203	204	205	206	207	208	209
DESCRIPTION	NONCOMPACTIBLE SOLID LLW GENERATED	COMPACTIBLE SOLID LLW GENERATED	SPENT RESIN DRUMS	DEWATERED SPENT RESIN DRUMS	COMPACTIBLE WASTE TO COMPACTOR	COMPACTED WASTE TO SUPERCOMPACTOR	DRY CEMENT FEED	200 LITER DRUM IN 300 LITER DRUM	300 LITER DRUM FOR ON-SITE DISPOSAL
lb/YEAR	1,347,960	267,900	77,268	13,000	267,900	267,900	824,041	—	—
ft^3/YEAR	8,986	26,790	1,545	400	24,558	6,698	8,766	—	—
DRUMS/YEAR (55 GALLON)	1,528	4,555	263	—	4,175	1,140	—	2,005	—
DRUMS/YEAR (85 GALLON)	—	—	—	—	—	—	—	—	2,005
BULK DENSITY, lb/ft^3	150	10	50	32.5	10.9	40	94	—	—
PRESSURE, PSIG	ATM	ATM	ATM	ATM	ATM	ATM	ATM	ATM	ATM
TEMPERATURE, °F	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT

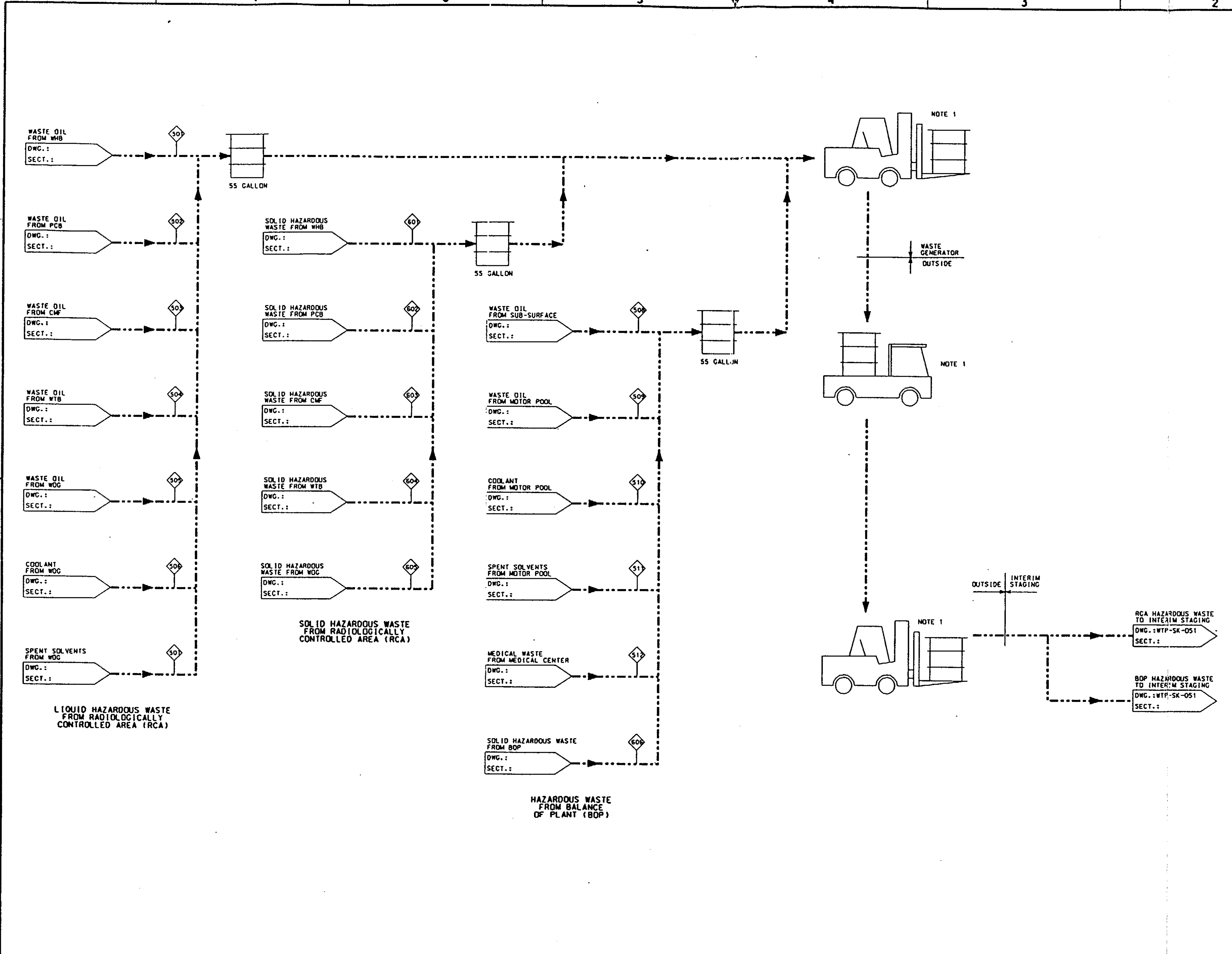
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

LIQUID & SOLID LLW PROCESSING MATERIAL BALANCE

WTP-SK-020

SCALE NONE

WTPSK020.DGN



NOTES :

1. EACH OF THE RCA AND BOP AREAS IS ASSUMED TO HAVE ITS OWN FLEET OF MATERIALS HANDLING TRUCKS THAT ARE SHARED BY THE FACILITIES WITHIN THE AREA.
2. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-052.

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

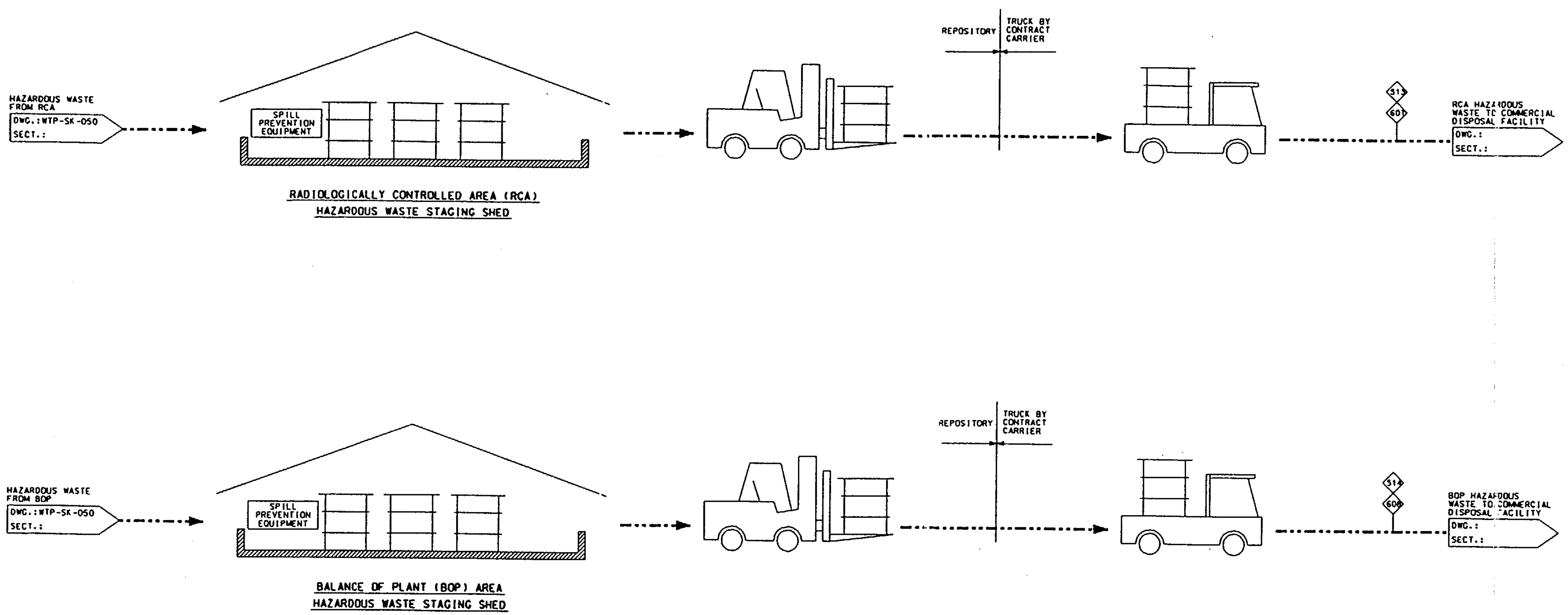
FLOW DIAGRAM HAZARDOUS WASTE HANDLING

REFERENCE NUMBER | SKETCH NUMBER WTP-SK-050
SCALE NONE | CAD FILE WTPSK050.DGN

$$$$USERNAME$$$$ $$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$

NOTES :

1. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-052.



Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

FLOW DIAGRAM HAZARDOUS WASTE HANDLING

REFERENCE NUMBER		SKETCH NUMBER	
		WTP-SK-051	
SCALE: NONE	FCN/FIELD DCP NUMBER	ATTACHMENT NO.	CAD FILE: WTPSK051.DGN

$$$$USERNAME$$$$ $$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$

LIQUID HAZARDOUS WASTE

STREAM NO.	501	502	503	504	505	506	507
DESCRIPTION	WASTE OIL FROM WHB	WASTE OIL FROM PCB	WASTE OIL FROM CMF	WASTE OIL FROM WTB	WASTE OIL FROM WOG	COOLANT FROM WOG	SPENT SOLVENTS FROM WOG
lb/YEAR	3,638	46	12	97	65	42	510
GALLONS/YEAR	486	6.2	1.6	13	8.7	4.8	72
DRUMS/YEAR (55 GALLON)	—	—	—	—	—	—	—
BULK DENSITY, lb/ft^3	56	56	56	56	56	66	53
PRESSURE, PSIG	ATM	ATM	ATM	ATM	ATM	ATM	ATM
TEMPERATURE, °F	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT

STREAM NO.	508	509	510	511	512	513	514
DESCRIPTION	WASTE OIL FROM SUB-SURFACE	WASTE OIL FROM MOTOR POOL	COOLANT FROM MOTOR POOL	SPENT SOLVENTS FROM MOTOR POOL	MEDICAL WASTE FROM MEDICAL CENTER	RCA LIQUID HW TO OFFSITE DISPOSAL	BOP LIQUID HW TO OFFSITE DISPOSAL
lb/YEAR	88,459	252	238	510	111	4,410	89,600
GALLONS/YEAR	11,816	34	27	72	12	600	12,000
DRUMS/YEAR (55 GALLON)	—	—	—	—	—	13	220
BULK DENSITY, lb/ft^3	56	56	66	53	69	—	—
PRESSURE, PSIG	ATM	ATM	ATM	ATM	ATM	ATM	ATM
TEMPERATURE, °F	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT

SOLID HAZARDOUS WASTE

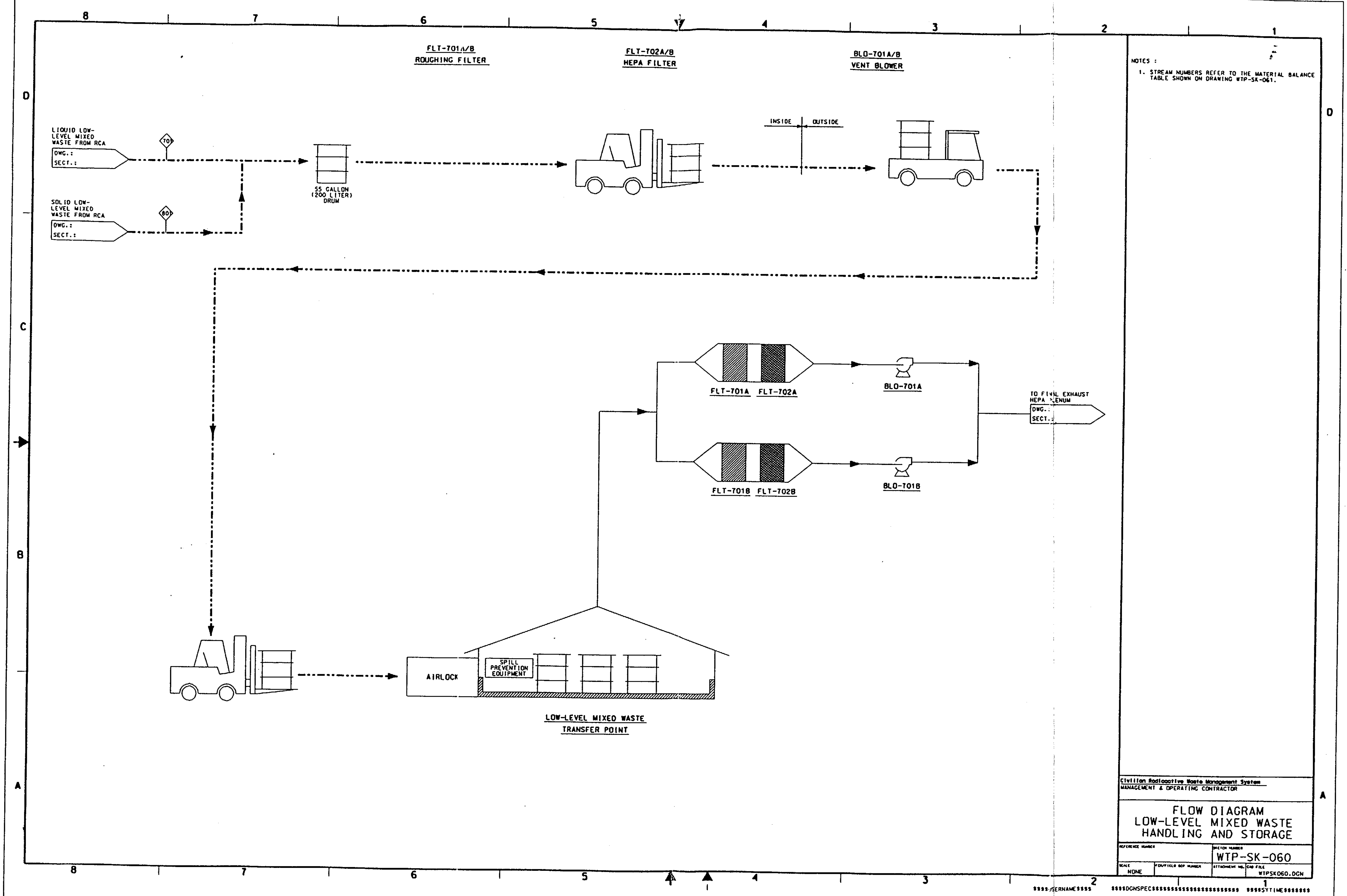
STREAM NO.	601	602	603	604	605	606	607	608
DESCRIPTION	SOLID HW FROM WHB	SOLID HW FROM PCB	SOLID HW FROM CMF	SOLID HW FROM WTB	SOLID HW FROM WOG	SOLID HW FROM BOP	RCA HW TO OFFSITE DISPOSAL	BOP HW TO OFFSITE DISPOSAL
lb/YEAR	6,143	79	20	164	1,081	149,720	7,486	149,720
ft^3/YEAR	154	2	0.5	4	27	3,743	187	3,743
DRUMS/YEAR (55 GALLON)	—	—	—	—	—	—	26	510
BULK DENSITY, lb/ft^3	40	40	40	40	40	40	40	40
PRESSURE, PSIG	ATM	ATM	ATM	ATM	ATM	ATM	ATM	ATM
TEMPERATURE, °F	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

FLOW DIAGRAM
HAZARDOUS WASTE HANDLING
MATERIAL BALANCE

REFERENCE NUMBER | SKETCH NUMBER: WTP-SK-052
SCALE: NONE | ATTACHMENT NO. | CAD FILE: WTPSK052.DGN

$$$$USERNAME$$$$ $$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$


FLT-701A/B
ROUGHING FILTER
FLT-702A/B
HEPA FILTER
BLO-701A/B
VENT BLOWER
LIQUID LOW-LEVEL MIXED WASTE FROM RCA
DWG.:
SECT.:
70
SOLID LOW-LEVEL MIXED WASTE FROM RCA
DWG.:
SECT.:
80
55 GALLON (200 LITER) DRUM
INSIDE
OUTSIDE
FLT-701A
FLT-702A
BLO-701A
FLT-701B
FLT-702B
BLO-701B
DWG.:
SECT.:
AIRLOCK
SPILL PREVENTION EQUIPMENT
LOW-LEVEL MIXED WASTE TRANSFER POINT
NOTES :
1. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-061.
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
FLOW DIAGRAM
LOW-LEVEL MIXED WASTE
HANDLING AND STORAGE
WTP-SK-060
NONE
WTPSK060.DGN
$$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$$

LIQUID LL MIXED WASTE

STREAM NO.	701
DESCRIPTION	LIQUID LL MIXED WASTE FROM RCA
lb/YEAR	243
GALLONS/YEAR	32
DRUMS/YEAR (55 GALLON)	1
BULK DENSITY, lb/ft^3	56
PRESSURE, PSIG	ATM
TEMPERATURE,°F	AMBIENT

SOLID LL MIXED WASTE

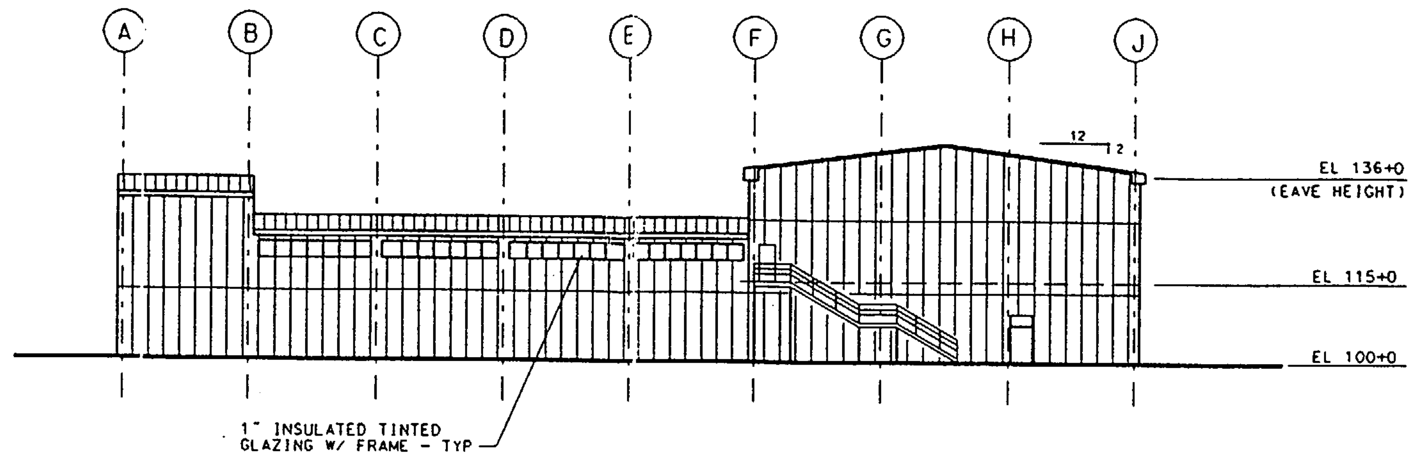
STREAM NO.	801
DESCRIPTION	SOLID LL MIXED WASTE FROM RCA
lb/YEAR	440
ft^3/YEAR	11
DRUMS/YEAR (55 GALLON)	2
BULK DENSITY, lb/ft^3	40
PRESSURE, PSIG	ATM
TEMPERATURE,°F	AMBIENT

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

FLOW DIAGRAM
LOW-LEVEL MIXED WASTE
MATERIAL BALANCE

SKETCH NUMBER: WTP-SK-061
SCALE: NONE
CAD FILE: WTPSK061.DGN

$$$$USERNAME$$$$ $$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$

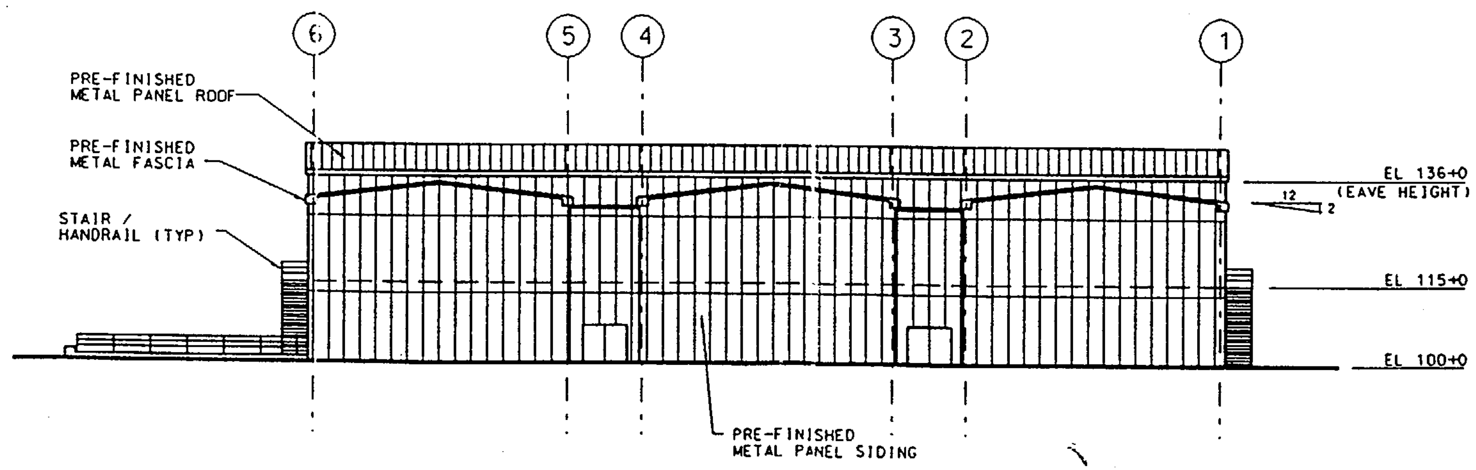


SOUTH ELEVATION

GRAPHIC SCALE

0 8 16 24 32 40 48 FEET

1/16" = 1'-0"



WEST ELEVATION

GRAPHIC SCALE

0 8 16 24 32 40 48 FEET

1/16" = 1'-0"

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

WASTE TREATMENT BUILDING
GENERAL ARRANGEMENT
ELEVATIONS

WTA-SK-006

SCALE 1/16"=1'-0"

WTA-SK-006

freeman

/rep/reps/arch/dgn/wta-sk-006.dgn 17-AUG-1995 13:30

CHEMICAL LIQUID LLW AREA EQUIPMENT

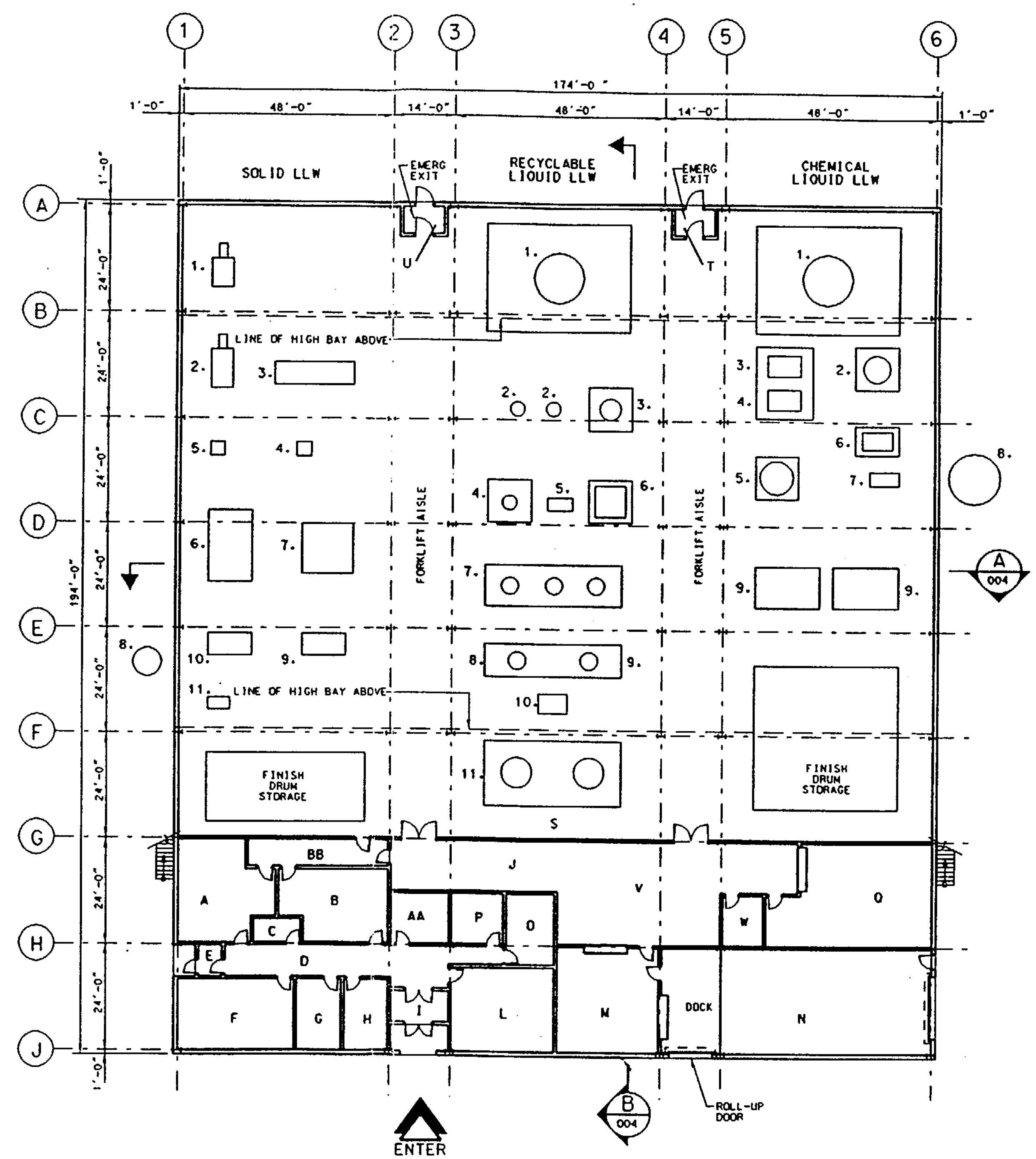
1. TNK-101 - CHEMICAL LIQUID LLW COLLECTION TANK
2. TNK-108 - pH ADJUSTMENT TANK
3. MIS-105 - CAUSTIC INJECTION SKID
4. MIS-106 - ACID INJECTION SKID
5. TNK-109 - FLOOR DRAIN COLLECTION TANK
6. MIS-103 - CHEMICAL WASTE DRUM FILLING STATION
7. MIS-108 - CEMENT FEEDER
8. MIS-107 - CEMENT STORAGE SILO
9. MIS-104 - CEMENT MIXING STATION

RECYCLABLE LIQUID LLW AREA EQUIPMENT

1. TNK-102 - RECYCLABLE LIQUID LLW COLLECTION TANK
2. FLT-101 - CARTRIDGE FILTERS
3. TNK-103 - EVAPORATOR FEED TANK
4. TNK-104 - CONDENSATE COLLECTION TANK
5. CND-101 - CONDENSER
6. EVP-101 - EVAPORATOR
7. INX-101 - ION EXCHANGE COLUMNS
8. TNK-105 - RESIN FEED TANK
9. TNK-106 - SPENT RESIN CATCH TANK
10. MIS-102 - SPENT RESIN DRUM FILLING STATION
11. TNK-107 - RECYCLE WATER STORAGE TANKS

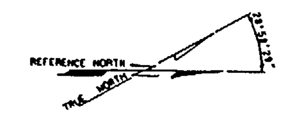
SOLID LLW AREA EQUIPMENT

1. MIS-201 - WASTE TYPE SORTING STATION
2. MIS-203 - WASTE SIZE SORTING STATION
3. MIS-204 - SIZE REDUCING STATION
4. MIS-205 - IN-DRUM COMPACTOR
5. MIS-206 - SUPERCOMPACTOR
6. CUT-201 - PRESS / CUTTER (MECH DISASSEMBLY AREA)
7. MIS-202 - DEWATERING STATION
8. MIS-207 - CEMENT STORAGE SILO
9. MIX-201 - DRUM MIXING STATION
10. MIS-208 - CEMENT FEEDER
11. DPR-202 - DRUM LIFTER



WASTE TREATMENT BUILDING FLOOR PLAN AT EL. 100+0

GRAPHIC SCALE
0 8 16 24 32 40 48 FEET
1/16" = 1'-0"



PLAN AT EL. 100+0

A. WOMEN'S TOILET / CHANGE RM
B. MEN'S TOILET / CHANGE RM
C. JANITOR RM
D. CORRIDOR
E. VESTIBULE
F. BREAK ROOM
G. HEALTH PHYSICS
H. ADMIN OFFICE
I. VESTIBULE
J. FORKLIFT AISLE
K. (NOT USED)
L. OFFICE
M. AIRLOCK / TEMP STORAGE
N. RECEIVING / SHIPPING
O. INVENTORY CONTROL OFFICE
P. QA OFFICE
Q. MIXED WASTE INTERIM STAGING
R. (NOT USED)
S. TOOL STORAGE AREA
T. VESTIBULE
U. VESTIBULE
V. FORKLIFT BATTERY CHARGER
W. SPARE PARTS STORAGE
AA. OFFICE
BB. AIRLOCK

PLAN AT EL. 115+0

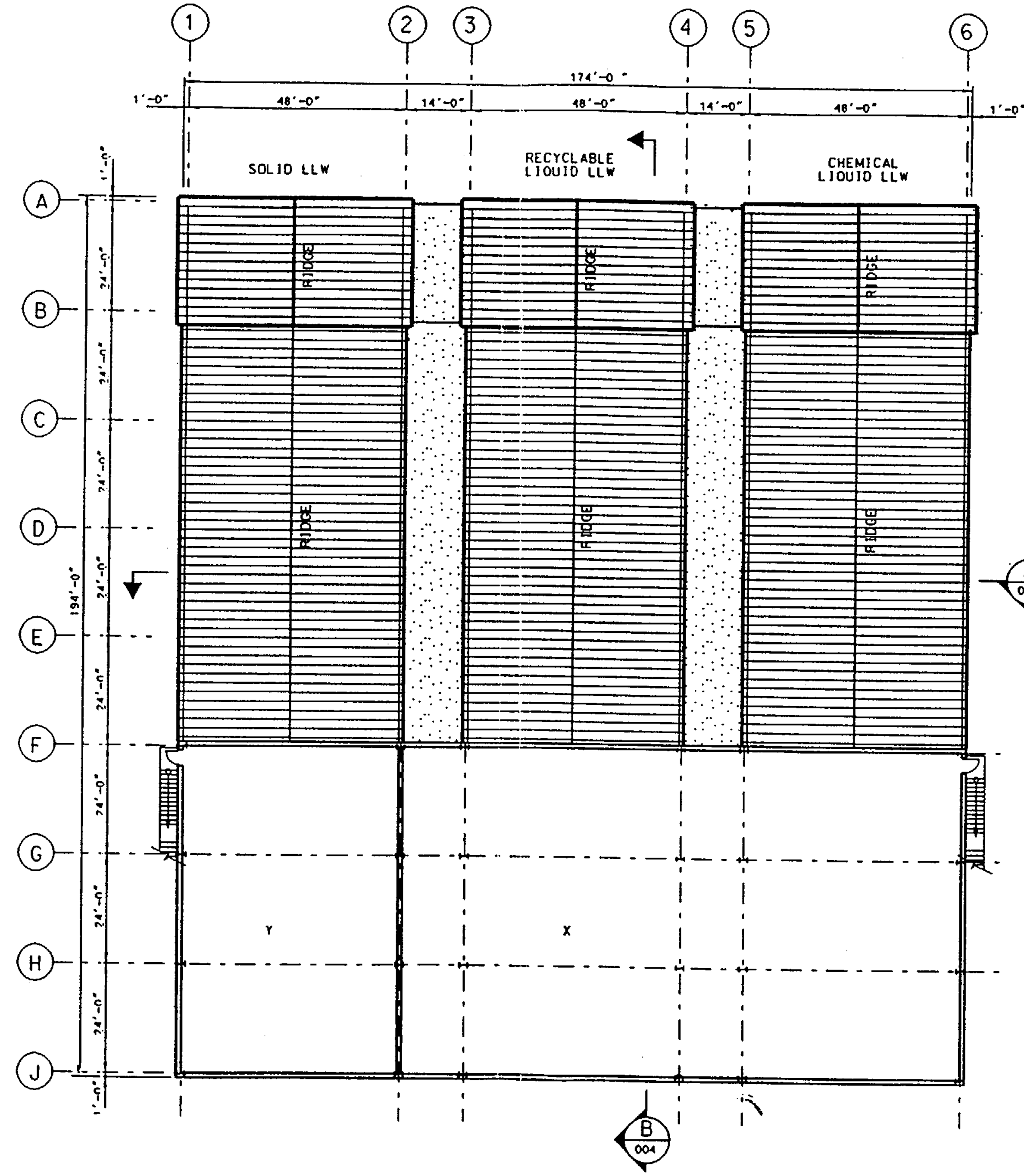
X. MECHANICAL EQUIPMENT ROOM #1
Y. MECHANICAL EQUIPMENT ROOM #2

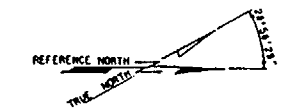
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

WASTE TREATMENT BUILDING GENERAL ARRANGEMENT FLOOR PLAN AT EL 100+0

SKETCH NUMBER: WTA-SK-001
SCALE: 1/16"=1'-0"
CAD FILE: WTA-SK-001a

/rap/raps/arch/dgn/wta-sk-001a.dg 15-SEP-1995 08:05





PLAN AT EL. 100+0

A. WOMEN'S TOILET / CHANGE RM
B. MEN'S TOILET / CHANGE RM
C. JANITOR RM
D. CORRIDOR
E. VESTIBULE
F. BREAK ROOM
G. HEALTH PHYSICS
H. ADMIN OFFICE
I. VESTIBULE
J. FORKLIFT AISLE
K. (NOT USED)
L. OFFICE
M. AIRLOCK / TEMP STORAGE
N. RECEIVING / SHIPPING
O. INVENTORY CONTROL OFFICE
P. QA OFFICE
Q. MIXED WASTE INTERIM STAGING
R. (NOT USED)
S. TOOL STORAGE AREA
T. VESTIBULE
U. VESTIBULE
V. FORKLIFT BATTERY CHARGER
W. SPARE PARTS STORAGE
AA. OFFICE
BB. AIRLOCK

PLAN AT EL. 115+0

X. MECHANICAL EQUIPMENT ROOM #1
Y. MECHANICAL EQUIPMENT ROOM #2

WASTE TREATMENT BUILDING FLOOR PLAN AT EL. 115+0

GRAPHIC SCALE
0 8 16 24 32 40 48 FEET
1/16" = 1'-0"

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

WASTE TREATMENT BUILDING
GENERAL ARRANGEMENT
FLOOR PLAN AT EL 115+0

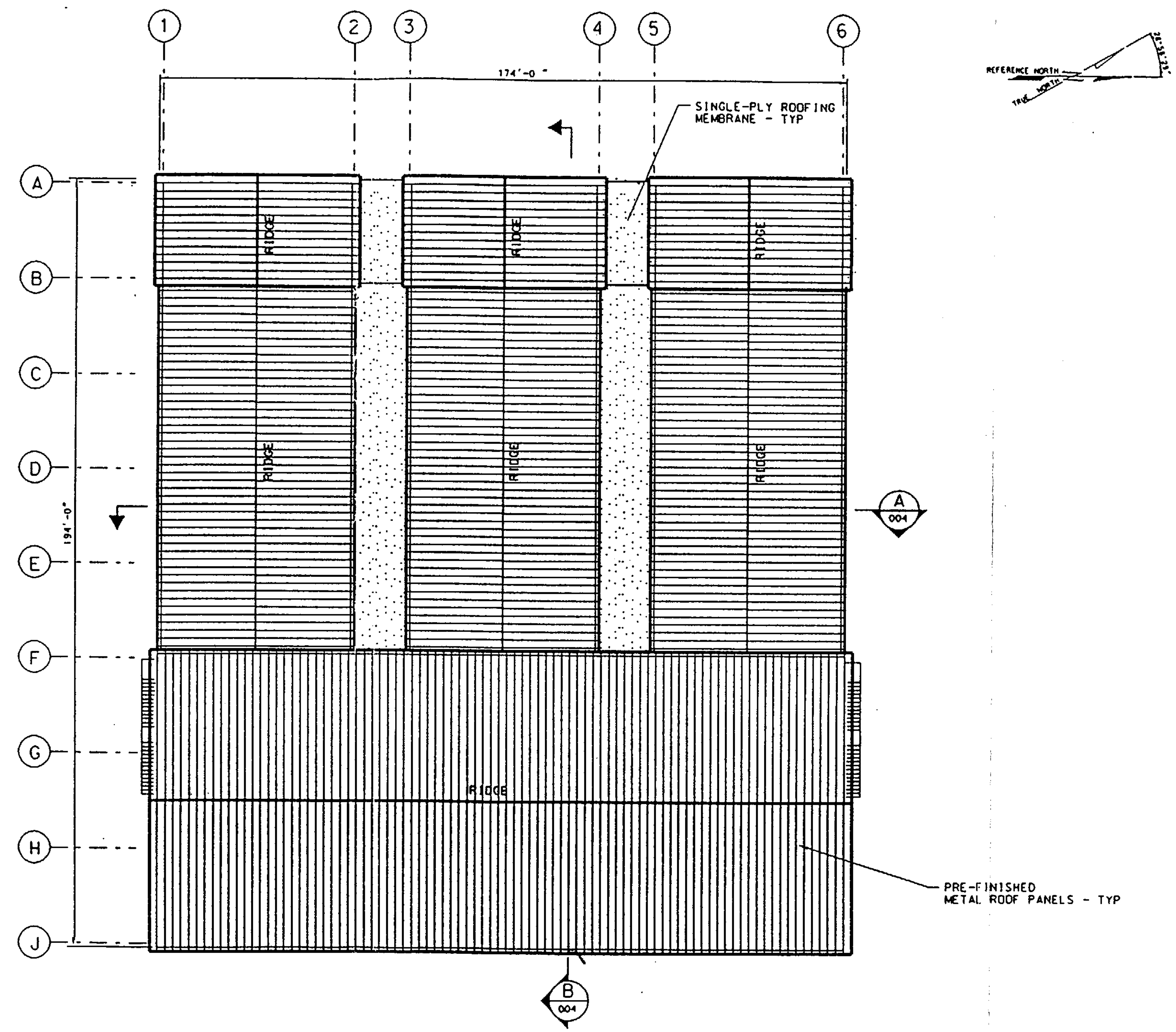
WTA-SK-002

1/16"=1'-0"

wra-sk-012

freeman /rep/reps/arch/dgn/wra-sk-012.dgn 27-SEP-1995 14:01

BCB000000-01717-5705-00007, REV. 00



WASTE TREATMENT BUILDING ROOF PLAN

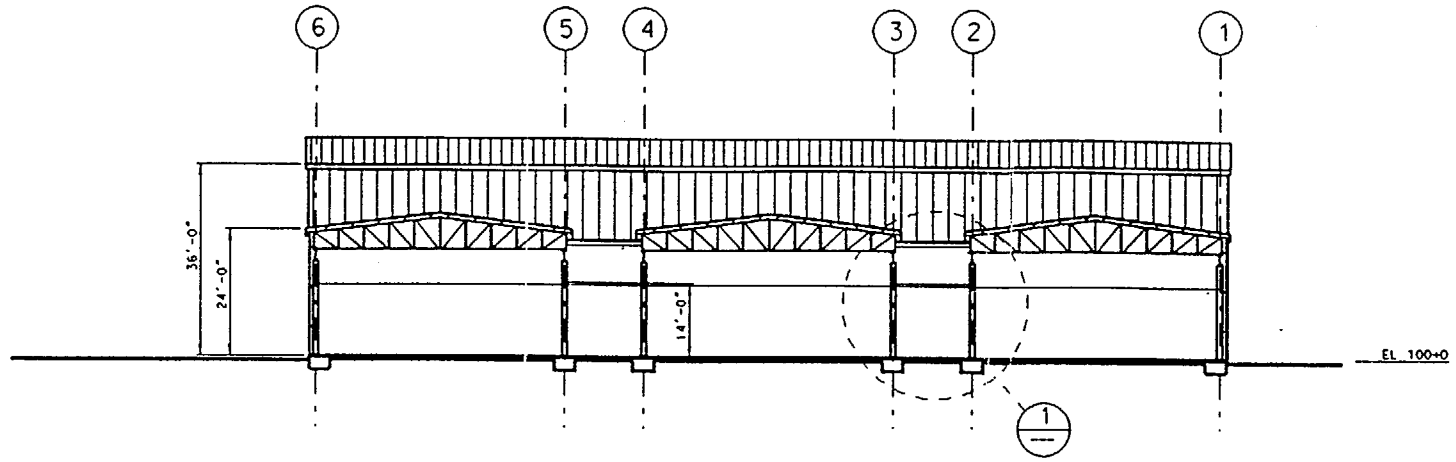
GRAPHIC SCALE

0 8 16 24 32 40 48 FEET

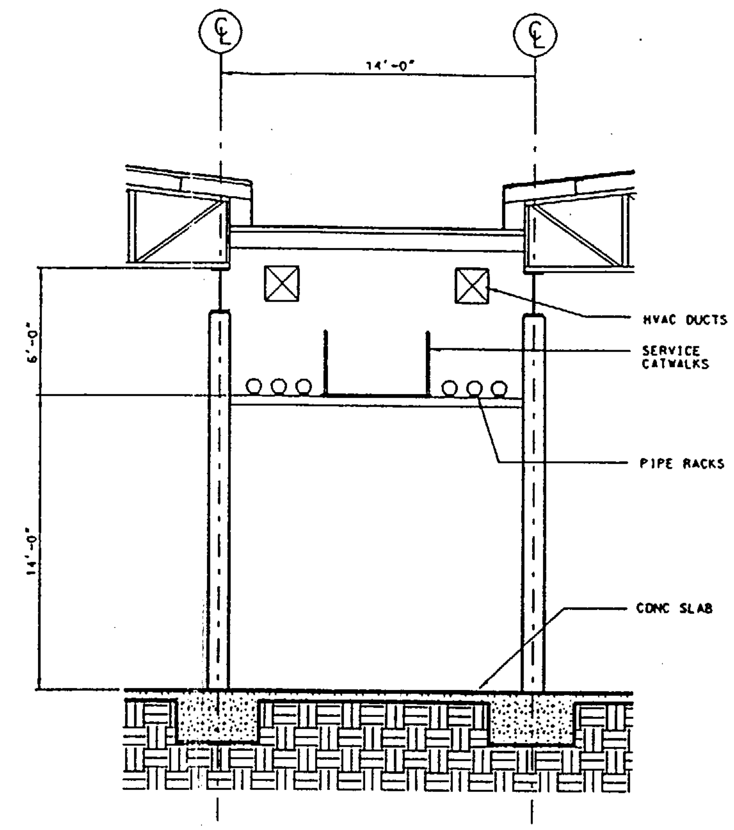
1/16" = 1'-0"

Civilian Radioactive Waste Management System MANAGEMENT & OPERATING CONTRACTOR	
WASTE TREATMENT BUILDING GENERAL ARRANGEMENT ROOF PLAN	
REFERENCE NUMBER	SKETCH NUMBER WTA-SK-003
SCALE 1/16"=1'-0"	CAD FILE WTA-SK-003

freeman /rep/reps/arch/dgn/wta-sk-003.dgn 17-AUG-1995 13:32



SECTION
SCALE: 1/16"=1'-0"
A
001



TYP DETAIL
SCALE: NONE
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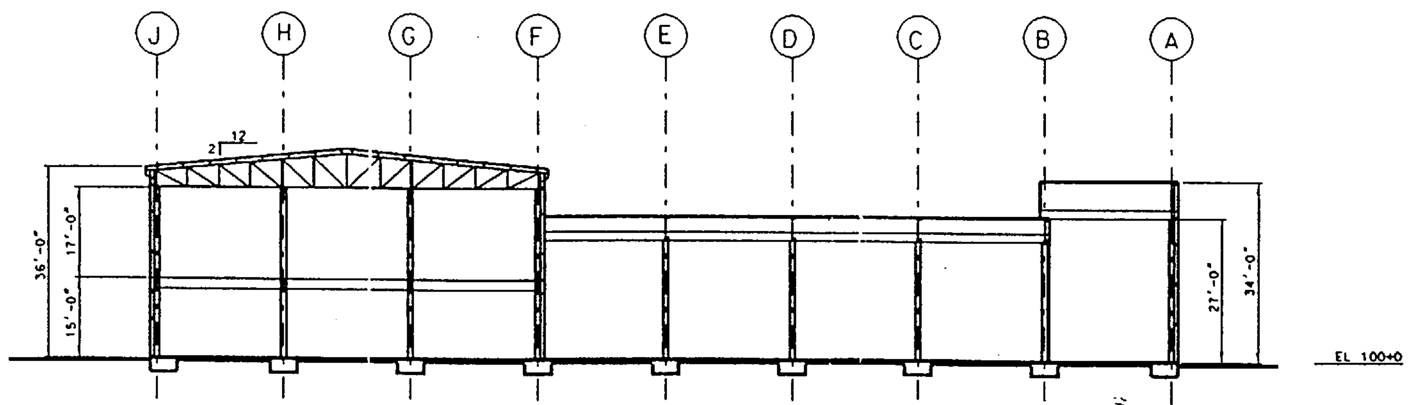


SECTION
SCALE: 1/16"=1'-0"
B
001

GRAPHIC SCALE
0 8 16 24 32 40 48 FEET
1/16" = 1'-0"

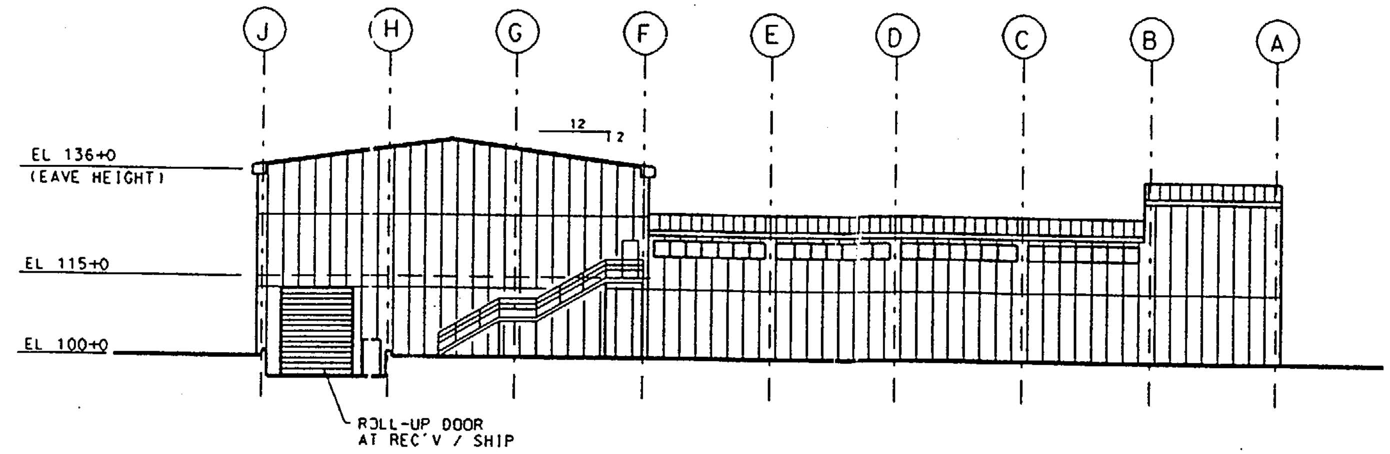
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

WASTE TREATMENT BUILDING
GENERAL ARRANGEMENT
BUILDING SECTIONS

SKETCH NUMBER: WTA-SK-004
SCALE: 1/16"=1'-0"
CAD FILE: WTA-SK-004

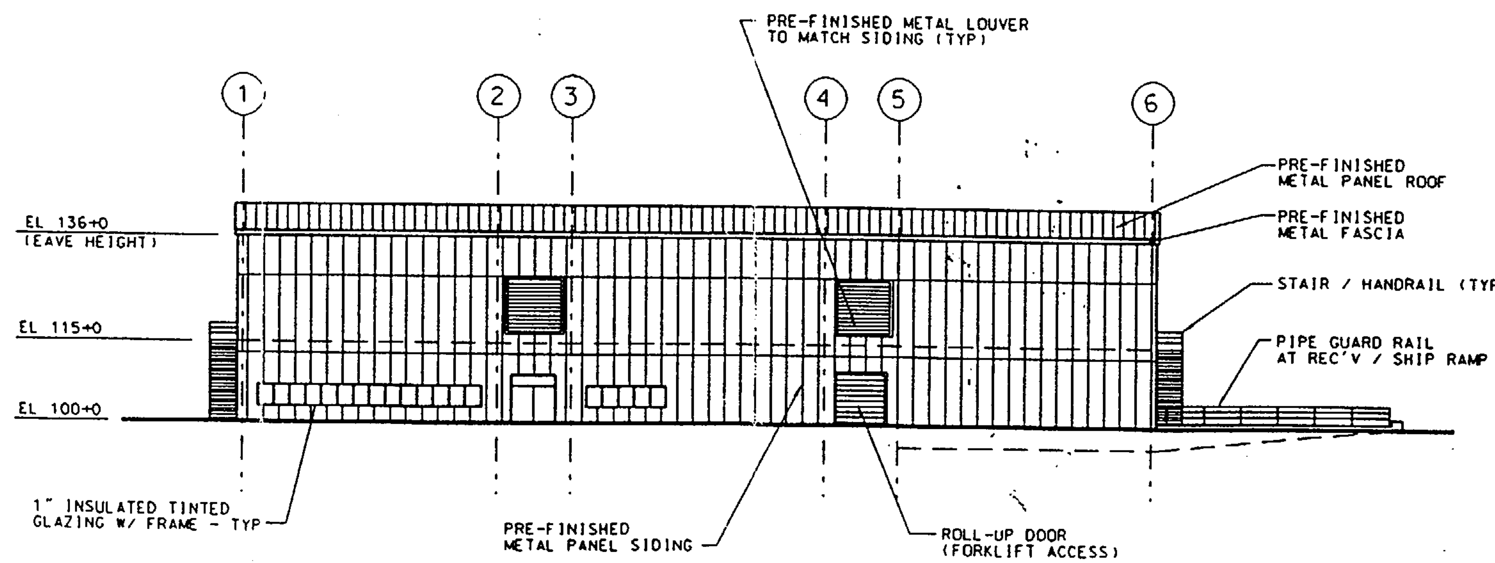
freeman /rep/reps/arch/dgn/wta-sk-004.dgn 17-AUG-1995 13:26

BCB000000-01717-5705-00007, REV. 00



NORTH ELEVATION

GRAPHIC SCALE
0 8 16 24 32 40 48 FEET
1/16" = 1'-0"

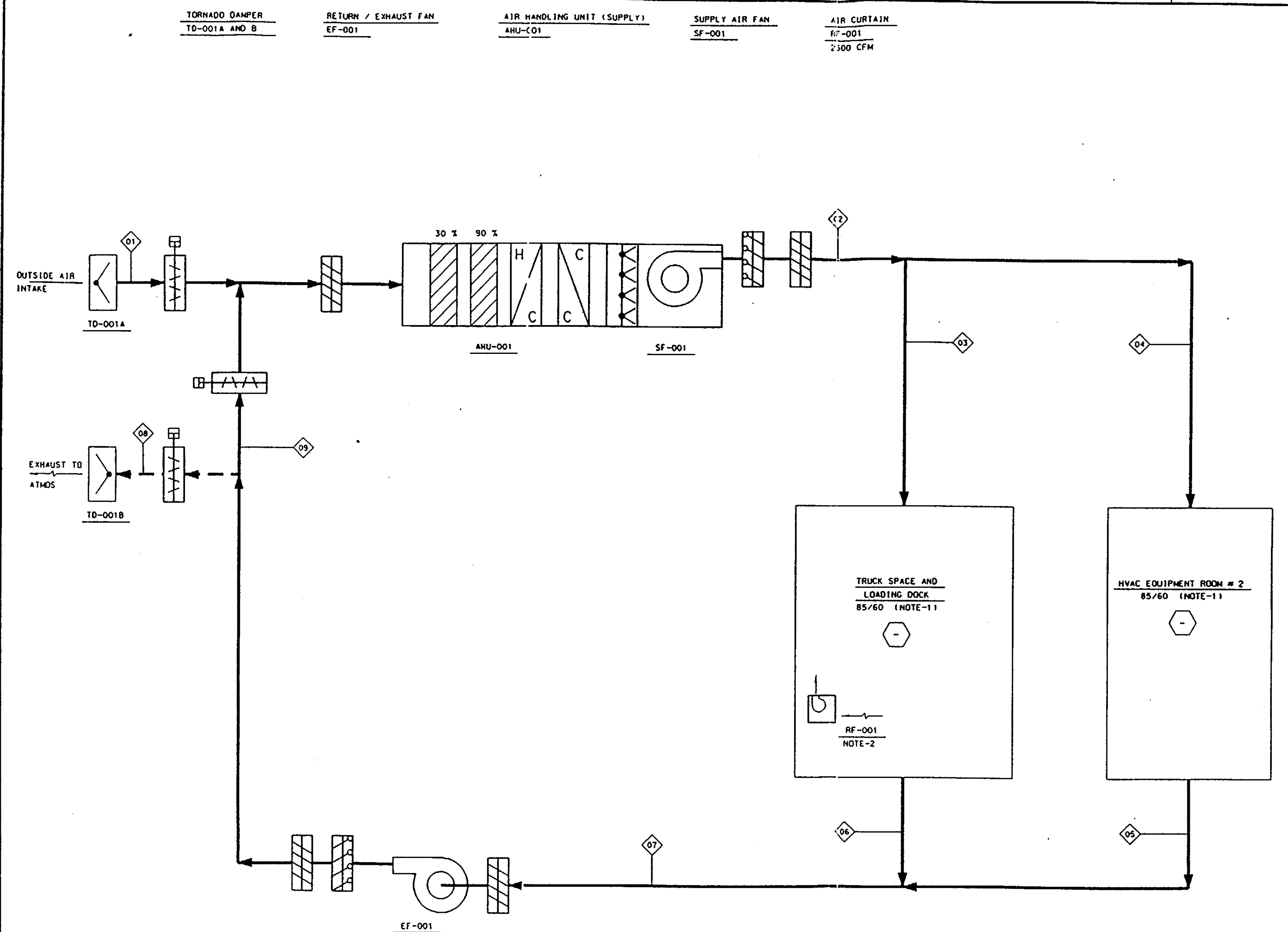


EAST ELEVATION

GRAPHIC SCALE
0 8 16 24 32 40 48 FEET
1/16" = 1'-0"

Civilian Radioactive Waste Management System MANAGEMENT & OPERATING CONTRACTOR
WASTE TREATMENT BUILDING GENERAL ARRANGEMENT ELEVATIONS
WTA-SK-005
SCALE 1/16"=1'-0"
WTA-SK-005

/rep/reps/arch/dgn/wta-sk-005.dgn 14-SEP-1995 15:57



NOTES:

1. INDICATE SUMMER/WINTER MAXIMUM TEMPERATURE (°F).
2. AIR CURTAINS ARE MANUALLY ACTIVATED BY INTEGRAL HAND SWITCH.

SYMBOLS AND LEGEND

- (P) PRESSURE CONTROLLER
- (F) FLOW CONTROLLER
- (-) NJ CONFINEMENT
- (N) NEUTRAL ZONE
- (1) PRIMARY CONFINEMENT
- (2) SECONDARY CONFINEMENT
- (3) TERTIARY CONFINEMENT
- DWG.# SECT. — REFERENCE (DIRECTION)
- AIR FLOW — SUPPLY (DIRECTION)
- AIR FLOW — EXHAUST/RETURN (DIRECTION)
- LEAKAGE/TRANSFER (DIRECTION)
- OPPOSED BLADE DAMPER
- PARALLEL BLADE DAMPER
- BACKDRAFT DAMPER
- TORNADO DAMPER (CHECK)
- FILTER
- HEPA FILTER
- MOISTURE ELIMINATOR
- HEATING COIL (ELECTRIC)
- COOLING COIL
- SPRAY
- FAN WITH INLET VANE DAMPER
- FAN
- BUTTERFLY DAMPER
- LINE NUMBER
- 18 ROOM NUMBER
- AIR FLOW (DIRECTION)
- EXHAUST AIR (DIRECTION)

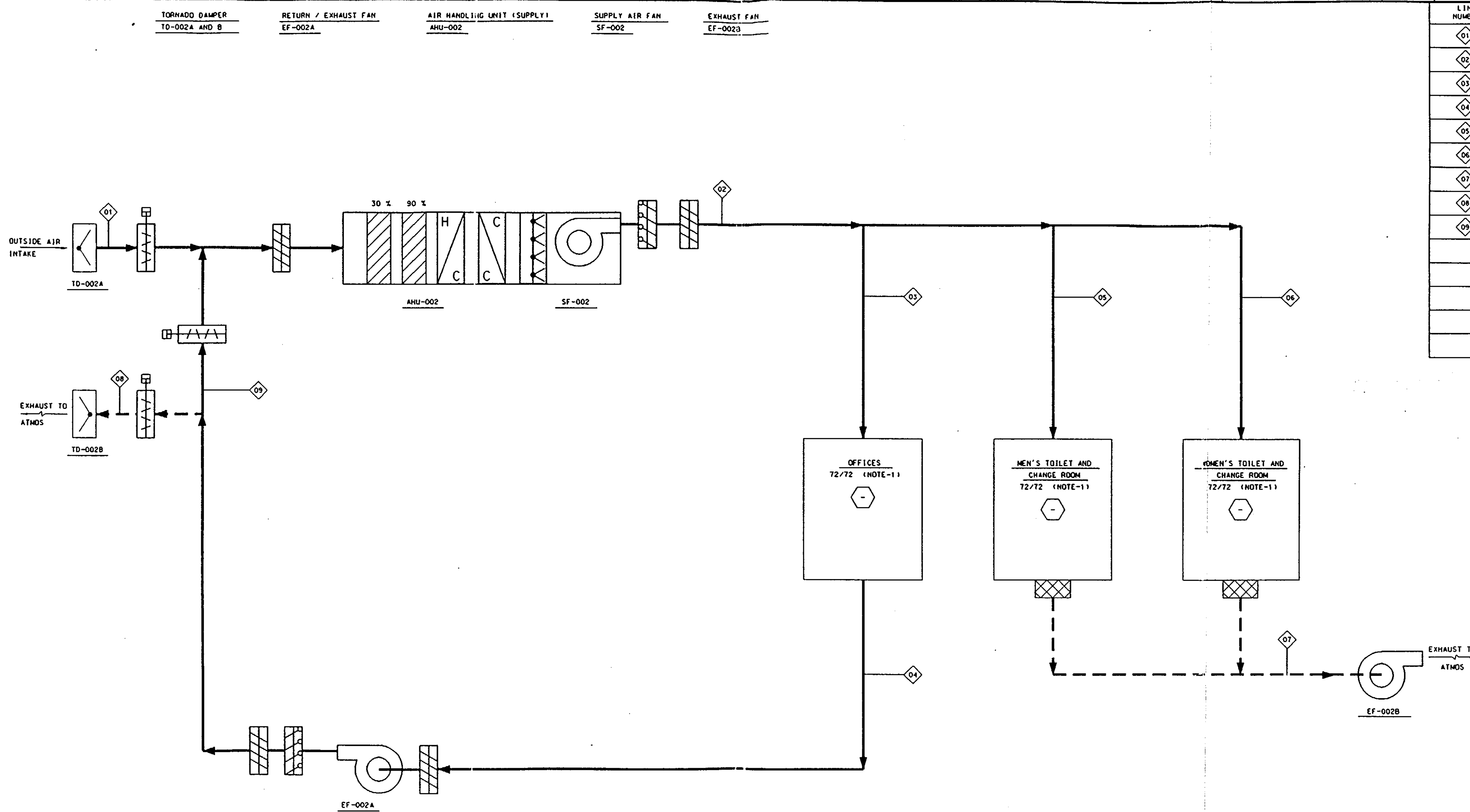
LINE NUMBER	AIR QUANTITY (CFM)
01	670
02	6,700
03	3,000
04	3,700
05	3,700
06	3,000
07	6,700
08	670
09	6,030

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

WASTE TREATMENT BUILDING SHIPPING & RECEIVING AREA HVAC FLOW DIAGRAM

REFERENCE NUMBER | SKETCH NUMBER: WTH-SK-101
SCALE: NONE | FCR/FIELD ECN NUMBER | ATTACHMENT NO. | CAD FILE: WTHSK101.DGN

chung /rep/reps/hvac/dgn/wthsk101.dgn 22-AUG-1995 14:03



LINE NUMBER	AIR QUANTITY (CFM)
01	1,110
02	3,900
03	3,100
04	3,100
05	400
06	400
07	800
08	1,110
09	2,790

NOTE:

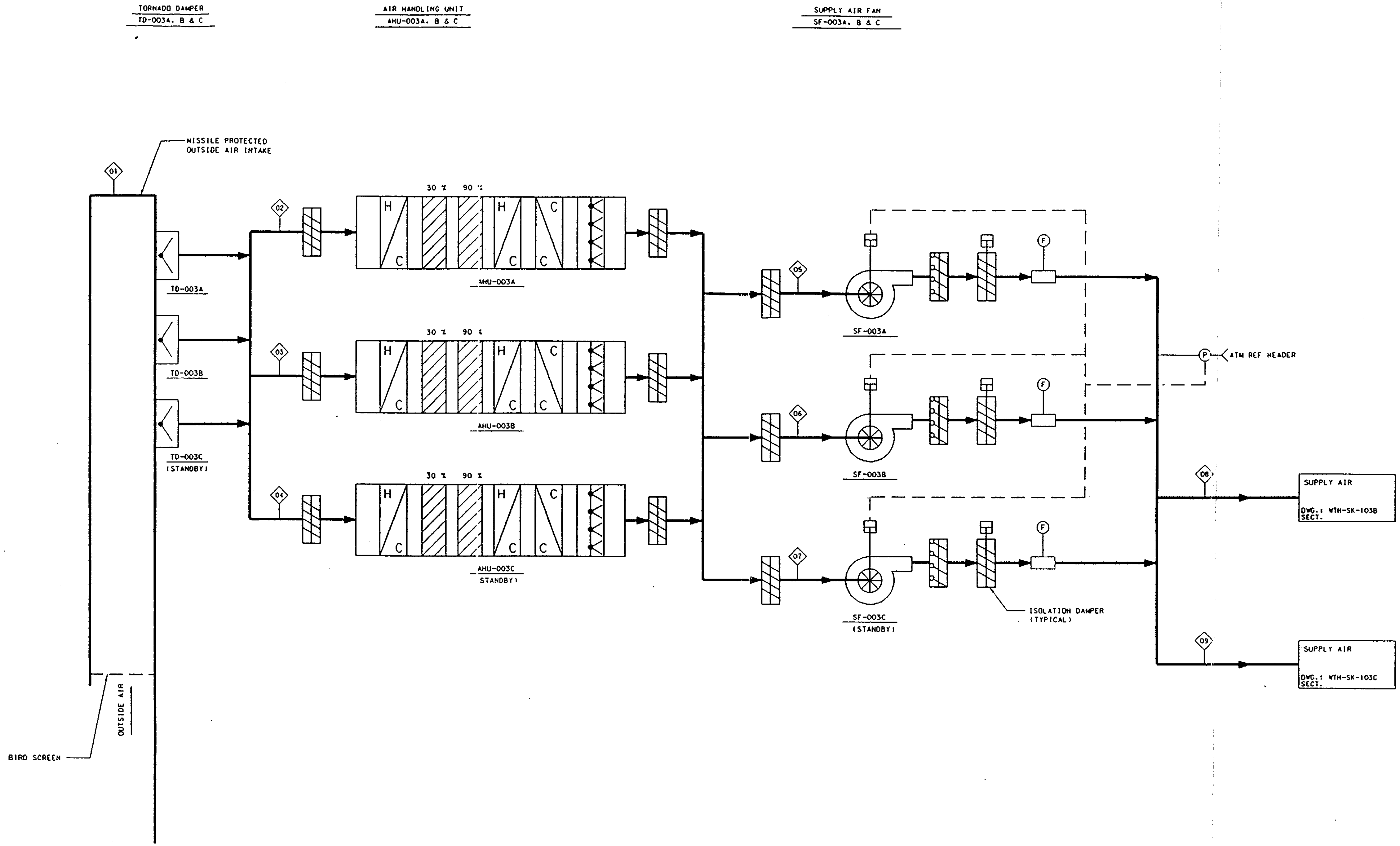
1. INDICATE SUMMER/WINTER MAXIMUM TEMPERATURE (°F).

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

WASTE TREATMENT BUILDING OFFICES & CHANGE ROOMS HVAC FLOW DIAGRAM

REFERENCE NUMBER | SKETCH NUMBER: WTH-SK-102
SCALE: NONE | CONF/FIELD ECR NUMBER | ATTACHMENT NO. | CAD FILE: WTHSK102.DGN

chung /rep/reps/hvac/dgn/wthsk102.dgn 22-AUG-1995 14:08



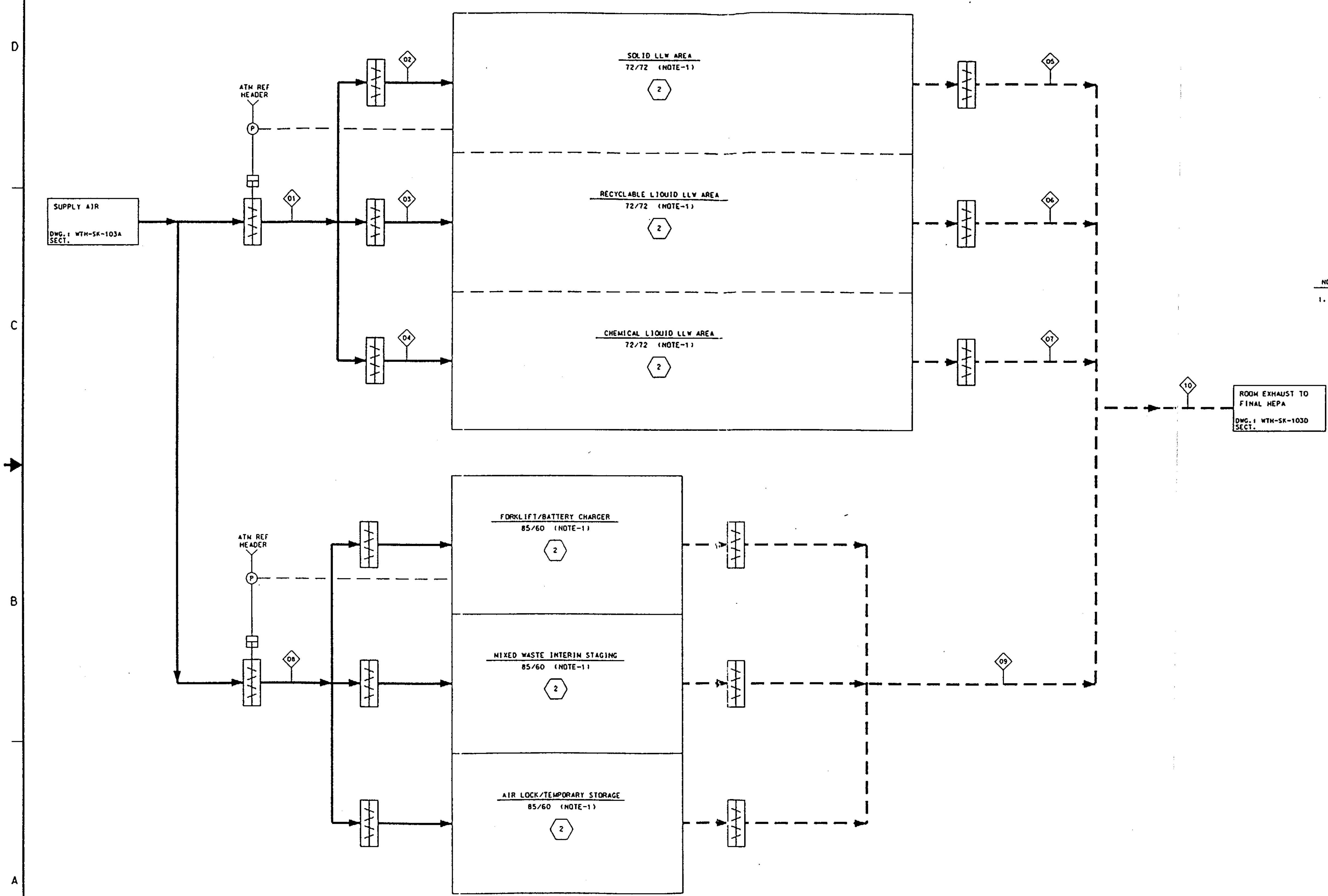
LINE NUMBER	AIR QUANTITY (CFM)
01	38,440
02	19,220
03	19,220
04	0/19,220
05	19,220
06	19,220
07	0/19,220
08	37,700
09	740

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

WASTE TREATMENT BUILDING PROCESS AREAS VENTILATION HVAC FLOW DIAGRAM

REFERENCE NUMBER
SKETCH NUMBER: WTH-SK-103A
SCALE: NONE
FCP-FIELD ECR NUMBER
ATTACHMENT NO.
CAD FILE: WTHSK103A.DGN

chung /rep/reps/hvac/dgn/wthsk103a.dgn 24-AUG-1995 09:07



LINE NUMBER	AIR QUANITY (CFM)
01	33,600
02	11,200
03	11,200
04	11,200
05	11,200
06	11,200
07	11,200
08	4,100
09	4,100
10	37,700

NOTE:

1. INDICATE SUMMER/WINTER MAXIMUM TEMPERATURE (°F).

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

WASTE TREATMENT BUILDING PROCESS AREAS VENTILATION HVAC FLOW DIAGRAM

WTH-SK-103B

SCALE: NONE

WTHSK103B.DGN

chung /rep/reps/hvac/dgn/wthsk103b.dgn 22-AUG-1995 08:24

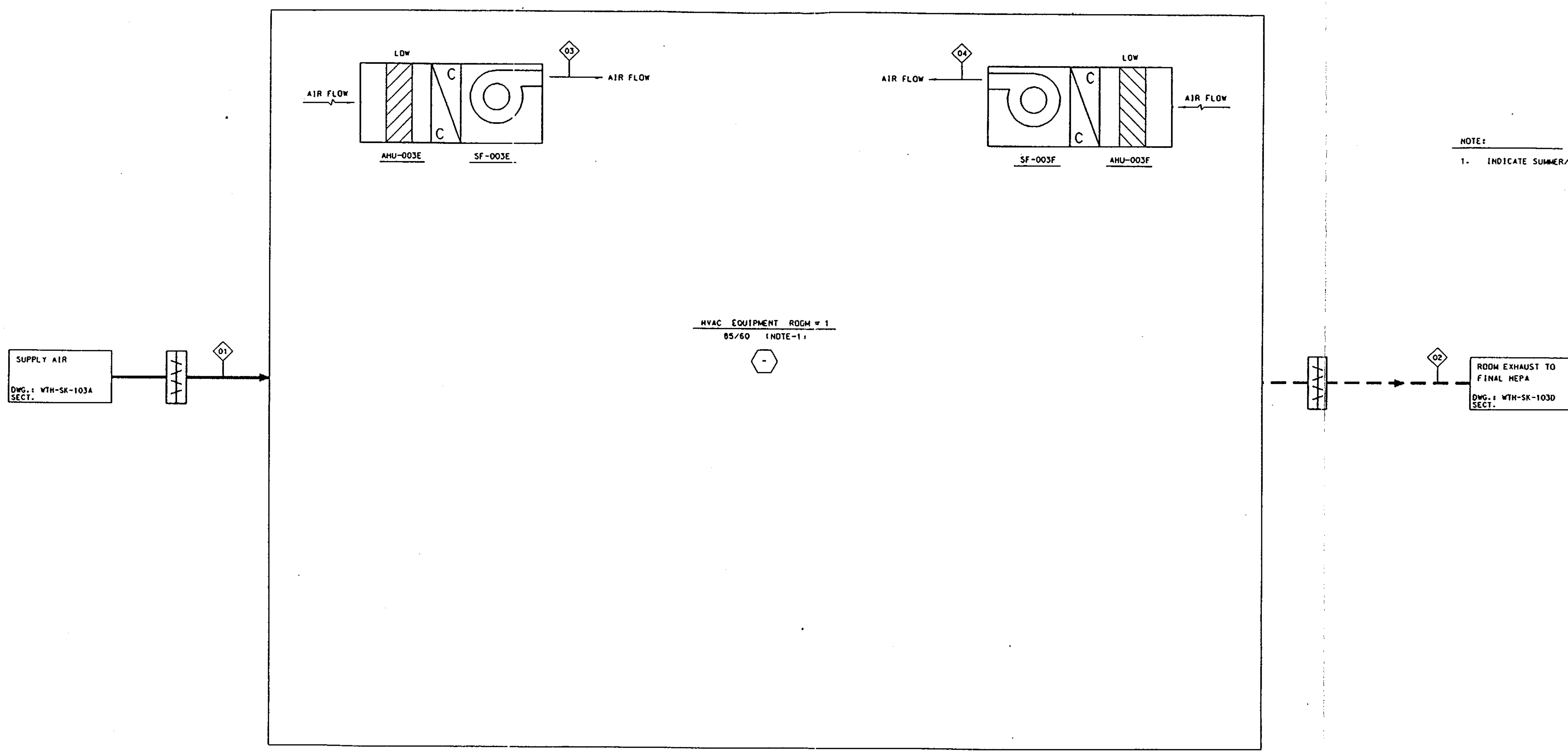
AIR HANDLING UNIT (RECIRC)
AHU-002E & F

SUPPLY AIR FAN
SF-002E & F

LINE NUMBER	AIR QUANTITY (CFM)
01	740
02	740
03	3,300
04	3,300

NOTE:

1. INDICATE SUMMER/WINTER MAXIMUM TEMPERATURE (°F).



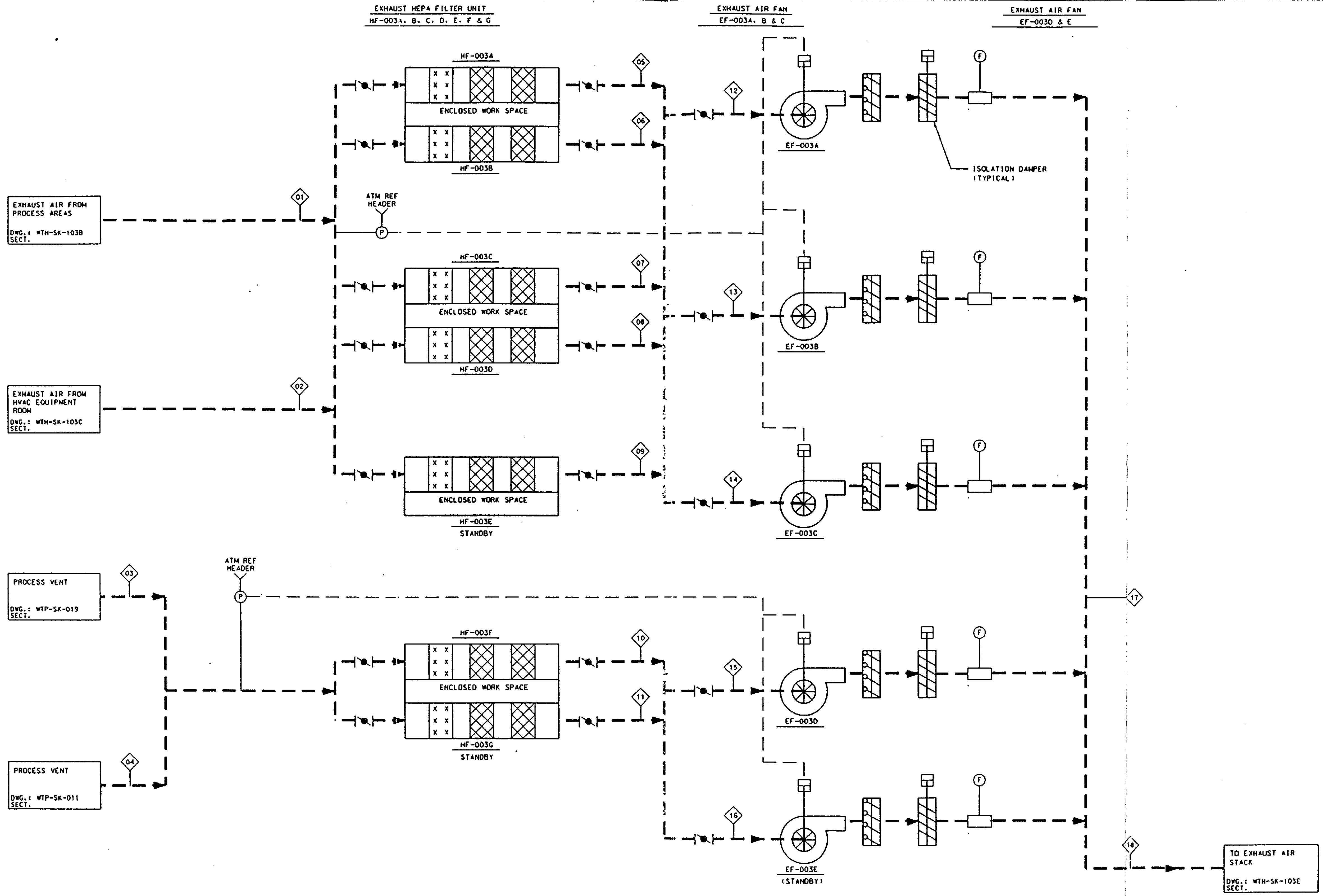
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

WASTE TREATMENT BUILDING HVAC EQUIPMENT ROOM HVAC FLOW DIAGRAM

REFERENCE NUMBER	SKETCH NUMBER
	WTH-SK-103C

SCALE	CA/FIELD ECP NUMBER	ATTACHMENT NO.	CAD FILE
NONE			WTHSK103C.DGN

chung /rep/reps/hvac/dgn/wthsk103c.dgn 12-SEP-1995 14:11



LINE NUMBER	AIR QUANTITY (CFM)
01	37,700
02	740
03	2,000
04	1,500
05	9,610
06	9,610
07	9,610
08	9,610
09	0/9,610
10	3,500
11	0/3,500
12	19,220
13	19,220
14	0/19,220
15	3,500
16	0/3,500
17	38,440
18	41,940

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

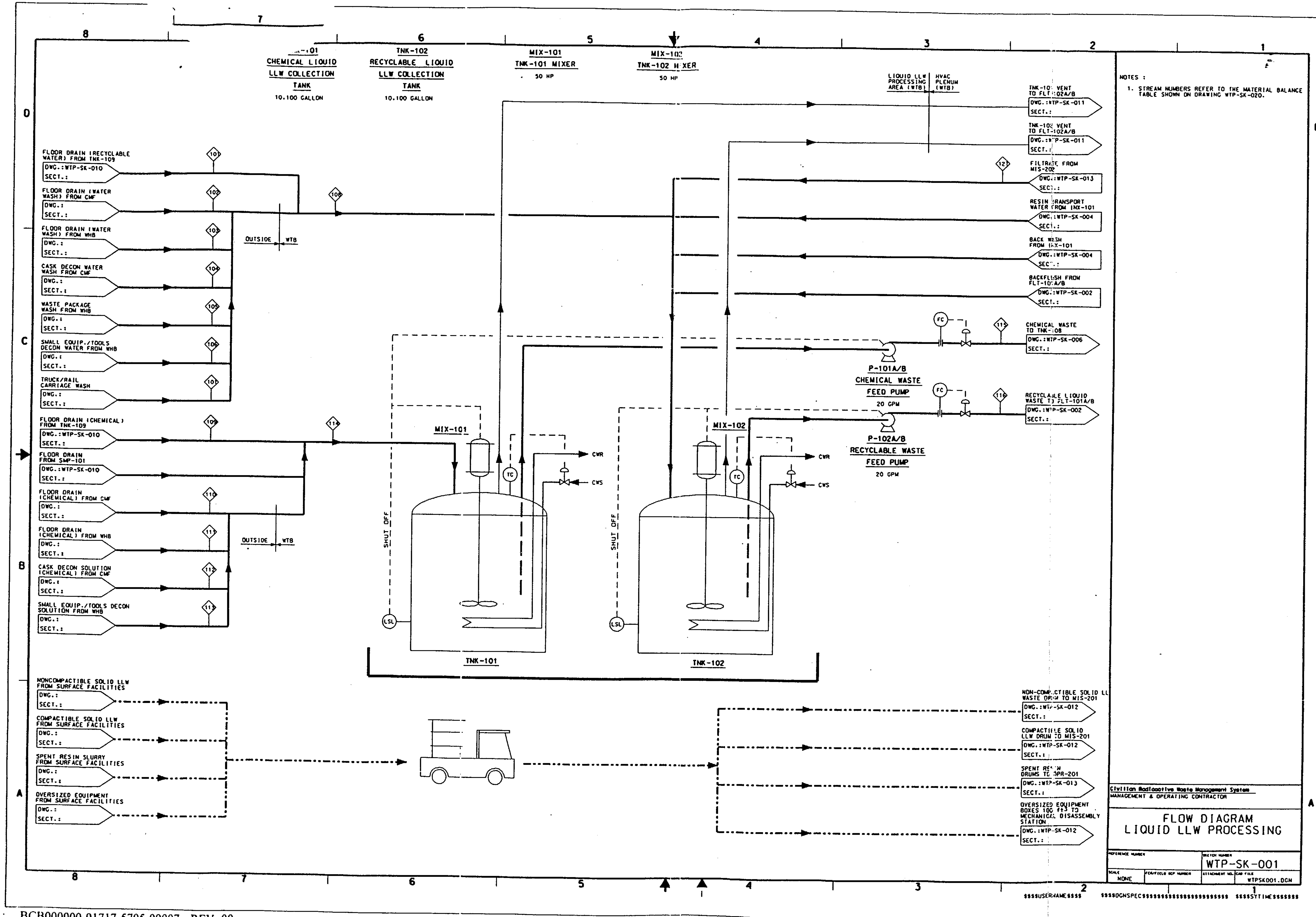
WASTE TREATMENT BUILDING PROCESS AREAS EXHAUST AIR HVAC FLOW DIAGRAM

WTH-SK-103D

SCALE: NONE

CAD FILE: WTHSK103D.DGN

chung /rep/repa/hvac/dgn/wthsk103d.dgn 24-AUG-1995 09:10



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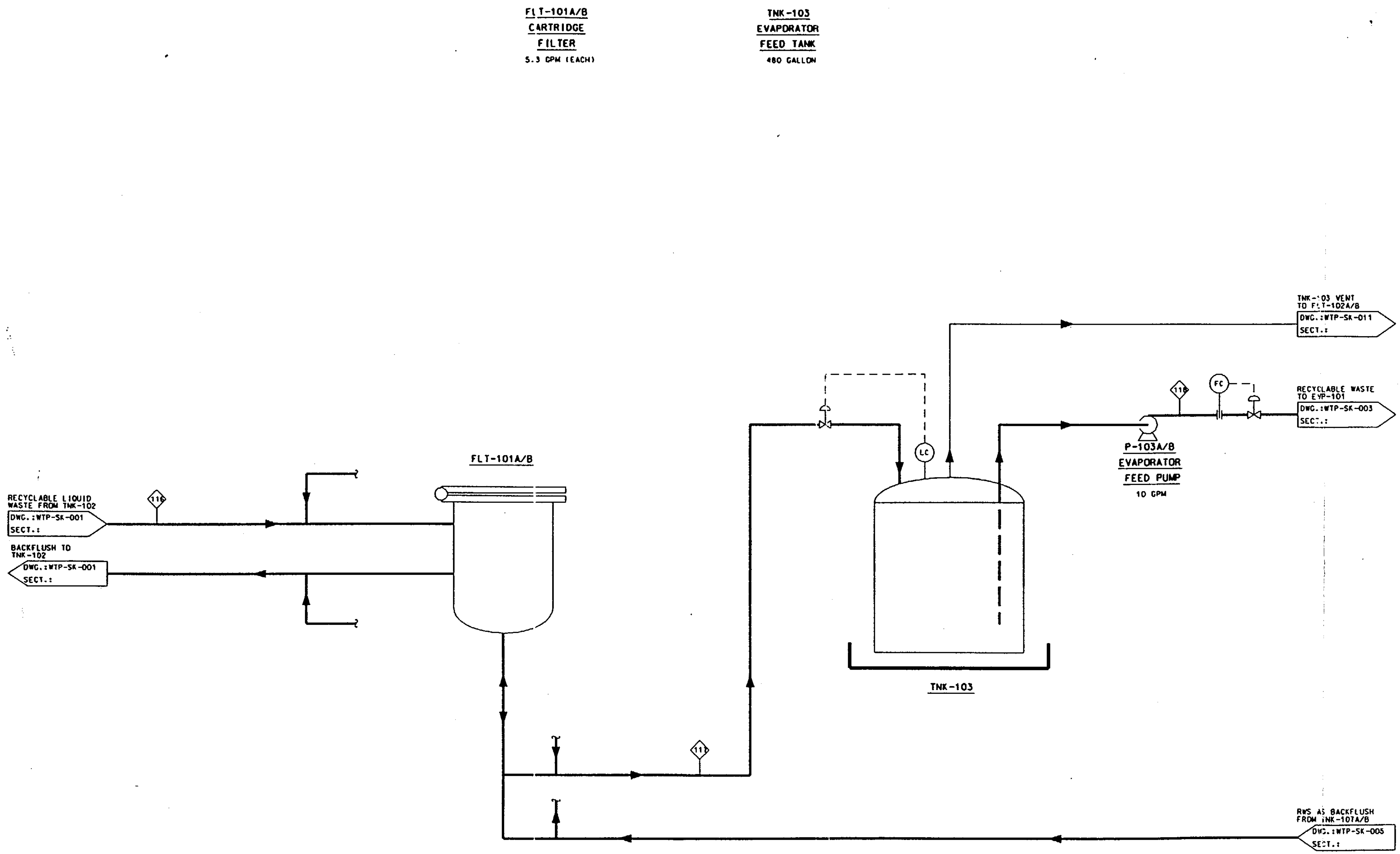


NOTES :

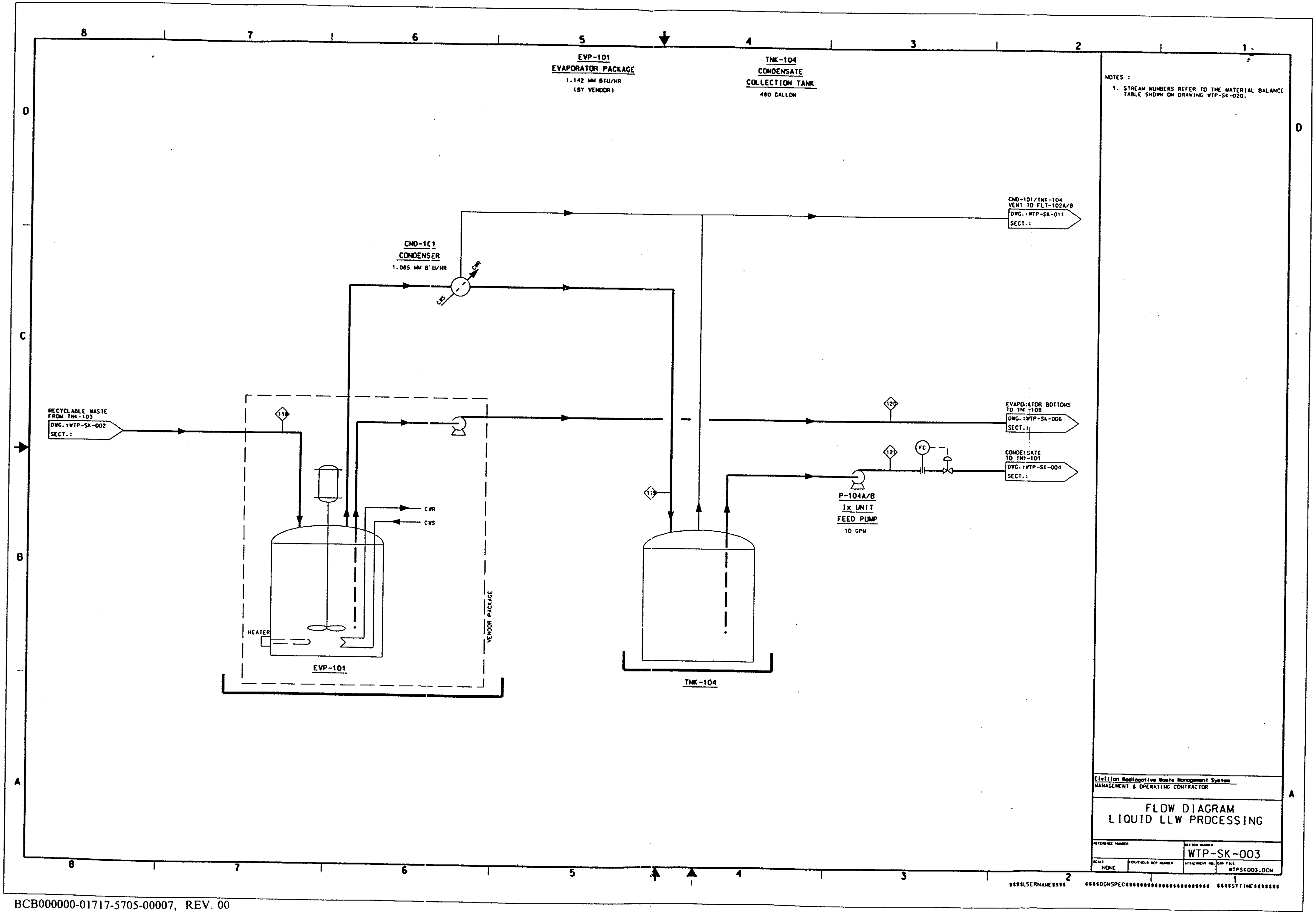
1. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-020.

Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

FLOW DIAGRAM
LIQUID LLW PROCESSING

REFERENCE NUMBER		SKETCH NUMBER	
		WTP-SK-002	
SCALE	CONTROLLED DCP NUMBER	ATTACHMENT NO.	CAD FILE
NONE			WTPSK002.DGN

$$$$USERNAME$$$$ $$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$ $$$$SYTIME$$$$$$$


EVP-101
EVAPORATOR PACKAGE
1.142 MM BTU/HR
(BY VENDOR)
TNK-104
CONDENSATE
COLLECTION TANK
480 GALLON
NOTES :
1. STREAM NUMBERS REFER TO THE MATERIAL BALANCE TABLE SHOWN ON DRAWING WTP-SK-020.
CND-101/TNK-104
VENT TO FLT-102A/B
DWG.:WTP-SK-011
SECT.:
CND-101
CONDENSER
1.085 MM BTU/HR
CWS
CWR
RECYCLABLE WASTE
FROM TNK-103
DWG.:WTP-SK-002
SECT.:
EVAPORATOR BOTTOMS
DWG.:WTP-SK-006
SECT.:
DWG.:WTP-SK-004
SECT.:
FC
P-104A/B
1x UNIT
FEED PUMP
10 GPM
HEATER
EVP-101
VENDOR PACKAGE
TNK-104
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
FLOW DIAGRAM
LIQUID LLW PROCESSING
WTP-SK-003
NONE
WTPSK003.DGN