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WASTE CHARACTERISTICS AND QUANTITIES - LOW LEVEL WASTE PROCESSING AND STORAGE SYSTEM - (USED AS A REFERENCE IN OU1 RI)

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WASTE CHARACTERISTICS AND QUANTITIES

LOW-LEVEL WASTE PROCESSING AND STORAGE SYSTEM

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO

DEPARTMENT OF ENERGY

CONTRACT NO. EY-76-C-05-1156

ENGINEERING PROJECT NO. G-724-C

Prepared By

NLO, Inc.
Fernald, Ohio

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INTRODUCTION

Low-Level radioactive waste at the FMPC is generated as a result of the production of uranium products. Process wastes containing some uranium are generated in the various plants as liquids, solids, or slurries. This waste is treated within each processing plant to recover uranium in forms such as filter cake for recycle. Aqueous wastes from each of these primary treatment units are transferred to the General Sump. The wastes are neutralized and then clarified by sedimentation. The remaining aqueous waste is discharged to the Great Miami River. There are control requirements on this aqueous waste for nitrate, copper, iron, nickel, total dissolved solids, and pH. Dry wastes such as depleted MgF_2 and broken crucibles are also generated in the various plants.

This section identifies the waste streams to be treated, describes their characteristics, and projects quantities and volumes. These streams are shown in Figure 1, Design Basis Waste Flows for the Low-Level Waste Processing and Storage System (LLWPS). The two requirements on the processed wastes are that the waste be dry and that the waste be readily transported into and (when required) out of storage. Thus, the waste streams can be divided according to the need for processing: wastes which must be dried, wastes which require size reduction, wastes which require filtering and wastes which can be transported directly to storage. The drying provides volume reduction and prevents leaching of contaminates into the aquifer. The design basis flows are based on handling the wastes as they are produced and include no provision for processing of wastes previously accumulated. (The scope of this proposed system does not include pit mining material.)

1.0 WASTE CHARACTERISTICS

The wastes to be treated by the proposed system can be grouped into eight streams:

- Depleted sump cake,
- General sump sludges,
- Miscellaneous dry wastes,
- Neutralized raffinate,
- Miscellaneous metal and wet wastes,
- Depleted milled slag and residue,
- Enriched slag leach filter cake, and
- Incinerator ash.

Although this section describes each of the streams, the available information is not adequate to provide all of the parameters. Therefore, several parameters are designated as "to be determined" or TBD. Similarly, in several cases the waste generation could not be correlated with production data and therefore an estimate of annual generation is used.

1.1 Depleted Sump Cake

Local sumps in each plant are drained and filtered. This waste stream is primarily the cake resulting from this filtration, which is transferred to the LLWPS for drying. In addition to depleted sump cake, this waste stream will include extrusion residues from off-site sources.

1.2 General Sump Sludges

The aqueous wastes transferred from each of the plant sumps are transferred to the General Sump. At the general sump the wastes are neutralized with lime and clarified by sedimentation. The resulting sludge in the General Sump makes up this waste stream. Characteristics of this stream are shown in Table 2.

1.3 Miscellaneous Dry Wastes

The miscellaneous dry wastes include non-combustible materials generated in the various plants. The principal contributor is expected to be ceramic pieces (e.g., tiles). Plants 5, 6, and 9 will be the main sources for this type of waste. This stream may also include miscellaneous samples and off-specification material (e.g. UF_4 from Plant 4). Although other wastes are often considered "dry" wastes, they are not included here if they contain either free metal or significant water. Graphite crucibles are not included because it is planned to send them to the incinerator. Characteristics of this waste stream are given in Table 3.

1.4 Neutralized Raffinate

The refinery is a major producer of wet wastes. Although the refinery has previously processed uranium ore concentrates, the projected future feed material is almost entirely recycle materials. The refinery aqueous raffinate stream will contain most of the nitric acid and impurities. This stream is neutralized with lime and caustic. The resulting material is then filtered and washed to remove a large part (but not all) of the soluble nitrate. The characteristics of this material are shown in Table 4. The amount and characteristics will depend on the characteristics of the refinery feed material and the amount of excess lime and caustic which is added. Previous estimates indicate that the amount of waste could vary by a factor of four. The projection is based on data from a recent refinery campaign. This projection appears to represent an upper limit on the amount of waste per unit of refinery production.

1.5 Miscellaneous Metal and Wet Wastes

As shown in Table 5, this stream primarily includes residues and the heat treat quench water. For a few years (through 1991) this stream will also include the de-cladding (Blue) water. The salt oil wash water will not be a separate stream, but will be included as part of the wastes going to the general sump. The residues include nonbriquettable turnings, and depleted fines from Plants 5, 6, and 9. The MgF_2 slag is included as a separate stream.

1.6 Depleted Milled Slag and Residue

Uranium metal is produced by reacting green salt (UF_4) with magnesium metal. The by-product slag is magnesium fluoride which fuses into a large mass. This material is broken out of the reaction vessel and then milled. Most of this material can be transported directly to storage. A few percent of the material will be oversized and will require further size reduction and/or oxidation in the LLWPS system. The characteristics of this stream are shown in Table 6.

1.7 Enriched Slag Leach Filter Cake

When enriched derbies are produced, the MgF_2 is leached to recover uranium and the material is filtered. The system proposed under Project 85-OR-7 will filter this material in Plant 2/3. The proposed process will leave the material sufficiently dry so that it can be sent directly to storage without further drying. In addition to the MgF_2 in this waste stream, off-site wastes are also included in this waste stream (e.g. crucible burn-out and ash from Oak Ridge). Characteristics of this stream are shown in Table 7.

1.8 Incinerator Ash

The incinerator will handle burnable solids and liquids. The incinerator is planned to be operational in FY 1989. Emissions equipment will be provided to control particulates and corrosive gases. The incinerator will burn contaminated crucibles and other materials. The ash characteristics are shown in Table 8.

2.0 PROJECTED WASTE QUANTITIES

In order to project the quantities of wastes to be processed, the planned production loads were investigated. The amount of waste was projected by multiplying the planned production load by the amount of waste produced per unit of production. Two plans were reviewed to provide a basis for projecting production loads: the 1983 Strategic Planning Study Base Case, and the 12/82 Long Range Plan Revised Base Case. In those cases where the amount of waste does not appear to be closely related to a given production stream, a value was selected using information on the amount of waste produced during the last three years. The design values given here are based on the year of peak demand for the Low-Level Waste Processing and Storage System. The values, in metric tonnes (MT)/year, represent the weight of the solids in the waste stream. Volumes of the wet wastes can be achieved by applying the water content and densities to these figures.

2.1 Depleted Sump Cake

The amount of sump cake is difficult to determine and varicus quantities have been used in recent studies for estimating purposes. The usual assumption is that the amount of sump cake is independent of production levels. A value of 40 MT/year (solids) is suggested as a design value.

2.2 General Sump Sludges

The split between depleted sump cake and general sump sludges is not well known. It is assumed that this quantity is independent of production levels. A value of 110 MT/year is suggested as a design value.

2.3 Miscellaneous Dry Wastes

Historically dry wastes included crucibles and other materials which will no longer be included. However, restoration projects may generate significant quantities of contaminated ceramic materials. It was assumed that past quantities were primarily crucibles. 10 MT/year has been selected as a design basis. Further study of potential sources is required.

2.4 Neutrallized Raffinate

The amount of waste from the refinery depends on the quality of feed, the amount of excess lime added for neutralization, and the total production output. The amount of waste generated during past years has varied from 0.22 to 0.96 MT of solids per MT of uranium production. Future refinery operations are expected to be closer to the middle of these values. A value of 0.5 MT of solids per MT of uranium production was used for projecting future quantities as shown in Figure 2. A value of 300 MT/year is suggested as a design basis.

2.5 Miscellaneous Metal and Wet Wastes

The metal scrap and wet wastes was based on the amount of depleted derbies. A value of 0.24 MT of solids per MTU was used for projecting future quantities as shown in Figure 3. A value of 450 MT/year is suggested as a design value. Note that the suggested value does not include capacity to handle the material generated if the Atomic Vapor Lasor Isotopic Separation (AVLIS) program would scale up as projected.

2.6 Depleted Milled Slag and Residue

The quantity of depleted milled slag is projected assuming 0.52 MT of solids per MTU of derby production. The suggested design value is 900 MT/year. As shown in Figure 4, this value does not include sufficient capacity to handle the waste generated if the AVLIS program would scale up as projected. Therefore, an expansion capability should be provided.

2.7 Enriched Slag Leach Filter Cake

The quantity of slag leach filter cake is projected assuming 0.52 MT of MgF_2 per MTU of enriched metal production plus a 20 percent allowance for neutralization. The projected amount of MgF_2 is shown in Figure 5. The suggested design value is the peak value plus the 20 percent allowance for neutralization, 2200 MT/year.

2.8 Incinerator Ash

The amount of ash that will be generated by the planned incinerator is uncertain. Based on the projected quantity of graphite crucibles and leaving an allowance for other materials a design value of 5 MT/year is suggested.

3.0 SPECIAL CONSIDERATIONS

There are changes which may occur and result in revised requirements for the low-level waste processing system. The following discussion is divided into five categories:

- Process changes,
- Treatment of accumulated wastes,
- Changes in regulations and requirements,
- Product changes, and
- Non-uniform flows.

Process changes would result in changes in the composition and quantities of waste streams. For example, the neutralized refinery raffinate may change in future years. Currently the stream is neutralized using a large excess of lime. However, the amount of excess lime may be reduced as the feed changes (e.g., if the feed contains no copper). Use of the excess lime in the pits has also been proposed (i.e., pump pit material back to the general sump). Finally, the neutralizing agent could be changed from lime to some other substance.

The current system contains no provision for the treatment of accumulated wastes, i.e., the material in the storage pits. Some accumulated material could be processed by working multiple shifts. However, the amount of material from the pits would dwarf all other feeds to the dryer and many years would be required to process this material. The pit material differs from current generation waste in several ways:

- There is no dry material (because of the rain all the material contains appreciable water).
- The quantity of material in the "wet pits" was increased due to the addition of fly ash for many years.
- The material in the "dry pits" is not homogeneous (for instance, it contains stray pieces of concrete).

Definitive regulations for the disposal of the FMPC low-level wastes do not exist. Therefore the requirements to be placed on the stabilized waste form by disposal considerations are unknown. Storing the waste as a dry powder allows the freedom to select a stabilized waste form when the regulations and requirements are better defined. A dry powder can be incorporated into any of the waste forms which have been proposed. The Low-Level Waste Processing Sub-System should incorporate the flexibility to transfer the waste directly to a stabilization process when this becomes desireable.

The Low-Level Waste Processing and Storage System must include provisions to accomodate product changes. Product changes include changes in major products (e.g., the change from MK-31 to MK-15), additions of new products (e.g., derbies for AVLIS), and special short duration jobs (e.g., thorium processing or copper recovery).

As can be seen from Figures 2 through 5, the production of products and the resulting wastes changes with time. Not as apparent is the change in flow rates during any given year. Much of the production at the FMPC is run on a campaign basis. The campaign method will result in large swings in the amount of a given type of waste. Therefore, the design must include a provision either for temporary holdup storage or overcapacity in the process equipment.

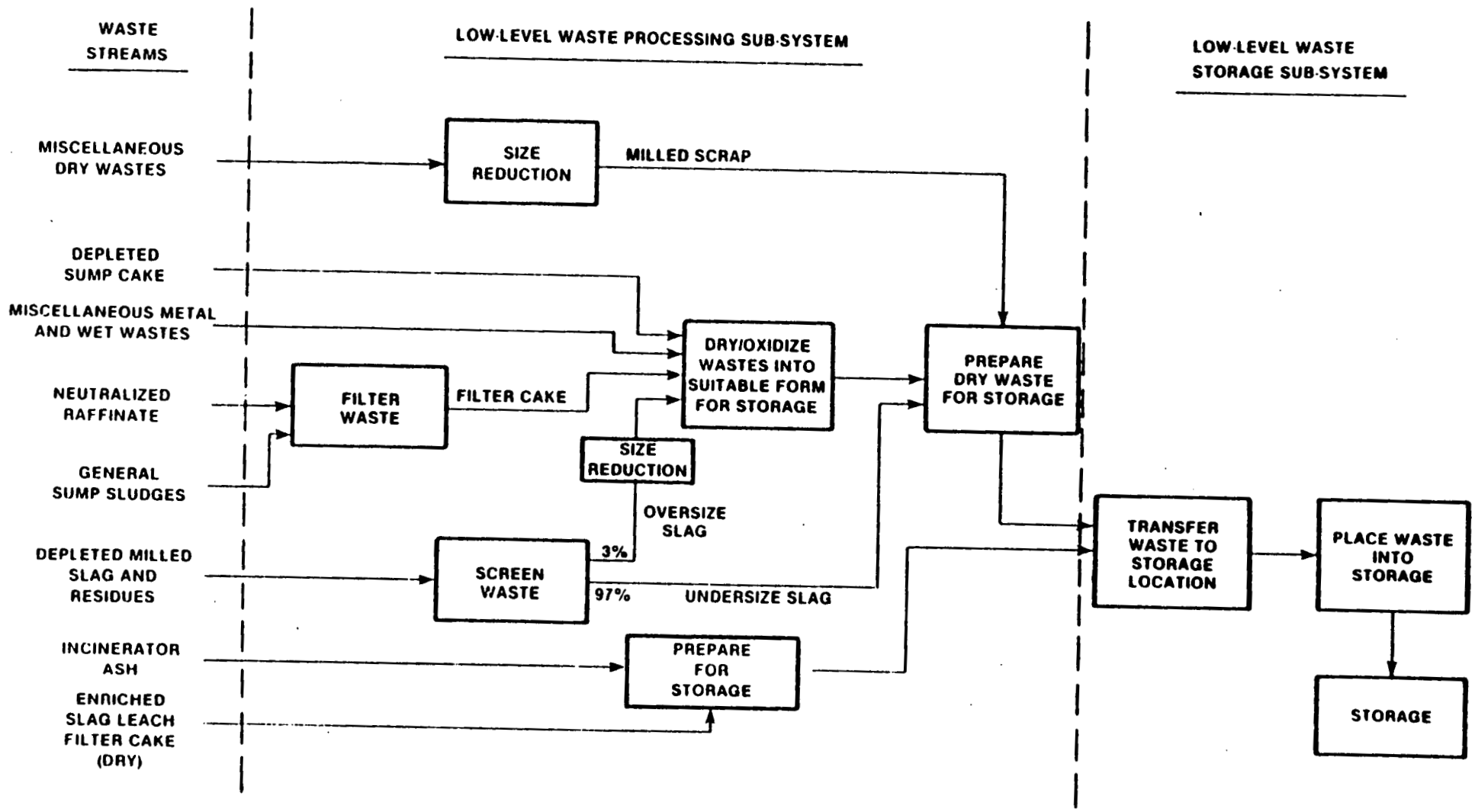

FIGURE 1. Functional Flow for FMPC Low-Level Waste Processing and Storage System

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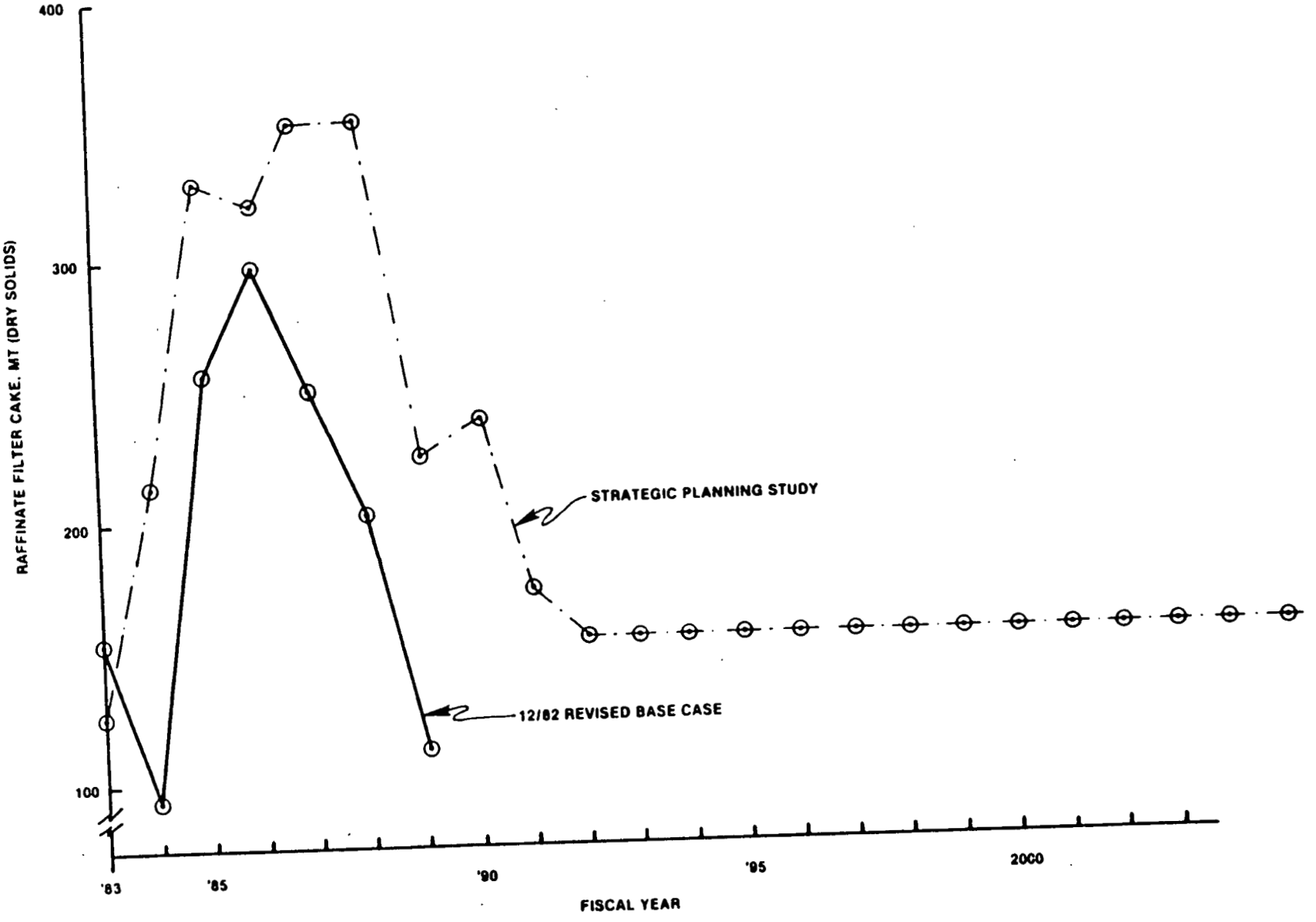

FIGURE 2. PROJECTED QUANTITIES OF RAFFINATE FILTER CAKE

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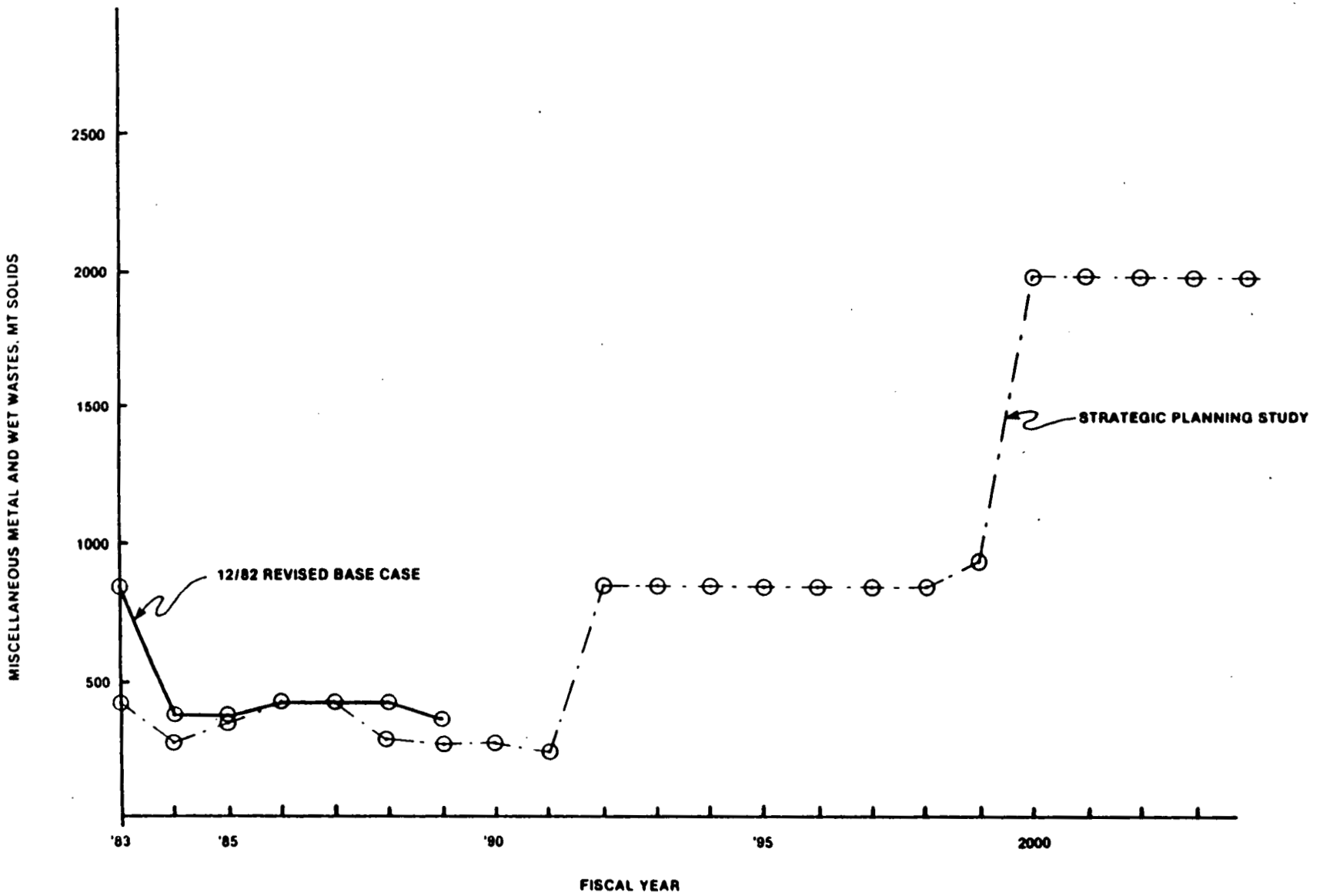

FIGURE 3. PROJECTED QUANTITIES OF METAL AND WET WASTES

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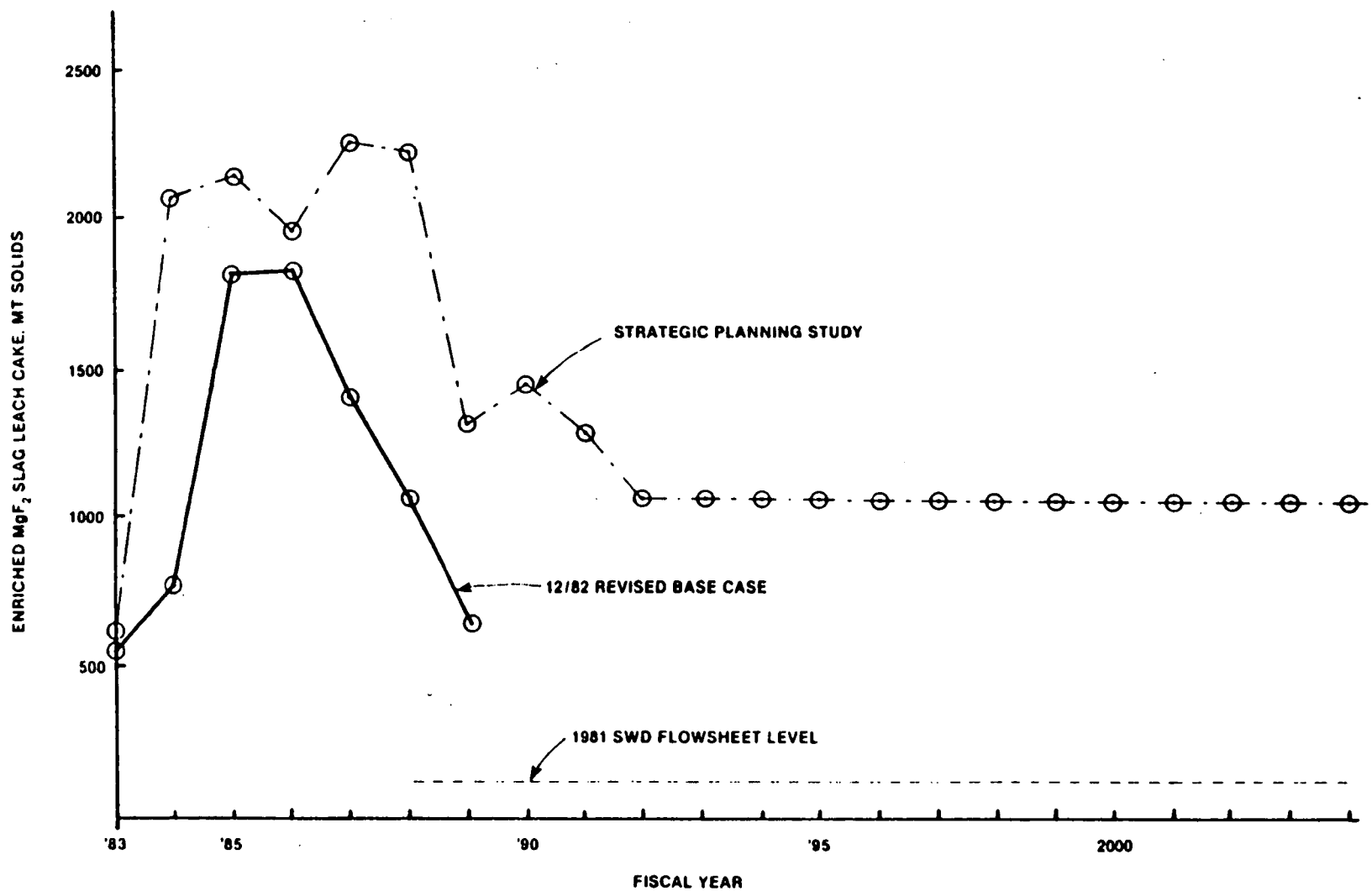

FIGURE 5. PROJECTED QUANITIES OF MgF_2 SLAG

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Table 1. Depleted Sump Cake Characteristics

General Description: Sump cake from all plants and extrusion residues from off-site sources.*

Amount of Materials Produced:

Total Design Basis, MT solids/year: 40

Water Content, wt. % H_2O: 60 to 70

Significant Constituents:

80% Uranium Oxides (dry weight basis)

12 to 15% calcium

Density:

wet, gm/cc: 1.3

dry, gm/cc: 1.7

Size Distribution: Fine

Flow Characteristics: Tends to cake in dry form

Other Properties;

gm U/gm solids: 0.8

% U^{235}: Depleted (0.2%)

pH: Neutral to basic (≥ 7)

*Characteristics are defined for sump cake only.

Table 2. General Sump Sludge Characteristics

General Description: Neutralization sludge from the general sump.

Amount of Materials Produced:

Total Design Basis, MT solids/year: 110

Water Content, wt. % H_2O: 60 to 70

Significant Constituents:

Undissolved lime and acid neutralization products

Density:

wet, gm/cc: 1.2

Size Distribution: Fine

Flow Characteristics: Tends to cake in dry form

Other Properties: TBD*

*To be determined during the design of the processing system.

Table 3. Miscellaneous Dry Waste Characteristics

General Description: Ceramic pieces (furnace insulation) from Plants 5, 6, and 9 and off-spec UF_4 from Plant 4.

Amount of Materials Produced:

Total Design Basis, MT solids/year: 10

Water Content, wt. % H_2O: dry

Significant Constituents: TBD*

Density:

dry, gm/cc: 2.0

Size Distribution: TBD*

Flow Characteristics: Generally free flowing

Other Properties: TBD*

*To be determined during the design of the processing system.

Table 4. Neutralized Raffinate Characteristics

General Description: The neutralized aqueous raffinate from the refinery plant 2/3. Neutralized with lime and caustic.

Amount of Materials Produced:

Unit Basis, MT solids/MTU in refinery: 0.5

Total Design Basis, MT solids/year: 300

Water Content, weight percent water, wt. %: 60 to 70

Significant Constituents:

Metal insoluble salts in wet form or oxides in dry form:

Calcium

Aluminum

Iron

Silicon

Density:

wet, gm/cc: 1.3

dry, gm/cc: 0.65

Size Distribution: Fine

Flow Characteristics: Lumpy when dried

Other Properties:

gm U/gm solids: 0.0005

% U^{235}: 1.1 (0.75 - 1.25)

pH: >7 basic

Table 5. Miscellaneous Wet and Metal Waste Characteristics

General Description: Miscellaneous streams containing free metal or significant water content. These include nonbriquettable turnings, depleted fines, heat treat quench water, and de-cladding (blue) water.

Amount of Materials Produced:

Total Design Basis, MT solids/year: 450

Water Content, wt. % H_2O: Varies

Significant Constituents: TBD*

Density:

wet, gm/cc: 1.0 - 2.0

dry, gm/cc: 1.2

Size Distribution: TBD*

Flow Characteristics: TBD*

Other Properties: TBD*

*To be determined during the design of the processing system.

Table 6. Depleted Milled Slag and Residue Characteristics

General Description: MgF_2 slag from the production of depleted uranium metal derbies in Plants 5 and 6.

Amount of Materials Produced:

Unit Basis, MT solids/MTU of derbies: 0.52

Total Design Basis, MT solids/year: 900

Water Content, wt. % H_2O: Dry

Significant Constituents:

MgF_2 95 to 98%

2 to 5% U in various oxidation states

Trace of free magnesium

Density:

dry, gm/cc: 1.4

Size Distribution: Bulk of waste is -20 mesh. Occasionally +20 mesh is observed.

Flow Characteristics: Free flowing

Other Properties:

gm U/gm solids: 0.02 to 0.05

% U^{235}: 0.2 (depleted)

Table 7. Enriched Slag Leach Filter Cake Characteristics

General Description: The MgF_2 from enriched uranium metal production which has been leached for uranium recovery, neutralized, filtered, and dried in Plant 2/3. Crucible burnout and ash returned from Oak Ridge is also included in this stream.*

Amount of Materials Produced:

Unit Basis, MT solids/MTU of derbies: 0.62

Total Design Basis, MT solids/year: 2200

Water Content, wt. % H_2O: 20 to 30%

Significant Constituents:

MgF_2

Precoat

Calcium Nitrate

Density:

dry, gm/cc: 1.4

Size Distribution: $\geq$90%, -230 mesh

Flow Characteristics: Free flowing

Other Properties:

gm U/gm solids: 0.0005

% U^{235}: ~1%

pH: >7

*Characteristics given are for filter cake only.

Table 8. Incinerator Ash Characteristics

General Description: Ash from the incinerator from burning skids, crucibles, and other contaminated combustible materials.

Amount of Materials Produced:

Total Design Basis, MT solids/year: 5

Water Content, wt. % H_2O: Dry

Significant Constituents: TBD*

Density:

dry, gm/cc: 0.1 to 0.2

Size Distribution: TBD*

Flow Characteristics: Free flowing

Other Properties: TBD*

*To be determined during the design of the process system.