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Time and Motion Study for Alternative Mixed Low-Level Waste Treatment Systems

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ACRONYMS AND ABBREVIATIONS

APC	air pollution control
CaSO ₄	calcium sulfate
CWO	catalytic wet oxidation
DOE	U.S. Department of Energy
FTE	full-time equivalent
GAC	granular activated carbon
GPCR	gas phase corona reactor
HEPA	high efficiency particulate air filter
gpm	gallons per minute
INEL	Idaho National Engineering Laboratory
INTS	integrated nonthermal treatment system
ITTS	integrated thermal treatment system
LMITCO	Lockheed Martin Idaho Technologies Company
MEO	mediated electrochemical oxidation
MLLW	mixed low-level (radioactive) waste
OSORT	open, dump and sort activities
psi	pounds per inch
PAN	passive/active neutron scanning
R&D	research and development
RCPRP	receiving and preparation activities
RTR	real-time radiography
SCC	secondary combustion chamber
SCM	system cost model
SGS	segmented gamma scanning
TDS	total dissolved solids
TOC	total organic carbon
TRU	transuranic
UV	ultraviolet light
TTTDC	
WB2	work breakdown structure

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EXECUTIVE SUMMARY

The time and motion study was developed to look at time-related aspects of the technologies and systems studied in the Integrated Thermal Treatment Systems (ITTS) and Integrated Nonthermal Treatment Systems (INTS) studies. The INTS and ITTS studies combined technologies into systems and subsystems for evaluation. The system approach provides DOE a method of measuring advantages and disadvantages of the many technologies currently being researched. For example, technologies which are more likely to create secondary waste or require extensive pretreatment handling may be less desirable than technologies which require less support from other processes.

The time and motion study was designed to address the time element in the INTS and ITTS systems studies. Previous studies have focused on material balance, cost, technical effectiveness, regulatory issues, community acceptance, and operability. This study looks at system dynamics by estimating the treatment time required for a unit of waste, from receipt to certification for shipping. Labor estimates are also developed, based on the time required to do each task for each process. This focus on time highlights critical path processes and potential bottlenecks in the INTS and ITTS systems.

Gant charts were selected to model functions in this study. Although Gant charts do show a critical path, this type of analysis is not sufficiently accurate to pinpoint the exact bottlenecks in a continuously operating facility. Other commercially available scheduling software might be used to provide a more accurate work schedule and a critical path analysis model.

The purpose of this time and motion study is to provide data for research prioritization and allocation of research resources. The study is based on a review of the technologies involved, discussions with vendors, and the authors' industrial chemical processing and material handling experience.

The time focus also allows quantification of task requirements, such as sorting and characterization. One of the more interesting results of this study is that radioactive characterization labor requirements are greater than those for shredding or sorting.

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The key results of the study are the following:

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- Characterization is a critical path process and very labor intensive
- The differences in receiving and preparation between thermal and nonthermal systems are less dramatic than estimated in the INTS and ITTS studies
- Material handling is more significant than processing in terms of labor and time
- One-step thermal treatment processes require significantly less labor than incineration combined with vitrification of ash
- Special waste treatment is on the critical path for thermal systems
- Treatment of special wastes will require significant allocation of resources
- Storage requirements for special waste will be extensive if processes are not available for treatment
- Debris treatment is on the critical path for nonthermal systems
- Labor FTEs may be about 20% higher than estimated in the INTS and ITTS reports

1. INTRODUCTION

The purpose of this time and motion study is to provide data for further research prioritization. The time and motion study was performed on five systems developed in the Integrated Thermal and Nonthermal Treatment System studies. Systems were selected to study the impacts of various treatment technologies on the flow of materials through an integrated mixed low level waste treatment facility. The time and motion study estimated the labor to operate each system, and the time required for treatment of a drum of waste for each system. The time to process a unit of waste highlights critical path issues and potential bottlenecks in each system. Research efforts to reduce such bottlenecks may provide significant dividends to the DOE in the form of reduced labor and cost. Time-efficient operation should reduce chemical and radioactivity exposure to workers. Also, systems and technologies with fewer bottlenecks are more attractive for development demonstrations and future implementation.

2. SYSTEM DESCRIPTIONS

Three systems from the Integrated Nonthermal Treatment Study (INTS) and two systems from the Integrated Thermal Treatment Study (ITTS) were studied. These systems were chosen as representative of the INTS and ITTS systems. The five systems are included in the report *Comparison oj Alternative Treatment Systems jor DOE Mixed Low-Level Waste* (Schwinkendorf, 1996).

2.1 Systems Processes

This section provides only a brief introduction to these systems. They are already thoroughly described in the INTS (Biagi, 1997) and ITTS reports (Feizollahi, 1995). This brief description references the key processes.

THERMAL SYSTEMS

System A-1

This system includes the following major subsystems:

- rotary kiln with air for combustion for organic destruction
- vitrification of ash
- polymer stabilization of secondary wastes
- decontamination of surface contaminated metals
- melting of metals with entrained contamination
- retorting of mercury contaminated waste, with amalgamation of mercury

System C-1

Major subsystems include:

- plasma furnace with air for combustion for organic destruction
- polymer stabilization of secondary wastes
- decontamination of surface contaminated metals
- melting of metals with entrained contamination
- retorting of mercury contaminated waste, with amalgamation of mercury

NONTHERMAL SYSTEMS:

System NT-2

This system includes the following major subsystems:

- catalytic wet oxidation for organic destruction
- thermal desorption of soil, process residue and debris
- decontamination of surface contaminated metals
- primary stabilization of treated sludge and secondary waste in polymer
- primary stabilization of treated soil and treated debris in grout
- amalgamation of mercury waste

System NT-3

Major subsystems include:

- mediated electrochemical oxidation for organic destruction
- washing of soil, process residue and debris
- decontamination of surface contaminated metals
- primary stabilization of treated sludge and secondary waste in polymer
- primary stabilization of treated soil and treated debris in grout
- amalgamation of mercury waste

System NT-5

This system includes the following major subsystems:

- catalytic wet oxidation for organic destruction of liquids and soft (combustible) debris
- thermal desorption of process residue
- washing of soil and debris
- decontamination of surface contaminated metals
- primary stabilization of treated sludge and secondary wastes in polymer
- primary stabilization of treated soil and treated debris in grout
- amalgamation of mercury waste

2.2 Subsystem Descriptions

Each system consists of several subsystems. Most of the subsystems are identical or only slightly modified for the different systems. The subsystems which are consistent for all systems in this time and motion study are the following:

- administration
- receiving and preparation
- aqueous waste treatment
- metal decontamination
- special waste treatment
- air pollution control
- polymer stabilization
- certification and shipping

The following subsystems are used in the ITTS and INTS systems as indicated:

- vitrification (ITTS: A-1)
- metal melting (ITTS: A-1)
- mercury amalgamation, with retorting of debris (ITTS: A-1, C-1)
- mercury amalgamation (INTS: NT-2, NT-3, NT-5)
- lead recovery (ITTS: A-1, C-1)
- lead decontamination and stabilization (INTS: NT-2, NT-3, NT-5)
- incineration (ITTS: A-1)
- plasma furnace thermal treatment (ITTS: C-1)
- mediated electrochemical oxidation (INTS: NT-1, NT-3)
- catalytic wet oxidation (INTS: NT-2, NT-5)
- vacuum thermal desorption (INTS: NT-2, NT-5)
- grout stabilization (INTS: NT-2, NT-3, NT-5)
- aqueous wash (INTS: NT-3, NT-5)
- high pressure wash (INTS: NT-3, NT-5)

These subsystems are described in detail in the ITTS and INTS reports (Feizollahi, 1995; Biagi, 1997).

3. STUDY METHODOLOGY

The overall approach of the time and motion study was to follow the waste received in a single shift of operation, through handling and treatment steps. This approach did not attempt to optimize the subsystems, but only to present the subsystems as currently developed. A series of interlinked spreadsheets was developed to estimate the processing time for each handling and treatment step. A

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series of Gant charts presents the time required for the waste to pass from receiving through primary and secondary treatment, stabilization and finally certification and shipping. The Gant charts are provided as Figures 1 through 5 to illustrate the time elapsed for treatment of waste in each subsystem and to identify critical path functions.

The labor requirements were estimated for each step, and the total labor for each subsystem was calculated. The labor estimate is provided in Table 1. This table provides the results of the time and motion study, and compares it with the full time equivalents (FTEs) presented in the ITTS and INTS studies. These results of the time and motion study were not incorporated in the ITTS and INTS reports.

The tables from the interlinked spreadsheets are provided in Appendix A. The tables are numbered by system (e.g., Table NT5-a through NT5-r). The first table for each subsystem (Table A1-a, Table C1-a, Table NT2-a, Table NT3-a and Table NT5-a) shows waste allocation (mass flow rate). The last table in each section of Appendix A provides a summary of the full time equivalent employees (FTEs) and the time required for processing.

3.1 Waste Allocation to Subsystems

Waste was allocated to the various treatment systems based on the INTS mass balance (Biagi, 1997) and the ITTS mass balance of April 23, 1996 (Brown, 1996). Secondary as well as primary flows are accounted for by using the INTS and ITTS mass balances developed by Blaine Brown of LMITCO (Brown, 1996). Because of secondary flows, more waste is treated than is received.

Waste densities are assumed for all waste entering a given subsystem. Where available, densities from the mass balance were used. Density data developed for the Systems Cost Model were used for waste streams without assigned densities (Shropshire, 1995). For each waste type, a drum density was developed (pounds /55 gallon drum). This allowed the expression of incoming waste in terms of drums of waste per shift. The drum densities are listed on Tables A1-a, C1-a, NT2-a, NT3-a and NT5-a.

3.2 System Dynamics Modeling

The time and motion study estimated the time required for various processing steps at the design throughputs of the equipment specified in the INTS and ITTS studies. Where multiple steps or steps with low throughput were necessary, the processing time required increased. For example, special waste processing through receiving and preparation includes time required for truck receiving and unloading, waste assay, container staging, container opening, dumping and sorting, size reduction, sampling, and container decontamination for each unit of waste. For convenience, a drum of waste

was selected as the unit of waste used for estimating processing time. The development of system dynamics provided insights into critical path processes and potential bottlenecks in the facility.

The time and motion study was performed by breaking down each subsystem into multiple discrete tasks. The time to perform each task was evaluated. Treatment time was estimated based on the design capacity of the equipment and estimated throughput. The total of all tasks performed in a subsystem defines the treatment time for a drum of waste. The number of drums which require treatment during a shift, multiplied by the treatment time per drum, provides a total treatment time.

For batch processes utilizing more than one drum, or for continuous processes, the total treatment time must be calculated for all the drums of waste processed in an 8 hour shift. The lag time between drums was estimated, multiplied by the number of drums, and added to the time for a single drum to traverse the subsystem. Sampling and equipment monitoring times were also estimated. The total time to process the waste sent to each subsystem was then calculated. This information was used in preparation of the Gant charts (Figures 1 through 5).

The processing time was used to determine the number of FTEs. For some processes, the FTEs were based on monitoring time, rather than flow through a process. Monitoring time was estimated by considering the number of times a piece of equipment would be monitored (typically every 20 minutes or 24 times/shift) and the amount of time required for each monitoring task (usually 2-5 minutes). Monitoring tasks are assumed to include periods of perfunctory monitoring as well as analysis during mechanical or process problems. This approach accounts for parallel operations, because it assumes an operator can monitor multiple equipment items. The assessment of total monitoring time for all operations in a subsystem provides an estimate of the number of FTEs required for monitoring. Start-up time is included for batch processes.

The FTEs are based on the total personnel required per day to run a subsystem. Supervisory personnel are included at a ratio of one supervisor to ten workers. Also, an FTE absentee value of 6 weeks per year was assigned to account for employee vacations, holiday, sick leave, jury duty, etc. Finally, an efficiency of 70 percent was assigned to all FTEs. This 70 percent factor includes time off for lunch, breaks and meetings as well as process downtime occurring during their shift.

Tables A1-b through A1-o, C1-b through C1-l, NT2-b through NT2-n, NT3-b through NT3-o, and NT5-b through NT5-q present the time and motion analysis for the subsystems associated with each system. In most subsystems, all the waste entering requires the same treatment, but in some cases waste is divided by subtypes for distinct treatment trains. For example, the receiving and preparation subsystem discussed in Section 4.2 allocates waste by waste type to certain separation processes. Another example is the aqueous waste treatment subsystem, where aqueous waste is divided into high and low total dissolved solids and organics.

Sampling frequency is generally estimated at one sample per ten drums. In-process sampling is assumed for most processes, although the type of analysis is not specified.

Table 1 and Tables A1-p, C1-m, NT2-o, NT3-p and NT5-r provide a summary of the results of the analysis. The total FTEs shown in the time and motion analysis are about 20% higher than the FTEs estimated in the ITTS and INTS study reports. The reasons for this difference are discussed in Section 5.2.

The Gant charts (Figures 1 through 5), developed with SureTrak software, are based on the summary tables A1-p, C1-m, NT2-o, NT3-p and NT5-r. The assumptions used in the modeling are presented in Appendix B.

4. TASKS EVALUATED FOR EACH SUBSYSTEM

This section discusses the tasks evaluated and the results for each subsystem. Results are discussed for the five systems in this study. Some subsystems, such as administration, will be the same for all systems. Others, such as incineration, are only appropriate for a single system. Subsystems such as certification and shipping have the same tasks for all systems, but the FTEs will be different depending on the volume of waste shipped.

4.1 Administration Subsystem

The administration subsystem analysis estimates the FTEs required to operate the facility. Tables A1-b, C1-b, NT2-b, NT3-b and NT5-b show the estimated FTEs for the Administration subsystem. The facility staff was estimated, assuming an operation similar to an industrial facility with a total of 300 FTEs. Additional supervisory staff is included for each subsystem. Laboratory staff is estimated based on:

- The estimated number of samples received per shift (totaled from other subsystems)
- Four FTEs are needed to fill all shifts in a 5 day week for a given shift assignment; this accounts for vacation, sick and holiday relief
- Analysis time for in-process samples (10 minutes)
- Analysis for characterization (30 minutes)
- Analysis for raw materials (20 minutes)

The non-laboratory staff is estimated to be the same for all thermal and nonthermal systems. A staff of 35 is estimated for the following functions:

- Facility management
- Operations Management
- Personnel/ Security
- Environmental
- Shipping/Receiving
- Purchasing
- Accounting
- Health Physics

The laboratory technician staff required is based on the expected sampling required for waste characterization, in-process testing, raw materials testing, and final waste form analysis. The laboratory staff ranges from 12 for System C-1 to 23 for System NT-3.

The total administration subsystem FTEs for each of the systems are presented below and in Table 1:

- 48 for System A-1
- 47 for System C-1
- 52 for System NT-2
- 57 for System NT-3
- 58 for System NT-5

4.2 Receiving and Preparation Subsystem

The operations in the receiving and preparation subsystem was divided into specific detailed tasks. In addition to the ITTS and INTS reports, the design document for Hanford Site's WRAP 2A (Shaw, 1995) was used as a basis for developing these tasks. Tables A1-c, C1-c, NT2-c, NT3-c and NT5-c present the Receiving and Preparation Subsystem time and motion study. Eighteen tasks are identified, but not all tasks are required for all waste types. Several assumptions are made regarding how much waste will be treated by various unit operations, such as sorting, shredding, size reduction, glove box sorting, etc. These assumptions are presented in Tables A1-c, C1-c, NT2-c, NT3-c and NT5-c.

The tasks are listed below:

- Receiving trucks containing waste
- Receiving trucks with empty containers
- Receiving trucks containing supplies
- Transfer of waste from truck to interim storage or staging areas
- Assay waste by real time radiography, gamma spectroscopy, passive/active neutron (PAN) assay
- Transfer and staging of waste for sorting
- Opening drums
- Dumping drums
- Sorting waste robotically at tables
- Glove box sorting
- Assessing debris for compliance with debris rule
- Gross size reduction (cutting)
- Shredding
- Characterization sampling
- Transferring waste to bins
- Transfer of waste between subsystem
- Box breakdown
- Container decontamination.

For each system, the mix of tasks varies. All waste must be received, staged, and assayed. For thermal systems, 50 percent of the waste is assumed to require sorting; for nonthermal systems 75 percent of the waste is assumed to require sorting. In this study, the type of waste determines the number of tasks required. For example, special waste is sorted within glove boxes. Lead waste is sent to gross size reduction, but not shredding. Many planning level assumptions were made to establish how much of each waste type would require processing through the various steps. Tables in Appendix A list the assumptions used.

The number of employees required was estimated as follows (Table 1):

- 170 for System A-1
- 168 for System C-1
- 198 for System NT-2
- 195 for System NT-3
- 192 for System NT-5

As expected, the additional sorting requirements translate into a greater number of FTEs for the nonthermal systems. However, the difference is less marked than expected.

Much of the FTE requirements are due to the initial assaying requirements. Vendor estimates show that more that two hours is typically needed to perform the three analyses (PAN, SGS and RTR) which translates to a requirement of over 60 FTEs to assay the waste (Mettler, 1996). With over nine drums of waste assayed per hour, nine of each type of instrument would be needed to avoid a bottleneck. Thus, significant savings in capital and labor could be made if assaying time was reliably reduced. Further savings would be experienced if the instrumentation did not require the constant attention of an operator.

4.3 Aqueous Waste Treatment Subsystem

This subsystem is very similar for thermal and nonthermal systems. Both require sampling and monitoring and both use UV oxidation for organic destruction. In the nonthermal systems, all aqueous waste is sent to UV oxidation, whereas in thermal systems scrubber liquor does not require further treatment for organics. Thermal systems process more aqueous waste (primarily scrubber liquor), but through fewer operations. Tables A1-e, C1-e, NT2-f, NT3-e and NT5-g present the time and motion analysis for the aqueous waste treatment subsystem. The tasks in this subsystem are divided as follows:

- Waste receiving
- Preliminary treatment (sampling, filtration, oil/water separation, precipitation)
- UV oxidation.

The number of employees required for each system was estimated to be (Table 1):

- 6 for System A-1
- 5 for System C-1
- 14 for System NT-2
- 5 for System NT-3
- 23 for System NT-5

The differences in nonthermal systems relate to the mass of waste transferred to this subsystem. System NT-5 has the highest labor requirement because of aqueous waste generated from soft debris treatment. Also, much of the wash water in System NT-3 is treated and recycled within the washing process and is not sent to the aqueous waste treatment subsystem.

4.4 Nonthermal Organic Destruction Subsystem

Two types of nonthermal organic destruction were analyzed: Mediated Electrochemical Oxidation (MEO) and Catalytic Wet Oxidation (CWO). For both subsystems, the following tasks are appropriate:

- Receiving waste through an air lock; transferring liquids into a tank, and sampling
- Feeding waste to the reactor
- Operating the reactor

For MEO, several additional tasks are specified:

- Silver recovery
- Acid recovery
- Offgas treatment.

For CWO, additional tasks include:

- Waste transfer/recycle of acids
- Treatment of inorganics.

Tables NT2-d, NT3-d and NT5-d present the time and motion analysis for the organic destruction subsystem. For MEO, 26 FTEs are needed; for CWO 11 FTEs are estimated. MEO requires more FTEs because of the complex recycling processes. For the treatment of soft debris by CWO, 21 FTEs are needed (Table NT-5e).

4.5 Vacuum Thermal Desorption

The tasks involved in this subsystem are as follows:

- Waste receiving
- Transfer of the waste into the batch vacuum thermal desorber
- Vacuum thermal desorber operation
- Monitoring offgas
- Unloading of desorbed waste and transfer of waste to mercury treatment or stabilization
- Mercury contaminated solids leaching
- Leachate /filtrate treatment.

To estimate FTEs, it was assumed that 30 percent of the desorbed solids would require leaching to remove the mercury contamination. Tables NT2-e and NT5-f present the time and motion analysis for the vacuum thermal desorption subsystem. System NT-2 was estimated to require 23 FTEs due to the large volume of waste treated in this subsystem. System NT-5, in which only sludges and process residue is desorbed, required 10 FTEs.

4.6 Aqueous Washing Subsystem

This subsystem was used to treat process residue and sludge in System NT-3, and soil in both NT-3 and NT-5. Tables NT3-f and NT5-h present the time and motion analysis for the aqueous washing subsystem. The steps required are:

- Waste receiving
- Wash water preparation
- Washing process
- Pre-rinse and rinse
- Recycle processes (solubility reduction, ultrafiltration, dissolved air flotation, surfactant separation, steam stripping).

Employee requirements were estimated at 7 FTEs for System NT-3 and 4 FTEs for System NT-5. Many operations require monitoring, but the simple nature of the equipment and operations requires less overall attention than more sophisticated and complex processes such as vacuum thermal desorption combined with mercury leaching. The monitoring requirements were more labor intensive than estimated in the INTS report, as shown on Table 5-1.

4.7 High Pressure Wash Subsystem

This subsystem uses a batch washing and rinsing process. The process was estimated to be 3000 lbs/batch, and 90 minutes for each of three stages of washing/rinsing. The tasks identified were:

- Debris waste receiving
- Waste transfer to wash/rinse vessel
- Wash water solution preparation
- Washing/rinsing process

Tables NT3-g and NT5-i present the time and motion analysis for the high pressure wash subsystem. System NT-3 processes much more waste by pressure washing than System NT-5. System NT-5 is estimated to require 5 FTEs, and NT-3 needs 37 FTEs.

4.8 Main Thermal Treatment Subsystem

Five tasks define the incineration subsystem:

- Waste receiving
- Shredding
- Characterization sampling
- Incineration (feed, incinerate, discharge)
- Monitoring instrumentation

In addition to the first three tasks listed for incineration, the plasma subsystem tasks are:

- Plasma treatment operation (feeding, reactor operation, discharge)
- Plasma treatment monitoring instrumentation
- Cooling
- Final waste container decontamination

Table A1- d presents the time and motion analysis for the incineration subsystem and Table C1-d presents the plasma treatment subsystem. Employee requirements were estimated at 20 FTEs for incineration and 23 FTEs for plasma treatment. These values are similar to those in the ITTS report. Notably, for the plasma system (C-1), the estimates are less than those reported in ITTS (Table 5-1).

4.9 Vitrification Subsystem

This subsystem provides capability to vitrify ash following thermal treatment. The tasks required are:

- Ash receiving through airlock
- Waste transfer to feed bin
- Vitrification
- Monitoring vitrification instrumentation and equipment
- Cooling
- Monitoring the APC
- Decontamination of the final waste container

This subsystem requires 14 FTEs. Only System A-1 requires this subsystem (Table A1-g). The additional labor needs showcase the advantage of the one-step thermal processes which do not require vitrification.

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4.10 Metal Melting Subsystem

System A-1 uses metal melting to process metal with entrained contamination (Table A1-f). The identified tasks are:

- Metal receiving (from receiving and preparation)
- Metal melting
- Metal cooling
- Instrumentation and monitoring of the APC.

This subsystem labor requirement is estimated at 6 FTEs.

4.11 Metal Decontamination Subsystem

This relatively simple subsystem requires two tasks:

- Metals receiving/feed preparation
- Waste decontamination

Tables A1-h, C1-f, NT2-g, NT3-h and NT5-j present the time and motion analysis for the metal decontamination subsystem. The number of FTEs for each system is similar for all systems because the volumes are similar. Sixteen FTEs are estimated for both nonthermal and thermal systems. This estimate is significantly higher than the ITTS and INTS estimates (Table 5-1). Assay and decontamination time estimates increased the labor needed.

4.12 Lead Recovery Subsystem

Lead recovery for nonthermal systems includes the following tasks:

- Lead receiving and feed preparation
- Decontamination

For thermal treatment, lead melting and metal cooling tasks are added. Because waste is treated by either decontamination or metal melting, both thermal and nonthermal systems have the same number of FTEs. The time and motion study analysis is based on volume of waste (Tables A1-i. C1-g, NT2-h, NT3-i and NT5-k). Lead has a high density and, therefore, the studied volume of waste is low. Only 2 FTEs are needed to treat this waste by decontamination or melting.

4.13 Mercury Amalgamation Subsystem

Like lead, the mercury waste has a high density and a low volume of waste requiring treatment. This subsystem has the following tasks for both thermal and nonthermal systems (Tables A1-j. C1-h, NT2-i, NT3-j and NT5-l):

- Waste receiving and feed preparation
- Mercury amalgamation.

Thermal systems also treat mercury contaminated debris, using the following tasks:

- Shredding debris
- Retorting debris for mercury removal.

The mercury recovered is amalgamated as in the nonthermal systems. The thermal systems require 2 FTEs, while the nonthermal systems, which process much less waste, need less than 1 FTE.

4.14 Special Waste Treatment Subsystem

The ITTS and INTS concept for special waste treatment was that certain wastes could not be treated in the other subsystems in the facility. Therefore, a space was allotted for treatment processes that were either mobile or under development to treat the variety of waste that could not be treated by other subsystems. To estimate FTEs, it was assumed that the waste required preparation, such as size reduction, for an average of one hour per drum of waste. The waste would be treated in an unspecified batch process for two hours, sampled, and repackaged. As shown in Tables A1-k. C1-i, NT2-j, NT3-k and NT5-m, the tasks defined are defined as follows:

- Waste receiving and feed preparation
- Waste treatment.

Because the amount of special waste is significant (5 percent of the total), 11 FTEs are needed. The labor estimates for this subsystem were significantly different from the ITTS and INTS estimates.

This analysis shows that the treatment of special waste will require significant allocation of resources. Storage of waste to be treated by mobile or temporary processes in campaigns will require extensive space because special waste volume is estimated at 5 drums per shift. Therefore, treatment processes must be available before the waste can be received at the facility. This finding shows the importance of developing treatment processes to treat the less common waste streams.

4.15 Grout Stabilization Subsystem

This subsystem provides encapsulation of waste in grout. As shown in Tables NT2-k, NT3-l and NT5-n, the tasks are:

- Waste receiving and preparation
- Waste micro- or macroencapsulation
- Curing
- Decontamination of containers

Curing is estimated only in terms of the time required to move the waste in and out of a curing area, and to monitor the curing process. The actual time required for curing is not estimated. The analysis indicates that storage requirements for curing will be needed for 60 to 80 drums per shift for each shift of curing required.

The labor requirements for this subsystem are highly dependent on the waste volume which varies by system. The number of employees required was estimated as follows (Table 1):

- 21 for System NT-2
- 16 for System NT-3
- 11 for System NT-5

4.16 Polymer Stabilization Subsystem

Polymer stabilization has the same basic tasks as grout, although the specific processing steps are different. As in the grout subsystem, the actual time required for curing is not estimated. As shown in Tables A1-m, C1-j, NT2-l, NT3-m and NT5-o, the tasks are:

- Waste receiving and preparation, including drying waste
- Waste microencapsulation
- Curing
- Decontamination of containers

Labor needs reflect volume throughput. The number of employees required was estimated as follows:

- 13 for System A-1
- 13 for System C-1
- 36 for System NT-2
- 41 for System NT-3
- 36 for System NT-5

4.17 Air Pollution Control Subsystem

Equipment monitoring is the only task identified for the air pollution control subsystem. The details are shown on Tables A1-n, C1-k, NT2-m, NT3-n and NT5-p. This subsystem is much less volume dependent than other subsystems because of the absence of waste handling. Labor is based on time required to monitor equipment. The nonthermal systems require 4 FTEs. The more complex APC subsystems for thermal systems require 10 FTEs.

4.18 Certification and Shipping Subsystem

As shown in Tables A1-o, C1-l, NT2-n, NT3-o and NT5-q, the certification and shipping subsystems include the following tasks:

- Waste receiving from processing subsystems
- Waste assay
- Staging of certified waste
- Shipping (loading trucks)

The differences in labor requirements are due to the volume of waste shipped. The number of employees required was estimated as follows (Table 1):

- 24 for System A-1
- 24 for System C-1
- 101 for System NT-2
- 110 for System NT-3
- 89 for System NT-5

5. MODELING RESULTS

The simple Gant charts developed for this study provide early indication of time consumed by major functions of the facilities, and identify activities which fall on the critical path. Figures 1

though 5 present Gant charts for the systems analyzed. Table 1 summarizes the labor resource needs for all major activities for each system. For comparison, the ITTS and INTS FTEs are also listed.

Key results of this modeling are:

- Characterization is a critical path process and very labor intensive
- The differences in receiving and preparation between thermal and nonthermal systems are less dramatic than estimated in the INTS and ITTS studies
- Material handling is more significant than processing in terms of labor and time
- One-step thermal treatment processes require significantly less labor than incineration combined with vitrification of ash
- Special waste treatment is on the critical path for thermal systems
- Treatment of special wastes will require significant allocation of resources
- Storage requirements for special waste will be extensive if processes are not available for treatment
- Debris treatment is on the critical path for nonthermal systems
- Labor FTEs may be about 20 percent higher than estimated in the INTS and ITTS reports

5.1 System Dynamics Results

The time and motion study estimates the time required for various processing steps at the throughputs provided for the equipment specified. This development of system dynamics provides insights into potential bottlenecks in the facility. The results are summarized below.

- The assay function stands out as the most limiting process in the facility. Following a discussion with the assay equipment vendor, the time assigned for assay by passive/active neutron and gamma scanning was determined to be one hour per container for each scanning process.
- Other time consuming processes include material handling, shredding, and sampling. The receiving and preparation subsystem, the polymer stabilization subsystem and the certification and shipping subsystem require the longest processing time.
- Soft debris, process residue and special waste treatment require the most preparation and processing time.
- Polymer stabilization requires more treatment time than grout stabilization. Curing time is not included in the analysis, although time for moving waste into and out of the curing area is included.

5.2 Labor Requirement Results

For most subsystems, the time and motion study indicates more full time equivalent employees will be needed than were estimated in the INTS and ITTS studies. Factors that are responsible for the differences include the following:

- The time and motion study included supervisory personnel, time lost due to vacation and sick leave, and a worker efficiency of 70 percent.
- Previous analysis focused on processing requirements. In this area, the ITTS and INTS numbers were closest to the time and motion study.
- The assay function requires nearly three hours per drum with constant supervision by an operator. This function requires 63 FTEs per shift for all systems. Time for individually supervised assays was not included in earlier analyses.
- Material handling was not the focus of the INTS and ITTS studies. In a typical chemical plant, feed to a process and equipment designed to handle that specific material will be consistent. For a radioactive waste processing facility, movement of a variety of waste streams contributes to considerable time per drum. This analysis assumes each INTS drum and most ITTS drums must be opened and emptied. For several processes, the rate limiting step is getting the waste from drums to the process.
- Previous analyses characterized sorting as time consuming. The time and motion study quantifies sorting requirements. For example, glove box sorting requires five employees per shift to sort slightly less than one drum per hour.

5.3 Conclusions

The following conclusions can be derived from the time and motion study analysis:

- Front-end and back-end handling are the areas requiring the most FTEs and processing time. These functions are most closely related to the volume of waste handled.
- After front and back-end handling and administration, stabilization processes for nonthermal systems, especially polymer, require the most time and FTEs.
- Metal decontamination and special waste treatment are labor-intensive and time consuming.
- Treatment of major waste streams, such as incinerable waste in ITTS systems and process residue in INTS systems, require significant labor and processing time. Although the processing time per unit is small, the volume of waste treated increases labor and processing time.
- Higher capacity equipment can lead to more efficient processing and reduced labor time. However, this efficiency would not be significant unless material handling and material transfer time can be reduced.
- Feed operations and transfer of material between cells require extensive effort; improvements in material transfer would have significant pay-back.
- Labor FTEs may be about 20 percent higher than estimated in the INTS and ITTS reports

6. RECOMMENDATIONS FOR FUTURE WORK

Real-time assay and characterization needs, sorting needs, size reduction needs, and material handling issues are among the major sources of design and cost uncertainties in the ITTS and INTS studies. These uncertainties indicate a need for increased R&D in this area.

The following areas are recommended for research:

- Gamma and PAN Assay:
 Develop methods with reduced assay time and reduced direct observation by an operator.
- Material handling bins:

Develop bins or hoppers which are easily transported, filled from drums and emptied into feed systems. These bins should be dust and liquid tight.

• Sorting and segregation:

Evaluate sorting and segregation material handling devices on the market for applicability to DOE mixed waste.

• Shredding:

Support development of efficient, reliable shredders which need little operator support yet meet process requirements.

• Special waste:

Develop treatment methods for special waste. Determine the effect of potential treatment processes on the size of the facility (including storage requirements) prior to facility design.

- Material handling of drums: Evaluate improved methods of drum transfer, drum opening, removal of drum contents, drum cleaning and drum sealing.
- Material transfer: Develop airlock system which allows for quick transfer of material, possibly by a closed conveyor.
- Drum decontamination: Develop methods that require little labor. Develop quick assay method.
- Polymer stabilization: Develop and optimize process to minimize labor. Automate material transfer to reduce handling.

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				_	_				_			The second se				,
Subsystems	System A-1	System A-1	System A-1	System C-1	System C-1	System C-1	System NT-2	System NT-2	System NT-2	System NT-3	System NT-3	System NT-3	System NT-5	System NT-5	System NT-5	Average % change between
	Time/			Time/			Time/			Time/			Time/			Time/ Motion
	motion FTEs	FTEs	% diff.	motion FTEs	FTES	% diff.	FTEs	FTEs	% diff.	FTEs	FTEs	% diff.	FTEs	FTE <u>s</u>	% diff.	ITTS
Administraton Subsystem	48	27	44.2%	47	27	42.1%	52	32	38.6%	57	32	44.2%	58	32	44.7%	42.8%
Receiving and Preparation Subsystem	170	112	34.2%	168	112	33.1%	198	170	14.0%	195	170	13.0%	192	170	11.4%	21.2%
Aqueous Waste Treatment Subsystem	6	16	-172.5%	5	16	-202.1%	14	5	65.3%	5	.5	3.5%	23	5	78.6%	-45.4%
Organic Destruction Subsystem							11	12	-12.5%	26	12	53.0%	11	12	-13.4%	9.0%
Vacuum Thermal Desorption Subsystem							23	16	30.5%				10	8	22.5%	26.5%
Aqueous Wash Subsystem										7	3	53.9%	4	2	53.7%	53.8%
Soft Debris-CWO Subsystem													21	14	31.9%	31.9%
Open Debris-High Pressure Wash Subsystem										37	16	56.6%	5	8	-67.5%	-5.4%
Main Thermal Treatment Subsystem	20	16	19.4%	23	32	-37.3%										-9.0%
Vitrification Subsystem	14	16	-16.9%													-16.9%
Metal Melting Subsystem	6	5	14.1%													14.1%
Metal Decontamination Subsystem	16	5	69.7%	16	5	69.7%	16	4	75.5%	16	4	75.5%	16	4	75.5%	73.2%
Lead Treatment Subsystem	2	8	-273.4%	2	8	-273.4%	2	3	-25.4%	2	3	-51.1%	2	3	-51.1%	-134.9%
Mercury Amalgamation Subsystem	2	4	-134.3%	2	4	-134.3%	0.31	1	-221.9%	0.09	1	-1072.6%	0.09	1	-986.2%	-509.9%
Special Waste Treatment Subsystem	11	2	81.3%		2	81.3%	11	3	72.3%	11	3	72.3%	11	3	72.3%	75.9%
Grout Stabilization Subsystem							21	8	61.3%	16	8	50.4%	11	8	27.4%	46.4%
Polymer Subsystem	13	8	39.5%	13	8	39,5%	36	38	-4.0%	41	40	4.6%	36	38	-2.8%	15.4%
Air Pollution Control Subsystem	10	4	59.6%	10	4	59.6%	4	4	1.8%	4	4	1.8%	4	4	1.8%	24.9%
Certification and Shipping Subsystem	24	32	-33.6%	24	32	-33.6%	101	105	-4.3%	100	110	-9.6%	89	88	1.0%	-16.0%
				- -												
Total	342	255	25.4%	321	250	22.1%	489	401	18.2%	518	411	20.8%	494	400	19.0%	20.7%

Note: Minor discrepancies can be noticed between the certification and shipping numbers shown here compared to those in the INTS report.

The numbers in the INTS report and ITTS/INTS comparison report reflect an earlier draft of the time and motion study, calculated with a slightly different mass balance.

Figure 1 Time and Motion Study, System A-1

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Act	Description	Orig							1996				<u> </u>		
ID	Description	Dur			1				JUN						
			01	02	03	04	05	06	07	08	09	10	11	12	13
1000	Receive and Assay	62				******	888888 R	eceive	and A	ssay					
1010	Incineration Prep	29				Δ		⊘ Incir	eration	Prep					
1020	Metal Melt prep	8						Metal	Melt p	rep					
1050	Metal decon prep	9					$\Delta \overline{\mathcal{M}}$	Metal	decon (prep					
1060	Lead prep	9					$\Delta $	⊘ Lead	d prep						
1070	Mercury waste prep	9					Δ	7 Mer	cury wa	iste prer)				
1080	Special waste prep	31					*******	Spec	ial was	te prep					
1100	Aqueous Waste	22				Δ-		Aque	ous Wa	aste					
1110	Incineration	17					<u>s</u> v	⊽ Inci	neratio	n					
1120	Metal Melting	11				1	Δ	🏹 Me	tal Melt	ing					
1160	Metal Decontamination	20							etal De	contam	ination				
1170	Lead Recovery	9							ead Re	covery					
1180 '	Mercury Amalgamation	10					Δ		ercury	Amalga	mation				
1190	Special Waste Treatment	7					Ø	🗙 Spe	cial Wa	aste Tre	atment				
1200	Vitrification	9							ificatior	1					
1210	Polymer Stabilization	5						7 Poly	mer Sta	abilizatio	on				
1300	Certification and Shipping	15					k		Certifica	ation and	d Shipp	ing			
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Time and Motion Study, System C-1

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1060	Lead prep	9		· · ·				/ Lead	prep						
1070	Mercury waste prep	9						🗸 Mer	cury wa	aste pre	р				
1080	Special waste prep	31						Speci	al was	e prep					
1100	Aqueous Waste	12					<u>A</u> W	Aqueo	us Wa	ste					
1110	Plasma Treatment	19					$\Delta = \nabla$		asma T	reatmer	nt				
1160	Metal Decontamination	20					, – <u>"</u>	XXXXXX N	letal D	econtan	nination		· ·		
1170	Lead Recovery	9						_ ∠ Le	ad Rec	overy					
1180	Mercury Amalgamation	10					L	J JAN N	ercury	Amalga	amation				
1190 ,	Special Waste Treatment	7					ASS -	🗙 Spec	ial Wa	ste Trea	tment				
1210	Polymer Stabilization	5						Polyn	ner Sta	bilizatio	n				
1300	Certification and Shipping	15					с		Certific	ation ar	nd Shipp	oing			

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	Early bar	Critical point
Act ID is the activity identification number	\bigtriangledown Late finish point	Summary point
	Total float bar	Start milestone point
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	🗱 Critical bar	

Figure 3

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Time and Motion Study, System NT-2

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1020	Soil prep	7		·.				Soil pr			<u></u>				
1020	Debris prep	8						Debris	pren						
1050	Metal decon prep	9					<u>xxxxxx</u>		etal der	con pre	n				
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1070	Mercury waste prep	q			-			Ļ			u picp	ste nro	n	,	
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1170	Lead Recovery	3						¥====				overy			ļ
1180	Mercury Amalgamation	6									rcury A	malgar	nation		
1190	Special Waste Treatment	7	ļ				Δ	<u>↓</u> =√ S	pecial V	Naste T	reatme	nt			
1200	Grout Stabilization	7						S G	rout Sta	bilizatio	on				
1210	Polymer Stabilization	30					L	<u>}</u>		blymer &	Stabiliza	ation			
1300	Certification and Shipping	53							*******		ertificat	ion and	l Shipp	ing	
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Figure 4

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Time and Motion Study, System NT-3

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1010	Process residue prep	22			·			Proce	ss resid	due pre					-	
1020	Soil prep	7						Soil pr	ep		1					
1040	Debris prep	8			-			Debris	prep					-		
1050	Metal decon prep	9			-		$\Delta \nabla$	V Meta	decon	prep						
1060	Lead prep	9						<u>}</u>	$ \nabla$	Lead	brep					
1070	Mercury waste prep	9			-			↓ ∕		Mercur	y waste	prep				
1080	Special waste prep	32				Δ	\ \	Speci	al was	te prep		1				
1100	Aqueous Waste	20					∇	Ā	queous	s Waste	e e	1			-	
1110	Organic Destruction	6						Organ	c Dest	ruction		1				
1120	Aqueous Wash (residue)	7							ous Wa	sh (res	sidue)	1				
1130	Aqueous Wash (Soil)	3						Aqueo	us Wa	sh (Soi	il)				1	
1150	High Pressure Wash	4			·		<i>8</i>	High F	ressur	e Wasi	h					
1160	Metal Decontamination	20					Δ		letal D	econta	minatio	'n			·	
1170	Lead Recovery	3					L	V	ζ	Lead	Recove	ery				
1180	Mercury Amalgamation	6					Z	\			ury Ama	algam	ation			
1190	Special Waste Treatment	7						Spec	ial Wa	ste Tre	atment					
1200	Grout Stabilization	6					Å	🕱 Grou	t Stabi	lization						
1210	Polymer Stabilization	33					Δ		V Poly	mer St	tabilizat	on				
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Figure 5Time and Motion Study, System NT-5

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1020	Soil prep	7						7 Soil p	rep			•						
1030	Soft debris prep	21					└ \V	- 	t debris	prep								
1040	Open debris prep	6						Open	debris p	rep								
1050	Metal decon prep	9							🖓 Meta	decon	prep							
1060	Lead waste prep	9						↓	+⊽L	ead wa	ste prep	C						
1070	Mercury waste prep	9						↓	- ⊽ Me	cury w	aste pro	эp						
1080	Special waste prep	32					L	🖞 Spec	cial was	te prep								
1100	Aqueous Waste	23				Δ	V		Aqueou	s Wast	e							
1110	Organic Destruction	5						Orga	nic Dest	ruction								
1120	Vacuum Thermal Desorption	18					Δ	↓, va	cuum T	hermal	Desorp	tion						
1130	Soil Treatment	3						🖞 Soil T	reatme	nt								
1140	CWO for Soft Debris	16						Ż=⊽ CN	NO for S	Soft De	bris							
1150 '	High Pressure Wash-Open	4					18	High	Pressur	e Wasł	h-Open	Debris						
1160	Metal Decontamination	20								Aetal D	econtar	ninatio	n					
1170	Lead Recovery	3						∕ӯ====	- -∇ l	ead Re	covery							
1180	Mercury Amalgamation	6						Å⊽==		Aercury	Amalg	amatio	'n					
1190	Special Waste Treatment	7						Spe 🖓	cial Wa	ste Tre	atment							
1210	Polymer Stabilization	30					Δ	<u></u>	村 Poly	mer Sta	bilizatio	on						
1230	Grout Stabilization	5					4	🗙 Grou	ut Stabil	ization							-	
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APPENDIX A

Time and Motion Study Calculations

Table of Contents

Introduction

System A-1 Time and Motion Study Tables System C-1 Time and Motion Study Tables System NT-2 Time and Motion Study Tables System NT-3 Time and Motion Study Tables

Introduction

The tables in this appendix are produced from five interlinked spreadsheets.

The first table in each series (Table A1-a, C1-a, NT2-a, NT3-a and NT5-a) presents the waste feed to each subsystem, as developed in the ASPEN mass balance. For each subsystem the dominant waste types were selected, based on the MWIR waste descriptions (DOE, 1993). As shown in the third column, Waste Type, the MWIR code is shown. The fifth column shows the estimated density of the unprocessed waste in kg/cu m, as developed in the Systems Cost Model (Shropshire, 1996). The density is converted to pounds per cubic foot and to pounds/drum in the sixth and seventh columns respectively. The fourth column is the result of the second column (mass flow, lb/hr) divided by the seventh column (drum density, lb/drum).

The remaining tables estimate full time equivalent employees (FTEs) and the time required for waste treatment. The columns of these tables are described below:

- Columns one and two: Tasks and subtasks are identified.
- Column three, administration subsystem: The administration subsystem table lists FTEs without calculation in this column, because they are an estimate based on a 300 person facility.
- Column three, other subsystems (as shown in Table A1-c and others): Shows the occurrence per shift, such as drums, trucks or pallets.
- Column four: The unit for occurrence per shift is expressed, usually drums.
- Column five: "Time required" is estimated for each subtask.
- Column six: "Total Time per Shift" is the product of column three and column five. Totals for each task are provided.
- Column seven: "FTEs needed" is the total time per shift divided by the minutes in a shift.
- Column eight: "Additional Time for Next Drum" shows the estimate of the lag time between drums.
- Column nine: "Average Minutes per Shift per Drum" only appears in the receiving and preparation subsystem, is the product of the required time (column five) times the frequency of occurrence. This accounts for waste types which require different tasks; e.g. special waste requires glovebox sorting but not shredding. Column nine shows the estimated average time

a drum of waste requires for processing. If only 10% of the waste is treated in a given task, then this column reflects 10% of the time required, shown in column five.

The last table in each series (Table A1-p, C1-m, NT2-o, NT3-p and NT5-r) shows the summary of the FTEs and time required for waste processing.

System A-1 Time and Motion Study Tables

- A1-a System A-1: Time and Motion Analysis
- A1-b Administration Subsystem
- A1-c Receiving and Preparation Subsystem
- A1-d Incineration Subsystem
- A1-e Aqueous Waste Treatment Subsystem
- A1-f Metal Melting
- A1-g Vitrification of Ash
- A1-h Metal Decontamination Subsystem
- A1-i Lead Recovery
- A1-j Mercury Amalgamation
- A1-k Special Waste
- A1-1 Grout Stabilization Subsystem
- A1-m Polymer Stabilization Subsystem
- Al-n Air Pollution Control Subsystem
- A1-o Certification and Shipping
- A1-p Summary of FTEs and time for a single drum to work through a system

Table A1-a.

System A-1: Time and Motion Analysis

Subsystem	Mass Flow	Waste Type	No. of	SCM Unprocessed	Density	Density
Subsystem		vvaste Type	Diditis	kg/m3	lb/ft3	lb/drum
Administration	2,927					
Receiving and preparation	2,927	all	6		64	471
Aqueous waste treatment	13,474	L1100	30		62	456
Incineration	2,000	S5300,5110	4		64	471
Vitrification	1,495	S3110	3	650	64	471
Metal Melting	149	S5110	1	509	32	234
Metal decontamination	468	S5110	2	509	32	234
Mercury amalgamation	50	X7100	0	2000	125	918
Lead recovery	26	X7200	0	2000	125	918
Polymer stabilization	113	S3120	0	700	44	321
Air pollution control	21,420		N/A			
Grout stabilization	0	soil/debris	0	750	47	344
Special treatment	153	X6000,X7500	1	500	31	229
Certification and shipping	1,958	Z000	1	2500	179	1320
Vol reduction (out/in)	1.49		0.24			

Notes:

This table provides the basis for the time and motion analysis.

Quantities of waste to a subsystem (lbs/hr) are based on LMITCO mass balance.

Densities are the same as the LMITCO mass balance except where values are shown in the SCM column.

Where values are shown in the SCM column, densities are taken from SCM and converted to lb/ft3..

Waste types are based on MWIR

The waste quantities are converted from lbs/hr to drums/hr.

Subsequent analysis is based on drums/shift of waste to a subsystem.

Table A1-b.

Administration Subsystem

				Time	
	•	FTEs	Samples/	Required	Total Time /
Task	Subtask	needed	Shift	(min)	Shift
Facility Management	Facility Manager	. 1			
	Secretary	1			
	Receptionist/word processor	1			
Operations Management	Department managers	2			
	Communications	1			
	Engineering Manager	1			
	Engineering staff	2			
	Maintenance Supervisor	1			
Personnel	Personnel Manager	1			
	Nurse/medical/industrial safety	1			
	Security guards at facility	4			
	Security at guard bldg	4			· · · · · · · · · · · · · · · · · · ·
Environmental	Environmental manager	1			-
	Environmental clerk	1			
Shipping/Receiving/Traffic	Manager	1			
	Clerk	1			
Purchasing	Buyer	1		·	
Accounting	Cost Accounting	2			
	Accounting Clerk	1			
· · · · ·	Payroll Clerks	2		L	
Laboratory	Laboratory Manager	1			
	Lab Shift manager	4			
	Lab technicians for OSORT	1	4.1	30.0	123.2
	Lab technicians for internal processes	4	36.2	10.0	362.1
	Lab technicians for final waste form	3	8.4	30.0	250.9
	Lab technicians for incoming supplies	0.2	1.0	20.0	20.0
Health Physics	Shift health physics staff	4			
	Health physics manager	1		1	
	Total except Lab	35			
	Total Lab	13			
	Total Admin	48			

Table A1-c. Receiving and Preparation Subsystem

		Occurrence/		Time Required	Total Time/	FTEs	Add'I/Time for Next	Ave Minutes/Shift/
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
Receive Waste	Truck decking	0.6	truck	20	47			
Truck	Sottle Depenverk	0.0	truck	30	17			
	Sellie Paperwork	0.0	truck	120	00			
	Staga polieta	0.0	truck	60	34			
	Stage pallets	0.0	uuck	00	34			
Total Took 1	No or pallets/shift		·	270	450	0.2		450
Dessive Empty				270	155	0.3	<u> </u>	153
	Truck docking	0.2	truck	20	0			
	Sottle Benenverk	0.3		30	<u> </u>			
	Selue Faperwork	0.3	truck	30	0			
	Stage pollete	0.3	truck	20	6			
Total Took 2	Slage pallets	0.5	LUCK	20	40	0.1	0	40
Pagaiva Supplian		0.2	truck	20	40	0.1	0	40
Receive Supplies	Sottle Benerwork	0.2	truck	30	- 0			
	Sellie Paperwork	0.2	truck	30	10			
	Stage pollete	0.2		00				
Total Taak 2	Stage pallets	0.2	TUCK	20	4	0.1	0	20
Transforta	Maya polleta to	i. T		140	20	0.1	0	20
Interim Storogo	storage area	62	Dallet	5	21			
intenin Storage	Stock polloto/	0.2	Fallet	5	31			
	Slack pallets/	62	Pallet	10	62			
•	Transfer to assay	6.2	Pallet	5	02			
Total Tack A	Transier to assay	0.2	Fallet	20	124	0.2	10	10
Accay Drume	Stage pallete	12.4	Pallot	20	62	0.3	10	10
Assay Diums	l cod op conveyor	12.4	drum	1	50			
	Accov DTD	49.0	drum	15	746			
	Assay KIK	49.0	drum	60	2086			
	Assay ganina	49.0	drum_	60	2900			
	Assay FAIN	49.0	uiun	00	2900		ļ	
		10.8	drum	2	140			
	Conveyor Depallatiza	49.0	drum	3	50			
	Staga polleto offer	49.0	uluili	l .				
	Stage pallets alter	12.4	Pollet	5	62			
Total Took 5	assaying	12.4	Fallet	150	7001	1/ 9	60	150
Stage and mayo	Store colid waste			100	7031	14.0	00	100
	Sille Solid Waste	121	Dallet	10	124			
10 030K1	Move to 50% to	12.4	Fanet	10	124			
		62	Dallet	5	21			
	Stage at OSOPT	6.2	Pallet	5	31			
Total Took 6	Slaye al USURI	0.2	Pallet		107	04	5	20
TULAI TASK O	Store et drum	1	Fallet	ZU	107	0.4	<u> </u>	
Open Drume	Stage at urum	62	Dallat	5	21			
open Diums	Load on conveyor	24.9	Drume	5	124		1	
	Drum lid clamp	24.3	drum	2	50			
	Drum lid opener	24.3	drum	5	124			
	Lid staging	24.3	drum	3	25			
	Demove from	27.3	Giulii		20			
	conveyor	24 9	drum	1	25			
Total Task 7				19	398	0.8	5	19

Table A1-c. Receiving and Preparation Subsystem

		Occurrence/		Time Required	Total Time/	FTEs	Add'l/Time for Next	Ave Minutes/Shift/
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
	Assign drums to				-7			
Dump Drums	dump stations	24.9	drum	3	75			
· •	Move drums to sort			-				
	table /bins	24.9	drum	5	124		.	
	Dump drums	24.9	arum	5	124		_	
I otal I ask 8				13	323	0.7	5	13
	Sort waste				740			
Son Drums	robotically	24.9	arum	30	/46			1
	I ransfer waste to		-1	45	070			
	container	24.9	arum	15	3/3			
	Select destination				-75			
	for sorted waste	24.9	arum	3	/5			
· · · ·	Move container to subsystem bin or							
	shredder	24.9	drum	3	75			
Total Task 9				51	1269	2.6	45	38
	Transfer to glove							
Glove Box Sort	box (several trips)	6.0	drum	30	180			
	Sort waste by hand							
	in glove box	6.0	drum	240	1440			
	Sampling (1/drum)	6.0	drum	15	90			
	Transfer waste to						1	
	containers	6.0	drum	60	360			
	Select destination							
	for sorted waste	6.0	drum	15	90			
	Move containers to							
	subsystem bin or			45	00			
Total Table 40	snredder	6.0	arum	15	90	47	045	-
Total Task 10				3/5	2250	4./	315	<u> </u>
Gross Size	ranster to cutting	54	deuro	2	46			
Reduction		5.4	drum	3	10			
		5.4	drum	30	101			
	Transfer to next	5.4	urum	3	21			
	Transfer to next	54	drum	2	16			
Total Tack 11	pilless	0.4	ululi	3	220	0.5	35	6
	Transfer drume to		<u> </u>		220	0.5		
Shredding	shredder	31	drum	2	6			
Sincouniy	Stage drume	31	drum	2	6	1		
	Feed waste to	0.1	Grunn	2		1		
	shredder	31	drum	2	6.22			
	Feed had drume to	0.1	Grunn	<u> </u>	<u><u> </u></u>	1		
	shredder	12.4	drum	2	25			
	Shred stage 1	12.4	drum	2	25			
	Shred stage 2	12.4	drum	2	25	1		
	Sample size of	• • • • • • • • • • • • • • • • • • • •	GI GITT			1		
	waste	12	drum	5	6			
	Rework 10%	0.1	drum	15	2			
	Return to container	12.4	drum	3	37	1		
	Transfer to next	·		† -				
	process	12.4	drum	2	25			
Total Task 12				37	164	0.3	2	30

Table A1-c.

Receiving and Preparation Subsystem

				Time			Add'l/Time	Ave
Taak	Subtook	Occurrence/	Linita	Required	Total Time/	FTEs	for Next	Minutes/Shift/
Sampling	JUDIASK	Sint	Units	(000)		Needed	Drum	Drum
Sampling	Sample opened				0			
	drume	25	drum	5	12			
	Sample sorted	2.0	Giani		12			
	Waste	12	drum	5	6			
	Resample (10%)	0.4	drum	5	2			
	Report/eval results	0.4 A 1	drum	10	<u> </u>			
Total Task 13	Reporteval. Tesuits	<u>4.1</u>	uluii	25	62	0.2	10	20
Subsystem Bin				25	02	0.2	10	30
operation	Monitor bin beight	24.9	drum	3	75			
operation		24.9	drum	3	75			
	Move containers	24.9	drum	3	75 50			-
	Stage containers	24.3	drum	2	75			
	Organiza	24.3			/5			
	compaigns	24.0	drum	15	272			
Total Task 14	campaigns	24.5	Grunn	26	647	10	0	26
TOLAT TASK 14	Move waste from	1		20	047	1.0	0	20
Internal Transfer	OSORT to other							
	subsystems	24 9	drum	10	249		}	
	Move waste from	27.0	Grunn	10	245			
	subsystems to							· · · ·
	CSHIP	11.8	drum	10	118			
		11.0	aran		110			
	Move treated							
	waste to		-1	10	000			
•	stabilization	80.0	arum	10	800			
	Move unsorted	~~~	-1	10				
	waste to incin	6.2	arum	10	62			
	wove waste to							
	secondary	20.0	drum	10	200			
	Maya aunaliaa	20.0	urum	10	200			
	around	20.0	drum		60			
	Movo pow drumo	20.0	drum	3	75			
	Schodulo	24.9	uiuiii	<u> </u>	13			
	Schedule	197.9	drum	1	199			
Total Task 15	movement	107.0	<u>urun</u>	57	1752	49	10	57
Box Breakdown	Stage hoves	10.0	box	2	20	4.5	10	
DOX DIEARGOWII	Move to opening	10.0	DUX		20			
	area	10.0	box	3	30			
	Open hoves	10.0	box	10	100			
	Transfer to dump	10.0	box	3	30			
Total Task 16		10.0	504	18	180	0.5	10	2
Container Decon	Stage containers	49.8	drum	5	249	0.0		
Container Beoon	Load conveyors	49.8	drum	5	249			
	Decon drums	49.8	drum	10	498			
	Assay drums	49.8	drum	15	746			
	Unload conveyers	49.8	drum	5	249			
	Stage drums	49.8	drum	5	249			
Total Task 17				45	2239	6.2	15	45

Table A1-c. Receiving and Preparation Subsystem

Task	Subtask	Occurrence/ Shift	Units	Time Required (min)	Total Time/ Shift	FTEs Needed	Add'I/Time for Next Drum	Ave Minutes/Shift/ Drum
FTEs/shift					0	32.3		
Supervision	Ratio of 1:10					3.2		
Vac/sick/holiday relief	Assume 6 wks of absence					4.1		
Break relief (included in 6 hr day)	One person can relieve 3 (accounted for in efficiency)							
Total/shift						39.7		
Adj for 70% Efficiency Total(day						56.7 170 1		670 7
rotal/day						170.1		0/0./

Notes:

Assume FTEs are available for 8 hrs/day; because overall 70% efficiency is taken at the end.

Trucks have 22 pallets. Waste density is 64 lb/ft3.

Pailets are assumed to hold four 55 gallon drums

As in inventory, assume 50% of drums are contaminated and can't be deconned.

Assume 50% of waste received requires interim storage; this will be dependent on assay system

Assume 10% of incoming waste is sampled

Assume opened and sorted waste is 50% of total

Assume 10% of sorted waste is sampled

Assume gross size reduction is necessary for wastes to metal decon & lead

Assume gross size reduction is 1 hr per drum.

Assume shredding is necessary for drums only

Assume 10% of shredded waste is sampled.

Box breakdown includes time beyond that required if waste was packaged in drums

Assume glove box sorting required for special, mercury and lead

Assume glove box waste requires 1 sample/drum

Assume transfer control for liquids takes the same time as for solids

Assume paperwork is accomplished within times shown

Ave. time per drum includes times for activities multiplied by the probability that the activity will occur.

Least time/drum/subsystem includes only the minimum requirements, no extra staging, sorting, or shredding Max time/drum/subsystem includes all staging, shredding, glove box, etc

Table A1-d. Incineration Subsystem

]				Time				Time/
		Occurrence/		Required	Total Time/	FTEs	Minutes/	Add'l
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
Receive Waste	Transfer through air lock	8.5	pallet	5	43		1	
	Stage drums for campaigns	8.5	pallet	15	128		-	
Total Task				20	170	0.35	20	15
	Transfer waste/drums to							
Shredding	shredder	34.0	drum	2	68			
	Stage drums and waste	34.0	drum	2	68			
	Shred stage 1	34.0	drum	2	68			
	Shred stage 2	34.0	drum	2	68			
	Sample size of waste	3.4	drum	5	17			
	Rework 10%	0.3	drum	11	4			
	Return to container	34.0	drum	3	102			
	Transfer to next process	34.0	drum	2	68			
Total Task		×		29	463	0.96	29	15
Sampling					0			
	Sample shredded waste to							
	characterize	3.4	drum	5	17			
	Resample (10%)	0.3	drum	5	2			
	Report/eval. results	3.7	drum	10	37			
Total Task	· · · · · · · · · · · · · · · · · · ·			20	56	0.16	20	10
Incineration	Select waste for feeding	34.0	drums	5	170			
	Stage waste for feeding	34.0	drums	5	170			
	Feed incinerator (50 ft3/hr or							
	6.8 drums/hr)	34.0	drums	0	4			
	Incinerate waste (1 hr)	34.0		60	2040			
	Discharge waste (50 ft3/hr)	20.4		0	2			
	Sample waste in and out	16.0	times	10	160			
Total Task				80	504	1.05	80	9
Monitor incinerator	Monitor feeding							
	Monitor gas/air ratio	24.0	times	5	120			
	Monitor burner	24.0	times	5	120			
	Monitor feeding	24.0	times	5	120			
	Monitor secondary	24.0	4:	E	100			
		24.0	times	5	120			
Tetel Teels	womtor discharge	24.0	umes		120	1.05		
TULAI TASK		1			600	1.25		- 15
FIES/SIIII	Potio of 1:10				0	0.28	149.25	10
Veoleick/belidev						0.30		
vac/sick/noliday	Assume 6 w/ks of absence					0.48		
Total/shift	nasume o was of absence					4.63	149	15
Adjustment for						4.00	143	10
70% Efficiency						6.61		
Total/day						19.84		

Notes:

Feed to incinerator requires shredding; whole drums can be shredded. Assume 15 min/drum per stage of shredding

Assume 1 hour kiln residence time

Assume rate of feeding and discharge @ 50 ft3/hr

Waste discharge based on bottom ash @ 80% of waste to vit (mass balance shows 1196 bottom ash and 299 fly ash) No. of samples = 20

Table A1-e.

Aqueous Waste Treatment Subsystem

			-	Time			1	Time/
		Occurrence		Required	Total Time/	FTEs	Minutes/	Add'i
Task	Subtask	/ Shift	Units	(min)	Shift	Needed	Drum	Drum
Receive Waste	Transfer through air lock	1.4	drum	5	7			
	Feed waste from drum	1.4	drum	3	4			
	Hook to transfer device	1.4	drum	3	4		1	
	Transfer to tank (10 gpm)	1.4	drum	6	8		1	
	Empty drum bottoms	1.4	drum	2	3		1	
	Sample feed vessel	2.0	drum	10	20		11	
	Detach & remove drum	1.4	drum	3	4			
	Sample waste from processes:							
	incin, vitrification, APC	4.0	N/A					
	Arrange for transfer	12863.0	gal	0	77		1	
Total Task 1			<u>×</u>	32	127	0.27	32	5
Preliminary								
Treatment	Sample high TDS tank	0.0	drums	15	0			
	Sample low TDS tank	9.4	drums	15	14			
	Sample TOC waste	1.1	drums	15	2			
	Select treatment methods (10							
	drum batch)	1.1	drums	20	2			
	Transfer organic waste to oil							
	water separator	1.1	drums	3	3			
	Filter high, low TDS and organic							
	waste (say 50 gal/min)	10.5	drums	1	12			
	Neutralize/ppt high TDS waste	0.0	drums	11	0			
	Settle precipitated aqueous			1				
	waste	0.0	drums	6	0			
	Evaporate solids(50 gpm)	10.5	drums	1	12			
	Monitor filter	24.0	times	5	120			
	Monitor evaporator	24.0	times	5	120			
Total Task 2				86	261	0.54	86	20
· · · · · · · · · · · · · · · · · · ·	Adjust UV oxidation (30 min/10							
UV Oxidation	drums)	1.1	drums	3	3			
	Process through UV oxidation							
ł	(50 gpm)	1.1	drums	1	1			
Ĩ	Carbon filtration (50 gpm)	10.5	drums	1	12			
	lon exchange (50 gpm)	10.5	drums	1	12		1	
	Monitor carbon & ion exchange	12.0	times	5	60			
	Sample waste before discharge	2.0	times	30	60			1
Total Task 3				6	147	0.31	6	
Total per shift					0	1.12	124	26
Supervision	Ratio of 1:10					0.11		
Vac/sick/holiday relief	Assume 6 wks of absence					0.14		
Adjustment for 70%					1			
Efficiency				L		1.96		<u> </u>
l otal per day]					5.87	1	

Notes:

Assume waste from APC is low TDS; assume other secondary waste = Assume waste from RCPRP is organic liq Total drums/hour = 236.4 Assume sampling of low TDS waste is one/25 drums Assume transfer of waste requires 15 min/2500 gallons

Assume tank batches are 550 gallons (10 drums)

Assume treatment selection time is required for waste from RCPRP only;scrubber liquor has the same treatment.

Assume residence time in oil water separator is 1 hour and tank is 1000 gallons (16 gpm)

Assume filtration, centrifuge and ppt rates are 10 gpm.

Assume evaporation rate is 50 gpm

Assume UV oxidation unit is 50 gpm

Process samples = 16.5

13413.70

60.30

lbs/hr

lbs/hr

235

1

drums/shift

drums/shift

Table A1-f.

		-		Time	Total			
		Occurrence/		Required	Time/	FTEs	Minutes/	Minutes/
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Add'l Drum
Metal Receiving	Transfor through air last	E 4	day	F	26			
	Transier un ough air iock	5.1	arums	3	20			
lotal Task			Ļ	5	26	0.05	5	5
Feed Waste from								
drum	Stage at feed bin (drums)	5.1	drums	3	15	_		
	Hook to transfer device	5.1	drums	3	15			
	Transfer into feed bin							
	(direct discharge)	5.1	drums	2	10			
	Empty drum bottoms	5.1	drums	2	10	<u> </u>	· <u> </u>	
	Sample feed vessel				~			
	(every 10 drums)	0.5	drums	10	5			
	Delach & remove drum	5.1	arums	3	15			
Total Task				23	72	0.15	23	10
			time/					
Metal Melting	Setup/check equipment	0.5	batch	30	15			
	Stage waste for feeding	0.5	batch	20	10			
	Adjust flux to melter	0.5	batch	20	10			
	Feed melter (10							
	min/drum)	0.5	batch	100	51			
	Melt waste	0.5	batch	60	31			
T .(.) T	Discharge waste	0.1	batch	60	6			
I OTAL I ASK				260	124	0.26	260	260
Matel Cection	Metal discharge into			45	~			
wetal Cooling		0.1	arums	15	2		·	
	Metal cooling	0.1	arums	N/A	<u> </u>			
	Staging waste into			45	~			ļ
		0.1	dayana		2			
	Staging wests out of	0.0	arums_	IN/A	0			<u></u>
	Staging waste out of	0.1		15	2			
	Collect samples	0.1	drume	15	2			
Total Task	Collect samples	0.1	uiums	60	6	0.01	60	0
Monitor APC	Quench cooler	40	times	5	20	0.01	00	
	Bachouse/ceramic filter	4.0	times	5	20	<u> </u>		<u> </u>
	Mist eliminator	4.0	times	2	8	<u> </u>		
	GAC	4.0	times	2	8		<u>}</u>	1
	HEPA filter	4.0	times	2	8			
	Offgas monitor	24.0	times	10	240			
Total Task				26	304	0.63	26	
Total FTEs/dav= FTE	Es per shift		1			1.11		
Supervision	Ratio of 1:10					0.11	348	
Vac/sick/holidav	Assume 6 wks of							
relief	absence					0.14		
Total/shift						1.36		
Adjustment for 70%						1		
Efficiency						1.94		
Total/day						5.82		

Notes:

Assume 3 hour batches at 10 drums/batch

Assume cooling time is long; staging of waste in and out is only time considered Assume 10% slag.

Table A1-g. Vitrification of Ash

		1		Time	1		1	1
		Occurrence		Required	Total Time/	FTFe	Minutes/	Minutes/
Task	Subtask	/ Shift	Units	(min)	Shift	Needed	Drum	Add'l Drum
1401	Transfer through air lock	7.01	01110			Heeded	Digiti	That Dian
Ash Receiving	(100 ft3 bins): 5 min/bin	1.9	bin	5	9			
· · · · · · · · · · · · · · · · · · ·	Transfer through air lock						1	+
Ash Receiving	(100 ft3 bins); 5 min/bin	1.9	bin	5	9			
Total Task				5	9	0.02	0	0
Feed Waste from							1	1
bin	Stage at feed bin (15 min/bin)	1.9	bin	15	28			
	Hook to transfer device	1.9	bin	3	6		1	1
	Transfer into vitrifier (metering							
	screw; 4000 lbs/hr)	1.9	bin	38	70			
	Sample feed vessel (once/bin;							
	10 min per sample)	1.9	bin	10	19			
	Detach & remove bin	1.9	bin	3	6			
Total Task				69	128	0.27	69	15
Vitrification	Adjust additives to melter	1.9	bin	15	28			Τ
	Melt waste @ 2000 lbs/hr	1.9	bin	192	359			
	Discharge waste @ 2000							
	lbs/hr	1.9	bin	192	359			
· · · · · · · · · · · · · · · · · · ·	·							
Total Task				399	28	0.06	29	<u> </u>
Monitor vitrifier	Monitor feeding	24.0	times	5	120		·	<u></u>
* *	Monitor gas/air ratio	24.0	times	5	120	······································		<u> </u>
	Monitor burner	24.0	times	5	120			4
T - 4 - 1 T 1	Monitor additions	24.0	times	5	120	4.00		
Iotal lask		<u> </u>		20	480	1.00		
0	Glass/slag discharge into	40.4						
Cooling	Close eacling	10.4	drums		0			+
		10.4	drume			_	<u> </u>	+
	Staging waste into cooling	10.4	drums	5	52			+
	Staging waste out of cooling	10.4	drume	16	JZ 16		+	+
Total Tack	Collect samples	1.0	urums	25	120	0.25	25	15
Monitor APC	Quench cooler	4.0	times	5	20	0.25	<u> </u>	<u>+</u>
	Bachouse/ceramic filter	4.0	times	5	20		<u>+</u>	+
	Mist eliminator	4.0	times	2	8	·····		
	GAC	4.0	times	2	8			+
	HEPA filter	4.0	times	2	8			+
	Offgas monitor	24.0	times	10	240		+	
Total Task				26	304	0.63	26	
Drum Decon	Stage containers	4.0	drum	5	20			+
	Load conveyors	4.0	drum	5	20		<u> </u>	+
	Decon drums	4.0	drum	10	40		+	+
	Assay drums	4.0	drum	15	60		<u> </u>	+
	Unload conveyers	4.0	drum	5	20		1	+
	Stage drums	4.0	drum	5	20	· · · · · · · · · · · · · · · · · · ·		
Total Task				45	180	0.38	45	45
FTEs per shift						2.60		1
				~				
Supervision	Ratio of 1:10					0.26	194	
Vac/sick/holiday								
relief	Assume 6 wks of absence					0.33		
Total/shift		· · · · · · · · · · · · · · · · · · ·				3.19		
Adjustment for								
70% Efficiency		4				4.56		
otal/day			1	1		13.69	1	

Notes:

Assume bins from incin are 100 ft3 (this is our design assumption).

For time evaluation, 13.6 Assume screw empties at 4000 lbs/hr = 63 ft3/hr

Assume retech vitrifier at 2000 lbs/hr;continuous operation

Assume cooling time is long; staging of waste in and out is only time considered

No of samples = 4.8

drums

Table A1-h.

Metal Decontamination Subsystem

	· ·			Time				
		Occurrence/		Required	Total Time/	FTEs	Minutes/	Minutes/
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Add'l Drum
Metals Receiving/		· ·	1]	
Feed Prep	Transfer through air lock	16.0	drums	5	80			
Total Task				5	80	0.17	5	0
Waste Decon	Stage containers	16.0	drum	5	80		1	
	Decon waste	16.0	drum	10	160			
	Assay for recycle	16.0	drum	30	480			
	Repack in drums	16.0	drum	15	240			
	Close drum lid	16.0	drum	15	240			
	Stage drums	16.0	drum	5	80			
	Monitor recirc filtration							
	and fugitive dust system	24.0	times	6	144			
Total Task				86	1424	2.97	86	
Total FTEs/shift		1				3.13	91	
Supervision	Ratio of 1:10					0.31		
Vac/sick/holiday	Assume 6 wks of	· ·					1	
relief	absence		1			0.40		
Total/shift						3.84		
Adjustment for		1				<u></u>		
70% Efficiency						5.49		
Total/day						16.48		

Notes:

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Assume 50% of waste must be size reduced. Assume 60 min/drum for cutting

Table A1-i.Lead Recovery

				Time		1		
		Occurrence		Required	Total Time/	FTEs	Minutes/	Minutes/
Task	Subtask	/ Shift	Units	(min)	Shift	Needed	Drum	Add'l Drum
Lead	· · · · · · · · · · · · · · · · · · ·							
Receiving/Feed								
Prep	I ransfer through air lock	0.2	drums	5	1			
	Glove box separation of							
	sheet lead and gloves	0.2	drums	60	14			
	Stage at decon (80%)	0.2	drums	10	2			
	Stage at melter (20%)	0.05	drums	10	0			
Total Task				85	18	0.04	85	
Waste Decon	Stage containers	0.2	drum	5	1			
	Decon waste	0.2	drum	10	2			
	Assay for recycle	0.2	drum	30	6			
	Repack in drums	0.2	drum	15	3			
	Close drum lid	0.2	drum	15	3			
	Stage drums	0.2	drum	5	1			
	Monitor recirc filtration							
	and fugitive dust system	24.0	times	6	144			
Total Task				86	159	0.33	86	30
			time/	r		T		
Lead Melting	Setup/check equipment	0.05	batch	30	1			
g	Stage waste for feeding	0.05	batch	20	1			
	Adjust flux to melter	0.05	batch	20	1			
l	Feed melter (10							
	min/drum)	0.05	batch	100	5			
	Melt waste	0.05	batch	180	9			
	Monitor APC during		1					
	batch	0.05	batch	350	17			
Total Task				670	15	0.03	320	180
	Metal discharge into				1		1	
Metal Cooling	containers	0.05	drums	_ 15	1			
	Metal cooling (90%)	0.04	drums	N/A	0			
	Staging waste into		1					}
	cooling	0.05	drums	15	1			
	Slag cooling (10%)	0.00	drums	N/A	0			
	Staging waste out of		1					
	cooling	0.05	drums	15	1			
	Collect samples	0.05	drums	15	1	T		
Total Task				60	3	0.01	60	0
Total FTEs/shift						0.41	551	
Supervision	Ratio of 1:10					0.04		
Vac/sick/holiday	Assume 6 wks of	1						
relief	absence					0.05		
Total/shift						0.50		
70% efficiency						0.71		
Total/day						2.14		

Notes:

Assume assay for all drums @ 30 min/drum 20% of input is melted and 80% is deconned (ITTS ph2 assumption, fig A1-4) Assume melter batch time is 3 hours

Assume 10 drum (9170 lb or 550 gal) batches

Table A1-j. Mercury Amalgamation

-				Time	1			7
		Occurrence/		Required	Total	FTFs	Minutes/	Minutes/
Task	Subtask	Shift	Units	(min)	Time/ Shift	Needed	Drum	Add'l Drum
Mecury Receiving/								
Feed Prep	Transfer through air lock	0.4	drums	5	2			
	transfer lig mercury to tank		arano					
	(5% of Hg waste)	0.0	drums	60	1			
•	transfer Hg contaminated		2. 2.110		· · · · · · · · · · · · · · · · · · ·			
	waste to feed bin	0.4	drums	15				
Total Task				65	3	0.01	65	15
	Transfer waste/drums to					<u>ى خانغان قىقى م</u>		
Shredding	shredder	0.4	drum	2	1			
J I	Stage drums and waste	0.4	drum	2	1			
	Shred stage 1	0.4	drum	2	1			
and the second second	Shred stage 2	0.4	drum	2	1			
	Sample size of waste	0.4	drum	5	2			
	Rework 10%	0.0	drum	11	0			
	Return to container	0.4	drum	3	1			
	Transfer to retort staging	0.4	drum	5	2			
Total Task				32	8	0.02	32	11
			time/					
Mercury Retorting	Setup/check equipment	0.4	batch	30	11			
	Stage shredded waste for							
	feeding (batch=1 drum)	0.4	drum	20	8			
	Feed retort (20 min/drum)	0.4	drum	20	8			
	Heat waste	0.4	drum	60	23			
	Condense mercurv	0.0	drum	10	0			
	Separate offgas and Ho	0.0	drum	10	0			
	Discharge waste	0.4	drum	60	22			
	Monitor APC during batch	0.4	drum	160	61			
Total Task				210	132	0.28	210	60
Mercury								
Amalgamation	Inspect equipment	0.0	drum	30	1			
	Transfer lig mercury to							
	amalgamater (1 gpm)	0.0	drum	55	2			
	Measure additives	0.0	drum	30	1			
	Batch amalgamation	0.0	drum	120	5			120
	Transfer out of amalgamater	0.0	drum	55	2			
	Sample waste	0.0	drum	15	1			
	Stage	0.0	drum	5	0			
	Place at assay	0.0	drum	5	0			
	Assay	0.0	drum	20	1			
	Remove from assay	0.0	drum	2	0			
Total Task				307	12	0.02	307	120
Total FTEs/shift		<u> </u>	1	007	<u> </u>	0.32	614	<u>+</u>
Supervision	Ratio of 1.10					0.03		
Vac/sick/holiday						0.00		
relief	Assume 6 wks of absence					0.04		
Total/shift						0.40		
Adjustment for								
70% Efficiency						0.57		
Total/day			1		· <u>}·</u> ······	1.71		

Notes:

Assume 5% of mercury waste is elemental, rest is debris

Assume 5% of debris is mercury.

Assume all debris requires 2 stage shredding

Assume retort is 1 drum batch.

Batch size for amaigamater: Assume 1 drum/batch, 2 hrs /batch

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Table A1-k.

Task	Subtask	Occurrence/ Shift	Units	Time Required (min)	Total Time/ Shift	FTEs Needed	Minutes/ Drum	Minutes/ Add'l Drum
Special							1	
Receiving/Feed Prep	Transfer through air lock	5.4	drums	5	27			
	Glove box preparation of							
	wastes	5.4	drums	60	322			
	Stage waste	5.4	drums	3	16			
Total Task				68	364	0.76	68	60
Waste Treatment	Stage containers	5.4	drum	3	16			
	Treat waste as special							
	processes TBD	5.4	drum	60	322			
	Sample treated waste	5.4	drum	15	80			
	Repack in drums	5.4	drum	30	161			
	Close drum lid	5.4	drum	3	16			
	Stage drums	5.4	drum	3	16			
Total Task				114	611	1.27	114	60
Total FTEs/shift			1		T I	2.03	182	
Supervision	Ratio of 1:10					0.20		
Vac/sick/holiday	Assume 6 wks of							
relief	absence					0.26		
Total/shift			1			2.49		
Adjustment for 70%				ļ				
Efficiency						3.56		
Total/day						10.69		1

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Notes:

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Assume all waste is prepared in glove box Assume waste is treated in various batch processes that average 2 hours/drum TBD=To be determined

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Table A1-I. **Grout Stabilization Subsystem**

				Time				
		Occurrence/		Required	Total Time/	FTEs	Minutes/	Minutes/
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Add'l Drum
Waste								
Receiving/				_				
Feed Prep	Transfer through air lock	0	drums	5	0			
	Sample waste	0	drums	15	0			
	Select process for waste	0	drums	5	0			
	Transfer to							
	macroencapsulation		drums	2	0			
	Transfer to			-				
	microencapsulation	0	drums	2	0			
Total Teals	Stage at process	0	drums	2	U		04	
I OTAL I ASK				31	0	0	31	5
vvaste Enconculation	Magaura bindar	•		45	•			
Encapsulation	Nix binder	0	arum	10	0			
	Combine with wests	0	drum	15	0			
	Bonook in drumo	0	drum	30	0			
	Close drum lid	0	drum	15	0			
	Stage pallets	0	daum	13	0			
	Monitor activated corbon	<u> </u>	arum		0			
	and fugitive dust system	2	times	6	12			
	and lugitive dust system		unes	0	12		00	
I OTAL I ASK		 	1	98	12		98	30
Binder setup	wove pallets to curing			F	•			
ume	area	0	arum	5	0			
	Curing ume	0	arum	10	0			
	Move pollete from ouris	U	arum	10	U			
	iviove pallets from curing	0	times	E	0			
	alta	0	unies	2	0			
Total Task			-	20	0	0	20	5
Drum Decon	Stage containers	0	drum	5	0			
	Load conveyors	0	drum	5	0			
	Decon drums	0	drum	10	0			
	Assay drums	0	drum	30	0			
	Unload conveyers	0	drum	5	0			
	Palletize drums	0	drum	2	0			
	Stage drums	0	drum	5	0			
Total Task				62	0	0		30
Total FTEs/shift			1	1	1	0		1
Supervision	Ratio of 1:10					0		
Vac/sick/holida	Assume 6 wks of							
y relief	absence					0		
Total/shift						0		
70% efficiency						0		
Total/day						0		

Notes:

Assume all complex debris (8 drums) will be sent to macroencapsulation, rest to micro. Assume 10% of drums are deconned.

Assume 10% of drums are assayed

Assume mixing requires 30 min/drum

Table A1-m.

Polymer Stabilization Subsystem

				Time	1		1	Minutes/
		Occurrence/		Required	Total Time/	FTEs	Minutes/	Add'l
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
Waste								
Receiving/Feed Prep	Transfer through air lock	2.8	drums	5	14			
	Sample waste	0.3	drums	15	4			
•	Evaluate dryness	0.3	drums	5	1			
· ·	Dry waste	2.8	drums	30	N/A			
	Monitor drying	24.0	times	10	240			
	Stage at process	2.8	drums	2	6			
Total Task				57	265	0.55	57	30
Encapsulation	Measure polymer	2.8	drum	5	14			
	Mix polymer	2.8	drum	10	28			
	Combine with waste in							
	extruder	2.8	drum	10	28			
	Repack in drums	24.0	drum	5	120			
	Close drum lid	2.8	drum	3	8			
	Palletize drums	2.8	drum	2	6			
	Stage drums	24.0	drum	2	48			
	Monitor activated carbon							
	and fugitive dust system	8.0	times	6	48			l
Total Task				43	300	0.63	43	60
Binder setup time	Move pallets to curing area	24.0	drum	5	120			
	Curing time	24.0	drum		0			
	Sample every 10 drums	2.4	drum	15	36			
1. A	Monitor curing	24.0	drum	10	240			<u> </u>
	Move pallets from curing		T				1	
	area	24.0	times	5	120			
Total Task				35	516	1.08	35	5
Drum Decon	Stage containers	2.8	drum	5	14			
•	Load conveyors	2.8	drum	5	14			
	Decon drums	2.8	drum	10	28			
	Assay drums	2.8	drum	15	42			
	Unload conveyers	2.8	drum	5	14			
	Stage drums	2.8	drum	5	14			
								· · ·
Total Task				45	126	0.26	45	60
Total FTEs/shift						2.52	180	
Supervision	Ratio of 1:10					0.25		
Vac/sick/holiday								
relief	Assume 6 wks of absence					0.32		
Total/shift						3.09		
Adjustment for 70%								
Efficiency						4.41		
Total/day					1	13.22	1	

Notes:

Assume 30% of process residue waste and 100% of other waste requires drying Assume dryer can accept waste at the rate of 2 drums/hour No. of samples = 2.4

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Table A1-n.

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Air Pollution Control Subsystem

				Time			
		Occurrence/		Required	Total Time/	FTEs	
Task	Subtask	Shift	_Units	(min)	Shift	Needed	Minutes/ Ib
Monitor Equipment	Dry filtration	8.0	times	10	80		
	Quencher	24.0	times	5	120		
	Prefilter/hepa filter	4.0	times	5	20		
	Acid gas scrubber	24.0	times	5	120		
	GAC	4.0	times	2	8	· ·	
	Mersorb	4.0	times	2	8		
	Evaporator System	24.0	times	5	120		
	Dioxin/ Denox Filter	8.0	times	5	40		
	Hydrosonic Scrubber	24.0	times	5	120		
	Liquid/ Solid Separator	24.0	times	5	120		
	Mist Eliminator	4.0	times	2	8		
	Heat Exchanger	4.0	times	5	20		
	Offgas monitor	24.0	times	5	120		
Total Task				61	904	1.88	0
Supervision	Ratio of 1:10					0.19	
Vac/sick/holiday							
relief	Assume 6 wks of absence					0.24	
Total/shift						2.31	
Adjustment for 70%							
Efficiency						3.30	
Total/day						9.90	

Table A1-o.

Certification and Shipping

-				Time	Į.			
		Occurrence/		Required	Total Time/	FTEs	Minutes/	Minutes/
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Add'l Drum
Waste Receiving	Transfer through air lock	11.8	drums	5	59			
	Sample waste	1.2	drums	15	18			
	Resample waste	0.1	drums	15	2			
	Stage waste	11.8	drums	5	59			
Total Task				40	138	0.29	40	15
Waste Assay	Stage pallets	11.8	drum	3	36		[
	Load on conveyor	11.8	drum	1	12		1	
	Assay RTR	11.8	drum	15	178			
	Assay gamma	11.8	drum	60	710		T	
	Assay PAN	11.8	drum	60	710		1	
	Remove from conveyor	11.8	drum	1	12		T	
	Repalletize	11.8	drum	3	36		1	
	Stage pallets after							
	assaying	11.8	drum	15	178			
Total Task				158	1871	3.90	158	60
Stage waste	Stage uncertified waste	11.8	drum	3	36			
	Transfer waste	11.8	drum	3	36		}	
	Stage certified waste	11.8	drum	3	36			
	Transfer waste	11.8	drum	3	36			
Total Task				12	142	0.30	12	
Ship Waste Truck	Truck docking	0.1	truck	30	4		T	T
	Settle Paperwork	0.1	truck	120	16		1	
	Load truck	0.1	truck	60	8			
	Truck leaving	0.1	truck	60	8			
Total Task				270	36	0.08	12	
Total FTEs/shift		}		[[4.56	222	
Supervision	Ratio of 1:10	· · · · · · · · · · · · · · · · · · ·	[0.46		
Vac/sick/holiday	Assume 6 wks of				1		1	
relief	absence		1		1	0.58		
Total/shift		1		[1	5.59		
Adjustment for 70%				[·····				
Efficiency			-			7.99		
Total/day		}				23.96		

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Notes:

Assume 10% of waste requires sampling Samples collected = 1.2

Table A1-p.

Summary of FTEs and time for a single drum to work through a system

				Add'l Time	Time/Drums	
		Time (min)/		for Next	Received in a	
	Daily FTEs	Single Drum	Time (hrs)	Drum	Shift (min)	Time (hrs)
Administration	48.4	N/A				
Possiving Inspection Tasks common	ļ					
Receiving /inspection Tasks common		000	10	60	2720	62
		002	13	00	3120	02
Receiving and Prep-incin	ļ	229	4	45	1714	29
Receiving and Prep-metal melt		267	4	45	452	8
Receiving and Prep-lead		557	9	315	557	9
Receiving and Prep-mercury		516	9	315	516	9
Receiving and Prep-special		516	9	315	1889	31
Receiving and Prep-metal decon		229	4	35	560	9
Receiving and Prep	170.1	670.7	11			0
Aqueous Waste	5.9	124	2	5	1301	22
Incineration	19.8	149	2	26	1007	17
Vitrification	13.7	194	3	15	561	9
Metal Decon	16.5	91	2	75	1216	20
Metal Melting	5.8	348	6	75	657	11
Lead	2	551	9	N/A	551	9
Mercury	1.7	614.0	10	N/A	614	10
Special	10.7	182.0	3	60.0	444	7
Grout	0.0	0	0		0	0
Polymer	13.2	180	3	60	288	5
APC	9.9	904	15		904	15
Certification and Shipping	24.0	222	4	60	872	15
Total	341.8					

Notes:

Allocation of receiving and preparation time was done as follows: Average time per drum was estimated, multiplied by the number of drums per shift. The time for each waste type was allocated according its percentage of total waste.







System C-1 Time and Motion Study Tables

- C1-a System C-1: Time and Motion Analysis
- C1-b Administration Subsystem
- C1-c Receiving and Preparation Subsystem
- C1-d Plasma Reactor
- C1-e Aqueous Waste Treatment Subsystem
- C1-f Metal Decontamination Subsystem
- C1-g Lead Recovery
- C1-h Mercury Amalgamation
- C1-i Special Waste
- C1-j Polymer Stabilization Subsystem
- C1-k Air Pollution Control Subsystem
- C1-1 Certification and Shipping
- C1-m Summary of FTEs and time for a single drum to work through a system

Table C1-a

System C-1: Time and Motion Analysis

Subsystem	Mass Flow (lb/hr)	Waste Type	No. of Drums	SCM Unprocessed Density kg/m3	Density _lb/ft3	Density lb/drum
Administration	2,927					
Receiving and preparation	2,927	all	6.2		64	471
Aqueous waste treatment	6,645	L1100	14.6		62	456
Plasma Treatment	2,149	S5300,5110	4.6		64	471
Thermal treated waste	1,451	S3110	1.1		187	1375
Metal Melting	0	S5110	0.0	509	32	234
Metal decontamination	468	S5110	2.0	509	32	234
Mercury amalgamation	50	X7100	0.1	2000	125	918
Lead recovery	26	X7200	0.0	2000	125	918
Polymer stabilization	113	S3120	0.4	700	44	321
Air pollution control	6,762		N/A			
Special treatment	153	X6000,X7500	0.7	500	31	229
Certification and shipping	1,958	Z000	1.5	2500	180	1326
vol reduction (out/in)	1.49		0.2			

Notes:

This table provides the basis for the time and motion analysis.

Quantities of waste to a subsystem (lbs/hr) are based on LMITCO mass balance.

Densities are the same as the LMITCO mass balance except where values are shown in the SCM column. Where values are shown in the SCM column, densities are taken from SCM and converted to lb/ft3.

Density for thermal treatment is based on 33% combustible (5300) and 67% noncombustible (5110).

The waste quantities are converted from lbs/hr to drums/hr.

Subsequent analysis is based on drums/shift of waste to a subsystem.

Thermal treated waste refers to waste processed through the plasma reactor.

Table C1-b.

Administration Subsystem

				Time	
	-	FTEs	Samples/	Required	Total Time/
Task	Subtask	Needed	Shift	(min)	Shift
Facility Management	Facility Manager	1			
	Secretary	1			
	Receptionist/word processor	1			
Operations Management	Department managers	2			
	Communications	1			
	Engineering Manager	1			
	Engineering staff	2			
	Maintenance Supervisor	1			
Personnel	Personnel Manager	1			
	Nurse/medical/industrial safety	1			
	Security guards at facility	4]
	Security at guard bldg	4			
Environmental	Environmental manager	1			
	Environmental clerk	1			
Shipping/receiving/Traffic					
	Manager	1			
	Clerk	1			
Purchasing	Buyer	1			
Accounting	Cost Accounting	2			
	Accounting Clerk	1			
1	Payroli Clerks	2			
Laboratory	Laboratory Manager	1			
]	Lab Shift manager	4			
	Lab technicians for OSORT	1	4.1	30.0	123.2
	Lab technicians for internal processes	4	32.0	10.0	320.3
	Lab technicians for final waste form	1	4.4	30.0	132.8
	Lab technicians for incoming supplies	0.2	1.0	20.0	20.0
Health Physics	Shift health physics staff	4			
	Health physics manager	1			
	Total except Lab	35			
	Total Lab	12			
	Total Admin	47			

Table C1-c.

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Receiving and Preparation Subsystem

			-	Time	1	· · · · · · · · · · · · · · · · · · ·	Add" Time	Ave
		Occurrence	-	Required	Total Time/	FTEs	for Next	Minutes/Shift/
Task	Subtask	/ Shift	Units	(min)	Shift	Needed	Drum	Drum
Receive Waste Truck	Truck docking	0.6	truck	30	17			
	Settle Paperwork	0.6	truck	120	68			
	Unload truck	0.6	truck	60	34			
	Stage pallets	0.6	truck	60	34			
	No of pallets/shift		······································		[]			
Total Task 1			· · · · · · · · · · · · · · · · · · ·	270	153	0.3	0	153
Receive Empty			. <u></u> .				1	
container Truck	Truck docking	0.3	truck	30	8			
	Settle Paperwork	0.3	truck	30	8			
	Unload truck	0.3	truck	60	17			
	Stage pallets	0.3	truck	20	6			
Total Task 2				140	40	0.1	0	40
Receive Supplies	Truck docking	0.2	truck	30	6		1	
	Settle Paperwork	0.2	truck	30	6			
	Unload truck	0.2	truck	60	12			
	Stage pallets	0.2	truck	20	4			
Total Task 3				140	28	0.1	0	28
Transfer to Interim	Move pallets to							
Storage	storage area	6.2	Pallet	5	31			
	Stack pallets/						-	
	organize storage	6.2	Pallet	10	62			
	Transfer to assav	6.2	Pallet	5	31			
Total Task 4				20	124	0.3	10	10
Assay Drums	Stage pallets	12.4	Pallet	5	62		<u>†````</u> _	
	Load on conveyor	49.8	drum	1	50	-		
· · · · · · · · · · · · · · · · · · ·	Assav RTR	49.8	drum	15	746			
	Assay gamma	49.8	drum	60	2986		Ì	
	Assav PAN	49.8	drum	60	2986			
	Remove from							
	COnveyor	49.8	drum	1	50			
	Repailetize	49.8	drum	3	149			
	Stage pallets after		Q1 4111		1-10			
	assaving	124	Pallet	5	62			
Total Task 5		12		150	7091	14.8	60	150
Stage and move to	Store solid waste							
OSORT	by category	124	Pallet	10	124			
	Move to 50% to	12.7			124		1	
	OSORT	62	Pallet	5	31			
	Stage at OSORT	62	Pallot	5	31			
Total Task 6		<u>V.</u> 2	Pallat	20	187	04	5	20
	Stage at drum		i auci	1 20	107	0.7	<u> </u>	
Open Drums	opener	62	Pallet	5	31			
open Diumo	l oad on conveyor	24.9	Drume	5	124			
	Drum lid clamp	24.0	drum	2	50			
	Drum lid opener	24.9	drum	5	124			
	Lid staging	24.8	drum		25			
	Remove from	24.3	Giulii		23			
	convevor	24.0	drum	1	25			
Total Task 7		27.3	uium	10	208	0.8	5	19
	Assign drume to	+		+			+	
Dump Drume	dumo statione	24.0	drum	2	75			
Dump Diums	Move drume to cost		Gium	+	15			
	table /bine	24.0	deum	5	124			
	Dump drume	24.9	drum	5	124	-		
Total Tack 9		24.9	arum		222	07	5	13
TUCAL LASK 8		L	1	13	323	0./	2	13

Table C1-c.

Receiving and Preparation Subsystem

E -				Time			Add" Time	Δισ
F		Occurrence		Required	Total Time/	ETER	for Next	Minutes/Shift/
Task	Subtask	/ Shift	Linite	(min)	Shift	Needed		Drum
Taok	Sort waste	/ Office	Onits	(((())))	Sime	Neeueu		Diam
Sort Drume	Sult waste	24.0	drum	20	746			
Sur Druins	Topoucally	24.9	arum	30	/40			
	I ransfer waste to							
	container	24.9	drum	15	373			
	Select destination							
(for sorted waste	24.9	drum	3	75			
	Move container to							
	subsystem bin or			1				
	shredder	24.9	drum	3	75			
Total Task 9				51	1269	2.6	45	38
	Transfer to glove			T			T	
Glove Box Sort	box (several trips)	6.0	drum	30	180			
	Sort waste by hand							
	in alove box	6.0	drum	240	1440		1	
	Sampling (1/drum)	6.0	drum	15	90			
	Transfer waste to	0.0					1	
	containers	60	drum	60	360		ļ	
1	Select dectination	0.0					Į	
1	for sorted waste	60	drum	16	00		1	
	Mayo container to	0.0	Gruin	10				
ł	iviove containers to							
	subsystem bin of	60	-	45	00		1	·
T-tol Tools 10	snredder	0.0	arum	15	90	47	015	
TOTAL LASK 10				3/5	2250	4./	315	5
	i ransfer to cutting							
Gross Size Reduction	table	0.2	drum	3	1		[
	Cut waste	0.2	drum	30	7			
	Return to container	0.2	drum	5	1		ļ	
	Transfer to next							
	process	0.2	drum	3	1			
Total Task 11		L		41	10	0.0	35	6
	Transfer drums to			}				
Shredding	shredder	3.1	drum	2	6		ł	
je -	Stage drums	3.1	drum	2	6			
	Feed waste to							
	shredder	3.1	drum	2	6.22			
	Feed bad drums to			ţ				ļ
	shredder	12.4	drum	2				
	Shred stage 1	12.4	drum	2	25			
	Shred stage 2	12.4	drum	2	25			
	Sample size of	16.7	Grann					
	Sample Size Of	10	drum	5	6			
	Rowerk 100/	1.2	drum	45		· · · ·		
1	Rework 1076	0.1	dium	15	2			
1	Return to container	12.4	arum	3	3/			
	I ransfer to next			-				
	process	12.4	drum	2	25			
Total Task 12				37	139	0.3	2	30
Sampling					0			
	Sample opened							
	drums	2.5	drum	5	12	-		
	Sample sorted							
	waste	1.2	drum	5	6			
	Resample (10%)	0.4	drum	5	2			
	Report/eval. results	4.1	drum	10	41			
Total Task 13		1		25	62	0.2	10	30

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Table C1-c.

Receiving and Preparation Subsystem

				Time			Add"I Time	Δισ
		Occurrence		Required	Total Time/	FTEs	for Next	Minutes/Shift/
Task	Subtask	/ Shift	Units	(min)	Shift	Needed	Drum	Drum
Subsystem Bin	Oublack		01110			Needed		Diam
operation	Monitor bin height	24.9	drum	3	75	1		
operation	Fill containers	24.9	drum	3	75	1		
	Move containers	24.9	drum		50			
	Stage containers	24.9	drum		75			
	Organiza	27.0	Grann					
	Campaigne	24.9	drum	15	373			
Total Tack 14	Campaigns	24.0	urum	26	647	1.8	0	26
IULAI I ASK 14	Move waste from	+		- 20	04/	1.0		20
Internal Transfer	OSOPT to other		1					
	eubeveteme	24.9	drum	10	249	l		
	Move waste from	24.0	urun		240	1		
	Move waste nom		1					
	COLID	11.8	drum	10	118	1		
	Mayo troated waste	11.0	arum		110			
	Nove treated waste	80.0	drum	10	900	1		
	to stabilization	80.0	dium	10	800	4		
	Move unsomed	00	destand	10	<u></u>			
1	Waste to Incin	0.2	arum	10	62	ł		
and the second sec	Move waste to		1					
	secondary	000	days	10	000	1		
	treatment	20.0	arum	10	200			
	Move supplies	20.0	1	2				
	around	20.0	drum	3	60			
and the second	Move new arums	24.9	drum	3	75			
	Schedule				100			
	movement	187.8	drum	1	188			
Total Task 15		<u></u>	l	5/	1752	4.9	10	57
Box Breakdown	Stage boxes	10.0	box	2	20			
	Move to opening)						
	area	10.0	box	3	30			
	Open boxes	10.0	box	10	100			
	Transfer to dump	10.0	box	3	30			
Total Task 16				18	180	0.5	10	2
Container Decon	Stage containers	49.8	drum	5	249		T	
	Load conveyors	49.8	drum	5	249			
	Decon drums	49.8	drum	10	498			
	Assay drums	49.8	drum	15	746	1		
	Unload conveyers	49.8	drum	5	249			
	Stage drums	49.8	drum	5	249	1		
Total Task 17		······		45	2239	6.2	15	45
FTEs/shift		1			0	31.9		
Supervision	Ratio of 1:10					3.2		
······	Assume 6 wks of							
Vac/sick/holiday relief	absence		1			4.0		
	One persón can							
	relieve 3							
Break relief (included in	(accounted for in							
6 hr dav)	efficiency)	1.						
Total/shift		1		1		39.1		
Adi for 70% Efficiency	1					55.8		
Total/day						167.5		671

Notes:

Assume FTEs are available for 8 hrs/day; because overall 70% efficiency is taken at the end.

Trucks have 22 pallets. Waste density is 64 lb/cu ft.

Pallets are assumed to hold 4 55 gallon drums

As in inventory, assume 50% of drums are contaminated and can't be deconned.

Assume 50% of waste received requires interim storage; this will be dependent on assay system

Assume 10% of incoming waste is sampled

Assume opened and sorted waste is 50% of total

Receiving and Preparation Subsystem

				Time			Add"I Time	Ave
		Occurrence		Required	Total Time/	FTEs	for Next	Minutes/Shift/
Task	Subtask	/ Shift	Units	(min)	Shift	Needed	Drum	Drum
Notes (cent):								

Notes (cont.):

Assume 10% of sorted waste is sampled

Assume gross size reduction is necessary for wastes to metal decon & lead

Assume gross size reduction is 1 hr per drum.

Assume shredding is necessary for drums only

Assume 10% of shredded waste is sampled.

Box breakdown includes time beyond that required if waste was packaged in drums

Assume glove box sorting required for special, mercury and lead

Assume glove box waste requires 1 sample/drum

Assume transfer control for liquids takes the same time as for solids

Assume paperwork is accomplished within times shown

Average time per drum includes times for activities multiplied by the probability that the activity will occur.

Least time/drum/subsystem includes only the minimum requirements, no extra staging, sorting, or shredding Max time/drum/subsystem includes all staging, shredding, glove box, etc

		Occurrence/		Time Required	Total Time/	FTEs	Minutes/	Minutes/
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Add'i drum
Receive Waste	Transfer through air lock	9.1	pallet	5	46			
	Stage drums for campaigns	9.1	pallet	15	137			
Total Task				20	183	0.38	20	15
	Transfer waste/drums to	_						
Shredding	shredder	36.6	drum	2	73			
	Stage drums and waste	36.6	drum	2	73			
	Shred stage 1	36.6	drum	2	73			
	Shred stage 2	36.6	drum	2	73			
	Sample size of waste	3.7	drum	5	18			
	Rework 10%	0.4	drum	11	4			
	Return to container	36,6	drum	3	110			1
	Transfer to next process	36.6	drum	2	73			
Total Task			wit carry t	29	108	1 04	29	15
TULAI TASK	Semple chredded waste to			20	400	1.0-	23	10
Compling	sample silleducu masic is	37	drum	5	18			
Samping	Posemple (10%)	0.4	drum	5	2			
	Resample (1070)	0.4	uium					
	Report/eval. results	4.0	drum	10	40			
Total Task				20	60	0.17	20	10
Feeding	Select waste for feeding	36.6	drums	5	183			
	Stage waste for feeding	36.6	drums	5	183			
	Feed plasma reactor (50 ft3/hr							
	or 6.8 drums/hr)	36.6	drums	0	4			
	Incinerate waste (1 hr)	36.6		60	2194			
	Discharge waste (50 ft3/hr)	6.8		0	1			
	Sample waste in and out	16.0	times	10	160			
Total Task				80	530	1.10	80	9
Plasma treatment	Monitor feeding							
	Monitor gas/air ratio	24.0	times	5	120			
	Monitor burner	24.0	times	5	120			
	Monitor feeding	24.0	times	5	120			
	Monitor secondary combustion	24.0	times	5	120			
and the second	Monitor discharge	24.0	times	5	120			
Total Task				25	360	0.75	25	9
Cooling	Glass/slag discharge into							
Cooling	containers (dens= 156 lb/ft3)	8.4	drums	0	0			
	Glass cooling	8.4	drums	N/A	0			
	Staging waste into cooling	8.4	drums	5	42			
	Staging waste out of cooling	8.4	drums	5	42			
	Collect samples	0.8	drums	15	13			
Total Task				25	97	0.20	15	0
Drum Decon	Stage containers	8.4	drum	5	42			1
	Load conveyors	8.4	drum	5	42			
	Decon drums	8.4	drum	10	84			
	Assay drums	8.4	drum	15	127			
	Unload conveyers	8.4	drum	5	42			
	Stage drums	8.4	drum	5	42		1.1.1	
Total Task				45	380	0.79	45	
FTEs/shift		1	1			4.43	234	15
Supervision	Ratio of 1:10				1	0.44		
Vanlaink/heliday rolief	Accume E who of abcance					0.56		<u></u>
Vac/Sick/10huay relier	ASSUME O WAS OF ADSCHOOL					5.44	234	15
1 Otal/Shitt						0.44	234	10
Adjustment for 70%						7 77		
						7.77		
				1	4			

Notes:

Feed to incinerator requires shredding; whole drums can be shredded.

Assume 15 min/drum per stage of shredding

Assume 1 hour reactor residence time

Assume rate of feeding and discharge @ 50 cu ft/hr Treated waste mass amount from LITCO mass balance of 4/23/96

Assume cooling time is long; staging of waste in and out is only time considered

No. of process samples = 20.0

				Time				
		Occurrence/		Required	Total Time/	FTEs	Minutes/	Minutes/
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Add'l drum
Receive Waste	Transfer through air lock	1.4	drum	5	7			
	Feed waste from drum	1.4	drum	3	4			
	Hook to transfer device	1.4	drum	3	4			
	Transfer to tank (10 gpm)	1.4	drum	6	8			
	Empty drum bottoms	1.4		2	3			
	Sample feed vessel	2.0		10	20			
	Detach & remove drum	1.4		3	4			
	Sample waste from processes:							
	incin, aqueous, Decon, APC	4.0	N/A					
	Arrange for transfer	6304.5	gal	0	38			
Total Task				32	88	0.18	32	5
Preliminary Treatment	Sample high TDS tank	0.0	drums	15	0			
	Sample low TDS tank	4.6	drums	15	7			
	Sample TOC waste	1.4	drums	15	2			
· · · · · · · · · · · · · · · · · · ·	Select treatment methods (10							
	drum batch)	1.4	drums	20	3			
	Transfer organic waste to oil							
	water separator	1.4	drums	3	5			
	Filter high, low TDS and organic							
	waste (say 50 gal/min)	6.0	drums	1	7			
	Neutralize/ppt high TDS waste	0.0	drums	11	0			
	Settle precipitated aqueous							
	waste	0.0	drums	6	0			
	Evaporate solids(50 gpm)	6.0	drums	1	7			
	Monitor filter	24.0	times	5	120			
	Monitor evaporator	24.0	times	5	120			
Total Task				86	256	0.53	86	20
	Adjust UV oxidation (30 min/10							
UV Oxidation	drums)	1.4	drums	3	4			
	Process through UV oxidation							
	(50 apm)	1.4	drums	1	2			
	Carbon filtration (50 gpm)	6.0	drums	1	7			
	Ion exchange (50 gpm)	6.0	drums	1	7			
	Monitor carbon & ion exchange	12.0	times	5	60			
	Sample waste before discharge	2.0	times	30	60			1
Total Task 3	<u> </u>			6	139	0.29	6	
Total per shift					0	1.01	124	26
Supervision	Ratio of 1:10		•	1		0.10		
Vac/sick/holidav relief	Assume 6 wks of absence					0.13		
Efficiency						1.77		
Total per day	· · · · · · · · · · · · · · · · · · ·					5.30		

Notes:

Assume waste from APC and other secondary waste is low TDS

Assume waste from RCPRP is organic liq

Total drums per hour= 116.6

Assume sampling of low TDS waste is one/25 drums

Assume transfer of waste requires 15 min/2500 gallons Assume tank batches are 550 gallons (10 drums)

Assume treatment selection time is required for waste from RCPRP only;scrubber liquor has the same treatement.

Assume residence time in oil water separator is 1 hour and tank is 1000 gallons (16 gpm)

Assume filtration, centrifuge and ppt rates are 10 gpm.

Assume evaporation rate is 50 gpm

Assume UV oxidation unit is 50 gpm

Number of process sampl 12.0

lbs/hr lbs/hr

6565.00

80.00

115 1

drums/shift drums/shift
Table C1-f.

Metal Decontamination Subsystem

Task	Subtask	Occurrence/	Units	Time Required (min)	Total Time/	FTEs	Minutes	Minutes/ Add'l Drum
Metals Receiving/ Feed		<u> </u>		(,,,,,,,				
Prep	Transfer through air lock	16.0	drums	5	80			
Total Task	_			5	80	0.17	5	0
Waste Decon	Stage containers	16.0	drum	5	80			
	Decon waste	16.0	drum	10	160			
	Assay for recycle	16.0	drum	30	480		1	
	Repack in drums	16.0	drum	15	240		1	
	Close drum lid	16.0	drum	15	240			
	Stage drums	16.0	drum	5	80			
4.1	Monitor recirc filtration and							
]	fugitive dust system	24.0	times	6	144			
Total Task				86	1424	2.97	86	
Total FTEs/shift				1	T I	3.13	91	
Supervision	Ratio of 1:10					0.31		
Vac/sick/holiday relief	Assume 6 wks of absence					0.40		
Total/shift						3.84	T	
Adjustment for 70% Efficiency						5.49		
Total/day						16.48		

-

Notes:

Assume 50% of waste must be size reduced. Assume 60 min/drum for cutting

Table C1-g

			•	Time				
		Occurrence		Required	Total Time/	FTEs	Minutes/	Minutes/
Task	Subtask	/ Shift	Units	(min)	Shift	Needed	Drum	Add'l Drum
Lead Receiving/Feed								
Prep	Transfer through air lock	0.2	drums	5	1			{
	Glove box separation of							
	sheet lead and gloves	0.2	drums	60	14			
	Stage at decon (80%)	0.2	drums	10	2			
	Stage at melter (20%)	0.0	drums	10	0			
Total Task				85	18	0.04	85	
Waste Decon	Stage containers	0.2	drum	5	1			
	Decon waste	0.2	drum	10	2			
	Assay for recycle	0.2	drum	30	6			
	Repack in drums	0.2	drum	15	3			
	Close drum lid	0.2	drum	15	3			
	Stage drums	0.2	drum	5	1			
	Monitor recirc filtration							
	and fugitive dust system	24.0	times	6	144			
Total Task			·····	86	159	0.33	86	30
			time/					
Lead Melting	Setup/check equipment	0.05	batch	30	1 1			
5	Stage waste for feeding	0.05	batch	20	1			
	Fdjust flux to melter	0.05	batch	20	1			
	Feed melter (10							
	min/drum)	0.05	batch	100	5		- -	
	Melt waste	0.05	batch	180	9			
	Monitor APC during							
	batch	0.05	batch	350	17			
Total Task				670	15	0.03	320	180
	Metal discharge into							
Metal Cooling	containers	0.05	drums	15	1			
-	Metal cooling (90%)	0.04	drums	N/A	0			
	Staging waste into							
	cooling	0.05	drums	15	1	1. A. A.		
-	Slag cooling (10%)	0.00	drums	- N/A	0			
	Staging waste out of				· ·			
	cooling	0.05	drums	15	1			
	Collect samples	0.05	drums	15	1			
Total Task				60	3	0.01	60	0
Total FTEs/shift						0.41	551	
Supervision	Ratio of 1:10					0.04		
	Assume 6 wks of							
Vac/sick/holiday relief	absence					0.05		
Total/shift				-		0.50		
Adjustment for 70%								
Efficiency						0.71		
Total/day						2.14		

Notes:

Assume assay for all drums @ 30 min/drum 20% of input is melted and 80% is deconned (ITTS ph2 assumption, fig A1-4) Assume melter batch time is 3 hours Assume 10 drum (9170 lb or 550 gal) batches

Table C1-h.

-	· · ·		-	Time				
		Occurrence		Required	Total	FTEs	Minutes/	Minutes/
Task	Subtask	/ Shift	Units	(min)	Time/ Shift	Needed	Drum	Add'l Drum
Mecury Receiving/							[
Feed Prep	Transfer through air lock	0.4	drums	5	2			
	Transfer lig mercury to tank							
	(5% of Hg waste)	0.0	drums	60	1			
	I ransfer Hg contaminated			4-				
Total Took	waste to teed bin	0.4	drums	15		0.04	05	45
I OLAL I ASK	Transformerstell	÷		65	3	0.01		15
Shradding	I ranster waste/drums to	0.4	deren	2			1	
Smedding	Streed dume and waste	0.4	drum		4			
	Stred store 1	0.4	drum	- 2	4			
	Shred stage 7	0.4	drum	- 2			<u> </u>	
	Sined slage 2	0.4	drum	2				
	Bawork 10%	0.4	drum	- 11	2			
	Return to container	0.0	drum	- 2	1			
	Transfer to retort staging	0.4	drum	5				
Total Task		0.4	Gidin	- 32	8	0.02	32	11
	+	+				<u> </u>		
Mercury Retorting	Setup/check equipment	04	time/ batch	30	11			
	Stage shredded waste for		ALL					
	feeding (batch = 1 drum)	0.4	drum	20	8			
	Feed retort (20 min/drum)	0.4	drum	20	8			
	Heat waste	0.4	drum	60	23			[
	Condense mercury	0.0	drum	10	0			
	Separate offgas and Hg	0.0	drum	10	0			
	Discharge waste	0.4	drum	60	22			
	Monitor APC during batch	0.4	drum	160	61			
Total Task				210	132	0.28	210	60
Mercury Amalgamation	Inspect equipment	0.0	drum	30	1			
	Transfer liq mercury to							
	amalgamater (1 gpm)	0.0	drum	55	2			
	Measure additives	0.0	drum	30	1			
	Batch amalgamation	0.0	drum	120	5			120
	Transfer out of amalgamater	0.0	drum	55	2		<u></u>	
	Sample waste	0.0	drum	15	1		ļ	J
	Stage	0.0	drum	5	0			
	Place at assay	0.0	drum	5	0			
	Assay	0.0	drum	20	1			ł
	Remove from assay	0.0	arum	2	0			
Total Task				307	12	0.02	307	120
Total FTEs/shift						0.32	614	
Supervision	Ratio of 1:10					0.03		
Vac/sick/holiday relief	Assume 6 wks of absence					0.04		
Total/shift						0.40		
Adjustment for 70%								
Efficiency			l	ļ		0.57		1
Total/day						1.71		

Notes:

Assume 5% of mercury waste is elemental, rest is debris Assume 5% of debris is mercury. Assume all debris requires 2 stage shredding Assume retort is 1 drum batch. Batch size for amalgamater: Assume 1 drum/batch, 2 hrs /batch

Table C1-i.

				Time	Total			
		Occurrence		Required	Time/	FTEs	Minutes/	Minutes/
Task	Subtask	/ Shift	Units	(min)	Shift	Needed	Drum	Add'l Drum
Special								
Receiving/Feed Prep	Transfer through air lock	5.4	drums	5	_27			
	Glove box preparation of							
	wastes	5.4	drums	60	322			
	Stage waste	5.4	drums	3	16			
Total Task				68	364	0.76	68	60
Waste Treatment	Stage containers	5.4	drum	3	16			
	Treat waste as special							
	processes TBD	5.4	drum	60	322			
	Sample treated waste	5.4	drum	15	80			
	Repack in drums	5.4	drum	30	161			
	Close drum lid	5.4	drum	3	16			
	Stage drums	5.4	drum	3	16			
Total Task				114	611	1.27	114	60
Total FTEs/shift						2.03	182	
Supervision	Ratio of 1:10					0.20		
	Assume 6 wks of							
Vac/sick/holiday relief	absence					0.26	1	
Total/shift						2.49		
Adjustment for 70%								
Efficiency						3.56		
Total/day						10.69		

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Notes:

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Assume all waste is prepared in glove box Assume waste is treated in various batch processes that average 2 hours/drum

TBD=To be determined

Table C1-j.

Polymer Stabilization Subsystem

			-	Time	-		}]
		Occurrence		Required	Total Time/	FTEs	Minutes/	Minutes/
Task	Subtask	/ Shift	Units	(min)	Shift	Needed	Drum	Add'l Drum
Waste Receiving/Feed								
Prep	Transfer through air lock	2.8	drums	5	14			
	Sample waste	0.3	drums	15	4			
1	Evaluate dryness	0.3	drums	5	1			
	Dry waste	2.8	drums	30	N/A			
	Monitor drying	24.0	times	10	240			
1	Stage at process	2.8	drums	2	6			
Total Task				57	265	0.55	57	30
Encapsulation	Measure polymer	2.8	drum	5	14			
	Mix polymer	2.8	drum	10	28			
	Combine with waste in							
	extruder	2.8	drum	10	28			
	Repack in drums	24.0	drum	5	120			
1	Close drum lid	2.8	drum	3	8			
	Palletize drums	2.8	drum	2	6			
	Stage drums	24.0	drum	2	48			
	Monitor activated carbon							
1	and fugitive dust system	8.0	times	6	48			
Total Task				43	300	0.63	43	60
	F						1	T
Binder setup time	Move pallets to curing area	24.0	drum	5	120		1	
	Curing time	24.0	drum		0			
	Sample every 10 drums	2.4	drum	15	36			
	Monitor curing	24.0	drum	10	240			
	Move pallets from curing							
1	area	24.0	times	5	120			
Total Task				35	516	1.08	35	5
Drum Decon	Stage containers	2.8	drum	5	14	1		T
	Load conveyors	2.8	drum	5	14			
i ·	Decon drums	2.8	drum	10	28			1
]	Assay drums	2.8	drum	15	42		1	
	Unload conveyers	2.8	drum	5	14			
ŀ	Stage drums	2.8	drum	5	14			
Totai Task				45	126	0.26	45	60
Total FTEs/shift				1	1	2.52	180	<u> </u>
Supervision	Ratio of 1:10				1	0.25		
Vac/sick/holiday relief	Assume 6 wks of absence				1	0.32		
Total/shift				1	1	3.09		
Adjustment for 70%	· · · · · · · · · · · · · · · · · · ·				1			
Efficiency						4.41		
Total/day				1		13.22		

Notes:

Assume 30% of process residue waste and 100% of other waste requires drying Assume dryer can accept waste at the rate of 2 drums/hour No. of samples = 2.4

Table C1-k.

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Air Pollution Control Subsystem

				Time			
		Occurrence/		Required	Total Time/	FTEs	
Task	Subtask	Shift	Units	(min)	Shift	Needed	Minutes/ Ib
Monitor Equipment	Dry filtration	8.0	times	10	80		
	Quencher	24.0	times	5	120		
	Prefilter/hepa filter	4.0	times	5	20		
	Acid gas scrubber	24.0	times	5	120		
	GAC	4.0	times	2	8		
	Mersorb	4.0	times	2	8		
	Evaporator System	24.0	times	5	120		
	Dioxin/ Denox Filter	8.0	times	5	40		
	Hydrosonic Scrubber	24.0	times	5	120		
	Liquid/ Solid Separator	24.0	times	5	120		
	Mist Eliminator	4.0	times	2	8		
	Heat Exchanger	4.0	times	5	20		
	Offgas monitor	24.0	times	5	120		
Total Task				61	904	1.88	0
Supervision	Ratio of 1:10	1				0.19	
Vac/sick/holiday relief	Assume 6 wks of absence					0.24	
Total/shift						2.31	
Adjustment for 70%		1 1		[I		
Efficiency						3.30	
Total/day						9.90	

Table C1-I.

Certification and Shipping

			. •	Time				
		Occurrence/		Required	Total Time/	FTEs	Minutes/	Minutes/
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Add'l Drum
Waste Receiving	Transfer through air lock	11.8	drums	5	59			
	Sample waste	1.2	drums	15	18			
	Resample waste	0.1	drums	15	2			
	Stage waste	11.8	drums	5	59			
Total Task				40	138	0.29	40	15
Waste Assay	Stage pallets	11.8	drum	3	36			
	Load on conveyor	11.8	drum	1	12			
	Assay RTR	11.8	drum	15	178			
	Assay gamma	11.8	drum	60	710			
	Assay PAN	11.8	drum	60	710			
	Remove from conveyor	11.8	drum	1	12			
	Repalletize	11.8	drum	3	36			
	Stage pallets after assaying	11.8	drum	15	178			
Total Task			l	158	1871	3.90	158	60
Stage waste	Stage uncertified waste	11.8	drum	3	36			
	Transfer waste	11.8	drum	3	36			
	Stage certified waste	11.8	drum	3	36			
	Transfer waste	11.8	drum	3	36			
Total Task				12	142	0.30	12	
Ship Waste Truck	Truck docking	0.1	truck	30	4			
	Settle Paperwork	0.1	truck	120	16			
1	Load truck	0.1	truck	60	8			
	Truck leaving	0.1	truck	60	8			
Total Task				270	36	0.08	12	
Total FTEs/shift			[4.56	222	
Supervision	Ratio of 1:10					0.46		
Vac/sick/holiday relief	Assume 6 wks of absence					0.58		
Total/shift	-					5.59		
Adjustment for 70%								
Efficiency						7.99		
Total/day						23.96		

--- "Notes:

Assume 10% of waste require sampling Samples collected = 1.2 Table C1-m.

Summary of FTEs and time for a single drum to work through a system

				Add'l Time	Time/Drums	
	Daily	Time (min)/		for Next	Received in a	Time (har)
	FIES	Single Drum	l ime (nrs)	Drum	Snint (minutes)	lime (nrs)
Administration	46.6	N/A		<u> </u>	·	
Receiving /Inspection Tasks common for all waste		802	13	60	3728	62
Receiving and Prep-plasma		229	4	45	1829	30
Receiving and Prep-lead		557	9	315	557	9
Receiving and Prep-mercury		516	9	315	516	9
Receiving and Prep-special		516	9	315	1889	31
Receiving and Prep-metal decon		229	4	35	560	9
Receiving and Prep	167.5	670.7	11			0
Aqueous Waste	5.3	124	2	5	702	12
Plasma Treatment	23.3	234	4	26	1159	19
Metal Decon	16.5	91	2	75	1216	20
Lead	2	551	9	N/A	551	9
Mercury	1.7	614.0	10	N/A	614	10
Special	10.7	182.0	3	60.0	444	7
Polymer	13.2	180	3	60	288	5
APC	9.9	904	15		904	15
Certification and Shipping	24.0	222	4	60	872	15
			-			
Total	320.8					

Notes:

Allocation of receiving and preparation time was done as follows: Average time per drum was estimated, multiplied by the number of drums per shift. The time for each waste type was allocated according its percentage of total waste. •



System NT-2 Time and Motion Study Tables

NT2-a System NT-2: Time and Motion Analysis

NT2-b Administration Subsystem

NT2-c Receiving and Preparation Subsystem

NT2-d CWO Organic Destruction Subsystem

NT2-e Vacuum Thermal Desorption for Process Residue

NT2-f Aqueous Waste Treatment Subsystem

NT2-g Metal Decontamination Subsystem

NT2-h Lead Recovery

NT2-i Mercury Amalgamation

NT2-j Special Waste

NT2-k Grout Stabilization Subsystem

NT2-1 Polymer Stabilization Subsystem

NT2-m Air Pollution Control Subsystem

NT2-n Certification and Shipping

NT2-o Summary of FTEs and time for a single drum to work through a system

Table NT2-a.

System NT-2: Time and Motion Analysis

				SCM		
	-		No. of	Unprocessed		
Subsystem	Mass Flow	Waste Type	Drums	Density	Density	Density
	(lb/hr)			kg/cu m	lb/cu ft	lb/drum
Administration	2,927					
Receiving and preparation	2,927	all	6.2		64	471
Aqueous waste treatment (total)	1,258	L1100	2.8		62	456
High TDS aqueous waste	641	L1100	1.4		62	456
Low TDS Aqueous waste	268	L1100	0.6		62	456
Organic aqueous waste	350	L1200	0.8		62	456
Organic destruction	268	L2110	0.6		62	456
Process residue and inorganic						
sludge treatment	1,020	S3120	3.2	700	44	321
Bulk soil treatment	329	S4100	0.7		67	493
Soft Debris treatment	435	S5300	3.0	320	20	147
Open Debris treatment	80	S5110	0.4	400	25	184
Complex Debris treatment	177	S5110	1.0	400	25	184
Metal decontamination	462	S5110	2.0	509	32	234
Mercury amalgamation	5	X7100	0.0	2000	125	918
Lead recovery	56	X7200	0.1	2000	125	918
Polymer stabilization	1,110	S3120	3.5	700	44	321
Pre-polymer drying	438	S3120	1.4	700	44	321
Air pollution control	823	·	N/A			
Grout stabilization	1,228	soil/debris	3.6	750	47	344
Special treatment	155	X6000,X7500	0.7	500	31	229
Certification and shipping	5,067	Z0000	6.2	N/A	111	815
Vol reduction (out/in)	0.58		1.0			

Notes:

This table provides the basis for the time and motion analysis.

Quantities of waste to a subsystem (lbs/hr) are based on LMITCO mass balance for system NT2

Densities are the same as the LMITCO mass balance except where values are shown in the SCM column.

Where values are shown in the SCM column, densities are taken from SCM and converted to lb/ft3..

The waste quantities are converted from lbs/hr to drums/hr.

Subsequent analysis is based on drums/shift of waste to a subsystem.

Pre-polymer drying assumes desorbed wastes that do not go through the leaching process (70% of output) will not need drying.

Table NT2-b.

Administration Subsystem

				Time	
		FTEs	Samples/	Required	Total Time/
Task	Subtask	needed	Shift	(min)	Shift
Facility Management					
	Facility Manager	1			
	Secretary	1			
	Receptionist/word processor	1			
Operations Management					
	Department managers	2			
	Communications	1			
	Engineering Manager	1			
	Engineering staff	2	-		
	Maintenance Supervisor	1			
Personnel	Personnel Manager	1			
	Nurse/medical/industrial safety	1			
	Security guards at facility	4			
	Security at guard bldg	4			
Environmental	Environmental manager	1			
	Environmental clerk	1			
Shipping/Receiving/Traffic					
	Manager	1			
	Clerk	1			
Purchasing	Buyer	1			
Accounting	Cost Accounting	2			
	Accounting Clerk	1			
	Payroll Clerks	2			
Laboratory	Laboratory Manager	1			
	Lab Shift manager	4	-		
	Lab technicians for OSORT	4	11.3	30.0	339.2
	Lab technicians for internal processes	5	42.7	10.0	426.7
	Lab technicians for final waste form	3	10.2	30.0	307.0
	Lab technicians for incoming supplies	0.2	1.0	20.0	20.0
Health Physics					
	Shift health physics staff	4			
· · · · · · · · · · · · · · · · · · ·	Health physics manager	1			
	Total except Lab	35			
	Total Lab	17			
	Total Admin	52			

Table NT2-c.

...

Receiving and Preparation Subsystem

				Time	1		Add'I Time	Average
		Occurrence	Units for	Required	Total Time/	FTEs	for Next	Minutes/Shift
Task	Subtask	/Shift	Occurrence	(min)	Shift	Needed	Drum	/Drum
Receive Waste								
Truck	Truck docking	0.6	truck	30	17		1	
	Settle Paperwork	0.6	truck	120	68			
	Unload truck	0.6	truck	60	34			
	Stage pallets	0.6	truck	60	34			
	No of pallets/shift							
Total Task 1				270	153	0.3	0	153
		1			1		1	
Receive Empty								
Container Truck	Truck docking	0.3	truck	30	8			
	Settle Paperwork	0.3	truck	30	8			
	Unload truck	0.3	truck	60	17		}	
	Stage pallets	0.3	truck	20	6			
Total Task 2				140	40	0.1	0	40
Receive Supplies	Truck docking	0.2	truck	30	6			
	Settle Paperwork	0.2	truck	30	6			
	Unload truck	0.2	truck	60	12			
	Stage pallets	0.2	truck	20	4		1	
Total Task 3				140	28	0.1	0	28
Transfer to Interim Storage	Move pallets to storage area	6.2	Pallet	5	31			
	organize storage	62	Dallet	10	62			
	Transfer to accav	6.2	Pallet	5	21			
Total Taek A	mansier to assay	0.2	Fallet	20	124	03	10	10
Accesy Drume	Stage pallete	124	Pallet	5	62	0.3	10	<u> </u>
Assay Drums.	Load on conveyor	12.4	drum		50			
	Access PTD	49.0	drum	15	746			
	Assay KIK	49.0	drum	60	2096			
ţ	Assay gamma	49.0	drum	-60	2900			
	Remove from	49.0	uluin		2900			
	Remove nom	40.9	drum	-	50			
	Depeiletize	49.0	dium		140			
	Store pollete offer	49.0	Grunn		143			
	Stage pallets alter	12.4	Pallat	5	62			
Total Tack 5	assaying	12.4	Fallet	150	7001	14.8	60	150
TOLAT TASK J	<u> </u>	+		150	7091	14.0		<u> </u>
Stage and Move to	Store solid waste							
OSORT	by category	10.9	Pallet	10	109			
	Move to OSORT	10.0	Pallet	5	55			
	Stage at OSORT	10.0	Pallet	5	55			
Total Task 6		10.0	Pallet	20	218	0.5	5	20
Total Table o	Stade at drum	<u> </u>	<u> </u>	<u> </u>		~	+	
Open Drums	opener	10.9	Pallet	5	55			
	Load on conveyor	43.6	Drums	5	218			
	Drum lid clamp	43.6	drum	2	87			
1	Drum lid opener	43.6	drum	5	218			
	Lid staging	43.6	drum	1	44			
	Remove from		Jun	<u>+</u>				
	conveyor	43.6	drum	1	44			
Total Task 7				19	589	1.2	5	19

Table NT2-c.

Receiving and Preparation Subsystem

F		1	1	Time	1		Add'l Time	Average
		Occurrence	Units for	Required	Total Time/	FTEs	for Next	Minutes/Shift
Task	Subtask	/Shift	Occurrence	(min)	Shift	Needed	Drum	/Drum
	Assign drums to							
Dump Drums	dump stations	43.6	drum	3	131		ļ	
	Move drums to sort							
l .	table /bins	43.6	drum	5	218			
	Dump drums	43.6	drum	5	218			
Total Task 8		40.0	Grunn	12	567	12	5	13
	Sortwaste					1.2		
Sort Drums	robotically	227	drum	20	000		1	
Soli Diuliis	Tropofor worth to	52.1	dium		902		}	
		20.7	a)	45	404			
	Container	32.1	arum	15	491			
	Select destination	007		_			1	
	for sorted waste	32.1	arum	3	98		{	
	Move container to							
	subsystem bin or			-				
	shredder	32.7	drum	3	98		1	
lotal Task 9			L	51	1669	3.5	45	38
	Transfer to glove							
Glove Box Sort	box (several trips)	7.1	drum	30	214			
	Sort waste by hand							1
	in glove box	7.1	drum	240	1711			
	sampling (1/drum)	7.1	drum	15	107]
	Transfer waste to							
	containers	7.1	drum	60	428		ļ	
•	Select destination							
	for sorted waste	7.1	drum	15	107			
}	Move containers to							
	subsystem bin or		.					
	shredder	7.1	drum	15	107			
Total Task 10				375	2673	56	315	5
Assess Debris for								
Debris Rule	Transfer soft open							
Compliance	and complex debris	35.0	drum	-3	105			
	Screen debris	35.0	drum	4	140		1	
and the second	Additional						1	
[sampling (25%)	87	drum	10	87			
	Inspection	35.0	drum	5	175			
Total Tack 11	поресноп		Giun		507	1 1	5	6
Cross Size	Transfor to outting		1				╞═══╴	
Gruss Size	toblo	14.2	der me	2	12			
Reduction	Cutweete	14.3	drum		43		1	
	Cui wasie	14.3	arum		429			
	Return to container	14.3	arum	5	12			
	I ranster to next			-				
	process	14.3	drum	3	43	10	05	6
lotal lask 12		L		41	587	1.2	35	0
	I ransfer to							
Shredding	shredder	37.3	drum	2	75			
1	Stage waste	37.3	drum	2	75			
	Feed waste to							
	shredder	37.3	drum	2	75			
	Feed bad drums to							
	shredder	21.8	drum	2	44			
	Shred stage 1	59.1	drum	2	118			
	Shred stage 2	59.1	drum	2	118			
	Sample size of			<u> </u>				
	waste	5.9	drum	5	30			
	Rework 10%	0,6	drum	15	9	1		
	Return to container	59 1	drum	3	177	1		

Table NT2-c.

Receiving and Preparation Subsystem

F			-	Time	1		Add'I Time	Average
		Occurrence	Units for	Required	Total Time/	FTEs	for Next	Minutes/Shift
Task	Subtask	/Shift	Occurrence	(min)	Shift	Needed	Drum	/Drum
	Transfer to next							
	process	59.1	drum	2	118			
Total Task 13		<u> </u>		37	838	1.7	2	
	Sample opened			_				
Sampling	drums	4.4	drum	5	22			
	Sample sorted			_				
• .	waste	5.9	drum	5	30			
	Resample (10%)	1.0	drum	5	5		l	
Table Table 4.4	Report/eval. results	11.3	drum	10	113			
Total Task 14		<u> </u>	l	25	1/0	0.5	10	30
Subsystem Bin				•	10			
operation		4.4	arum	3	13			
	Fill containers	4.4	drum	3	13			
	Store containers	4.4	drum	<u> </u>	9			
	Stage containers	4.4	<u> </u>		13			,
	Organize		drum	15	65			
Total Task 15		4.4	didin	10	113	0.2	0	26
	Move waste from				113	0.3	<u> </u>	20
Internal Transfer	OSORT to other							
	subsystems	44	drum	10	44		1	
	Move waste from							
	subsystems to							
	CSHIP	49.8	drum	10	498			
	Move treated							
	waste to							
	stabilization	80.0	drum	10	800		Ì	
· ·	Move liquid waste							
	to AQWTR and							
	OrgDes	6.1	drum	10	61		1	
}	Move waste to	Ĩ		-]	
	secondary	20.0		10	200			
	Move supplies	20.0	urum	10	200			
	around	20.0	drum	2	60			
	Move new drums	20.0	drum		75			
	Schedule	24.5	uluit	<u>_</u>	13			
	movement	205.1	drum	1	205			
Total Task 16		200.1	Grann	57	1942	54	10	57
Box Breakdown	Stage boxes	10.0	box	2	20		<u> </u>	
	Move to opening							
	area	10.0	box	3	30			
	Open boxes	10.0	box	10	100			
	Transfer to dump	10.0	box	3	30			
Total Task 17				18	180	0.5	10	2
Container Decon	Stage containers	49.8	drum	5	249			
	Load conveyors	49.8	drum	5	249			
	Decon drums	49.8	drum	10	498			
	Assay drums	49.8	drum	15	746			
	Unload conveyers	49.8	drum	5	249			
THEFT	Stage drums	49.8	drum	5	249		45	AF
Iotal Lask 18				45	2239	6.2	15	40

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Table NT2-c.

Receiving and Preparation Subsystem

Task	Subtask	Occurrence /Shift	Units for Occurrence	Time Required (min)	Total Time/ Shift	FTEs Needed	Add'l Time for Next Drum	Average Minutes/Shift /Drum
FTFs/shift					0	37.6		
Supervision	Ratio of 1:10				<u> </u>	3.8	4	
Vac/sick/holiday relief	Assume 6 wks of absence					4.8		
Total/shift			1.1			46.1	1	
Adj for 70% Efficiency						65.9		
Total/day						197.7	{	676

Notes:

Assume FTEs are available for 8 hrs/day; because overall 70% efficiency is taken at the end.

Trucks carry 22 pallets. Truckloads received based on total inventory to shipping at 300 lb/drum (see separate truck calc sheet) Pallets are assumed to hold 4-55 gallon drums

Assume 50% of drums are contaminated and can't be deconned.

Assume 50% of waste received requires interim storage (this will be dependent on assay system)

Assume 10% of incoming waste is sampled

Assume sorted waste is 75% of total; all of debris, no liq, no lead/merc/spec, 70% of residue and soil

Assume 10% of sorted waste is sampled

Assume gross size reduction is necessary for wastes to metal decon & lead

Assume gross size reduction is 1 hr per drum.

Assume shredding is necessary for waste to proc res, soil, soft debris(sorted or not)

0.75 =fraction of feed to RCPRP requiring shredding

Assume 10% of shredded waste is sampled.

Box breakdown includes time beyond that required if waste was packaged in drums

Assume glove box sorting required for 10% of open and complex debris, + all of special, mercury and lead

0.14 =fraction of feed to RCPRP requiring sorting

Assume glove box waste requires 1 sample/drum

Assume all debris must be assessed as none will be destroyed.

Assume liquids will arrive in drums and be transferred from receiving, and not go to the sorting cell

Assume transfer control for liquids takes the same time as for drums

Assume paperwork is accomplished within times shown

Average time per drum includes times for activities multiplied by the probability that the activity will occur.

Least time/drum/subsystem includes only the minimum requirements, no extra staging, sorting, or shredding Max time/drum/subsystem includes all staging, shredding, glove box, etc

Table NT2-d

CWO Organic Destruction Subsystem

-			-	Time				
		Occurrence/		Required	Total Time /	FTEs	Minutes/	Minutes/
Task	Subtask	shift	Units	(min)	Shift	Needed	First Drum	Add'l Drum
Receive Waste	Transfer through air lock	3.3	drum	5	16			
	Feed waste from drum	3.3	drum	3	10			
	Hook to transfer device	3.3	drum	3	10			
	Transfer to tank (10 gpm)	3.3	drum	6	18			
	Empty drum bottoms	3.3	drum	2	7			
	Detach & remove drum	3.3	drum	3	10			
	Sample feed vessel	3.3	drum	5	16			
	Arrange for transfer of							
	secondary waste from other						i.	
	subsystems	1.5	drum	2	2			
Total Task)		28	88	0.2	28	17
Feed waste to	Startup Instrumentation and							
reactor	valve check	1.0		30	30			
	Meter waste to reactor							
	(monitoring time)	24.0		10	240			
	Meter waste to reactor (300							
	lbs/hr)	4.7	drums	6	26			
Total Task				36	270	0.6	36	6
Operate Reactor	Instrumentation/Equip check	1.0	time	30	30			
	Time to react organics						1	
	(min/drum) reaction rate: 797						1	
	lbs/hr	4.7	drums	34	162			
	Flow velocity (gpm)=			[[
	drums/shift*55gal/drum /(480				Į I			
	min/shift)	0.5			<u> </u>			
	Residence time (min)=Reactor							}
	volume/flow velocity: Reactor			l.			1	
	volume is 5% of 500 gal	46.2	minutes	L				
Total Task		<u></u> _		64	192	0.4	64	34
Waste Transfer/	Waste removed from tank]	1
Recycle	(pump 500 gal @10 gpm)	9.1	drum	6	50			L
	Filter solution	24.0	times	2	48		ļ	
м. С.	Sample filtrate	2.0	times	15	30			ļ
-	Recycle acids	24.0	times	2	48			
	Operate condenser	1.0	times	16	16		<u></u>	
	Wash solution	24.0	times	2	48	L	L	
1	Sample	2.0	times	15	30			
1	Transfer @ 10 gpm to filter	47.2	drums	6	260			
	Transfer @ 10 gpm from filter	47.2	drums	6	260			
Total Task				63	270	0.6	63	6
Treat inorganics	Transfer to neutralizer	24.0		2	48			
	Precipitate filtered solids	24.0		2	48			
	Filter precipitate	24.0		2	48			
	Transfer filtrate to Aq. Waste	24.0		2	48			
	Transfer precipitated solids to							
	polymer	24.0		2	48		1	1
	Collect sample	2.0		5	10		1	
Total Task		1		15	250	0.5	15	34

.

Table NT2-d

CWO Organic Destruction Subsystem

	· · · ·	Occurrence/		Time Required	Total Time /	FTEs	Minutes/	Minutes/
Task	Subtask	shift	Units	(min)	Shift	Needed	First Drum	Add'l Drum
Receive Waste	Transfer through air lock	3.3	drum	5	16			
FTEs/shift						2.2	206	
Supervision	Ratio of 1:10					0.2		
Vac/sick/ holiday relief	Assume 6 wks of absence					0.3		
Adjustment for 70%								
Efficiency						0.8		
Total/shift						3.6		
Total/day						10.7		

241

lbs/hr

Notes:

4.3

Total samples/shift Assume sampling frequency = 10% of drums

From Blaine's mass balance, the feed to subsystem = Total feed is (drums/hr) =

(See Overall Table) 0.6

Assume continuous CWO process

Assume solids removal once/day

Waste transfer/recycle processes are continuous. Time is expected labor monitoring time

Table NT2-e.

Vacuum Thermal Desorption for Process Residue

				Time	T	1			Minimum	Maximum
		Occurrence		Pequired	Total Time /	ETEC	Minl	Time/Add'l	(minutoo)	(minutes)
T = 1	Quiltan all	Occurrence	1.1	Required	iotai Time /	FIES	Min	Time/Add1	(minutes/	(minutes/
lask	Subtask	/sniπ	Units	<u>(min)</u>	Shift	Needed	Drum	drum	shift)	shift)
Receive Waste	Transfer through air lock	65.8		5	329				L	
Receive Waste	Transfer through air lock	65.8		5	329					
	Stage drums for campaigns	65.8		2	132					
Total Taak				7	460	0.96	7	2	7	7
Total Task				/	400	0.30	1	<u>∠</u>	· · · · · · · · · · · · · · · · · · ·	
reed vvaste		05.0		•	407					
from drum	Stage at feed bin (drums)	65.8		3	19/					
	Hook to transfer device	65.8		3	197					
	Transfer into feed bin	65.8		5	329					
	Empty drum bottoms	65.8		2	132					
	Sample feed vessel	2.0		5	10				1	
	Detach & remove drum	65.8		3	197					
T					700	4.50	40		10	10
I OTAL I ASK				16		1.53	16	5	16	16
Vacuum Thermal	Unit is number of batchs	··	1	drums/						
Desorption	Batch is 15,000 lbs or	46.7		batch						
	Check equipment, instruments	· · ·								
	before startup	1.1		30	33					
	Charge desorber (15000 lbs/hr)	1.1		60	65					
	Heat desorber	11		60	65					
	Desorber batch			60	65					
	Cool december	1.1			22					
		1.1	<u> </u>	30	33					L
	Discharge desorbed waste	1.1	<u> </u>	15	16		005	<u> </u>		
I OTAL I ASK				225	245	0.51	225	0	225	225
Monitor Offgas	Monitor cooler 1	24.0	<u> </u>	1	24					
	Monitor condenser 1	24.0		1	24					
	Monitor condenser 2	24.0		1	24					l
	Monitor transfer lines to APC	24.0).	1	24					
Total Task				4	96	0.20	0	0	0	0
Condensate	Sample holding vessel from				1	Γ			T	
handling	cond. 1	1.0	time	15	15					
	Sample holding vessel from						-			
	condenser 2	10	time	15	15					
	Transfer to aqueous waste									
	treatment	10	time	20	20					
		1.0	ume			<u> </u>				
	I ranster to mercury			-		{			1	
	amalgamation	1.0	time	20	20	<u> </u>				
Total Task				70	70	0.15	1		0	70
Separate			<u> </u>	ſ		1	1		1	[
desorbed waste	Sample waste	1.1	batch	5	5	Į				
	Select destination	41.8	drums	1	42					
	Transfer waste to Ha leaching pr	125	drume	2	25	+				
	Transfer waste to rig leaching pi	20.2	drumo	2	50					
Total Table	Transier waste to polymer stabil	23.2	urums	40	424	0.07	40		10	10
I OTAL I ASK	1			10	131	0.27	10	8	10	10
Mercury cont.										
solids leaching	Process is sized for 1000 lbs/hr	of waste or 2	25 drun	is/shift						
	Measure leaching agent	0.5	drums	20	9					
	Leach waste	0.5		90	41					
	Transfer to wash 1	0.5		20	9					
	Wash	0.5		60	28	1			1	
	Sample	0.5		15	7	<u> </u>	1			
	Transfer to wash 2	0.5		20	9	<u> </u>				
	Mach	0.5		60	28		1		<u> </u>	ł
	Semple	0.5	<u>+</u>	15	7		+		-	
	Transfer to filter	0.5		20	6					
	Tansier to mer	0.5		20	3					
		0.5		30	14					
	Sample/evaluate	0.5		30	14					
	I ranster liquid to aqueous waste	0.5		10	5					
	Transfer solid to polymer	0.5		10	5					1
Total Task		1		400	184	0.38	84	0		400

Table NT2-e.

Vacuum Thermal Desorption for Process Residue

		7		Time	i		1		Minimatura	Mostingung
		Occurrence		Required	Total Time /	ETEc	Min/	Time/Add'	(minutoo/	(minutool
Task	Subtask	/shift	Units	(min)	Shift	Needed	Drum	drum	(minutes/	(minutes/
Receive Waste	Transfer through air lock	65.8		5	329				0	orarej
Leachate/ filtrate						·····				
treatment										1
	Transfer leachate to mercury									
	reduction	0.5		20	9				1	
1	Transfer rinse waste water to									
	mercury reduction	0.5	ļ	20	9					l.
	Mercury reduction over steel									
	wool	0.5		60	28					
	Sample	0.5		15	7				······	
	Transfer to mercury ppt	0.5		20	9			_		
	Sample	0.5		15	7					
	Add precipitation agents	0.5		15	7					
	Settle tank	0.5		60	28					
	Sample solids	0.5		15	7					
	Transfer solids to polymer	0.5		10	5					
	Transfer liquid to iodine	1								
	recovery	0.5		10	5					
	Add chemicals (H2SO4, H2O2)	0.5		15	7					
	Reaction	0.5		30	14					
	Recover iodine	0.5		60	28					
	Transfer solids	0.5		20	9			-		
	Transfer liquid to wash 2	0.5		10	5					
Total Task				395	182	0.38	83	0		395
FTEs/shift					0	4.38	425	15	258	1123
Supervision	Ratio of 1:10					0.44				
Vac/sick/holiday										1
relief	Assume 6 wks of absence					0.56				
Total/shift						5.37	425	15	258	1123
70% efficiency						7.68				
Total/day						23.03				

Notes:

Thermal Desorption Batch size of 15,000 lbs

Assume drum transfer of 15 min/drum or .5cu ft/min

Only 1.14 batches are required per shift based on feed to subsystem

The condenser/aqueous transfer monitoring functions will occur when the desorber is running

Number of drums following treatment is based on the 5/30 mass balance: 1020 lbs/hr in and 648 lbs/hr out

Assume 30% of the waste goes to mercury leaching process

Mercury leaching process was sized for 1000 lbs/hr of waste (@ 297 lbs/drum thisconverts to 25 drums/shift)

The weighted average of drum density was calculated to be 297 lbs/drum for this system. 1

Table NT2-f

Aqueous Waste Treatment Subsystem

-		Occurrence	÷	Time Required	Total Time /	FTEs	Minutes/	Minutes/
Task	Subtask	/ Shift		(min)	Shift	Needed	Drum	Add'i Drum
Receive Waste	Transfer through air lock	1.4	drum	5	7			
	Feed waste from drum	1.4	drum	3	4			
	Hook to transfer device	1.4	drum	3	4			
	Transfer to tank (10 gpm)	1.4	drum	6	8			
	Empty drum bottoms	1.4		2	3			
	Sample feed vessel	2.0		10	20			
	Detach & remove drum	1.4		3	4			
	Sample waste from processes:		· · · · · · · · · · · · · · · · · · ·					
	CWO, Desorb, Decon, APC	4.0	N/A					
	Arrange for transfer	20.7	drum	2	31	· · · · · ·		
Total Task 1				33	81	0.17	33	5
Preliminary							ļ	
Treatment	Sample high TDS tank	11.2	drums	15	17		1	
	Sample low TDS tank	4.7	drums	15	7			
	Sample TOC waste	6.1	drums	15	9			
	Select treatment methods (10						1	
	drum batch)	10.8	drums	20	22			
	Transfer organic waste to oil	·					1	
	water separator	6.2	drums	3	20		Į	
	Filter high, low TDS and							
	organic waste (sav 10 gal/min)	22.1	drums	6	122			
	Neutralize/ppt high TDS waste	11.2	drums	11	124	······································		
	Settle precipitated aqueous							
	waste	11.2	drums	6	62		{	
	Evaporate solids	0.6	drums	6	3	·····		
Total Task 2				90	382	0.80	90	20
UV oxidation	CaSO4 ppt (10 gpm)	22.1	drums	11	243			
	Centrifuge (10 gpm)	22.1	drums	11	243			
•	sample waste	22	drums	15	33			11
	Adjust UV exidation (30 min/10		<u>urumo</u>					
	drums)	22.1	drums	3	66			
-	Process through LIV oxidation						1	
	(50 gpm)	221	drums	1	24			
	Carbon filtration (10 opm)	22.1	drums	6	122			
	lon exchange (10 gpm)	22.1	drums	6	122	·		
	Sample waste before discharge	22		30				1
Total Task 3				52	853	1 78	52	
Total per shift				ļ		2,74	175	26
Supervision	Ratio of 1:10					0.27	1	
Vac/sick/								
holiday relief	Assume 6 wks of absence					0.35		
							1	
70% efficiency			<u></u>			4.81	<u> </u>	
Total per day						14.42		
Notes:								
Assume high TI debris treatm	DS waste comes from RCPRP, on nent and metal decon.	rg destructio	n, soil treat	ment,	640.50	lbs/hr	11	drums/shift
Assume waste	from polymer, APC is low TDS				267.70	ibs/hr	5	drums/shift
Assume waste	from process residue is organic l	ia			349.60	lbs/hr	6	drums/shift
Total drums per	r hour	•			22.1	drums/hr		
Assume tank ba	atches are 550 gallons (10 drums	5)						
Assume treatme	ent selection time is required for	10 drum bat	ches.					

Assume residence time in oil water separator is 1 hour and tank is 1000 gallons (16 gpm)

Assume filtration, centrifuge and ppt rates are 10 gpm.

Assume solids to evaporator are 5% of incoming waste; assume drying rate is 10 gpm Assume UV oxidation unit is 50 gpm

1

Table NT2-g Metal Decontamination Subsystem

	· · · · · · · · · · · · · · · · · · ·			Time	Total Time (ETEA	Minutes	Minutes/
Task	Subtask	Occurrence/	I Inite	(min)	Shift	Needed	Drum	Drum
Metals		Onne	Onita		<u> </u>	HUUUUU		Diam
Receivina/								
Feed Prep	Transfer through air lock	15.8	drums	5	79			
Total Task				5	79	0.17	5	0
Waste Decon								
	Stage containers	15.8	drum	5	79			
	Decon waste	15.8	drum	10	158			
	Sssay for recycle	15.8	drum	30	475			
	Repack in drums	15.8	drum	15	238			
	Close drum lid	15.8	drum	15	238			
	Stage drums	15.8	drum	5	79			
	Monitor recirc filtration and							
	fugitive dust system	24.0	times	6	144			
Total Task				86	1411	2.94	86	<u> </u>
Total FTEs/shift						3.11	91	
Supervision	Ratio of 1:10					0.31		
Vac/sick/								
holiday relief	Assume 6 wks of absence				·	0.39		
Total/shift						3.81		
70% efficiency						5.44		
Total/day						16.33		

Notes:

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Assume 50% of waste must be size reduced. Assume 60 min/drum for cutting

j:\inei\ents\time\TIMEMNT2.WK4

Table NT2-h.Lead Recovery

				Time				
		Occurrence		Required	Total Time /	FTEs	Minutes/	Minutes/
Task	Subtask	/ Shift	Units	(min)	Shift	Needed	Drum	Add'l Drum
Lead Receiving/								
Feed Prep	Transfer through air lock	0.48	drums	5	2			
	Glove box separation of							
	sheet lead and gloves	0.48	drums	60	29			
	Stage at decon	0.48	drums	10	5			
Total Task				75	36	0.08	75	
Waste Decon								
	Stage containers	0.48	drum	5	2			
	Decon waste	0.48	drum	10	5			
	Assay for recycle	0.48	drum	30	14			
	Repack in drums	0.48	drum	15	7			
	Close drum lid	0.48	drum	15	7			
	Stage drums	0.48	drum	5	2			
	Monitor recirc filtration							
	and fugitive dust system	24.00	times	6	144			
Total Task				86	182	0.38	86	30
Total FTEs/shift			[T	0.46	161	
Supervision	Ratio of 1:10					0.05		
Vac/sick/holiday	Assume 6 wks of							
relief	absence					0.06		
Total/shift]				0.56		
70% efficiency		{				0.80		
Total/day						2.39		

Notes:

Assume assay for all drums @ 30 min/drum

Table NT2-i. Mercury Amalgamation

				Time				Minutes/
		Occurrence		Required	Total Time	FTEs	Minutes/	Add'i
Task	Subtask	/ Shift	Units	(min)	/ Shift	Needed	Drum	Drum
Metals Receiving/	· ·							
Feed Prep	Transfer through air lock	0.08	drums	5	0			
Metals Receiving/			-					
Feed Prep	Transfer through air lock	0.08	drums	5	0			
•	Transfer liq mercury to tank	0.06	drums	60	4			
	Transfer steel wool w/ Hg to							
	holding bin	0.02	drums	10	0			
Total task		l		75	4	0.01	75	60
Mercury								
Amalgamation	Inspect equipment	1.00	time	30				
	Transfer liq mercury to							
	amalgamater (1 gpm)	0.06	drum	55	3			
	Measure additives	0.08	drum	30	2			
	Transfer steel wool to							
	amalgamater	0.08	drum	20	2			
	Batch amalgamation	0.08	drum	120	10			120
	Transfer out of amalgamater	0.08	drum	55	4			
	Stage	0.08	drum	5	0			
	Place at assay	0.08	drum	5	0			
	Assay	0.08	drum	20	2			
	Remove from assay	0.08	drum	2	0			
Total Task			-	312	24	0.05	312	120
Total FTEs/shift						0.06	387	
Supervision	Ratio of 1:10					0.01		
Vac/sick/holiday	· ·							
relief	Assume 6 wks of absence					0.01		
Total/shift						0.07		
70% efficiency						0.10		
Total/day						0.31		

Notes:

Volume of steel wool: assume 3x vol of steel to mercury

Assume 5% of mercury is in residue (this should be conservative; 5% of mercury

is assumed to be in debris, not process residue)

Total volume of mercury in study is 82 lbs/hr.

Therefore volume of steel wool w/mercury =

0.50 lbs/hr 0.02 drums/shift

Batch size for amalgamater: Assume 1 drum/batch, 2 hrs /batch

Table NT2-j

-

		0	1. A.	Time	Total	ETEs	Minutos	Minutes
Tack	Subtook	Sccurrence/	11000	Required	Time/Shift	Needed	Doum	
I ask	Sublask	Snint	Units	(min)	i ime/ Shirt	needeu	Dium	
Special Beesiving/Food								
Receiving/reeu	Terraforthrough sintest	5.44			07.0			
Prep	Transfer through air lock	5.44	arums	5	21.2	ļ	<u> </u>	<u> </u>
	Glove box preparation of							}
	wastes	5.44	drums	60 ·	326.4			L
and the second	Stage waste	5.44	drums	3	16.32			
Total Task				68	369.9	0.77	68	60
Waste Treatment	Stage containers	5.44	drum	3	16.32			
	Treat waste as special							
	processes TBD	5.44	drum	60	326.4			
	Sample treated waste	5.44	drum	15	81.6			
	repack in drums	5.44	drum	30	163.2			
	Close drum lid	5.44	drum	3	16.32			
	Stage drums	5.44	drum	3	16.32			
Total Task				114	620.16	1.29	114	60
Total FTEs/shift						2.06	182	
Supervision	Ratio of 1:10					0.21		
Vac/sick/holiday	Assume 6 wks of							
relief	absence					0.26		
Total/shift		[1	2.53		
70% efficiency				1	1	3.62		
Total/day				1		10.85		

...

Notes:

Assume all waste is prepared in glove box Assume waste is treated in various batch processes that average 2 hours/drum TBD=To be determined

Table NT2-k.

Grout Stabilization Subsystem

-		1	-	Time	1			
		Occurrence/		Required	Total Time/	FTEs	Minutes/	Minutes/
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Add'i Drum
Waste Receiving/								
Feed Prep	Transfer through air lock	28.6	drums	5	143			
	Sample waste	2.9	drums	15	43			
	Select process for waste	28.6	drums	5	143			
	Transfer to							
	macroencapsulation	7.8	drums	2	16			
	Transfer to							
	microencapsulation	20.8	drums	2	42			
	Stage at process	28.6	drums	2	57			
Total task				31	443	0.92	31	5
		1						
Waste Encapsulation	Measure binder	28.6	drum	5	143			
	Mix binder	28.6	drum	5	143			
	Combine with waste	28.6	drum	10	286			
	Repack in drums	28.6	drum	5	143			
	Close drum lid	28.6	drum	3	86			
	Stage pallets	28.6	drum	2	57			
	Monitor activated carbon							
	and fugitive dust system	2.0	times	6	12			
Total Task			<u> </u>	36	869	1.81	36	10
	Move pallets to curing						}	
Binder setup time	area	28.6	drum	2	57			
	Curing time	28.6	drum		0			
	Sample	2.9	drum	15	43			
	Monitor curing process	28.6	drum	10	286			
-	Move pallets from curing area	28.6	times	2	57			
Total Task				29	443	0.92	29	5
Drum Decon	Stage containers	29	drum	5	14			
	Load conveyors	2.9	drum	5	14			
	Decon drums	2.9	drum	10	29			
	Assav drums	2.9	drum	15	43			
	Unload conveyers	2.9	drum	5	14			· · · · · · · · · · · · · · · · · · ·
	Palletize drums	2.9	drum	2	6			
	Stage drums	2.9	drum	5	14			
Total Task				47	134	0.28	47	15
Total FTEs/shift		1		1		3.93	143	
Supervision	Ratio of 1:10					0.39		
	Assume 6 wks of	1						
Vac/sick/holiday relief	absence					0.50		
Total/shift						4.83		
70% efficiency						6.90		
Total/day						20.69		

Notes:

Assume all complex debris (8 drums) will be sent to macroencapsulation, rest to micro.

Assume 10% of drums are deconned.

Assume 10% of drums are assayed

Assume mixing requires 30 min/drum

Number of samples = 2.9

Table NT2-I **Polymer Stabilization Subsystem**

				Time	4 9			Minutes/
		Occurrence/		Required	Total Time/	FTEs	Minutes/	Add'l
Task	Subtask	shift	Units	(min)	Shift	Needed	Drum	Drum
Waste								
Receiving/Feed								
Prep	Transfer through air lock	27.6	drums	5	138			
	Sample waste	2.8	drums	15	41			
	Evaluate dryness	2.8	drums	5	14			
	Dry waste	10.9	drums	30	N/A			
	Monitor drying	24.0	times	10	240			
	Stage at process	27.6	drums	2	55			
Total Task				57	488	1.02	57	30
Encapsulation	Measure polymer	27.6	drum	5	138			
	Mix polymer	27.6	drum	10	276			
	Combine with waste in							
	extruder	27.6	drum	10	276			
	Repack in drums	24.0	drum	5	120			
	Close drum lid	27.6	drum	3	83			
	Palletize drums	27.6	drum	2	55			1
	Stage drums	24.0	drum	2	48		<u> </u>	
	Monitor activated carbon				[
· · · · ·	and fugitive dust system	8.0	times	6	48			
Total Task				43	1044	2.18	43	60
	Move pallets to curing		1	1			† 	
Binder setup time	area	24.0	drum	5	120	}		
	Curina time	24.0	drum		0	†	<u> </u>	<u> </u>
	Sample	2.4	drum	15	36		<u> </u>	
	Monitor curing	24.0	drum	10	240		†	
	Move pallets from curing		1				<u> </u>	
	area	24.0	times	5	120	}		
Total Task				35	516	1.08	35	5
Drum Decon	Stage containers	27.6	drum	5	138		†	
	Load conveyors	27.6	drum	5	138		<u> </u>	
	Decon drums	27.6	drum	10	276		<u> </u>	
	Assav drums	27.6	drum	15	414			
	I Inicad conveyers	27.6	drum	5	138	·	<u> </u>	
	Stage drums	27.6	drum	5	138			
			Grunn		100		┼────	<u> </u>
Total Task				45	1242	2.59	45	60
Total FTFe/ehift	<u>+</u>		+			6.86	180	
Supervision	Ratio of 1:10		1			0.69		
Vac/sick/holidov		<u> </u>	1			- 0.00		
relief	Assume 6 wks of absence					0.87		
Total/shift	rissume o was of absence					8 41		
70% officiancy						12 02		
Total/day	· · · · · · · · · · · · · · · · · · ·	<u> </u>				36.05		
Li utal/uay				1		1 30.03		l

Notes:

Assume 30% of process residue waste and 100% of other waste requires drying Assume dryer can accept waste at the rate of 2 drums/hour No. of samples = 2.4

Table NT2-m. Air Pollution Control Subsystem

-

		Occurrence/		Time Required	Total Time /	FTEs	
Task	Subtask	Shift	Units	(min)	Shift	Needed	Minutes/lb
Monitor					}		
Equipment	Dry filtration	4	times	10	40		
	HEPA filter	4	times	5	20		
	GPCR	24	times	2	48		
	Acid gas scrubber	12	times	10	120		
	Mist eliminator	4	times	2	8		
i	GAC	4	times	2	8		
	Mersorb	4	times	2	8		
	Offgas monitor	24	times	5	120		
Total Task				38	372	0.78	0
Supervision	Ratio of 1:10					0.08	
Vac/sick/holiday	Assume 6 wks of						
relief	absence			·		0.10	
Total/shift						0.95	
70% efficiency						1.36	
Total/day						4.08	

Table NT2-n.

Certification and Shipping

		-		Time				Minut
		Occurrence/		Required	fotal fime/	FIES	Minutes/	Add
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Dru
Naste Receiving	Transfer through air lock	49.8	drums	5	249	<u> </u>	<u> </u>	·
	Sample waste	5.0	drums	15	75			ļ
	Resample waste	0.5	drums	15	7	L		ļ
	Stage waste	49.8	drums	5	249	1		<u></u>
Total Task		<u> </u>		40	580	1.21	40	15
Waste Assay	Stage pallets	49.8	drum	3	149			ļ
	Load on conveyor	49.8	drum	1	50	1	<u> </u>	L
	Assay RTR	49.8	drum	15	746			<u> </u>
	Assay gamma	49.8	drum	60	2986			
	Assay PAN	49.8	drum	60	2986			
	Remove from conveyor	49.8	drum	1	50			
	Repalletize	49.8	drum	3	149			
	Stage pallets after assaying	49.8	drum	15	746			
Total Task				158	7862	16.38	158	60
Stage waste	Stage uncertified waste	49.8	drum	3	149	1	T	
-	Transfer waste	49.8	drum	3	149			
	Stage certified waste	49.8	drum	3	149			
	Transfer waste	49.8	drum	3	149		1	
Total Task				12	597	1.24	12	<u> </u>
Ship Waste Truck	Truck docking	0.6	truck	30	17			
	Settle Paperwork	0.6	truck	120	68	1	1	1
	Load truck	0.6	truck	60	34	1		1
	Truck leaving	0.6	truck	60	34	1	1	1
Total Task		1	1	270	153	0.32	12	1
Total FTEs/shift			1	+	1	19.15	222	T
Supervision	Ratio of 1:10		1		+	1.91	1	
Vac/sick/holiday			1	1		1	+	1
relief	Assume 6 wks of absence		1	}		2.43	}	
Total/shift			-		+	23.49	1	1
Adjustment for 70%				1	+			1
Efficiency			ţ			33 56		
Tetol/dov		+	+		+	100.60	+	+

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Notes: Assume 10% of waste require sampling Samples collected = 5.0

Table NT2-o.

Summary of FTEs & Time for a Single Drum to Pass Through a System

			1	Add'I Time	Time/ Drums	
		Time (min)/		for Next	Received in a Shift	
	Daily FTEs	Single drum	Time (hrs)	Drum	(minutes)	Time (hrs)
Admininstration	52.1	N/A				
Receiving /InspectionTasks						
common for all waste		802	13.4	60	3727.6	62
Receiving and Prep-CWO		0	0.0		0.0	0
Receiving and Prep-residue		229	3.8	45	1328.8	22
Receiving and Prep-soil		229	3.8	45	425.2	7
Receiving and Prep-debris		288.5	4.8	5	458.3	8
Receiving and Prep-lead		557	9.3	315	557.0	9
Receiving and Prep-mercury		516	8.6	315	516.0	9
Receiving and Prep-special		516	8.6	315	1914.6	32
Receiving and Prep-metal decon		229	3.8	35	554.4	9
Receiving and Prep	197.7	676.2	11.3			0
Aqueous Waste	14.4	175	2.9	36	934.3	16
Organic Destruction	10.7	206	3.4	34	333.5	6
Vacuum Thermal Desorption	23.0	425	7.1	26	1060.4	18
Metal Decon	16.3	91	1.5	75	1204.0	20
Lead	2.4	161	2.7	N/A	161.0	3
Mercury	0.3	387.0	6.5	N/A	387.0	6
Special	10.8	182.0	3.0	60.0	448.4	7
Grout	20.7	143	2.4	10	418.6	7
Polymer	36.0	180	3.0	60	1776.0	30
APC	4.1	372	6.2		372.0	6
Certification and Shipping	100.7	222	3.7	60	3147.6	52
Total	489.4					

Notes:

Allocation of receiving and preparation time was done as follows:

Average time per drum was estimated, multiplied by the number of drums per shift. The time for each waste type was allocated according its percentage of total waste.





System NT-3 Time and Motion Study Tables

- NT3-a System NT-3: Time and Motion Analysis
- NT3-b Administration Subsystem

NT3-c Receiving and Preparation Subsystem

NT3-d MEO Organic Destruction Subsystem

NT3-e Aqueous Waste Treatment Subsystem

NT3-f Aqueous Wash for Soil and Process Residue

NT3-g High Pressure Wash for Open Debris

NT3-h Metal Decontamination Subsystem

NT3-i Lead Recovery

NT3-j Mercury Amalgamation

NT3-k Special Waste

NT3-1 Grout Stabilization Subsystem

NT3-m Polymer Stabilization Subsystem

NT3-n Air Pollution Control Subsystem

NT3-0 Certification and Shipping

NT3-p Summary of FTEs and time for a single drum to work through a system
Table NT3-a.

System NT-3: Time and Motion Analysis

	Mass Flow		No of	SCM Unprocessed		
Subsystem	(lb/hr)	Waste Type	Drums	Density	Density	Density
,				ka/m3	lb/ft3	lb/drum
Administration	2,927					
Receiving and preparation	2,927	all	6.2		64.0	470.6
Aqueous waste treatment	1,632	L1100	3.6		62.0	455.9
Organic destruction	326	L2110	0.7		62.0	455.9
Process residue and inorganic						
sludge treatment	1,020	S3120	3.2	700	43.7	321.2
Bulk soil treatment	329	S4100	0.7		67.0	492.6
Soft Debris treatment	435	S5300	3.0	320	20.0	146.8
Open Debris treatment	80	S5110	0.4	400	25.0	183.5
Complex Debris treatment	177	S5110	1.0	400	25.0	183.5
Metal decontamination	462	S5110	2.0	509	31.8	233.5
Mercury amalgamation	3	X7100	0.003	2000	124.8	917.6
Lead recovery	26	X7200	0.0	2000	124.8	917.6
Polymer stabilization	1,246	S3120	3.9	700	43.7	321.2
Air pollution control	827		N/A			
Grout stabilization	958	soil/debris	2.8	750	46.8	344.1
Special treatment	155	X6000,X7500	0.7	500	31.2	229.4
Certification and shipping	4,919	Z000	6.2	N/A	107.9	793.4
vol reduction (out/in)	0.60		1.0			

Notes:

This table provides the basis for the time and motion analysis.

Quantities of waste to a subsystem (lbs/hr) are based on LMITCO mass balance.

Densities are the same as the LMITCO mass balance except where values are shown in the SCM column. Where values are shown in the SCM column, densities are taken from SCM and converted to lb/cu ft

The waste quantities are converted from lbs/hr to drums/hr.

Subsequent analysis is based on drums/shift of waste to a subsystem.

Waste to CSHIP includes recyclable metals and treated solid waste ready for disposal.

Table NT3-b.

Administration Subsystem

F				Time	
		FTEs	Samples/	Required	Total Time /
Task	Subtask	Needed	Shift	(min)	Shift
Facility Management					
, c	Facility Manager	1			
	Secretary	1			
	Receptionist/word processor	1			
Operations Management					1
- -	Department managers	2			
	Communications	1	ĺ		
	Engineering Manager	1			
	Engineering staff	2			
	Maintenance Supervisor	1			
Personnel	Personnel Manager	<u> </u>			
	Nurse/medical/industrial safety	1			
	Security quards at facility	Å			
	Security at quard bldg				
Environmental	Environmental manager				
Environmental	Environmental clerk	1			
		i			
Shipping/receiving/rrame	Manager	4			
		1			
Durah a ain a		I			
Purchasing	Buyer Coat Accounting				
Accounting	Cost Accounting	2	ł		
	Accounting Clerk	1			
	Payroll Clerks	2			
Laboratory	Laboratory Manager	1			
	Lab Shift manager	4			
	Lab technicians for OSORT	4	11.1	30.0	334.0
	Lab technicians for internal processes	10	89.5	10.0	895.5
	Lab technicians for final waste form	3	10.3	30.0	308.6
	Lab technicians for incoming supplies	0.2	1.0	20.0	20.0
Health Physics					
	Shift health physics staff	4			ļ
	Health physics manager	1			
	Total except Lab	35			
	Total Lab	22			
	Total Admin	57			

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Table NT3-c. Receiving and Preparation Subsystem

-				Time			Add'l Time	Averade
		Occurrence	Units for	Required	Total Time /	FTEs	for Next	Minutes/ Shift/
Task	Subtask	/ Shift	Occurrence	(min)	Shift	Needed	Drum	Drum
Receive Waste								
Truck	Truck docking	0.6	truck	30	17			
	Settle Paperwork	0.6	truck	120	68		l	
	Unload truck	0.6	truck	60	34			
· ·	Stage pallets	0.6	truck	60	34			
the second second	No of pallets/shift							
Total Task 1				270	153	0.32	0	153
Receive Empty							<u>+</u>	<u></u>
container Truck	Truck docking	0.3	truck	30	8			
	Settle Paperwork	0.3	truck	30	8			
	Unload truck	0.3	truck	60	17			
	Stage pallets	0.3	truck	20	6			
Total Task 2				140	40	0.08	0	40
Receive supplies	Truck docking	02	truck	30	6		1	<u> </u>
	Settle Paperwork	0.2	truck	30	6			
	Unload truck	02	truck	60	12			
	Stage pallets	02	truck	20	4			
Total Task 3	Clago palloto	<u></u>		140	28	0.06	0	28
Transfer to	Move pallets to			1-10		0.00		
Interim Storage	storage area	62	Pallet	5	31			
internit otorage	Stack pallete/	0.2	i anci	·	+			1
	organize storage	62	Pallet	10	62			
1	Transfer to accay	62	Pallet	5	31			
Total Task A	Tansier to assay	0.2	anci	20	124	0.26	10	10
Assay Drume	Stage nallete	124	Pallet	- 20	62	0.20		+
, way Druins	Load on conveyor	40.8	drum	1	50			
	Assay PTP	10.0	drum	15	746			
	Assay nin	49.0	drum	60	2096			
	Accesy DANI	45.0	daum	60	2000	1	1	
	Demove from	43.0			2300			
L		10.9	daum	4	50			
1	Penalletiza	49.0	drum		140	1		
	Stage pellete offer	49.0	uium	3	149	ł		
	Stage pallets after	10.4	Dellat	F	60			
Total Table 5	assaying	12.4	Pallet	5	7004	44.77	60	150
Stead ask 5	Change and distant		+	150	1091	14.77		150
stage and move	Store solid waste	1000	Dellet	40	100			
ID OSORI	by category	10.6	Pallet	10	106		4	
	MOVE TO USOR	10.6	Pallet	5	53		-	1
Total Table 0	Stage at USORT	10.6	Pallet	5	53	0.44	E	47
I OTAL LASK 6			Pallet	20	213	<u> </u>		
open orums	Stage at drum	100	Dellat	-	50			
	opener	10.6	Pallet	5	53	-		
	Load on conveyor	42.6	Drums	5	213	ł		
	Drum lid clamp	42.6	arum	2	85	4		
	Drum lid opener	42.6	drum	5	213	4		
	LIG staging	42.6	drum	1	43	4		
	Remove from							
L	conveyor	42.6	drum	1	43	-	-	10
Total Task 7			<u></u>	19	575	1.20	5	16
Dump Drums	Assign drums to							
	dump stations	42.6	drum	3	128	4		
	Move drums to sort							
	table /bins	42.6	drum	5	213	4		
	Dump drums	42.6	drum	5	213	4		
Total Task 8				13	554	1.15	5	11

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Table NT3-c. Receiving and Preparation Subsystem

				• Time			Add'I Time	Average
		Occurrence	Units for	Required	Total Time	FTEs	for Next	Minutes/ Shift/
Task	Subtask	/ Shift	Occurrence	(min)	Shift	Needed	Drum	Drum
Sort Drums	Sort waste	, Chine	o o o a nonoc	(1,1,1,1)	<u>Onne</u>	Heeded	Diam	Diditi
	robotically	31.9	drum	30	958		1	
l	Transfer waste to	01.0	Gram					
	container	31 9	drum	15	479			
	select destination	01.0	Grann	10				
	for sorted waste	310	drum	3	96			
	Move container to	51.5	Giuni					
	subsystem hip or							
	subsystem bin or	310	drum	3	20			
Total Task 9	Silleddel	51.5	dium	61	1620	2 20	45	29
Glove Box Sort	Transfer to glove			51	1029	3.35	45	
Giove Box Son	hansier to give	60	drum	20	205			
	Dux (Several trips)	0.0	diuiti		205			
	in glove box	6.0	drum	240	1620			
	Sompling (1/drive)	0.0	drum	240	1039			
	Transfer waste to	0.0	uluin	15	102			
	manster waste to	6.9	ala:	60	440			
	Containers	0.0	arum	00	410		1	
	Select destination		-1	45	400			
	for sorted waste	0.8	arum	15	102			
	Move containers to							
	subsystem bin or	6.0		45	100			
Tatal Task 40	snredder	0.0	arum	15	102	5.04	245	F
Total Task TU		<u> </u>		3/5	2362	<u> </u>	315	
Assess Debris for	Transfer and	1 · · ·						
	Transfer open and	25.0	daum	2	105		1	
Compliance	Complex debris	35.0	drum	3	140			
	Screen debris	35.0	drum	4	140			
	Additional	07		40	07			
	sampling (25%)	0.7	drum	10	0/			
Total Tools 44	inspection	35.0	arum	3	1/5	1 06	5	6
Total Task 11					507	1.00	<u> </u>	<u> </u>
Gross Size	transfer to cutting	42.0						
Reduction	lable	13.8	drum	3	41			
	Cut waste	13.8	arum	30	413			
	Return to container	13.8	arum	5	69			
	I ransfer to next	10.0		_	44			
Total Table 40	process	13.0	arum	3	41	4 4 0	25	
Total Task 12	Transforts		<u> </u>	41	204	1.10	30	
Silledding	chansier to	27.2	da	~	75			
	Store wests	31.3	drum	4	15			
		31.3	arum	2	/5			
	reed waste to			•	75			
	Silleddel	31.3	arum	2	/5			
	reed bad drums to	21.2		-	10			
	Shiedder	21.3	drum		43			
	Shred stage 1	50.0	drum	4	447			
	Silled stage 2	30.0	arum	2	1			
	Sample size of	50		F	20			
	Waste Dowerts 109/	5.9	arum	<u> </u>	29			
	Rework 10%	0.6	arum	10	9			
	Return to container	38.6	arum	3	1/0			
	i ranster to next	59.0	-		4477			
Total Table 40	process	56.5	arum	2	11/	4 70	2	20
10tal 1ask 13	1		1	3/	832	1./3		

Table NT3-c. Receiving and Preparation Subsystem

È.	· · · · · · · · · · · · · · · · · · ·			- Time			Add'I Time	Average
		Occurrence	Units for	Required	Total Time /	FTEs	for Next	Minutes/ Shift/
Task	Subtask	/ Shift	Occurrence	(min)	Shift	Needed	Drum	Drum
Sampling	Sample opened				1			
	drums	4.3	drum	5	21			
1	Sample sorted				1			
	waste	5.9	drum	5	29			
	Resample (10%)	1.0	drum	5	5			
· · ·	Report/eval. results	11.1	drum	10	111			
Total Task 14				25	167	0.46	10	30
Subsystem Bin								
operation	Monitor bin height	4.3	drum	3	13			
	Fill containers	4.3	drum	3	13			
	Move containers	4.3	drum	2	9			
	Stage containers	4.3	drum	3	13			
	Organize							
	campaigns	4.3	drum	15	64			
Total Task 15				26	111	0.31	0	26
Internal Transfer	Move waste from						T	1
	OSORT to other							
	subsystems	4.3	drum	10	43			
	Move waste from			-				
	subsystems to							
	CSHIP	49.6	drum	10	496			
	Move treated							
	waste to							
•	stabilization	80.0	drum	10	800			
$(A_{ij})_{i \in \mathbb{N}} = \{a_{ij}\}_{i \in \mathbb{N}} \in \{a_{ij}\}_{i \in \mathbb{N}}$	Move liquid waste							
1	to AQWIR and	70		10	70)	
	OrgDes	1.2	arum	10	12			
· · ·	Move waste to							
	secondary	20.0	alay year	10	200		1	
r in the second s	Ireament	20.0	arum	10	200		1	
ł	move supplies	20.0	dauses		60			
	Mayo pour drumo	20.0	drum		75			
	Rebedule	24.9	drum	3	/5			
	Schedule	205.0	drum	4	206			
Total Took 16	movement	205.9	Gruin	57	1051	5 42	10	57
TULAI TASK TU	┿ ┈┈╴┈╺┈ ╼╼╼╼╼	+		57	1951	<u> </u>		
Box Breakdown	Stage boxes	10.0	box	2	20			
	Move to opening				1			
	area	10.0	box	3	30			
	Open boxes	10.0	box	10	100	ļ		
	Transfer to dump	10.0	box	3	30		10	
I otal Task 17	010	40.0		18	180	0.50		<u> </u>
Container Decon	Stage containers	49.8	drum	5	249			
	Load conveyors	49.8	arum	5	249	4		
	Decon arums	49.8	arum	10	498	4		
	Assay drums	49.8	arum	15	240	1		
	Store driveyers	49.0	drum	5	249			
Total Table 19	Stage urums	49.0	urum	J AE	249	6.22	15	45
IULAI IASK 10	4	1		40	1 2233	0.22		-10

Table NT3-c. Receiving and Preparation Subsystem

		Occurrence	Units for	Time Required	Total Time /	FTEs	Add'l Time for Next	Average Minutes/ Shift/
Task	Subtask	/ Shift	Occurrence	(min)	Shift	Needed	Drum	Drum
FTEs/shift					0	35.78		
Supervision	Ratio of 1:10					3.58		
Vac/sick/holiday relief	Assume 6 wks of absence					4.54		
Break relief (included in 6 hr day)	One person can relieve 3 (accounted for in efficiency)							
Total/shift						43.9		
Adj for 70% Efficiency						62.7		
Total/day						188.2		669

Notes:

Assume FTEs are available for 8 hrs/day; because overall 70% efficiency is taken at the end.

Trucks have 22 pallets. Truckloads received based on total inventory to shipping at 300 lb/drum (see separate truck calc sheet)

Pailets are assumed to hold 4 55 gallon drums

As in inventory, assume 50% of drums are contaminated and can't be deconned.

Assume 50% of waste received requires interim storage; this will be dependent on assay system

Assume 10% of incoming waste is sampled

Assume sorted waste is 75% of total; all of debris, no liq, no lead/merc/spec, 70% of residue and soil

Assume 10% of sorted waste is sampled

Assume gross size reduction is necessary for wastes to metal decon & lead

Assume gross size reduction is 1 hr per drum.

Assume shredding is necessary for waste to proc res, soil, soft debris(sorted or not)

0.75= fraction of feed to Receiving and Prep requiring shredding

Assume 10% of shredded waste is sampled.

Box breakdown includes time beyond that required if waste was packaged in drums

Assume glove box sorting required for 10% of open and complex debris, + all of special, mercury and lead

0.14 =fraction of feed to RCPRP requiring sorting

Assume glove box waste requires 1 sample/drum

Assume only complex and open debris require assessment, because open debris goes to CWO.

Assume liquids will arrive in drums and be transferred from receiving, and not go to the sorting cell

Assume transfer control for liquids takes the same time as for drums

Assume paperwork is accomplished within times shown

Average time per drum includes times for activities multiplied by the probability that the activity will occur.

Least time/drum/subsystem includes only the minimum requirements, no extra staging, sorting, or shredding Max time/drum/subsystem includes all staging, shredding, glove box, etc

Table NT3-d.

				Time				
		Occurrence/	-	Required	Total Time /	FTEs	Minutes/	Minutes/
Task	Subtask	Shift	Units	(min)	Shift	Needed	First drum	Add'l Drum
Receive Waste	Transfer through air lock	3	drum	5	16			
	Feed waste from drum	3	drum	3	10			
	Subtask Occurrence/ Shift Required (rota) Total Time / Shift The Shift Needed First dr First dr a framsfer through air look 3 drum 3 10							
	Transfer to tank (10 gpm)	3	drum	6	18		1	
	Empty drum bottoms	3	drum	2	7	······································	<u> </u>	
	Detach & remove drum	3	drum	3	10			
	Sample feed vessel	3	drum	5	16			
	Arrange for transfer of					·		
	secondary waste from other							
	subsystems	3	drum	2	Δ			
Total Took	Subsystems		<u>a</u> rans	29		0.10		17
Food Monto	Somple wests in tank		timee	15	30	0.19		
reed waste	Sample waste in tank	<u> </u>	umes	10	30		· · · · · · · · · · · · · · · · · · ·	
	0		·					
	Screen and transfer waste (5				~			
	gpm) to primary reactor	6	arums	11	63			
	Meter waste to reactor			_				
	(monitoring time)	24		3	72			
	Meter waste to reactor (300							
	lbs/hr)	6	drums	6	32			
Total Task				17	135	0.28	17	6
	Time to react organics						1	
	(min/drum) reaction rate:	- · · ·						
Reactor	50kg/day/unit*42 MEO units	6	drum	142	818			
	Reaction rate 192 lbs/hr	6	drums				1	
	Monitor pumps and manifold	24	times/shift	5	120		1	1
	Monitor MEO cells	24	times/shift	5	120			
	Monitor and adjust electrolyte							
	concentration	24	times/shift	5	120			
	Monitor and adjust		ci noci ci nic	<u>v</u>				
	turbo-aerator for nitrous acid							
	conversion	24	times/shift	5	120			
	Monitor and adjust oxygen		difficerentite	·				
	input to perator	24	times/shift	5	120			
	Collect samples	16	times/shift	15	240			
	Manifes primary another and		uncoronit		240			
	wontor primary reactor and	24	Aires of a brift	e .	120			
Total Table	carrolyte reactor		umes/smit	142	120	2.00	142	
TOLAL TASK				142	900	2.00	142	ļ
Silver Recovery	ivionitor and adjust blowdown		******		400			
	from anoiyte stream	24	umes	5	120			
	Nonitor and adjust blowdown			-	100			
	from catholyte stream	24	times	5	120			
	Sample blowdown (anolyte and							
	catholyte	4	times	15	60			
	Monitor precipitation of silver	_						
	nitrate	24	times	2	48			ļ
	Monitor centrifuge	24	times	5	120			
1	Transfer silver chloride	24	times	2	48			
	Precipitate silver	24	times	5	120			
	Separate silver	24	times	5	120			
	React silver to silver nitrate	24	times	5	120			
	Transfer AgNO3 to primary				1			
1	reactor	24	times	2	48			
	Transfer salts to Aq Waste	24	times	2	48			
ł	Sample precipator, reactor	4	times	15	60			
Total Task			1	68	1032	2.15	68	6

Table NT3-d. **MEO Organic Destruction Subsystem**

				Time				
		Occurrence/		Required	Total Time /	FTEs	Minutes/	Minutes/
Task	Subtask	Shift	Units	(min)	Shift	Needed	First drum	Add'l Drum
Acid Recovery	Transfer blowdown to							
	evaporator	24	times	2	48			
	Monitor evaporator	24	times	5	120			
	Transfer to filtration or							
	fractionater	24	times	2	48			
	Monitor fractionater	24	times	5	120			
	Monitor condenser	8	times	2	16			1
	Filter solution	24	times	2	48			
	Sample filtrate	2	times	15	30			
	Sample recycle acids	8	times	15	120			
Total Task				32	198	0.41	32	6
Offgas	Monitor anolyte offgas transfer	24	times	2	48			
	Monitor catholyte offgas	24	times	2	48			
	Monitor and adjust NOx							
	removal	24	times	2	48			
Total Task				6	144	0.30	6	0
FTEs/shift						5.33	293	17
Supervision	Ratio of 1:10					0.53		
Vac/sick/holidav relief	Assume 6 wks of absence					0.68		
	Adjust for 70% Efficiency			1		1.96	1	
Total/shift						8.50		
Total/day						25.51		

241

lbs/hr

Notes:

Assume sampling frequency = 10% of drums

From Blaines mass balance, the feed to subsystem is

Total feed = 1 Drum/hr See overall table

Assume continuous CWO process

Assume solids removal once/day

Waste transfer/recycle processes are continuous. Time is expected labor monitoring time

Assume drums of liquid transferred from Rec and Prep

Assume paperwork is accomplished within times shown 33

Total samples/shift =

Table NT3-e.

Aqueous Waste Treatment Subsystem

				Time				
		Occurrence/		Required	Total Time /	FTEs	Minutes/	Minutes/
Task	Subtask	Shift	Unit	(min)	Shift	Needed	Drum	Add'l Drum
Receive Waste	Transfer through air lock	1	drum	5	7			
	Feed waste from drum	1	drum	3	4			
	Hook to transfer device	1	drum	3	4			
	Transfer to tank (10 gpm)	1	drum	6	8	_		
	Empty drum bottoms	1		2	3			
	Sample feed vessel	2		10	20			
	Detach & remove drum	1		3	4			
	Sample waste from processes:				_			
	CWO, Desorb, Decon, APC	4	N/A					
	Arrange for transfer	27	drum	2	41			
Total Task 1		·		33	91	0.19	33	5
				1				
Preliminary Treatment	Sample high TDS tank	1	drums	15	2			
	Sample low TDS tank	7	drums	15	10			
	Sample TOC waste		drums	15				
	Select treatment methods (10		1				· · · · · · · · · · · · · · · · · · ·	
	drum batch)	7	drums	20	13			
	Transfer organic waste to oil							
	water separator		drums	3				
	Filter high, low TDS and organic							
	waste (say 10 gal/min)	8	drums	6	42			
	Neutralize/ppt high TDS waste	1	drums	11	13			
	Settle precipitated aqueous				1		<u> </u>	
	waste	1 .	drums	6	6			
	Evaporate solids	0	drums	6	0		†	
Total Task				90	86	0.18	90	20
UV oxidation	CaSO4 ppt (10 gpm)	8	drums	11	84		T T	
	Centrifuge (10 gpm)	8	drums	11	84			
and the second	Sample waste	1	drums	15	12			
	Adjust UV oxidation (30 min/10							1
	drums)	8	drums	3	23		1	
	Process through UV oxidation							
	(50 gpm)	8	drums	1	8			
	Carbon filtration (10 gpm)	8	drums	6	42			
	lon exchange (10 gpm)	8	drums	6	42			
and the second second second	Sample waste before discharge	1		30			1	1
Total Task 3				52	296	0.62	52	
Total per shift				1	1	0.99	175	
Supervision	Ratio of 1:10					0.10		
Vac/sick/holiday relief	Assume 6 wks of absence					0.13		
70% efficiency					1	1.73		
Total per day						5.18	1	1170
Notes:			<u>.</u>	·	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·		
Assume high TDS was	te comes from RCPRP, ora dest	ruction, debris	treatment.	and metal de	econ.	lbs/hr	1	drums/shift
Assume waste from po	olymer, APC is low TDS	,			1233.10	lbs/hr	21	drums/shift
Assume waste from pr	ocess residue and soil is organic	liauid			371.70	lbs/hr	7	drums/shift
		•						

Total drums per hour= 29 Assume tank batches are 550 gallons (10 drums) Assume treatment selection time is required for 10 drum batches.

Assume residence time in oil water separator is 1 hour and tank is 1000 gallons (16 gpm)

Assume filtration, centrifuge and ppt rates are 10 gpm.

Assume solids to evaporator are 5% of incoming waste; assume drying rate is 10 gpm Assume UV oxidation unit is 50 gpm

Number of samples per shift =

11

Table NT3-f.

Aqueous Wash for Soil and Process Residue

				Time	Total			
		Occurrence/		Required	Time /	FTEs	Minutes/	Minutes/
Task	Subtask	Shift	Units	(min)	Shift	Needed	First drum	Add'l Drum
Soil Receiving	Transfer through air lock	31	drums	5	154			
Total Task				5	154	0.3	5	5
Feed Waste from								
drum	Stage at feed bin (drums)	31	drums	3	92			
	Hook to transfer device	31	drums	3	92			
	Transfer into feed bin							
	(metering screw)	31	drums	5	154			
	Feed screw monitoring							
	time		drums					
	Empty drum bottoms	31	drums	2	62			
	Sample feed vessel	2	drums	5	10			
	Detach & remove drum	31	drums	3	92			
Total Task				16	503	1.0	16	16
Wash Water Prep	Sample wash water	3	drums	5	15			
	Adjust Water Volume	3	drums	10	31			
	Adjust surfactant	3	drums	10	31			
Total Task				25	77	0.2	25	
	Add waste to tank (5000	· · · · · · · · · · · · · · · · · · ·						
Washing Process	lbs/hr)	92	drums	4	356			
-	Wash waste (4000 lbs/hr)	92	drums	5	N/A			
	Transfer waste and water							
	from tank (35 gpm)	462	drums	2	726			
	Monitor tank	24	times	5	120			
Total Task				6	120	0.3	6	5
	Screening (35 gpm)		· ·					
Pre-rinse and Rinse	(most of water leaves							
	process here)	462	drums	2	726			
	Hydrocyclone (2@35							
	gpm)	185	drums	1	145			
	transfer to rinse contactor	185	drums	1	145			
· · · · ·	Rinse contactor (5000							
	gal); 6:1 water to			_				
	soil/residue; 9000 lbs/hr	185	drums	2	396			
	Transfer to dryer (2x vol							
	of soil)	185	drums	1	145			
	Drying @ 35 gpm	185	drums	2	290			
	Monitor operations	24	times	5	120			
	Collect samples	16	times	5	80			
Total Task				6	200	0.4	6	2

Table NT3-f. Aqueous Wash for Soil and Process Residue

				Time	Total			
-		Occurrence/		Required	lime /	FIES	Minutes/	Minutes/
Task	Subtask	Shift	Units	(min)	Shift	Needed	First drum	Add'l Drum
Recycle Processes	These are all monitoring							
	times				0			
	Solubility Reduction	8.0	times	5	40			
	Additive Adjustment	8.0	times	5	40			
	Transfer to Wash Tank	16.0	times	2	32			
	Transfer to Ultrafiltration	8.0	times	2	16			
	Ultrafiltration	24.0	times	5	120			
	Dissolved Air Flotation	8.0	times	5	40			
	Surfactant Separation	24.0	times	5	120			
	Additive Adjustment	8.0	times	5	40			
	Steam stripping	8.0	times	5	40			
	Transfer recycled							
	surfactant	8.0	times	5	40			
	Transfer waste to organic							
	destruction	8.0	times	5	40			
	Transfer metals to							
	polymer	8.0	times	5	40			
[Collect samples	24.0	times	5	120			
Total Task				59	728	1.5	59	
Total FTEs/day= FT	Es per shift					3.7		
Supervision	Ratio of 1:10					0.4	117	2
Vac/sick/holiday	Assume 6 wks of							
relief	absence					0.5		
Total/shift						4.6		
70% efficiency						6.5		
Total/day						6.5		

Notes:

Sample wash water every 10 drums

Assume drum transfer of 15 min/drum or .5 cu ft/min

System designed for 1 shift not 3

Residence time in wash tank based on 4x wt of water to feed

Wash tank is 3000 gal.

Assume transfer rates are 10 gpm; this includes both waste and rinse or wash water

Waste to screening includes water in tank (4x input volume)

Waste to rinse contactor and hydrocyclone assumes 1:1 soil to water (2x input volume)

Rinse tank has 5000 gallons of water and soil (size is 6000 gal)

Drying: assume 1 hr drying time,2000 lbs/hr (6 drums/hr)

For purposes of processing time, recycle is not included, as these are not soil treatment Samples collected per shift= 45

Table NT3-g. High Pressure Wash for Open Debris

				Time			1	Minutes/
	· · · · ·	Occurrence/		Required	Total Time /	FTEs	Minutes/	Add'l
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
								1
Debris Receiving	Transfer through air lock	35	drums	5	175			
	Stage drums for campaigns	35	drums	15	524			
Total Task			•	20	699	1.5	20	15
Feed Waste from								
bin	Stage at feed bin (drums)	35	drums	3	105			
	Hook to transfer device	35	drums	3	105			
	Transfer into feed bin							
	(metering screw)	35	drums	15	524			
	Empty drum bottoms	35	drums	2	70			
	Sample feed vessel	3	drums	10	35			
	Detach & remove drum	35	drums	3	105			
Total Task				36	944	2.0	36	23
Wash Water Prep	Sample wash water	3	drums	5	17			
	Adjust Water Volume	3	drums	10	35			
	Adjust surfactant	3	drums	10	35			
Total Task				25	87	0.2	25	
Washing Process	Check out Equipment	1	times	30	30			
	Add waste to tank	35	drums	15	524			15
See notes; based								
on 16 drum batch	Wash/ rinse waste	35	drums	17	N/A			
	Transfer water from tank	35	drums	28	961			
	Monitor tank	24	times	5	120			
	Collect Samples	3	times	5	15			
Total Task				94	1636	3.4	94	
Total per shift						7.0	175	
Supervision	Ratio of 1:10					0.7		
Vac/sick/holiday								
relief	Assume 6 wks of absence					0.9		
Total/shift						8.6		
70% efficiency						12.3		
Total/day						36.9		
Total FTEs						36.9		

Notes:

Sample wash water every 10 drums Assume drum transfer of 15 min/drum or .5cu ft/min Batch size is 1 to 2 tons; say 3000 lbs or 16 drums Residence time in wash tank based on 3 stages, 90 minutes each Assume transfer rates are 10 gpm; this includes both waste and rinse or wash water Assume water volume is roughly 5x waste volume

Table NT3-h. Metal Decontamination Subsystem

Task	Subtask	Occurrence/ Shift	Units	Time Required (min)	Total Time / Shift	FTEs Needed	Minutes/ Drum	Minutes/ Add ^{*1} Drum
Metals Receiving/				_				
Feed Prep	Transfer through air lock	16	drums	5	79			
Total Task				5	79	0	5	0
Waste Decon	Stage containers	16	drum	5	79			
	Decon waste	16	drum	10	158			
	Assay for recycle	16	drum	30	475			
	Repack in drums	16	drum	15	238			
	Close drum lid	16	drum	15	238			
	Stage drums	16	drum	5	79			
	Monitor recirc filtration and	· ·			1			
	fugitive dust system	24	times	6	144			
Total Task				86	1411	3	86	
Total FTEs/shift				······		3	91	
Supervision	Ratio of 1:10					0		
Vac/sick/holiday					1			
relief	Assume 6 wks of absence					0	(
Total/shift					1	4		
70% efficiency	· · · · · · · · · · · · · · · · · · ·		1		1	5		
Total/day						16		

Notes:

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Assume 50% of waste must be size reduced. (need basis for this) Assume 60 min/drum for cutting

j:\inel\ents\time\TIMEMOT3.WK4

Table NT3-i Lead Recovery

		Occurrence/		Time Required	Total Time/	FTEs	Minutes/	Minutes/
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Add'l Drum
Lead								
Receiving/Feed								
Prep	Transfer through air lock	0.24	drums	5	1			
	Glove box separation of							
	sheet lead and gloves	0.24	drums	60	14			
	Stage at decon	0.24	drums	10	2			
Total Task				75	18	0	75	
Waste Decon	Stage containers	0.24	drum	5	1			
	Decon waste	0.24	drum	10	2			
	Assay for recycle	0.24	drum	30	7			
	Repack in drums	0.24	drum	15	4			
	Close drum lid	0.24	drum	15	4			
	Stage drums	0.24	drum	5	1			
	Monitor recirc filtration							
	and fugitive dust system	24.00	times	6	144			
Total Task				86	163	0	86	- 30
Total FTEs/shift						0	161	
Supervision	Ratio of 1:10					0		
Vac/sick/holiday	Assume 6 wks of							
relief	absence					0		
Total/shift						0		
70% efficiency						1		
Total/day						2		

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Notes:

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Assume assay for all drums @ 30 min/drum

Table NT3-j. Mercury Amalgamation

				Time				Minutes/
		Occurrence/		Required	l otal	FIES	Minutes/	Addi
lask	Subtask	Shift	Units	(min)	lime/ Sniπ	Needed	Drum	Drum
Metals Receiving/				1				
Feed Prep	Transfer through air lock	0.02	drums	5.0	0.1			
	Transfer liq mercury to tank	0.02	drums	60.0	1.3			
Total Task				65.0	1.4	0.0	65.0	60.0
Mercury		1		[
Amalgamation	Inspect equipment	1.00	time	30.0				
	Transfer lig mercury to							
	amalgamater (1 gpm)	0.02	drum	55.0	1.2			
	Measure additives	0.02	drum	30.0	0.7			
	Batch amalgamation	0.02	drum	120.0	2.6			120.0
}	Transfer out of amalgamater	0.02	drum	55.0	1.2			
	Stage	0.02	drum	5.0	0.1			
	Place at assay	0.02	drum	5.0	0.1			
	Assay	0.02	drum	20.0	0.4			
	Remove from assay	0.02	drum	2.0	0.0			
Total Task				292.0	6.4	0.0	292.0	120.0
Total FTEs/shift			Ţ	1	1	0.0	357.0	
Supervision	Ratio of 1:10			1		0.0		
Vac/sick/holiday relief	Assume 6 wks of absence					0.0		
Total/shift		1	1	1		0.0	1	
70% efficiency			1	1		0.0	1	
Total/day		1	1			0.1		

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Notes:

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Batch size for amalgamater: Assume 1 drum/batch, 2 hrs /batch

Special Waste Table NT3-k.

				Time				Minutes/
and the second second		Occurrence		Required	Total Time	FTEs	Minutes/	Add'l
Task	Subtask	/ Shift	Units	(min)	/ Shift	Needed	Drum	Drum
Special								
Receiving/Feed								
Prep	Transfer through air lock	5.4	drums	5.0	27.2			
	Glove box preparation of							
1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -	wastes	5.4	drums	60.0	326.4			
	Stage waste	5.4	drums	3.0	16.3			
Total Task				68.0	369.9	0.8	68.0	60.0
Waste Treatment	Stage containers	5.4	drum	3	16.3	·····		
	Treat waste as special							
	processes TBD	5.4	drum	60	326.4			
	Sample treated waste	5.4	drum	15	81.6			
	Repack in drums	5.4	drum	30	163.2			
	Close drum lid	5.4	drum	3	16.3			
	Stage drums	5.4	drum	3	16.3			
Total Task				114.0	620.2	1.3	114.0	60.0
Total FTEs/shift				-		2.1	182.0	
Supervision	Ratio of 1:10					0.2		
Vac/sick/holiday	Assume 6 wks of							
relief	absence					0.3		
Total/shift						2.5		
70% efficiency						3.6		
Total/day						10.8		

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Notes:

Assume all waste is prepared in glove box Assume waste is treated in various batch processes that average 2 hours/drum

TBD=To be determined

Table NT3-I. Grout Stabilization Subsystem

				Time				Minutes/
		Occurrence/		Required	Total Time /	FTFs	Minutes/	l'bbA
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
Waste								
Receiving/Feed								
Prep	Transfer through air lock	22	drums	5	111			
	Sample waste	2	drums	15	33			
	Select process for waste	22	drums	5	111			
	Transfer to							
	macroencapsulation	8	drums	2	16			
	Transfer to							·····
	microencapsulation	14	drums	2	29			
	Stage at process	22	drums	2	44			
Total Task	· · · · · · · · · · · · · · · · · · ·			31	345	0.7	31	5
Waste								
Encapsulation	Measure binder	22	drum	5	111			
	Mix binder	22	drum	5	111			
	Combine with waste	22	drum	10	222			
	Repack in drums	22	drum	5	111			
	Close drum lid	22	drum	3	67			
	Stage pallets	22	drum	2	44			
	Monitor activated carbon	1						
	and fugitive dust system	2	times	6	12			
Total Task				26	670	14	26	10
Rinder eatur	Move pallets to curing	1		<u> </u>	073			
time	area	22	drum	2	44			
anc	Curing time	22	drum	<u>∠</u>			l	
	Samples	2	times	15	22	·		
	Monitor curing process	22	drum	10	222			
	Move pallets from curing		dium	10	<u> </u>			
	area	22	timos	2	44			
	aica	<u> </u>	unes	Z		······		
Total Task					345	0.7	29	5
Drum Decon	Stage containers	2	drum	5	11			
	Load conveyors	2	drum	5	11			
	Decon drums	2	drum	10	22			
	Assay drums	2	drum	15	33			
	Unload conveyers	2	drum	5	11			
	Palletize drums	2	drum	2	4			
	Stage drums	2	drum	5	11			
Total Task				47	105	0.2	47	15
Total FTEs/shift		1	1			3	143	
Supervision	Ratio of 1:10					0		
Vac/sick/holidav	Assume 6 wks of							
relief	absence					0		
Total/shift						4		
70% efficiency			<u> </u>			5		
Total/day						16		

Notes:

Assume all complex debris (8 drums) will be sent to macroencapsulation, rest to micro.

Assume 10% of drums are deconned.

Assume 10% of drums are assayed

Assume mixing requires 30 min/drum

No. of samples= 2

Table NT3-m. **Polymer Stabilization Subsystem**

		1		Time	· · · ·			Minutes/
		Occurrence/		Required	Total Time /	FTFs	Minutes/	l'bbA
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
Waste								Diani
Receiving/Feed	Transfer through air							
Prep	lock	31	drums	5	155			
-	Sample waste	3	drums	15	47			
	Evaluate dryness	3	drums	5	16			
	Dry waste	31	drums	30	N/A			
	Monitor drying	24	times	10	240			
	Stage dried waste at							
	process	31	drums	2	62			
Total Task				57	519	1	57	30
Encapsulation	Measure polymer	31	drum	5	155			
	Mix polymer	31	drum	10	310	, ,		
	Combine with waste in							
	extruder	31	drum	10	310			
	Repack in drums	31	drum	5	155			
	Close drum lid	31	drum	3	93			
	Palletize drums	31	drum	2	62			
	Stage drums	31	drum	2	62			
	Monitor activated							
	carbon and fugitive dust							
	system	8	times	6	48			
Total Task				43	1196	2	43	60
	Move pallets to curing							
Binder setup time	area	31	drum	5	155			
	Curing time	31	drum		0			
	Samples	3	times	15	47			
	Monitor curing	31	drum	10	310			
	Move pallets from			-				
	curing area	31	times	5	155			
Total Task				35	667	1	35	5
Drum Decon	Stage containers	31	drum	5	155			
	Load conveyors	31	drum	5	155			
	Decon drums	31	drum	10	310			
	Assay drums	31	drum	15	466			
	Unload conveyers	31	drum	5	155			
	Stage drums	31	drum	5	155		-	
Total Task				45	1397	3	45	60
Total FTEs/shift						8	180	
Supervision	Ratio of 1:10					1		
Vac/sick/holiday	Assume 6 wks of							1
relief	absence					1		
Total/shift						10		
70% efficiency						14		
Total/day						41		

Notes:

Assume 30% of process residue waste and 100% of other waste requires drying Assume 1 hr drying time, 2000 lbs/hr No. of samples= 3

Table NT3-n. Air Pollution Control Subsystem

· · · · · · · · · · · · · · · · · · ·				Time			
$(1,1,2,\dots,n) \in \mathbb{R}^{n}$		Occurrence/		Required	Total Time /	FTEs	
Task	Subtask	Shift	Units	(min)	Shift	Needed	Minutes/ Ib
Monitor Equipment	dry filtration	4	times	10	40	_	
	hepa filter	4	times	5	20		
	GPCR	24	times	2	48		
	Acid gas scrubber	12	times	10	120	_	
	mist eliminator	4	times	2	8		
	GAC	4	times	2	8		
	mersorb	4	times	2	8		
	offgas monitor	24	times	5	120		
Total Task				38	372	1	0
Supervision	Ratio of 1:10					0	
Vac/sick/holiday	Assume 6 wks of						
relief	absence		1			0	
Total/shift						1	
70% efficiency						1	
Total/day						4	

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Table NT3-o. **Certification and Shipping**

-	· · · · ·			Time		Į		Minutes/
		Occurrence/		Required	Total Time /	FTEs	Minutes/	Add"i
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
Waste Receiving	Transfer through air lock	50	drums	5	248			
	Sample waste	5	drums	15	74			
	Resample waste	0	drums	15	7			
	Stage waste	50	drums	5	248			
Total Task				40	578	1	40	15
Waste Assay	Stage pallets	50	drum	3	149			
	Load on conveyor	50	drum	1	50			
	Assay RTR	50	drum	15	744			
	Assay gamma	50	drum	60	2976			
	Assay PAN	50	drum	60	2976			
	Remove from conveyor	50	drum	1	50			
	Repalletize	50	drum	3	149			
	Stage pallets after							
	assaying	50	drum	15	744			
Total Task				158	7837	16	158	60
Stage waste	Stage uncertified waste	50	drum	3	149			
	Transfer waste	50	drum	3	149			
	Stage certified waste	50	drum	3	149			
	Transfer waste	50	drum	3	149			
Total Task				_12	595	1	12	
Ship Waste Truck	Truck docking	1	truck	30	17			
	Settle Paperwork	1	truck	120	68			
	Load truck	1	truck	60	34			
	Truck leaving	1	truck	60	34			
Total Task			· · · ·	270	152	0	12	
Total FTEs/shift						19	222	
Supervision	Ratio of 1:10					2		
Vac/sick/holiday	Assume 6 wks of							
relief	absence					2		
Total/shift						23		
Adjustment for 70%								
Efficiency	<u> </u>					33		
Total/day						100		

Notes:

Samples collected = 5 Assume 10% of waste require sampling

Table NT3-p.

Summary of FTEs & Time for a Single Drum to Pass Through a System

				Add'l Time	Time/ Drums	
		Time (min)/		for Next	Received in a	
	Daily FTEs	Single drum	Time (hrs)	Drum	Shift (minutes)	Time (hrs)
Admin	57.3	N/A				
Receiving /Inspection Tasks						
common for all waste		802.0	13.4	60.0	3727.6	62.1
Receiving and Prep-liquids		0.0	0.0		0.0	0.0
Receiving and Prep-residue		229.0	3.8	45.0	1328.8	22.1
Receiving and Prep-soil		229.0	3.8	45.0	425.2	7.1
Receiving and Prep-debris		288.5	4.8	5.0	458.3	7.6
Receiving and Prep-lead		557.0	9.3	315.0	557.0	9.3
Receiving and Prep-mercury		516.0	8.6	315.0	516.0	8.6
Receiving and Prep-special		516.0	8.6	315.0	1914.6	31.9
Receiving and Prep-metal decon		229.0	3.8	35.0	554.4	9.2
Receiving and Prep	195.5	668.7	11.1			0.0
Aqueous Waste	5.2	175	2.9	36	1170.4	19.5
Organic Destruction	25.5	293	4.9	17	371.1	6.2
Residue/Soil Treatment	6.5	117	2.0	16	594.3	9.9
Open Debris	36.9	175	2.9	23	233.0	3.9
Metal Decon	16.3	91	1.5	75	1204.0	20.1
Lead	2	161	2.7	N/A	161.0	2.7
Mercury	0.1	357.0	6.0	N/A	357.0	6.0
Special	10.8	182.0	3.0	60.0	448.4	7.5
Grout	16.1	143	2.4	10	355.4	5.9
Polymer	41.4	180	- 3.0	60	1982.4	33.0
APC	4.1	372	6.2		372.0	6.2
Certification and Shipping	100.4	222	3.7	60	3138.0	52.3
Total	518.1					

Notes:

Allocation of receiving and preparation time was done as follows: Average time per drum was estimated, multiplied by the number of drums per shift. The time for each waste type was allocated according its percentage of total waste.





System NT-5 Time and Motion Study Tables

NT5-a System NT-5: Time and Motion Analysis

NT5-b Administration Subsystem

NT5-c Receiving and Preparation Subsystem

NT5-d CWO Organic Destruction Subsystem

NT5-e CWO Organic Destruction Subsystem for Soft Debris

NT5-f Vacuum Thermal Desorption for Process Residue

NT5-g Aqueous Waste Treatment Subsystem

NT5-h Aqueous Wash for Soil

NT5-i High Pressure Wash for Open Debris

NT5-j Metal Decontamination Subsystem

NT5-k Lead Recovery

NT5-1 Mercury Amalgamation

NT5-m Special Waste

NT5-n Grout Stabilization Subsystem

NT5-0 Polymer Stabilization Subsystem

NT5-p Air Pollution Control Subsystem

NT5-q Certification and Shipping

NT5-r Summary of FTEs and time for a single drum to work through a system

Table NT5-a.

System NT-5: Time and Motion Analysis

Subsystem	Mass Flow (lb/hr)	Waste Type	No. of Drums	SCM Unprocessed Density kg/m3	Density Ib/ft3	Density Ib/drum
Administration	2,927					
Receiving and preparation	2,927	all	6.22		64	471
Aqueous waste treatment	1,956	L1100	4.29		62	456
Organic destruction	256	L2110	0.56		62	456
Process residue and inorganic						
sludge treatment	1,020	S3120	3.18	700	44	321
Bulk soil treatment	329	S4100	0.67		67	493
Soft Debris treatment	435	S5300	2.96	320	20	147
Open Debris treatment	80	S5110	0.44	400	25	184
Complex Debris treatment	177	S5110	0.97	400	25	184
Metal decontamination	462	S5110	1.98	509	32	234
Mercury amalgamation	3	X7100	0.00	2000	125	918
Lead recovery	26	X7200	0.03	2000	125	918
Polymer stabilization	1,127	S3120	3.51	700	44	321
Pre-polymer drying	459	S3120	1.43	700	44	321
Air pollution control	1,433		N/A			
Grout stabilization	651	soil/debris	1.89	750	47	344
Special treatment	155	X6000,X7500	0.68	500	31	229
Certification and shipping	4,270	Z000	5.49	N/A	106	777
vol reduction (out/in)	0.69		0.88			

Notes:

This table provides the basis for the time and motion analysis.

Quantities of waste to a subsystem (lbs/hr) are based on LMITCO mass balance of 5/30/96 except for grout and polymer, and certification and shipping (9/10/96 balance).

Densities are the same as the LMITCO mass balance except where values are shown in the SCM column.

Where values are shown in the SCM column, densities are taken from SCM and converted to lb/ft3..

The waste quantities are converted from lbs/hr to drums/hr.

Subsequent analysis is based on drums/shift of waste to a subsystem.

_Table NT5-b.

Administration Subsystem

	•			Time	
		FTEs	Samples/	Required	Total Time/
Task	Subtask	Needed	Shift	(min)	Shift
Facility Management					
	Facility Manager	1			· · ·
1	Secretary	1			
	Receptionist/word processor	1			
Operations Management					
	Department managers	2			
	Communications	1			
	Engineering Manager	1			
	Engineering staff	2			
	Maintenance Supervisor	1			
Personnel	Personnel Manager	1			
	Nurse/medical/industrial safety	1			
	Security guards at facility	4	Ì		
1	Security at guard bldg	4			
Environmental	Environmental manager	1			
	Environmental clerk	1			
Shipping/Receiving/Traffic					
	Manager	1			
	Clerk	1			
Purchasing	Buyer	1			
Accounting	Cost Accounting	2			
	Accounting Clerk	1			
	Payroll Clerks	2			
Laboratory	Laboratory Manager	1			
-	Lab Shift manager	4			
	Lab technicians for OSORT	4	11.3	30.0	340.3
	Lab technicians for internal processe	11	100.2	10.0	1002.1
	Lab technicians for final waste form	3	8.3	30.0	249.1
	Lab technicians for incoming supplie	0.2	1.0	20.0	20.0
Health Physics					
	Shift health physics staff	4			
	Health physics manager	1			
	Total except Lab	35			
	Total Lab	23			
	Total Admin	58			

Note:

Laboratory time is estimated by calculating the samples per shift. To fill all shifts for a 7 day week, 4 FTEs @ 6 hours per day of analysis time are assumed.

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Receiving and Preparation Subsystem

				Time			Add'/Time	Ave.
[Occurrence/	Units for	Required	Total Time /	FTEs	for Next	Minutes/Shift/D
Task	Subtask	Shift	Occurrence	(min)	Shift	Needed	Drum	rum
Receive Waste Truck	Truck docking	0.6	truck	30	17			
	Settle Paperwork	0.6	truck	120	68		1	
	Unload truck	0.6	truck	60	34		1	
	stage pallets	0.6	truck	60	34			
	No of pallets/shift						1	
Total Task 1			<u> </u>	270	153	0.3	0	153
Receive Empty							†	
container Truck	Truck docking	03	truck	30	-8			
	Settle Paperwork	0.3	truck	30	8			
	Unload truck	0.3	truck	60	17			
ł .	Stage nallets	0.3	truck	20	6		1	
Total Tack 2		0.0	- Guok	140	40	0.1	0	40
Receive supplies	Truck docking	0.2	truck	30			┼────	+ + V
iveceive supplies	Settle Papenvork	0.2	truck	30	6		1	
	Upland truck	0.2	truck		42			
	Stage pollete	0.2	truck	00	12		1	
Total Task 2	Stage panets	0.2	UUCK	20	4			
Total Task S		l		140		0.1		20
Change to interim	Move pallets to storage		Dellet	-			}	
Slorage	area	0.2	Pallet	2	31			
	Stack pallets/ organize							
	storage	6.2	Pallet	10	62		1	
	I ransfer to assay	6.2	Pallet	5	31			
liotal lask 4				20	124	0.3	10	10
Assay Drums	Stage pallets	12.4	Pallet	5	62		1	
	Load on conveyor	49.8	drum	1	50			
	Assay RTR	49.8	drum	15	746			
	Assay gamma	49.8	drum	60	2986			
	Assay PAN	49.8	drum	60	2986			
	Remove from conveyor	49.8	drum	1	50			
	Repalletize	49.8	drum	3	149			
1	Stage pallets after							
t	assaying	12.4	Pallet	5	62			
Total Task 5				150	7091	14.8	60	150
Stage and move to	Store solid waste by			T	1		1	
OSORT	category	11.0	Pallet	10	110		1	
	Move to OSORT	11.0	Pallet	5	55			
	Stage at OSORT	11.0	Pallet	5	55			
Total Task 6			Pailet	20	219	0.5	5	20
Open Drums	Stage at drum opener	11.0	Pallet	5	55			
	Load on conveyor	43.9	Drums	5	219			
	Drum lid clamp	43.9	drum	2	88			
	Drum lid opener	43.9	drum	5	219			
	Lid staging	43.9	drum	1	44			
	Remove from conveyor	43.9	drum	1	44			
Total Task 7			1	19	592	1.2	5	19
	Assign drums to dump	Ì		1			1	
Dump Drums	stations	43.9	drum	3	132			
	Move drums to sort			1		1		
	table /bins	43.9	drum	5	219			
	Dump drums	43.9	drum	5	219	1	1	
Total Task 8			1	13	570	1.2	5	13
Sort Drums	Sort waste robotically	32.9	drum	30	987		1	T
	Transfer waste to	1		1				
	container	32.9	drum	15	494			
	Select destination for			1		1		
	sorted waste	32.9	drum	3	99	1		
	Move container to					1		
	subsystem bin or			1		l		
	shredder	32.9	drum	3	99			
Total Task 9				51	1678	3.5	45	38
						A		

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_Table NT5-c

Receiving and Preparation Subsystem

TaskSubtaskOccurrence/ ShiftUnits for OccurrenceRequired (min)Total Time / ShiftFTEs NeededMinut for NextGlove Box SortTransfer to glove box (several trips)6.8drum30205Sort waste by hand in glove box6.8drum2401639Sampling (1/drum)6.8drum15102Transfer waste to0.00.00.00.0	tes/Shift/E rum
TaskSubtaskShiftOccurrence(min)ShiftNeededDrumGlove Box SortTransfer to glove box (several trips)6.8drum30205Sort waste by hand in glove box6.8drum2401639Sampling (1/drum)6.8drum15102Transfer waste to0.00.00.00.0	rum
Glove Box Sort Transfer to glove box (several trips) 6.8 drum 30 205 Sort waste by hand in glove box 6.8 drum 240 1639 Sampling (1/drum) 6.8 drum 15 102 Transfer waste to 0.0 440 1639	5
Glove Box Sort (several trips) 6.8 drum 30 205 Sort waste by hand in glove box 6.8 drum 240 1639 Sampling (1/drum) 6.8 drum 15 102 Transfer waste to 0.0 440 440	5
Sort waste by hand in glove box6.8drum2401639Sampling (1/drum)6.8drum15102Transfer waste to0.0drum0.0440	5
glove box6.8drum2401639Sampling (1/drum)6.8drum15102Transfer waste to0.0drum0.0110	5
Sampling (1/drum) 6.8 drum 15 102 Transfer waste to 0.0 14.0	5
Transfer waste to	5
	5
i containers b b b i drum i bu i 410 i i i	5
Select destination for	5
sorted waste 6.8 drum 15 102	5
Move containers to	5
subsystem bin or	5
shredder 6.8 drum 15 102	5
Total Task 10 375 2562 5.3 315	
Assess Debris for	
Debris Rule Transfer open and	
Compliance complex debris 11.3 drum 3 34	
Screen debris 11.3 drum 4 45	
Additional sampling	
(25%) 2.8 drum 10 28	
Inspection 11.3 drum 5 56	
Total Task 11 22 164 0.3 5	6
Gross Size Reduction Transfer to cutting table 14.2 down 3 43	
Citos de la contra	
Return to container 14.2 drain 55 71	
Transfer to next	
process 14.2 drum 3 43	
Total Task 12 41 581 12 35	6
Stredding Transfer to stredder 37.3 drum 2 75	
Stare waste 37.3 drum 2 75	
Feed waste to shredder 37.3 drum 2 75	
Feed damaged drums	
to shredder 21.9 dawn 2 44	
Shred stage 1 59.3 drum 2 119	
Shred stage 2 59.3 drum 2 119	
Sample size of waste 6.9 drum 5 30	
Rework 10% 0.6 drum 15 9	
Return to container 59.3 drum 3 178	
Transfer to next	
process 59.3 drum 2 119	
Total Task 13 37 840 1.7 2	30
Sampling	
Sample opened drums 4.4 drum 5 22	
Sample sorted waste 5.9 drum 5 30	
Resample (10%) 1.0 drum 5 5	
Reporteval results 11.3 drum 10 113	
Total Task 14 25 170 0.5 10	30
Subsystem Bin	
operation Monitor bin height 4.4 drum 3 13	
Fill containers 44 drum 3 13	
Move containers 44 drum 2 9	
Stage containers 44 drum 3 13	
Organize campaigns 44 drum 15 66	
Total Task 15 26 114 0.3 0	26

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Table NT5-c

Receiving and Preparation Subsystem

				Time			Add'I/Time	Ave.
		Occurrence/	Units for	Required	Total Time /	FTEs	for Next	Minutes/Shift/D
Task	Subtask	Shift	Occurrence	(min)	Shift	Needed	Drum	rum
	Move waste from							
Internal Transfer	OSORT to other							
	subsystems	4.4	drum	10	44			
	Move waste from							
	subsystems to CSHIP	43.9	drum	10	439			
	Move treated waste to							
	stabilization	80.0	drum	10	800		ļ	
	Move liquid waste to							
	AQWTR and OrgDes	5.9	drum	10	59			-
	Move waste to				T]			
and the second	secondary treatment	20.0	drum	10	200			
	Move supplies around	20.0	drum	3	60			1
	Move new drums	24.9	drum	3	75		1	
	Schedule movement	199.1	drum	1	199			
Total Task 16	[°]			57	1876	5.2	10	57
Box Breakdown	Stage boxes	10.0	box	2	20		[
	Move to opening area	10.0	box	3	30			
	Open boxes	10.0	box	10	100		1	
· · · ·	Transfer to dump	10.0	box	3	30			
Total Task 17				18	180	0.5	10	2
Container Decon	Stage containers	49.8	drum	5	249		[
	Load conveyors	49.8	drum	5	249			
	Decon drums	49.8	drum	10	498			
	Assay drums	49.8	drum	15	746		(
	Unload conveyers	49.8	drum	5	249			
	Stage drums	49.8	drum	5	249			
Total Task 18		1		45	2239	6.2	15	45
FTEs/shift						36.5		
Supervision	Ratio of 1:10					3.7		
	Assume 6 wks of							
Vac/sick/holiday relief	absence					4.6]	
	One person can relieve						1	
Break relief (included	3 (accounted for in			-				
in 6 hr day)	efficiency)						[
Total/shift			1			44.8		676
Adj for 70% Efficiency						64.0		
Total/day						191.9	1	

Notes:

Assume FTEs are available for 8 hrs/day; because overall 70% efficiency is taken at the end.

Trucks have 22 pallets. Truckloads received based on total inventory to shipping at 300 lb/drum (see separate truck calc sheet) Pallets are assumed to hold 4 55 gallon drums

As in inventory, assume 50% of drums are contaminated and can't be deconned.

Assume 50% of waste received requires interim storage; this will be dependent on assay system Assume 10% of incoming waste is sampled

Assume sorted waste is 75% of total; all of debris, no liq, no lead/merc/spec, 70% of residue and soil

Assume 10% of sorted waste is sampled

Assume gross size reduction is necessary for wastes to metal decon & lead 0.3

Assume gross size reduction is 1 hr per drum.

Assume shredding is necessary for waste to proc res, soil, soft debris(sorted or not)

0.75 = fraction of feed to RCPRP requiring shredding

Assume 10% of shredded waste is sampled.

Box breakdown includes time beyond that required if waste was packaged in drums

Assume glove box sorting required for 10% of open and complex debris, + all of special, mercury and lead 0.14 =fraction of feed to RCPRP requiring glove box sorting

Assume glove box waste requires 1 sample/drum

Assume only complex and open debris require assessment, because open debris goes to CWO.

Assume liquids will arrive in drums and be transferred from receiving, and not go to the sorting cell

Assume transfer control for liquids takes the same time as for drums

Assume paperwork is accomplished within times shown

Average time per drum includes times for activities multiplied by the probability that the activity will occur.

Table NT5-c

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Receiving and Preparation Subsystem

				Time			Add'I/Time	Ave.
1		Occurrence/	Units for	Required	Total Time /	FTEs	for Next	Minutes/Shift/D
Task	Subtask	Shift	Occurrence	(min)	Shift	Needed	Drum	rum

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Notes (cont.)

Least time/drum/subsystem includes only the minimum requirements, no extra staging, sorting, or shredding Max time/drum/subsystem includes all staging, shredding, glove box, etc

Table NT5-d

CWO Organic Destruction Subsystem

				Time			Add'/Time	Average
	1	Occurrence/	Units for	Required	Total Time /	FTEs	for Next	Minutes/Shift
Task	Subtask	Shift	Occurrence	(min)	Shift	Needed	Drum	/Drum
Receive Waste	Transfer through air lock	3.3	drum	5	16			,
	Feed waste from drum	3.3	drum	3	10	· · ·		
Task Receive Waste Total Task Feed waste to reactor Total Task Operate Reactor Total Task Waste Transfer/ Recycle	Hook to transfer device	3.3	drum	3	10			
	Transfer to tank (10 gpm)	3.3	drum	6	18			
	Empty drum bottoms	33	drum	2	7			<u> </u>
•	Detach & remove drum	33	drum	3	10			
	Sample feed vessel	33	drum	5	16		<u>}</u>	<u>}</u> ₽
	Arrange for transfer of	0.0					<u> </u>	
	secondary waste from other							
	subsystems	12	drum	2	2			
Total Task		1 - da		28	88	0.18	28	17
	Startup Instrumentation and			~~~				
Feed waste to reactor	valve check	10		30	30		1	
	Mater waste to reactor	1.0					<u> </u>	
	(monitoring time)	24.0		10	240			
	Meter waste to reactor (300	27.0			240		+	
	the (br)	45	daumo	e	25			
Total Tack		4.5	arums		25	0.50	26	
Operate Reactor	Upote imonitation // autio aboat	10		30	210	0.56		0
Operate Reactor	Time to react erganics	1.0	une					
	(min/drum) reaction rate: 707						1	
	(initiation) reaction rate. 757	45	daum	24	154			
	Flow volcoity (com)=	4.0	arun	- 34	104		<u>+</u>	
	drume/chi@*55.go)/drum // A80						1	
	min/chift)	05						
	Residence time (min)=Reactor	0.0					<u> </u>	
	volume/flow velocity: Reactor						· ·	
	volume is 5% of 500 gal	487	minutos			I		
Total Task	Volume is 0 % of 000 gai		mandles	64	194	0.29	64	- 24
Total Task	Maste removed from tank				104	0.30	04	
Waste Transfer/ Recycle	(pump 500 gal @10 gpm)	01	daum	e	50			
Vaste Transfell Recycle	Filter solution	24.0	timee				┼╼────	
	Sample fittate	24.0	times	4	40		<u> </u>	
		2.0	times	10	30	<u> </u>	<u> </u>	
	Operate condenses	24.0	times	4	40		+	
	Meeta echidenser	1.0	umes	10	10			
	Comple	24.0	times	<u></u>	40	<u></u>	<u> </u>	
	Sample	2.0	umes	15	30			
	Transfer @ 10 gpm to mer	44.0	arums	0	240			
Total Task	mansier @ in gpm from filter	44.5	arums	0	240	0 EC		6
	l Transforte noutraliner	24.0				0.56	<u> </u>	0
rreat inorganics	Dresisters fitered calida	24.0			40		<u> </u>	
		24.0			40		ļ	
	Transfor Strate	24.0	·	2	48		<u> </u>	·
	Transfer filtrate to Aq. waste	24.0			48		ļ	
	I ranster precipitated solids to				40]	
	Polymer	24.0		2	48			
T-t-1 Tl-		2.0		5	10	0.00	AE	
TT John		<u> </u>	<u></u>	15	250	0.52	15	
	Dette - (4.40					2.21	206	
Supervision						0.22		
vac/sick/holiday relief	Assume 6 wks of absence					0.28	ļ	
Adjust for /U% Efficiency						0.81	ļ	
i otal/shitt						3.53	ļ	
l otal/day	· · · · · · · · · · · · · · · · · · ·					10.58		

Notes:

Total Samples/Shift = 4.3

Assume sampling frequency = 10% of drums From Blaines mass balance, the feed to subsystem =

Total feed is (drums/hr) = 0.6

Assume continuous CWO process

Assume solids removal once/day

Waste transfer/recycle processes are continuous. Time is expected labor monitoring time Assume drums of liquid transferred from Rec and Prep

Assume paperwork is accomplished within times shown

lbs/hr

241.40

Table NT5-e

CWO Organic Destruction Subsystem for Soft Debris

,

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Task Subtask Cocurrence/ thit Units for Required for Transfer through air lock 24 drum 5 118 Orum Drum Drum Total T				1	Time	Total		Add'I/Time	Average
Task Subtask Shift Cocurrence Imit Shift Drum Drum Receive Wasie Transfer fruopial ni lock 24 drum 5 118 - - Total Task Stage drums for campaigns 24 drum 5 118 - - Feed Waste from drum Stage at feed bin (drums) 24 drum 3 71 - - Feed Scrow monitoring time 24 drum 3 71 - - Total Task Stage at feed bin (drums) 24 drum 15 348 - - Total Task Stage at feed bin (drums) 24 drum 10 240 - - - Total Task Stage at monitoring time 24 10 20 1 36 33 Feed waste to reactor Starup instrumentation and time/stape at mone time 30 30 - - - Feed waste to reactor Residum nitation (Equip chack) 1 30			Occurrence/	Units for	Required	Time /	FTEs	for Next	Minutes/Shift
Receive Wasts Transfer through air look 24 drum 15 118 Lender Lender <thlender< th=""> Lender <thlender< th=""></thlender<></thlender<>	Task	Subtask	Shift	Occurrence	(min)	Shift	Needed	Drum	Drum
Stage drums for campaigns 24 drum 5 116	Receive Waste	Transfer through air lock	24	drum	5	118			
Total Task Total T		Stage drums for campaigns	24	drum	5	118			
Total Task Total T					<u> </u>				
Feed Waste from drum Stage at tend bur (drums) 24 drum 3 71 Transfer device 24 drum 3 71	Total Task				10	237		10	15
Hock to transfer device 24 drum 3 71 Transfer infored bin (2-200 -	Feed Waste from drum	Stage at feed bin (drums)	24	drum	3			Ļ	
Transfer Transfer Intervention (2.30) . <t< td=""><td></td><td>Hook to transfer device</td><td>24</td><td>drum</td><td>3</td><td>71</td><td></td><td></td><td>L</td></t<>		Hook to transfer device	24	drum	3	71			L
Ibbr metering screws) 24 drum 15 348		Transfer into feed bin (2-300	-						
Feed screw monitoring time 24 10 240		lb/hr metering screws)	24	drum	15	348			
Empty drum bottoms 24 2 47 Sample feed vessel 2 10 20		Feed screw monitoring time	24		10	240			
Sample feed vessel 2 10 20 Total Task 36 520 1 36 33 Feed waste to reactor Startup Instrumentation and valve check 1 30 30		Empty drum bottoms	24		2	47			
Detach & remove drum 24 3 71		Sample feed vessel	2		10	20			
Total Task Startup Instrumentation and valve check 36 520 1 36 33 Feed waste to reactor Startup Instrumentation and valve check 1 30 30		Detach & remove drum	24	l.	3	71			
Feed waste to reactor Sartup instrumentation and valve check 1 30 30 1 Total Task Image: screw monitoring time 24 15 348 1 1 Total Task Instrumentation/Equip check 1 30 30 1 1 Total Task Instrumentation/Equip check 1 30 30 1 1 Total Task Reaction rate (see non calcs table): 1089 k/m in a 2500 gal vessel 24 drum 21 488 1 <td>Total Task</td> <td></td> <td></td> <td></td> <td>36</td> <td>520</td> <td>1</td> <td>36</td> <td>33</td>	Total Task				36	520	1	36	33
Feed waste to reactor value check 1 30 30		Startup Instrumentation and						<u>+</u>	
Meter waste to reactor (600 bb/tr) 24 15 348	Feed waste to reactor	valve check	1		30	30			
Ibsch Insch Insch <th< td=""><td></td><td>Meter waste to reactor (600</td><td>·</td><td>·</td><td></td><td></td><td></td><td></td><td></td></th<>		Meter waste to reactor (600	·	·					
Feed screw monitoring time 24 10 240 1 Total Task		lbe/br)	24		15	348			
Total Task 10 200 10 200 10 200 10 200 10 200 10 200 10 200 10 200 10 200 10 200 10 200 10 200 100 200 100 200		Feed screw monitoring time	24		10	240	·····	<u> </u>	
Total Task Instrumentation/Equip check 1 30 30 30 Operate reactor Instrumentation/Equip check 1 30		Teed screw monitoring diffe				240			
Operate reactor Instrumentation/Equip check 1 30 30 30 Reaction rate (see non calcs table): 1069 lb/hr in a 2500 gal vessel 24 drum 21 488	Total Task			<u> </u>	45	270	1	45	15
Reaction rate (see rxn calcs table): 1068 lb/n' in a 2500 24 drum 21 488 Total Task 51 518 1 51 21 Waste Transfer/ Recycle Waste removed from tank (pump 5 gpm) 24 times 2 48	Operate reactor	Instrumentation/Equip check	1		30	30			
table): 1069 lb/hr in a 2500 24 drum 21 488		Reaction rate (see rxn calcs							
gal vessel 24 drum 21 488		table): 1069 lb/hr in a 2500							
Total Task Vaste removed from tank (pump 5 gpm) 24 times 2 48 1 51 21 Waste Transfer/ Recycle Filter solution 24 times 2 48		gai vessel	24	drum	21	488			
Waste Transfer/ Recycle Waste removed from tank (pump 5 gpm) 24 times 2 48 Filter solution 24 times 2 48	Total Task				51	518	1	51	21
Waste Transfer/ Recycle (pump 5 gpm) 24 times 2 48 Filter solution 24 times 2 48		Waste removed from tank							1
Filter solution 24 times 2 48	Waste Transfer/ Recycle	(pump 5 gpm)	24	times	2	48			
Sample fibrate 2 times 15 30		Filter solution	24	times	2	48			
Recycle acids 24 times 2 48 Operate condenser 1 times 16 16		Sample filtrate	2	times	15	30		<u> </u>	
Operate condenser 1 times 16 16 Wash solution 24 times 2 48		Recycle acids	24	times	2	48		<u> </u>	1
Wash solution 24 times 2 48 Sample 2 times 15 30		Operate condenser	1	times	16	16			
Sample 2 times 15 30 Transfer @ 10 gpm to filter 237 drums 6 1302		Wash solution	24	times	2	48			
Transfer @ 10 gpm to filter 237 drums 6 1302		Sample	2	times	15	30			
Transfer @ 10 gpm from filter237-drums61302		Transfer @ 10 gpm to filter	237	drums	6	1302			
filter 237 -drums 6 1302 Total Task 65 268 1 65 Treat inorganics Transfer to neutralizer 24 2 48 Precipitate filtered solids 24 2 48 Filter precipitate 24 2 48 Filter precipitate 24 2 48 Transfer filtrate to Aq. Waste 24 2 48 Transfer precipitate 24 2 48 Transfer precipitate to Aq. Waste 24 2 48 Transfer precipitate solids to polymer 24 2 48 Collect sample 2 5 10 Total Task 15 250 1 15 FTEs/shift 15 250 1 15 Supervision Ratio of 1:10 10 0 1 Vac/sick/holiday relief Assume 6 wks of absence 1 2 2 Adjustmet for 70% Efficiency 2 2 15 20 Total/shift 1 7 221 15		Transfer @ 10 gpm from							
Total TaskImage: Transfer to neutralizer24248Image: Transfer to neutralizerTreat inorganicsTransfer to neutralizer24248Image: Transfer to neutralizer1mage: Transfer to neutralizer1mage: Transfer to neutralizer24248Image: Transfer to neutralizer1mage: Transfer to		filter	237	-drums	6	1302			
Treat inorganics Transfer to neutralizer 24 2 48 Precipitate filtered solids 24 2 48 Filter precipitate 24 2 48 Transfer filtrate to Aq. Waste 24 2 48 Transfer precipitate 24 2 48 Transfer filtrate to Aq. Waste 24 2 48 Transfer precipitate 24 2 48 Transfer precipitated solids to polymer 24 2 48 Collect sample 2 5 10 Total Task 15 250 1 15 FTEs/shift 4 4 4 Supervision Ratio of 1:10 0 1 Vac/sick/holiday relief Assume 6 wks of absence 1 1 Adjustmet for 70% Efficiency 2 2 15 Total/day 0 7 221 15	Total Task				65	268	1	65	
Precipitate filtered solids 24 2 48 Filter precipitate 24 2 48 Transfer filtrate to Aq. Waste 24 2 48 Transfer precipitated solids to polymer 24 2 48 Collect sample 2 5 10 Total Task 15 250 1 15 FTEs/shift 4 4 15 Supervision Ratio of 1:10 0 1 Vac/sick/holiday relief Assume 6 wks of absence 1 1 Adjustmet for 70% Efficiency 2 2 15 Total/shift 1 2 2	Treat inorganics	Transfer to neutralizer	24	<u> </u>	2	48			
Filter precipitate 24 2 48 Transfer filtrate to Aq. Waste 24 2 48 Transfer precipitate 24 2 48 Transfer precipitate solids to polymer 24 2 48 Collect sample 2 5 10 Total Task 15 250 1 15 FTEs/shift 4 15 10 Supervision Ratio of 1:10 0 0 Vac/sick/holiday relief Assume 6 wks of absence 1 1 Adjustment for 70% Efficiency 2 7 21 15		Precipitate filtered solids	24		2	48		+	1
Transfer filtrate to Aq. Waste 24 2 48 Transfer precipitated solids to polymer 24 2 48 Total Task 2 5 10 Total Task 15 250 1 15 FTEs/shift 15 250 1 15 Supervision Ratio of 1:10 0 1 1 Vac/sick/holiday relief Assume 6 wks of absence 1 1 1 Adjustmnet for 70% Efficiency 1 7 221 15		Filter precipitate	24		2	48			
Transfer filtrate to Aq. Waste24248Transfer precipitated solids to polymer24248Collect sample2510Total Task15250115FTEs/shift15250115SupervisionRatio of 1:10000Vac/sick/holiday reliefAssume 6 wks of absence122Adjustment for 70% Efficiency0221Total/Shift022115			<u> </u>						
Indicate to Fig. Waste 24 2 46 Transfer precipitated solids to polymer 24 2 48 Collect sample 2 5 10 Total Task 15 250 1 15 FTEs/shift 15 250 1 15 Supervision Ratio of 1:10 0 0 0 Vac/sick/holiday relief Assume 6 wks of absence 1 1 Adjustment for 70% Efficiency 2 7 221 15		Transfor filtrate to Ag Maste	24		2	40		1	
Infansier precipitated solids to polymer24248Collect sample2510		Transfer mudie to Aq. Waste	24	<u> </u>	<u> </u>	40		+	
Dolymer 24 2 40 10 <th< td=""><td></td><td>naminater precipitated solids to</td><td>24</td><td></td><td>2</td><td>40</td><td></td><td></td><td></td></th<>		naminater precipitated solids to	24		2	40			
Collect sample2510-Total Task15250115FTEs/shift15250115SupervisionRatio of 1:104-Vac/sick/holiday reliefAssume 6 wks of absence1-Adjustment for 70% Efficiency2-Total/shift-7221Total/shift21			24		- 2	40		<u> </u>	
Total Task 15 250 1 15 FTEs/shift 4 4 4 Supervision Ratio of 1:10 0 0			<u>_</u>		3	10			
FTEs/shift 4 Supervision Ratio of 1:10 0 Vac/sick/holiday relief Assume 6 wks of absence 1 Adjustment for 70% Efficiency 2 Total/shift 7 221	Total Task				15	250	1	15	
Supervision Ratio of 1:10 0 Vac/sick/holiday relief Assume 6 wks of absence 1 Adjustmet for 70% Efficiency 2 Total/shift 7 221 Total/day 21	FTEs/shift						4	l	
Vac/sick/holiday relief Assume 6 wks of absence 1 Adjustment for 70% Efficiency 2 Total/shift 7 221 Total/day 21	Supervision	Ratio of 1:10		1			0		
Vac/sick/holiday relief Assume 6 wks of absence 1 Adjustment for 70% Efficiency 2 Total/shift 7 221 Total/day 21									
Adjustmet for 70% Efficiency 2 Total/shift 7 221 15 Total/day 21 21 21	Vac/sick/holiday relief	Assume 6 wks of absence					1		
Total/shift 7 221 15	Adjustment for 70% Efficiency						2		
Total/day 21	Total/shift						7	221	15
	Total/day						21	1	+

Notes:

From Blaines mass balance, the feed to subsystem is Total feed is (drums/hr) = 3 Assume continuous process for CWO 435 lbs/hr

Assume solids removal once/day

Waste transfer/recycle processes are continuous. Time is expected labor monitoring time Number of process samples = 8

__Table NT5-f

Vacuum Thermal Desorption for Process Residue

		-		Time				Time/
Tel	Outstanle	Occurrence/	Linter	Required	Total Time/	FTEs	Minutes/	Add'l
l ask	Subtask	Shift	Units	(<u>min)</u>	Shift	Needed	Drum	Drum
Receive Waste	I ranster through air lock	25.4		5	12/			
х	Stage drums for campaigns	25.4		2	51	· · · · · · · · · · · · · · · · · · ·		
Total Task				7	178	0.37	7	2
Feed Waste from								
drum	Stage at feed bin (drums)	25.4		3	76			
	Hook to transfer device	25.4		3	76			
	Transfer into feed bin	25.4		5	127			
	Empty drum bottoms	25.4		2	51		1	
	Sample feed vessel	2.0		5	10			
	Detach & remove drum	25.4		3	76		1	
Total Task				16	200	0.60	16	5
Vocum Thormal	I Init is number of batches:		1	daumo/	230	0.00	10	ĭ
Decorption	batch is 15000 lbs or	467		hatch				
Description	Check equipment instrument	40.7		Datcii				
	before startun	0.5		20	16			
	Charge departer (15000	0.5			10			
	Unalge desorber (15000	05		60	22			
	Host deserber	0.5		60	33			
	Please bestel	0.5		00	33	<u> </u>	<u> </u>	
	Ceel deepther	0.5		00	33			
		0.5		30	16		h	
· · · · · · · · · · · ·	Discharge desorbed waste	0.5		15	8			
lotal lask			<u> </u>	225	122	0.26	225	
Monitor Offgas	Monitor cooler 1	24.0		1	24			
and the second	Monitor condenser 1	24.0		1	24	l		
	Monitor condenser 2	24.0		1	24		·	
	Monitor transfer lines to APC	24.0	<u> </u>	1	24			
Total Task		<u> </u>		4	96	0.20	0	0
	Sample holding vessel from							
Condensate handling	cond. 1	1.0		15	15			
	Sample holding vessel from							
	condenser 2	1.0		15	15			
	Transfer to aqueous waste		-					
	treatment	0.5		20	10		L	
	Transfer to mercury			1	1			
	amalgamation	0.5	1	20	10			
Total Task			1	70	50	0.10		
Separate described			+		+	0.10	+	
vaeta	Sample waste	0.5	hatah	5	3			
masle	Select dectination (acc note)	16.0	drume		16			<u> </u>
	Transfer waste to He loophing	10.2	daumo		10			
	Transfer waste to not mar atchi	4.0	daime		22			
Total Task	Transier waste to polymer stad	11.3	arums	10	23	0.11	10	8
Moroupu acat actida				10		0.11		
wercury cont. solids	Presson in sized for 4000 lbs/	of worth on a		habift				
reaching	riocess is sized for 1000 lbs/hi	or waste or 2	p arum				+	
	weasure leacning agent	0.2	arums	20	4			<u> </u>
	Leach waste	0.2		90	18	+		
	I ranster to wash 1	0.2		20	4			
1	vvasn	0.2		60	12	ļ		
	Sample	0.2	-	15	3			ļ
	I ranster to wash 2	0.2		20	4	+		
	Wash	0.2		60	12			<u> </u>
	Sample	0.2		15	3			
	Transfer to filter	0.2		20	4		ļ	
	Filter solids	0.2		30	6			ļ
	Sample/evaluate	0.2		30	6			
	Transfer liquid to aqueous was	0.2		10	2			ļ
	Transfer solid to polymer	0.2		10	2			
Total Task				400	78	0.16	84	0

Table NT5-f

Vacuum Thermal Desorption for Process Residue

		Occurrence/		Time Required	Total Time/	FTEs	Minutes/	Time/ Add'l
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
Leachate/ filtrate								
Ttreatment	Transfer leachate to mercury re	0.2		20	4			
	Transfer rinse waste water to m	0.2		20	4			
	Mercury reduction over steel w	0.2		60	12			
	Sample	0.2		15	3			
	Transfer to mercury ppt	0.2		20	4			
	Sample	0.2		15	3			
	Add precipitation agents	0.2		15	3			
	Settle tank	0.2		60	12			
	Sample solids	0.2		15	3			
	Transfer solids to polymer	0.2		10	2			
	Transfer liquid to iodine recover	0.2		10	2			
	Add chemicals (H2SO4, H2O2	0.2		15	3			
	Reaction	0.2		30	6			
	Recover iodine	0.2		60	12			
	Transfer solids	0.2		20	4			
	Transfer liquid to wash 2	0.2		10	2			
Total Task				395	77	0.16	83	0
FTEs/shift					0	1.96	425	15
Supervision	Ratio of 1:10					0.20		
Vac/sick/holiday relief	Assume 6 wks of absence					0.25		
Total/shift			1			2.41	425	15
Adjustment for 70%								
efficiency						3.44		
Total/day						10.32		

Notes:

Thermal Desorption Batch size of 15,000 lbs

Assume drum transfer of 15 min/drum or 0.5 ft3/min

Only 0.6 batches required per shift based on feed to subsystem

The condenser/aqueous transfer monitoring functions will occur when the desorber is running

Number of drums following treatment is based on the 5/30 mass balance: 1020 lbs/hr in and 648 lbs/hr out Assume 30% of the waste goes to mercury leaching process

Mercury leaching process was sized for 1000 lbs/hr of waste (@ 321 lbs/drum thisconverts to 25 drums/shift) Number of process samples = 5.7

Table NT5-g

Aqueous Waste Treatment Subsystem

				Time			1	Time/
		Occurrence/		Required	Total Time/	FTEs	Minutes/	Add'i
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
Receive Waste	Transfer through air lock	1	drum	5	7			
	Feed waste from drum	1	drum	3	4			1
- · · ·	Hook to transfer device	1	drum	3	4			
	Transfer to tank (10 gpm)	1	drum	6	8			
	Empty drum bottoms	1		2	3			
	Sample feed vessel	2		10	20			
	Detach & remove drum	1		3	4			
	Sample waste from processes:	·····		1			1	
	CWO, Desorb, Decon, APC	4	N/A				1	Į
	Arrange for transfer	33	drum	2	49		1	
Total Task				33	100	0.21	33	5
				Γ			Ţ	
Preliminary Treatment	Sample high TDS tank	28	drums	15	42			
	Sample low TDS tank	6	drums	15	9			
	Sample TOC waste	0	drums	15	0			
	Select treatment methods (10							
	drum batch)	6	drums	20	12			
	Transfer organic waste to oil			1			1	
	water separator	0	drums	3	0		1	
	Filter high, low TDS and organic							Į.
	waste (say 10 gal/min)	34	drums	6	188			
	Neutralize/ppt high TDS waste	28	drums	11	309		1	1
	Settle precipitated aqueous			T				ļ
	waste	28	drums	6	154			
	Evaporate solids	1	drums	6	8			
Total Task				90	715	<u> </u>	90	
UV Oxidation	CaSO4 ppt (10 gpm)	34	drums	11	376			
	Centrifuge (10 gpm)	34	drums	11	376			<u> </u>
•	sample waste	3	drums	15	51	·	ļ	
	Adjust UV oxidation (30 min/10						1	
	drums)	34	drums	3	103			
	Process through UV oxidation							
	(50 gpm)	34	drums	1	38		·	
	Carbon filtration (10 gpm)	34	drums	6	188			<u> </u>
	lon exchange (10 gpm)	34	drums	6	188			<u> </u>
	Sample waste before discharge	3		30				1
Total Task 3			با من از روان ا	52	1321	2.75	52	
lotal per shift					0	4.45	175	26
Supervision	Ratio of 1:10					0.44		
Vac/sick/holidav relief	Assume 6 wks of absence					0.56		
Adjustment for 70%				1			1	1
efficiency						7.80		
Total per day						23.39	1	1170

28.08 Assume high TDS waste comes from RCPRP, org destruction, soil treatment, debris treatment, drums/shift and metal decon. ibs/hr 0.11 drums/shift Assume waste from polymer, APC is low TDS 6.40 drums/shift 349.60 lbs/hr 6.13 Assume waste from process residue is organic liq Assume waste from RCPRP is organic liq Total drums per hour= 34.32

Assume tank batches are 550 gallons (10 drums)

Assume treatment selection time is required for 10 drum batches.

Assume residence time in oil water separator is 1 hour and tank is 1000 gallons (16 gpm)

Assume filtration, centrifuge and ppt rates are 10 gpm.

Assume solids to evaporator are 5% of incoming waste; assume drying rate is 10 gpm

41.6

Assume UV oxidation unit is 50 gpm

Number of process sample

_Table NT5-h

Aqueous Wash for Soil

		+		Time	Total			
		Occurrence/		Required	Time/	FTEs	Minutes/	Time/ Add'l
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
Soil Receiving	Transfer through air lock	5.4	drums	5	27			
Total Task				5	27	0.06	5	5
Feed Waste from			<u> </u>					
drum	Stage at feed bin (drums)	5.4	drums	3	16			
	Hook to transfer device	5.4	drums	3	16			1
	Transfer into feed bin							
	(metering screw)	5.4	drums	5	27			
	Feed screw monitoring time		drums					
	Empty drum bottoms	5.4	drums	2	11			
	Sample feed vessel	2.0	drums	5	10			
	Detach & remove drum	5.4	drums	3	16			
Total Task				16	96	0.20	16	13
Wash Water Prep	Sample wash water	0.5	drums	5	3	T T		
	Adjust Water Volume	0.5	drums	10	5			
	Adjust surfactant	0.5	drums	10	5			
Total Task				25	13	0.03	25	
Washing Process	Add waste to tank	16.1	drums	5	80			
Ŭ	Wash waste (1200 lbs/hr)	16.1	drums	25	N/A			
	Transfer waste and water from							
	tank	80.4	drums	6	442			
	Monitor tank	24.0	times	5	120			
Total Task				30	120	0.25	30	25
Pre-Rinse and	Screening (10 gpm) (most of							
Rinse	water leaves process here)	80.4	drums	2	_126			
	Hydrocyclone (10 gpm)	32.2	drums	6	177			
	Transfer to rinse contactor	32.2	drums	6	177			
•	Rinse contactor (2000 lbs/hr)	32.2	drums	15	475			
	Transfer to dryer (2x vol of soil)	32.2	drums	2	51			
•	Drying @4 drums/hr	32.2	drums	15	482			
-	Monitor operations	24.0	times	5	120			
	Collect samples	16.0	times	5	80			
Total Task				42	200	0.42	42	15
Recycle Processes	These are all monitoring times				0			
	Solubility Reduction	8.0	times	5	40			
	Additive Adjustment	8.0	times	5	40			
	Transfer to Wash Tank	16.0	times	2	32			
	Transfer to Ultrafiltration	8.0	times	2	16			
	Ultrafiltration	24.0	times	5	120			
	Dissolved Air Flotation	8.0	times	5	40		ļ	
	Surfactant Separation	24.0	times	5	120	<u> </u>		<u></u>
	Additive Adjustment	8.0	times	5	40	<u> </u>	·	
	Steam stripping	8.0	times	5	40			
	I ransfer recycled surfactant	8.0	times	5	40			
	Transfer waste to organic			-				
	destruction	8.0	times	5	40			
	Collect complex	8.0	times	5	40			
Total Task	Collect samples	24.0	umes	5	720	1.50		
TOTAL LASK			1	59	128	1.52		

-
Jable NT5-h Aqueous Wash for Soil

	· ·	-		Time	Total			
		Occurrence/		Required	Time/	FTEs	Minutes/	Time/ Add'l
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
Total FTEs/day= FT	Es per shift					2.47		
Supervision	Ratio of 1:10					0.25	118	15
Vac/sick/holiday								
relief	Assume 6 wks of absence		· · · ·			0.31		
Total/shift						3.03		
Adjustment for								
70% Efficiency						4.32		
Total/day						4.32		

Notes:

Sample wash water every 10 drums Assume drum transfer of 15 min/drum or .5 ft3/min

System designed for 1 shift not 3

Residence time in wash tank based on 4x wt of water to feed

Wash tank is 700 gal (12 drums); residence time per drum = 358.21 min

Assume transfer rates are 10 gpm; this includes both waste and rinse or wash water Waste to screening includes water in tank (4x input volume)

Waste to rinse contactor and hydrocyclone assumes 1:1 soil to water (2x input volume)

Rinse tank has 1300 gallons of water and soil. Residence time = 705.56

Drying: assume 1 hr drying time,2000 lbs/hr (4 drums/hr)

For purposes of processing time, recycle is not included, as these are not soil treatment No. of samples = 40.5

Table NT5-i High

High Pressure Wash for Open Debris

	· ·			Time				Time/
		Occurrence/		Required	Total Time/	FTEs	Minutes/	Add'l
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
Debris Receiving	Transfer through air lock	3.5	drums	5	18			
Debris Receiving	Transfer through air lock	3.5	drums	5	18			
_	Stage drums for campaigns	3.5	drums	15	53			
Total Task				20	70	0.15	20	15
Feed Waste from		1				• • • • • • • • •		
drum	Stage at feed bin (drums)	3.5	drums	3	11			
	Hook to transfer device	3.5	drums	3	11			
	Transfer into feed bin (metering							
	screw)	3.5	drums	15	53			
	Empty drum bottoms	3.5	drums	2	7			
	Sample feed vessel	0.4	drums	10	4			
	Detach & remove drum	3.5	drums	3	11			
Total Task		1		36	95	0.20	36	23
Wash Water Prep	Sample wash water	0.4	drums	5	2			
	Adjust Water Volume	0.4	drums	10	4			
	Adjust surfactant	0.4	drums	10	4			
Total Task				25	9	0.02	25	
Washing Process	Check out Equipment	1.0	times	30	30			
See notes; based								
on 16 drum batch	Wash/ rinse waste	3.5	drums	17	N/A			
	Transfer water from tank	3.5	drums	28	97			
	Monitor tank	24.0	times	5	120			
	Collect Samples	3.0	times	5	15			
	Remove waste from tank	3.5	drums	15	53			15
Total Task				84 _	262	0.55	84	
Total per shift						0.91	165	
Supervision	Ratio of 1:10					0.09		
Vac/sick/holiday					· · ·			
relief	Assume 6 wks of absence					0.12		
Total/shift						1.11		
Adjustment for 70%								
efficiency						1.59		
Total/day		4				4.78		
Total FTEs						4.78		

Notes:

Sample wash water every 10 drums Assume drum transfer of 15 min/drum or .5 cu ft/min Batch size is 1 to 2 tons; say 3000 lbs or 16 drums Residence time in wash tank based on 3 stages, 90 minutes each Assume transfer rates are 10 gpm; this includes both waste and rinse or wash water Assume water volume is roughly 5x waste volume

-Table NT5-j Metal Decontamination Subsystem

				Time				
Test	Quilitératio	Occurrence/	1.1	Required	I otal Time/	FIES	Minutes/	Time/ Add'l
lask	Subtask	Snift	Units	(<u>min)</u>	Shift	Needed	Drum	Drum
Metals Receiving/								
Feed Prep	Transfer through air lock	15.8	drums	5	79			
Total Task				5	79	0.2	5	0
Waste Decon	Stage containers	15.8	drum	5	79			
	Decon waste	15.8	drum	10	158			
	Assay for recycle	15.8	drum	30	475		1	
	Repack in drums	15.8	drum	15	238			
	Close drum lid	15.8	drum	15	238			
	Stage drums	15.8	drum	5	79			-
	Monitor recirc filtration and							
	fugitive dust system	24.0	times	6	144			1
Total Task				86	1411	2.9	86	
Total FTEs/shift						3.1	91	
Supervision	Ratio of 1:10					0.3		
Vac/sick/holiday								
relief	Assume 6 wks of absence					0.4	1	ł
Total/shift						3.8		
Adjustment for				1				
70% efficiency						5.4		
Total/day						16.3		

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Notes:

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Assume 50% of waste must be size reduced. Assume 60 min/drum for cutting

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Table NT5-k Lead Recovery

		Occurrenced		Time	Total Time/	ETE	Minutoo/	Time/ Add!
Task	Subtask	Shift	1 Inite	(min)	Shift	Needed	Drum	
l ead		Oran	Onito		<u> </u>	necucu	Didin	Diam
Receiving/Feed							1	
Prep	Transfer through air lock	0.24	drums	5	1			
	Glove box separation of							
	sheet lead and gloves	0.24	drums	60 _	14	1		
	Stage at decon	0.24	drums	10	2			
Total Task				75	18	0.04	75	
Waste Decon	Stage containers	0.24	drum	5	1			
	Decon waste	0.24	drum	10	2	_		
	Assay for recycle	0.24	drum	30	7			
	Repack in drums	0.24	drum	15	4			
	Close drum lid	0.24	drum	15	4			
	Stage drums	0.24	drum	5	1			
	Monitor recirc filtration	24.00	times	6	144			
Total Task	and lugitive dust system	24.00	unco	86	163	0.34	86	30
Total FTEs/shift						0.38	. 161	
Supervision	Ratio of 1:10					0.04		
Vac/sick/holiday relief	Assume 6 wks of absence					0.05		
Total/shift						0.46		
Adjustment for								
70% efficiency						0.66		
Total/day						1.98		

Notes:

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Assume assay for all drums @ 30 min/drum

Table NT5-I Mercury Amalgamation

		•		Time				Time/
		Occurrence/	-	Required	Total	FTEs	Minutes/	Add'l
Task	Subtask	Shift	Units	(min)	Time/ Shift	Needed	Drum	Drum
Metals Receiving/		1						
Feed Prep			ļ					
	Transfer through air lock	0.02	drums	5	0			
	Transfer lig mercury to tank	0.02	drums	60	1			
	Transfer steel wool w/ Hg to	*~						
·	holding bin	0.001	drums	10	0			
Total Task				75	1	0.00	75	60
Mercury								
Amalgamation								
	Inspect equipment	1.00	time	30				
	Transfer liq mercury to							
	amalgamater (1 gpm)	0.02	drum	55	1	-		
	Measure additives	0.02	drum	30	1			
	Transfer steel wool to							
	amalgamater	0.02	drum	20	0			
	Batch amalgamation	0.02	drum	120	3			120
	Transfer out of amalgamater	0.02	drum	55	1			
	Stage	0.02	drum	5	0			
	Place at assay	0.02	drum	5	0			
	Assay	0.02	drum	20	0			
	Remove from assay	0.02	drum	2	0		· ·	
Total Task				312	7	0.01	312	120
Total FTEs/shift		1			1	0.02	387	
Supervision	Ratio of 1:10					0.00		
Vac/sick/holiday								
relief	Assume 6 wks of absence					0.00		
Total/shift						0.02		
Adjustment for								
70% efficiency			-			0.03		
Total/day						0.09		

Notes:

Volume of steel wool: assume 3x vol of steel to mercury Assume 5% of mercury is in residue (this should be conservative; 5% of mercury is assumed to be in debris, not process residue) Total volume of mercury in study is 2.5 + 0.1 lbs/hr. Therefore volume of steel wool w/mercury = 0.020 lbs/hr

0.020 lbs/hr 0.001 drums/shift

Batch size for amalgamater: Assume 1 drum/batch, 2 hrs /batch

_Table NT5-m

Task	Subtack	Occurrence/	Lipito	Time Required	Total	FTEs	Minutes/	Time/ Add'l
Idok	Sublask	Shint	Onits	(11111)		Needeo		Dium
Special								
Receiving/Feed Prep	Transfer through air lock	5.4	drums	5	27			
	Glove box preparation of	51	drume	60	326			
	Stage waste	5.4	drume		16	·····		
Total Task	Clage Waste	<u> </u>	urums	69	270	0.77	69	60
Waste Treatment	Stage containers	51	drum	3	16	0.77	00	0
vvasio ricatiliciti	Tract waste as energial	<u> </u>	ulum		10			
	processes TBD	5.4	drum	60	326			
	Sample treated waste	5.4	drum	15	82			
	Repack in drums	5.4	drum	30	163			
	Close drum lid	5.4	drum	3	16			
× 1	Stage drums	5.4	drum	3	16			
Total Task				114	620	1.29	114	60
Total FTEs/shift					· · · · ·	2.06	182	
Supervision	Ratio of 1:10					0.21		
Vac/sick/holiday	Assume 6 wks of							
relief	absence					0.26		
Total/shift						2.53		
Adjustment for 70%								
efficiency						3.62		
Total/day						10.85		-

Notes:

Assume all waste is prepared in glove box Assume waste is treated in various batch processes that average 2 hours/drum TBD=To be determined

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-Table NT5-n

Grout Stabilization Subsystem

		•		Time		· ·		
		Occurrence/		Required	Total Time/	FTEs	Minutes/	Time/ Add'l
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
Waste Receiving/								
Feed Prep	Transfer through air lock	15.1	drums	5	76			ļ.
	Sample waste	1.5	drums	15	23			
	Select process for waste	15.1	drums	5	76			
	Transfer to							
	macroencapsulation	78	drums	2	16			
	Transfer to		dianto					
	microencansulation	74	drume	2	15			
	Stage at process	15.1	drume	2	30		1	
Total Task		10.1	GIUIIIS	21	234	0.40	31	5
	Г			- 31	234	0.43		
Masta Enconculation	Measure hinder	15.1	drum	5	76			
Wasie Elicapsulation	Mix binder	15.1	drum	5	76			
	Combine with wests	15.1	drum	10	161			
	Combine with waste	15.1	drum	10	151			
	Repack in drums	10.1	arum	2	10		ļ	
		15.1	arum	3	45		<u> </u>	
	Stage pallets	15.1	arum	2	30		 	
	Monitor activated carbon							
	and fugitive dust system	2.0	times	6	12		<u> </u>	
Total Task				36	466	0.97	36	10
	Move pallets to curing							
Binder setup time	area	15.1	drum	2	30			
	Curing time	15.1	drum		0			
	Sample	1.5	drum	15	23			
•	Monitor curing process	15.1	drum	10	151			
	Move pallets from curing							
	area	15.1	times	2	30			
Total Took			_	20	224	0.40	20	5
Drum Decen		4.5		5	234	0.43	23	
Drum Decon	Stage containers	1.0	arum	5 F	0		<u> </u>	
	Decendration	1.5	arum	5	0			
	Decon drums	1.5	arum	10	15			
	Assay drums	1.5	arum	10				
		1.5	arum	2	8			
· · · · · · · · · · · · · · · · · · ·	Palleuze drums	1.5	arum	2	3			
	Stage drums	1.5	arum	5	8			<u> </u>
			ļ					
Total Task				47	71	0.15	47	15
Total FTEs/shift						2.09	143	
Supervision	Ratio of 1:10	· ·	[[0.21		
Vac/sick/holiday	Assume 6 wks of							
relief	absence					0.27		
Total/shift						2.57		
Adjustment for 70%								
Efficiency						3.67		
Total/day						11.01		

Notes:

Assume all complex debris (8 drums) will be sent to macroencapsulation, rest to micro.

Assume 10% of drums are deconned.

Assume 10% of drums are assayed

Assume mixing requires 30 min/drum

No. of samples 1.5

-Table NT5-0

Polymer Stabilization Subsystem

			1	Time				Time/
		Occurrence		Required	Total Time/	FTE	Minutes/	
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
	Gubtuan		01110		<u> </u>	1100000	Orani	Diam
Waste	Transfer through air							
Receiving/Feed Prep	lock	28.1	drums	5	140			
,	Sample waste	2.8	drums	15	42			
	Evaluate dryness	2.8	drums	5	14			
	Dry waste	11.4	drums	30	N/A			
	Monitor drying	24.0	times	10	240			
	Stage at process	28.1	drums	2	56	·		
Total Task				57	493	1.03	57	30
Encapsulation	Measure polymer	28.1	drum	5	140			
	Mix polymer	28.1	drum	10	281			
	Combine with waste in		aran					
	extruder	28.1	drum	10	281			
	Repack in drums	24.0	drum	5	120			
	Close drum lid	28.1	drum	3	84			
	Palletize drums	28.1	drum	2	56	·		
	Stage drums	24.0	drum	2	48			
	Monitor activated	24.0	aran	<u> </u>			· · · · · ·	
	carbon and fugitive dust							
	system	80	times	6	48			
Total Task	oyotom	0.0	annos	43	1058	2 21	43	60
	Move pallets to curing	1						
Binder setup time	area	24 0	drum	5	120			
	Curing time	24.0	drum		0			
	Sample	24		15	36			
	Monitor curing	24.0	drum	10	240			
	Move pallets from	27.0	Giulii					
	curing area	24.0	timés	5	120			
Total Task		24.0	timos	35	516	1 08	35	5
Drum Decon	Stage containers	28.1	drum	5	140			
Bruin Booon	Load conveyors	28.1	drum	5	140			
	Decon drums	28.1	drum	10	281			
	Assav drums	28.1	drum	15	421			
	Linioad conveyers	28.1	drum	5	140			
	Stage drums	28.1	drum	5	140			
Total Task		20.1	Gium	45	1264	2.63	45	60
Total FTEs/shift					1204	6.94	180	
Supervision	Ratio of 1.10	<u></u>				0.69	100	
Vac/sick/boliday	Assumo 6 wks of				<u> </u>	0.00	<u>├</u>	
relief	absence					0.88		
Total/shift						8.51		
Adjustment for 70%					<u> </u>	0.01		
Efficiency						12 16		
Total/day						36.40	t	
iolanuay		I	1	1	1	00.70	1	

Notes:

Assume 30% of process residue waste and 100% of other waste requires drying Assume dryer can accept waste at the rate of 2 drums/hour No. of samples = 2.4

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--Table NT5-p Air Pollution Control Subsystem

		-)	· · · · · · · · · · · · · · · · · · ·	Time		-	
		Occurrence/		Required	Total Time/	FTEs	
Task	Subtask	Shift	Units	(min)	Shift	Needed	Minutes/ Ib
Monitor Equipment	Dry filtration	4	times	10	40		
	HEPA filter	4	times	5	20		
	GPCR	24	times	2	48		
	Acid gas scrubber	12	times	10	120		
	Mist eliminator	4	times	2	8		
	GAC	4	times	2	8		
	Mersorb	4	times	2	8		
	Offgas monitor	24	times	5	120		
Total Task				38	372	0.8	0
Supervision	Ratio of 1:10			<u> </u>		0.1	
	Assume 6 wks of						
Vac/sick/holiday relief	absence					0.1	
Total/shift						1.0	
Adjustment for 70%							
Efficiency				L		1.4	
Total/day						4.1	

.

__Table NT5-q

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Certification and Shipping

		-		Time				
		Occurrence/		Required	Total Time/	FTEs	Minutes/	Time/ Add'l
Task	Subtask	Shift	Units	(min)	Shift	Needed	Drum	Drum
Waste Receiving	Transfer through air lock	43.9	drums	5	220		1	
	Sample waste	4.4	drums	15	66			
	Resample waste	0.4	drums	15	7			
	Stage waste	43.9	drums	5	220			
Total Task				40	512	1.07	40	15
Waste Assay	Stage pallets	43.9	drum	3	132			
_	Load on conveyor	43.9	drum	1	44			
	Assay RTR	43.9	drum	15	659			
	Assay gamma	43.9	drum	60	2635			
· · ·	Assay PAN	43.9	drum	60	2635			
	Remove from conveyor	43.9	drum	1	44			
	Repalletize	43.9	drum	3	132			
	Stage pallets after							
	assaying	43.9	drum	15	659		l	
Total Task				158	6939	14.46	158	60
Stage waste	Stage uncertified waste	43.9	drum	3	132	_		
	Transfer waste	43.9	drum	3	132			
	Stage certified waste	43.9	drum	3	132			
-	Transfer waste	43.9	drum	3	132			
Total Task				12	527	1.10	12	L
Ship Waste Truck	Truck docking	0.5	truck	30	15			
	Settle Paperwork	0.5	truck	120	60			
	Load truck	0.5	truck	60	30			
	Truck leaving	0.5	truck	60	_30			
Total Task				270	135	0.28	12	
Total FTEs/shift						16.90	222	
Supervision	Ratio of 1:10					1.69		
	Assume 6 wks of							
Vac/sick/holiday relief	absence					2.15		
Total/shift						20.74		
Adjustment for 70%								
Efficiency						29.62		
Total/day						88.87		

Notes:

Assume 10% of waste require sampling Samples collected = 4.4 -Table NT5-r

Summary of FTEs & Time for a Single Drum to Pass Through a System

		•		Add'l Time	Time/Drums	
		Time (min)/		for Next	Received in a	
	Daily FTEs	Single Drum	Time (hrs)	Drum	Shift (min)	Time (hrs)
Administration	57.9	N/A				
			-			
Receiving /Inspection Tasks						
common for all waste	· · · · · · · · · · · · · · · · · · ·	802	13	60	3728	62
Receiving and Prep-CWO	2 	0	0		0	0
Receiving and Prep-soft		229	4	45	1250	21
Receiving and Prep-residue		229	4	45	1329	22
Receiving and Prep-soil		229	4	45	425	7
Receiving and Prep-debris		289	5	5	340	6
Receiving and Prep-lead		557	9	315	557	9
Receiving and Prep-mercury		516	9	315	516	9
Receiving and Prep-special		516	9	315	1915	32
Receiving and Prep-metal decon		229	4	35	554	9
Receiving and Prep	191.9	676.2	11			0
Aqueous Waste	23.4	175	3	36	1375	23
Organic Destruction	10.6	206	3	34	325	5
	40.0			~~~~	4000	40
Vacuum Inermai Desorption	10.3	425	/	20	1060	18
Soli Treatment	4.3	118	2	15	183	3
Soft Debris	20.6	221	4	33	962	16
Open Debris	4.8	165	3	23	223	4
Metal Decon	16.3	91	2	75	1204	20
Lead	2.0	161	- 3	N/A	161	3
Mercury	0.1	387.0	6.45	N/A	387	6
Special	10.8	182.0	3	60.0	448	7
Grout	11.0	143	2	10	284	5
Polymer	36.5	180	3	60	1805	30
APC	4.1	372	6		372	6
Certification and Shipping	88,9	222	4	60	2797	47
,						
Total	493.5	<u></u>				

Notes:

Allocation of receiving and preparation time was done as follows: Average time per drum was estimated, multiplied by the number of drums per shift. The time for each waste type was allocated according its percentage of total waste.

APPENDIX B

SureTrak Modeling Assumptions

SureTrak Modeling Assumptions

The Gant charts (Figures 1 through 5) were developed with SureTrak software and are based on the summary tables A1-p, C1-m, NT2-o, NT3-p and NT5-r. Figures A1, C1, NT2, NT3 and NT5 use the following bases:

- 1) Receiving and Preparation is divided into multiple steps.
- 2) All waste is processed through Receive and Assay.
- 3) Following Receive and Assay, sorting or other feed preparation is performed. Since this is different based on waste type, a preparation stage is included for all nonliquid feed.
- Successors to Receive and Assay are on a finish-to-finish basis. Feed preparation cannot end before all waste is assayed; a lag time required to process a drum though feed preparation is inserted.
- 5) Successors to Receive and Assay are also on a start-to-start basis. Some waste can be treated at feed preparation before all waste is received. However, no waste can be treated before at least one drum has been processed through Receive and Assay. A start-to-start lag is required to process one drum though Receive and Assay.
- 6) Successors to processing systems are all modeled as both finish-to-finish and start-to-start.
- 7) Lead recovery and mercury amalgamation are modeled on a finish-to-finish basis only. This allows waste to be received at Certification and Shipping before these processes have treated a single drum. These small volume processes would otherwise delay the start of certification and shipping which is not representative of anticipated operations.