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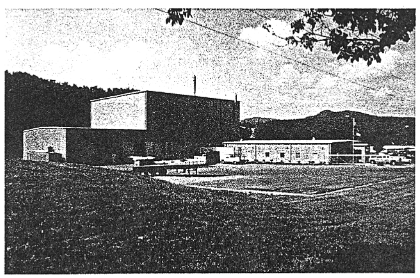
HLW & FD

EIS PROJECT - AR/PF
Control # DC-57

Idaho High-Level Waste and Facilities Disposition Draft Environmental Impact Statement (DOE/EIS-0287D)

RECEIVED APR 14 2000

Studsvik, Inc. Comments



Studsvik's Fluid Bed/Steam Reforming Processing Facility
Erwin, TN

April 12, 2000

Studsvik, Inc.
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Columbia, SC 29210

ORIGINAL

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April 12, 2000
2K067L

Mr. T.L. Wichmann
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Idaho Falls, ID 83401-1563

Ms. Ann Dold
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State of Idaho INEEL Oversight Program
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Subject: **Studsvik's Comments on the Idaho High-Level Waste and Facilities Disposition Draft Environmental Impact Statement (DOE/EIS-0287D)**

Dear Mr. Wichmann:

57-1 III.D.4(4) **Studsvik is requesting that the subject EIS provide recognition of newly commercialized "non-separation" technologies, such as Studsvik's patented THOR^{sm} pyrolysis/steam reforming fluid bed system, which is presently operational on a large-scale basis in the commercial nuclear power market.**

Steam Reforming Technology as deployed by Studsvik in a fluid bed can offer:

- Non-Incineration Thermal Treatment
- Thermal treatment of SBW without the problems encountered with typical incinerators or the presently operated calciner.
  - Direct conversion of nitrates to nitrogen in the fluid bed without the resultant NOx emission problems.
  - Reduced operating temperatures, eliminating the need for bulky additives to prevent molten alkali metal salt agglomerations.
  - Elutriating operation to prevent the build up of waste salts in the fluid bed.
  - Low gas flow processing for simplified off-gas control.

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Mr. T.L. Wichmann / Ms. Ann Dold
April 12, 2000
Draft EIS Comments, Page 2

- Reduced Overall Waste Processing Cost and Schedule
  - Duplication of existing full-scale, commercialized equipment already active in the nuclear marketplace.
  - Flexible Processing System
    - Input of liquid, slurry, solid, or gaseous nitrate and organic wastes.
    - Applicable to processing SBW, Low-Level Mixed Waste, gaseous NOx emissions and others.
- Inert, easy to handle final product that can be packaged for shipment to a final waste depository, or stored at INEEL
- Potential for replacement of the incinerator systems originally considered for the AMWTP

Studsvik recognizes that the EIS process has been very thorough and we do not desire to interject any new processing approaches that would delay the accomplishment of the INEEL waste cleanup mission. However, we feel that it should recognize technologies that have been commercialized in the private sector since the technical review activities for this EIS were completed. We regret that we have not brought this technology to your attention before this date, however, our total focus has been on the construction and operation of our processing facility in Erwin, TN. The Erwin facility focuses on the processing of high activity (up to 100 R/hr, beta/gamma activity) ion exchange resins produced by the commercial nuclear power stations. With this effort in full operation, we are now turning our attention to the needs of the DOE community. Attachment One provides a description of our technology and its deployment at the Studsvik Processing Facility.

<u>Overview</u>

Studsvik's patented THOR℠ pyrolysis/steam reforming technology is presently deployed for the destruction of water slurries of high specific activity ion exchange resins (up to 100 R/hr beta/gamma). The THOR℠ steam reformer in operation in Erwin, TN can continuously process over 500 kg/hr of slurry waste feed. The technology has been proven to be able to process nitrate bearing wastes by converting the nitrates directly to nitrogen without the associated NOx off-gas emissions typically present with other thermal conversion processes. The system can input either a wet, sodium bearing (high nitrate) waste slurry or solids.

Other adaptations of the technology can be utilized for processing of high NOx off-gas streams. By utilization of the THOR℠ technology, expensive NOx off-gas conditioning units can be avoided. Additionally, and of significant importance, is the fact that the primary THOR℠ technology, steam reforming, exhibits none of the attributes of an incinerator and in fact has been classified by DOE as an "alternative to incineration".

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Mr. T.L. Wichmann / Ms. Ann Dold
April 12, 2000
Draft EIS Comments, Page 3

The EIS (EIS Page No. F-2) indicates that the it has been developed in part to facilitate negotiations required by the Settlement Agreement.

> *"Because of technology developments and changes needed in existing treatment facilities to properly manage sodium-bearing waste, Idaho agreed with DOE that an EIS could facilitate negotiations required by the Settlement Agreement."*

It is within the scope of "technology developments", as referenced above, that these comments are submitted. We feel that the patented THOR℠ technology is directly applicable to the processing of many of the waste streams at INEEL and is in fact superior in some aspects to the technologies specifically mentioned in the EIS. Comments to the EIS would have been made at an earlier date, however, full-scale commercial deployment of the THOR℠ process did not commence until July 1999. Routine operations were established in December 1999 and over 8,000 ft^3 of radioactive waste was processed through March 2000. This fully demonstrates the large-scale application of the technology.

<u>Alternative to Incineration</u>

In 1997, the Mixed Waste Focus Group, completed an evaluation of Nonflame technologies to be utilized for an alternative to incineration for mixed waste processing. The final report from that effort, Evaluation of Alternative Nonflame Technologies for Destruction of Hazardous Organic Waste, INEL/EXT-97-00123 of April 1997 specifically listed the advantages of steam reforming for processing organic mixed wastes. <u>In fact, steam reforming was listed as the recommended process</u>. Studsvik's unique pyrolysis/steam reforming fluid bed system can not only process organic wastes, but has proven to be highly effective at processing liquid and solid nitrate waste streams. The unique operating modes for nitrate conversion using the THOR℠ steam reformer are subjects of pending patents.

<u>Comparison to Existing Calciner Technology</u>

Studsvik is requesting that the subject EIS provide recognition of newly commercialized "non-separation" technologies, such as Studsvik's patented THOR℠ pyrolysis/steam reforming fluid bed system. This technology had its genesis in fluid bed technology for biomass gasification utilizing auto-thermal steam reforming, but is truly a next generation design which offers the following advantages over the existing INTEC calciner:

1. Reformer has significantly reduced off-gas volume of $1/8^{th}$ to $1/20^{th}$ of the off-gas volume of the current calciner.
2. Reformer has gaseous NOx emissions that meet MACT standard without addition of gaseous de-NOx unit. Nitrates are fully converted to N_2 in the reformer fluid bed. Reformer has estimated NOx emissions at $1/1{,}000^{th}$ of those emitted from current calciner.

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Mr. T.L. Wichmann / Ms. Ann Dold
April 12, 2000
Draft EIS Comments, Page 4

3. Reformer minimizes use of additives to prevent agglomerations. Low temperature operation minimizes or eliminates the need for additives to prevent alkali metal compounds from melting in the bed. This also significantly reduces the final volume of the end product.
4. Reformer provides high conversion of nitrates to nitrogen and minimizes or eliminates the presence of nitrates in the high sodium end product.
5. Reformer has lower Cs volatility than high temperature units operating over 600 °C.
6. Efficient mercury recovery unit can be easily utilized in the off-gas from the reformer.
7. Construction labor to build new plant is estimated to be 2 times that required for performing continued current operations modifications of adding a de-NOx unit to existing calciner off-gas system. The new reformer plant could be designed and built to meet the same schedule as estimated to modify the existing calciner.

In addition to improvements directly related to utilization of the existing calciner, the fluid bed reformer has other significant advantages:

1. Potentially eliminate the use of the INTEC evaporator, as reformer can process large percentage water input waste streams.
2. Can process tank heels as well as SBW and newly generated liquid waste.
3. Can Safely and efficiently process/destroy spent organic solvents from Separations Alternatives operations in a "non-incineration" process.
4. Operations staff for new reformer facility is estimated to be 60 to 70 full-time personnel for operations, maintenance and plant management.

We have also reviewed the safety and accident aspects of a reformer facility compared to modification of the current calciner to meet MACT (as referenced in the EIS). The reformer provides a higher level of safety than the current calciner.

Accident Analysis:	Comments:
ABN 01	No liquid or gaseous fuel is used in the Reformer, therefore, no fuel spills or fire scenarios apply.
ABN 02	See above.
ABN 15	No ammonia additive is needed to promote NOx conversion in off-gas. Therefore, no ammonia spill scenarios apply.
DBE 01	The existing calciner uses kerosene injection that could cause explosive mixtures to form. An explosion could cause subsequent failure of HEPA filtration. This scenario is impossible as the reformer is of explosion-proof design and will contain any postulated explosion condition. The THOR℠ reformer does not use gaseous or liquid fuels that could cause such an explosion due to operator error or equipment or control failures.

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Mr. T.L. Wichmann / Ms. Ann Dold
April 12, 2000
Draft EIS Comments, Page 5

The THOR℠ steam reformer has direct applicability to many project elements as shown in Table 1.

Draft EIS References and Comments

Studsvik has performed a complete review of the Draft EIS and noted concerns about operation of the existing calciner and the time schedules involved with the processing options evaluated.

Attachment Two, Studsvik Comments on Draft EIS, provides excerpts from the Draft EIS and provides a brief description of how the THOR℠ technology could improve the overall processing approach under consideration. We request that these comments and those of this letter be considered in the final EIS.

Options to Current Processing Activities for Denitration and NOx Control

The THOR℠ approach has several unique advantages for the processing of SBW and other wastes due to its ability to process nitrate wastes without the generation of NOx as a significant off-gas component.

The system can either process the input waste streams directly or it can be utilized to receive the off-gas of an existing system, such as the calciner, and process this off-gas to meet MACT standards in a low cost, straight forward manner. Studsvik would recommend that the technology be evaluated on a stand-alone basis, however, it could be considered as an upgrade to existing facilities.

Potential upgrades are applicable to the following existing or evaluated technologies for gaseous NOx control:

1. Continued Present Calciner Operations
2. Planned Basis Option
3. Hot Isostatic Pressed Waste
4. Direct Cement Waste

Significant advantages include:

- Only NOx destruction process that requires no ammonia addition or expensive catalyst matrix
- Reduces NOx in off-gas streams from levels above 50,000 ppm to less than 100 ppm in a single step
- Reduces NOx using operating temperatures of 400 - 650°C

Mr. T.L. Wichmann / Ms. Ann Dold
April 12, 2000
Draft EIS Comments, Page 6

Table 1 - THOR^sm Pyrolysis/Steam Reformer Capabilities (Single Step Fluid Bed)

Project Number	Description	Slurry/Solid(4) Denitration Reformer	Integral(3) Evaporator	Off-gas(1) NOx Reduction	Off-gas(1) Organics Destruction	Liquid(2) Organics Destruction	Mercury Separation
P1A	Calcine SBW Including New Waste Calciner Facility Upgrades	Yes	NR*	Yes	Yes	NR	Yes
P1B	Newly Generated Liquid Waste and Tank Form Heel Waste Management	Yes	Yes	Yes	Yes	NR	Yes
P9J	HAW Denitration, Packaging, and Cask Loading Facility	Yes	Yes	Yes	Yes	NR	Yes
P9C, P23C	Class A Grout Plant	Yes	Yes	Yes	Yes	NR	Yes
P49C	Class C Grout Plant	Yes	Yes	Yes	Yes	NR	Yes
P88	Early Vitrification Facility with MACT	NR	NR	Yes	Yes	NR	Yes
P118	Separations Organic Incinerator	NR	NR	Yes	Yes	Yes	Yes
P133	Waste Treatment Pilot Plant	Yes	Yes	Yes	Yes	Yes	Yes
P111	SBW and Newly Generated Liquid Waste Treatment with Cs Ion Exchange of CH-TRU grout and LLW grout	NR	Yes(5)	NR	NR	NR	NR

<u>Notes:</u>

1. THOR^sm steam reformer converts gaseous NOx to nitrogen and oxidizes organics to CO_2 and water. THOR^sm process utilized less energy than "Noxidizer" as the Reformer operates at only 400 to 700°C. THOR^sm process is much more efficient at converting NOx to nitrogen than "Noxidizer" . The outlet of Reformer will contain less than 100 ppm NOx. THOR^sm reformer does not utilize ammonia injection or expensive catalysts.
2. THOR^sm steam reformer will fully oxidize liquid organics to CO_2 and water. Steam reforming is a non-incineration thermal treatment process.
3. THOR^sm steam reformer fluid bed has high water evaporation capacity that could eliminate need for separate liquid waste evaporator.
4. THOR^sm steam reformer can convert nitrates directly to nitrogen. Reformer can process direct injection of acidic or basic nitrate wastes. Little to no additives needed to prevent formation of alkali metal agglomerates. No liquid or gaseous fuels are used.
5. Use of THOR^sm reformer could replace evaporator and eliminate need to add CaO to neutralize liquid wastes.

*NR = Not Required

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Mr. T.L. Wichmann / Ms. Ann Dold
April 12, 2000
Draft EIS Comments, Page 7

Off-gas control is perhaps the most significant advantage of the THOR^sm technology. During the extensive, multi-year test program, Studsvik identified the need for a simple, single-step nitrate destruction process. Tests were performed to determine the capabilities of THOR^sm for nitrate destruction. A unique combination of operating parameters and equipment design yielded a simple system that can process liquid, slurry, solids and/or gaseous nitrates in a safe and efficient operation.

Nitrate destruction tests confirmed that the THOR^sm fluid bed system can achieve the following performance specifications:

Nitrate Feed:	5.2 M $NaNO_3$, in water slurry
Processing Rate:	Proprietary
Reductant:	
Main Additive:	Sucrose (granular sugar)
Other Additive:	Proprietary
Addition Rate:	Proprietary
Fluidizing Medium:	Proprietary Bed Material Used
Fluid Bed Media:	<2% nitrates, during steady state operation <0.5% nitrates during startup and shutdown periods
Heating Method:	Electrical Resistance Heaters
Operating Temp.:	450-700°C
Nitrate Destruction:	>99 percent, in solid outlet stream
Chromium +6:	Converted to Cr^{+3}, below detectable levels of Cr^{+6} on TCLP test
Bed Agglomerates:	None
Off-gas System:	Thermal Oxidizer and Scrubber
NOx in Off-gas at Outlet of THOR^sm Fluid Bed (prior to thermal oxidizer and scrubber):	
At Startup:	>5,000 ppm, quickly dropped within one hour to steady state values
Steady State:	<100 ppm, normally <50 ppm, 25% of test time <15 ppm

NOx measurements were made continuously on-line using an extractive EPA method. In addition, gas bag samples were analyzed off-line at a certified lab. Off-gas analysis from a typical large-scale test run shows below detectable levels for NO and NO_2 and approximately 69 ppm of N_2O. Depending upon local air permit requirements and design throughput, the THOR^sm process will require <u>no</u> NOx off-gas control system.

We have performed numerous nitrate destruction tests utilizing fluid bed and mechanical contactor hardware over the past several years. The current process application practices have proven to be safe, efficient and easy to control. The unique reformer denitration operating parameters are subject of pending patents.

Utilization of Studsvik's approach would provide for waste processing that meets the MACT requirements in a single process operation thus yielding a "final" rather than an interim solution.

- New Information -

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Mr. T.L. Wichmann / Ms. Ann Dold
April 12, 2000
Draft EIS Comments, Page 8

The THOR[sm] gaseous NOx conversion reformer far surpasses the ability of any other commercial scale technology for converting high NOx input streams directly to nitrogen.

Material Handling and Final Waste Form

Material handling of input waste and output residue are generally the most critical components of a processing system with the most potential for operational failures. Studsvik's fluid bed/steam reforming system can input waste in either a liquid slurry, solid (powder or small particle) or gaseous form. In working with radioactive waste, the wet slurry form is generally preferred because it provides for ease of handling, it provides a level of contamination control should a system require breaching, and it accommodates a wide variety of waste streams.

The output residue from the system is an inert dry granular material that can be pneumatically transferred to remotely filled and handled output packages or can be directly input to a grout facility. The output package would be designed specifically for criticality concerns and to meet the requirements of the final depository or interim storage location.

Criticality and Other Safety Considerations

A fluid bed system operating in a continuous feed, elutriating mode has a unique advantage over batch processing technologies in the area of criticality issues. Conventional waste processing fluid bed systems retain the waste residue in the fluid bed which is periodically drained. This build up of residue provides the potential for a criticality concern.

With the THOR[sm] system operating in an elutriating mode, there is little to no "build up" of fissionable or other materials in the fluid bed. The process residue is continually carried with the gas stream out of the bed and captured downstream where it can be closely monitored and controlled. Controlled input and continuous removal of residue help to alleviate criticality concerns.

Studsvik, through one of its sister companies SCANDPOWER (formerly Studsvik USA, Inc.), has the capability to provide a complete criticality analysis of the system design. SCANDPOWER is one of the world leaders in the area of power reactor core reload analysis and other nuclear physics reaction calculations.

Another unique property of our continuously feed/elutriating system is that only a very small amount of material is actually "in process" at a given time. Should an upset condition occur, simply by securing feed, the chemical conversion processes and resultant off-gas ceases in a matter of seconds. This represents an important safety advantage for the system.

Additionally, the Studsvik system is design as an "explosion proof" system. The materials of construction and design is such that the maximum credible upset that can be postulated will be retained by the system without the requirement for a complicated relief and expansion gas

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Mr. T.L. Wichmann / Ms. Ann Dold
April 12, 2000
Draft EIS Comments, Page 9

capture system. This feature substantially reduces the overall complexity of the system and contributes to the innate safety of the system design.

The operational experience that we have gained at our commercial processing facility has demonstrated the inherent safety and the ease of operator control of the reformer. "Lessons learned" through present operations would translate directly to an improved design for any systems that may be provided for use at INEEL.

AMWTP

57-2 X1(5)

With the recent termination of the incinerator system originally incorporated into the AMWTP, there is the potential that improved technology, not available when the AMWTP was contracted for, such as pyrolysis/steam reforming could be incorporated into the revised facility design. If this were to be the case, then it could prove beneficial to include an evaluation of steam reforming for processing of SBW at the AMWTP in the final EIS. The steam reformer technology could be utilized to process low-level mixed TRU waste originally planned for the incinerator and to destroy the nitrates in the SBW. The resultant nitrate free, alkali compounds could then be efficiently packaged as TRU waste.

Modifications could be made to the AMWTP to enable the processing of SBW that would have no impact on the overall schedule for the AMWTP and would not jeopardize compliance with the Settlement Agreement/Consent Order.

Other Considerations

The Draft EIS provided a summary description of Project Number P9J, HAW Denitration, Packaging and Cask Loading Facility (listed in Table C.6.1-1 and more fully described in section C.6.2.10, page C.6-73). Project P9J discussed utilization of an elutriating fluid bed, of a similar nature to Studsvik steam reforming system, to process high-activity wastes with a nitrate component.

Due to the many advantages listed throughout this document, we feel that it is imperative that provisions be made for the evaluation of fully deployed technologies, such as steam reforming, prior to issuance of the final EIS. The advantages to be realized far outweigh the effort that would be required to perform the revision.

Again, we are asking that the fluid bed pyrolysis/steam reforming approach be evaluated in the EIS as a non-separation alternative for the various waste streams discussed in this letter. Additionally, we invite the DOE to visit our operating facility and view first-hand the Reformer technology application in commercial radioactive operation.

- New Information -

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We thank you for your time and consideration in this matter and look forward to having the opportunity to directly discuss the issues addressed in this letter. If you have any questions on this information, please call me directly at (803) 731-8220.

Sincerely,

Maurice ... for

Thomas W. Oliver, P.E.
Vice President

Attachments: 1. THOR℠ Technology and Processing Facility, Erwin TN
2. Studsvik Comments on the Idaho High-Level Waste and Facilities Disposition Draft Environmental Impact Statement (DOE/EIS-0287D),

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Attachment One
THOR℠ Technology and Processing Facility, Erwin TN

STUDSVIK PROCESSING FACILITY
PYROLYSIS/STEAM REFORMING TECHNOLOGY FOR VOLUME AND WEIGHT REDUCTION AND STABILIZATION OF LLRW AND MIXED WASTES

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ABSTRACT

Studsvik has completed construction, start-up testing, and has commenced commercial operation of a Low-Level Radioactive Waste (LLRW) processing facility in Erwin, TN. The Studsvik Processing Facility (SPF) has the capability to safely and efficiently receive and process a wide variety of solid and liquid LLRW streams including: ion exchange resins (IER), charcoal, graphite, sludge, oils, solvents, and cleaning solutions with contact radiation levels of up to 1.5 Sv/h (150 R/hr). The licensed and heavily shielded SPF can receive and process liquid and solid LLRWs with high water and/or organic content.

The SPF employs the THermal Organic Reduction (THOR[sm]) process, developed and patented by Studsvik, which utilizes pyrolysis/steam reforming technology. THOR[sm] reliably and safely processes a wide variety of LLRWs in a unique, moderate temperature, pyrolysis/reforming, fluidized bed treatment system. The THOR[sm] technology is suitable for processing hazardous, mixed and dry active LLRW (DAW) with appropriate licensing and waste feed modifications.

Operations have demonstrated consistent, reliable, robust operating characteristics with consistent volume reductions of up to 70:1 and weight reductions of up to 30:1 when processing depleted, mixed bed, ion exchange resins with over 99.8% of all radionuclides in the waste feed incorporated in the final solid residue product. Final reformed residue comprises a non-dispersible, granular solid suitable for long-term storage or direct burial in a qualified container. THOR[sm] effectively converts hexavalent chromium to non-hazardous trivalent chromium and can convert nitrates to nitrogen with over 99 percent efficiency in a single pass.

The paper provides an overview of the first 6 months of commercial operations processing radioactive ion exchange resins from commercial nuclear power plants. Process improvements and lessons learned will be discussed. Plans for new mixed waste and graphite steam reforming processing will be presented.

PROCESS OVERVIEW

Since 1947 Studsvik has been actively involved as a research center for nuclear power in Sweden. Studsvik operates a research test reactor and hot cell facility for production of medical isotopes, commercial nuclear fuel testing, and materials irradiation. Studsvik operates a Dry Active Waste (DAW) incinerator, which has been in commercial operation since the early 1970s. Full metal melting and recycling capabilities for carbon and stainless steels and aluminum have been in use for several years.

A five phase test program was implemented to develop a process that could effectively volume reduce and stabilize a wide variety of liquid and solid LLRWs that could not be processed by the Studsvik incinerator. The successful test program culminated in the decision to proceed with the licensing, design, and construction of a commercial LLRW processing facility that utilizes the patented THOR[sm] process. The Studsvik Processing Facility (SPF) has completed construction, startup testing, and commenced commercial operations with processing of radioactive IER from nuclear power stations in July 1999.

The THOR[sm] process utilizes two fluid bed contactors to process a wide variety of solid and liquid LLRWs. Figure 1 provides an overview flow diagram of the THOR[sm] process. Radioactive waste feeds are received at the SPF and stored in holdup tanks. As waste is needed in the process, waste is transferred to the waste feed tanks for metering and injection into the first stage fluid bed pyrolyzer/reformer. Solid, dry, granular wastes such as charcoal, graphite, soil, etc are metered into the pyrolyzer by the solids feeder. Liquids and slurry wastes such as IER, sludges, oils, antifreeze, solvents, cleaning solutions, etc are metered into the pyrolyzer by a pump.

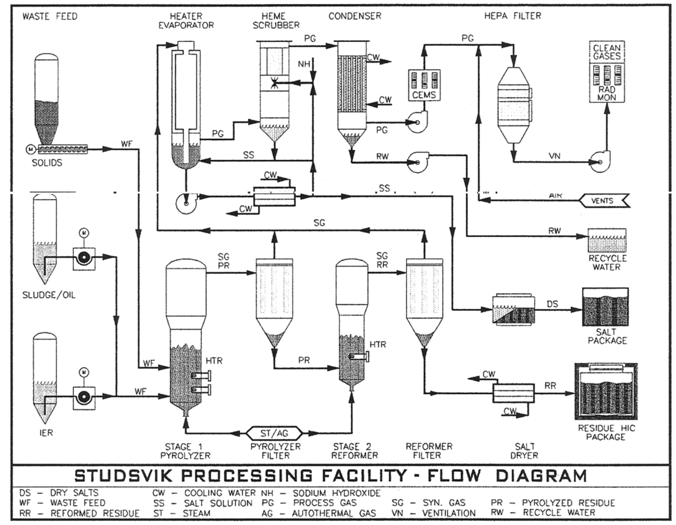

Figure 1 - THOR[sm] Process Flow Diagram

The pyrolyzer fluid bed serves to evaporate all water from the IER slurry and liquid waste feeds, and pyrolyze the organic components through destructive distillation. Fluidizing gases, volatile organic vapors, and steam released in the pyrolyzer fluid bed comprise a synthesis gas which passes through the ceramic filters and to the gas handling system. The low-carbon, metal oxide-rich residue removed by the ceramic filter can be further processed in the second stage steam reformer to remove any final carbon or to convert the oxidation state of selected metals. The stage 2 Reformer can also be used as a primary waste processing unit by the direct injection of liquid wastes. The radioactive, volume reduced residue is packaged in qualified high integrity containers for burial at licensed burial sites or return to the generator. The final reformed residue volume is routinely only 1 to 4 percent of the incoming resin volume. For depleted, mixed-bed IER it is possible to achieve a volume reduction (VR) of 20-100 times with a corresponding weight reduction (WR) of 12-85 times.

Through selection of autothermal steam reforming operating conditions it is possible to produce an inert, inorganic final waste that consists of only the radioactive elements, metal oxides and inorganic calcium and silica compounds initially absorbed on the IER. It is possible to reach near theoretical mass reductions with the THOR[sm] process. Another significant improvement realized by the THOR[sm] process is the ability to process wastes with high water content. Aqueous wastes do not need to be dried prior to processing, but can be injected directly into the fluid bed using reliable slurry pumping equipment. Sodium nitrate slurry, oils, activated carbon, antifreeze solution, steam generator cleaning solvent and several types of IERs have all been successfully processed by the THOR[sm] process.

STUDSVIK PROCESSING FACILITY

Studsvik has completed construction and start-up testing of a Low-Level Radioactive Waste (LLRW) processing facility in Erwin, TN. The SPF has all applicable licenses and permits for operation including a radioactive materials license from the State of Tennessee. Commercial operation of the Studsvik Processing Facility (SPF) began in July 1999. The SPF and THOR^{sm} process systems are described below. The SPF is designed to meet all laws, codes, and standards related to processing LLRW. A photograph of the SPF is shown in Fig. 2.

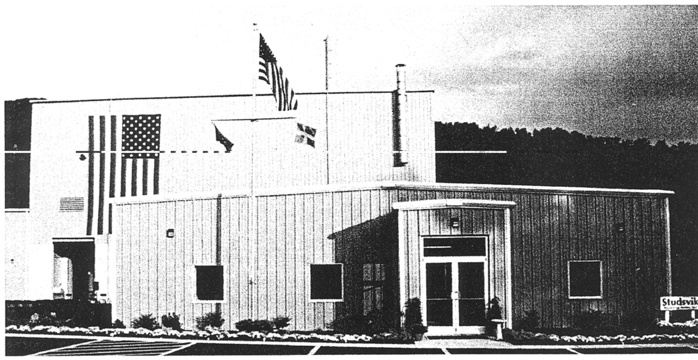

Figure 2 - SPF Overview

The SPF is designed to meet the following criteria:

Facility Curie Inventory:	up to 2,000 Ci (74 TBq)
LLRW Input Curies:	up to 2.0 Ci/cu.ft. (2.6 TBq/m^3) Contact dose of up to 150 R/h (1.5 Sv/h)
LLRW Inputs:	Ion Exchange Resins, Charcoal, Graphite, Organic Solvents and Oils, Aqueous Decon and Cleaning Solutions, Slurries, and Sludge

The SPF consists of a heavily shielded Process Building, unshielded Ancillary Building, and an Administration Building. The Process and Ancillary Buildings are licensed for receipt, handling, processing, and packaging of LLRW.

Process Building

The Process Building contains all radioactive processing, handling, and packaging systems for volume and weight reduction of incoming LLRW. Major areas include truckbays, LLRW input holding tank vault, pyrolysis/reforming vault, gas handling vault, salt dryer room, final residue packaging vault, and auxiliary equipment rooms.

Truckbays

LLRW is shipped to the SPF in DOT or NRC qualified non-shielded containers and/or shielded casks. Most LLRW is received in the truckbay where containers and casks are surveyed, opened and the waste transferred to shielded waste input holding tanks located in shielded vaults. Cask maintenance activities are performed in the truckbay where an overhead bridge crane provides lifting capability. Figure 3 is a photograph of the dual station truckbay.

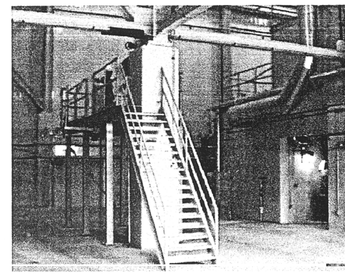

Figure 3 – Truckbay

Waste Input Holding Tanks

Three large stainless steel slurry holding tanks are provided for receipt and holdup of incoming liquid and slurry wastes. A separate liquid waste tank is used to receive more volatile organic solvents, cleaning solutions, and oils. A lockhopper feeder is used to receive and feed granular and powdered LLRW, such as charcoal. A separate waste feed tank with injection pumps is used to meter slurry and liquid wastes from the slurry holding tanks into the stage one pyrolysis vessel. Figure 4 is a photograph of the slurry holding tank vault.

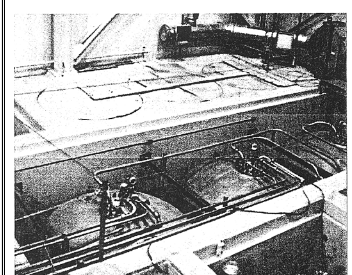

Figure 4 – Slurry Holding Tank

Pyrolysis/Reforming System

The Pyrolysis/Reforming THOR^{sm} system comprises: stage one pyrolysis contactor (pyrolyzer), stage two reformer contactor and associated filters. The pyrolyzer is a vertical, cylindrical fluid bed gasifier designed to operate at up to 800°C. LLRW is injected into the electrically heated, fluidized pyrolyzer where: 1) water is instantly vaporized and superheated, and 2) organic compounds are destroyed as organic bonds are broken and resulting synthesis gas (principally carbon dioxide, carbon monoxide, and steam) exits the Pyrolyzer. Residual solids from the pyrolysis of the LLRW (including fixed carbon, >99.8 percent of the incoming radionuclides, metal oxides and other inorganics and debris present in the LLRW feed) are removed from the pyrolyzer and collected in the stage one ceramic filter vessels. The pyrolyzer is fluidized with superheated steam and additive gas. Figure 5 is a photograph of the reformer process area.

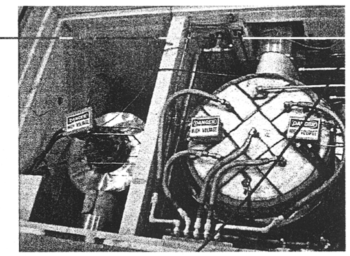

Figure 5 - Process Area - Reformer

The stage two reforming contactor is a vertical, cylindrical fluid bed designed to operate at up to 800°C. Pyrolyzed solid residues from the stage one filters or additional LLRW feed can be transferred to the reformer, which is an electrically heated, fluidized bed. The reformed, low-carbon, final residue is collected in the stage two ceramic filter vessel. The reformer is fluidized with superheated steam and additive gas.

Gas Handling System

The gas handling system comprises an energy recovery heater, submerged bed evaporator, scrubber/mist eliminator, condenser, CEMS, process blower, HEPA filter, vent blower and radiation monitor. The purpose of the gas handling system is to convert synthesis gas constituents to carbon dioxide and water, recover energy from the synthesis gas, convert acid gases to stable salts, control water content of exiting process gases, and control negative pressure levels throughout the THOR^{sm} pyrolysis/reformer system.

Synthesis gases from the pyrolyzer and reformer are filtered and then oxidized in the energy recovery heater to carbon dioxide and water. The heater recovers energy from the synthesis gas and provides heat to the submerged