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STATUS OF HIGH LEVEL AND ALPHA BEARING WASTE MANAGEMENT IN PNC

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1. Introduction

Nuclear power in Japan has played an important role in supplying electric power. Namely, the total electricity generating capacity of 22 operating nuclear power reactors has reached approximately 16 Gigawatt as of October 1981. This is the third in the world in nuclear power generating capacity. A certain amount of the spent fuels from these reactors has been reprocessed at the Reprocessing Plant of PNC at Tokai since September 1977, and as a result about one hundred cubic meters of high level liquid waste (HLLW) have been generated and placed into storage tanks. Fig. 1 summarizes the expected amount of accumulation of vitrified HLLW in Japan.

The Power Reactor and Nuclear Fuel Development Corporation (PNC) of Japan is now making efforts for the development of such new types of reactors as LMFBR and HWR, and all areas of the nuclear fuel cycle including uranium enrichment, mixed oxide fuel fabrication, reprocessing of LWR and LMFBR spent fuels, waste treatment and disposal. Technologies developed by PNC will be utilized during the commercialization stage of the respective fuel cycle activity. As a typical example, planning for the construction of a commercial reprocessing plant by Japan Nuclear Fuel Service Co., Ltd. (JNFS) will be facilitated through the systematic utilization of the experience of PNC obtained at the Tokai Reprocessing Plant.

Difficult problems are still remain to be resolved within the fuel cycle development. One of the major roles of PNC is to promote the management of high level and alpha bearing waste which is indispensable in completing the fuel cycle in Japan.

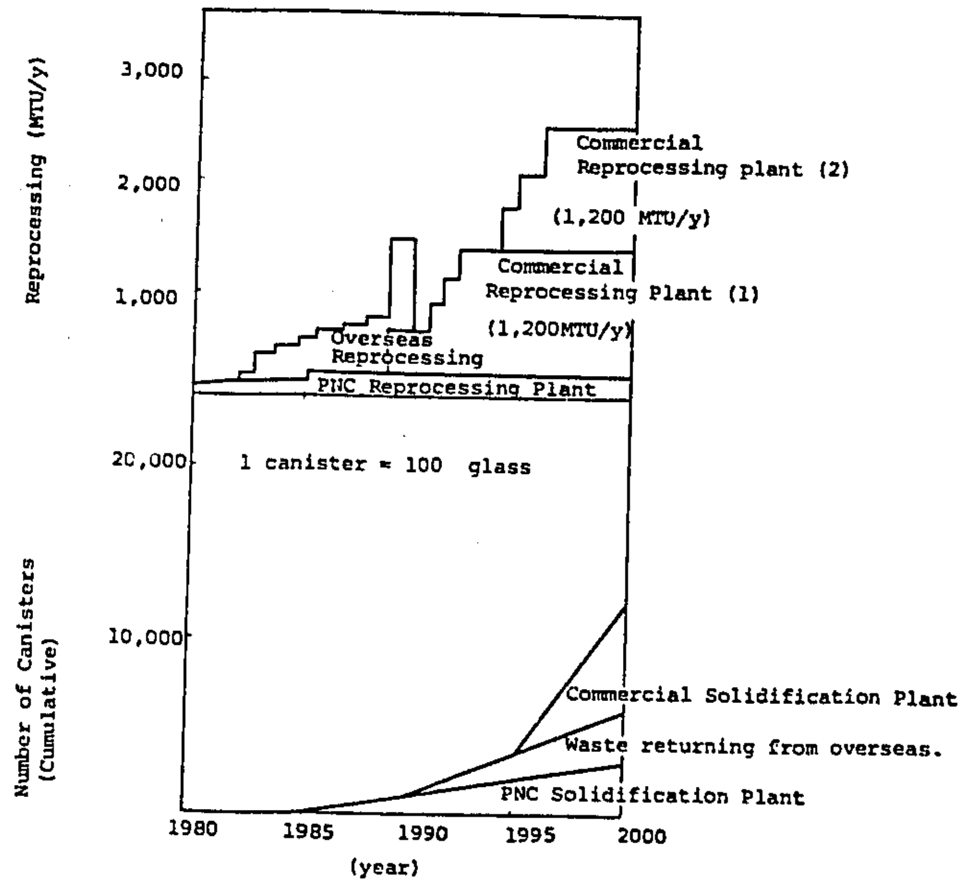


Fig. 1 Reprocessing Capacity and Number of Canisters Accumulated in Japan

2. High Level Waste Management

2.1 Policy and Program

The Japan Atomic Energy Commission (JAEC) established the following policy in 1976 concerning the management of high level waste.

(1) High-level radioactive waste shall be solidified into stable form and be disposed of following an appropriate period of storage.

(2) Reprocessing industries shall be responsible for the treatment (solidification and storage directly associated therewith) of high level radioactive waste using the techniques demonstrated by the Government.

(3) The Government shall be responsible for permanent disposal (final disposal including terminal storage equivalent to final disposal). However, the cost of final disposal should be beared by the nuclear industries under the poluter-pays principle.

The scenario for high level waste management based on JAEC's policy is shown in Table 1.

Table 1 Scenario for HLW Management

(1)	HLLW should be stored in tanks for a certain period of time until its radioactivity is decayed and the heat reduced to be suitable for solidification.
(2)	HLLW should be solidified.
(3)	The solidified waste (HLW) should be stored for a certain period of time to be cooled for suitable disposal.
(4)	HLW should be disposed.

The reorientation of research and development program on high level waste management was recently recommended by the Radioactive Waste Management Committee, taking JAEC's new policy and the progress of research and development program into account, in 1980. The recommendations are as follows.

The principal goal of the program is to initiate hot operation of the Vitrification Pilot Plant by 1987 for the development of the solidification process and to make it possible to initiate trial disposal by 2015 for the development of geological disposal technology.

The Power Reactor and Nuclear Fuel Development Corporation (PNC) is one of the major leading organizations for these research and development programs. Therefore, PNC is responsible for performing technology development associated with solidification, storage and disposal processes. The evaluation of safety related to the disposal of high level waste will fully be executed prior to disposal using the results of safety evaluation study being done by Japan Atomic Energy Research Institute.

2.2 Vitrification Program

Monolithic borosilicate glass is selected as the final form in our solidification process. In support of this vitrification process development, pretreatment of high level liquid waste, off-gas treatment, glass melting and canister handling techniques are also being developed.

Technology development has been underway since 1976 in combination of cold laboratory scale test and cold engineering scale test. Hot laboratory test is expected to begin soon. The interaction between these tests and theirschedule are illustrated in Table 2.

Table 2 R & D Schedule of High-Level Liquid Waste Vitrification Technology

	1980	1981	1982	1983	1984	1985	1986	1987	1988
Pilot Plant	Conceptual Design	Basic Design	Detail Design		Construction			Operation	
CPF (Hot Cell Study)	Construction		Hot Cell Test (Phase I)					Hot Cell Test (Phase II)	
Mockup Test	Design	Construction	Test (Phase I)		Test (Phase II)				
Remote Operability Test	Test								
Cold Engineering Test Pretreatment Test Vitrification Test Off-gas Treatment Test Canister Handling Test Characterization of Glass Air Cooling Test of Package	Test								
Laboratory Test Glass Composition Development Characterization of Glass Alternative Waste Form Development	Test								

The Engineering Test Facility (ETF) to prove the performance and reliability of the process has been in operation since February 1980. This facility consists of such processes as pretreatment (denitration and concentration), off-gas treatment, glass melting, canister handling, canister welding and storage. Two different type joule-heated ceramic melters were operated for 300 and 230 days respectively, to produce 18.7 tons of borosilicate glass successfully by March 1981.

The Remote Maintenance Test Facility (RMTF) was completed in March 1981, where various tests using power and masterslave manipulators have been continued.

The Mock-up Test Facility (MTF) is now under construction and is expected to be completed in March 1982, where the whole process equipment will be tested as a system using a full scale model.

The construction of the Chemical Processing Facility (CPF) was completed in June 1981, and it is planned to initiate hot tests in early 1982 using actual high level liquid waste coming from the Tokai Reprocessing Plant of PNC.

2.3 Geological Disposal Program

Since the Research and development of geological disposal requires a very long period of time, the program is planned to be conducted in stages from a long-range perspective, and each new stage will be proceeded based on the research and development results during the prior stage, as indicated in Fig. 2.

The research and Development Program is divided into five stages as indicated in Table 3;

Survey on potential geological formation by 1984; Research on candidate geological formation by 1995; In-situ test with simulated waste, In-situ test with actual waste and Trial disposal by 2015.

Concerning the current stage of survey on potential geological formation, research and development procedures and research items of the program have already been developed, and details for future stage will be established in 1984.

PNC has been conducting a survey on geological formations and research for engineered barriers and geological disposal systems. Literature surveys, geological explorations and a survey on the hydro-geological structure are underway to clarify the current state of available geological formations. Futhermore, the rock characteristics test, water permeability test and nuclide sorption test are being conducted to clarify the function of geological formations as natural barriers and to study their barrier effects.

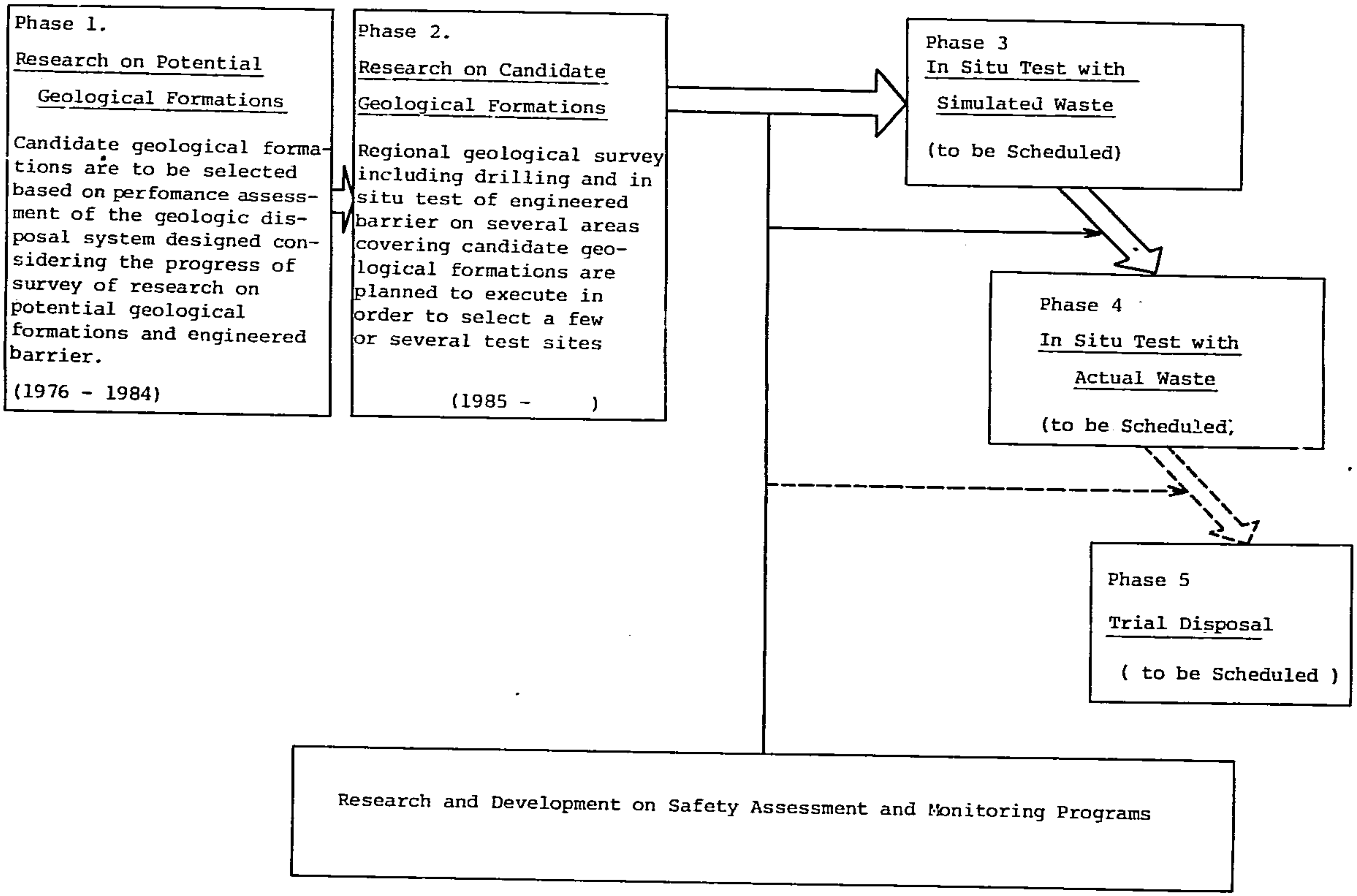
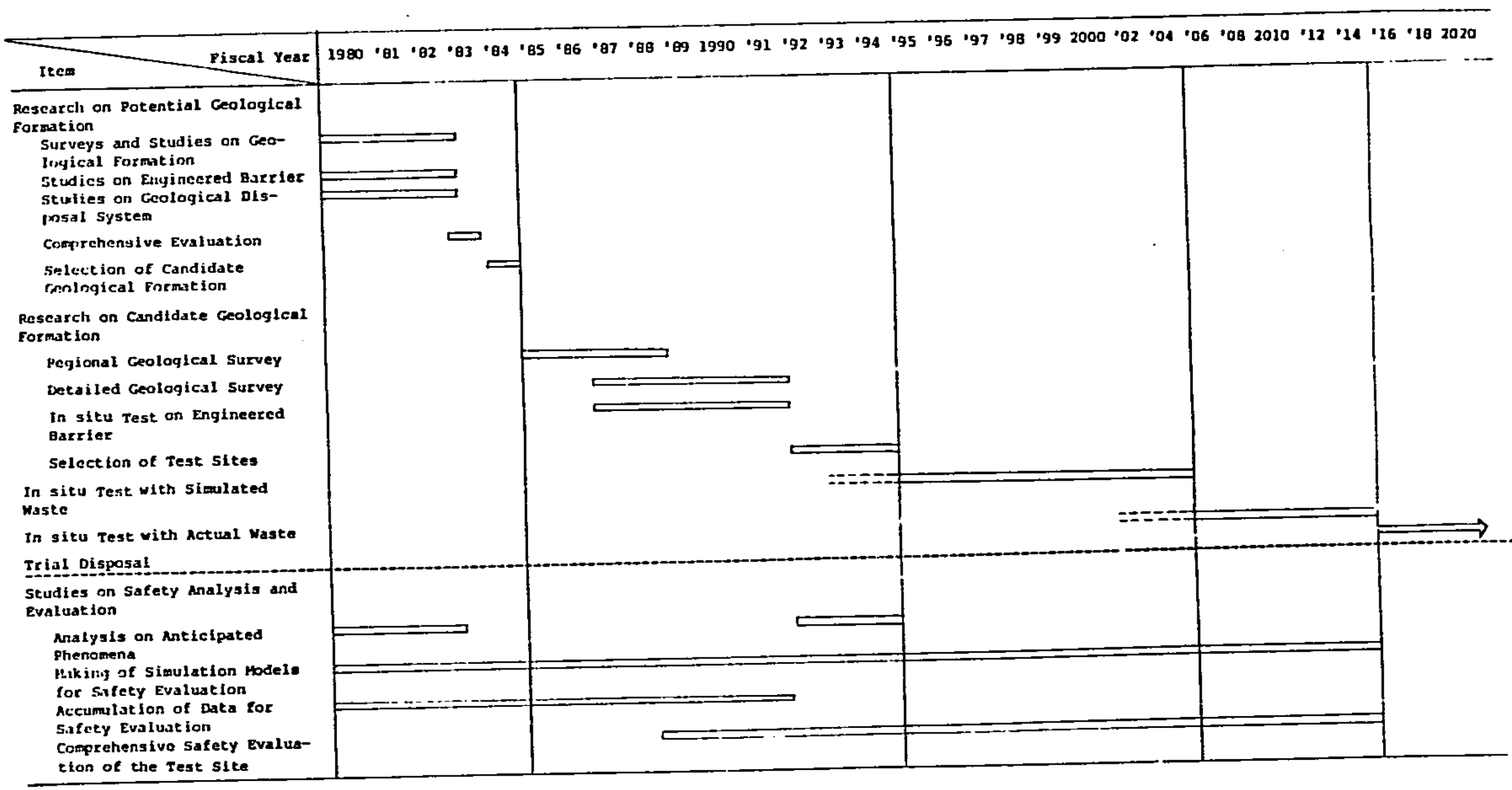


Fig. 2 General Scheme for the Geological Disposal Program

Table 3 R & D Schedule of HLLW Geological Disposal



Geological formations under consideration are granite, diabase, shale, zeolitic tuff, limestone, slate and schist. 18 areas have already been surveyed and evaluated, and survey of another 7 areas is expected to be completed by 1983. A competent government agency will examine these evaluation results and select target rocks and areas to be subjected to further detailed field investigations including drilling in 1984.

PNC has been conducting three in-situ test programs which include the domestic Shimokawa project for Diabase and the Hosokura project for Zeolitic Tuff, as well as the international STRIPA project for Granite.

As to the engineered barrier which will be combined with the natural barriers of geological formations, cement grouting and buffer-mass technology are being developed. The integrity evaluation test for estimating the effectiveness of engineered barriers and the compatibility test between engineered barriers and geological formations will soon be initiated.

3. Alpha Bearing Waste Management

3.1 Policy and Program

Alpha bearing wastes are produced at the Mixed Oxide Fuel fabrication facility and the reprocessing plant in PNC. Although a limited amount of alpha bearing wastes from these facilities have been accumulated to the present, it is anticipated that the amount will increase in the future through the operation of a commercial reprocessing plant and also through overseas reprocessing contracts.

In the policy established by JAEC in 1976, the development of techniques related to the treatment, storage and disposal of low level wastes is placed under the responsibility of industry, while the technical criteria and trial disposal fall under the responsibility of the government.

The alpha bearing wastes have been treated similar to the low level wastes. However, the research and development program on alpha bearing wastes is now under reevaluation by the Radioactive Waste Management Committee focusing the following items:

- Reduction of the creation of waste
- Reduction of the volume of waste
- Solidification of waste into a form appropriate for disposal
- Disposal

3.2 Waste Treatment Program

As for the treatment of alpha bearing wastes, improvements in processing, equipment, operation techniques, etc. are being carried out from the viewpoint of reducing the creation of wastes.

Furthermore, the development of techniques for volume reduction of wastes is underway. These involve the incineration of combustible wastes, acid digestion of organic chlorirated wastes, melting of filter elements by induction heating, electroslag remelting of metal wastes and solidification of non-combustible wastes exclusing metals into ceramic waste form by microwave heating. These techniques will be demonstrated at the Pu-contaminated Waste Treatment Facility (PWTF), which is now under design and is scheduled to initiate operation in 1986. Table 4 shows the detailed schedule of PWTF and Fig. 3 shows the schematic process flow diagram of PWTF. The techniques for decontamination and dismantling of large-size equipment contaminated with transuranium elements and recovery of useful nuclides will be developed.

3.3 Alpha Bearing Wastes Disposal Program

Since alpha bearing wastes contain long half-lived nuclides, long term isolation is required as in the case of high level waste from the standpoint of preventing environmental contamination and exposure to radiation from these wastes. Alpha-bearing wastes are considered to be a little easier to dispose of than high level waste as a result of such characteristics as requiring limited consideration for radiation shielding and for heat discipation. Therefore, it is necessary to develop particular disposal techniques for alpha bearing wastes taking high level waste disposal techniques into account.

While high level wastes are tailored to homogeneous stable glass, alpha bearing wastes are converted into several types of waste forms because of the variety of wastes being created and waste materials. In this respect, research has mainly been directed to improve and identify the characteristics of waste form including leachability, solubility of plutonium and interaction with rock under simulated underground conditions.

4. Conclusion

High level and alpha bearing wastes management in PNC is summarized. It is indispensable to find the solution of managing the radioactive waste in completing the nuclear fuel cycle in Japan. Thus, Japanese government, especially PNC in accordance with the decision of JAEC, is working hard for seeking the solution. Although progress in research and development in waste management has been remarkable, it is believed that the international cooperative efforts in waste management are necessary to achieve the goal of completing the nuclear fuel cycle.

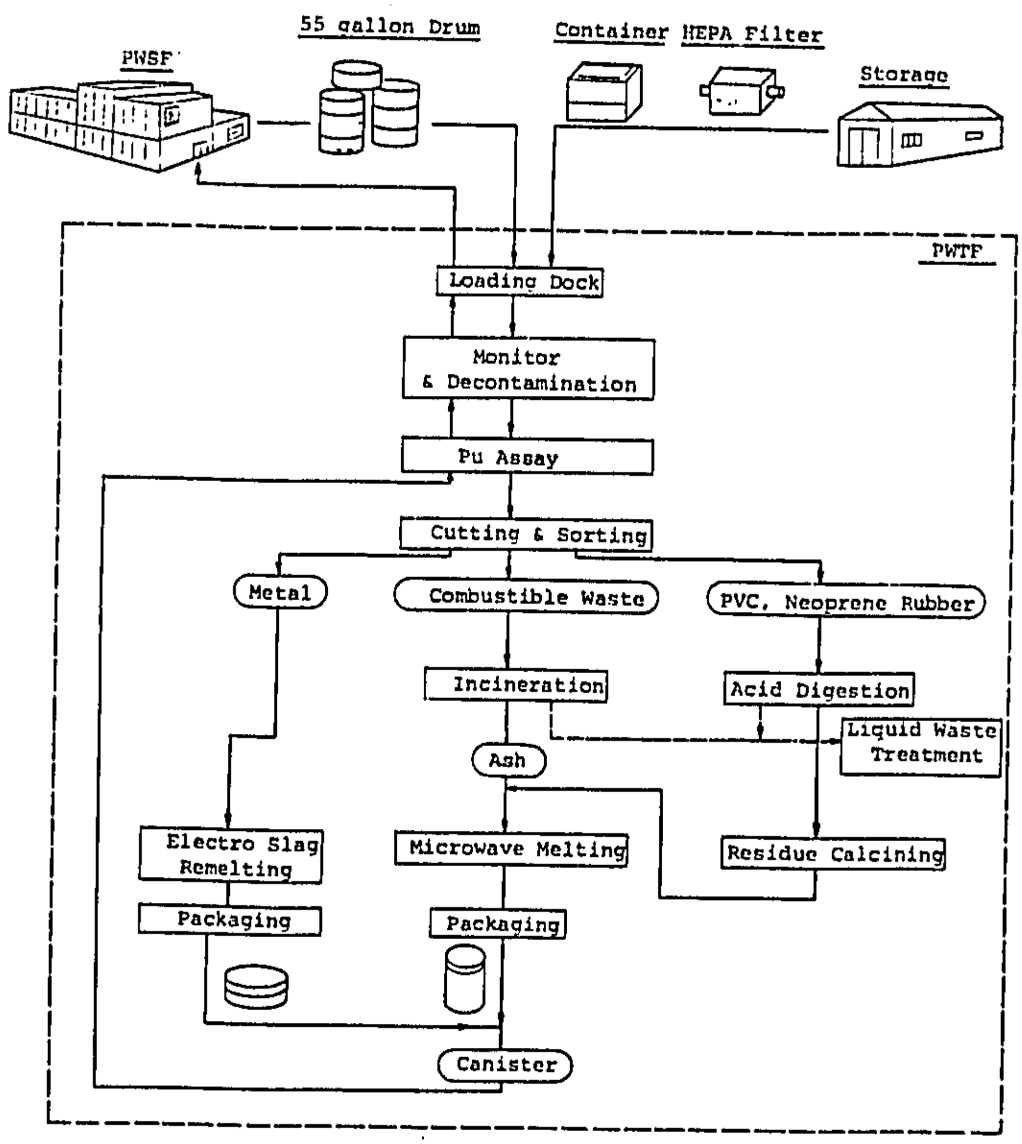


Fig. 3 Process Flow Diagram in PWTF

Table 4 Schedules for Major Technology Development Efforts on ALPHA Bearing Waste Treatment