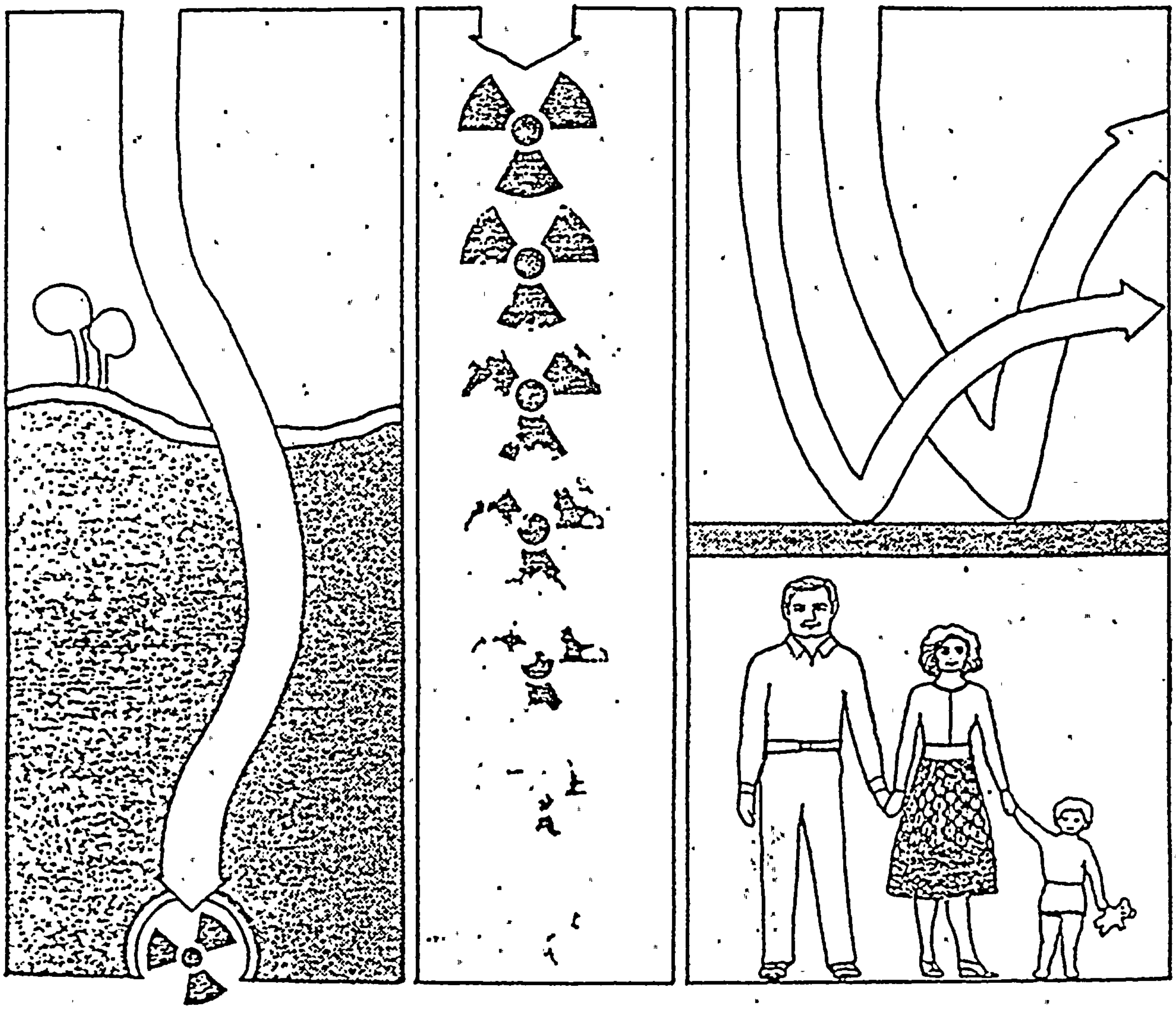
UNIVERSITY OF FLORIDA

Low-Level Radioactive Wastes in Florida



REPORT:

PROGRESS REPORT - UF LLRW - 4

8106190311

STAFF

W. Emmett Bolch, Ph.D. Professor Environmental Engineering Sciences	Principal Investigator
Charles E. Roessler, Ph.D. Professor Environmental Engineering Sciences	Co-Investigator
John A. Wethington, Ph.D. Professor Nuclear Engineering Sciences	Co-Investigator
Thomas LaVoy	Graduate Assistant
Marcia Borter	Graduate Assistant
Linda Sewell	Graduate Assistant
Joan Pisarcik	Graduate Assistant
Gary Kaplan	Graduate Assistant
Jim Keeler	Student Assistant
Shirley Johnson	Secretary
Raul Rodriquez	Indep. Study
Pedro Salas	Work Study
Bradley Devendorf	Work Study
Dave Hall	Grad. Asst. (7/1/80 - 10/8/80)
Joel Case	Grad. Asst. (7/1/80 - 1/13/81)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

I would like to express my gratitude to the United States Department of Energy and the Florida Department of Health and Rehabilitative Services for providing the funding for the Low Level Radioactive Waste Study, and to the Florida Power & Light Company and the Florida Power Corporation for their cooperation and assistance. I would also like to thank Dr. Emmett Bolch, Dr. Genevieve Roessler, and Dr. Phillip Achey for serving on my graduate committee; and a special thanks to Dr. Bolch for his assistance and patience during the course of my work on this study.

ABSTRACT

The State of Florida currently has four operational commercial nuclear power plant. In 1979, over 91,000 cubic feet of low-level radioactive waste(LLRW) was generated in Florida; 86 percent of that by nuclear power plants.

The generation of LLRW in nuclear power plants serves to protect the environment near the plant site and to protect the personnel working in the plant. Radioactive contaminants are removed from the plant's liquid systems before the liquids are discharged to the environment. The LLRW resulting from processing the liquids is then packaged to prevent the radioactivity from being released to the environment before and after burial. LLRW is also generated in a nuclear power plant during housekeeping and maintenance activities. This LLRW is the result of personnel protection measures taken against the radioactive contamination hazards inherent to a nuclear plant.

The primary method of reducing the volume of LLRW in the nuclear power plants in Florida is compaction. The plant personnel are also trained in work practices which reduce LLRW volumes. In addition to this, both of the utilities' operating nuclear power plants in Florida are involved in studies of their current LLRW management practices and are examining the feasibility of employing advanced volume reduction techniques, such as incineration, to further reduce LLRW volumes.

To date, over 391,000 cubic feet of LLRW has been generated by the nuclear power plants in Florida. The annual volume reached a peak in 1978 and has since shown a decline which should continue through 1980. One of the Florida plants has

had a number of significant problems throughout its short operating history which contributed to the above normal LLRW volumes. It is believed that these problems have been resolved and lower LLRW volumes are expected in the future. Two other operating plants have shown declining volumes in recent years; but, due to necessary maintenance, the LLRW volumes from these plants will increase from 1981 through 1983. The other nuclear power plant has had exceptionally low LLRW volumes in the past and decreases are anticipated for the immediate future. In 1983, the fifth nuclear power plant is expected to begin operation. It is anticipated that this plant will generate relatively small volumes of LLRW.

By 1985, it is projected that the volume of LLRW from nuclear power plants in Florida will be about 75,000 cubic feet per year, compared to almost 99,000 cubic feet generated in 1978. The projected value includes the effects of an additional plant and credits volume reduction methods which are currently planned.

INTRODUCTION

The University of Florida, under a contract from the United States Department of Energy, is conducting a study on low level radioactive waste (LLRW) generation within the State of Florida. The commercial nuclear power plants in Florida constitute a major source of LLRW in the state, accounting for 68 percent of the total LLRW volume in 1978 and for 86 percent in 1979. (NUS 80)

The purpose of this portion of the University of Florida's LLRW study is to provide a general descirption of LLRW management in nuclear power plants including were applicable, specific information related to the nuclear plants in Florida. The topics which will be discussed in this report are LLRW sources, liquid processing systems, packaging methods, volume reduction techniques, quality control programs, and onsite storage capacities. Additionally, LLRW volume histories and projections for each of the nuclear power plants in Florida will be presented.

The information presented relating specifically to the nuclear power plants in Florida was obtained through questionaires submitted to the Florida Power and Light Company (FP&L) and the Florida Power Corporation (FPC). The actual questionaires and the utilities' responses are enclosed in Attachment 1. This information was supplemented through telephone conversations with the FP&L and FPC LLRW management personnel.

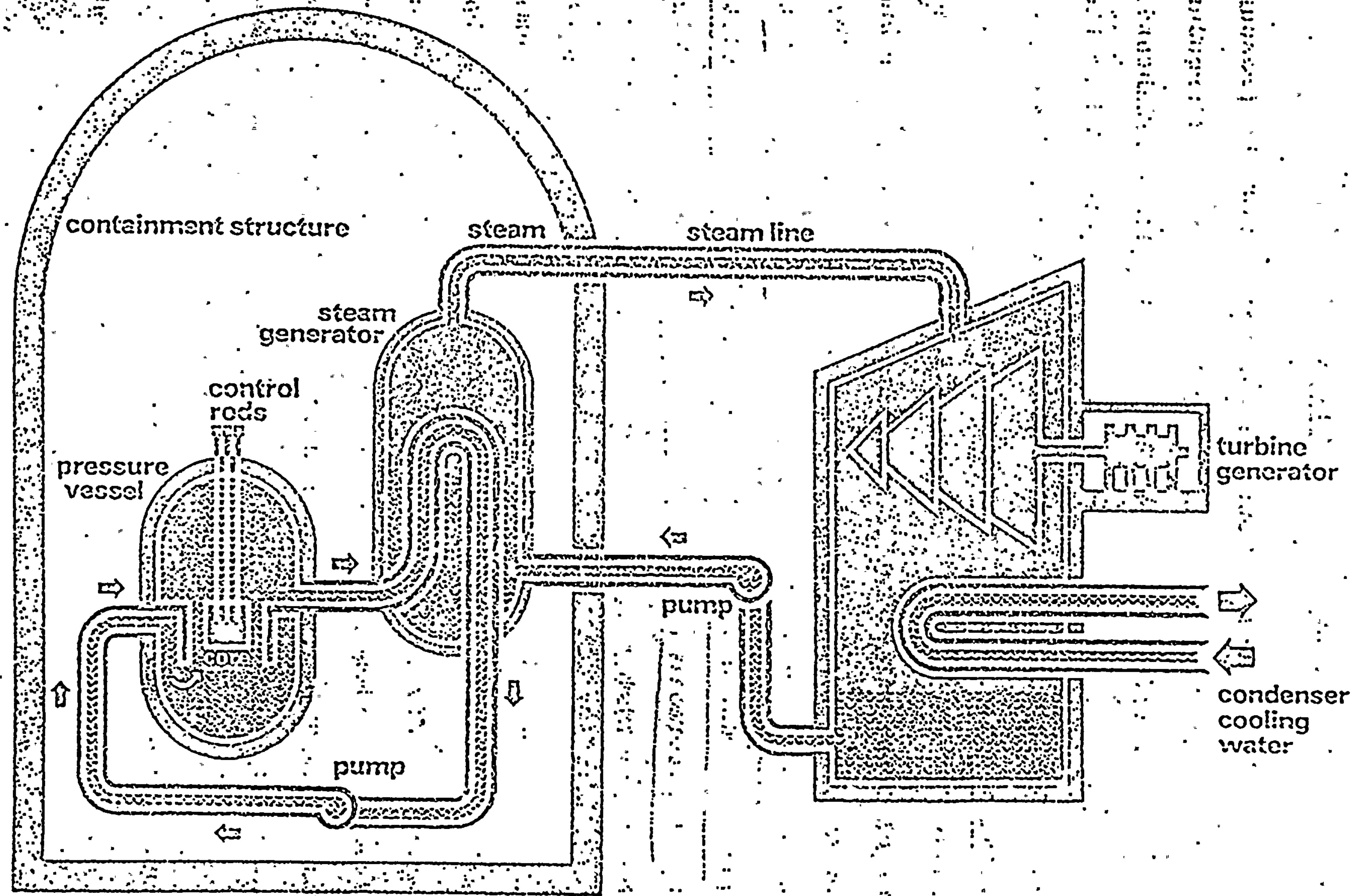
NUCLEAR POWER PLANT TYPES

Florida's nuclear power plants are all of the pressurized water design. Figure 1 is a simple schematic of a pressurized water reactor (PWR). Instead of a coal, oil or gas heat source, a nuclear power plant fissions nuclear fuel to produce the heat. All four types, coal, oil, gas, and nuclear plants must produce steam to drive a turbine which turns an electric generator. A boiling water reactor (BWR) generates steam within the pressure vessel-core unit, thus eliminating the steam generator and secondary loop. The steam passes directly to the turbine in a BWR. In the PWR shown in Figure 1, water, often termed the primary coolant, is pumped in a closed loop to transfer the heat from the core to the steam generator. This primary coolant is kept under high pressure to prevent boiling in the core, i.e. a PWR. The heat taken to the steam generator is transferred to a secondary coolant system. After the energy of the steam is utilized to the maximum possible, it must be condensed back to water by an external cooling source in order to re-enter the steam generation loop.

Three U.S. companies manufacture PWR's: Westinghouse Electric Corp., Combustion Engineering, Inc., and the Babcock and Wilcox Co. Although Florida has only four operating nuclear power plants, all three manufacturers are represented.

Figure 1

Pressurized water reactor (PWR)

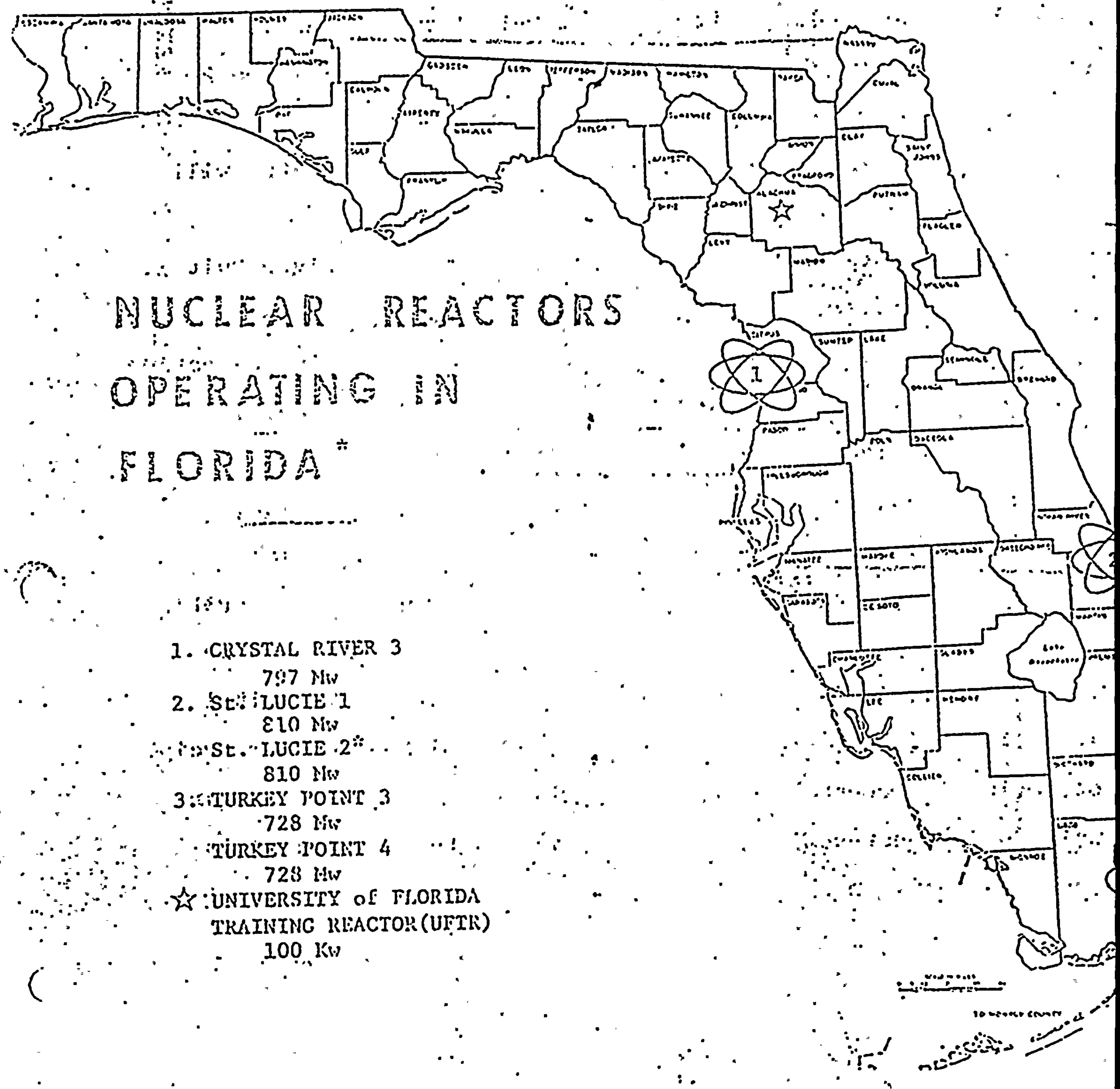


NUCLEAR POWER PLANTS IN FLORIDA

Florida is currently served by four nuclear power plants, producing over 3000 megawatts of electrical energy (MWe). Figure 2 shows the locations of these four plants. Figure 2 also shows a nuclear reactor located at the University of Florida. The LLRW generation from this low power reactor will not be discussed in this report.

FPC operates one nuclear power plant, Crystal River Unit 3, near Crystal River, Florida. This plant is a 797 MWe, Babcock and Wilcox, PWR. Crystal River Unit 3 began commercial operation in March, 1977. FP&L operates three nuclear power plants. Two of these plants, Turkey Point Units 3 and 4, are located near Homestead, Florida. Both of these units are 728 MWe, Westinghouse, PWRs. Turkey Point Unit 3 began commercial operation in December, 1972 and Unit 4 in August, 1973. FP&L's other nuclear power plant, St. Lucie Unit 1, is located near Fort Pierce, Florida on Hutchinson Island. St. Lucie Unit 1 is a 810 MWe, Combustion Engineering, PWR which began commercial operation in December, 1976. FP&L also has a second, similar unit under construction at the St. Lucie site. This unit is expected to begin commercial operation in 1983.

Figure 2



NUCLEAR REACTORS OPERATING IN FLORIDA*

1. CRYSTAL RIVER 3
   797 Mw
2. St. LUCIE 1
   810 Mw
   St. LUCIE 2*
   810 Mw
3. TURKEY POINT 3
   728 Mw
   TURKEY POINT 4
   728 Mw

☆ UNIVERSITY of FLORIDA TRAINING REACTOR (UFTR)
   100 Kw

* St. Lucie 2 is scheduled to begin operation in 1983

SOURCE OF LLRW

The initial source of LLRW in a nuclear power plant is the reactor core; more specifically, it is the fission reaction which occurs in the reactor core. There are two types of radioactive products, or contaminants, produced by the fission reaction: direct fission fragments and corrosion products activated by the neutron flux.

Fission products are the radioactive atoms produced when the uranium atoms of the fuel split. Some typical fission products produced by the fission reaction are krypton-85, strontium-90, iodine-131, and cesium-137. Core structures do not provide complete containment of the fission products and traces of the fission fragments enter into the coolant surrounding the reactor fuel. The primary coolant water also contains various trace, nonradioactive elements. Some of these elements are inherent to the water, some are deliberately added as chemical controls, and others are elements which have corroded and/or leached from the metal surfaces of the primary coolant system. When the nonradioactive atoms in the primary coolant are exposed to the high neutron flux of the reactor core, some are transformed into radioactive atoms by a process called neutron activation. These radionuclides are referred to as the activated corrosion products. Some typical activated corrosion products are hydrogen-3 (tritium), iron-55 and -59, zinc-65, and cobalt-58 and -60. Table 1 lists the fission and activated corrosion products and the approximate concentrations found in the primary coolant of a typical PWR nuclear power plant.

Table 1

Concentrations of Radioactive Material in PWR Primary Coolant

Nuclide	Concentration μCi/cc	Nuclide	Concentration μCi/cc	Nuclide	Concentration μCi/cc
		Fission Products			
Rb-86	0.00017	Ru-106	0.000021	I-132	0.19
Sr-89	0.0007	Rh-103m	0.00009	I-133	0.75
Sr-90	0.000019	Rh-106	0.000021	I-135	0.38
Sr-91	0.0013	Te-125m	0.000058	Cs-134	0.05
Y-90	0.000033	Te-127m	0.00056	Cs-136	0.025
Y-91m	0.00075	Te-127	0.0017	Cs-137	0.035
Y-91	0.0039	Te-129m	0.0027	Ba-137m	0.033
Y-93	0.00025	Te-129	0.0031	Ba-140	0.00044
Zr-95	0.00012	Te-131m	0.0049	La-140	0.0003
Nb-95	0.0001	Te-131	0.0022	Ce-141	0.00013
Mo-99	0.89	Te-132	0.054	Ce-143	0.000089
Tc-99m	0.76	I-130	0.0042	Ce-144	0.000066
Ru-103	0.00009	I-131	0.54	Pr-143	0.0001
				Pr-144	0.000066
		Activated Corrosion Products			
Cr-51	0.0019	Fe-55	0.0016	Co-58	0.016
Mn-54	0.00031	Fe-59	0.001	Co-60	0.002
				Np-239	0.0012
		All others[a]	0.075 ?		
		Total[a]	4.76		

[a] Except tritium and noble gases
Taken from NUS78a

The radioactive contaminants migrate fr... the primary coolant system into supporting auxillary systems. The radioactivity may then deposit on the interior surfaces of the piping, valves, and pumps of the auxilliary systems. When small leaks occur the radioactive contaminants seep onto the exterior surfaces of the piping, the surrounding equipment and building surfaces, and eventually into the plant's nuclear related drainage systems. The radioactive contaminants may be transferred to other materials such as wiping rags, protective clothing, and tools when personnel work on the system components. In order to reduce the concentrations of these radioactive contaminants at the source and to contain and dispose of the contaminants which migrate to other systems and areas of the plant, nuclear power plants have a LLRW management system. This system contains, collects, processes, stores, and packages all the LLRW which is generated. Figure 3 illustrates the typical LLRW management flowpath for a PWR nuclear power plant. In the upcoming sections, each part of the LLRW management system will be discussed.

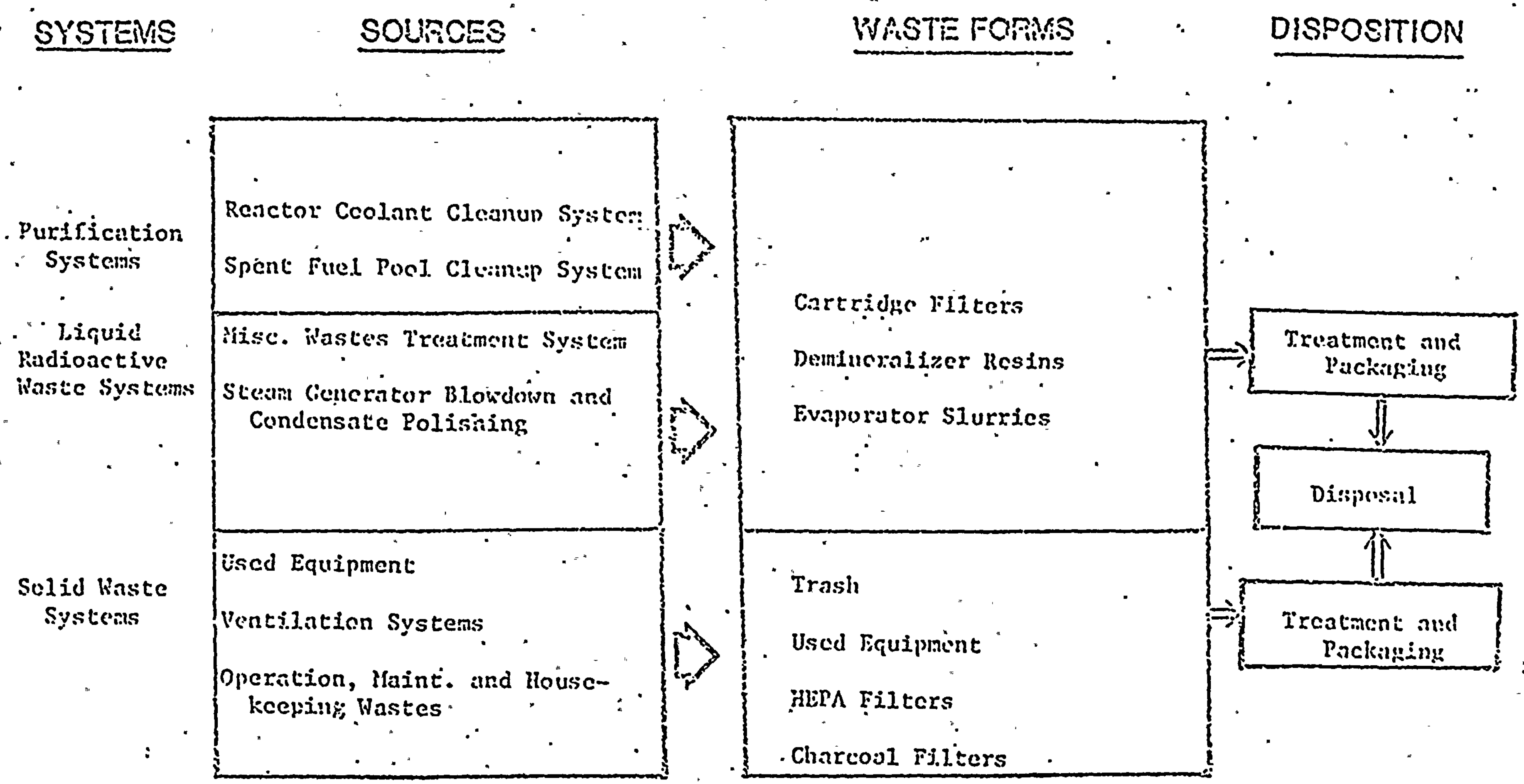


FIGURE 3. LLRW MANAGEMENT PATH FOR A PWR NUCLEAR POWER PLANT

LIQUID LLRW COLLECTION AND PROCESSING

There are basically four radioactive waste processing systems which remove radioactive contaminants from liquid waste streams in a nuclear power plant. Typically these systems generate approximately 50 percent of the total LLRW volume of the plant; however, the actual percentage for any individual nuclear power plant depends upon the operating characteristics of that plant.

Reactor Coolant Cleanup (or Chemical and Volume Control) System

The reactor coolant cleanup system processes the primary coolant to remove the radioactive contaminants. In this system, as in many non-nuclear industrial applications involving closed circulating systems, the concentration of contaminants is controlled by "blowdown". This process involves continually or intermittantly removing a fraction of the circulating fluid and replacing it with a similar volume of "clean" fluid. Unlike non-nuclear industrial applications, the displaced fluids in a nuclear power plant may not be discharged directly to the environment.

The "blowdown" primary coolant is stored in large tanks, commonly called reactor coolant bleed tanks, until the plant management desires to process it. The coolant is then routed through a combination of filters and demineralizers to remove the radioactive contaminants. The processed coolant, called makeup water, is then stored in tanks until it is necessary to feed it back into the primary coolant system. The plant also has the option of discharging the makeup water to the environment,

providing the radionuclide concentrations are below federal regulations.

The LLRW generated by this system is in the form of filter cartridges and demineralizer resins. The volume of LLRW generated by this system is estimated to be 370 cubic feet per year for a 1000 MWe PWR plant. (NUS78a)

Another system incorporated into the reactor coolant cleanup system is the boron recovery system. In a PWR plant the boron in the primary coolant acts as a chemical control rod for the nuclear reaction. By varying the concentration of boron in the coolant, the plant can "finetune" the power level of the reactor. As the fuel "burns up" during extended operation, it becomes necessary to reduce the boron concentration of the primary coolant. This is done by removing coolant through the reactor coolant cleanup system and replacing it with makeup water having a lower boron concentration. It also occasionally becomes necessary to increase the boron concentration in the primary coolant. In order to have a ready supply of boron concentrate for that purpose, the primary coolant is processed through a series of deborating demineralizers and evaporators to provide a boron concentrate. The boron concentrate may then be stored in tanks until needed. The boron recovery sysem also generates LLRW in the form of evaporator concentrates and demineralizer resins. The volume is estimated to be 690 cubic feet per year for a 1000 MWe PWR plant. (NUS78a)

Steam Generator Blowdown and Condensate Polishing Systems

As described previously, a PWR nuclear power plant employs an indirect cycle to generate steam which turns the turbines.

Transfer of the heat energy of the primary coolant to the secondary coolant system involves several large heat exchanger called steam generators. The number of steam generators in a nuclear power plant and their design varies amoung the three PWR manufacturers. The Westinghouse plants at Turkey Point use three steam generators, while the Combustion Engineering and Babcock and Wilcox plants at St. Lucie and Crystal River utilize two steam generators.

The primary coolant from the reactor enters the primary side of the steam generator at a temperature of about 650 degrees Fahrenheit and a pressure of 2250 pounds per square inch. The flow rate of the primary coolant entering the steam generator can exceed 60 million pounds per hour. The primary coolant is directed through from 4000 to 8000 small diameter, thin-walled, heat exchanger tubes in the steam generator. The thermal energy of the primary coolant is transferred to the secondary coolant which surrounds the heat exchanger tubes. The heated secondary coolant (steam) leaves the secondary side of the steam generator at a temperature of about 550 degrees Fahrenheit, a pressure of 1000 pounds per square inch and at a flow rate of over 5 million pounds per hour. The steam travels through the turbine and then is condensed back to a liquid before returning to the steam generator.

The secondary coolant system also goes through a "blowdow process to control the level of contaminants in the system. Unlike the primary coolant "blowdown" system, the contaminant of major concern in the secondary system are nonradioactive atoms which could form mineral deposits within the turbine system. The "blowndown" secondary coolant is replaced with

water which has been purified using filters and demineralizers. The secondary "blowdown" system does not pose a serious LLRW problem unless there is an inordinate amount of coolant leakage from the primary to the secondary side of the steam generator. If this occurs, secondary coolant cleanup systems can produce a substantial amount of LLRW.

When primary to secondary leakage does occur, it is generally due to small hairline cracks which develop in the walls of the steam generator heat exchanger tubes. The cracks form because of the tremendous stresses which the heat exchanger tubes are exposed to during the operation of the plant. Nuclear power plants do several things to prevent tube leakage and to control the discharge of radioactivity when it does occur. The preventative measure taken involves a process called eddy current testing. In eddy current testing, a magnetic probe is run through the individual heat exchanger tubes to detect any cracks or thin spots in the walls of the tubes. If any indications of cracks or thin spots are discover in the tubes, the tubes are closed. Eddy current testing is performed on a percentage of the steam generator tubes during each refueling outage as a part of the nuclear power plant's inservice inspection program.

Despite preventative measures, it is possible that some primary to secondary leakage will develop in the steam generator during plant operation. The plants use gamma spectroscopy to check for any leaks. Samples of the secondary coolant are taken periodically and analyzed

for fission and activated corrosion products. If the secondary coolants contains any radioactive contaminants, the "blowdown" secondary coolant could require some degree of processing to remove the contaminants before being discharged from the plant. There are two methods of processing this secondary coolant, both utilizing a series of filters and demineralizers. The first involves only processing the "blowdown" coolant. Recently, PWR designers, in light of the potential for steam generator leakage, have incorporated a full-flow secondary coolant cleanup system, called a condensate polishing system, into plant designs. A condensate polishing system processes all the secondary coolant which passes through the steam generator. It is these filters and demineralizer resins from these systems which may contribute to the plant's LLRW volumes. Estimates of the LLRW volume generated by these systems range from 1000 to 2000 cubic feet per year for a 1000 MWe PWR plant. (NUS78c) The actual volume of LLRW generated by these systems for any particular plant varies tremendously, as can be seen by examining the nuclear power plants in Florida.

FP&L's St. Lucie plant has never had any significant primary to secondary leakage problems or LLRW resulting from secondary coolant processing. The St. Lucie plant does have a condensate polishing system available for use in the event this should become a problem in the future.

FP&L's Turkey Point plants have had problems with cracks in their steam generators heat exchanger tubes for several years; but the resulting primary to secondary leakage has not contributed to Turkey Point's LLRW volumes. The reason for this never severe enough "at one time" to exceed plants discharge limits - how about cumulative

is that the leakage occurred slowly over the years and has never been severe enough at any one time to cause the radionuclide concentrations in the steam generator "blowdown" to exceed the plant's discharge limits. Turkey Point's steam generator problems will produce a LLRW problem of a different type in the future. Because so many of the steam generator tubes have been plugged, the heat transfer efficiency of the steam generators has been reduced. In the near future, the faulty steam generato will have to be replaced, adding an estimated one time productio of 37,000 cubic feet to Turkey Point's LLRW volumes.

FPC's Crystal River plant has also had primary to secondary leakage problems with their steam generators. The problems started when a control rod in the reactor shattered. The fragme traveled through the primary coolant system producing punctures in some of the steam generator tubes. The incident occurred in early 1978 and forced the Crystal River plant to be shutdown from March to September of that year for repairs and testing. During 1979 the volume of water processing LLRW, i.e. filters, demineralizer resins, shipped from the Crystal River plant increased by 50 percent. In the first half of 1980 the volume of water processing LLRW has declined to the same level as befo the control rod incident. If it can be assumed this increase was due to increased secondary coolant processing, the control rod incident led to the generation of an additional 8500 cubic feet of LLRW for Crystal River Unit 3.

Miscellaneous Waste Processing System

The miscellaneous waste processing system collects and processes the waste liquids from drainage systems in the

nuclear portion of the power plant, such as floor, equipment, laundry, decontamination station, and chemical drains. The input to the floor drains is from solutions used to decontaminate areas and from draining system piping to the floor drains. The equipment drains handle any liquids which leak from the pumps and other equipment during operation. The laundry drains receive the detergent solutions used in cleaning protective clothing worn by plant personnel. Decontamination of equipment also contributes to the volume of liquids processed through the miscellaneous waste processing system, as does the chemical waste liquids from chemistry laboratories and other areas of the plant.

Each of these liquid waste streams is collected, sampled for radioactive contaminants, and, if necessary, processed through filters, evaporators, and demineralizers, then discharged from the plant.

The contribution ot the LLRW volume from the miscellaneous waste processing system is estimated to be 7800 cubic feet per year for a 1000 MWe PWR plant. (NUS 78a)

Spent Fuel Pool Cleanup System

The spent fuel pool cleanup system removes radioactive contaminants from the cooling water in the spent fuel storage pool. After the fuel bundles are removed from the reactor, they are placed in the spent fuel storage pool. During storage, some of the radioactive contaminants in and on the fuel leach into the surrounding cooling water. These contaminants are removed by a filter and demineralizer. The LLRW contribution from the spent fuel cleanup system is estimated to be 180 cubic feet per year for a 1000 MWe PWR plant. (NUS 78a)

LIQUID LLRW PROCESSING TECHNIQUES

Each of the liquid LLRW processing systems discussed uses a combination of filters, demineralizers, and evaporators to remove the radioactive contaminants from the liquid waste streams.

Filtration is used to remove suspended solids from a solution. Any radioactive contaminants contained in the suspended particles are removed by this process. Many types of filters are available for use in nuclear power plants; however, the predominant type used by nuclear plants in Florida is a disposable, cartridge filter. A cross-sectional view of this type of filter is shown in Figure 5. The filters units are replaced when the pressure drop across the unit becomes to large. It is the individual filters which constitute LLRW.

Demineralizers utilize an ion exchange process to remove radioactive ions from a solution. A household water softener operates on the same principle. A solution is passed through a resin bed containing anion resin, cation resin or a mixture of both. The atoms and molecules having a negative ionic charge, i.e. an anion, are attracted to the anion resins, and the positively charged atoms and molecules, i.e. a cation, attach to the cation resins. The chlorides, borates, cesiums, and nearly all of the other fission and activated corrosion products in the liquid waste streams are removed in varying degrees by this process. The efficiency of a resin for removing a contamin is referred to as the decontamination factor of the resin. The decontamination factor is defined as the ratio of the concen trations of a radionuclide in the solution entering the system t

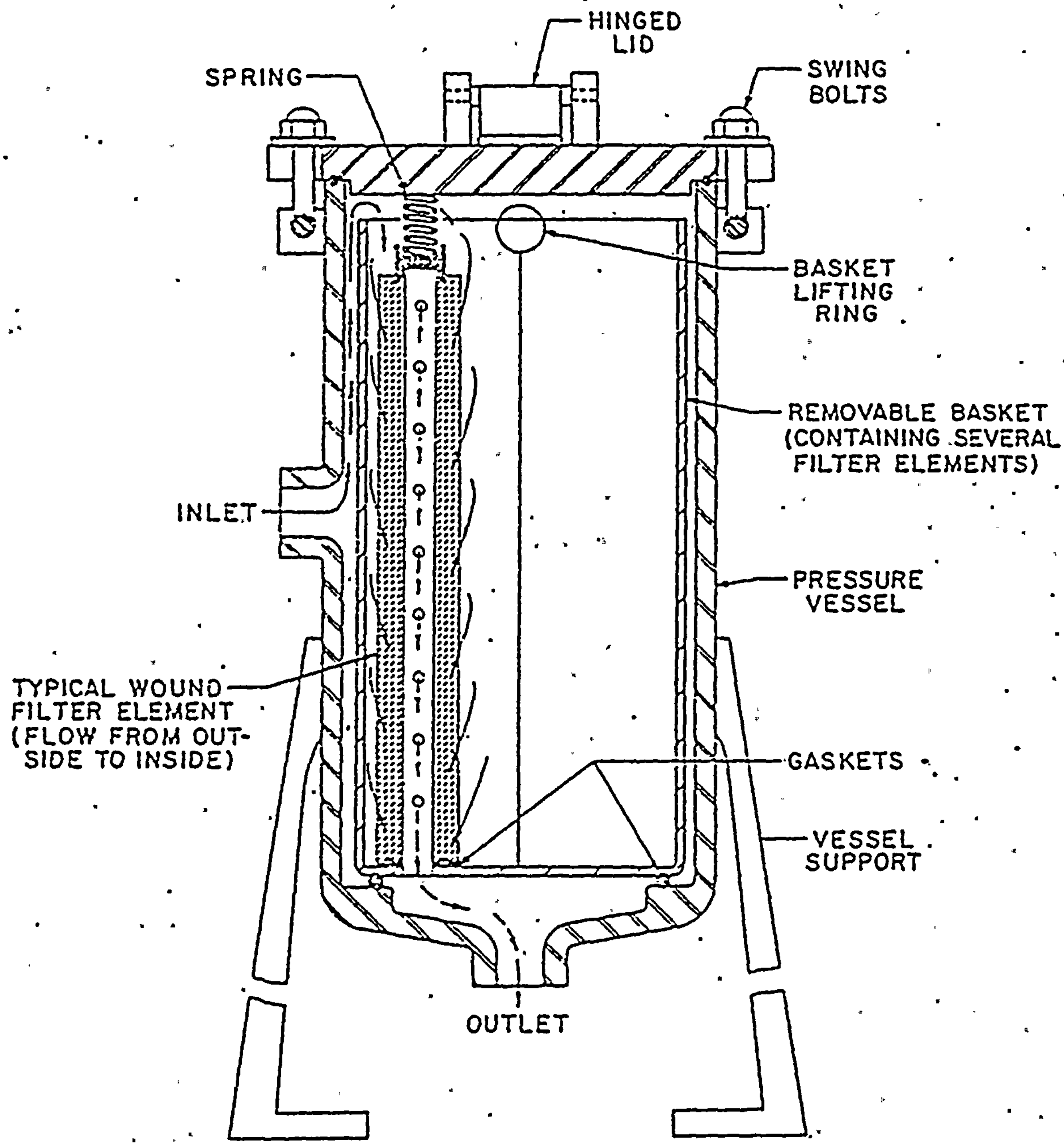


Figure 4. : Typical Disposable Cartridge Filter

Taken from NUS79

its concentration in the effluent. The decontamination factors for a demineralizer used in a PWR nuclear plant is shown in Table 2. The majority of the LLRW generated by demineralizers is in the form of ion exchange resins. A cross-sectional veiw of a typical demineralizer is shown in Figure 6.

The function of an evaporator is to produce a condensed vapor, as free of the original contaminants as possible, by boiling off the liquid radioactive waste solution. In simple terms the unit is a still, producing distilled water and a concentrated slurry. The contaminants in the slurry may then be disposed of as LLRW. Evaporators are used in PWR plants to concentrate the boron in the boron recovery system and to remove radioactive contaminants from miscellaneous waste solutions, which because of their chemical properties, may not be processed using demineralizers. Evaporators provide the best overall decontamina factors of any single piece of process equipment used for the removal of radioactive and nonradioactive contaminants from liqui process streams. Table 3 lists the accepted decontamination factors for evaporators in PWR Plants.

There are many types of evaporators used in nuclear power plants. The evaporator shown in Figure 7 is similar to the one used at the Crystal River plant to process miscellaneous wastes; an evaporator similar to the one in Figure 8 is used to process borated water at the St. Lucie plant; and the Turkey Point plants use both types of evaporators for liquid waste processing.

Table 2

Demineralizer Decontamination Factors for PWRs

Demin Type	Anion	Cs, Rb	Other
Mixed bed (Li_3BO_3)	10	2	10
Mixed bed (H^+OH^-)			
Condensate	10	2	10
Radwaste	$10^2(10)^{(1)}$	2(10)	$10^2(10)$
Boron recycle system feed (H_3BO_3)	10	2	10
Steam generator blowdown	$10^2(10)$	10(10)	$10^2(10)$
Cation bed	$1^{(1)}$	10(10)	10(10)
Anion bed	$10^2(10)$	$1^{(1)}$	$1^{(1)}$

Note: Decontamination factors in parentheses are for evaporator polishing and second demineralizer in series.

Taken from NUS79

Table 3

Evaporator Decontamination Factors

Application	All nuclides except iodine	Iodine
Miscellaneous radwaste	10^4	10^3
Boric acid recovery	10^3	10^2
Laundry wastes	10^2	10^2

Taken from NUS79

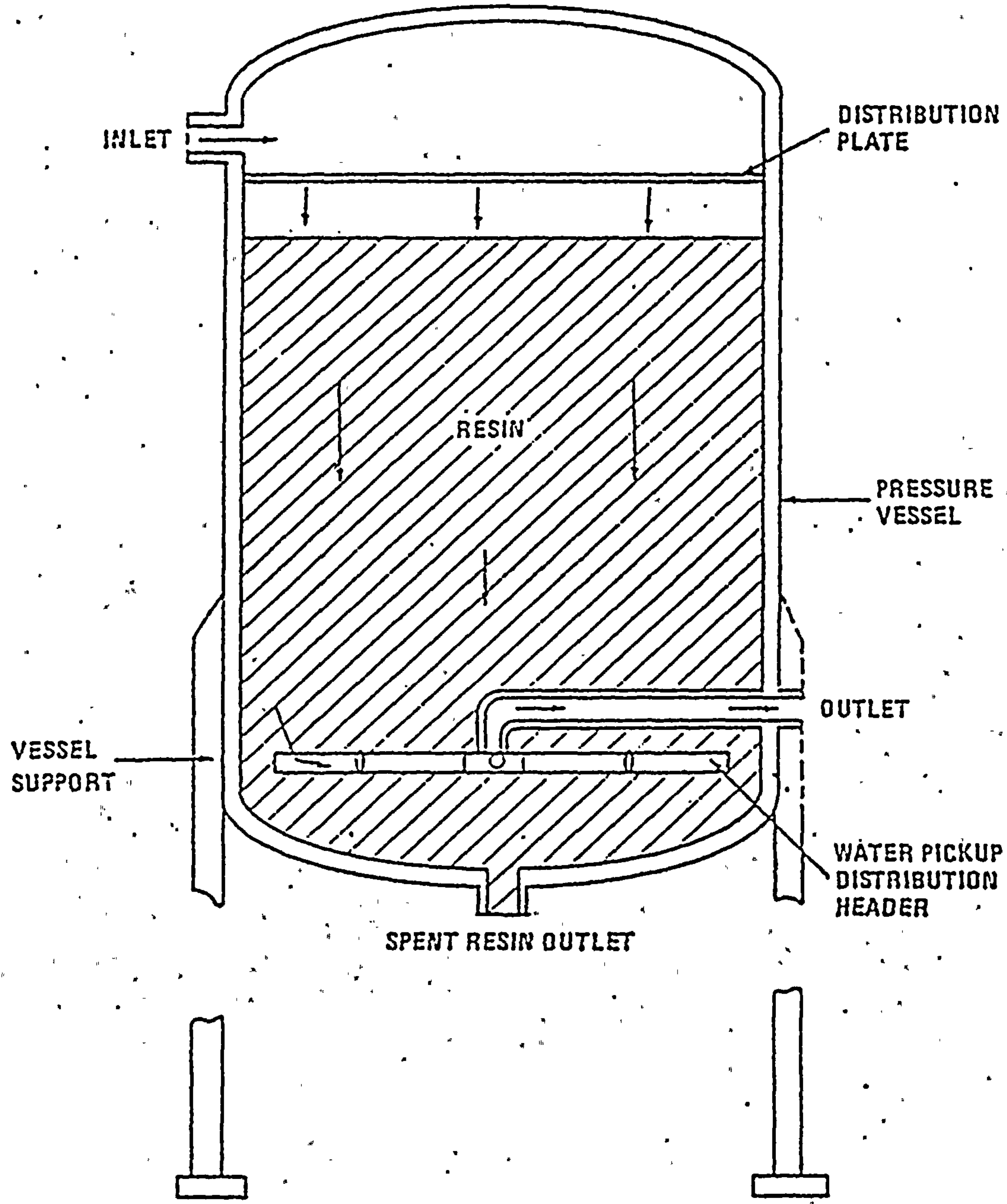


Figure 5. Typical Deep Bed Demineralizer

Taken from NUS79

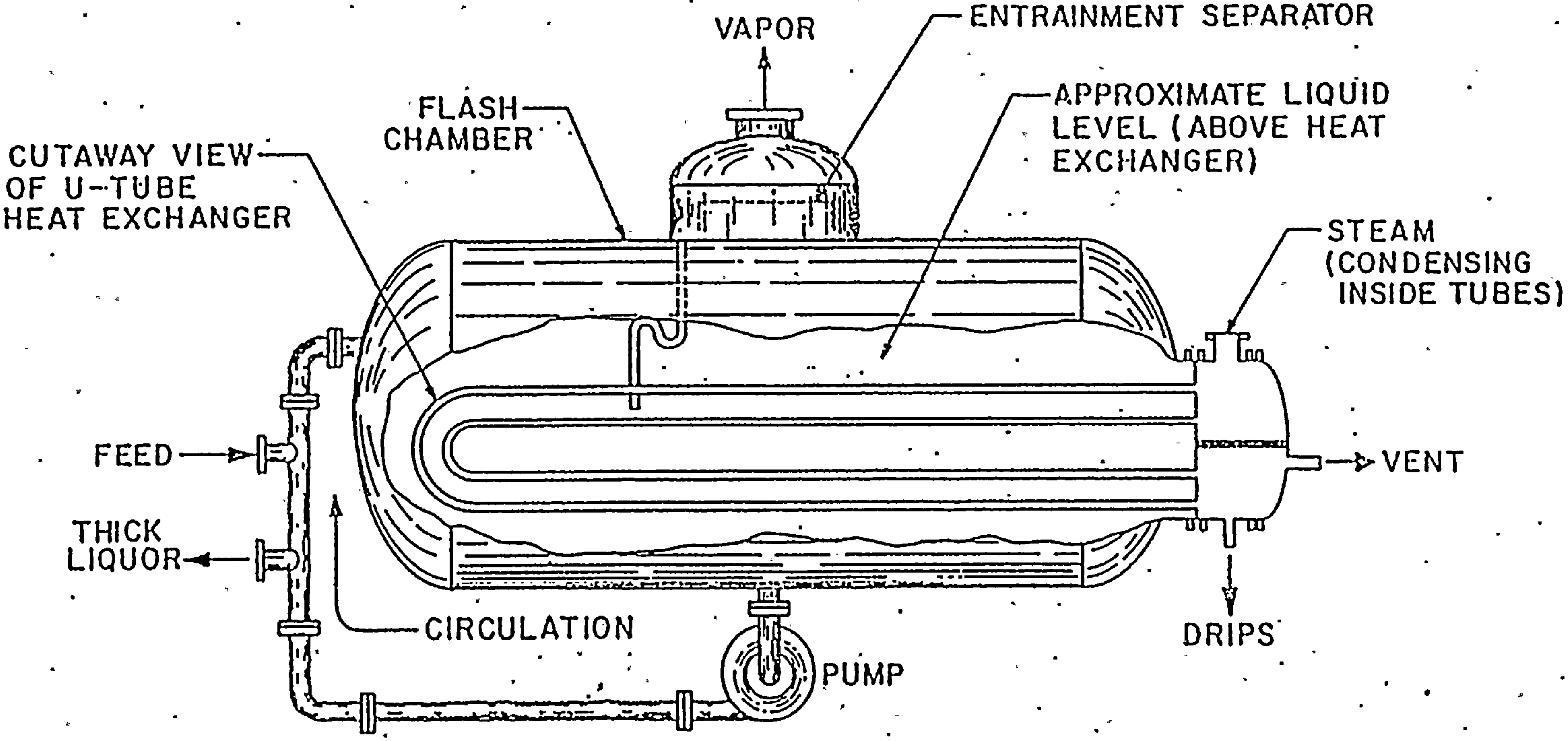


Figure 6. Submerged U-Tube Evaporator

Taken from NUS79

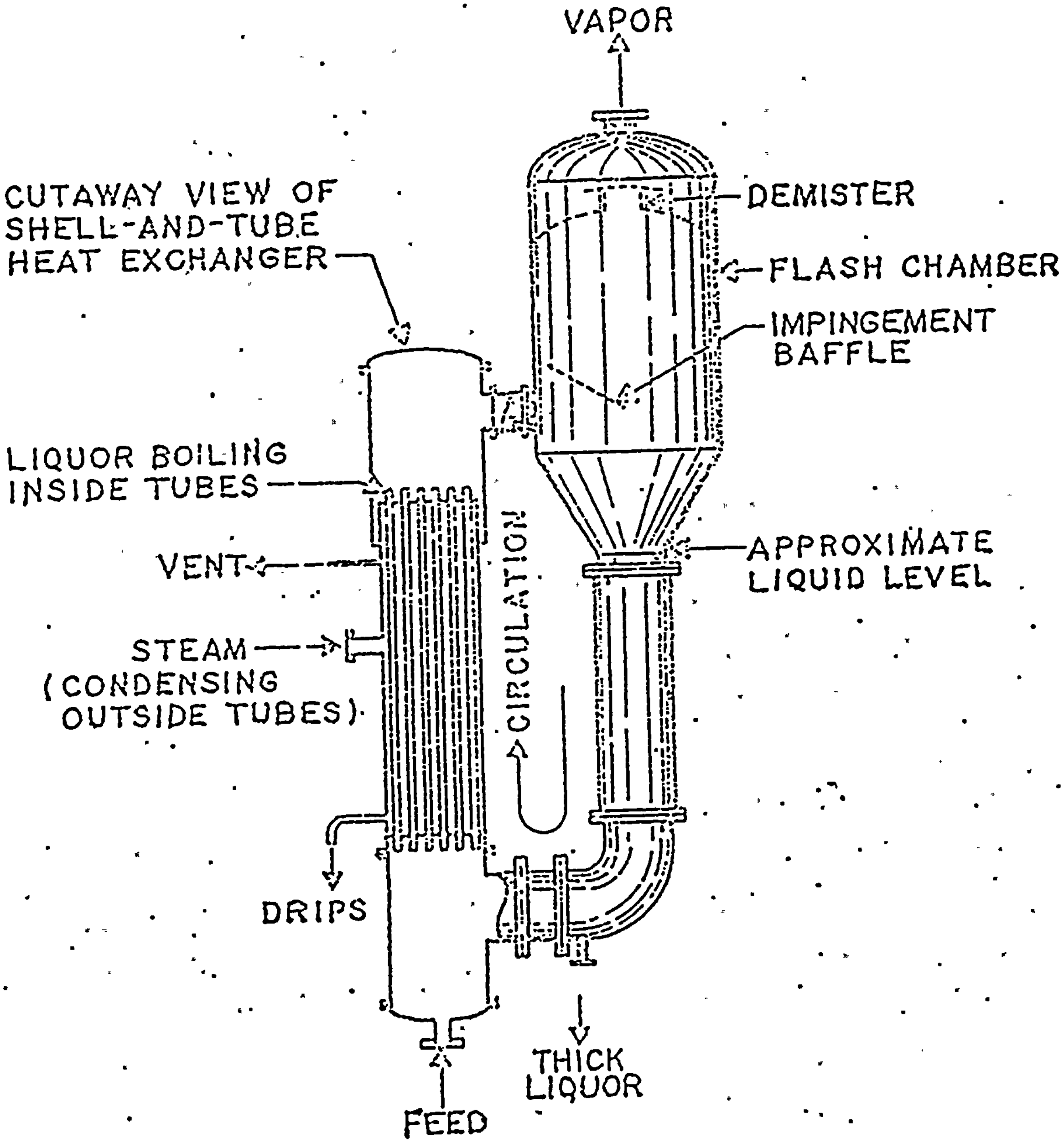


Figure 7. Long Vertical-Tube Evaporator with External Heater and Natural Circulation

Taken from NUS79

VOLUME REDUCTION IN LIQUID LLRW PROCESSING

There are two basic approaches to reducing the volume generated by a nuclear plant's liquid LLRW processing systems. The first approach involves reducing the volume of liquid which must be processed. By reducing inputs to the processing systems, the volume of evaporator concentrates is decreased and the effective lifetime of filters and demineralizer resins is increased; decreasing the LLRW volume generated by the systems. However, many of the liquid LLRW processing systems are related directly to plant operation and the input volumes to the systems are not easily reduced.

The second method of reducing the volume of liquid processing LLRW involves reducing the volume of the filters, demineralizer resins, and evaporator concentrates after processing has taken place. This approach uses advanced volume reduction systems to incinerate the liquid processing wastes. The section on advanced volume reduction systems discusses the types of systems currently available for this purpose.

FP&L and FPC are currently conducting detailed studies of their nuclear plants' LLRW management systems. A portion of these studies is devoted to examining the various input volumes to the liquid LLRW processing systems and the feasibility of employing volume reduction systems to reduce their LLRW volumes.

PACKAGING OF LLRW FROM LIQUID WASTE PROCESSING

The filters, resins, and evaporator concentrates from liquid waste processing must be properly packaged prior to shipment for burial. The primary objective of the packaging process is to convert the LLRW into a stable, monolithic form to minimize the possibility of any radionuclides being released to the environment during interim storage, transportation, and burial.

To obtain a stable, monolithic form the processing wastes are combined with a solidification agent. The most common agents used by nuclear power plants in the United States are cement and ureaformaldehyde (UF). Solidification agents such as these immobilize any freestanding liquids in the processing wastes; but they also contribute to the LLRW volume which is shipped for burial. The volume increase for solidification with cement ranges from 1.2 to 2.4 times the original volume, (NUS 79) depending upon the type of waste, i.e. resin or evaporator concentrate, which is solidified. In the case of UF, the volume increase from solidification is about a factor of 1.4 greater for all types of wastes. (NUS 79) FPC's Crystal River nuclear plant currently uses UF to solidify liquid processing wastes; however, in the near future a switch to cement for solidification is anticipated.

Some nuclear power plants in the United States, including those of FP&L, do not solidify their processing wastes, but ship the wastes in a dewatered form. In dewatering wastes, the freestanding liquid is removed by either centrifuging or decantin[g]. The dewatering process has the advantage of not contributing to the original volume of the processing wastes. The disadvantage o[f] dewatering is that it is nearly impossible to remove 100 percent

of the freestanding liquid. Because of this, dewatering may become an unacceptable practice in the near future. The Nuclear Regulatory Commission (NRC) has ruled that, as of January 1, 1981, the volume of freestanding liquid in a shipping container can be no more than one-half of one percent of the volume of the container; and by July 1, 1981, no amount of freestanding liquid will be acceptable. As an alternative solution, the NRC has given specifications for a high integrity shipping liner which could be used for shipping dewatered processing wastes which have small amounts of freestanding liquid. These liners should be available for use in the near future.

The containers used to ship liquid processing wastes are normally 55-gallon steel drums or steel liners of various volumes sized to fit a particular shield cask. The volume of these liners can vary from 50 to about 200 cubic feet. In some cases, the steel liners are loaded and transported inside a reuseable, shield cask, such as the one shown in Figure 9. The shield cask reduces the radiation exposure levels to which the driver of the transport vehicle and the general public are exposed to during transport to the burial site. At the burial site, the liners may be removed from the shield cask and buried. Some nuclear facilities also use large liners around which a disposable concrete shield has been cast. With this type of container, the liner and the shield cask are buried as one unit and thus the shield contributes to the LLRW volume.

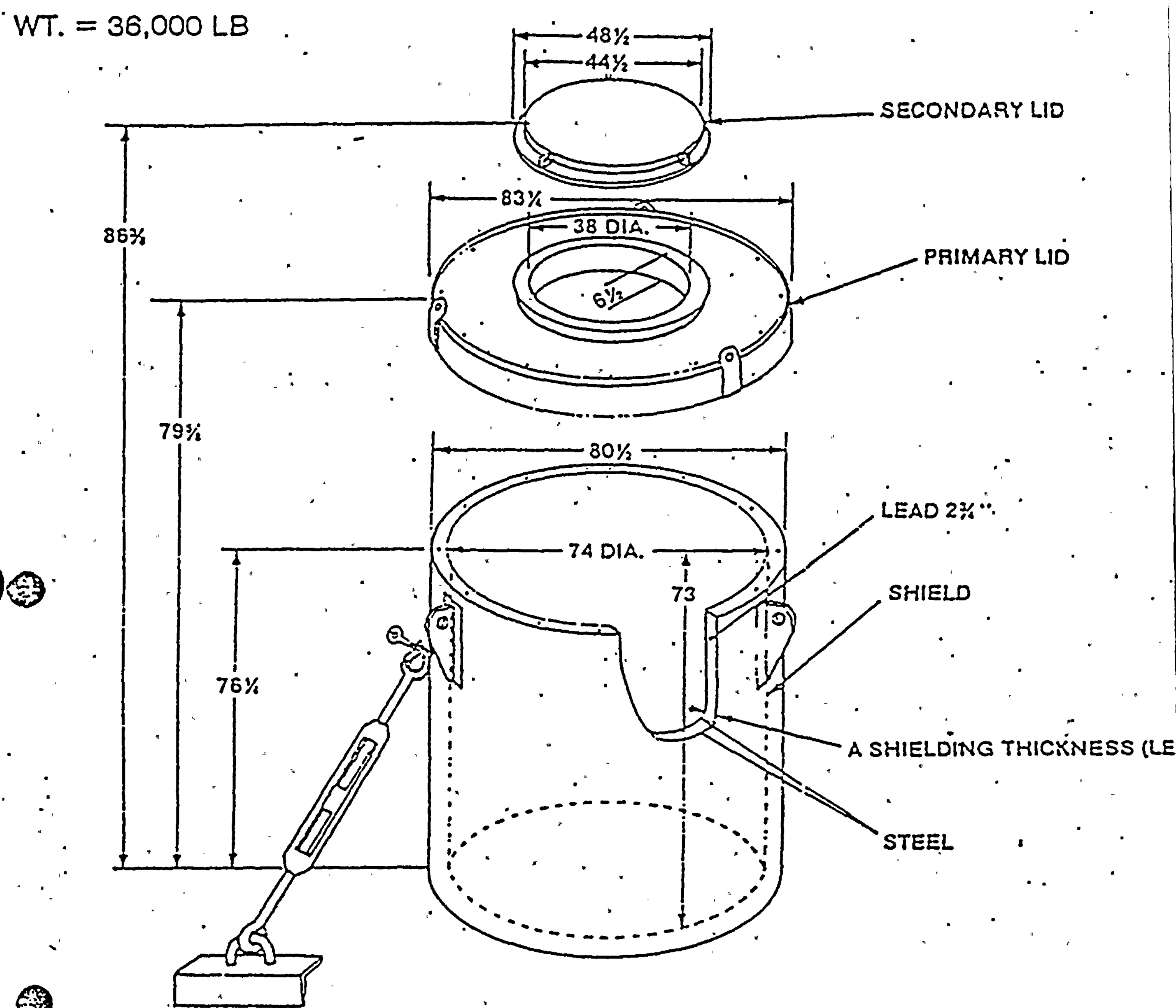


Figure 8. L3-181 Transport Cask

Taken from NUS79

LIQUID PROCESSING LLRW VOLUMES

In each of the previous discussions on liquid LLRW processing systems, volume estimates were given for a 1000 MWe PWR nuclear power plant. The values given were obtained by combining data given in: final safety analysis reports for a typical 1000 MWe PWR plant; the proposed standard by American Nuclear Society Committee N55.1, draft 1 of ANSI-N198, "Solid Radioactive Waste Processing System for Light Water Reactors"; American Nuclear Society Committee N55.2, ANSI-N199, "Radioactive Waste Processing System for Pressurized Water Reactor"; and from two NUS Corporati surveys of operating nuclear power plants. (NUS78a) The estimated LLRW volume from all the liquid processing systems for a 1000 MWe PWR plant ranges from 10,100 to 10,900 cubic feet per year. (NUS78a) However, these values are for unpackaged LLRW. If a factor of 1.5 is applied to the values to account for packaging effects, the value become 15,100 to 16,400 cubic feet of LLRW per year.

The values listed in Table 3 are the LLRW volumes from liqui waste processing reported by St. Lucie Unit 1 and Crystal River Unit 3 in their "Effluent and Waste Disposal Semiannual Reports" These values are displayed graphically in Figure 10.

The LLRW volume reports for Turkey Point Units 3 and 4 did not distinguish between liquid processing LLRW and other types o Because of this, all the data concerning the Turkey Point plants will be presented in the discussion on each plant's total LLRW volume history and volume projections.

Crystal River's liquid processing LLRW volumes decreased from 9888 cubic feet shipped during the second half of 1977 to 7804 cubic feet during the last half of 1978, a level which is

Table 4

Liquid Processing LLRW Volumes

St. Lucie Unit 1

Reporting Period	Volume(cubic feet)	% of Plant's Total LLRW Volu
7/1/76 to 12/31/76	860	28%
1/1/77 to 6/30/77	689	15%
7/1/77 to 12/31/77	820	6%
1/1/78 to 6/30/78	3482	41%
7/1/78 to 12/31/78	777	18%
1/1/79 to 6/30/79	293	5%
7/1/79 to 12/31/79	243	5%
1/1/80 to 6/30/80	170	3%
Total to Date	7334	

Crystal River Unit 3

Reporting period	Volume(cubic feet)	% of Plant's Total LLRW Vol
7/1/77 to 12/31/77	9888	95%
1/1/78 to 6/30/78	9500	85%
7/1/78 to 12/31/78	7804	59%
1/1/79 to 6/30/79	12,784	58%
7/1/79 to 12/31/79	13,349	62%
1/1/80 to 6/30/80	7981	53%
Total to Date	61,306	

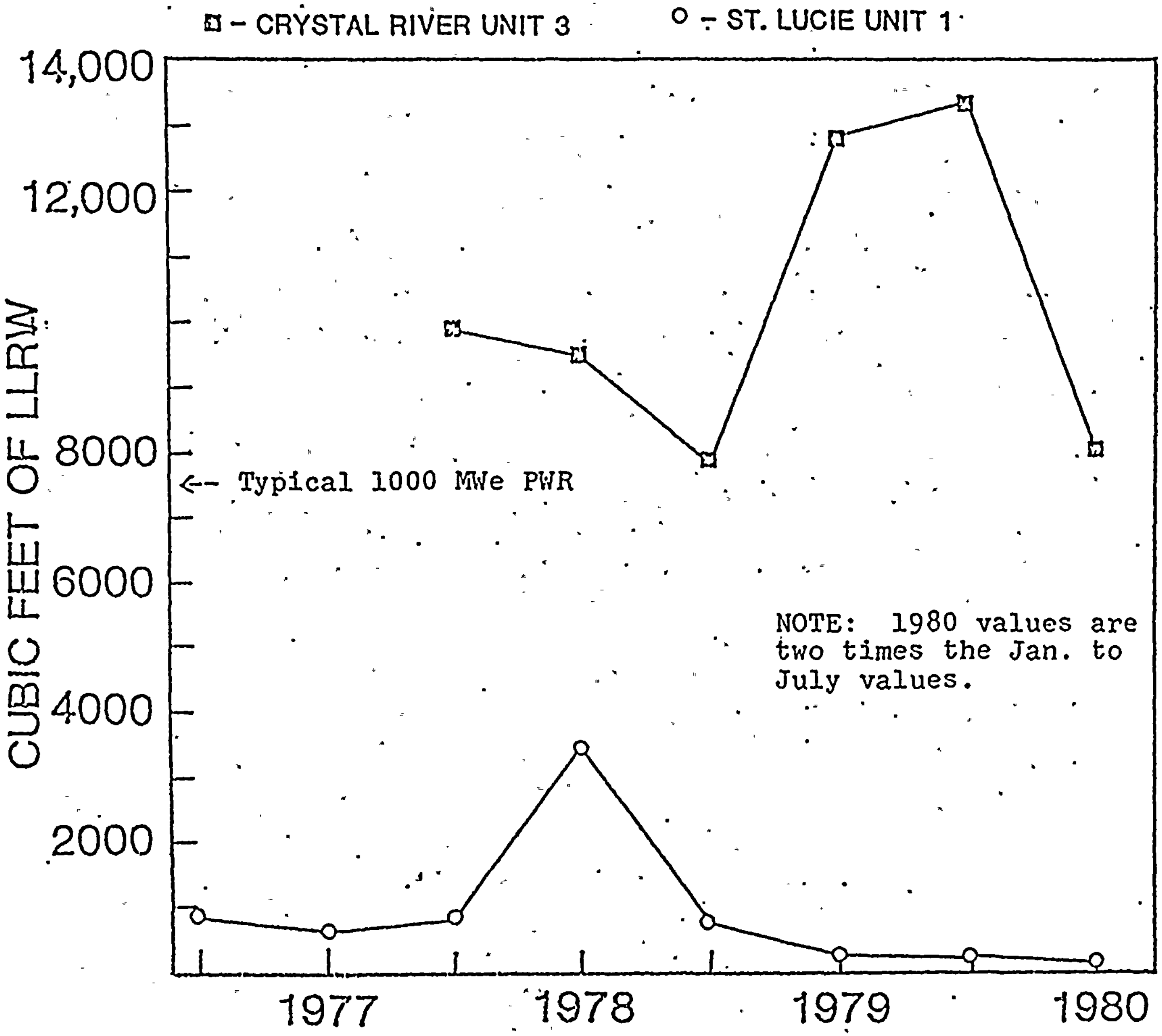


Figure 9. Liquid Processing LLRW Volumes

considered average for a 1000 MWe PWR plant. However, in the early part of 1978, the Crystal River plant developed control rod problems which resulted in steam generator primary to secondar leakage. This increased the liquid processing LLRW volumes for 1979 to over 26,000 cubic feet for the year. The LLRW volume for the first six months of 1980 show a decrease to the level seen prior to the control rod incident. As far as future liquid processing LLRW volumes from Crystal River, it is doubtful that there will be any significant, long-term increase in volumes as seen in 1979; however, it remains to be seen whethe or not the decreasing trend shown during the first 18 months of plant operation will resume. For the purposes of this report, future LLRW volume projections will be based upon 8000 cubic feet semiannually or 16,000 cubic feet per year of liquid processing LLRW from Crystal River Unit 3.

The liquid processing LLRW volumes shipped from St. Lucie Unit 1 are drastically lower than both Crystal River's volumes and volume estimates given for a 1000 MWe PWR plant. St. Lucie's liquid processing LLRW volumes have been consistantly under 1000 cubic feet semiannually and recently gone below 500 cubic feet. The only exception to this was during the first half of 1978 when the volume increased to 3482 cubic feet. It is beyond the scope of this study to perform a detailed comparison of the St. Lucie plant's liquid LLRW processing systems to other nuclear plants'; however, the nuclear industry in the United States could not find better plant to study and learn from regarding of liquid LLRW processing. Volume projections for St. Lucie Unit 1 and, after 1983, from St. Lucie Unit 2 will be based upon 1000 cubic feet of liquid processing LLRW semiannually or 2000 cubic feet per yea

SOLID LLRW SOURCES

The solid LLRW generated in a nuclear power plant can be divided into three basic categories: ventilation filters, fail or used equipment, and trash. Approximately 50 percent of a plant's total LLRW volume consists of these types of materials.

The ventilation filters are used to remove radioactive particulates and airborne contaminants (primarily iodine radioisotopes) from the plant's ventilation systems before rele of the air to the environment. The filters are composed of a cellulose or charcoal filter bed in a wooden or metal frame. Because of their construction, the filters are not readily subj to volume reduction techniques such as compaction or incinerati Ventilation filters account for approximately 500 cubic feet of LLRW per year for a 1000 MWe PWR plant. (NUS78a)

The failed and used equipment contributing to the LLRW volume is composed of a wide variety of materials and sizes. A cross-section of this material might include items such as valves, valve parts, piping, pump components, motors, hand tool air lines, water hoses, ladders, scaffolding, and wood. These materials originate from or are used during maintenance in the plant's contaminated areas or on contaminated systems. The materials are normally not compactable or combustable. Failed and used equipment accounts for an estimated 800 cubic feet of LLRW annually in a 1000 MWe PWR plant. (NUS78a)

Contaminated trash makes up the bulk of the solid LLRW generated in a nuclear power plant. It is estimated that almo 90 percent of a plant's solid LLRW volume is composed of contaminated trash. Some typical materials and their uses whi

- polyethylene sheeting - to cover areas, equipment, and construct tents for contamination control;
- polyethylene bags - to contain contaminated waste, tools, and equipment for contamina[tion] control;
- disposable protective clothing - for personnel protection against contamination;
- worn-out reusable protective clothing - for personnel protection against contamination;
- respirator filter cartridges - for personnel respiratory protection;
- wiping rags and mops - for area and equipment decontamination.

All of these materials are directly related to the protection of plant personnel from the radioactive contamination present in the workplace. Whether the materials are used directly by personnel, such as protective clothing and respiratory equipment, or benefit personnel indirectly, as with materials used for contamination control of areas and equipment, the materials provide the only barrier between the plant personnel and the contamination hazards inherent to a nuclear power plant. The majority of the contaminated trash volume is both compactable and combustable. Contaminated trash accounts for an estimated

10,700 cubic feet of LLRW per year in a 1000 MWe PWR plant. (NUS78a)

VOLUME REDUCTION OF SOLID LLRW

The predominant method used by nuclear power plants in the United States to reduce solid LLRW volumes is compaction. It is estimated that 66 to 80 percent of the solid LLRW generated in a nuclear plant is compactable. (NUS79) All of the nuclear plants in Florida use compactors to reduce the volume of solid LLRW prior to shipment for burial. The type of compactor in use at St. Lucie Unit 1 or Crystal River Unit 3 is a 55-gallon drum compactor similar to the one shown in Figure 11. A drum compactor such as this will give a uncompacted to compacted volume ratio of about 2.5 to 1. (NUS79) The Turkey Point nuclear plants use a box compactor for volume reduction of solid LLRW. A box compactor compresses material into a 110 cubic foot plywood or metal box with a force of more than 82,000 pounds. The compaction ratio for this type of compactor is about 4.5 to 1. Turkey Point's box compactor was installed in June, 1980, so volume reduction from it will not be noticible until 1981. At the time of installation, FP&L conducted a test of the compactor in which material which had been compacted with a drum compactor was recompacted in the box compactor. The box compactor achieved an additional 37 percent decrease in the volume of the material. Compaction of solid LLRW into boxes instead of drums also provid more efficient use of storage space. Storage of drums wastes 40 percent of the total storage space volume (e.g. 12 cubic feet of storage space is needed to store a drum having a volume of 7.3

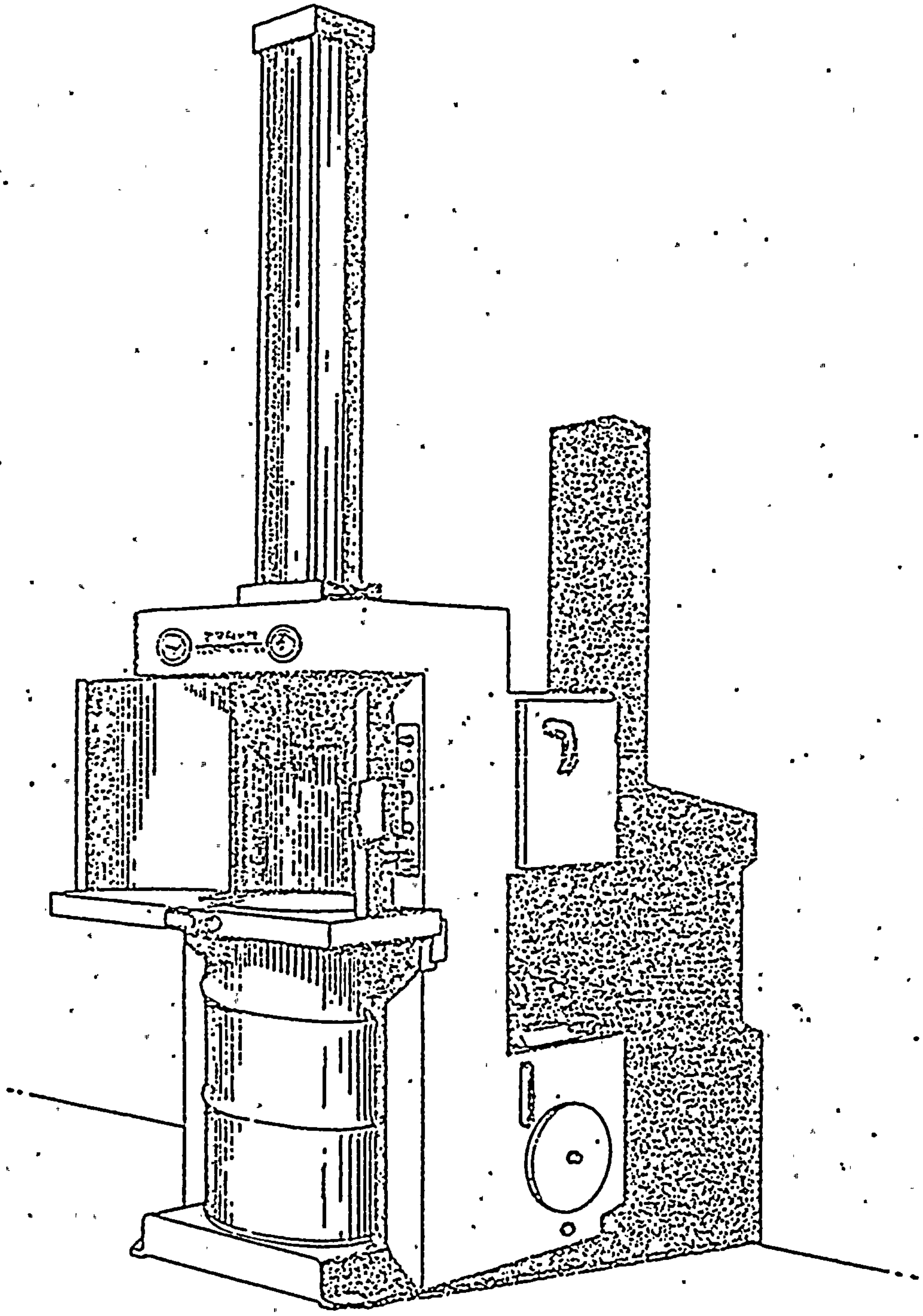


Figure 10. . DRY RADWASTE DRUM COMPACTOR

cubic feet). FP&L will also be installing a box compactor at the St. Lucie plant in the near future.

Most of the solid LLRW generated in a nuclear plant is generated by plant personnel during the performance of their work. Because of this, it is important that the plant personnel have an understanding of the problems facing nuclear power plants in regard to LLRW and know how to keep the amount of LLRW generated to minimum. FP&L and FPC both provide some amount of LLRW training to personnel. The training given to FPC employees stresses keeping all unnecessary materials out of contaminated and radiation control areas where it might become contaminated and be processed as LLRW. FP&L's general employee training on LLRW includes: FP&L burial allocations at Barnwell; regulations on LLRW handling, transport and disposal; discussion on keeping unnecessary materials out of areas where it could be processed as LLRW; nuclear housekeeping practices; and proper decontamination techniques. It is not possible to measure the amount of volume reduction achieved through programs such as these; however, the training does increase employee awareness of the LLRW problems which benefits the utility.

There are some work practices followed by the FP&L and FPC nuclear power plants which also help reduce solid LLRW volumes. The practice of keeping all unnecessary materials out of areas where it might end up as solid LLRW was previously mentioned. An example of this practice would be uncrating equipment outside of the plant's radiation control area to keep the containers and packing materials from eventually being processed as solid LLRW. Another plant practice which helps reduce LLRW volumes is good housekeeping. If areas are contaminated, they require protective

clothing for access which adds to the LLRW volume. Nuclear plants are also discontinuing the use of disposable protective clothing wherever possible and are substituting reuseable protective clothing. ?

The possible use of incinerators to reduce solid LLRW volumes is also being studied by FP&L and FPC as a part of their LLRW management studies. The section on volume reduction systems discusses one type of incinerator available.

SOLID LLRW VOLUMES

The average volume of solid LLRW generated in PWR plants is about 8800 cubic feet per year. (NUS 79) This figure includes both compactable and noncompactable LLRW. The values listed in Table 4 are the solid LLRW volumes reported by St. Lucie Unit 1 and Crystal River Unit 3 in their "Effluent and Waste Disposal Semiannual Reports". These values are displayed graphically in Figure 12. The Turkey Point LLRW volume reports did not distinguish solid LLRW volumes from liquid processing volumes. All the data concerning the Turkey Point plants will be presented in the discussion on the plants' total LLRW volume history and volume projections.

The solid LLRW volumes shipped from St. Lucie Unit 1 have been slowly increasing since initial startup. The only large increase in volume was during the second half of 1977 when over 8000 cubic feet of solid LLRW was shipped for burial. That large increase was due to modifications on the plant's spent fuel racks The old racks shipped for burial accounted for 5763 cubic feet. Had the modifications not been necessary, the solid LLRW volume would have been about 2400 cubic feet for that period (shown by broken line on Figure 12). One factor which affects the volume of solid LLRW generated by a nuclear plant is outage or shutdown time. When a plant is shutdown, the amount of maintenance performed increases dramatically, increasing the solid LLRW volume. St. Lucie Unit 1 was shutdown for refueling and maintenance activities for a period of 6 to 8 weeks during the first half of 1978, 1979, and 1980. During each of these

Table 5

Solid LLRW Volumes

St. Lucie Unit 1

Reporting Period	Volume(cubic feet)	% of Plant's Total LLRW Volume
7/1/76 to 12/31/76	2190	72%
1/1/77 to 6/30/77	3709	80%
7/1/77 to 12/31/77	8141	91%
1/1/78 to 6/30/78	4909	59%
7/1/78 to 12/31/78	3461	82%
1/1/79 to 6/30/79	5686	95%
7/1/79 to 12/31/79	4661	95%
1/1/80 to 6/30/80	6215	97%
Total to Date	38,972	

Crystal River Unit 3

Reporting Period	Volume(cubic feet)	% of Plant's Total LLRW Volume
7/1/77 to 12/31/77	530	5%
1/1/78 to 6/30/78	1640	15%
7/1/78 to 12/31/78	5191	39%
1/1/79 to 6/30/79	9394	42%
7/1/79 to 12/31/79	8087	38%
1/1/80 to 6/30/80	7204	47%
Total to Date	32,020	

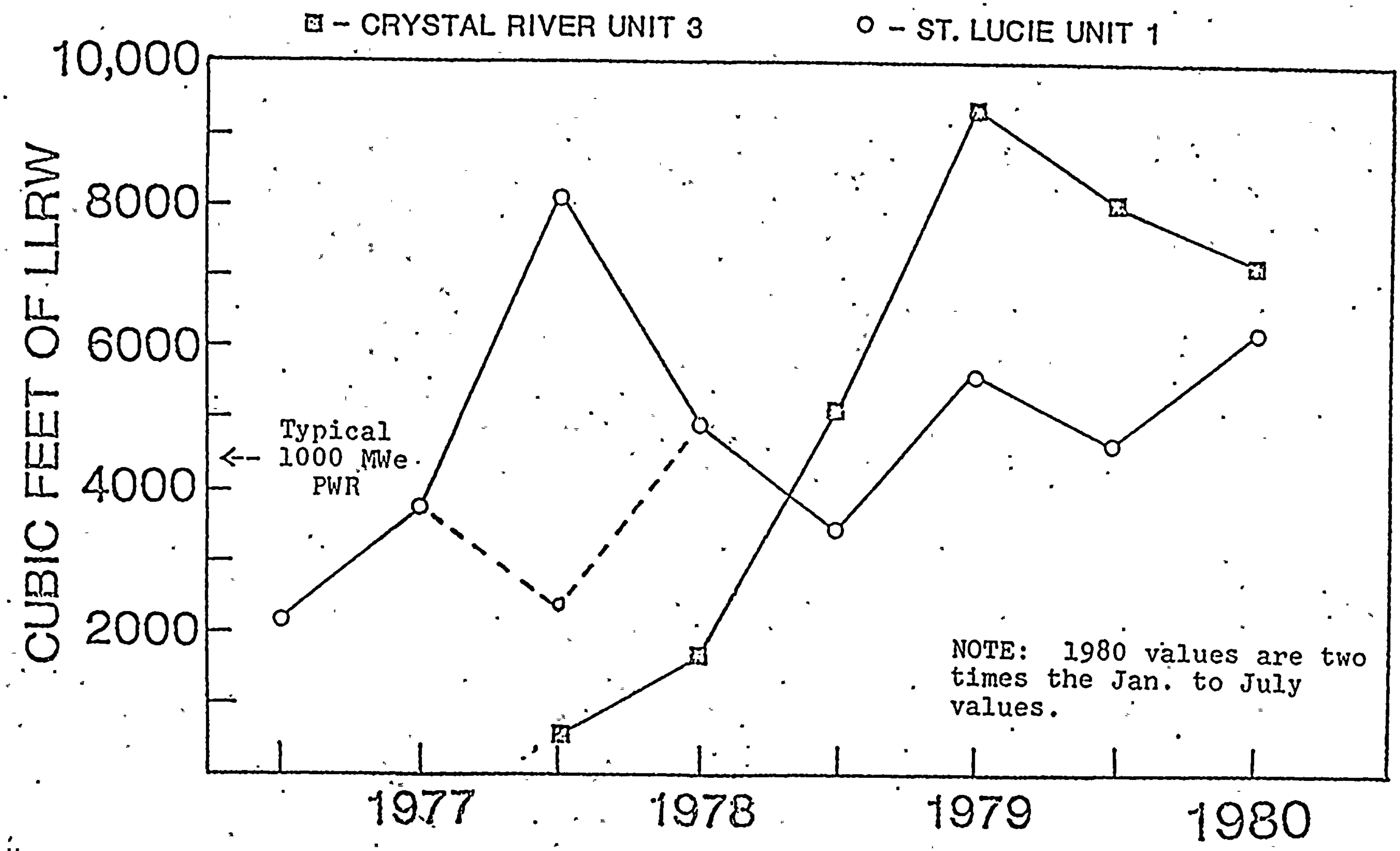


Figure 11. Solid LLRW Volumes

periods there were increases in the solid LLRW volumes shipped for burial. FP&L estimates that LLRW volumes increase as much as 32 percent per month during shutdown periods. It follows that if a plant can decrease the amount of shutdown time the volume of solid LLRW will also decrease. In the near future, the St. Luci plant will be converting an 18 month fuel cycle instead of their present 12 month cycle. That means a refueling shutdown will only be required about every 18 months. FP&L estimates a 10 percent reduction in St. Lucie's LLRW volumes because of the decrease in shutdown time resulting from the extended fuel cycle. The installation of a box compactor will also help reduce solid LLRW volumes at the St. Lucie plant. As much as a 37 percent decrease in the volume of compactable LLRW will be achieved by use of the box compactor.

If the period from July 1978 to July 1980 is used as a baseline for projections, the volume of solid LLRW generated by the St. Lucie plant will be about 5000 cubic feet semiannually or 10,000 cubic feet per year. The volume reduction effects of a box compactor and the extended fuel cycle could reduce that volume to as low as 2800 cubic feet semiannually or 5600 cubic feet of solid LLRW per year. Similar volumes should also be generated by St. Lucie Unit 2 after startup in 1983.

The solid LLRW volumes reported by Crystal River Unit 3 do not display the consistency seen in the values reported by St. Lucie. The reason for this is the amount of time Crystal Riv has been shut-down for repairs and refueling. During the 36 month period covered by Figure 12, the Crystal River plant was shutdown about 40 percent of the time. That has had a major impact on Crystal River's solid LLRW volumes. During the last 12

months the volume of solid LLRW being shipped has been steadily decreasing. Except for minor fluctuations, the decreasing trend should continue to a level similar to St. Lucie's current generation rate of 10,000 to 12,000 cubic feet per year.

VOLUME REDUCTION SYSTEMS

In the previous discussions on volume reduction of liquid processing and solid LLRW, it was mentioned that FP&L and FPC are investigating the possibility of using volume reduction systems in the future. There are several volume reduction processes currently available for use in nuclear power plants.

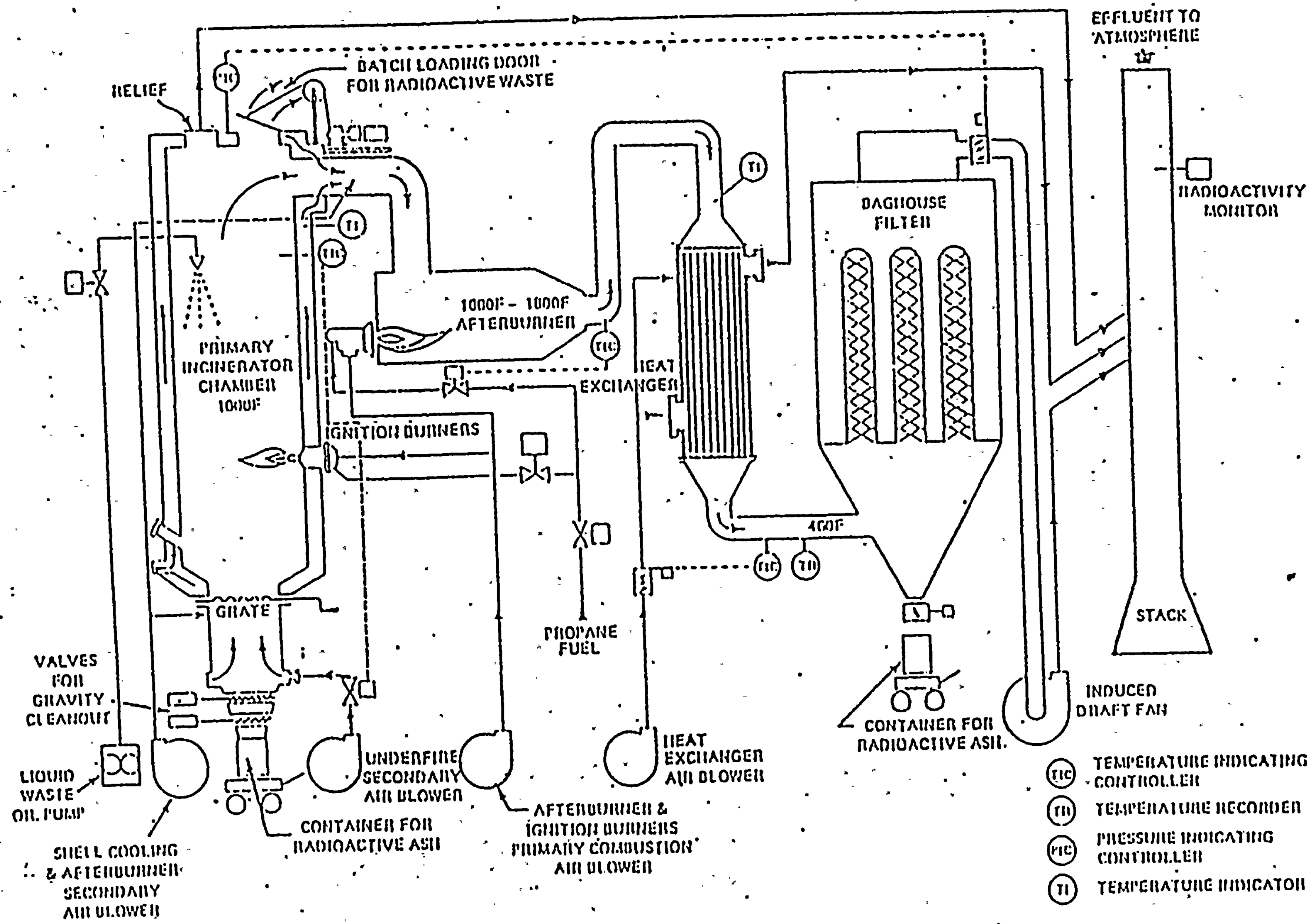
The volume reduction systems currently in use are: incinerators, fluidized-bed dryers, bitumen systems, evaporative crystallizers, and high-pressure compactors.

Incinerators

Incinerators are used to reduce the volume of combustible solids. There are several fuel-fabrication facilities and laboratories in the United States which have used incinerators to process LLRW for several years. Incinerators are also used in many other countries for LLRW applications.

A example of an incinerator used in a commercial nuclear power plant is the Trecan incinerator which is operated by Ontario Hydro of Canada. The Trecan incinerator is a 'starved air' batch-type which uses two combustion chambers. Figure 12 is a simple diagram of the Trecan model. The combustible LLRW enters the primary chamber and is pyrolysed at temperatures up to 1100 degrees Fahrenheit. The offgases from the primary chamber enter the afterburner chamber where they are burned at temperatures up to 1800 degrees. The flue gases are processed through a heat exchanger for cooling and then a baghouse filter unit. The Ontario Hydro incinerator can process batch loads of LLRW up to 700 cubic feet. The burn cycle for each load ranges from 30 to 60 hours. The volume reduction (including packaging effects) achieved by this incinerator is about 25 to 1; (0479) although some manufactures claim to obtain as high as a 40 to 1 volume reduction ratio.

In 1978, the Ontario Hydro operation processed over 65,000 cubic feet



Ontario Hydro Tracan Incinerator

of LLRW. That involved an average of two burn cycles per week. The total activity released out of the stack for 1978 was 2.8 millicuries of iodine-131 and 2.1 millicuries of particulate radionuclides.(OH79) It should be noted however that Ontario Hydro limits the radiation dose rate of the materials to be incinerated to 5 millirem per hour. During 1978, the incinerator required 10,311 manhours of mechanical maintenance; 4054 manhours of control maintenance; 7500 manhours of technical support; and 750 manhours of supervisory support. The incinerator was shutdown for maintenance about 39 percent of the time. The total cost for 1978 to operate the incineration facility and a compactor was $2,335,000 (Canadian dollars). The incinerator started operation in 1977. During the first two years there were unexpected problems and a significant amount of testing involved with the operation. Ontario Hydro expects the performance of the Trecan unit to improve greatly in future years.(OH79)

High-pressure Compactors

Another volume reduction system used for processing solid LLRW is the high-pressure compactor. This compactor will provide a volume reduction ratio of about 4 to 1.(NUS786) Most compactor used in nuclear power plants today have about 2 to 1 ratios. The box compactors which FP&L is installing at their plants are high-pressure compactors.

Evaporative Crystallizers

Evaporative crystallizers are basically a very efficient evaporator. They will concentrate boric acid solutions up to about 50 percent solids by weight, where as a typical nuclear power plant evaporator achieves only about 12.5 percent solids by weight. After solidification and packaging of the LLRW, an evaporative crystallizer will reduce the volume of evaporator concentrates with a ratio of about 4 to 1.(NUS786)

Fluidized-bed Dryers(Calciners)

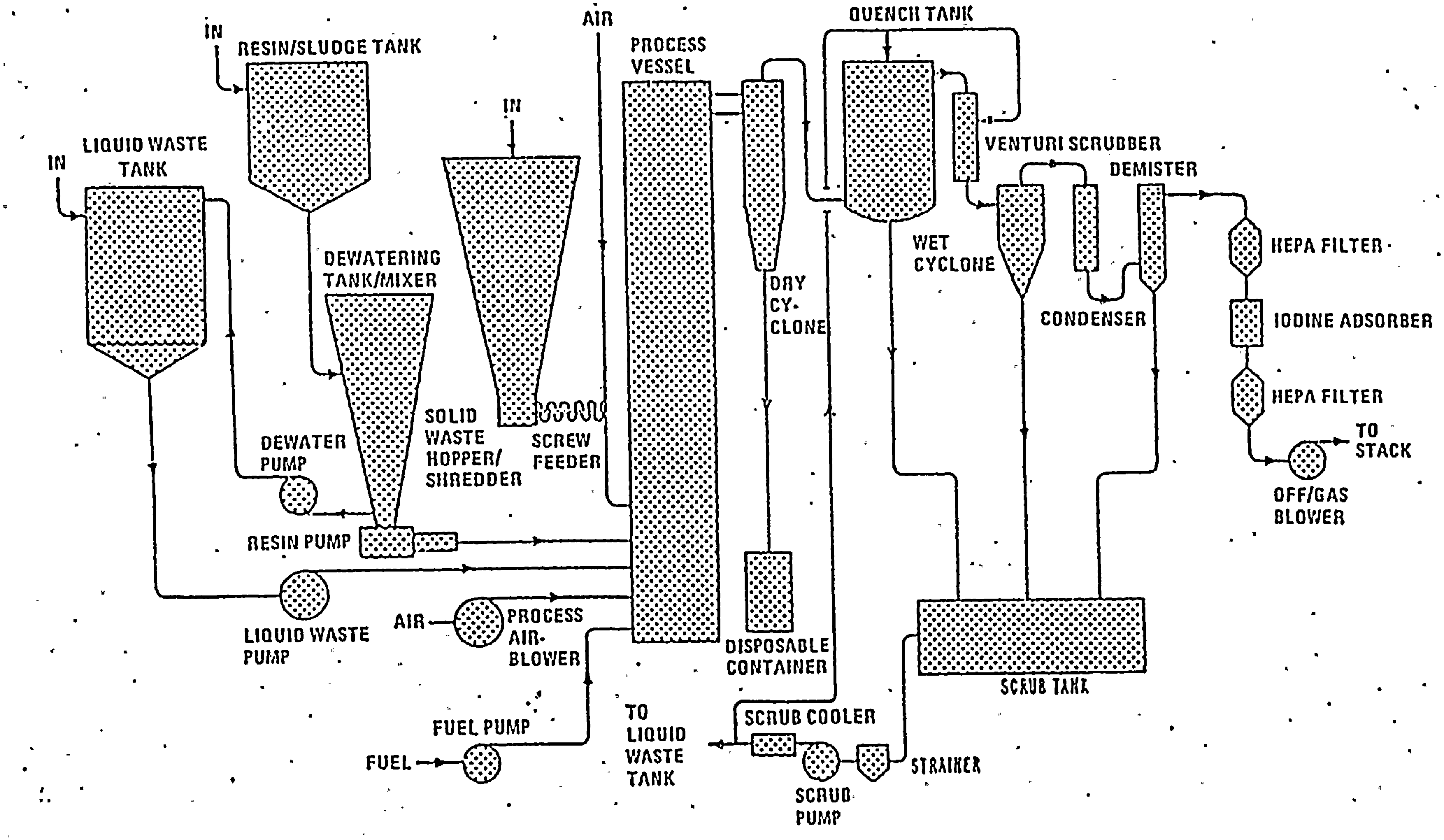
A fludiized-bed consists of inert particles which are continuously agitated by a stream of hot air in a vertical chamber. Typically, concentrated liquid solutions, such as evaporator slurries, are sprayed onto the bed, where the liquids are evaporated, leaving the solid particles to be solidified and discarded. After packaging, calcination of evaporator slurries can give a volume reduction ratio of about 5 to 1. (NUS78b)

Fluidized-bed techniques can also be used to incinerate combustible solids as well as evaporate liquids. Currently, two combined calcination/ incineration systems are being marketed in the United States. A flow diagram of the Newport News Industrial Corp. RWR-1 system is shown in Figure 13. This system can process demineralizer resins, evaporator slurries, and combustible solids. All processed materials are reduced to an anhydrous granular solid. After the materials are processed at temperatures from 750 to 1800 degrees Fahrenheit, the solid residue is removed by a dry cyclone, then solidified and packaged. The offgases from the system are processed through a venturi scrubber, condenser, demister, iodine filter, and several particulate filters before being vented. The calciner/incinerator systems achieve a volume reduction ratio, after packaging, of about 5 to 1 for evaporator slurries and about 40 to 1 for combustible solids. (NUS78b)

Bitumen Systems

Volume reduction with bitumen systems is accomplished by introducing concentrated liquid solutions into hot moltem bitumen. The heat from the bitumen drives off the excess water and the solids are retained in the bitumen. The bitumen mixture is then extruded into containers for shipment.

Bitumen systems originated in Europe and have been used there for several years. As yet, there are no bitumen systems in use at commercial nuclear power plants in the United States. Figure 14 shows the basic arrangement of a Werner & Pfleiderer Corp. bitumen system. Bitumen systems have the advantage of providing volume reduction and solidification of LLRW


IN
RESIN/SLUDGE TANK
AIR
PROCESS
VESSEL
QUENCH TANK
IN
LIQUID WASTE
TANK
VENTURI SCRUBBER
DEMISTER
WET
CYCLONE
HEPA FILTER
DEWATERING
TANK/MIXER
DRY
CY-
CLONE
CONDENSER
IODINE ADSORBER
HEPA FILTER
SOLID
WASTE
HOPPER/
SHREDDER
SCREW
FEEDER
DEWATER
PUMP
TO
STACK
OFF/GAS
BLOWER
RESIN PUMP
LIQUID WASTE
PUMP
AIR
PROCESS
AIR-
BLOWER
DISPOSABLE
CONTAINER
SCRUB TANK
FUEL PUMP
FUEL
TO
LIQUID
WASTE
TANK
SCRUB COOLER
SCRUB
PUMP
STRAINER

48.

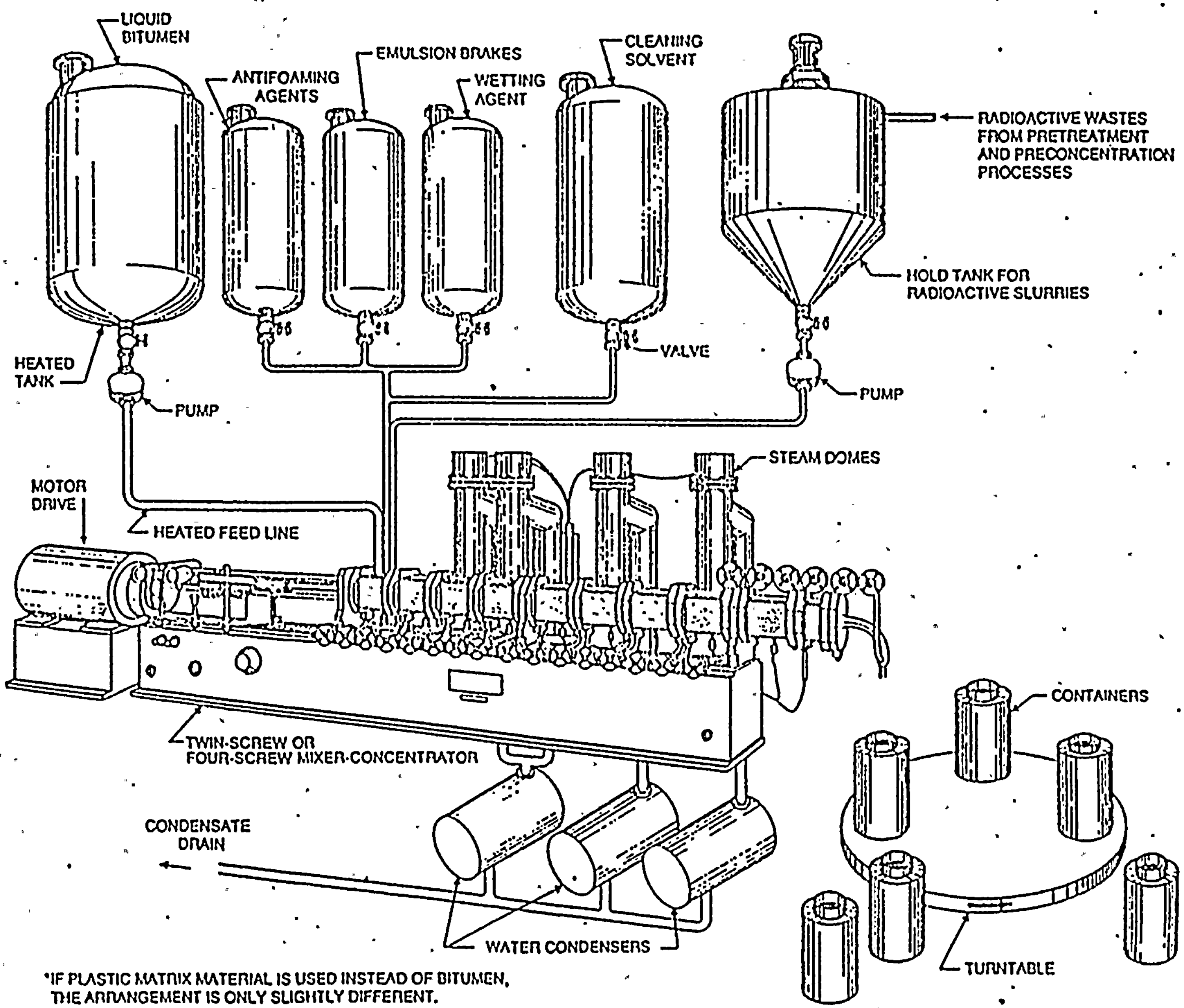


Figure 14. General Arrangement for WPC Extruder/Evaporator

all in one step. A bitumen system will give a volume reduction ratio of about 5 to 1 for LLRW such as evaporator slurries. (NUS786)

In Table 6 the effect that these volume reduction systems can have upon the annual LLRW volumes of a 1000 MWe PWR is illustrated. Although a high degree of volume reduction is achieved by these systems, they are not without problems. Installation of a system such as an incinerator requires engineering design reviews, existing system changes, and possibly construction of a structure to contain the system. Along with this there are NRC and other agencies which must review the proposed system and plant modifications. The systems are expensive to purchase and operate; depending upon the volume of LLRW to be processed, it may not be economically feasible for a utility to install a volume reduction system without tax incentives or electrical rate increases. Even if all the problems are resolved and the system installed, the increased specific activity of the LLRW can produce radiation shielding problems for the plant staff and personnel at the burial grounds, and could possible increase the alpha radionuclide specific activity t a level which would not be acceptable at some burial grounds. All in all, there are many things which must be considered before installing a volume reduction system.

Table 6

Effect of Volume Reduction Systems on a 1000 MWe PWR's Annual LLRW Volume.

Plant Description	Generated Waste Quantity (Unpackaged)	Shipped Waste Quantity (Packaged): Current Practice (a)	Evaporator Crystallizer w/ Cement	High Pressure Compactors (b)	Bitumen Systems	Calciner with Cement	Incinerator with cement	Incinerator/ Calciner with cement
PWR with Deep Bed Resin CPS System								
Volume: ft^3	22,080	31,650	20,120	23,250	17,670	18,610	21,010	4250
Packaging Factor	1.00	1.43	.91	1.05	.80	.84	.95	.19
PWR without CPS Volume: ft^3	22,920	32,880	21,350	24,480	18,510	19,840	21,960	4440
Packaging Factor	1.00	1.43	.93	1.06	.80	.86	.95	.19

(a) Under current practice, the waste is packaged without volume reduction processing.
(b) A packaging factor of 0.25 has been used for packaging of dry bulk solid wastes with high pressure compactor
CPS = Condensate polishing system.

Taken from NUS78b

ONSITE LLRW STORAGE

Each of the nuclear power plants in Florida has storage space set aside for short term storage of LLRW. The storage space is used primarily to hold LLRW until such time when it can be shipped for burial. In the event of a shutdown of one or more of the burial grounds in the United States, the amount of onsite storage space available as the plants would be critical. Recognizing this potential problem, FPC and FP&L are conducting studies to determine how much onsite storage space is needed to overcome any short term shutdowns of burial sites.

The onsite storage available at FPC's Crystal River Unit 3 is approximately 800 cubic feet for LLRW for items such as demineralizer resins and filters. These areas require shielding. For LLRW such as compacted trash, there is about 8000 cubic feet of space available. This amount of storage space at the very best, would only hold about 4 months worth of Crystal River's LLRW.

FP&L's Turkey Point plants have about 10,000 square feet of floor space available for LLRW items that require shielding, thus a maximum of 100,000 cubic feet of storage for demineralizer resins, evaporator concentrates, and filters. In contrast to the Crystal River plant, Turkey Point plants store their compacted LLRW outdoors. In the event of a burial ground shutdown, Turkey Point's major concern would be providing a storage building for the compacted trash to prevent any deterioration of the containers due to weathering.

FP&L's St. Lucie plant has about 250 square feet of floor space available for that LLRW requiring shielding and about 800 more feet of floor space for compacted trash. These areas would provide a maximum of 2500 cubic feet of storage for filters, demineralizer resins, and evaporator concentrates, and 8000 cubic feet for storage of compacted trash. Under ideal conditions, this would hold about 10 months worth of St. Lucie's LLRW.

LLRW MANAGEMENT AND QUALITY CONTROL

The number of regulations and guidelines governing the packaging and shipping of LLRW is staggering. The NRE, the Department of Transportation (DOT), and the invididual burial grounds all have specific requirements to be followed for ship[illegible] LLRW. Attachment 2 is a flowchart on shipping LLRW from a nuclear power plant. The complexity of shipping LLRW compels utilities to have a LLRW management staff cognizant of all current and proposed regulations. As an additional check against inadvertent violations of packaging and shipping regulations, nuclear power plants should have a LLRW quality control program. Both FP&L and FPC have fulltime LLRW manageme[illegible] staffs and quality control programs at their nuclear power plan[illegible]

FP&L has one individual on the corporate staff and one at each of the nuclear plants whose primary responsibility is LLRW management. The LLRW management staff is assisted by other department managers who also have LLRW responsibilities. The LL[illegible] quality control program at the FP&L plants covers certification of shipping containers, inspection of transport vehicles, and inspection of waste packaging and loading operations.

FPC's LLRW management staff includes seven individuals at the Crystal River site and one person on the corporate staff. The LLRW quality control program at the Crystal River plant cove[illegible] wastewater movements, water chemistry, radiochemistry analysis, and certification of LLRW shipping containers.

LLRW VOLUME HISTORIES AND PROJECTIONS

The volume of LLRW shipped by the nuclear power plants in Florida for each operating year is listed in Table 7. To date, the plants in Florida have shipped over 391,000 cubic feet of LLRW for burial. For perspective, this is about the size of a residential lot 200 feet x 100 feet stacked to a height of 20 feet. Turkey Point Units 3 and 4 shipped 64 percent of that volume, 12 percent from St. Lucie Unit 1, and 24 percent from Crystal River Unit 3. The Turkey Point plants accout for a large percentage because of the longer operation time (since 1973) and the larger electrical generation capacity (1455 MWe combined). For this reason, it is more realistic to compare LLRW volumes in terms of cubic feet per MWe. Figure 16 shows the cubic feet generated per MWe for each of the nuclear plants in Florida. Surveys of operating PWR nuclear power plants in the United States show an average LLRW generation rate of 21.5 cubic feet per MWe. (NUS79) Since 1977, the four nuclear power plants in Florida have averaged 25.5 cubic feet of LLRW per MWe.

The LLRW volumes listed in Table 7 and volume projections for each plant are displayed graphically in Figure 17. The LLRW volume projections for Crystal River Unit 3 are based upon the generation of liquid processing LLRW continuing at the current rate of about 16,000 cubic feet per year; and an anticipated decrease in solid LLRW generation to about 10,000 cubic feet per year. The decrease in solid LLRW volumes should be brought about as the plant's shutdown time per year lessens. Because of the Crystal River plant's short operating history and the problems which have caused a large amount of shutdown time,

Table 7

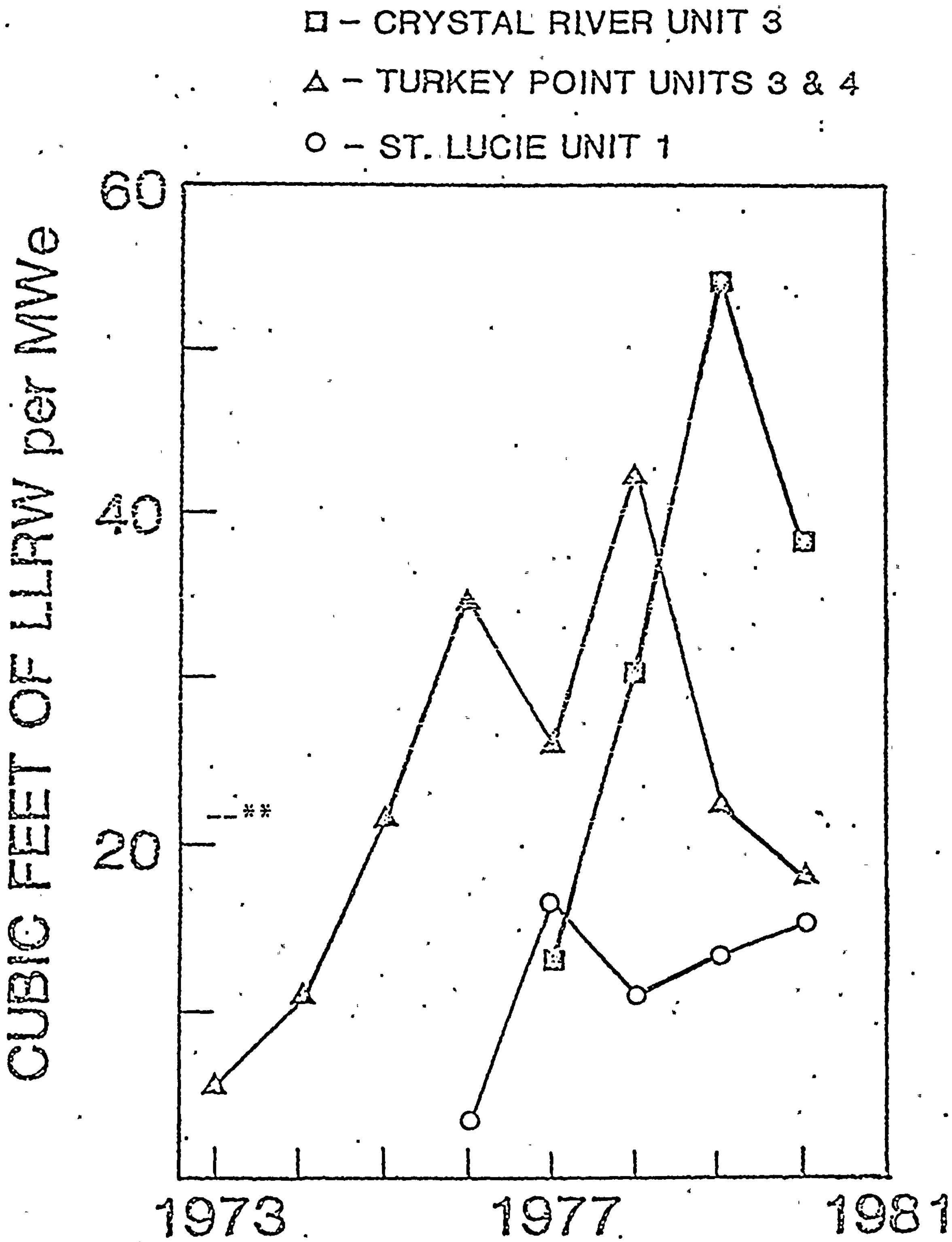
LLRW VOLUMES FROM NUCLEAR POWER PLANTS IN FLORIDA

PLANTS	MWe	1973	%	1974	%	1975	%	1976	%	1977	%	1978	%	1979	%	1980[1]	%	TOTAL
Turkey Point Units 3&4	1456	8200	100	15,900	100	31,400	100	50,725	94	37,710	61	62,032	63	32,483	37	13,060	38	251,510
St. Lucie Unit 1	810							3062	6	13,576	22	12,636	13	10,884	13	6385	18	46,543
Crystal River Unit 3	797									10,418	17	24,271	24	43,613	50	15,185	44	93,407
TOTAL	3063	8200		15,900		31,400		53,787		61,704		98,939		86,980		34,630		[illegible]

[1] Data for 1980 is for January to July only

Taken from FP&L and FPC "Effluent and Waste Disposal Semiannual Reports"

Figure 15. Cubic Feet of LLWR per MWe versus Year.



*Note: 1980 values are two times the Jan. to July values.
**Typical 1000 MWe PWR.

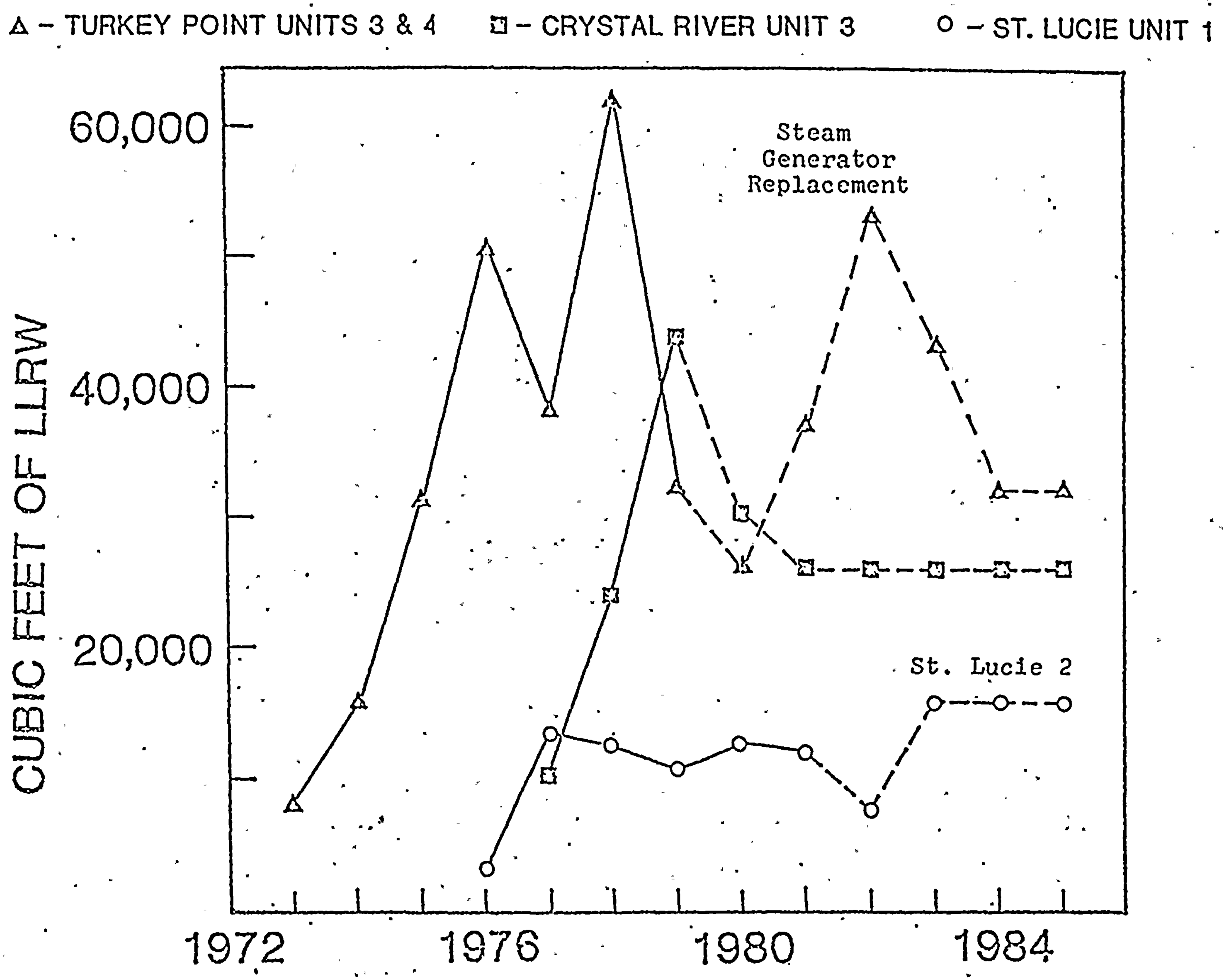


Figure 16. Nuclear Power Plants in Florida: LLRW Histories and Volume Projections.

it is very difficult to make accurate long term projections. Disregarding any significant problems in the future for Crystal Ri 26,000 cubic feet per year should be a reasonable upper limit estimate for LLRW generation.

St. Lucie Unit 1 has consistantly generated from 10,000 to 14,000 cubic feet of LLRW per year. Projections for the St. Lucie plant are based upon a continuation of the 2000 cubic feet or less of liquid processing LLRW per year, and a decrease in the current average solid LLRW generation rate of 10,000 cubic feet per year to about 6000 cubic feet per year by 1982. The anticipated decrease is due to the use of a box compactor and the 18 month fuel cycle. The increase shown for St. Lucie in Figure 17 for 1983 is due to the startup of St. Lucie Unit 2. Unit 2 is of the same design as Unit 1 and should generate a similar amount of LLRW. The startup of St. Lucie Unit 2 could be delayed somewhat; but, by 1985, the St. Lucie plants should be generating about 16,000 cubic feet of LLRW per year.

The LLRW volume history of Turkey Points Units 3 and 4 has been somewhat erratic, reaching as high as 62,000 cubic feet in 1978. The high volumes seen in 1976 and 1978 were due to extensive maintenance activities and were not used to establish a baseline for projections. The LLRW volumes from 1975, 1977, 1979, and the first half of 1980 yielded an average volume of about 32,000 cubic feet per year. Projections were based upon this value; the effect of Turkey Point's box compactor; and the steam generator replacement outage scheduled for October 1981 through June 1983. In calculating the effect of a box compactor, it was assumed that 50 percent of Turkey Point's LLRW volume was compactable. FP&L estimates that an additional 37,000 cubic

feet of LLRW will be generated during the steam generator work. If that volume is distributed proportionately over 1981, 1982, and 1983, it would increase Turkey Point's LLRW volume by 5000, 21,000 and 11,000 cubic feet, respectively.

In Figure 18 the data and projections of Figure 17 are combined to show the total volume of LLRW shipped from the nuclear power plants in Florida from previous years and the anticipated volumes through 1985.

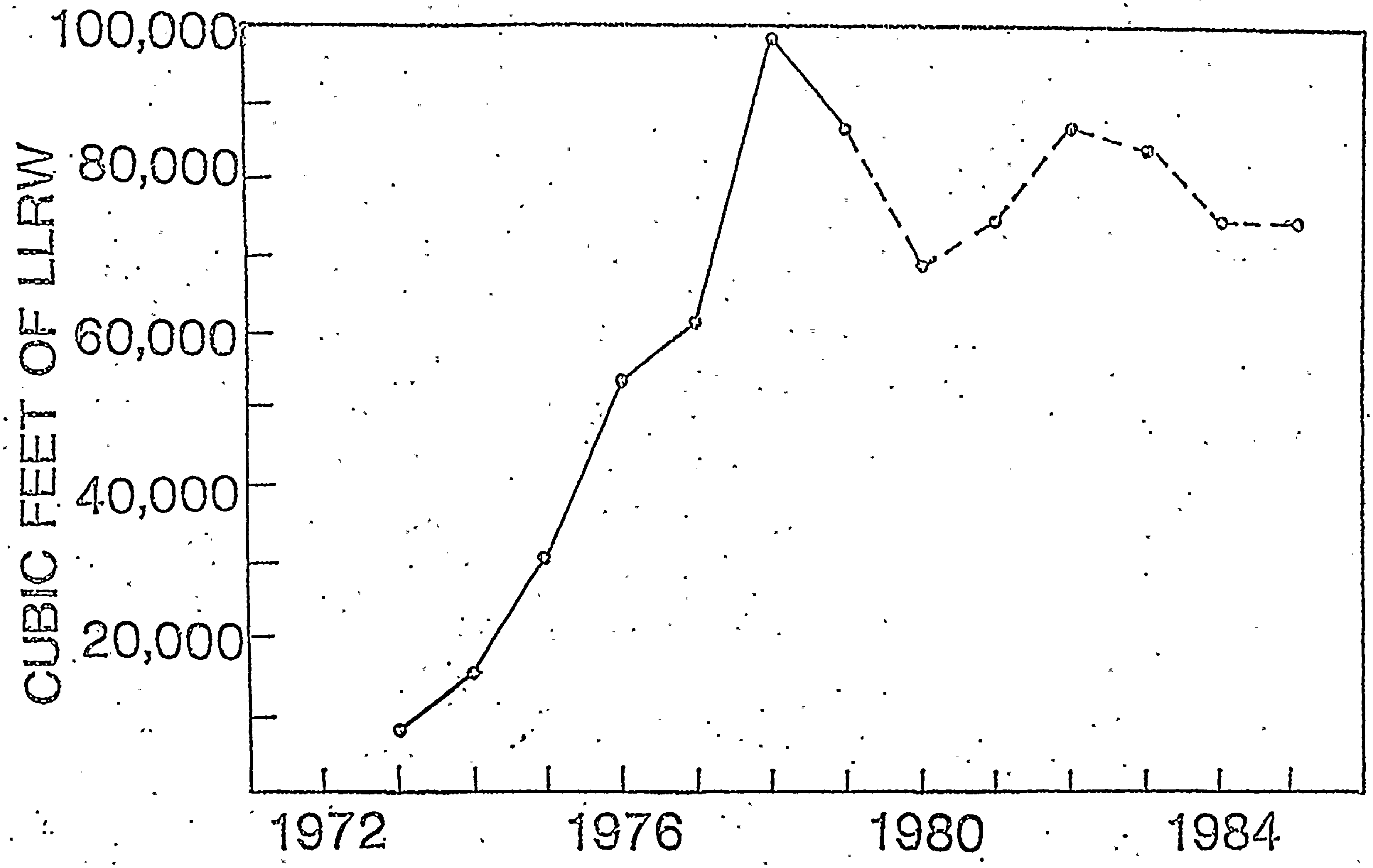


Figure 17. Nuclear Power in Florida: Total LLRW History and Volume Projections.

CONCLUSIONS

It is a fact that nuclear power plants generate LLRW. To some extent the volume of LLRW generated can be controlled; however, situations do arise in which the LLRW volumes increase as a result of maintaining the operation and safety of the plant. The nuclear power plants in Florida have had in the past, and will have in the future, times when LLRW volumes increase. The reasons for the increases are relatively short term problems which do not result in increased levels throughout the operating history of the plants. Overall, the LLRW volume from Florida's nuclear power plants is decreasing. By 1985, the volume should be lower than in 1980, even with an additional power plant operating.

FP&L and FPC are interested in maintaining the LLRW volumes as low as possible. This is shown by the existence of their LLRW management staffs; the LLRW training programs; and the inplant LLRW management studies being conducted by the utilities.

In planning for the future, each of the utilities is looking at the feasibility of volume reduction systems. The systems available can reduce LLRW volumes to a fraction of the current levels. What these systems cannot do is reduce the amount of radioactive material contained in those volumes. The questioned to be answered for the future is how much time and money should be expended to place the same amount of radioactivity into a smaller space.

REFERENCES

NUS78a NUS Corporation, 1978, "Low-Level Radioactive Waste Management, Volume I: Current Power Reactor Low-Level Radwaste", California Energy Commission Report CAEC-007.

NUS78b NUS Corporation, 1978, "Low-Level Radioactive Waste Management, Volume III: Feasibility of Volume-Reduction Processes", California Energy Commission Report CAEC-007.

NUS79 NUS Corporation, 1979, "A Waste Inventory Report for Reactor and Fuel-Fabrication Facility Wastes", United States Energy Research and Development Administration: Office of Waste Isolation Report ONWI-20.

NUS80 NUS Corporation, 1980, "Preliminary State by State Assessment of Low-Level Radioactive Wastes Shipped to Commercial Burial Grounds".

OH79 Ontario Hydro, 1979, "Volume Reduction of Low-Level Radioactive Solid Waste in Ontario Hydro".

ATTACHMENT 1

Questionaires and Responses on LLRW

from

Florida Power & Light Company

and

Florida Power Corporation

LLRW PROJECT
Nuclear Power Plant Questionaire
Florida Power & Light

I. Radioactive waste volumes

1. List the radioactive waste volumes generated, for each FP&L nuclear site, during each six month period of operation. List the data for each of the following categories:
   1. Spent resins, filters and evaporator bottoms
   2. Compactable and noncompactable trash(LSA)
   3. Irradiated components

   Note: Copies of data from the plants' semiannual waste disposal reports may be substituted.

2. Estimate the radioactive waste volumes (LSA and irradiated components) that will be generated during Turkey Point's steam generator replacement outage. Include anticipated start/stop dates for the outage.

3. Will the radioactive waste volumes generated from the St. Lucie Unit 2 plant be similar to the past history of St. Lucie Unit 1? When is the anticipated start up date for Unit 2.

II. Volume reduction

1. Enclose any copies of FP&L policy statements issued regarding volume reduction of radioactive waste.

2. Briefly describe the training given to radiation workers as to how they might reduce radioactive waste volumes.

3. List the types of compactors and the compaction ratios (or lbs. of force) for the equipment in use at the FP&L plants.

4. Estimate the amount of volume reduction, if any, that is attributable to the 18 month fuel cycle.

5. Describe any future plans of FP&L which will lead to a reduction in the radioactive waste volumes being generated.

III. Miscellaneous

1. Briefly describe the quality control steps in use during the processing and shipping of radioactive waste.

2. Estimate the amount of on-site storage available at each site for LSA and high-rad type materials. Does FP&L have any plans for increasing the amount of storage available on-site?

3. How many individuals are envolved in radioactive waste management at the corporate level and the operational level?

LLW Volume

Copies of Turkey Point 3 & 4 and St. Lucie 1 Solid Waste Disposal Reports are provided. This data is submitted to the NRC semiannually as part of an effluent and waste disposal report. The period covered by this data is January 1976 through June 30, 1980.

Schedule and Effect of Steam Generator Repair on LLW Volume

The anticipated dates for the Turkey Point steam generator repair outages are as follows:

Unit 4	Oct. 81 - June 82
Unit 3	Oct. 82 - June 83

We estimate the total additional LLW generated as a result of both unit steam generator repair outages (e.g. 18 months) will be as follows:

Dry compressible waste, contaminated equipment etc. - approximately 26,000 $ft.^3$

Spent resins, filter sludges, etc. - approximately 11,000 $ft.^3$

These estimates include approximately 1620 $ft.^3$ of concrete per unit which will be removed from the containment internal walls and floors as discussed in FPL's Steam Generator Repair Report, Turkey Point 3 & 4 but is exclusive of the steam generator lower assemblies themselves.

St. Lucie, Unit 2 Start-up

We anticipate waste volumes generated from operation of St. Lucie, Unit 2 to be similar to the amounts which we will be generating at St. Lucie 1 at the time St. Lucie 2 becomes operational. Our current anticipated startup date for St. Lucie, Unit 2 is early 1983.

Radiation Worker Training

Personnel who will be working within a radiation controlled area (RCA) receive extensive training in health physics and radiological control practices. At Turkey Point 3 & 4 new employees, contractor personnel and visitors with duties in the RCA are given 16-24 hours of training. Additionally, 8-10 hours of requalification training are given at two year intervals. At St. Lucie initial training consists of 12 hours and requalification training consists of 4 hours.

A portion of each worker's initial & requalification training is dedicated to radioactive waste management. The training is designed to heighten awareness and produce results with respect to overall better individual waste management practices. More specifically each worker is instructed and advised in the following areas:

The Barnwell, S.C. volume allocation plan and what it means to Florida Power & Light Company.

Regulations and restrictions that govern the handling, transport and disposal of low level radioactive waste.

The individual as a contributor to the generation of radioactive wastes. His responsibilities for continuously striving to minimize the amount of low level radioactive waste that he or his co-workers generate.

Plant administrative procedures and policies for materials control within the RCA which are designed to minimize LLW generation.

The importance of good nuclear housekeeping practices

Proper decontamination techniques and controls.

In addition to the above formal training, frequent discussions of radwaste management related topics are held with all FPL workers during monthly safety meetings.

LLW Volume Reducing Compactors

Currently at Turkey Point 3 & 4 we are employing a CGR box compactor. The CGR compactor packages both compressible and non conpressible LLW directly into a 110 $ft.^3$ LSA box. The unit develops more than 82,000 lbs. of downward force resulting in an overall compaction ratio of approximately 4.5:1.

At. St. Lucie we are planning to procure a CGR compactor. The unit currently in use is a drum compactor rated at 25,000 lbs. of force.

Extended Fuel Cycle

The per month quantity of LLW generated during normal plant operations is approximately 32% of that which is generated during an outage, therefore; it can be calculated that the extended fuel cycle at St. Lucie can result in reductions of LLW by approximately 10%.

Future Plans for Volume Reduction

FPL has already taken several positive steps towards achieving volume reduction in LLW. At each nuclear plant, a radioactive waste coordinator has been assigned to directly supervise the activities associated with radioactive waste management. Plant and corporate waste management reviews were conducted. FPL promptly instituted administrative procedures, material controls, and training; all designed to heighten awareness and achieve an end result of reducing LLW generation. A consultant was retained to study low level solid waste operations and make specific recommendations regarding radioactive waste management practices.

With an eye towards the future, FPL assembled a project group to initiate a study concerning the feasibility of employing high technology volume reduction equipment (e.g. incinerators). The study is scheduled to be completed in approximately one year.

Quality Control

FPL has in force a number of Quality Control checks associated with processing and shipping of radioactive wastes.

Quality Control is achieved in processing and shipping of LLW by the direct participation of plant health physics personnel in the packaging and loading of radioactive wastes. Waste containers are certified prior to use to insure they conform to applicable DOT, NRC, and burial site regulatory requirements. Transportation vehicles and containers are given arrival inspections. Numerous QC checkpoints are conducted during laoding and again prior to release for transportation to verify that regulatory requirements and good practices are all being adhered to.

On Site Storage

FPL's two nuclear plants are limited with respect to storage facilities for LLW. At Turkey Point 3 and 4 a radwaste building contains an area of

approximately 10,000 square feet in which storage of high activity LLW is suitable. Outside and adjacent to the Rad Waste Building, a fenced area serves as a place in which low activity LLW is placed while awaiting shipment.

At. St. Lucie, facilities are even more limited. An area of approximately 250 square feet is suitable for storage of high activity LLW. An additional area of approximately 800 square feet could be used for other low activity LLW storage.

FPL plans to construct a facility at Turkey Point and St. Lucie which will be suitable for temporary storage of low dose rate LLW containers in the event it becomes necessary to retain the LLW at our sites. *

In addition, FPL plans to further study the LLW on site storage issue with respect to long range planning. This study is expected to be completed in approximately one year.

LLW Management

The Health Physics Supervisor and Radwaste Coordinator at each nuclear plant have direct and day to day responsibility for supervising and managing radioactive waste operations. In addition, the Operations Superintendents and Plant Managers have management responsibilities in the management of radioactive wastes.

Within FPL's General Office, the Corporate Health Physicist and Radwaste & Radiochemistry Specialist have day to day activities and responsibiities in radioactive waste management. The Manager Power Resources, Nuclear, Assistant Manager Power Resources, Nuclear; and Power Resources Department Head each have Direct management responsibilities associated with the management of radioactive waste at the Turkey Point 3 and 4 and St. Lucie Plants.

LLRW PROJECT
Nuclear Power Plant Questionaire
Florida Power Corporation

I. Volume reduction of radioactive waste

1. Enclose any copies of FPC policy statements that have been issued regarding volume reduction of radioactive waste.

2. Briefly describe the training given to radiation workers as to how they might reduce radioactive waste volumes.

3. List the type of compactor in use and the compaction ratio (or lbs. of force).

4. Estimate the amount of volume reduction, if any, that is attributable to the 18 month fuel cycle.

5. Describe any future plans of FPC which will lead to a reduction in the radioactive waste volumes being generated.

II. Miscellaneous

1. Briefly describe the quality control steps that are taken during the processing and shipping of radioactive waste.

2. Estimate the amount of on-site storage available at Crystal River for LSA and high-rad materials. Does FPC have any plans for increasing the amount of storage available on-site?

3. How many individuals are envolved in radioactive waste management, both at the corpoate level and the plant level?

LLRW PROJECT
Nuclear Power Plant Questionnaire
Florida Power Corporation

I. Volume Reduction of Radioactive Waste.

1. Presently there exists no hard copy policy statement regarding volume reduction of radwaste.

2. Radwaste reduction techniques such as work area preparation don't take any unnecessary materials in the RCA and philosophy is presented in general employee training for radiation protection and is further covered during job planning, and radiation work permit generation.

3. The waste compactor is a vertical piston type, designed for 55 gallon drums and compacts up to 1500 lbs.

4. Presently it is considered that an 18 month fuel cycle would have no significant impact on waste volumes.

5. FPC has developed an in-depth plan for waste management, which includes:

   a. Entire waste stream study by our Architect Engineering firm and other consultants.
   b. Waste scheme operator training.
   c. Amplified general employee training in waste generation control.

II. Miscellaneous

1. Waste Quality Control Steps Include:

   a. Wastewater movement control.
   b. Water chemistry.
   c. Radio Chemistry (scanning).
   d. Certification of shipping casks supplied by vendor and approved by NRC. These qualifications are verified by Plant Compliance Section during shipment preparation.

2. The estimated amount of on-site storage space for high rad. materials is approximately 800 cubic ft. and LSA storage capacity is approximately 8000 cubic ft. Increased storage areas are a prime part of the overall waste engineering study.

3. Individuals involved in radioactive waste management are:

Plant	7
Corporate	1
TOTAL	8

ATTACHMENT 2

LLRW Shipping Flowchart

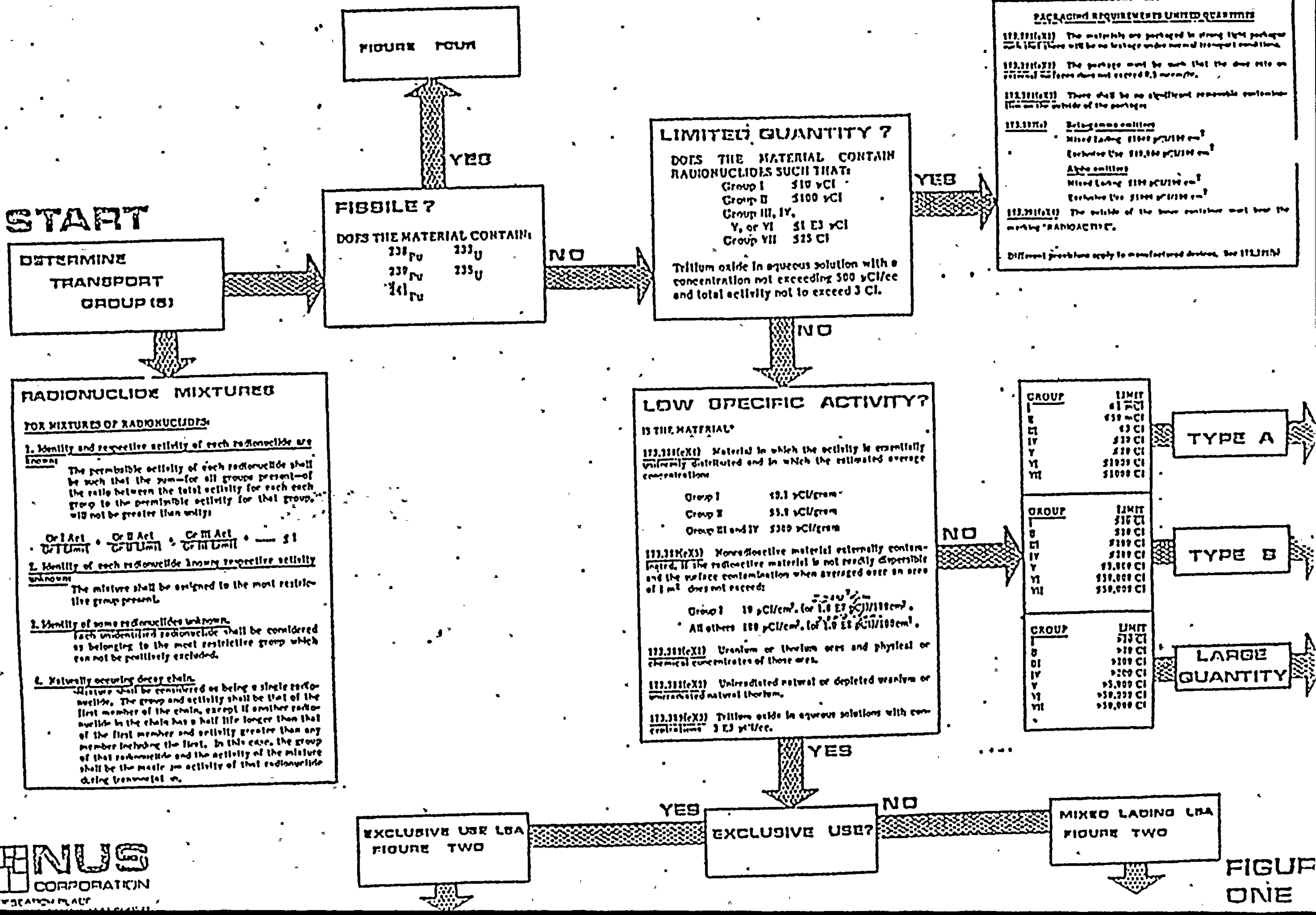


FIGURE ONE

NUS CORPORATION

FIGURE ONE
EXCLUSIVE USE LSA

DOES THE MATERIAL CONTAIN RADIONUCLIDES SUCH THAT:

Group I	>1 mCi (1 E3 μCi)
Group II	>50 mCi (5 E4 μCi)
Group III	>3 Ci
Group IV	>20 Ci
Group V	>20 Ci
Group VI, VII	>1000 Ci

YES

PACKAGING REQUIREMENTS LSA>TYPE A

10CFR71.7 Materials must be packaged in licensed packaging which has been approved for >TYPE A quantities of LSA material.

NO

PACKAGING REQUIREMENTS EXCLUSIVE USE LSA

173.392(c)(1) Materials must be packaged in strong tight containers so that there will be no leakage under normal transport conditions.

THE FOLLOWING ADDITIONAL GENERAL REQUIREMENTS APPLY TO TYPE B SPECIFICATION PACKAGES and/or LICENSED PACKAGES:

10CFR71.12(a)(1)(i) The person using a TYPE B Specification package or a package licensed by the NRC shall possess a copy of the specific license, certificate of compliance, or other approval authorizing use of the package and all supporting documents as applicable.

10CFR71.12(a)(1)(ii) The person using a TYPE B Specification package, or a package licensed by the NRC shall comply with all terms and provisions of the license, certificate of compliance, or other approval, as applicable.

10CFR71.12(b)(1)(iii) The person using a TYPE B Specification package, or a package licensed by the NRC, shall submit in writing to the NRC, his name and license number, the name and license number of the person to whom the package approval has been issued, and the package identification number specified in the package approval-prior to the first use of the package.

10CFR71.51 The licensee shall establish, maintain and execute a quality assurance program satisfying each of the applicable criteria specified in Appendix E to 10CFR71.

THE FOLLOWING ADDITIONAL GENERAL REQUIREMENTS APPLY TO NRC LICENSED PACKAGES:

173.393c(1) The outside of each package must be durably and legibly marked with the package identification marking indicated in the NRC license.

173.393c(2) Each shipping paper related to the shipment of the package must bear a notation of the package identification marking indicated in the NRC license.

173.393c(3) and 173.393b (Export provisions)

173.392(c)(2) Packages must not have significant external loose contamination

173.397(a) Beta-gamma emitters
≤10,000 pCi/100 cm²
Alpha emitters
≤1,000 pCi/100 cm²

173.392(c)(3) Radioactive materials packaged for shipment as exclusive use shall not exceed:

173.393(j) 1,000 mrem/hr at 3 feet from the package (closed transport only).

200 mrem/hr on any external surface of a closed transport vehicle.

10 mrem/hr at 6 feet from the sides of a closed vehicle or 6 feet from the outer edge of a open vehicle.

2 mrem/hr in any normally occupied in the vehicle.

173.392(c)(4) Shipments must be loaded by consignor and unloaded by the consignee from the vehicle initially loaded.

173.392(c)(5) There shall be no loose radioactive material in the vehicle.

173.392(c)(6) Shipment shall be braced to prevent load shifting during transport.

173.392(c)(7) The transport vehicle shall be placarded.

173.392(c)(8) The outside of each package must be stencilled or otherwise marked "RADIOACTIVE—LSA"

173.392(c)(9) Instructions for maintaining exclusive use controls shall be given to the driver, and attached to the shipping papers.

173.392(d) This paragraph concerns bulk, unpackaged shipments of LSA materials. Refer to this paragraph for complete provisions.

FIGURE ONE
MIXED LADING LSA

PACKAGING REQUIREMENTS MIXED LADING LSA

173.392 Materials must be packaged in a TYPE A or TYPE B specification container.

173.392(f) Materials capable of spontaneous ignition shall meet requirements of 173.114 or 173.115.

173.392(g) There must be no significant contamination on the exterior of the package.

173.397(a) Beta-gamma emitters
≤1,000 pCi/100 cm²
Alpha emitters
≤100 pCi/100 cm²

173.393(i) Radioactive materials shall be packaged such that the radiation level does not exceed 200 mrem/hr on any surface, and the transport index does not exceed 10.

173.393(k) [illegible]
173.393(l) [illegible]

173.393(m) Prior to shipment of any package for the first time it must be examined or tested as specified in this paragraph.

173.393(n) Prior to each shipment of any package the following test and examination shall be performed:

(1) The package is proper for the contents.
(2) The packaging is in unimpaired condition.
(3) Each closure device is properly installed and free from defects.
(4) [illegible]
(5) Any special instructions regarding filling closing and preparation have been followed.
(6) Each closure, valve, or opening of the containment is properly closed and sealed.
(7) [illegible]
(8) Internal pressure of container will not exceed design pressure.
(9) All radiation and contamination levels are within specified limits.

173.393(o) Heat generating material

173.393(p) Radioactive material is not to be shipped in passenger aircraft, (see 173.10 for exemptions).

172.310 Each package shall be marked with the proper shipping name "Radioactive LSA-N.O.S."

172.310 Each package must be labeled with the name and address of the consignee or consignor except if the package will be transported by highway and will not be transferred from one carrier to another.

172.310(a)(1) Each package of radioactive material in excess of 110 lbs in weight, shall have the weight of the package marked on the outside of the package.

172.310(a)(2) Type A and/or Type B packages shall be marked with the words "TYPE A" or "TYPE B", as appropriate on the outside of the package.

172.312(a) Each package having a inside package containing radioactive liquid shall be packed with closures upward, and the outside package labeled to indicate "THIS SIDE UP".

172.403(a) A RADIOACTIVE WHITE-I label must be affixed to each package measuring 0.5 mrem/hr or less.

172.403(c) A RADIOACTIVE YELLOW-II label must be affixed to each package measuring more than 0.5 but less than 50 mrem/hr and not exceeding 1.0 mrem/hr at three feet from the package.

172.403(d) A RADIOACTIVE YELLOW-III label must be affixed to each package which measures 200 mrem/hr, or more than 1.0 mrem/hr at three feet.

172.402(a) Each package of radioactive material which contains material that also meets the definition of another hazard, such as FLAMMABLE, or CORROSIVE, shall be labeled for all hazards present.

172.406(e) Each package shall have two of the required label on opposite sides of the package.

NUS

GENERAL PACKAGE REQUIREMENTS

173.24(a) Shipments shall meet specific requirements stated elsewhere, unless excepted.

173.24(b) The outside of the package must incorporate a feature, such as a seal, to give evidence of tampering.

173.24(c) The smallest outside dimension must be 4 inches or greater.

173.24(d) Each package must maintain shielding and leak integrity under normal conditions of transport.

173.24(e) Packaging must be designed, constructed, and loaded so that during transport heat generated will not reduce the efficiency of the package, and that the outside surfaces of the package will not exceed 122°F, [illegible] for exclusive use, 180°F.

173.24(f) Materials capable of spontaneous ignition shall meet requirements of 173.[illegible] or 173.[illegible].

173.24(g) Type A quantities of liquid radioactive material must be packaged within or in a leak resistant and corrosion resistant containment vessel (see 173.393(g) for complete provisions).

173.24(h) There must be no significant contamination on the exterior of the package.

173.24(i) Beta-gamma emitters
Mixed loading [illegible] $\mu Ci/100\ cm^2$
Exclusive Use [illegible] $\mu Ci/100\ cm^2$
Alpha emitters
Mixed loading [illegible] $\mu Ci/100\ cm^2$
Exclusive Use [illegible] $\mu Ci/100\ cm^2$

173.24(j) Radioactive materials shall be packaged such that the radiation level does not exceed 200 mrem/hr on any surface, and the transport index does not exceed 10, for mixed loading.

173.24(k) Radioactive materials packaged for shipment as exclusive use shall not exceed:

1,000 mrem/hr at 3 feet from the package (closed transport only).

200 mrem/hr on any external surface of a closed transport vehicle.

10 mrem/hr at 6 feet from the sides of a closed vehicle or 6 feet from the outer edge of a open vehicle.

2 mrem/hr in any normally occupied in the vehicle.

173.24(l) (Reserved)

173.24(m) (Export only)

173.24(n) Prior to shipment of any package for the first time it must be examined or tested as specified in this paragraph.

173.24(o) Prior to each shipment of any package the following test and examination shall be performed:

(1) The package is proper for the contents.

(2) The packaging is in unimpaired condition.

(3) Each closure device is properly installed and free from defects.

(4) (Fissile material)

(5) Any special instructions regarding filling closing and preparation have been followed.

(6) Each closure, valve, or opening of the containment is properly closed and sealed.

(7) (Air shipment)

(8) Internal pressure of container will not exceed design pressure.

(9) All radiation and contamination levels are within specified limits.

173.24(q) (Heat generating material)

173.24(p) Radioactive material greater than limited quantities are not to be shipped on passenger aircraft. (see 175.10 for exceptions).

TYPE A

TYPE B

LARGE QUAN.

PACKAGE REQUIREMENTS—TYPE A

TYPE A quantities of radioactive materials shall be packaged as follows:

173.393(A)(1) In a specification 7A package. Each shipper of a specification 7A package shall maintain complete certification and supporting safety analysis demonstrating compliance with specification requirements.

173.393(A)(2) Any TYPE B specification or NRC licensed container.

PACKAGE REQUIREMENTS—TYPE B

TYPE B quantities of radioactive materials shall be packaged as follows:

173.393(b)(1) In a TYPE B package approved and licensed by the NRC.

PACKAGE REQUIREMENTS—LARGE QUANTITY

Large quantities of radioactive materials must be packaged as follows:

173.393(c)(1) In a package which has been approved and licensed for Large Quantities of radioactive materials.

THE FOLLOWING ADDITIONAL GENERAL REQUIREMENTS APPLY TO TYPE B SPECIFICATION PACKAGES and/or LICENSED PACKAGES:

10CFR71.12(c)(1)(i) The person using a TYPE B Specification package or a package licensed by the NRC shall possess a copy of the specific license, certificate of compliance, or other approval authorizing use of the package and all supporting documents as applicable.

10CFR71.12(c)(1)(ii) The person using a TYPE B Specification package, or a package licensed by the NRC shall comply with all terms and provisions of the license, certificate of compliance, or other approval, as applicable.

10CFR71.12(c)(1)(iii) The person using a TYPE B Specification package, or a package licensed by the NRC, shall submit in writing to the NRC, his name and license number, the name and license number of the person to whom the package approval has been issued, and the package identification number specified in the package approval prior to the first use of the package.

10CFR71.51 The licensee shall establish, maintain and execute a quality assurance program satisfying each of the applicable criteria specified in Appendix E to 10CFR71.

THE FOLLOWING ADDITIONAL GENERAL REQUIREMENTS APPLY TO NRC LICENSED PACKAGES:

173.393a(2) The outside of each package must be durably and legibly marked with the package identification marking indicated in the NRC license.

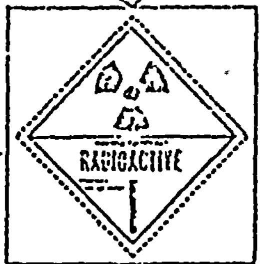
173.393a(3) Each shipping paper related to the shipment of the package must bear a notation of the package identification marking indicated in the NRC license.

173.393a(4) and 173.393a (Export provisions)

172.403(b)
Surface Dose Rate ≤0.5 mrem/hr.
No Large Quantities

172.403(c)
Transport Index ≤1
Surface Dose Rate >0.5≤50 mrem/hr.
No Large Quantities.

172.403(d)
Transport Index >1
Surface Dose Rate >50≤200 mrem/hr.
Large Quantities



172.403(e) Each package containing a radioactive material that also meets the definition of one or more additional hazards (OXIDIZER, CORROSIVE, FLAMMABLE, etc) must be labeled as a radioactive material and for each additional hazard.

172.403(f) Each package required to be labeled with a radioactive label must have two labels attached to two opposite sides of the package. Labels for additional hazards shall be placed adjacent to the radioactive labels.

177.842(a) The total transport index number shall not exceed 50 in a single mixed loading shipment.

FIGURE THREE

NUS
Corporation

... Secretary.

NEW JERSEY

... for Emergency ...

... of making emergency ... section 321 of the Con- ... Administration ... (U.S.C. 1931), it has been ... the hereinafter- ... the State of New Jer- ... has caused a need ... credit not readily avail- ... banks, cooperative ... other responsible ...

... Cumberland. ...

... Ocean. ...

... the authority set forth ... loans will not be made ... counties after June ... to applicants who pre- ... emergency for special ... assistance and who can ... established policies and ...

... Washington, D.C., this 6th day ...

ORVILLE L. FREEMAN,
Secretary.

... Filed, July 9, 1964; ... a.m.]

TEXAS

... for Emergency ... loans ...

... of making emergency ... section 321 of the Con- ... Home Administration ... (U.S.C. 1961), it has been ... the hereinafter- ... in the State of Texas ... have caused a need for ... credit not readily available ... banks, cooperative ... or other responsible ...

Texas

Knox.
Live Oak.
Morris.
Red River.
Refugio.
Starr.
Throckmorton.
Titus.
Upshur.
Victoria.
Wood.
Zapata.

... the authority set forth ... loans will not be made ... counties after June ... to applicants who pre- ... emergency or special ... assistance and who can ... established policies and ...

Done at Washington, D.C., this 6th day of July 1964.

ORVILLE L. FREEMAN,
Secretary.

[F.R. Doc. 64-6860; Filed, July 9, 1964; 8:47 a.m.]

ATOMIC ENERGY COMMISSION

AGREEMENT BETWEEN ATOMIC ENERGY COMMISSION AND STATE OF FLORIDA

Discontinuance of Certain Commission Regulatory Authority and Responsibility Within State

Whereas, The United States Atomic Energy Commission (hereinafter referred to as the Commission) is authorized under section 274 of the Atomic Energy Act of 1954, as amended (hereinafter referred to as the Act), to enter into agreements with the Governor of any State providing for discontinuance of the regulatory authority of the Commission within the State under chapters 6, 7, and 8, and section 161 of the Act with respect to byproduct materials, source materials, and special nuclear materials in quantities not sufficient to form a critical mass; and

Whereas, The Governor of the State of Florida is authorized under section 290.13 of the Florida Nuclear Code (Chapter 290, Florida Statutes, 1961) to enter into this Agreement with the Commission; and

Whereas, The Governor of the State of Florida certified on April 2, 1964, that the State of Florida (hereinafter referred to as the State) has a program for the control of radiation hazards adequate to protect the public health and safety with respect to the materials within the State covered by this Agreement, and that the State desires to assume regulatory responsibility for such materials; and

Whereas, The Commission found on June 17, 1964, that the program of the State for the regulation of the materials covered by this Agreement is compatible with the Commission's program for the regulation of such materials and is adequate to protect the public health and safety; and

Whereas, The State and the Commission recognize the desirability and importance of cooperation between the Commission and the State in the formulation of standards for protection against hazards of radiation and in assuring that State and Commission programs for protection against hazards of radiation will be coordinated and compatible; and

Whereas, The Commission and the State recognize the desirability of reciprocal recognition of licenses and exemption from licensing of those materials subject to this Agreement;

Now, therefore, It is hereby agreed between the Commission and the Governor of the State, acting in behalf of the State, as follows:

Article I. Subject to the exceptions provided in Articles II, III, and IV, the Commission shall discontinue, as of the effective date of this Agreement, the regulatory authority of the Commission in the State under chapters 6, 7, and 8, and section 161 of the Act with respect to the following materials:

A. Byproduct materials;
B. Source materials; and
C. Special nuclear materials in quantities not sufficient to form a critical mass.

Article II. This Agreement does not provide for discontinuance of any authority and the Commission shall retain authority and responsibility with respect to regulation of:

A. The construction and operation of any production or utilization facility;

B. The export from or import into the United States of byproduct, source, or special nuclear material, or of any production or utilization facility;

C. The disposal into the ocean or sea of byproduct, source, or special nuclear waste materials as defined in regulations or orders of the Commission;

D. The disposal of such other byproduct, source, or special nuclear material as the Commission from time to time determines by regulation or order should, because of the hazards or potential hazards there of, not be so disposed of without a license from the Commission.

Article III. Notwithstanding this Agreement, the Commission may from time to time by rule, regulation, or order, require that the manufacturer, processor, or producer of any equipment, device, commodity, or other product containing source, byproduct, or special nuclear material shall not transfer possession or control of such product except pursuant to a license or an exemption from licensing issued by the Commission.

Article IV. This Agreement shall not affect the authority of the Commission under Subsection 161 b. or i. of the Act to issue rules, regulations, or orders to protect the common defense and security, to protect restricted data or to guard against the loss or diversion of special nuclear material.

Article V. The Commission will use its best efforts to cooperate with the State and other agreement States in the formulation of standards and regulatory programs of the State and the Commission for protection against hazards of radiation and to assure that State and Commission programs for protection against hazards of radiation will be coordinated and compatible. The State will use its best efforts to cooperate with the Commission and other agreement States in the formulation of standards and regulatory programs of the State and the Commission for protection against hazards of radiation and to assure that the State's program will continue to be compatible with the program of the Commission for the regulation of like materials. The State and the Com-

mission will use their best efforts to keep each other informed of proposed changes in their respective rules and regulations and licensing, inspection and enforcement policies and criteria, and to obtain the comments and assistance of the other party thereon.

Article VI. The Commission and the State agree that it is desirable to provide for reciprocal recognition of licenses for the materials listed in Article I licensed by the other party or by any agreement State. Accordingly, the Commission and the State agree to use their best efforts to develop appropriate rules, regulations, and procedures by which such reciprocity will be accorded.

Article VII. The Commission, upon its own initiative after reasonable notice and opportunity for hearing to the State, or upon request of the Governor of the State, may terminate or suspend this Agreement and reassert the licensing and regulatory authority vested in it under the Act if the Commission finds that such termination or suspension is required to protect the public health and safety.

Article VIII. This Agreement shall become effective on July 1, 1964, and shall remain in effect unless, and until such time as it is terminated pursuant to Article VII.

Done at Tallahassee, State of Florida, in triplicate, this 1st day of July 1964.

For the United States Atomic Energy Commission.

JAMES T. RAMEY,
Commissioner.

For the State of Florida.

C. FARRIS BRYANT,
Governor.

[F.R. Doc. 64-6845; Filed, July 9, 1964; 8:45 a.m.]

CIVIL AERONAUTICS BOARD

[Docket 13777; Order No. E-21034]

INTERNATIONAL AIR TRANSPORT ASSOCIATION

Agreement Relating to Specific Commodity Rates

Adopted by the Civil Aeronautics Board at its office in Washington, D.C., on the 6th day of July 1964.

There has been filed with the Board, pursuant to section 412(a) of the Federal Aviation Act of 1958 (the Act) and Part 261 of the Board's Economic Regulations, an agreement between various air carriers, foreign air carriers, and other carriers, embodied in the resolutions of Traffic Conference 1 of the International Air Transport Association (IATA), and adopted pursuant to the provisions of Resolution 590 (Commodity Rates Board).

The agreement, adopted pursuant to unprotested notices to the carriers and promulgated in IATA memoranda, names additional rates as set forth below:

C.A.B. 17666	IATA memorandum TCU Rates	Commodity item	Rates
R-42	2005	1304	45/40 cents per kilogram, minimum weight, 100/1000 kilograms, respectively: Sao Paulo to New York.
R-43	2005	2002	45/35 cents per kilogram, minimum weight, 100/1500 kilograms, respectively: Buenos Aires and Montevideo to New York.
R-43	2006	2102	45/35 cents per kilogram, minimum weight, 100/1500 kilograms, respectively: Buenos Aires to New York.
R-43	2005	2102	35 cents per kilogram, minimum weight, 1500 kilograms: Montevideo to New York.

The Board, acting pursuant to sections 102, 204(a), and 412 of the Act, does not find the subject agreement to be adverse to the public interest or in violation of the Act, provided that approval thereof is conditioned as hereinafter ordered.

Accordingly, it is ordered, That Agreement C.A.B. 17666, R-42 and R-43, be and hereby is approved, provided that such approval shall not constitute approval of the specific commodity descriptions contained therein for purposes of tariff publication.

Any air carrier party to the agreement, or any interested person, may, within 15 days from the date of service of this order, submit statements in writing containing reasons deemed appropriate, together with supporting data, in support of or in opposition to the Board's action herein. An original and nineteen copies of the statements should be filed with the Board's Docket Section. The Board may, upon consideration of any such statements filed, modify or rescind its action herein by subsequent order.

This order will be published in the FEDERAL REGISTER.

By the Civil Aeronautics Board.

[SEAL] HAROLD R. SANDERSON,
Secretary.

[F.R. Doc. 64-6875; Filed, July 9, 1964; 8:49 a.m.]

FEDERAL COMMUNICATIONS COMMISSION

[List 58; FCC 64-603]

STANDARD BROADCAST APPLICATIONS READY AND AVAILABLE FOR PROCESSING

JULY 7, 1964.

Notice is hereby given, pursuant to § 1.571(c) of the Commission rules, that on August 13, 1964, the standard broadcast applications listed below will be considered as ready and available for processing. Pursuant to § 1.227(b)(1) and § 1.591(c) of the Commission's rules, an application, in order to be considered with any application appearing on the attached list or with any other application on file b ness on August 12, 1 a conflict necessitat an application on th with interim criteri ance of standard bro set forth in the for of the Commission r tially complete and at the offices of t Washington, D.C., is earlier: (a) The c August 12, 1964, or (tive cut-off date wh tion or any other co may have by virtue sitating a hearing appearing on previo

The attention of a desiring to file plead pending standard br pursuant to section Communications A amended, is directe the Commission r governing the time requirements relatin

Adopted: July 1, 1

FEDERAL
COMM
[SEAL] BEN F.

Applications From the
Li

BP-15077 New, Burle
John W. M
ban Broac
Req: 800 kc

BP-15967 KRED, Eur
California
Has: 1480
Req: 1480

BMP-11113 WPRT, P.
Stephens I
Has Lic: 96
Has CP: 96
Req MP: 9

BP-16011 KSTP, St. 1
Hubbard B
Has: 1500 k
Req: 1500

BP-16055 WDEA, Ell
Coastal B
Inc.
Has: 1370 k
Req: 1370
DA-N, U.

BP-16083 KOTE, Fe
Northland
Has: 1250
DA-N, U.
Req: 1250 k

BP-16097 New, Electe
American
Corp.
Req: 720 k

BP-16141 KEYL, Lon
Communic
Has: 1400
Req: 1400

BP-16150 WNVW, J
Electrocast
Has: 1450
Req: 1450

BP-16153 New, Plym
Pemigewa
Req: 1390

BP-16154 KDHS, F
KDHS, Inc
Has: 1450
Req: 1450

[1] Commissioner Ford

STATE OF FLORIDA

DEPARTMENT OF
Health & Rehabilitative Services

Bob Graham, Governor

1317 WINEWOOD BOULEVARD TALLAHASSEE, FLORIDA 32301

March 31, 1981

Ms. Joette Lorian, Executive Director
Floridians United for Safe Energy, Inc.
7210 Red Road Suite 208
Miami, Florida 33143

Dear Ms. Lorian:

We have your letter of March 23 concerning low-level radioactive waste being generated at Turkey Point nuclear power stations.

I will respond to your questions as you have numbered them.

1. The Nuclear Regulatory Commission (NRC) is responsible for all on-site activities and will approve or disapprove the construction of any facility to store nuclear waste on-site.

2. In Article II of the NRC-Florida Agreement, it is clear that NRC retained authority over nuclear power plants. Any waste site outside the confines of a nuclear power plant must be licensed by the Department of Health and Rehabilitative Services. The land must be owned by the State or the Federal government and the applicant for the license must meet a host of other requirements designed to protect public health, drinking water sources and the entire environment.

3. Since the licensing of a nuclear waste building on-site is the responsibility of NRC, I would assume that NRC would require an Environmental Impact Statement (EIS) if they felt it necessary.

4. Although I follow the Federal Register rather closely, I do not recall seeing any mention of a nuclear waste building at Turkey Point.

If we can be of further service, please let us know.

Sincerely,

Ulray Clark

Ulray Clark
Administrator
Radiological Health Services

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	Docket Nos. 50-250-SP
	)	50-251-SP
FLORIDA POWER & LIGHT COMPANY	)	
	)	(Proposed Amendments to
(Turkey Point Nuclear	)	Facility Operating Licenses
Generating Units Nos. 3	)	to Permit Steam Generator
and 4)	)	Repairs)

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that a true and correct copy of Intervenor's Position as to Action that Board Should Take Regarding the Disposal of the Solid Waste Resulting from the Steam Generator Repairs was mailed on this the 12th day of June, 1981, to the following addressees:

Marshall E. Miller, Esq. Administrative Judge
Chairman, Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dr. Emmeth A. Luebke, Administrative Judge
Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dr. Oscar H. Paris, Adminstrative Judge
Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Mr. Mark P. Oncavage
12200 S. W. 110th Avenue
Miami, Florida 33176

Harold F. Reis, Esq.
Steven P. Frantz, Esq.
Lowenstein, Newman, Reis & Axelrad
1025 Connecticut Avenue, N.W.
Washington, D. C. 20036

Steven C. Goldberg, Esq.
Office of the Executive Legal Director
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Atomic Safety and Licensing Board Panel
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Docketing and Service Section
Office of the Secretary
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Burt Saunders, Esq.
Assistant Dade County Attorney
1626 Dade County Courthouse
Miami, Florida 33130

Henry H. Harnage, Esq.
Peninsula Federal Building
10th Floor
200 S. E. 1st Street
Miami, Florida 33131

Norman A. Coll, Esq.
STEEL, HECTOR & DAVIS
Co-Counsel for Licensee
1400 S. E. 1st National Bank Bldg.
Miami, Florida 33131

LAW OFFICES OF NEIL CHONIN, P.A.
Attorneys for Intervenor
Suite 1400 Amerifirst Bldg.
One S. E. 3rd Avenue
Miami, Florida 33131
Telephone: 377-3023

By Neil Chonin
Neil Chonin