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EPICOR-II RESIN/LINER RESEARCH PLAN

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Idaho National Engineering Laboratory
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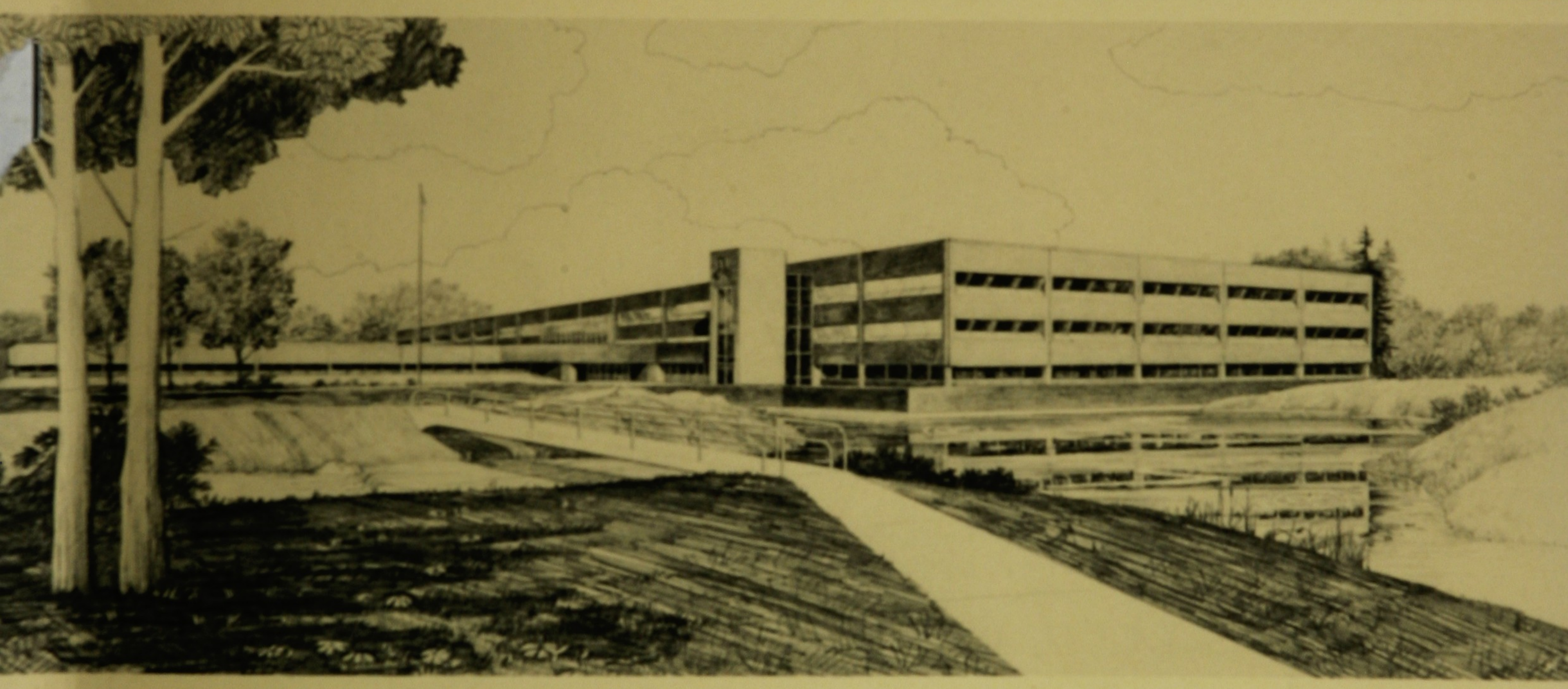

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EG&G Idaho

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March 1983

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ABSTRACT

The resin/liner research project being conducted at the Idaho National Engineering Laboratory on EPICOR-II prefilters from Three Mile Island (TMI) is discussed. The duration of that DOE funded effort as planned is three years. Technical justification is presented to extend the plan in several areas. The contents of several of the highest loaded prefilters are used in this program to investigate degradation in resin and zeolite, solidification of resin and zeolite with Portland cement and Dow polymer and prefilter liner integrity.

The degradation studies describe use of resin and zeolite samples analyzed chemically and physically for degradation. During the extended studies, the radiation dose is expected to increase from 3×10^8 to 10^9 rads which should result in pronounced degradation of the resin. Solidification studies are described. Coupons will be cast using commercial formulations of solidification agents. Solidified coupons will be bench scale and field leach tested. Field testing will utilize in-soil lysimeters at various national laboratories throughout the country. Results from field test will be correlated with bench scale leach test results. Liner integrity examination will investigate integrity of the inner plastic coating of several liners. Failure of the coating could lead to premature failure of the liners during storage.

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EPICOR-II RESIN/LINER RESEARCH PLAN

1. INTRODUCTION

Ion exchange media presently are used extensively by the nuclear industry in process related applications. Ion exchangers are applied in nuclear power generation, nuclear fuel reprocessing, radioactive waste treatment, and radioisotope processing. Both inorganic and organic media are found in these applications with organic resins being used most often. Numerous studies have been conducted (References 1, 2, and 3) on the effects of radiation on these exchange media and have shown that degradation is a result.

The EPICOR-II prefilters used to clean up water from TMI-2 have become available for study of the effects of high loadings of radionuclides on both organic and inorganic ion exchange media. The Resin/Liner Research Plan is shown in Figure 1 and Table 1. Eleven prefilter liners containing organic media and 39 prefilter liners filled with layers of inorganic and organic media are available. Material from liners containing up to 2200 curies of radionuclide loadings will be examined for exchange media degradation, media solidification capability and attendant laboratory and field leach resistance, and prefilter liner degradation. The duration of the research projects is planned for three years. A longer program is under evaluation which would extend the degradation studies to ten years and the field testing to twenty years. The NRC is being approached for funding this extended plan.

The EPICOR-II prefilter liners and ion exchange media present an unusual opportunity to investigate a number of items of interest to the nuclear industry. This is the first time such highly loaded ion exchange media has become available. Studies of media degradation, media immobilization, bench leaching and field leaching of solidified media are planned to obtain a maximum amount of information from EPICOR-II prefilters and to correlate immobilization behavior with media degradation. The liner

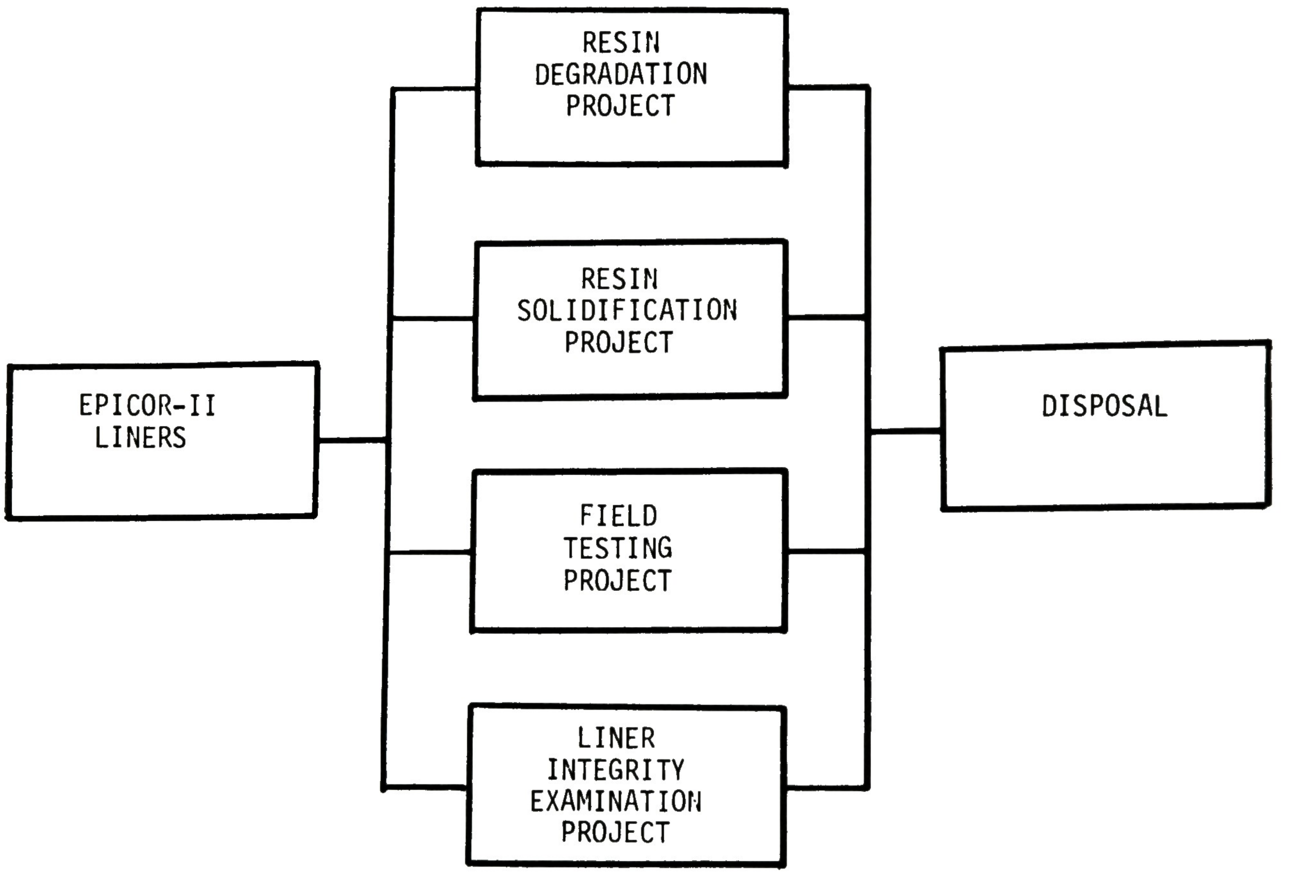

Figure 1. Flow Chart of EPICOR-II Resin/Liner Research Plan.

TABLE 1. PROJECT BREAKDOWN FOR EPICOR-II RESIN/LINER RESEARCH PLAN

Source	Project	Action	Product
Organic resin liner	Resin Degradation	Visual examination Chemical analysis Physical analysis	Five 2-in.-diameter x 39-in. long core samples
	Resin Solidification	Bench leach test	Four resin/cement test specimens four resin/Dow polymer specimens
		Compression test	Four resin/cement test specimens four resin/Dow polymer specimens
	Field testing	Lysimeter field test	Four resin/cement and four resin/Dow test specimens four 300-gallon lysimeters
	Liner Integrity Examination	Scopic examination Subscopic examination	Five 3-in.-diameter metal samples
Organic resin zeolite liner	Resin Degradation	Visual examination Chemical analysis Physical analysis	Five 2-in.-diameter x 39-in. long core samples
	Resin Solidification	Branch leach test	Four resin/cement test specimens four resin/Dow polymer specimens
		Compression test	Four resin/cement test specimens four resin/Dow polymer specimens
	Field testing	Lysimeter field test	Four resin/cement and four resin/Dow test specimens four 55-gallon lysimeters
	Liner Integrity Examination	Scopic examination Subscopic examination	Five 3-in.-diameter metal samples

integrity examination will yield data on the response of typical plastic coated carbon steel disposal containers to the rigors of storage of highly radioactive ion exchangers.

Current information concerning the degradation of organic ion exchange media has been obtained through studies using exchangers which were irradiated by external sources to doses of 2×10^9 rads or less, with one experimenter in the USSR using doses of 10^{10} rads on one type of organic resin (Reference 2). The EPICOR-II prefilter ion exchangers represent an opportunity to examine degradation of resins and zeolites that have been exposed to internal radiation sources with resultant doses of from 1.5×10^8 to 3×10^8 rads. While the changes to organic exchange media caused by external radiation are similar to internal radiation, the extent of degradation has been reported to be greater for internal radiation (References 1 and 3). Thus it is important that the EPICOR-II exchange media containing high loadings of radionuclides be analyzed carefully and results compared with findings from external radiation experiments. The EPICOR-II prefilters also present a chance to study zeolite and organic exchangers which have been exposed to like conditions of radiation, temperature, pressure, water flow, and age after loading. Degradation with time will be observed over the planned test period.

Studies on solidification of ion exchange media have been conducted with media loaded with trace radioactive isotopes, media loaded with non-radioisotopes, and media loaded with non-radioisotopes and irradiated with an external source. In studies conducted by Neilson[4] external irradiations produced doses above 10^8 rads. The internal loadings used by most investigators were added in trace amounts and produced no appreciable dose. As noted in the previous paragraph, the external radiation produces somewhat less degradation than internal radiation. Immobilization of EPICOR-II exchange media in commercial materials provides the opportunity to study the effect of high internal radiation at a level not previously examined. It also provides continuity of purpose with the Resin Degradation Project. Information concerning swelling, moisture absorption, exchange capacity developed under that project will be directly applicable to the Resin Solidification Project in the identification of failure modes in the immobilized waste forms.

Under the Solidification Project, laboratory leach testing will determine waste form capabilities to withstand a standardized leaching for comparison between EPICOR-II samples and data of other experimental tests. Compression tests will determine the strength of a given waste form. Lysimeter tests will determine the behavior of radionuclides in a given waste form under actual disposal environment at four locations across the United States. Combining the lysimeter data with that from EPICOR-II resin projects will provide more detail on the behavior of two types of solidified waste. Information from the lysimeter experiments will be directly relatable to other immobilization studies through the laboratory bench leach tests conducted under the Solidification Project. Locations in various parts of the country were chosen to provide different environmental settings. Certain parameters which are difficult to simulate are primary to the field leach tests. These parameters include: the sample temperature including freezing and thawing; rainfall quantity and rate, content of rain such as organic compounds; atmospheric humidity and wind velocity which determine evaporation rates; and the microbiotics of the soil which can affect sample aging.

During the conduct of this research, identified in Table 1, the EPICOR-II liners being sampled will be placed in interim storage at the TAN-607 Hot Shop at the INEL. The integrity of the stored liners is vital to INEL during storage operations and is of general interest to industry. Integrity will be examined by metallographic methods. The primary intent will be to identify failure mechanisms.

2. TASK DESCRIPTION

2.1 Background

Reactor coolant water can be contaminated with radioactivity during routine operation in light water reactor (LWR) plants by leakage from fuel rods and by activation of materials of construction. Also, the water can become highly contaminated in a LWR during an accident in which the core is uncovered long enough for damage to occur to the fuel cladding. In both cases a combination of filters and ion exchange processes can be used to decontaminate the water. A substantial part of the particulate matter is removed by filtration and the dissolved material by ion exchange. The ion exchange media can become highly loaded with radionuclides in the process. As Table 2 shows, up to 2200 curies have been loaded onto the EPICOR-II prefilter liners (at 57.1 Ci/ft^3) used to decontaminate the Auxiliary and Fuel Handling Building water at TMI Unit-2. In contrast, operating utilities load reactor water clean-up resins to approximately 10 Ci/ft^3, or about 18% of the specific activity realized with the EPICOR-II resin at TMI.

The Nuclear Regulator Commission requires solidification of resins from operating reactors as a prerequisite to commercial disposal. That requirement is being imposed to assure immobilization of the radioactivity. Solidification of ion exchange resins such as used in EPICOR-II, poses some technical problems for the long-term, including the chemical and physical stability of the final product. In accordance with proposed 10 CFR, Part 61 (draft) (Reference 5), the media must be immobilized and isolated for a minimum of 150 years, since the principal fission products contained therein have half lives of approximately 30 years (principally Cs^{137} and Sr^{90}).

The degradation of ion exchange media due to ionizing radiation caused by high internal loading such as seen in the EPICOR-II liners can determine the stability of the solidified product. Swelling and gas release are radiation caused occurrences which affect solidified products.

TABLE 2. CHEMISTRY AND RADIOISOTOPIC SUMMARY FOR EPICOR PREFILTERS 1 THROUGH 50[a]

Prefilter	DOT Transportation Group[b] (curies) 1	2	3	4	Total Activity	Volume Processed (Gallons)	pH	Final[c] Conductivity μmhos/cm	Sodium (PPM)	Boron (PPM)	Concentration[d] TRU (nCi/g)[b]	Waste Water (Ci/ml)
1	3.63(-5)	162	1,172	163	1,498	19,380	5.15	3.22	< 1	672	2.5(-2)	2.04(+1)
2	8.09(-3)	119	814	119	1,052	14,100	6.44	14.5	12	728	6.2(00)	1.97(+1)
3	1.41(-2)	167	1,542	169	1,878	17,700	7.33	202	19	1,160	11.(00)	2.80(+1)
4	6.54(-3)	44.3	595	44.6	684	10,100	8.0	942	10	822	5.2(00)	1.79(+1)
5	2.57(-4)	8.63	142	8.65	160	4,280	8.27	3,980	< 1	656	2.0(-1)	9.88(00)
6	2.67(-4)	8.97	148	8.99	166	7,225	7.57	1,220	150	517	2.4(-1)	6.07(00)
7	9.53(-3)	173	1,055	173	1,402	12,235	7.09	365	3	1,984	7.8(00)	3.03(+1)
8	9.56(-3)	34.2	1,298	34.7	1,367	5,475	7.36	235	24	1,109	7.8(00)	6.60(+1)
9	9.60(-3)	23.6	1,304	24.0	1,351	5,500	7.58	342	27	1,298	7.8(00)	6.49(+1)
10	1.92(-3)	4.31	219	4.40	227	1,000	7.92	24.6	1.8	76	1.6(00)	6.00(+1)
11	7.68(-3)	17.2	874	17.6	910	4,000	8.05	0.45	< 1	< 10	6.5(00)	6.01(+1)
12	1.50(-2)	34.4	1,457	35.1	1,526	7,420	7.87	1,100	104	1,568	12.(00)	5.43(+1)
13	1.38(-2)	29.4	1,358	30.0	1,417	6,820	7.7	1,220	180	1,807	11.(00)	5.49(+1)
14	1.44(-2)	34.3	1,389	34.8	1,458	11,320	8.08	1,900	420	1,460	12.(00)	3.40)+1)
15	1.95(-2)	39.6	1,399	35.0	1,469	8,000	7.75	1,300	115	1,552	12.(00)	4.85(+1)
16	5.24(-4)	29.6	1,998	30.5	2,058	8,250	2.79	700	< 1	1,392	4.2(-1)	6.59(+1)
17	1.74(-2)	31.0	1,707	31.3	1,768	7,035	3.52	140	< 1	1,320	14.(00)	6.62(+1)
18	2.03(-2)	35.0	1,955	35.9	2,025	8,100	3.39	180	6.6	1,298	16.(00)	6.60(+1)
19	1.99(-2)	34.4	1,918	35.3	1,988	7,952	3.13	300	< 1	1,353	15.(00)	6.60(+1)
20	7.13(-4)	8.75	1,936	9.68	1,954	8,100	4.89	7.2	2	259	5.5(-1)	6.37(+1)
21	7.13(-4)	8.75	1,936	9.68	1,954	8,100	6.3	84.5	4.3	801	5.5(-1)	6.37(+1)
22	6.23(-4)	7.67	1,697	8.49	1,713	7,103	5.28	3.15	< 1	498	4.8(-1)	6.37(+1)
23	1.37(-2)	98.7	1,213	99.3	1,411	11,300	7.56	2,100	180	2,770	11.(00)	3.30(+1)
24	7.13(-4)	8.75	1,936	9.68	1,954	8,100	4.95	7.76	< 1	801	5.5(-1)	6.37(+1)
25	7.13(-4)	8.75	1,936	9.68	1,954	8,100	5.07	10.9	< 1	686	5.5(-1)	6.37(+1)
26	7.13(-4)	8.75	1,936	9.68	1,954	8,100	4.96	13.1	1.23	757	5.5(-1)	6.37(+1)
27	7.13(-4)	8.75	1,936	9.68	1,954	8,100	4.82	6.31	< 1	779	5.5(-1)	6.37(+1)
28	1.04(-2)	53.3	810	53.8	918	14,212	7.19	440	35.0	1,514	7.9(00)	1.71(+1)
29	7.13(-4)	8.75	1,936	9.68	1,954	8,100	5.55	18.0	4.0	757	5.5(-1)	6.37(+1)
30	2.76(-3)	16.4	1,403	17.1	1,436	9,405	5.08	6.68	< 1	763	2.1(00)	4.03(+1)
31	7.32(-4)	9.21	1,748	9.77	1,767	5,100	5.12	4.60	< 1	965	5.8(-1)	9.15(+1)
32	7.32(-4)	9.21	1,748	9.77	1,767	5,100	5.19	4.12	< 1	963	5.8(-1)	9.15(+1)
33	7.32(-4)	9.21	1,748	9.77	1,767	5,100	5.66	1.86	< 1	595	5.8(-1)	9.15(+1)
34	7.32(-4)	9.21	1,748	9.77	1,767	5,100	4.70	9.25	< 1	920	5.8(-1)	9.15(+1)
35	7.32(-4)	9.21	1,748	9.77	1,767	5,100	5.31	3.40	< 1	693	5.8(-1)	9.15(+1)

TABLE 2. (continued)

Prefilter	DOT Transportation Group[b] (curies) 1	2	3	4	Total Activity	Final[c] Volume Processed (Gallons)	pH	Conductivity µmhos/cm	Sodium (PPM)	Boron (PPM)	Concentration[d] TRU (nCi/g)[b]	Waste Water (Ci/ml)
36	7.32(-4)	9.21	1,748	9.77	1,767	5,100	5.43	3.15	1.50	985	5.8(-1)	9.15(+1)
37	7.32(-4)	9.21	1,748	9.77	1,767	5,100	5.08	4.60	2.10	963	5.9(-1)	9.15(+1)
38	7.32(-4)	9.21	1,748	9.77	1,767	5,100	5.13	4.00	< 1	1,039	5.9(-1)	9.15(+1)
39	7.32(-4)	9.21	1,748	9.77	1,767	5,100	5.53	8.50	< 1	909	5.9(-1)	9.15(+1)
40	7.32(-4)	9.21	1,748	9.77	1,767	5,100	4.00	41.5	< 1	930	5.8(-1)	9.15(+1)
41	7.32(-4)	9.21	1,748	9.77	1,767	5,100	3.80	55.0	< 1	985	5.8(-1)	9.15(+1)
42	7.32(-4)	9.21	1,748	9.77	1,767	5,100	4.70	9.65	< 1	952	5.8(-1)	9.15(+1)
43	7.32(-4)	9.21	1,748	9.77	1,767	5,100	3.67	69.0	< 1	1,017	5.8(-1)	9.15(+1)
44	2.76(-1)	82.4	1,680	83.0	1,845	16,225	7.60	370	100	433	213(00)	3.00(+1)
45	3.05(-1)	90.1	1,853	91.6	2,036	17,900	6.89	230	88	757	233(00)	3.00(+1)
46	3.27(-1)	97.5	1,988	98.2	2,184	19,200	6.05	140	38	822	248(00)	3.00(+1)
47	2.53(-2)	115.3	1,708	116	1,939	28,600	7.82	540	130	509	19.(00)	1.79(+1)
48	2.53(-2)	115.3	1,708	116	1,939	28,600	6.38	200	1.10	530	19.(00)	1.79(+1)
49	1.75(-1)	1.31(-3)	1,774	1.75	1,776	32,731	3.79	670	2.60	1,039	133(00)	1.43(+1)
50	8.52(-2)	3.39(-3)	1,559	4.65(-1)	1,600	91,046	6.69	270	9.40	2,229	56.(00)	4.64(00)

a. Numbers in parentheses refer to power of 10.

b. Data corrected to 1 April 1982 (submitted 9 March 1982).

c. GPUN data as of 6 January 1982.

d. Calculated at EG&G Idaho, Inc. base upon data in "b" and "c." Calculations take into account weights of the resin and liner only.

The ion exchange capacity, one of the most important characteristics of an ion exchange medium, is known to be reduced by large doses of ionizing radiation. Thus, it is possible that the radionuclides initially held by the media could be released.

It should be reemphasized that the determination of chemical and physical properties of the media while at the same time conducting solidification and field leach experiments can develop much useful information. The plan described herein will provide data on the degradation of organic and inorganic ion exchange media containing high radiation loadings for long periods of time. It will provide data on the efficiency of immobilizing organic and inorganic resins in Portland cement and Dow polymer. It will provide information on the behavioral movements of radionuclides through soils from highly loaded solidified samples. It also will provide data on the behavior of polymer coated carbon steel liners containing highly loaded ion exchange media for long periods of time.

The EPICOR-II prefilters present an opportunity to study the physical and chemical changes in zeolite and organic resin caused by having been exposed to like conditions of radiation, temperature, pressure, water and age after loading. The plan provides an integrated approach to determining the behavior of zeolite and organic resin after exposure to high internal doses of ionizing radiation. The research plan described here represents the first time similar zeolite and similar resin samples with high loadings of radionuclides, have been subjected to studies of degradation, bench leachability, compression strength, field leach resistance.

2.2 Description

Resins from EPICOR-II liners which exhibit the highest curie content will be used to conduct the Resin Research Project. Liners PF-7, -8, and -9 will be used to furnish the organic resins while PF-20, -24, and -27 will be sampled for organic/inorganic resins (Table 2). The liners containing all organic media that have been selected have similar pH and conductivity for the type while the organic/inorganic liners have similar pH and conductivity for their type. The combination of resins and zeolites used to load each liner is propriatory to Epicor Inc. but it is known that PF-7, -8, and -9 have similar arrangements as do PF-20, -24, and -27.

2.2.1 Resin Degradation Project

Chemical and physical analysis will be conducted as part of the resin degradation project on the exchange media from two EPICOR-II liners (Figure 2) containing all organic resin and two containing organic and inorganic resin to determine resin degradation caused by internal ionizing radiation. One liner of each type (organic and organic/inorganic) will be sampled initially and once each 6 months for 2 years (5 total samplings) for degradation while one liner of each type is to be sampled at the end of the 2 year period as a control sample. Only the highest loaded media will be examined initially. Should the need arise, analysis of lesser loaded resin will be conducted and the results compared with those of other researchers.

The resins will be removed from liners for degradation tests and solidification by means of a coring tool in the TAN Hot Shop. That tool, patterned after the Battelle Columbus Laboratory design, will be square in cross section and will take a full depth sample (39-in.) from any location in the manhole area not obstructed by inlet or drain manifolds. An alignment guide fixture, placed on the manway, will be used for positioning and vertical insertion. The coring tool will have a closing feature in the lower or entry end to entrap the exchange media firmly within. The tool will contain a sharp edge to ease passage through the media or any crust on the media surface and the tool walls will be thin to minimize resin disturbance and displacement during insertion. The tool will feature a removable side which will aid insertion and be used to expose the full length of the sample for detailed examination. The tool will maintain resin relative position. A vibrator will be used to assist insertion. Included with this tool will be a casing or sleeve which will fit closely to the outside of the coring tool and be placed in the liner before removal of the coring tool to fill the void left by removing the resin. The tool thus can be used to remove a number of full depth cores from a liner

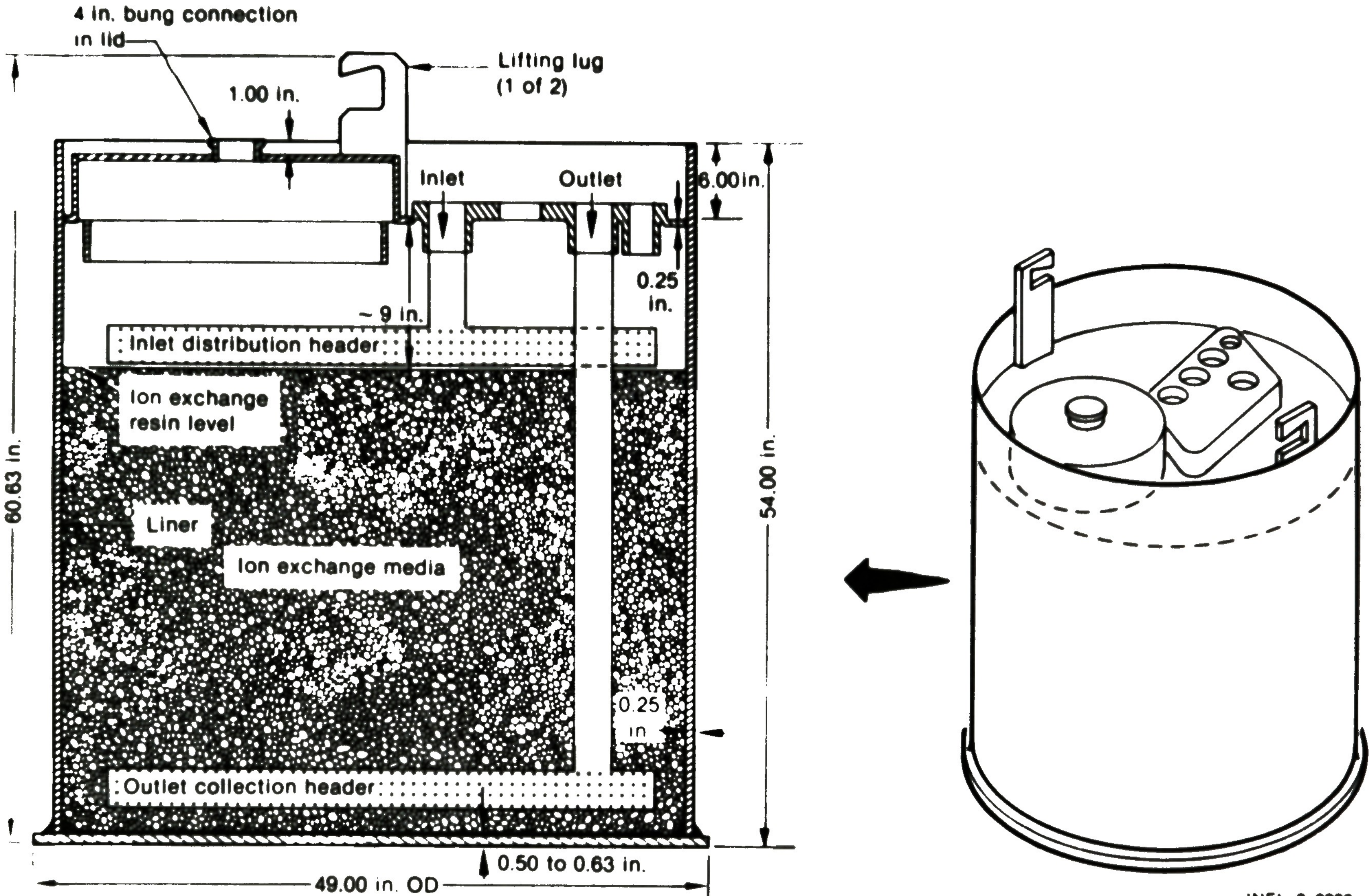

Figure 2. Schematic Diagram of EPICOR-II Liner

without significant disturbance of remaining media. By maintaining the relative location of the media intact, the system will enable a more meaningful examination of those stratified exchanger media.

A gamma survey will be conducted over the full length of the core. With the shipping cannister positioned horizontally and open, photographs will be taken of the core to record physical appearance. While the commercial type and location of exchange media within each liner is proprietory information, it will be possible to identify separation between types during examination. That is important because degradation samples will be taken in the highest radiation zone of each type of resin present near that zone. Also, fresh medium samples of the types included in the liners will be procured. That will allow direct comparison between the fresh samples and the irradiated loaded samples such that degration evaluations can be made precisely. One or two samples will be used from each core with one core taken from each liner at each sampling. Possible light isotopic loading at the bottom of the liner makes the resin in that area of less interest in these experiments. Resin degradation will be determined as a function of a number of chemical and physical changes. Some of these are (1) ion exchange capacity, (2) polymer backbone integrity, (3) liquid degradation products, (4) radiolysis gases, (5) partical size distribution, (6) surface condition, (7) stickiness, (8) melting point, and (9) dry weight density. A gamma survey of the core hole in the liner will verify radiation dose to the samples. Results of analyses will be reported in a final report. Comparisons with the findings of other reseachers will be developed.

2.2.2 Solidification Project

The resin solidification project will be performed using the ion exchange media from one EPICOR-II liner containing all organic resin and one containing organic and inorganic resin. Leach test samples will be formed using commercial formulations of Portland cement and commercial Dow polymer to immobilize the exchange media. The leach test samples will be sent to Brookhaven National Laboratory for leach and compression testing.

The leach tests will be conducted to comply with a modification of the proposed ANS 16.1 standard or the ISO method for the measurement of leachability of low-level radioactive waste forms (References 6 and 7). The compression tests will be performed in accordance with ASTM C 39-80 (Reference 8). Results will be presented in a final report and compared with results of the leach testing.

Exchange media to be solidified and used in compression, leach and lysimeter testing will be removed from each liner by use of the coring tool in the TAN Hot Shop. Eleven full depth cores will be required but, because of probable interference with the outlet piping near the bottom of the liner, it is planned to remove several additional partial depth cores.

About 1300 cubic inches of media will be removed from each liner of which 300 cubic inches will be used to form 2-in. diameter by 3-in. long leach test coupons and the remaining 1000 cubic inches will go into lysimeter field test samples will each be about 2-in. in diameter by 3-in. long assembled end to end to form a column 21-in. in height. Those volumes will provide about twice as much material as needed for immobilization for contingency purposes. It has been estimated that radiation from the test coupons will be about 4R at 1-foot and from the lysimeter samples 30R at 1-foot.

The cores to be immobilized will be placed in a transfer container with no attempt made to maintain relative shape or position. All core material from a liner will be placed in a storage bin after transfer to a hot cell. A hot cell facility at the INEL will be equipped with resin, cement and polymer storage bins and suitable facilities for metering from each bin. Means for weighing the constituents of each mix will be provided in the hot cell and a simple paint stirring device will be employed for mixing. Disposable molds will be used for both specimen sizes. All leach coupons and lysimeter samples of each mix formula will be mixed and poured at the same time. The mixing equipment will be disposed after use with no cleanup planned. Molds will be sealed after the mix has been poured to restrict escape of moisture from the specimens.

The organic and organic/inorganic resins each will be mixed separately with the cement and the polymer to form the test items. Sixteen test coupons will be made from each liner. This will result in 32 coupons, 8 from the all organic liner with cement and 8 samples with polymer plus 8 samples from the organic/inorganic liner with cement and 8 with polymer. Eight lysimeter samples will be formed from the exchange media from each liner. The samples will consist of 4 organic with cement, 4 organic with polymer, 4 organic/inorganic with cement and 4 organic/inorganic with polymer.

After the coupons have been cured, they will remain sealed, be placed in shipping casks, and sent to Brookhaven National Laboratory for leach and compression testing. Once received at Brookhaven and removed from the molds, half of the coupons will be placed in leach solution and leach tested per the modified ANS 16.1 or ISO method. Compression tests will be conducted on the other half per the ASTM method C39-80. Results from the leach and compression tests will be compared with past experimental data to determine the ability of the selected mixes to immobilize these highly loaded exchange media.

2.2.3 Field Testing Project

The Field Testing Project will be conducted at four national laboratories. Each laboratory will test four samples, each in a separate lysimeter experiment. Solidified samples will be placed in the earth at each laboratory, and the leach rate caused by local environment will be monitored periodically. Analysis of the leachate will indicate the amount of radionuclides released from the sample under local environmental conditions. Comparison with other samples will provide a qualitative evaluation of each solidified sample. The comparison and data evaluation will be provided in a final project report.

The field lysimeter experiments will consist of a 300-gallon fiberglass drum with a screened opening attached to the bottom as shown in Figure 3. A water collection sump and sump pump are integral with the screened opening and will capture any moisture existing in the barrel. The

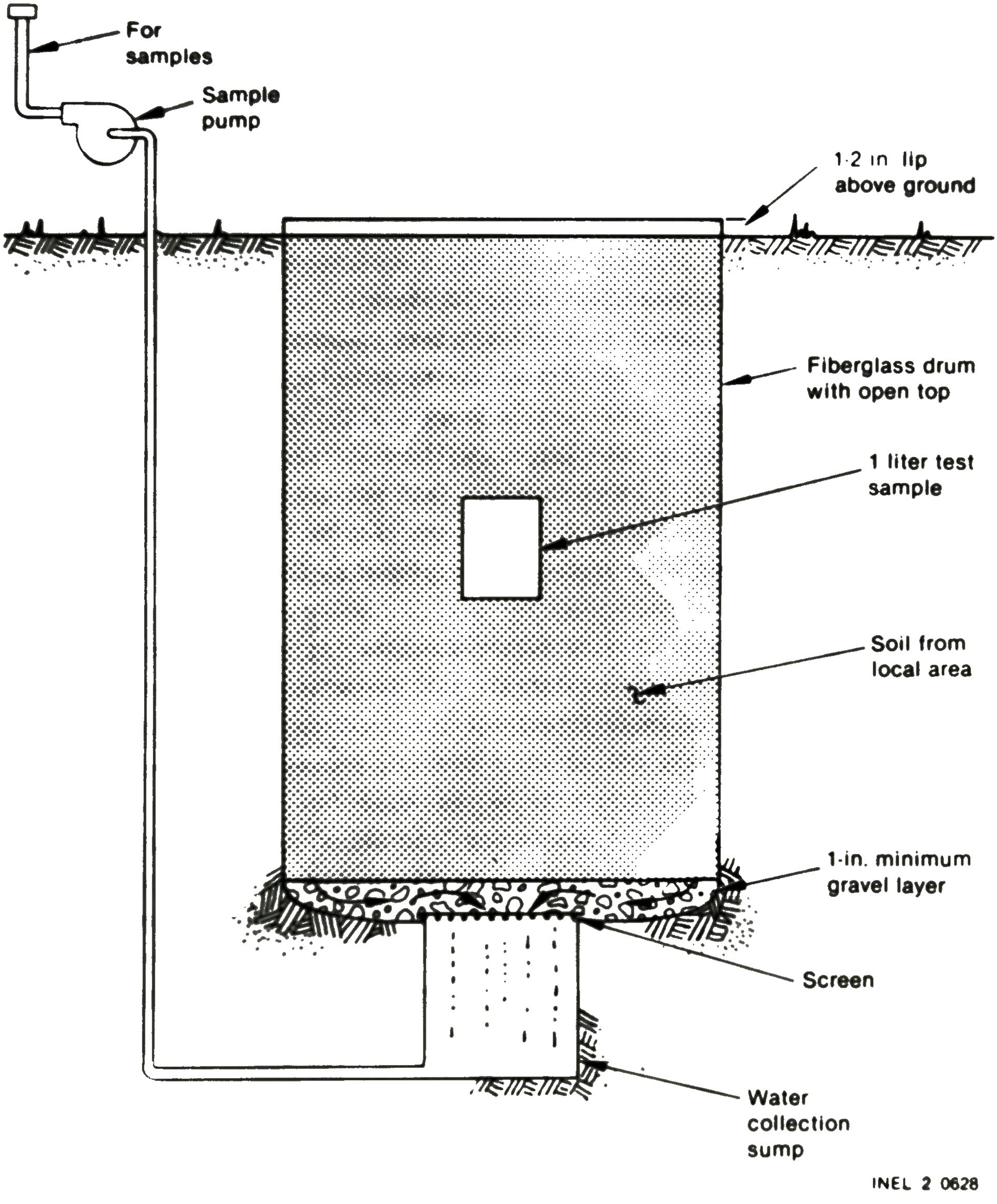

Figure 3. Concept of Lysimeter for Field Testing of EPICOR-II Resins

barrel will be buried in the earth such that the upper lip is 1 to 2 inches above the ground surface. The drum will be filled first with one inch of local gravel over the bottom screen and then local soil to the top lip. The solidified sample with associated instrumentation will be located in the center of the drum during filling. The pump will withdraw any moisture contained by the sump and transfer it above-ground for analysis. The experiment is designed to expose the sample to local infiltration and resultant leaching.

Specimens for lysimeter test as noted above, will be cast at the same time with the same equipment as the leach test coupons. The samples will be removed from the molds after proper curing and placed in shipping containers inside shipping casks. The samples along with the lysimeter equipment, all provided by EG&G Idaho, will be shipped to the laboratories where the field tests will be conducted. Each national laboratory will install the drums in the ground and place the samples in local earth within the drums in accordance with procedures developed by EG&G Idaho.

Each laboratory will provide suitable monitoring instrumentation to measure local air temperature, rainfall, soil temperature, and soil moisture content at the sample throughout the duration of the experiment. Evaluation of the leachate collected in the sump and at locations above, along side and below the sample will be the responsibility of the participating laboratories. A monitoring interval of once each three months will be used as a minimum. Results of the four separate laboratory lysimeter field tests will be forwarded to EG&G Idaho, Inc. and compiled into a final report. Those results will be compared in total and evaluated in light of the data collected from the bench leach and compression test results of the Solidification Project.

2.2.4 Liner Integrity Examination Project

Examination of two liners (PF-3 and PF-16) will be conducted in the Liner Integrity Project to determine liner integrity. Interest in liner integrity developed during characterization by Battelle Columbus

Laboratories when the condition of PF-16 came into question (Reference 9). That examination will require pumping the resins from the subject liners to new liners procured from EPICOR Inc. The empty liners will be decontaminated inside and out. It is expected that that will reduce the radiation to levels which will allow hands-on activities. If decontamination is not possible equipment will be available to remotely complete this task. Visual examination of both exterior and interior surfaces of the two liners will be conducted using television camera and video recorder before decontamination. Samples of the bottom to cylinder joint, vertical seam, and bare metal spot will be removed along with up to three other samples from other areas of interest for metallographic examination. Both macro- and micro-examination will be accomplished. The integrity of the plastic coating and the carbon steel liner will be determined and reported in a final project report.

The liner will be positioned in a tilt fixture next to a new liner in the TAN-607 Hot Shop, the manway covers removed, and the media transferred into the empty liner by using a vacuum system especially adapted for this work. Vacuum pumping will be employed to transfer the media from the subject liner to the new liner. Zeolite crusting and packing may affect resin transfer by resisting entry of the vacuum wand and by not flowing to the suction point. A vibrator will be attached to the liner wall and water will be added to assist in loosening the zeolite. If significant resin degradation occurs and it results in agglomeration of the resins in either PF-3 or -16, it is conceivable that problems could occur when transferring the media to the new liners. The addition of water to break the agglomeration is a known process method (Reference 8) that should work in this case. The water added to aid in the transfer will be removed by draining from the full liner to the building hot waste system. The newly filled liner will be closed and stored normally.

The study liner then is removed from the tilt fixture and moved to the decontamination system for cleanup. This system consists of fixed spray nozzles to wash the exterior of a liner and a movable spray nozzle which is positioned inside the liner and covers all surfaces. The decontamination solution contained on the top and within the liner is pumped out through the decontamination solution return line back to the decontamination system. Expended solution will be discharged to the building hot waste system. After a decontamination cycle is complete, the liner is surveyed for alpha, beta or gamma activity. If the activity level is too high for hands-on work, a second cycle will be run and the liner resurveyed. If activity is still too high for hands-on work, a third cycle will be run. If the liner does not decontaminate successfully, remote sample removal will be necessary. If it is clean it will be moved to the TAN Warm Shop for further work.

Visual inspection will be accomplished with a television camera and video tape in the case of a hot unit or by in-person observation with a decontaminated unit. During this observation, the location of each sample will be selected and marked on the outside of the liner. Sites will be selected where obvious failure of the plastic has occurred. The samples will be removed by use of a circular saw. Each sample will be about 3-in. in diameter.

The sample pieces will be removed from the Hot Shop and shipped to TRA for further processing. The liner will be sent to the RWMC for final disposition. Macro- and micro-examination will be performed on the samples to determine the extent of any breakdown in the epoxy coating and the amount of corrosion in the carbon steel tank. From that examination, the overall liner integrity will be determined. The samples will be photographed and the results presented in a GEND[a] report at the concul sion of the project.

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a. GEND is a form of report originating from TMI work and is an accronim for General Public Utilities, Electric Power Research Institute, U.S. Nuclear Regulatory commission and U.S. Department of Energy.

2.3 Deliverables

2.3.1 Documentation

2.3.1.1 Monthly Letter Report. A monthly letter report will be provided to the Program Manager on each project and will contain:

1. Technical status and update,
2. Milestone status,
3. Budget status, and
4. Statement of problem areas and solution.

2.3.1.2 Interim Letter Reports. An interim letter report will be furnished to the Program Manager which will include results of the visual and metallographic examinations of the liners.

2.3.1.3 GEND Report. A GEND Final Report will be written upon completion of each project:

1. Resin degradation,
2. Resin solidification,
3. Field Testing,
4. Liner integrity examination.

2.3.2 Physical Items

2.3.2.1 Tools and Equipment. Following is a list of the tools and equipment to be provided in the plan:

1. Resin coring tool,
2. EPICOR-II liner manway opening and closing tool,
3. Resin core casing,
4. TAN 607 Hot Shop window "G" transfer table,
5. Solidification system including storage, metering and mixing equipment,

6. Sample molds,
7. Resin transfer system,
8. Liner tilt fixture.

2.3.2.2 Samples. Listed below are the samples which will be produced during the conduct of this plan:

1. Resin degradation core samples--5 seperate samplings from 2 liners,
2. Solidified compression and leach test coupons--resin in cement and Dow polymer, zeolite in cement and DOE polymer,
3. Solidified field test samples--resin in cement and Dow polymer, zeolite in cement and Dow polymer,
4. Metallographic samples.

2.3.2.3 Lysmeters. A total of 16 lysimeters complete with sumps, moisture detectors and pumps will be provided in the plan.

3. SCHEDULE AND COST

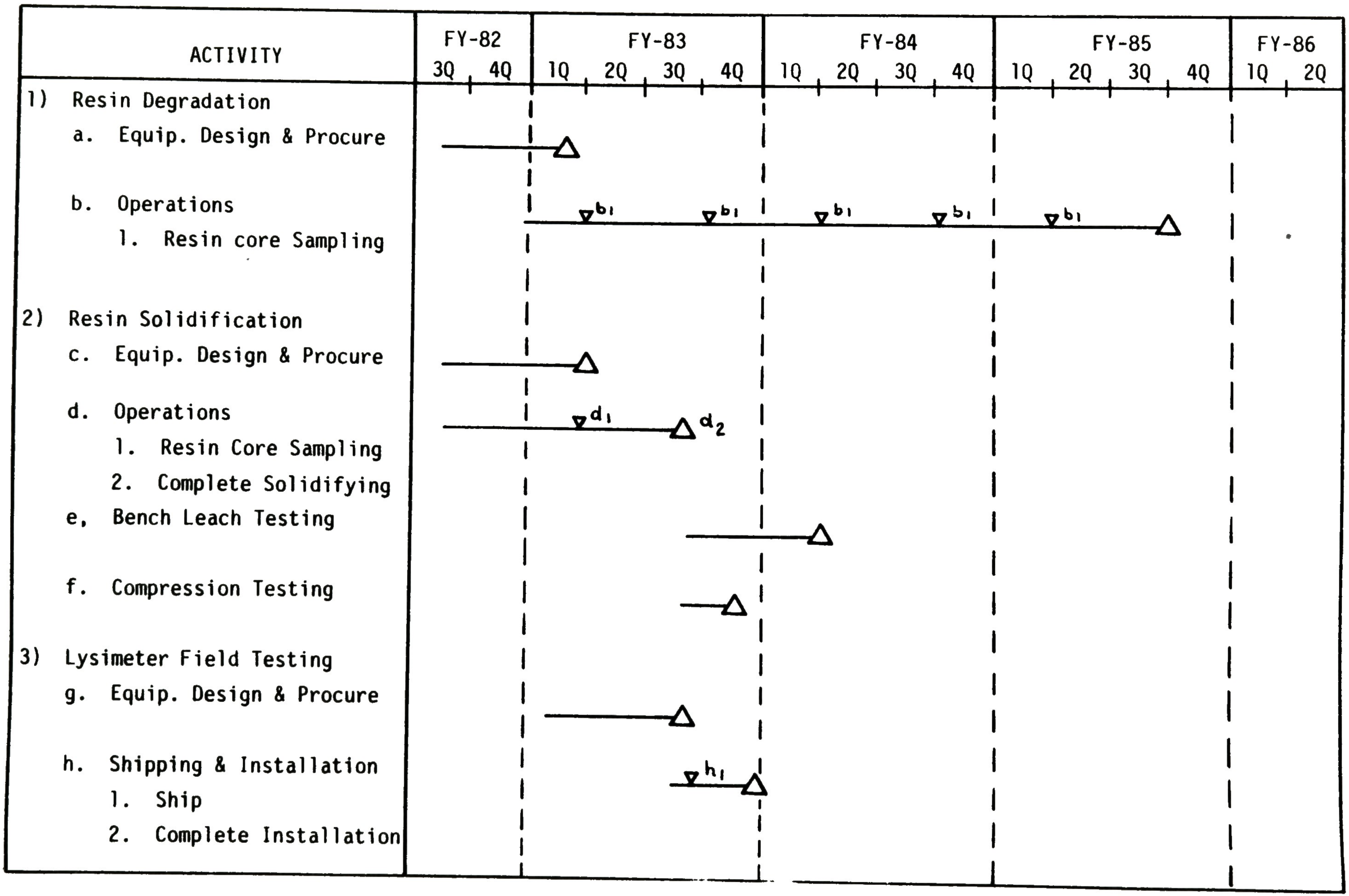
3.1 Schedule

The research schedule is shown in Figure 4. The TMI funded Resin Research will extend for three years. There is technical justification to conduct the study of the resin degradation for a total of 10 years and the lysimeter field testing work for a total of 20 years. This justification is based on obtaining a higher radiation dose of 10^9 rads in the degradation work and allowing enough time for significant leaching in the field testing. Funding for the extension of these projects would come from other than TMI. This will result in the requirements to dispose the four liners used in degradation studies plus the lysimeter samples at a later date than originally planned.

3.2 Cost Estimate

The cost estimates are presented in Table 3. Estimates are presented for the TMI funded portions only. TMI funding will see the completion of the Solidification Project and Liner Integrity Examination Project. If an extended schedule is adapted, a majority of the Lysimeter Field Test Project will still have been completed with TMI money leaving only intermittent sampling and disposal to be funded by other means. Four samplings, analysis, and liner disposal would be conducted in the Resin Degradation Project beyond TMI funding. The funding required for an extended program would come from other than TMI sources.

FIGURE 4. EPICOR-II RESIN/LINER RESEARCH SCHEDULE



FIGURF 4 (continued)

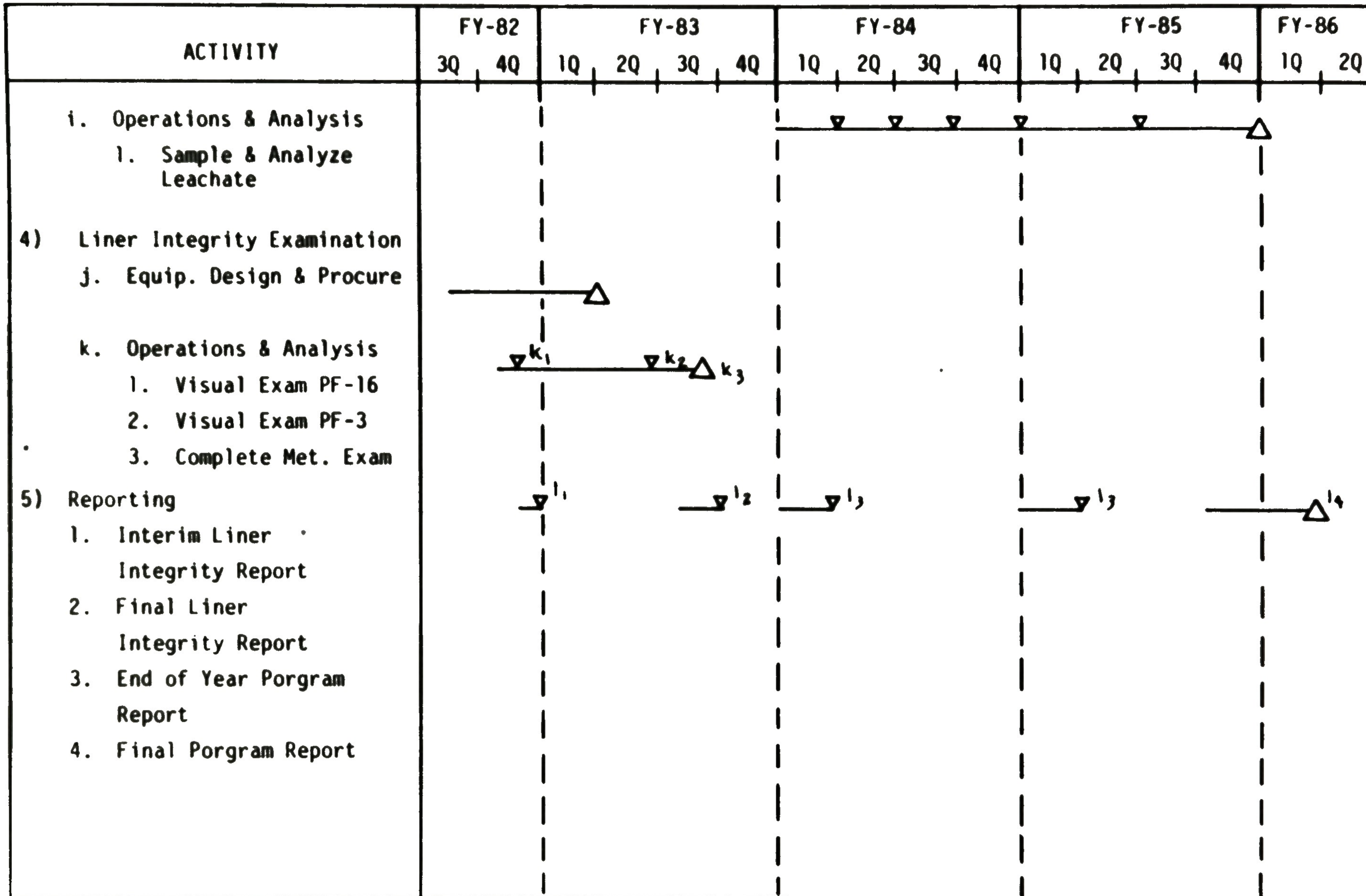


TABLE 3. COST SUMMARY EPICOR-II RESIN/LINER RESEARCH PROJECTS

Project	Thousand of dollars				
	FY-82	FY-83	FY-84	FY-85	FY-86
Resin Degradation					
Equipment Design and Procurement (Cap. Equip.)	28	154	--	--	--
Options and Analysis	29	128	--	158	--
Resin Solidification					
Equipment Design and Procurement (Cap. Equip.)	4	151	--	--	--
Operations	11	82	--	--	--
Bench Leach Testing	--	100	75	--	--
Compression Testing	--	30	--	--	--
Lysimeter Field Testing					
Equipment Design and Procurement (Cap. Equip.)	--	85	--	--	--
Installation and Shipping	--	140	234	--	--
Operation and Analysis	--	--	36	48	48
Liner Integrity Examination					
Equipment Design and Procurement	35	10	--	--	--
Operations and Analysis	60	100	--	--	--
Operating Dollars	135	590	345	206	48
Capital Equipment Dollars	32	390	--	--	--

Note: Extending the plan would result in the completion of the Resin Degradation Project in FY-1993 and the Lysimeter Field testing in FY-2003.

4. INTERFACES

4.1 Technical

The research projects will be directed by the EG&G EPICOR-II Research and Disposition Program. In turn this program is part of the TMI Technical Support and Projects Office (TS&P) of EG&G. All requests for information or meetings with Government agencies except consultants or subcontractors shall be coordinated through the TS&P.

Epicor, Incorporated will provide definition of the EPICOR-II liner designs and with ion exchange media loading information necessary to perform the resin degradation, solidification, field test, and liner examination tasks.

Information on past resin degradation and solidification work will be obtained from Brookhaven National Laboratory. Field test experimental design will be coordinated with Savannah River, Pacific Northwest and Brookhaven National Laboratories.

4.2 Management

The EPICOR-II Resin/Liner Research is an element and responsibility of the EPICOR-II Research and Disposition Program. The EPICOR-II Research and Disposition Program is an element and responsibility of the TMI-2 Technical Support and Projects Office (TS&P). The TS&P Program is the responsibility of DOE/ID in support of the TMI-2 Information and Examination Program (TI&EP). TIO is established at TMI in accordance with the terms of the GPUN, EPRI, NRC, and DOE (GEND) Coordination Agreement and functions within guidelines established by the DOE TMI-2 Programs Management Plan. The relationship between the TI&EP and TMI-2 TS&P is described in the TMI TS&P Management Plan.

The functional organization of the EPICOR-II Research and Disposition Program is shown in Figure 5. The program is responsible for management and control of all phases of the program, from its inception to completion including negotiations with DOE, establishment of program requirements and criteria, identification and authorization of work to be performed, establishment and control of direct management on program requirementsd and criteria, identification and authorization of work to be performed, establishment and control of direct budget and schedule requirements, monitoring and reporting to DOE and EG&G management on program performance, and maintenance of liaison with TIO.

The EPICOR-II Resin/Liner Research Project is responsible for developing and managing an integrated resin research plan in accordance with the overall objectives of the EPICOR-II Research and Disposition Program. These responsibilities include; coordination of technical and operational support, developing procedures, informing management of status of projects, budgeting, scheduling, preparing the appropriate documentation (monthly reports, annual reports, test results, analytical reports, etc.), and providing the program manager support as needed.

Periodic program reviews will be conducted within EG&G Idaho to ensure peer review, schedule, and cost review, and technical work scope status. These reviews will result in written meeting minutes, including agreements and action items with responsible parties and schedules for completion.

Day-to-day technical and management matters requiring coordination between EG&G/TIO and the task managers will be handled through the EG&G/TS&P at EG&G Idaho.

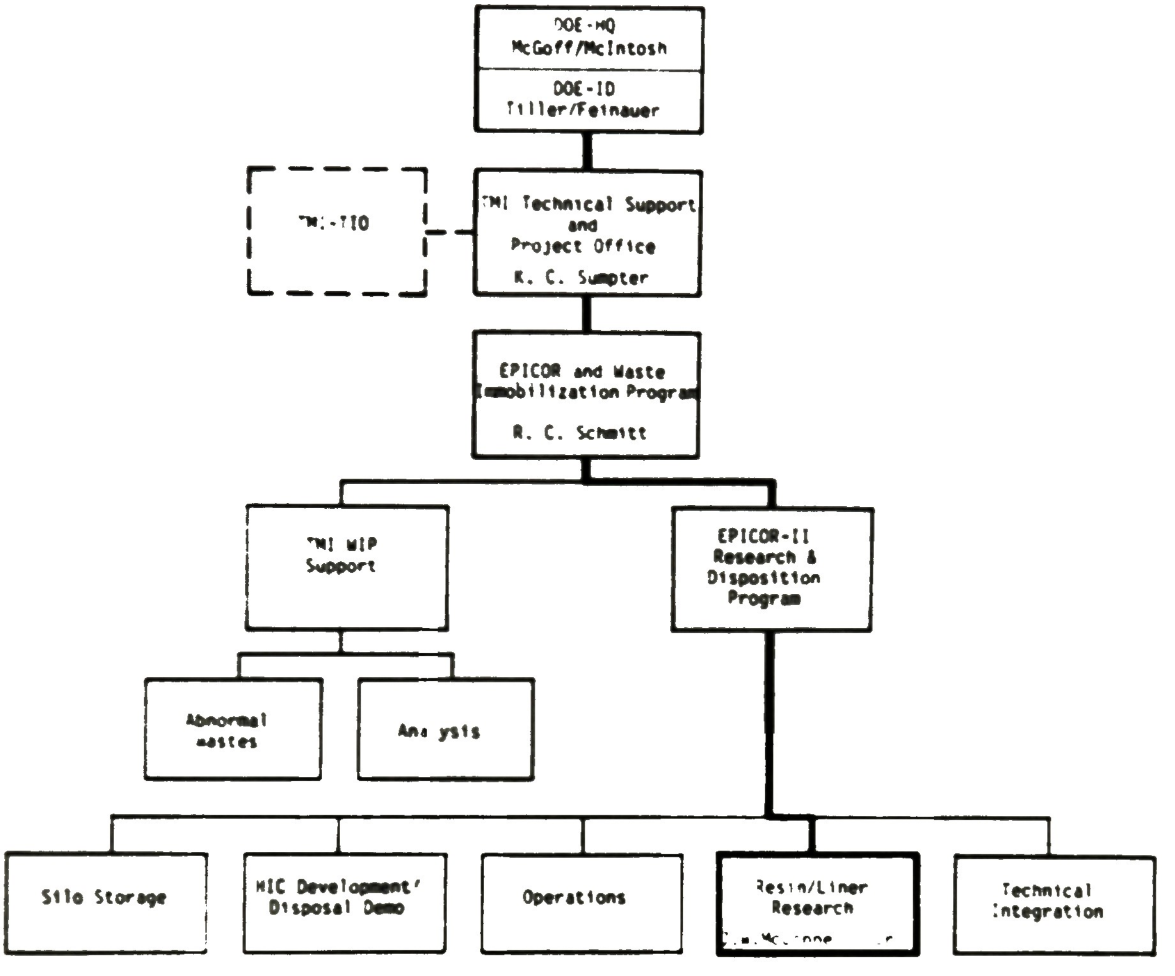


Figure 5. Functional Organization Structure of the EPICOR-II Resin/Liner Research

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