UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

Final EIR

May 30, 1980

Docket No. 50-10

Mr. D. Louis Peoples
Director of Nuclear Licensing
Commonwealth Edison Company
Post Office Box 767
Chicago, Illinois 60690

Dear Mr. Peoples:

The Nuclear Regulatory Commission has issued a Draft Environmental Statement related to the primary cooling system chemical decontamination at Commonwealth Edison Company's Dresden Nuclear Power Station, Unit No. 1. Ten copies of the Draft Statement are enclosed for your use. Also enclosed is a copy of a related notice of availability which has been forwarded to the Office of the Federal Register for publication.

Sincerely,

Dennis M. Crutchfield

Dennis M. Crutchfield, Chief
Operating Reactors Branch #5
Division of Licensing

Enclosures:
1. DES (10)
2. Notice (1)

cc w/enclosures
See next page

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UNITED STATES NUCLEAR REGULATORY COMMISSION

DOCKET NO. 50-10

COMMONWEALTH EDISON COMPANY

NOTICE OF AVAILABILITY OF DRAFT ENVIRONMENTAL STATEMENT

Pursuant to the National Environmental Policy Act of 1969 and the United States Nuclear Regulatory Commission's regulations in 10 CFR Part 51, notice is hereby given that a Draft Environmental Statement prepared by the Commission's Office of Nuclear Reactor Regulation related to the proposed primary cooling system chemical decontamination at Commonwealth Edison Company's Dresden Nuclear Power Station, Unit No. 1 located in Grundy County, Illinois is available for inspection by the public in the Commission's Public Document Room at 1717 H Street, N. W., Washington, D. C. 20555 and in the Local Public Document Room at Morris Public Library, 604 Liberty Street, Morris, Illinois 60451. The Draft Statement is also being made available at the State Clearinghouse, Bureau of the Budget, Lincoln Tower Plaza, 524 S. Second Street, Room 315, Springfield, Illinois 62706. Requests for copies of the Draft Environmental Statement should be addressed to the U. S. Nuclear Regulatory Commission, Washington, D. C., Attention: Director, Division of Licensing.

Pursuant to 10 CFR Part 51, interested persons may submit comments on the Draft Environmental Statement for the Commission's consideration. Federal and State agencies are being provided with copies of the Draft Environmental Statement (local agencies may obtain these documents upon request). Comments are due by July 21, 1980. Comments by Federal, State,

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and local officials, or other persons received by the Commission will be made available for public inspection at the Commission's Public Document Room in Washington, D. C. and the Local Public Document Room. Upon consideration of comments submitted with respect to the draft environmental statement, the Commission's staff will prepare a final environmental statement, the availability of which will be published in the FEDERAL REGISTER.

Comments on the Draft Environmental Statement from interested persons of the public should be addressed to the U. S. Nuclear Regulatory Commission, Washington, D. C. 20555, Attention: Director, Division of Licensing.

Dated at Bethesda, Maryland, this 30th day of May, 1980.

FOR THE NUCLEAR REGULATORY COMMISSION

Dennis M. Crutchfield

Dennis M. Crutchfield, Chief
Operating Reactors Branch #5
Division of Licensing

NUREG-0686

draft environmental statement

related to

PRIMARY COOLING SYSTEM CHEMICAL DECONTAMINATION AT DRESDEN NUCLEAR POWER STATION UNIT NO. 1

COMMONWEALTH EDISON COMPANY

MAY 1980

DOCKET NO. 50-10

U. S. Nuclear Regulatory Commission • Office of Nuclear Reactor Regulation

NUREG-0686
MAY 1980

DRAFT ENVIRONMENTAL STATEMENT

BY THE

U. S. NUCLEAR REGULATORY COMMISSION

FOR

DRESDEN NUCLEAR POWER STATION, UNIT NO. 1

PRIMARY COOLING SYSTEM CHEMICAL DECONTAMINATION

COMMONWEALTH EDISON COMPANY

Docket No. 50-10

This draft environmental statement was prepared by the U. S. Nuclear Regulatory Commission staff.

The proposed action addressed by this environmental impact statement is the approval by NRC to carry out the chemical decontamination of the primary cooling system of the Dresden Nuclear Power Station, Unit No. 1.

For further information regarding this environmental review, contact:

Paul W. O'Connor, Project Manager
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555
(301) 492-7215

Comments on this draft statement must be received by the Director, Division of Licensing, U. S. Nuclear Regulatory Commission, Washington, D. C. 20555, by JUL 21 , 1980, to be assured that they are taken into account in the preparation of the final environmental statement.

ABSTRACT

The staff has considered the environmental impact and economic costs of the proposed primary cooling system chemical decontamination at Dresden Nuclear Power Station, Unit 1. The staff has focused this statement on the occupational radiation exposure associated with the proposed Unit 1 decontamination program, on alternatives to chemical decontamination, and on the environmental impact of the disposal of the solid radioactive waste generated by this decontamination. The staff has concluded that the proposed decontamination will not significantly affect the quality of the human environment. Furthermore, any impacts from the decontamination program are outweighed by its benefits.

SUMMARY

By letter dated December 19, 1974 Commonwealth Edison Company (CECo) proposed to decontaminate the primary cooling system of the Dresden Nuclear Power Station Unit No. 1. The NRC staff issued a Safety Evaluation and conditional authorization to initiate the proposed chemical decontamination by a letter dated December 9, 1975. Three petitions regarding the proposed action have been received. Two of these petitions, one from Ms. Kay Drey and one from Citizens for a Better Environment asked for the preparation of an environmental impact statement (EIS). The third petition from the Illinois Safe Energy Alliance (ISEA) asked for a public hearing in anticipation of an NRC denial of requests for an EIS. These petitions are under review by the Director of Nuclear Reactor Regulation.

The major issues in this environmental review are the occupational radiation exposure associated with the proposed decontamination and the environmental impact of the disposal of the radioactive waste generated by the decontamination.

The staff evaluated the environmental impacts of the proposed decontamination and the following alternatives:

1. Continue reactor operation without decontamination.

2. Shut the reactor down permanently

3. Alternative methods of decontamination.

The staff found none of the alternatves to be obviously superior to the proposed program. Furthermore, the staff has concluded that the proposed program will not significantly affect the quality of the human environment. The staff has also concluded that any impacts from the proposed decontamination program are outweighed by its benefits (Sections 4-6).

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1.0 PURPOSE OF THIS ENVIRONMENTAL STATEMENT

This environmental statement was prepared in response to extensive expressions of public interest in this action. The purpose of this draft environmental statement is to evaluate the environmental impact of, and alternatives to, a proposal by Commonwealth Edison Company to decontaminate the primary cooling system of the Dresden Nuclear Power Station Unit No. 1. This statement was prepared in accordance with the statement of general policy and procedures on implementing the National Environmental Policy Act of 1969.

The staff's responses to the questions contained in the prinicipal requests are contained in Appendix A.

2.0 BACKGROUND

2.1 PROPOSED ACTION

Commonwealth Edison Company (CECo) (the licensee) has proposed to decontaminate the primary cooling system of Dresden Nuclear Power Station Unit No. 1. The decontamination will involve the circulation of a decontamination solution through the system to dissolve a thin layer of radioactive corrosion products which have accumulated during the 20-year operation of Dresden 1.

CECo originally proposed the decontamination by letter dated December 19, 1974. On December 9, 1975 NRC authorized CECo to begin preparation for the decontamination but conditioned final approval upon the completion of three open items as follows:

1. The testing program will be completed and the results submitted for the review and approval of the NRC staff prior to performing the proposed chemical cleaning.

2. A pre-service inspection program for the primary coolant boundary will be formulated and submitted for our review and approval prior to returning the reactor to service.

3. A post-cleaning surveillance program which includes additional surveillance specimens and a specimen withdrawal and examination schedule will be submitted for our review and approval prior to returning the reactor to service.

Since our 1975 authorization, CECo has completed construction of all of the support facilities needed to carry out the decontamination and has submitted all of the information required by the staff to satisfy the above open items.

2.2 DRESDEN DESCRIPTION

Dresden 1 is a dual cycle boiling water reactor manufactured by General Electric. It is located near Morris, in Grundy County, Illinois. Dresden 1 is the world's first privately financed, full scale, commercial, nuclear power reactor. The facility began commercial operation in 1960 and has produced 16.8 billion Kilowatt hours of electrical energy since that date.

2.3 NEED FOR DECONTAMINATION

During the 20 years that Dresden 1 has been operating, traces of the materials used in piping and components in contact with the primary coolant have corroded and become entrained in the circulating primary coolant.

These trace quantities of metals have become radioactive through neutron activation while circulating through the reactor core. Such quantities of metals have subsequently plated out on the inner surfaces of the pipes, valves and pumps in a thin layer of tightly adherent oxide. The radioisotope of most particular concern in this process is Cobalt-60 (Co-60). This radioisotope is produced by neutron activation of stable cobalt that is present in trace quantities in the large amount of stainless steel used in the reactor primary cooling system. Table 1 lists the predominant radionuclides present in the oxide layer at Dresden 1 along with an estimate of the number of Curies of each nuclide to be removed during decontamination.

TABLE 1

NUCLIDE	CURIES	HALF LIFE	ESTIMATED* Ci/55 Gal. DRUM
^{60}Co	2160	5.3 years	1.80
^{58}Co	630	22 days	0.53
^{144}Ce-^{144}Pr	117	290 days	0.10
^{54}Mn	30	25 days	0.03
^{95}Zr-^{95}Nb	21	63 days	0.02
^{57}Co	15	270 days	0.01
^{141}Ce	15	32 days	0.01
^{103}Ru	9	41 days	.01
MFP	3	**	.01
	3000		2.50

* Assumes that the waste will be uniformly distributed in 1200 drums.

** The half life of mixed fission products may be approximated by assuming that $T_{\frac{1}{2}} = t$ where t is the time since fission.

The buildup of radioactive corrosion products on the inside surfaces of the primary cooling system piping and components, causes an increased occupational exposure for personnel who have to work on or adjacent to these components.

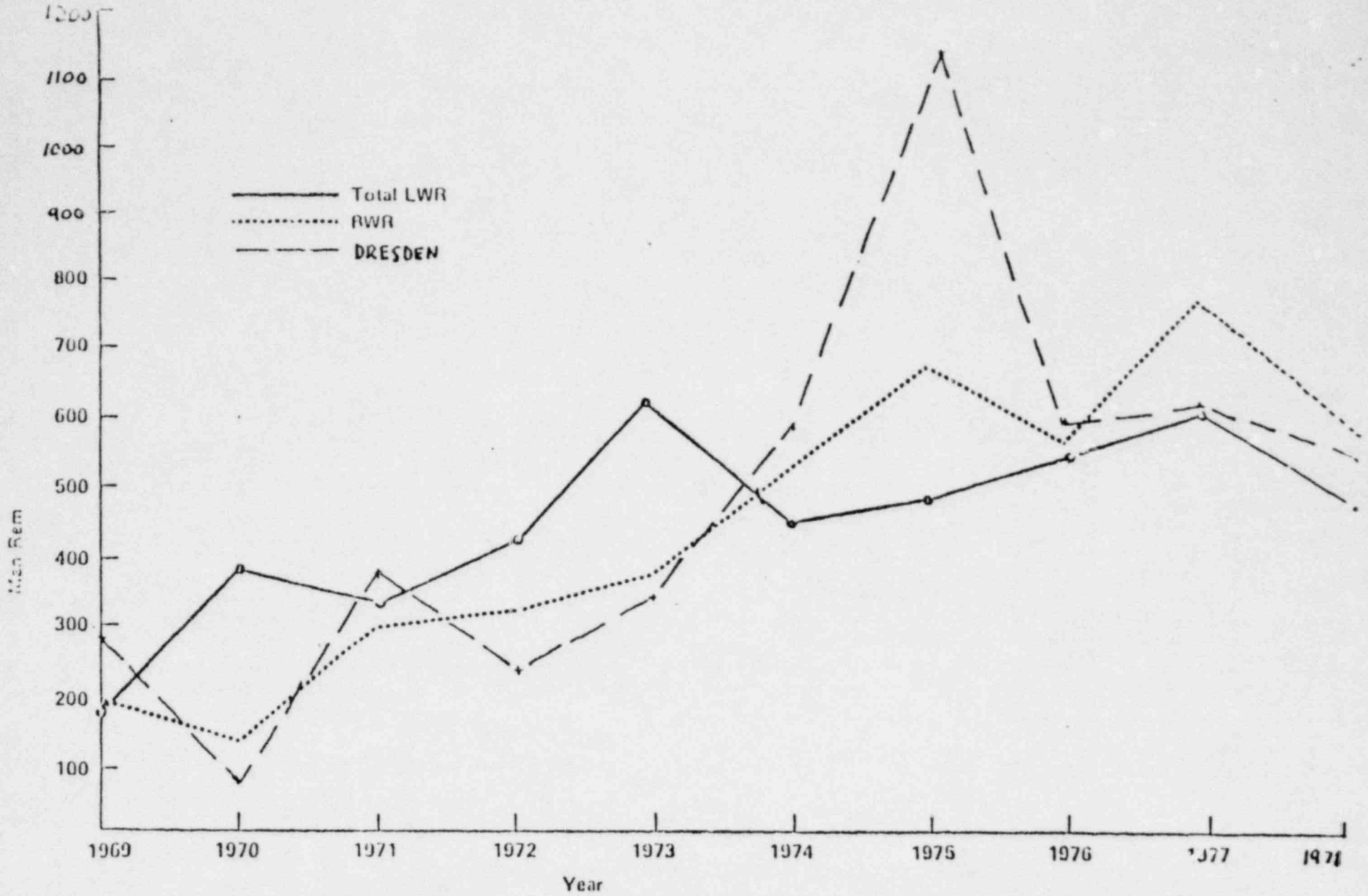


Figure 1. Average Man-Rem per Reactor Year.

TABLE 2
BOILING WATER REACTORS
LISTED IN ASCENDING ORDER OF MAN-REMS PER REACTOR
1973 THROUGH 1977

BWR AVG

1973 Site Name	[1]Man Rems per Site	Dose per Worker (Rems)	Man Rems per MW Yr
Vermont Yankee	85	0 34	0 38
Pilgrim	176	0 54	0 76
Monticello	476	0 43	0 52
La Crosse	221	1 40	9 71
Humboldt Bay	266	1 26	5 32
Big Rock Point	285	1 18	5 56
Dresden 1,2&3	939	0 70	0 84
Nine Mile Point	567	1 03	1 38
Millstone Point 1	663	0 56	2 95
Oyster Creek	1236	1 58	2 91
Averages per Reactor	380	0 85	1 36

1974 Site Name	[1]Man Rems per Site	Dose per Worker (Rems)	Man Rems per MW Yr
La Crosse	139	1 71	3 66
Vermont Yankee	216	0 61	0 71
Quad Cities 1&2	482	0 71	0 50
Big Rock Point	27[illegible]	[illegible]98	6 73
Humboldt Bay	318	[illegible]	7 39
Monticello	349	0 41	1 00
Pilgrim 1	415	0 90	1 77
Dresden 1,2,3	1662	1 04	1 90
Nine Mile Point	824	1 11	2 13
Oyster Creek	984	1 05	2 27
Millstone Point 1	1430	0 55	3 33
Averages per Reactor	507	0 81	1 76

1975 Site Name	[1]Man Rems per Site	Dose per Worker (Rems)	Man Rems per MW Yr
Peach Bottom 2&3	228	0 23	0 19
Cooper Station	117	0 70	0 26
Vermont Yankee	153	0 54	0 36
Big Rock Point	180	0 60	5 15
La Crosse	234	1 42	7 31
Browns Ferry 1	325	0 14	2 01
Humboldt Bay	339	1 78	7 53
Nine Mile Point	681	1 05	1 95
Pilgrim 1	798	1 69	2 59
Quad Cities 1&2	1618	1 49	1 55
Oyster Creek	1440	0 94	3 05
Dresden 1,2&3	3423	1 48	4 83
Monticello	1353	1 00	3 92
Millstone Point 1	2022	0 78	4 35
Averages per Reactor	701	0 86	2 18

1976 Site Name	[1]Man Rems per Site	Dose per Worker (Rems)	Man Rems per MW Yr
Duane Arnold	105	0 30	0 35
La Crosse	110	0 93	5 23
Brown Ferry 1&2	234	0 11	0 69
Hatch	134	0 21	0 27
Fitzpatrick	202	0 34	0 41
Monticello	263	0 81	0 55
Big Rock Point	289	0 59	9 97
Brunswick 2	326	0 26	1 10
Cooper Station	350	0 46	0 81
Vermont Yankee	411	0 50	1 06
Peach Bottom 2&3	840	0 39	0 61
Nine Mile Point	428	1 09	0 89
Dresden 1,2&3	1680	0 96	3 55
Humboldt Bay	683	1 31	29 70
Quad Cities 1&2	1651	1 35	1 74
Oyster Creek	1078	0 68	2 37
Millstone 1	1194	0 87	2 66
Pilgrim 1	2468	7 01	9 23
Averages per Reactor	547	0 71	1 52

1977 Site Name	[1]Man Rems per Site	Dose per Worker (Rems)	Man Rems per MW Yr
Cooper Station	198	0 63	0 37
La Crosse	225	1 59	20 36
Vermont Yankee	258	0 40	0 61
Duane Arnold	299	0 58	0 84
Big Rock Point	334	0 72	7 59
Millstone Point 1	394	0 37	0 68
Browns Ferry 1&2	863	0 46	0 65
Hatch 1	465	0 36	1 04
Quad Cities 1&2	1031	1 14	1 06
Dresden 1,2&3	1694	0 91	1 50
Monticello	1000	1 16	2 34
Peach Bottom 2&3	2037	0 72	1 94
Fitzpatrick	1080	0 78	2 34
Brunswick 2	1170	0 74	3 86
Nine Mile Point	1383	1 27	3 99
Oyster Creek	1614	0 96	4 18
Humboldt Bay	1905	1 79	[illegible]
Pilgrim 1	3142	1 67	9 91
Averages per Reactor	828	0 89	2 1

[1]For Those Sites With More Than One Operating Reactor, the Numbers of Man-rems per Reactor is Obtained by Dividing the Number of Man-rems Reported by the Site by the Number of Reactors

The occupational exposure at Dresden Station and the average exposure at all Boiling Water Reactors (BWRs) and all Light Water Reactors (LWRs) is shown on Figure 1, and the individual Man-Rem occupational exposures at all BWRs is shown in Table 2 for the years 1973 through 1977.

The trend and absolute value of the exposures at Dresden Station is similar to that at other reactors. Dresden 1 does have a somewhat more difficult occupational radiation exposure problem. Unit 1 was built prior to the development of some of the remote inservice inspection techniques currently used at newer reactors. Because these remote techniques cannot be used at Dresden 1, a significant radiation exposure is accumulated by technicians carrying out required inservice inspections required to ensure the integrity of the primary cooling system boundary. Due to the high occupational exposures that have been experienced in the past, CECo requested and was granted relief from some inservice inspection requirements in 1973. In 1974, we informed CECo that the relief would not be granted indefinitely and that they must develop a plan to carry out all required inspections.

Because of increased exposure rates, and the need to modify the plant to meet NRC inspections requirements, CECo determined that chemical decontamination of the primary cooling system was the best approach to complete the required inspections while attempting to maintain occupational exposure to its personnel as low as reasonably achievable (ALARA).

The decontamination effort will facilitate implementation of other actions ordered by the Commission such as the installation of a new high pressure coolant injection system, in service inspection, and modifications to the reactor protection system.

2.4 ALTERNATIVES TO CHEMICAL DECONTAMINATION

CECo considered various methods of radiation level reduction. These methods were grouped into four general categories:

1. Mechanical Cleaning
2. Water Flushing
3. Operational Techniques
4. Chemical Cleaning

TABLE 3

ALTERNATIVE METHODS FOR REDUCING
RADIATION LEVELS IN DRESDEN-1

Reduction Method	Advantages	Disadvantages	Evaluation
1. Mechanical Cleaning			
a. Brushing, wiping, scrubbing & scouring	Simple - No chemical waste Filtration disposal	Not highly effective Access not possible in many areas High personal exposure	Cannot be used as a solution to total problem
b. Poly-pig (pumped scouring projectile)	Waste handling eased Technique available	Applies only to piping High radiation exposure Access not possible in many areas Leaves residue	Does not meet program goals for reduction of radiation levels
c. Ultrasonic cleaning	No system modifications required Waste handling eased	High radiation exposure Access not possible in many areas Gives only localized effect	Does not meet program goals for reduction of radiation levels
d. Component replacement	Achieves minimum radiation level	Expensive High radiation exposure Partial solution only Waste disposal difficult	Cannot be used as a solution to the total problem Consider supplemental use for certain problem areas

TABLE 3 (Continued)

Reduction Method	Advantages	Disadvantages	Evaluation
2. Water Flushing			
a. Fill & drain	Simple - No significant additional equipment	Ineffective on scale and crud traps	Does not meet program goals for reduction of radiation levels
b. High pressure jetting	Waste handling eased	Piping access difficult or impossible without major changes Not effective without chemical addition Airborne contamination problems	Does not meet program goals for reduction of radiation levels Requires extensive Pressure boundary disturbance
1. Operational Techniques			
a. On-line chemical addition (transport deposit to cleanup system)	No or minimum outage Provides on-going solution for future	Proven or even promising method unknown at this time Licensing/safety questions difficult to answer	Not feasible at this time
b. Improve feedwater	Minimize future buildup	Long response time Does not remove scale or crud trap material Does not affect primary system generated corrosion products	Does not meet program goals for reduction of radiation levels

TABLE 3 (Continued)

Reduction Method	Advantages	Disadvantages	Evaluation
4. Chemical Cleaning			
a. Flushing with existing solvents shown below: (See Tables 4 and 5)	Techniques well known Treats total system No substantial system modification required	Extensive corrosion testing required Large waste disposal problem Low decontamination factors Lower solubility than desired	Does not meet goals for reduction of radiation levels
b. New solvent flushing (NUTEK-L106)	Techniques well known Treats total system No substantial modification required	Extensive corrosion testing required Large waste disposal problem (demin resins) Low decontamination factors Lower solubility than desired	Effectiveness questioned Test results not available Cannot consider at this time
c. New solvent flushing Dow Solvent NS-1	Same as 4.b Single phase system Close to 100% solubility High decontamination factors Liquid waste problem reduced by factor of 2 to 3 over known solvents	Extensive corrosion Testing required Waste Processing required	Appears to be the best alternative to achieve program goal

CECo selected the Dow Chemical Company as their prime contractor for the project. In each case, CECo and Dow evaluated the cleaning technique against the following goals:

1. Reduce radiation levels to improve plant accessibility.

2. Ensure future safe and efficient operation at Dresden 1.

3. Develop and prove techniques usable on other reactors.

4. Encourage broad vendor manufacturers and consultant participation.

Evaluation of each of the cleaning categories against these criteria were performed and are summarized in Table 3.

Based upon its assessment of cleaning alternatives, CECo selected the chemical cleaning method for reducing the primary system radiation levels. CECo considered numerous chemicals which have been employed by the nuclear industry. Tables 4 and 5 list a number of decontamination chemicals tested by CECo on radioactive components removed from the Dresden 1 primary cooling system.

CECo evaluated these test results by the following criteria:

1. Greatest possible reduction in radiation levels

2. Complete dissolution of film

3. No reprecipitation and redeposition

4. Low corrosion rates

5. One-solution treatment

Based upon CECo's criteria and the preliminary feasibility tests carried out by CECo and its contractors, the decision was reached to use Dow Chemical's proprietary solvent NS-1 for the Dresden Decontamination.

TABLE 4

EVALUATION OF DECONTAMINATION SOLVENTS DESCRIBED IN THE LITERATURE WITH DRESDEN 1 SPECIMEN

Code Name	Chemical Formula	g/l	Conditions of Use	Decontamination Factor for Cobalt 60
APAC (Shippingport 1964)				
(AP)	$KMnO_4$	13	24 hrs. - 121°C	1
	NaOH	100		
(AC)	$(NH_4)_2HC_6H_5O_7$	13	28 hrs. - 121°C	1.15
AP-Citrox (PRTR 1965)				
(AP)	$KMnO_4$	30	2 hrs. - 105°C	1
	NaOH	100		
(Citrox)	$H_2C_2O_4$	25		
	$(NH_4)_2HC_6H_5O_7$	50	3 hrs. - 81°C	1.15
	$Fe_2(SO_4)_3$	2		
	diethyl thiourea	1		
60% H_4PO_4 (Dresden 1968)				
	H_3PO_4	600	4 hrs. - 121°C	2.0

TABLE 5

EVALUATION OF "KNOWN" DECONTAMINATION SOLVENTS USING CONDITIONS DIFFERING FROM "THE LITERATURE"

Code Name	Chemical Formula	g/l	Conditions of Use	Decontamination Factor for Cobalt 60	Reason For Rejection
AP	$NaOH$	10	12 hrs. - 97°C	1	Low DF
	$KMNO_4$	30			
ACE	$(NH_4)_2HC_6H_5O_7$	100	pH 5	450	Insufficent removal of fission products & sloughing
	$EDTA+NH_4OH$	0.4	100 hrs. - 130°C		
	inhibitor				
Citrox	$H_2C_2O_4$	24	pH 2.4	780	Corrosion
	$(NH_4)_2HC_6H_5O_7$	50	100 hrs. - 130°C		
	$Fe(NO_3)_3 \cdot 9H_2O$	2			
	inhibitor				
AC	$(NH_4)_2HC_6H_5O_7$	100	100 hrs. - 130°C	45	Sloughing and low DF
	inhibitor				
Sulfox	H_2SO_4	30	100 hrs. - 130°C	928	Corrosion
	$H_2C_2O_4$	9			
	inhibitor				
(AP)(AC)	Each used in sequence; formulated etc, as above AP and AC			547	2-stage system and sludging
(AP)(ACE)	Each used in sequence; formulated etc, as above AP and ACE			230	2-stage system and sludging
(AP)(Citrox)	Each used in sequence; formulated etc, as above AP and Citrox			1350	2-stage system and sludging

3.0 DESCRIPTION OF PROPOSED DECONTAMINATION

The decontamination will involve the circulation of the cleaning solvent, Dow NS-1, through the primary cooling system. The primary cooling system is shown in Figure 2.

After removal of the uranium fuel, the solvent will be circulated through the primary coolant system for approximately 100 hours at about 250°F. After circulation the solvent and the dissolved oxides will be drained from the reactor to a waste treatment facility located adjacent to the reactor. Any remaining solvent will be cleaned from the reactor by rinsing with demineralized water. The rinse water and solvent will be stored in the waste treatment facility storage tanks until processed to concentrate and solidify the solvent and dissolved radioactive corrosion products.

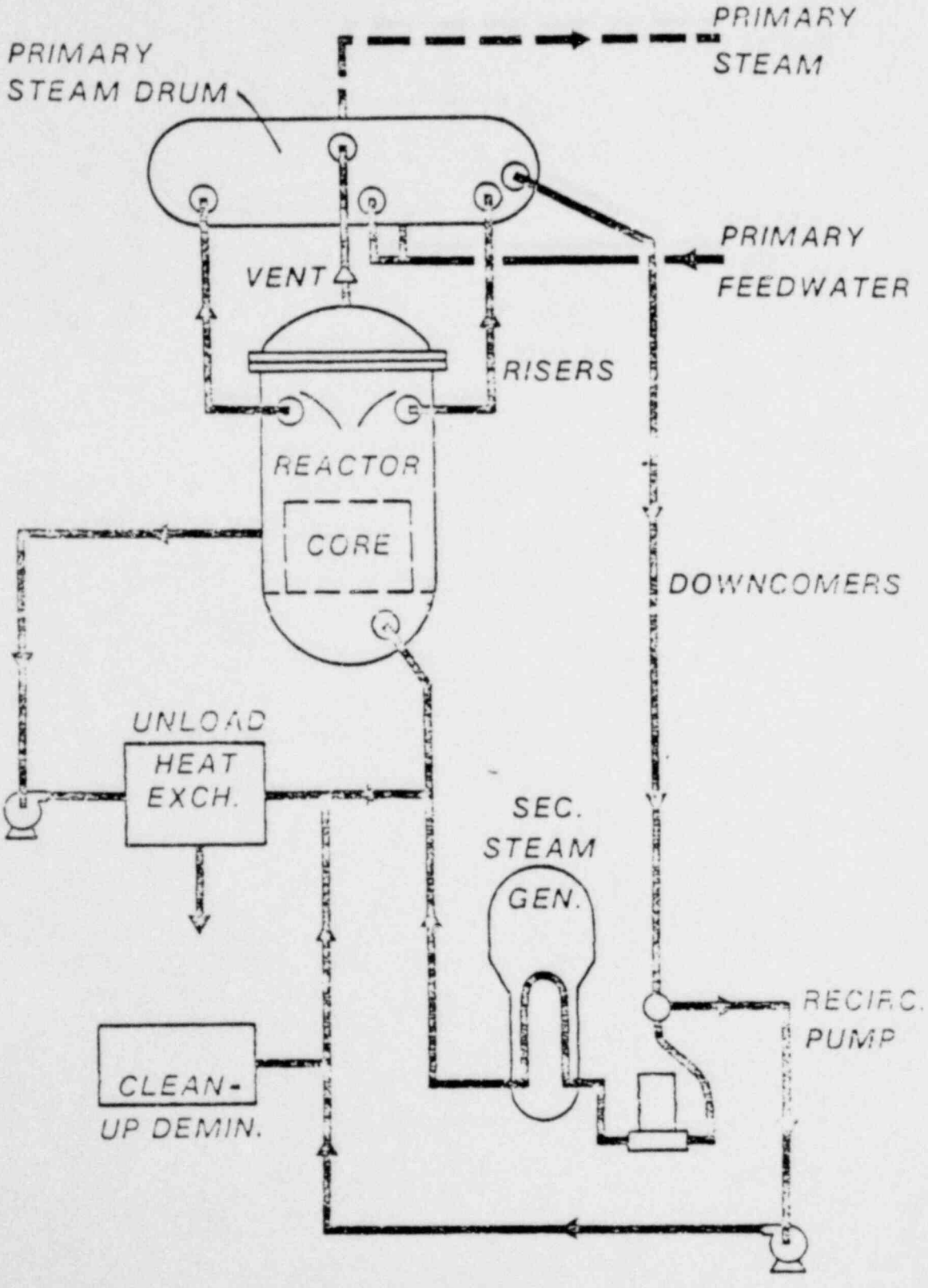
The decontamination will be carried out entirely within a closed system and all waste processing will be accomplished within a seismically designed building.

After processing, the concentrated waste solution will be solidified in 55 gallon drums using a process developed by the Dow Chemical Company for the solidification of low level radioactive wastes. This solidification process has been tested on the NS-1 solvent and produced a solid waste form that contained no free liquids. The waste solidification procedures include a quality control process test on each barrel of waste to provide additional assurance that the liquid waste has been properly solidified.

After solidification, all decontamination waste will be shipped to a commercial low level waste disosal site located at Hanford, Washington or Beatty, Nevada. The waste will be packaged and transported in accordance with all applicable NRC and Department of Transportation Regulations and disposed of in accordance with the conditions of the state licenses governing operation of the disposal sites.

Figure 2

PRIMARY SYSTEM



4.0 ENVIRONMENTAL IMPACTS OF THE PROPOSED DECONTAMINATION

4.1 NON-RADIOLOGICAL ASSESSMENT

All of the structures, procedures, and components associated with the decontamination project have been designed and prepared to preclude the release of chemical effluents to the environment. All of the chemicals that are involved in the cleaning will be contained within the closed decontamination system and solidified along with the radioactive corrosion products. After solidification the waste will be shipped to a licensed commercial waste burial site.

The decontamination will not cause any increase in the amount of waste heat emitted from Dresden 1. Therefore, we conclude that there will be no significant increase in non-radiological impact at Dresden Station caused by the decontamination project.

4.2 RADIOLOGICAL ASSESSMENT

4.2.1 OCCUPATIONAL RADIATION EXPOSURE

A. Reduction of Future Occupational Radiation Exposure

The purpose of the proposed decontamination operation is to reduce overall occupational radiation exposure to meet regulatory limits and to meet the objective of maintaining dose to ALARA. Due to the buildup of radioactive corrosion products on plant piping and component surfaces, the radiation levels of the Dresden 1 primary systems have been increasing. The increased radiation levels cause a corresponding increase in occupational radiation exposure. Besides the need to reduce this exposure to achieve ALARA for normal plant operation and maintenance, exposure reduction is necessary to accomplish mandatory inservice inspections which are unfeasible because of the existing high radiation levels. It is expected that 40 to 50 welds considered to be inaccessible because of radiation levels should be able to be inspected after the decontamination operation and thereby significantly increasing the safety margin of future plant operation.

The effectiveness of radiation level reduction by the proposed chemical decontamination operation has been successfully demonstrated by the licensee when a primary system test loop was chemically cleaned by the same proposed method in 1976. The licensee has estimated that a total of 10,000 to 15,000 man-rems will be saved by chemically decontaminating the primary system. This is based on an average savings of 500 man-rem/yr for the next 10-years of operation and an immediate saving of 5000 to 10,000 Man-Rem during the current outage related to modifications and in service inspections. This estimate is based upon those normal operations that have taken place in the past. Other special activities that may be required by NRC in the future could cause the expected dose to increase thereby increasing the Man-Rem that could be saved by decontamination. However, the decontamination procedure itself and the handling and disposal of the spent decontamination solutions will result in some occupational radiation exposure.

The staff has reviewed the methodology of CECo's estimates relating to occupational exposures. We conclude that the estimates are adequately conservative and based on a detailed review of the radiation levels and anticipated working times expected during the present outage. Because of uncertainties related to future radiation levels and the extent of future inspections and modifications we have extrapolated the occupational exposure savings for only 5 years and estimate a probable saving of 2500 Man-Rem. We, therefore, conclude that the decontamination will result in a saving of approximately 7500 Man-Rem to 12,500 Man-Rem over the next five years of operation.

B. Occupational Radiation Exposure Because of Decontamination Operation

Extensive testing, planning, and engineering has gone into the proposed decontamination. Operation of the radwaste treatment equipment to concentrate and dispose of the spent decontamination solutions will result in some occupational exposure. In addition, several modifications must be made to the existing facility to permit the decontamination. Some of these modifications must be made in radiation fields near existing contaminated components. Consequently, consideration must be made to keep occupational exposures ALARA while making these modifications, performing the decontamination, and disposing of the contaminate solutions. The major contribution to occupational exposures has been from installation of decontamination and radwaste treatment system interface piping to the reactor primary system and the installation of instrumentation and electrical equipment in the containment. This work was performed in existing radiation areas inside the containment.

The licensee has an extensive program for keeping occupational exposures ALARA. This program consists of engineering pre-operational testing, monitoring, and training. Temporary shielding was used where a significant reduction in exposure could be expected. The primary system was drained and flushed prior to the installation of interface piping and instrumentation. Portions of the primary system were backfilled with water to provide additional self-shielding. Primarily because of these precautions, with over 90% of the pre-decontamination installation completed, the occupational exposure expended was kept to about 200 man-rem. This compares with an original estimate prior to the installation of about 400 man-rem. The reduction is mainly due to the extensive planning, training, and strict adherence to the ALARA objective and demonstrates the success of the licensee's program in keeping occupational exposures ALARA.

Following the installation phase, the licensee plans an operational test with clean water before the actual decontamination. The actual cleaning step will follow. Most of the cleaning operations will be done remotely, at the control panel area where the design radiation level is less than 1 mrem/hr. However, some valve lineups must be done manually prior to the start of the decontamination and will result in some exposure. The licensee has estimated a dose of 8 man-rem will be accumulated during the test and 15 man-rem during the actual cleaning.

The decontamination solution and rinses are to be stored in tanks and processed through the special radwaste system. The processing includes evaporation of the spent decontamination solution with solidification of the evaporator concentrate. The radwaste facility specifically constructed for the process has been designed for remote operation of all phases, including filling, capping, and storage of the waste drums. These processes will be operated from the control panels in the Chemical Cleaning building with radiation levels designed to be less than 1 millirem/hr CECo has estimated that 6 man-rem will be accumulated during the evaporation (including the solidification of concentrate) of the radioactive waste solutions. They also estimate another 4 man-rem will be expended for transportation of the solidified waste to a licensed burial facility. Distillate from the evaporator will be further cleaned (polished) by a demineralizer system. The polished water will be stored and recycled as reactor makeup water in the

later operation of Dresden 1. The spent demineralizer resins will be solidified similar to the evaporator concentrate. The licensee has estimated an occupational dose of 10 man-rem for operating the demineralizer system.

Preparation of the reactor for return to service will again entail modifying piping, instrumentation, and electrical equipment. These activities will follow the decontamination and will, therefore, be performed in lower radiation fields. The licensee estimates an expenditure of 20 man-rem for preparing the reactor for a return to service. Finally, dismantlement of equipment used in the decontamination and cleanup of the unit will result in 25 man-rem.

With 90% of the pre-decontamination installation work completed, the estimated total occupational dose for the entire decontamination procedure is about 300 man-rem. The estimates quoted include only those operations associated with the decontamination operation. Normal work items such as removal of control rod drives and other normal reactor outage maintenance not associated with the decontamination are not included.

The NRC staff has reviewed the licensee's methods of estimating occupational exposure expected during this project. We conclude that these methods are conservative and that the estimates realistically bound the anticipated dose and are acceptable to the staff.

C. Conclusion From Occupational Exposure Review

We have reviewed the licensee's submittals regarding occupational exposures and conclude that the licensee has taken adequate actions to maintain occupational radiation exposure ALARA during the decontamination operation. By extensive pre-operation planning and training and the effective methods of reducing radiation levels, occupational exposure for pre-decontamination operations has been reduced to about one-half of earlier estimates. Based on our review of the work to be performed, the estimate of additional exposure of about 100 man-rem is reasonable. The licensee has stated the actual decontamination operations will be continually monitored by his Health Physics staff such that experiences gained during the operation will be considered in his ALARA program. Based on the information available and the licensee's commitment to an ongoing radiation exposure ALARA plan, we conclude that the licensee can maintain occupational exposures ALARA.

Based on the estimated occupational exposure saving of 7500 to 12,500 man-rem because of the decontamination operation, we conclude that the expenditure of the estimated total exposure of 300 man-rem for the decontamination operation would result in a significant net reduction of exposure over the remaining years of plant operation. The decontamination operation itself, therefore, can be an effective method of maintaining the long-term overall occupational exposure to ALARA.

For the decontamination operation, the estimated radiation exposure of 300 man-rem represents an increased risk of premature fatal cancer induction prediction of less than one-tenth of one event (e.g., 0.03 events risk estimation from data for the population as a whole as given in the November 1972 report of the National Academy of Science, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation"). The increased risk of this exposure on genetic effects to the ensuing five generations is also predicted to be less than one-tenth of one event (e.g., 0.075 events risk estimation from data for the population as a whole as given in the same National Academy of Sciences report). For a selected population such as is likely for the exposed workers involved in the decontamination program, consisting principally of adult males, these risks would tend to be even less. These risks are incremental risks, risks in addition to the normal risks of cancer deaths and genetic effects which all persons face continuously. To put into perspective, for a population of 350, corresponding to the approximate number of workers that will be involved in the various phases of operation, these normal risks from all factors (genetic or environmental) would result in roughly 40-60 cancer deaths and 15-20 genetic effects.

Another view of assessing the occupational exposure impact is a comparison with variation of natural background radiation. The average annual dose to an individual due to natural background radiation is about 0.1 rem. However, there are variations in average background radiation levels due to a number of factors characterizing the locations (e.g., altitude above sea level, local geological formations). For example, because of the higher altitude, the average background dose in Denver, Colorado, is roughly 0.08 rem per year higher than that in Washington, D. C. Over the average

lifespan of an individual, an individual would receive about 4 rem more dose by residing in Denver than he would by living in Washington. The estimated dose of 300 man-rem will spread over about 350 workers over at least a one-year period. Therefore, the average dose to a worker for this operation will be roughly 1 man-rem or one-fourth of the variation in natural background radiation between Denver and Washington over an average lifetime of an individual. It is not evident that the variation in natural background would be a significant factor influencing any decision on an individuals activities (i.e., moving from Denver to other locations of lower background radiation levels). Therefore, the fractional increase in comparison to background radiation resulting from the decontamination operation represents an insignificant and acceptable impact.

For the foregoing reasons, the staff concludes that the environmental effect due to occupational radiation exposure is not a significant environmental impact. The staff has determined that relative to the requirements set forth in 10 CFR Part 51 and the Council of Environmental Quality's Guidelines, 40 CFR 1500.6, the proposed decontamination operation will not significantly affect the human environment on account of occupational exposure.

4.2.2 RADIOACTIVE WASTE

The decontamination operation is not expected to result in the liquid or gaseous radioactivity releases to the environment in any significant quantities. The expected generation and treatment of the radioactive wastes is discussed below.

A. Radioactive Liquid Waste

A total of approximately 3,000 Ci of radioactivity is expected to be in the decontamination solvent and subsequent rinses. About 95% of the radioactivity is expected to be in the form of cobalt isotopes. Over 99% of the radioactivity will be in the decontamination solvent and the first rinse, containing about 200,000 gallons of liquid. This liquid will be processed through an evaporator. The concentrated waste, about 20,000 gallons of evaporator bottoms, will be solidified for offsite burial. The remaining 180,000 gallons of waste (distillate

from evaporator) will be sampled and sent to the existing plant holdup system or will be polished through the demineralizer before being stored for plant re-use. Water from the subsequent rinse(s) will be sampled and processed through the demineralizer and/or the evaporator. The processed water will also be recycled into plant holdup systems for re-use. It is expected that no liquid radioactive effluents will result from the decontamination operation.

B. Gaseous Radioactive Waste

No significant source of gaseous radioactive effluent is anticipated. The NS-1 solvent for the decontamination is non-volatile. All radioactive iodine isotopes have been decayed to insignificant levels. The only expected source of gaseous radioactivity effluents during the decontamination operation is the venting of the noncondensable gases from the evaporator distillate. A number of partition and decontamination factors during the evaporation, condensation, and filtration processes, however, reduce this source to a small quantity (estimated to be less than 1 uCi).

Unplanned releases due to leaks or spills will be continuously sampled and monitored. Technical Specifications limiting release rates during normal plant operation will also be in effect during the decontamination operation. Consequently, the environmental impact from airborne radioactive effluents should not be greater than those described in the Final Environmental Statement (FES), November 1973 (FES for Dresden Units 2 and 3 also addresses radiological impact of releases from the site which includes Dresden Unit 1).

C. Solidified Radioactive Waste

About 1,200 55-gallon drums of solidified radioactive waste containing approximately 3,000 Ci of radioactivity will be shipped for offsite burial. The radioactivity consists mainly of activated corrosion products (over 95% consists of Co-58 and Co-60). The 3000 curies of radioactive waste generated by this cleaning do not represent a significant increase in the quantity of radioactive waste generated by the routine operation of the three units at the Dresden site (28,554 curies shipped from 1973 to 1977). Solidification of the evaporator bottoms and spent resins will utilize the Dow Chemical Company's proprietary

vinyl ester-styrene polymer system. Solidification tests with spent radioactive decontamination solvent obtained from the actual decontamination of a Dresden Unit 1 test loop has been performed. The decontamination solvent was then solidified using the Dow system. Samples of the solidified waste indicated no free-standing liquid. Leach tests on samples indicated that the Dow solidification process is equivalent or better than other solidification methods being routinely employed by nuclear power plants.

For the solidification of the spent decontamination waste, controls will be implemented to ensure a completely solidified waste with no free-standing liquid. As a part of the initial start up testing for the project, prior to the solidification of any radioactive waste, a nonradioactive batch simulating the chemical properties of the waste will be solidified and destrictively tested to establish the acceptability of the process as it is actually installed.

The simulated solidified waste drum will be sectioned to demonstrate that there is no free-standing liquids for the acceptable process control program which will be followed. For each drum of solidifying waste, thermocouples will be inserted to show the temperature increase as an indication of the occurrence of polymization and solidification process. Television cameras will also allow the observation of solidification at the top of the waste drum. Since the liquid waste for solidification is added to the top of the drum above the solidification agent prior to mixing, any incomplete solidification would likely be observable from the top.

The amount of radioactivity of the solidified radwaste amounts to less than 0.1% of the 4.3×10^6 Ci of total radioactivity shipped to commercial burial sites as of 1977. The volume of solidified radwaste expected to be generated by the Dresden Unit 1 decontamination operation amounts to less than 0.06% of the 1.8×10^7 cubic feet of total radwaste shipped to commercial burial sites as of 1977.

The licensee has committed to meet all the applicable NRC and Department of Transportation regulations regarding packaging of the radwaste for shipment. Therefore, the environmental impact enroute to the burial site (e.g., direct radiation, accident considerations) is not significantly different from those already analyzed in the FES, November 1973.

Based on the above discussion, we have determined that there is no significant environmental consequences resulting from the liquid, gaseous, and solid radioactive wastes generated from the decontamination operation. In reference to the requirements set forth

in the 10 CFR Part 51 and the Council on Environmental Quality's Guidelines, 40 CFR 1500.6, we have determined that the radioactive wastes will not significantly affect the quality of human environment.

4.2.3 RADIOACTIVE WASTE DISPOSAL

The solidified radioactive waste from the Dresden Unit 1 Decontamination will be shipped to a commercial low-level waste burial site in either Beatty, Nevada or Hanford, Washington. These sites have been chosen as waste burial locations because of their dry, arid environment and their favorable geologic, hydrologic and meteorologic features. These two sites are located in dry desert locations where there is a very low annual rate of precipitation and a very deep water table. These two features combined with the remote location of these burial sites, provide assurance that the waste can remain isolated from the human environment for a period long enough to allow the principal radionuclides to decay to significant levels.

In addition to the favorable physical features of these disposal sites, the concentrated NS-1 decontamination solvent from Dresden 1 will be solidified using the Dow Chemical Company process. Moreover, it will be packaged in a Department of Transportation (DOT) approved 55 gallon steel drum and will be disposed of in an arid disposal environment. The Hanford disposal site license (January 11, 1980) requires segregation of this type of waste from other wastes in the burial trenches as follows:

> Decontamination wastes containing chelating agents will be segregated from other wastes, stored separately, and be disposed of either in separate trenches or in specifically segregated areas within an existing trench, and isolated from other wastes with 10 feet of soil. However, this waste does not require segregation from wastes containing toluene, xylene or other organic material.

We have discussed the disposal of the solidified waste with the representatives of the State of Nevada, the licensing authority for radioactive waste disposal at Beatty, Nevada. We recommend that similar segregation requirements be imposed if the waste is disposed at that site.

Based on this information and confirmatory tests discussed below, we find that this combination of waste form, container and disposal environment provides an acceptable approach for disposing of this waste.

Laboratory tests by our contractor, Brookhaven National Laboratories (BNL), confirm that wide variations (±20%) in the chemical components used in the Dow system do not produce free standing liquid. The Dow process parameters used to solidify the Dresden waste will be controlled within ±10% of the parameters which were varied in our confirmatory tests. Further assurances that the final product will not contain free standing liquid will be provided by system design and quality control checks which are part of the Dow solidification system (Reference: Dow Topical Report DNS-RSS-001-P and Amendment 1). This includes mixing sequence interlocks, quality control checks on each barrel of solidified waste (e.g., visual monitoring, temperature monitoring, and compressive strength testing) and in process sample verification during the production runs. In addition full scale qualification tests using simulated wastes will be conducted under NRC observation prior to startup of actual solidification operations. The waste from the qualification test will be destructively examined to ensure adequate solidification.

The waste container (DOT approved 55 gallon drums) metal has been tested by our contractor, BNL, and based on the test results we find the container is adequate for waste in this solidified form. BNL measured the corrosion rate bounding case where a layer of liquid waste was in contact with the drum steel to simulate the worst case for condensate in the drum. Such a layer of liquid waste has not been observed in wastes solidified by BNL or the manufacturer (Dow Chemical Company) when the wastes were solidified in accordance with the procedure specified by the manufacturer. The results of this test show that the barrel could be expected to last one or two years. This indicates that assuming the above as a trial worst case, a container would not corrode through during handling and storage if buried within a few months of solidification. A container corroding through after burial would not present a problem since the waste is a solid and the quantity of condensate that could leak from the drum would be easily absorbed in the undersaturated soils at a semi-arid disposal site. Further corrosion tests conducted under expected conditions show that after 4 weeks of exposure no significant corrosion occurs to the barrel steel in contact with solidified waste or vapor from liquid waste. The corrosion rate in contact with solidified waste indicate that the barrel could last tens of years and the vapor was found to be non-corrosive.

With regard to disposal of this waste, we consider the solidified waste form and container, disposed of in an arid environment where

there is minimal potential for actual contact of the waste with water, and with the waste segregated from other wastes in accordance with requirements (minimum of 10 feet separation) of the Hanford, Washington license, provides an acceptable approach for disposal of this waste.

4.3 ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

The decontamination of the Dresden 1 primary cooling system takes place entirely within a closed system that is contained inside of low leakage structures. No releases from the primary cooling system or from the waste treatment facility are planned or expected.

In the event of leakage within the reactor containment building or the waste treatment facility, all gaseous releases must pass through a pathway monitored for radioactivity that will be isolated if the Technical Specification setpoint is exceeded.

In the event that the waste storage tanks fail within the waste treatment facility, all leakage will be contained within the "bathtub" portion of the facility. This "bathtub" is the portion of the waste treatment facility that surrounds the waste storage tanks. It is a leakproof structure designed with all penetrations located above the height necessary to contain all 300,000 gallons of liquid waste that could leak out of the high level storage tanks.

Therefore, we have concluded that the decontamination process and the associated facilities built to solidify the radioactive waste will not be subject to any accidents more severe than those previously considered for the Dresden site and will not result in any hazards not previously considered.

5.0 IMPACT OF ALTERNATIVES

There are several alternatives related to the proposed action that have been evaluated to determine their impact. These alternatives are (1) continue reactor operation without decontamination, (2) shut the reactor down permanently, and (3) alternative methods of decontamination. CECo evaluated these alternatives and concluded that the chemical decontamination of the facility was the best choice from economic and environmental considerations. Further discussion of each of these alternatives is provided below.

5.1 CONTINUE REACTOR OPERATION WITHOUT DECONTAMINATION

Commonwealth Edison must carry out five major modification and inspection projects before returning Dresden 1 to service. These projects are:

1. High Pressure Cooling System Installation (by Commission order)

2. In-service Inspection Program (required by 10 CFR 51.53)

3. Unloading Heat Exchanger Replacement

4. Inspection of Piping System to Satisfy Office of Inspection and Enforcement Bulletins.

5. Modifications to the Reactor Protection System (by Commission order)

These programs require extensive occupancy in areas in which the radiation exposure levels are in the 1 R/hr to 30 R/hr range. The inspections and modifications require long term close up operations that will result in unacceptably large occupational exposures to the workers. Commonwealth Edison has estimated that, without decontamination these operations could result in total occupational exposures to the work force of 5000 Man-Rem to 10,000 Man Rem. Occupational exposures of this magnitude are clearly unacceptable to the utility and to the NRC staff if they can be prevented by readily available techniques.

CECo has evaluated the possibility of utilizing local shielding to reduce the occupational exposure that would be received in the no decontamination option. It is not practical to shield the workers from the source of radiation in this case because the major source is located on the inside surfaces of the component. In addition the design of the Dresden facility is such that physical access to the components is severely limited and there is insufficient space available to construct the necessary shielding.

Another method that has been considered to permit the continued operation of the facility is to carry out the required safety inspections and modifications remotely. CECo is planning to utilize remote in-service inspection techniques to examine some of the inaccessible beltline welds on the reactor vessel. However, these remote methods cannot be used for the inspection of pipe welds, nozzles, and other primary cooling system components without a significant amount of work to install the remote equipment and prepare the componants for remote inspection. Without decontamination, higher doses would be received during these preparatory activities than would be received during the manual inspections.

The NRC staff has reviewed the potential for carrying out these necessary safety inspections remotely and concludes that CECo cannot remotely inspect these components as they are presently designed and that it is not practical to install the remote inspection equipment in the currently existing high radiation fields.

The licensee has further estimated that in the future, approximately 500 Man-Rem will be received each year without decontamination. This annual increase in occupational exposure projects to a total occupational exposure increase of 2500 Man-Rem over the next 5 year period of the Dresden 1 operation. In addition to the directly measurable increase in occupational exposures that will be received in the future, failure to decontaminate will cause future outages to last longer than necessary due to the extensive radiological safety precautions that will have to be employed.

Based upon the projected increase of occupational exposure, which the NRC Staff concludes will be in excess of 5000 Man-Rem, we have concluded that (1) the occupational exposure at Dresden 1 will be increased significantly without this decontamination, (2) a long term dose increase of over 2500 Man-Rem will be received without the decontamination and (3) that the occupational exposure that would result from inspection and modifications without decontamination would be unacceptable under the principal of maintaining occupational exposures as low as reasonable achievable. Based upon the foregoing we conclude that the alternative of continuing reactor operation without decontamination is undesirable and would result in environmental impacts that can be avoided by decontamination.

5.2 SHUT THE REACTOR DOWN PERMANENTLY

The cost of purchasing replacement power for Dresden 1 is estimated to be $100,000 per day. Assuming a 60% availability factor over the 15 years that will remain before expiration of the Dresden 1 Operating License, approximately 300 million dollars would be required to purchase power to replace the Dresden 1 generating capacity.

The cost of the decontamination including solvent research and development, solvent compatibility testing construction of the decontamination facility and the operational cost of the decontamination total 39.5 million dollars.

The permanent shutdown of the reactor would, therefore, result in the need to purchase approximately 300 million dollars worth of replacement power over the remaining 15 years that the Dresden 1 license is in effect. The cost of this alternative to decontamination is significantly more than the 39.5 million dollars expended to carry out the decontamination and is not justified by any improvement in the quality of the human environment. Therefore, the immediate shutdown alternative is less favorable than decontamination.

5.3 ALTERNATIVE METHODS OF DECONTAMINATION

Commonwealth Edison conducted an extensive search for alternative methods for decontaminating the reactor primary cooling system. These alternatives are discussed in Section 2.4 of this statement. Based upon their evaluation of the available alternative methods of decontamination CECo chose to use Dow Chemical's NS-1 solvent. The staff has reviewed CECo's decision to use NS-1 for the Dresden decontamination and concludes that the use of NS-1 solvent will not result in excessive corrosion of the materials of construction and will result in the most effective reduction of radiation levels of all of the alternatives considered. Based upon our review of the corrosion properties of the solvent and the proposed methods of solidification and disposal we have concluded that the use of NS-1 solvent is acceptable to the staff.

6.0 CONCLUSION

We have reviewed the proposed primary cooling system decontamination and have reached the following conclusions.

1. The occupational exposure associated with this will be approximately 400 Man-Rem. The occupational exposure aspect of this program has been carefully planned by the licensee and we conclude that the estimated exposures are as low as reasonably achievable.

2. The decontamination will result in the saving of over 5000 Man-Rem over the remaining life of the facility. The radiological benefit of decontamination outweighs the occupational exposure received carrying out the decontamination.

3. There will be no significant increase in radiological effluents from the facility due to the decontamination.

4. The radioactive wastes created by this decontamination will be similar in type and quantity to that which has been produced by the facility in the past.

5. The off site transportation disposal of the radioactive waste generated by the decontamination will be in accordance with all applicable NRC, Department of Transportation, and Agreement State Rules and Licensee and will not result in any unacceptable risk to the public.

For the foregoing reasons, the staff concludes that the benefits of this action outweigh the impacts associated therewith and the proposed decontamination will not significantly affect the quality of the human environment.

7.0 FEDERAL, STATE, LOCAL AGENCIES,AND INDIVIDUALS TO WHOM THIS ENVIRONMENTAL STATEMENT WAS SENT

This Draft Environmental Statement was sent to the following:

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Energy
Department of Health & Human Services
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Environmental Protection Agency
State of Illinois
Grundy County
Citizens for a Better Environment
Illinois Safe Energy Alliance
Ms. Kay Drey

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APPENDIX A

STAFF RESPONSE TO QUESTIONS CONTAINED

IN

PETITIONS FROM THE PUBLIC

APPENDIX A

STAFF'S RESPONSE TO QUESTIONS CONTAINED IN MS. DREY'S MARCH 19, 1979 PETITION

(DOCKET NO. 50-10)

QUESTION

1. First, is it possible that an environmental impact assessment and a negative declaration have already been written regarding the proposal to decontaminate Dresden Unit One?

RESPONSE

The Nuclear Regulatory Commission evaluated the environmental impact of the Dresden decontamination in 1975. As stated in our December 9, 1975 Safety Evaluation, the decontamination will take place within the closed cooling system located inside of the containment sphere. No decontamination effluents will be released to the environment as either liquids or gases. All of the radio-active waste will be solidified for shipment to a burial site authorized to accept the waste. The packaging and shipping of the waste will be in accordance with applicable Department of Transportation and NRC regulations.

Our 1975 review did not identify any adverse environmental impact associated with this project and the facility changes did not involve a change to the Technical Specifications or an unreviewed safety question. Therefore, no Environmental Impact Statement or Negative Declaration and Environmental Impact Appraisal was issued to support our conditional approval to begin the work necessary to prepare for the decontamination of the reactor.

QUESTION

2. What do field or laboratory tests demonstrate to be the migration potential of radioactive wastes entrapped in the Dow Chemical solvent, assuming some were to escape from buried containers into the environment?

RESPONSE

The migration of radionuclides at a burial site is determined by the physical form of the waste, the rainfall at the site, and the geological and hydrologic features of the burial site. The risk associated with potential migration is further defined by the land uses in the vicinity of the buried waste.

The migration of radioactive waste which you have referred to was reported by Means, Crerar and Duguid (Science, Vol. 200, 30 June 1978). The referenced paper discusses the disposal of 35 million gallons of liquid waste in burial pits at

Oak Ridge National Laboratory between 1951 and 1965. Commonwealth Edison, the licensee for Dresden Unit No. 1, has agreed to dispose of the Dresden 1 solidified waste at either Beatty, Nevada or Hanford, Washington commercial low level waste burial sites. These sites differ significantly in their geologic and hydrologic characteristics from the Oak Ridge site where chelant-aided migration of radionuclides was observed by Means, Crerar and Duguid.

Specifically, the Oak Ridge site, where migration occurred, experiences very high precipitation and has a water table so shallow that it probably intersects the disposal pits and trenches during periods of heavy rainfall. In addition, the Oak Ridge topography is hilly with steep slopes underlain by fractured shale material which allows underground water and radioactive waste to flow down hill for approximately 50 meters through the fractures until it seeps to the surface within 75 meters of a perennial stream.

Conversely, the commercial waste burial sites at Beatty and Hanford, where no migration of radionuclides has been observed, are flat desert areas with very low precipitation, a water table approximately 90 meters below ground level and a distance of 13 to 16 kilometers to the nearest perennial stream.

In addition to these site characteristics, which prevent the migration of radioactive material from the desert waste burial sites, another significant difference between the proposed waste disposal technique and the now discontinued Oak Ridge methods is that Dresden waste will be disposed of as a solid. At Oak Ridge over 35 million gallons of liquid radioactive waste was pumped into the disposal trenches. We estimate that approximately 7 million gallons of liquid waste was disposed of in Trench No. 7, which was identified as a source of chelated radionuclides. Because of the differences we have concluded that solidified Dresden wastes, in a dry burial site will not migrate in the manner that liquid waste migrated at Oak Ridge.

We do not have field or laboratory tests results which quantify the migration potential of radionuclides associated with Dow solvent, assuming that some escapes from solidified waste and into the soils of a disposal site. The rate of water movement at a particular disposal site is the limiting factor for migration. Migration potential of chelated radionuclides is decreased when placed in a solid waste matrix and disposed at an arid disposal site.

The upper bound of the migration potential of non-volatile contaminants is determined by the availability of water and its rate of movement through soils. The lower bound is achieved when contaminants become fixed on solids or are held long enough to undergo decomposition or decay. In the absence of interactions with soils, such as adsorption, the migration potential of soluble contaminants is governed by the potential for water to carry contaminants from a source.

QUESTION

3. Whether or not decontamination wastes can accurately be classified as "low-level" remains unanswered. What radionuclides and in what concentrations are expected besides cobalt 58 & 60, cerium, manganese, zirconium and cesium? According to NRC information, 3000 curies of radioactive material will be removed and eventually placed in 1200 55 gallon drums. If the radioactive material is uniformly distributed throughout the solidification agent, one can conclude each barrel will contain 2 1/2 curies of radioactivity or 12,500 nanocuries per gram. Can waste with this concentration of radionuclides be defined as low-level? What assurances does the public have that significant amounts of transuranics won't be present? According to Mr. Steve Lange of Commonwealth Edison, "transuranics are not expected," but apparently their presence cannot be ruled out. If the waste contains 10 or more "nanocuries of transuranic contaminants per gram of material," where will it be buried? Or will it remain at the Dresden site forever as stated by Mr. Lange?

RESPONSE 3

The radionuclides expected to be present in the Dresden decontamination waste are listed in Table 1 below along with the estimated total activity of each isotope expected.

Radioactive wastes are separated into two broad classifications: "high level wastes" and "other than high level wastes". High level wastes are radioactive wastes produced in the first solvent extraction cycle of fuel reprocessing operations. If fuel is not reprocessed, the unprocessed fuel will be classified as high level waste should it be discarded. High level wastes are highly radioactive, contain significant quantities of transuranic radionuclides, and require extensive shielding, sophisticated remote handling techniques, and often require cooling to remove the heat generated by the decay of the contained fission products.

The second waste classification "other than high level wastes" includes wastes that are not produced in the first step of the solvent extraction cycle of fuel reprocessing or the unprocessed fuel. The Dresden 1 waste that will be produced from the decontamination falls into this class and therefore may be buried in a commercial waste burial site.

The Dresden decontamination waste will not be high level wastes. These wastes will be packaged and shipped in full conformance with all applicable NRC and Department of Transportation requirements.

Commonwealth Edison has committed to measure the concentration of the transuranic nuclides in the waste generated by the decontamination of the Dresden 1 primary cooling system. The presence of transuranic elements in levels in excess of 10 nanocuries per gram is definitely not expected based upon measurements of the transuranic content of the corrosion product film observed on artifacts and samples removed from the Dresden Unit No. 1 primary system and other boiling

TABLE 1

NUCLIDE	CURIES	HALF LIFE	ESTIMATED* Ci/55 Gal. DRUM
^{60}Co	2160	5.3 years	1.80
^{58}Co	630	22 days	0.53
^{144}Ce-^{144}Pr	117	290 days	0.10
^{54}Mn	30	25 days	0.03
^{95}Zr- ^{95}Nb	21	63 days	0.02
^{57}Co	15	270 days	0.01
^{141}Ce	15	32 days	0.01
^{103}Ru	9	41 days	.01
MFP	3	**	.01
	3000		2.50

* Assumes that the waste will be uniformly distributed in 1200 drums.

** The half life of mixed fission products may be approximated by assuming that $T_{\frac{1}{2}} = t$ where t is the time since fission.

water reactors. However, the actual waste will be analyzed for transuranic content and if greater than 10 nanocuries per gram (10^{-9} Ci/gm) is detected, the waste will not be disposed of at a commercial waste burial site that has a 10^{-9} Ci/gm limit for transuranics.

In the unlikely event that transuranic radionuclides are discovered present in concentrations above these applicable limits, the waste will not remain at Dresden "forever". The waste would be disposed of at a waste depository operated by the U. S. Government which is authorized to dispose of transuranic waste.

QUESTION

4. What is the long term environmental impact of combining radioactive waste with chelating agents? As you know, Drs. Means, Crerar and Duguid found chelating agents to be the very agents responsible for radionuclid mobilization at Oak Ridge, Tennessee (See Science, Vol. 200, June 30, 1978). The NRC response that decontamination wastes from Dresden 1 will be buried in "dry" areas is not adequate in light of man's inability to predict climatic conditions over the long time spans this waste remains dangerous to life. Furthermore, radionuclides can leach out (in a manner similar to the operation of a flea collar) even in dry areas and be carried from original burial sites by scant amounts of rain water. At least one recent study shows radionuclide-chelate complexes are persistent over time and can readily be taken up by plants, etc.

RESPONSE 4

Migration as observed at the Oak Ridge site would not occur at the Beatty, Nevada or Hanford, Washington commercial disposal sites. A solid waste is to be disposed of at the commercial sites. The climate, geology and hydrologic conditions eliminate the possibility for flow to saturate soils and transport radionuclides as observed at Oak Ridge.

The migration as observed at the Oak Ridge site would not occur at the disposal sites which may receive the solidified Dresden 1 decontamination wastes, assuming that container corrosion and leaching of soluble radionuclides occur. Commonwealth Edison has notified NRC staff that the disposal sites which are being considered for the Dresden 1 wastes are the Beatty, Nevada and Hanford, Washington commercial low-level waste disposal sites. Table 2 gives a brief summary of the disposal and environmental conditions at these sites, with a comparison to the region of disposal pits 2, 3 and 4, and trenches 5, 6 and 7 at Oak Ridge. These pits and trenches are clustered in the vicinity of Whiteoak Creek. There are many similarities between these disposal units, which include trench 7, which was found to be a source of chelated radionuclides. The major difference between Oak Ridge site, where migration has been observed, and the commecial sites, where no migration has been detected, is the general lack of water at the commercial sites and the abundance of water at the Oak Ridge site. Oak Ridge experiences very high

Table 2 Comparison of the conditions at the Hanford, Washington, and Beatty, Nevada, commercial low-level radioactive waste disposal sites to the conditions at the Oak Ridge, Tennessee, liquid waste disposal area (Pits 2, 3, and 4, and trenches 5, 6, and 7)

	Oak Ridge	Beatty	Hanford
Average precipitation	50"/year	4.5"/year	6.25"/year
Waste to aquifer distance	0+	300 feet	290 feet
Distance to nearest perennial stream	250 feet	10 miles	8 miles
Average evaporation from open water surfaces	34"/year	70"/year	42"/year
Waste form	35,000,000 gallons (liquid)	Solid*	Solid*
General description of site	Hilly, humid area	Flat, desert area	Flat, desert area

*Some liquid wastes were solidified on site or received sorbed on solids or packaged in sorbent material.

+The water table intersects some trench bottoms in the Oak Ridge disposal areas.

precipitation, has a water table which probably intersects pits and trenches, and the Oak Ridge waste was disposed of as a liquid. For trench 7, which was identified by Duguid, Means and Crerar as a source of chelated radionuclides, we estimate that approximately 7 million gallons of liquid waste was disposed during a three year period from 1962 to 1965. Considering the liquid to be evenly distributed over the area of trench 7, the equivalent water flow in terms of precipitation would be on the order of 100 feet per year. This is far in excess of the few inches of precipitation incident at the desert sites, where the majority of the precipitation is rapidly returned to the atmosphere by evaporation. The estimates of water flows at Oak Ridge are based on figures reported by Lomenick, Struxness, and Jacobs and trench dimensions from Duguid.

Migration of radionuclides from the Oak Ridge disposal trenches to the surface was also promoted by the type of geologic material in which the trenches were excavated. The trenches were founded in fractured shale which may have small solution cavities as well as fractures available to conduct water at rapid rates. Trench 6, which received liquid wastes for approximately one month, had to be taken out of service due to the breakthrough of radionuclides at a seep 100-feet downslope. Cesium-137 and strontium-90 were present in seep water, having migrated 100 feet in less than one month, due to fracture flow. In comparison, the commercial disposal trenches at Beatty and Hanford are excavated in a weakly cemented alluvial fill and unconsolidated sand and gravel, neither supporting fracture flow. The topography and location of the Oak Ridge disposal sites promoted migration to surface seeps. The trenches were excavated on hills, such that trench bottoms were higher than wet swampy areas downslope. Thus, when the trench bottoms are saturated, a hydraulic gradient exists to drive flow to surface seeps. The slopes leading from the wet low areas up to the disposal trenches are often in the range of 1:5 to 1:10. The commercial disposal sites at Beatty and Hanford on the other hand are characterized as flat desert areas with slopes on the order of 1:100 to 1:300, providing a much longer path between the trench bottoms and points where the surface are at equal elevation. Also, the intervening material is undersaturated, and volumes of water which are much greater than available in the desert would be required to saturate the soil before any significant flow to the surface could occur (for example as would cause the swampy regions associated with the Oak Ridge seeps).

Also, the solid wastes disposed at Beatty and Hanford are covered with three to five feet of dry sandy materials, which would absorb precipitation. This provides some protection against the occurrence of waste leaching. Should water be supposed to enter a desert disposal trench, it would tend to be

absorbed by the trench walls and bottoms rather than collect in the trench bottom, thus preventing saturation of the wastes and minimizing the time of contact of wastes and water.

QUESTION

5. How stable will vinyl ester plastic resin be which is supposed to encapsulate the decontamination wastes? According to NUREG-0471, "There are no current criteria for acceptability of solidification agents." Therefore, what it the basis established by the NRC (and not Dow Chemical or Commonwealth Edison) for concluding this solidification process will be acceptable? What consideration has been given to the fact that organic solvents present in much radioactive waste can disolve the Dow solidification agent?

RESPONSE 5

The basic formulation of the Dow Chemical solidification process was developed in the late 1960s under the trade name NAJVAR. The first solidified samples of prototype test has remained free of liquid (since 1974 when the test was made). Analysis has shown that the longest lived significant isotope that will be solidified after the decontamination is Co-60 with half-life of 5.2 years. Tests have been performed to demonstrate that the stability of the solid polymer will not substantially alter for over 50 years, corresponding to 10 half-lives of Co-60. These tests include accelerated aging, biological degradation, radiation degradation and temperature cycling (freeze and thaw resistance tests). After 10 half-lives, the original 2160 curies of Co-60 will have decayed to less than 2.16 Ci.

The use of the Dow solidification media is explicitly authorized in the state of Washington license issued to the Hanford, Washington commercial waste disposal operation. The NRC staff has reviewed the Dow solidification process and has concluded that the solid waste form resulting from the process is acceptable for burial.

QUESTION

6. What the the maximum levels of radiation exposure workers could receive while carrying out decontamination? What are the expected levels of radiation exposure workers may receive? If NS-1 is regarded as corrosive or a "strong chemical decontamination," (NUREG-0410), how can it be claimed that "it is essentially non-irritating when applied directly to the skin or eyes ...? (Letter from D.O.E.).

RESPONSE 6

Workers are normally limited to 1.25 rem to the whole body per calendar quarter. However, in accordance with the provisions of 10 CFR 20 Section 20.101, a licensee may permit an individual in a restricted area to exceed 1.25 rem per quarter if 1) the dose does not exceed 3 rem, 2) the total cumulative occupational dose to the whole body shall not exceed 5(N-18) rems where "N" equals the individual and 3) the licensee has determined the individual's accumulated occupational dose on Form NRC-4. The exposures at Dresden are expected to be maintained below these limits.

During the decontamination regular industrial safety measures will be employed to prevent all hazardous chemicals from contacting the skin or eyes. Experience to date has not indicated any significant indistrial safety problems with NS-1.

QUESTION

7. How many truckloads of waste will have to be shipped and at what risk? This question has not been adequately answered because it is possible NS-1 will have to be flushed through the system more than once. According to Mr. Lange, the absorption capacity of the solvent may be taken up by iron instead of "crud" resulting in the production of twice as much waste.

RESPONSE 7

The exact quantity of solid waste that will be generated by the decontamination cannot be identified until the decontamination has been completed. The uncertainty exists because it is the concentration of radioactivity that will limit the concentration of waste placed in each barrel.

Based upon CECo's preliminary estimates, approximately 600 to 1200 55 gallon drums of solidified waste may be produced by the decontamination. The number of barrels that will be placed on a truck depends on the radiation levels at the drum surface and will not be known until the decontamination takes place. We estimate that between 10 and 100 truck loads of waste will be generated.

QUESTION

8. What is the status of the NRC's consideration of the need for an Environmental Impact Statement for the Dresden 1 decontamination?

RESPONSE 8

As stated in the Director's Decision on your petition, the NRC is preparing an environmental impact statement on the decontamination. You will receive a copy as soon as it is available. The statement is expected to be complete by the end of May.

STAFF'S RESPONSE TO QUESTIONS CONTAINED IN THE
ILLINOIS SAFE ENERGY ALLIANCE'S SEPTEMBER 20, 1979 PETITION

(DOCKET NO. 50-10)

QUESTION

1. What effect(s) will the admittedly corrosive solvent NS-1 have on the reactor's piping system? As stated under Category A Technical Activity No. A-15, "The primary NRC concern related to the decontamination is to assure that the decontamination method does not degrade the integrity of the primary coolant system boundary. This consideration involves both immediate degradation during decontamination and latent effects that could cause degradation during subsequent operation of the reactor." How can all the crucial welds, valves and joints, etc., many of which are inaccessible, be inspected to assure decontamination has not caused damage?

RESPONSE 1

All primary cooling system materials that will be in contact with NS-1 have been tested extensively to assure that the integrity of the primary cooling system will not be degraded by the cleaning. The corrosion research program covered several thousand individual corrosion tests of all the basic Dresden Unit No. 1 primary cooling system materials that will be exposed to the solvent under conditions of time and temperature exceeding those proposed for the actual decontamination.

Based upon the staff's review of the tests carried out by CECo, we have concluded that the plant materials will not be significantly damaged by the decontamination solution.

The successful laboratory testing program has provided a significant basis for authorizing this action. In addition, pilot scale projects utilizing NS-1 have been successfully carried out at the Peach Bottom Nuclear Power Station where a heat exchanger was decontaminated and at Dresden Station where the Dresden Unit No. 1 Corrosion Fatigue Test Loop was decontaminated. These decontaminations, carried out on full scale components of portions of the primary cooling systems at these facilities have provided assurance that full scale operations utilizing NS-1 will produce similar results to the laboratory scale experiments.

The inspection program that will be carried out by CECo after the cleaning will be used to determine whether the decontamination has caused the structural integrity of the primary cooling system to be degraded. Only a very small number of the "welds, valves and joints, etc." are physically inaccessible for inspection. These components are inaccessible only because it is impractical to inspect them while they are radioactive. The chemical cleaning will allow the inspection of these components and will increase the level of confidence that the primary cooling system does not contain incipient defects.

In the case of the few welds that are physically inaccessible, there is no reason to expect that their condition following decontamination will differ from the condition of the inspectible welds that have been cleaned by the same NS-1 solvent under identical conditions of time and temperature. Therefore, if the inspection of the accessible welds indicates that there has been no significant degradation caused by the cleaning, there will be reasonable basis to conclude that similar welds in inaccessible locations will exhibit similar results.

QUESTION

2. What standards or guidelines will be utilized for "'baseline' inspection and appropriate followup inspections to provide a high degree of confidence that no degradation has occurred?" Reliance on existing Technical Specifications and "special inspections" seems inadequate in light of the following NRC admission: "Since this is an area (decontamination) where the NRC staff has limited expertise and experience with commecial nuclear power plants, it will be difficult to establish the necessary meaningful guidance and criteria for the decontamination of operating reactors in advance of these anticipated licensee submittal." (Emphasis added) To my knowledge the NRC has not yet published a NUREG Document on Decontamination and/or a Regulatory Guide which identifies acceptable methods of decontamination and establishes materials testing criteria that must be satisfied to qualify each decontamination method for licensing approval. Whether or not enforceable. However, since the integrity of the primary coolant system is essential for protection of the public health, decontamination should not proceed until this important unresolved generic safety issue is resolved.

RESPONSE 2

The integrity of the primary cooling system is inspected on a continuing basis in accordance with the requirements of Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code and Addenda.

Section 50.55a(g) of Title 10 Part 50 of the code of Federal Regulations establishes the requirements for inspection of the primary cooling system integrity. The inspection program for Dresden Unit No. 1 is in accordance with the requirements contained therein.

Facility Operating License No. DPR-2 issued to Dresden Unit No. 1 requires that Commonwealth Edison operate the facility in accordance with Section XI of the Code and periodically update their inspection proram to agree with the Edition of the Code currently required by our Regulations.

We have concluded that inspection of the primary cooling system in accordance with Section XI of the ASME Boiler and Pressure Vessel Code provides adequate assurance that the system is free of incipient flaws larger than those allowed by the ASME code and therfore provides adequate assurance that the primary cooling system has not been significantly degraded.

Migration potential of dissolved contaminants is generally assessed in laboratory tests using disposal site soils and water spiked with traces of contaminants. In the tests, the distribution coefficient (K_d) is typically measured and it is assumed that with a few adjustments the ratio of the velocity of dissolved contaminants to the velocity of water passing through the soil can be estimated. Referring to the example of migration at Oak Ridge site it has been observed that water flow rates are extremely rapid, and have been on the order of 100 feet in less than one month, at a trench similar to the one in which chelating agents have been found[1]. Since the migrating radionuclides were Strontium-90 and Cesium-137 (which do not form strong complexes with chelating agents), it appears that water flowing at high velocity through fractures caused these radionuclides to migrate. Fractures probably augmented the migration of chelated radionuclides at Oak Ridge as well.

We assume that the tests of migration potential which are addressed in your question refer to the adsorption of radionuclides by soil or K_d measurements. There are several caveats which must be considered in using K_d values from laboratory and site tests to predict conditions at other sites. In the case of laboratory tests, there is considerable uncertainty as to the chemical conditions which should be used to represent the disposal site environment in laboratory tests. Eh, pH, microbial activity and other dissolved substances are among the variables known to influence the distribution coefficient. Also, there may be differences in the results obtained under the same chemical conditions but with different testing techniques. Field tests may avoid some of these problems, but they have drawbacks in that many years of sampling may be required and the results may only apply to a limited range of conditions such as at the site being tested.

QUESTION

3. For how many years have radioactive corrosion products, bonded with the proposed Dow Chemical solvents, remained free of water after being solidified by the Dow Chemical polymer process?

RESPONSE

Radioactive corrosion products, bonded with the Dow Chemical solvent, have been tested to remain free of water after being solidified by the Dow Chemical polymer process since 1974.

(1) Loemenick, Jacobs, and Struxness, Health Physics, Pergamon Press 1967, Vol. 13, Behavior of Sr^{90} and Cs^{137} in Seepage Pits at Oak Ridge National Laboratory.

QUESTION

3a. Has the Dow solidification process been tested on reactor corrosion products comparable to those which will result from the Dresden experiment? What assurance is there that the encapsulated waste is going to be low-level?

RESPONSE

The Dresden decontamination is not an experiment, it represents the application of a proven method of decontamination that has been specifically developed and tested before being used on the Dresden Unit 1 primary cooling system.

The Dow Chemical polymer solidification process has been tested on reactor corrosion products comparable to those that will result from the Dresden Unit 1 decontamination operation. In June 1976, a Dresden Unit 1 corrosion test loop was decontaminated with the Dow Chemical Solvent, NS-1, to provide data on future decontamination operations. The test loop was originally installed to obtain stress corrosion data. Isotopic surveys indicated that the crud in the loop was representative of the rest of Dresden Unit 1 primary system. The spent decontamination solvent was solidified by employing the Dow Chemical polymer process.

Isotopic analyses of crud samples have been used to identify the type and amount of radioactivity. The total amount of radioactivity from the decontamination of the Dresden reactor system is estimated to be approximately 3,000 Ci and each 55-gallon drum of solidified radwaste will contain up to approximately 3 Curies of predominately Co-58 and Co-60. These radioactivity concentrations are not unlike those normally produced by typical operating reactor radwaste systems. These types of waste are considered to be low level for waste disposal purposes because they do not contain high concentrations of fission product nor transuranic isotopes.

QUESTION

3b. When did Dow Chemical first develop its solidification process for low-level radioactive wastes? What is the longest duration period for one of its "monoliths" or matrixes -- that is, how has such a solidified Dow substance remained free of liquid? What would be the long-term stability of the solid polymer over a period of thousands of years?

RESPONSE

The basic formulation of the Dow Chemical solidification process was developed in the late 1960s under the trade name of NAJVAR. The first solidified sample

of prototype test has remained free of liquid since 1974 when the test was made. Analysis has shown that the longest lived significant isotope that will be solidified after the decontamination is Co-60 with half-life of 5.2 years. Tests have been performed to demonstrate that the stability of the solid polymer will not substantially alter for over 50 years, corresponding to 10 half-lives of Co-60. These tests include accelerated aging, biological degradation, radiation degradation and temperature cycling (freeze and thaw resistance tests). After 10 half-lives the original 3,000 curies will have decayed to approximately 3 curies.

QUESTION

3c. What is the leach rate of the polymer under burial conditions, or the potential for diffusion and release of encapsulated radionuclides, solvents, etc.?

RESPONSE

We do not know the leach rate of Dow polymer under burial conditions. In arid disposal areas the potential for water to contact waste is very small, limiting the potential for leaching. The potential for diffusion and release of encapsulated radionuclides has been compared to other commonly used solidification agents under standardized laboratory conditions. Dow polymer was found to leach more slowly than cement, urea formaldehyde, and bitumen for strontium and cesium isotopes. Cement showed a lower leach rate for Cobalt-60.

There is not as yet any test which can simulate leaching under burial conditions. The potential for release of radionuclides has been compared on a relative basis, in the NRC funded study "Properties of Radioactive Wastes and Waste Containers", conducted at Brookhaven National Laboratories in Upton, New York. Dow polymer was compared to other common solidification agents (urea formaldehyde, cement, and bitumen) and found to have generally superior radioisotope leach rates. Cement was found to have a lower cobalt leach rate, however, the tests were performed with Cobalt-60 in an unchelated state. In the tests, small samples of solidified reactor wastes (excluding decontamination wastes) were immersed in salt, distilled, and ground waters for one to four months.

Dow has performed leach tests using wastes similar to those in the Brookhaven work and the results showed close agreement. Dow also performed leach tests with NS-1 decontamination waste solidified in Dow polymer, and found that the leach rates were slightly better for Cobalt-60 when the NS-1 waste was compared

to the other reactor wastes tested. It is possible that the reason for lower Cobalt-60 leach rates in the presence of NS-1 may be due to association with a larger molecule, resulting in slower diffusion through Dow polymer. The tests showed that after one week of immersion 0.7 percent of the cobalt leached from the solid waste and an additional 0.2 percent of the cobalt leached during the following two months. These results indicate a rapid reduction in leach rate after the first week.

It has been proposed by the International Atomic Energy Agency that the results of small sample leach testing be scaled by the ratio of the volumes to the surface areas of the sample and the actual waste (55 gallon drum dimensions in this case) using a formula specially derived for use with the leach test procedure. This scaling would result in a reduction by a factor of approximately 0.1 for comparing the cumulative fractions released in the drum sized wastes to the laboratory samples. The leach rates measured in the laboratory are mostly of use for estimating leaching under saturated conditions, or as a basis for comparing various solidification agents. In actual burial conditions at the low-level waste disposal sites considered for the disposal of Dresden 1 decontamination wastes, the waste is disposed in a dry unsaturated environment with very little moisture available. This is explained in more detail in the response to Question 4c.

QUESTION

3d. During the evaporation step, is the solvent volatile, and if so, will an ion exchange resin completely scrub chelated radionuclides from the evaporate? (I am told by one person that his experience indicates it will not).

RESPONSE

At the evaporation temperature, the chelating agent portion of the solvent is not volatile except for ammonia and organic compound components. Carryover of chelated radionuclides entrained in the vapor mist is an insignificantly small fraction. This carryover will be further reduced as the spent solvent is further processed by a mixed-bed demineralizer which has been tested to be effective in removing chelated radionuclides. The conductivity of the liquid is a strong function of the solvent concentration. In order to purify the water for reactor grade and suitable for plant reuse, the processing required has to reduce the residual solvent concentration to an insignificant amount.

QUESTION

4. For how many years have the barrels designed for burying the solidified wastes been found to remain resistant to corrosion from both the proposed contents and from surrounding environmental impacts?

RESPONSE

The barrels were designed to meet the packaging requirements for transport of the solidified waste and are not designed to serve the purpose of remaining corrosion resistant after burial. However, although there is no experience with buried barrels of the same Dow Chemical polymer content, actual experience with barrels of similar design and chemically comparable content at the burial sites has shown that most barrels remain resistant to corrosion and maintain their integrity for up to 5 years.

QUESTION

4a. According to a letter I received from Mr. Paul Pettit (Light Water Reactor Section, Division of Nuclear Power Development, DOE) dated February 6, 1979, the solidified wastes from the Dresden experiment are to be shipped in drums to a commercial low-level waste disposal site. Since additional wastes are no longer being accepted at the nearby Sheffield, Illinois burial site (in fact, the licensee has just walked away, with the NRC in hot pursuit), will the wastes be shipped to Nevada, South Carolina, or Washington? Were the drums designed to comply with the Department of Transportation's (DOT) packaging and shipping regulations for low-level or high-level wastes (49 CFR Parts 170-178), or to comply with the NRC transit regulations for fissile materials (10 CFR 71 and 73)? And/or were the drums designed for indefinite burial?

RESPONSE

The solidified radwaste will be shipped to a licensed commercial low level waste burial site located at either Beatty, Nevada or Hanford, Washington. Prior to shipment, estimates of radioactivity content and direct radiation measurements of the drums will be made. The licensee has committed to meet the applicable packaging, labeling and transportation regulations under 10 CFR Part 71 of the Nuclear Regulatory Commission and under 49 CFP Part 170-178 of the Department of Transportation. Regulations pertaining to fissile materials will not be applicable since the reactor fuel is removed prior to decontamination and no fissile material is expected in the decontamination waste.

QUESTION

4b. What is the estimated lifespan of the barrels? What precautions are going to be taken at the life-end of the barrels to ensure continued containment of the residual radioactivity? Have any metals been found that will resist the corrosive action of the proposed contents for even a decade? Is there apt to be any chemical reaction between the compounds going into the barrels and the materials of which the barrels are composed?

RESPONSE

It is not our present policy to rely upon barrels to contain wastes after disposal. The hydrogeological conditions of the disposal site and the waste solid are relied on to provide containment after containers are no longer intact. The specifications of the container are based on transportation requirements, not disposal requirements. The lifespan of the barrels has not been relied upon to contain the wastes after disposal. This has been the usual practice in the past for evaluating the performance of disposal sites.

The waste container (DOT approved 55 gallon drums) metal has been tested by our contractor, BNL, and based on the test results we find the container is adequate for waste in this solidified form. In the first series of tests we requested BNL to measure corrosion under the condition that the waste does not solidify. Under this assumption corrosion breakthrough could occur to a 55 gallon drum in about one month. In view of the assurance provided by the quality control and system design features of the solidification system, if the conditions that would result in the present of liquid NS-1 were to occur, they would be detected and appropriate corrections would be made. The corrosion rate was also determined for a more realistic hypothetical bounding case where a layer of liquid waste was tested in contact with the drum steel to simulate the worst case for condensate in the drum. Such a layer of liquid waste has not been observed in wastes solidified by BNL or the manufacturer (Dow Chemical Corporation) when the wastes were solidified in accordance with the procedure specified by the manufacturer. The results from this test show that the barrel could be expected to last one or two years, based on corrosion observed after 4 weeks of contact. This indicates that assuming the above as a trial worst case, corrosion would not penetrate the wall during handling and storage, if buried within a few months of solidification. A container corroding through in the disposal site would not present a problem since the waste is a solid and the quantity of condensate which could leak from the drum would be easily absorbed in the undersaturated soils at a semi-arid disposal site. Further corrosion tests conducted under expected conditions show that after 4 weeks of exposure no significant corrosion occurs

to the barrel steel in contact with solidified waste or vapor from liquid waste. The corrosion rate in contact with solidified waste indicate that the barrel could last tens of years and the vapor was found to be non-corrosive.

QUESTION

4c. In the June 30, 1978 Science article, Dr. Crerar and colleagues describe the accelerated dispersal through the groundwater and the increased uptake by vegetation of the radionuclides when bonded to nonbiodegradable chelates. If the buried drums with the solidified Dresden effluent were to corrode and the matrix were to come into contact with water, would the radionuclide-chelate complex not become soluble again? Could this solution then migrate through the environment in the same manner found at the Oak Ridge burial site?

RESPONSE

No. The migration of radionuclides at Oak Ridge was associated with the disposal of 35,000,000 gallons of liquid waste. The significance of the migration at Oak Ridge was addressed by Means, Crerar, and Duguid in 1976 as follows:

> "A seep approximately 50 meters east of trench 7 within the ORNL restricted area contains ^{60}Co in concentrations of 10^4 to 10^6 dpm/g in the soil and 10^3 dpm/ml in the water. Traces of ^{125}Sb and various transuranics have also been detected in the soil. However, because the volume of water discharge from the seep is small, the total radionuclide contribution from the trench 7 area to White Oak Creek and the Clinch River is insignificant."

Migration as observed at the Oak Ridge site would not occur at the Beatty, Nevada or Hanford, Washington commercial disposal sites. A solid waste is to be disposed at the commercial sites. The climate, geology, and hydrologic conditions eliminate the possibility for flow to saturate soils and transport radionuclides as observed at Oak Ridge.

(2) MEANS, J. L., D. A. CRERAR, and J. O. Duguid. 1976. Chemical Mechanisms of ^{60}Co transport in ground water from intermediate-level liquid waste trench 7: Progress report for period ending June 30, 1975. ORNL/TM-5348. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

The migration as observed at the Oak Ridge site would not occur at the disposal sites which may receive the solidified Dresden 1 decontamination wastes, assuming that container corrosion and leaching of soluble radionuclides occur. Commonwealth Edison has notified NRC staff that the disposal sites which are being considered for the Dresden 1 wastes are the Beatty, Nevada and Hanford, Washington commercial low-level waste disposal sites. Table 1 gives a brief summary of the disposal and environmental conditions at these sites, with a comparison to the region of disposal pits 2, 3 and 4 and trenches 5, 6 and 7 at Oak Ridge. These pits and trenches are clustered in the vicinity of Whiteoak Creek. There are many similarities between these disposal units, which include trench 7. This trench was found to be a source of chelated radionuclides. The major difference between the Oak Ridge site, where migration has been observed, and the commercial sites, where no migration has been detected, is the general lack of water at the commercial sites and the abundance of water at the Oak Ridge site. Oak Ridge experiences very high precipitation, has a water table which probably intersects pits and trenches, and the waste disposed was entirely liquid. For trench 7, which was identified by Duguid, Means and Crerar as a source of chelated radionuclides, we estimate that approximately 7 million gallons of liquid waste was disposed during a three year period from 1962 to 1965. Considering the liquid to be evenly distributed over the area of trench 7, the equivalent water flow in terms of precipitation would be on the order of 100 feet per year. This is far in excess of the few inches of precipitation incident at the desert sites, where the majority of the precipitation is rapidly returned to the atmosphere by evaporation. The estimates of water flows at Oak Ridge are based on figures reported by Lomenick, Struxness, and Jacobs and trench dimensions from a report by Duguid.

Migration of radionuclides from the Oak Ridge disposal trenches to the surface was also promoted by the type of geologic material in which the trenches were excavated. The trenches were founded in fractured shale which may have small solution cavities as well as fractures available to conduct water at rapid rates. Trench 6, which received liquid wastes for approximately one month, had to be taken out of service due to the breakthrough of radionuclides at a seep 100-feet downslope. Cesium-137 and Strontium-90 were present in the seep water, having migrated 100 feet in less than one month, due to fracture flow. In comparison the commercial disposal trenches at Beatty and Hanford are excavated in a weakly cemented alluvial fill and unconsolidated sand and gravel, neither supporting fracture flow. The topography and location of the

Oak Ridge disposal sites promoted migration to surface seeps. The trenches were excavated in hills, such that trench bottoms are saturated, a hydraulic gradient exists to drive flow to surface seeps. The slopes leading from the wet low areas up to the disposal trenches are often in the range of 1:5 to 1:10. The commercial disposal sites at Beatty and Hanford on the other hand are characterized as flat desert areas with slopes on the order of 1:100 to 1:300, providing a much longer path between the trench bottoms and points where the surface are at equal elevation. Also, the intervening material is under-saturated, and volumes of water which are much greater than available in the desert would be required to saturate the soil before any significant flow to the surface could occur (for example as would cause the swampy regions associated with the Oak Ridge seeps).

Also, the solid wastes disposed at Beatty and Hanford are covered with three to five feet of dry sandy materials, which would absorb precipitation. This provides some protection against the occurrence of waste leaching. Should water be supposed to enter a desert disposal trench, it would tend to be absorbed by the trench walls and bottoms rather than collect in the trench bottom, thus, preventing saturation of the wastes and minimizing the time of the contact of wastes and water.

Table 1. Comparison of the conditions at the Hanford, Washington, and Beatty, Nevada, commercial low-level radioactive waste disposal sites to the conditions at the Oak Ridge, Tennessee, liquid waste disposal area (Pits 2, 3, and 4, and trenches 5, 6, and 7)

	Oak Ridge	Beatty	Hanford
Average precipitation	50"/year	4.5"/year	6.25"/year
Waste to aquifer distance	0+	300 feet	290 feet
Distance to nearest perennial stream	250 feet	10 miles	8 miles
Average evaporation from open water surfaces	34"/year	70"/year	42"/year
Waste form	35,000,000 gallons (liquid)	Solid*	Solid*
General description of site	Hilly, humid area	Flat, desert area	Flat, desert area

*Some liquid wastes were solidified on site or received sorbed on solids or packaged in sorbent material.

+The water table intersects some trench bottoms in the Oak Ridge disposal areas.

QUESTION

4d. If chelates are to be used, can they be deactivated thermally, chemically, or biologically before evaporation and solidification?

RESPONSE

The chelating agent can be "deactivated" (reduced to simple molecules) thermally or chemically. However, this process has not been chosen by the licensee because: (1) the leach rate with chelating agent is tested to be less than those of solidified radioactivity without the chelating agent and (2) the additional process of "deactivation" adds complication to radwaste handling and may also result in additional equipment maintenance and personnel radiation exposure.

QUESTION

5. Is it possible that any of the solvent with or without dissolved radionuclides may remain after the principal effluent and first rinse water have been removed for evaporation and solidification -- and then be flushed into the Illinois River? If so, might the radionuclides absorbed by the river's sediment near the plant's cooling water outfall in years past become resuspended and migrate into the food chain?

RESPONSE

Approximately 99.9% of the radioactivity and chelating agents will be contained in the drainage of the initial decontamination solution and first rinse. These waste volumes will be evaporated because of their relatively high radioactivity and chemical concentration. After the decontamination solution and the first rinse, the subsequent rinses are expected to contain only 0.1% (approximately 3 Ci) of the total radioactivity from the decontamination operation. These subsequent rinses will be stored (after processing to improve purity if necessary) for plant reuse. No liquid waste from the decontamination operation will be flushed into the Illinois River.

QUESTION

5a. How much radioactivity and residual chelating agent are expected in the first rinse? How many additional rinses will there be? Scientists have told me that they did not think that chelated, radioactive metal ions would be removed by a demineralizer; although demineralizers have a high affinity for naked metal ions, I have been informed that they generally do not remove chelated forms. Or will the chelating agent perhaps be charged, and thereby be removable by the demineralizing step? People with whom I have spoken seem surprised to learn that the purification of the first rinse -- the removal of the residual chelating agents and chelated metal ions -- was to be done with a demineralizer. What is the explanation for this apparent departure from traditional practice?

RESPONSE

It is expected that approximately 140 Ci of radioactivity will be present in the first rinse. There is no estimate on the amount of residual chelating agent in the first rinse. However, since the solvent will be drained prior to the first rinse, the amount of chelating agent in the first rinse should be proportional to the small amount of residual fluid after the drainage. One or more rinses will be performed after the first rinse depending on the analysis of the rinse water. After each rinse, the water will be drained. Considering the large amount of water for each rinse (100,000 gallons), the amount of chelating agent in the second and/or third rinse should be minimal. The first rinse will be processed through the evaporator. No significant amount of chelating agent should be present in the distillate. Additional treatment by demineralizer of the distillate and/or subsequent rinses may be performed if necessary. The licensee's tests indicate that the demineralizer is effective in removing radioactive metals bonded by the chelating agent.

QUESTION

5b. According to Mr. Pettit's letter of February 6, 1979, "the formulation of the Dow Chemical solvent is known to DOE staff, but is protected from release to the public by a proprietary agreement." Solvents used for decontamination purposes at nuclear facilities have been described elsewhere, however, by DOE, Dow and Commonwealth Edison representatives as being "chelating agents" (pronounced key-lay-ting) -- that is, a chemical compound (typically organic) capable of forming clawlike multiple bonds with a metal ion. Typically these agents are also non-irritating to skin or eyes, a characteristic of the solvent which Mr. Pettit happened to mention.

Assuming the components of the solvent fit the definition of a chelating agent, is there any likelihood that there will be enough residual after the primary effluent and first rinse water have been removed, that some might be flushed into the Illinois River along with future routine releases of the coolant water? (The coolant-water discharge canal empties into the Illinois River at the confluence of the Des Plaines and Kanakee Rivers at Illinois River Mile 272.4). How tightly does the solvent bond metals? That is, if some were to pass through the sediment near the canal's discharge point, might it leach out additional radionuclides which have accumulated in the sediment near the outfall? Or if it is a relatively weak agent, might the sediments attract radioactive metals out of the chelate solution, thereby increasing the amount of radionuclides in the sediment and the potential for further contamination of the benthos? (The EPA report entitled "Radiological Surveillance Studies at a Boiling Water Nuclear Power Reactor", BRH/DER 70-1, describes the contents of the Dresden Unit One liquid waste effluents during tests in 1967 and 1968. Two later companion studies at reactors in Massachusetts and Connecticut describe the significance of the concentration of radionuclides in the sediments).

RESPONSE

No liquid waste, including water from all the rinses, from the decontamination operation will be discharged into the river. The licensee has committed to process all liquid waste to meet reactor coolant (RC) purity requirements for recycle as plant makeup water. RC purity requirement precludes significant quantities of chelating agent. In addition, any trace amounts of chelating agent will be decomposed to simple molecules at plant heatup during startup (chelating agent decomposition temperature is around 300°F).

QUESTION

6. What will be the impact of the solvent on the future safe operation of the Dresden plant?

According to the book, Dangerous Properties of Industrial Materials, by N. Irving Sax, published in 1963:

> "One fallacy in the initial concept of stainless steel or other 'impervious' surfaces is that they are truly impervious. This has been shown to be false. Stainless steel after one vigorous cleaning is found to deteriorate in that more and more material may be absorbed or adsorbed and retained on the surface. Successive cleanings have been found to become more difficult and to require more vigorous methods of decontamination." (p. 149)

a. I understand that the NRC is responsible for making certain that this project will not compromise the integrity of the reactor vessel and its parts. What assurances, however, does either the NRC or the DOE have that this massive cleaning effort will not increase the surface fouling of the reactor system in the future, causing an acceleration in the buildup of crud in its many nooks, crannies and blind holes? Will even stronger chelating agents be needed at Dresden Unit One for future decontamination efforts, assuming the stainless steel properties quoted above from the Sax book are correct?

b. Could an acceleration in the rate of buildup of crud after the decontamination project increase the potential for pipe cracking or rupture? And also increase the radiation hazards to workers?

RESPONSE

a. There is no evidence based upon decontaminations that have been performed at the Canadian reactors and at the British reactors to indicate that the rate of recontamination or the rate of crud deposition on the cleaned surfaces would be accelerated by the decontamination process. On the surfaces of cleaned carbon steel, subsequent rates of deposition of copper have been shown to increase, but in the Dresden 1 cleaning process this copper will be removed by a "copper rinse". In fact, rather than using stronger chelating agents at Dresden Unit 1 in the future, it is quite possible that, following the strong decontamination solution the utility may elect to use a weaker but more frequent decontamination process on line that is currently being developed under EPRI sponsorship by Battelle Northwest.

b. There is no evidence that the buildup of crud either during routine operation or following decontamination could increase the potential for pipe cracking or rupture. The initiation of pipe cracking appears to require relatively high stresses and perhaps a specific rate of straining of the stainless steel in conjunction with the oxygen in the coolant. There is no evidence that crud deposits influence this initiation. Various laboratory tests on specimens that have been decontaminated and then re-exposed to typical BWR primary coolant water have shown no increased sensitivity to integranular stress corrosion of the type that causes the pipe cracking incidents that have occurred in boiling water reactors. Since there is no anticipated acceleration in the buildup of crud, it would appear that there would be no concomitant increase in radiation hazards to workers. In fact, the primary reasons for doing the decontamination in the first place is to reduce these radiation hazards. In some units the rate of recontamination has been shown to decrease simply because a substantial

portion of the Cobalt 59 has been removed from the surfaces of the piping materials by corrosion processes earlier in operation of the unit, so that the buildup of Cobalt 60 following the decontamination is reduced substantially.

QUESTION

7. What assurances are there that the men who participate in the Dresden decontamination experiment will not suffer from exposure to the combination of the solvent and the radioactive materials suspended in the solvent in either the aqueous or gaseous forms?

One of the possible reasons for the increased incidence of leukemia and cancer at Portsmouth and other naval shipyards which Drs. Thomas Najarian and Theodore Colton mention in their communication published in The Lancet, May 13, 1978, is that: "Other factors (asbestos, smo[illegible]ng, industrial solvents) may have interacted synergistically with radiation to cause more deaths from cancer and leukemia than radiation alone would have caused." (emphasis added). I realize that one of the primary reasons for trying to develop an effective decontamination process is to reduce the accumulation of gamma-emitting corrosion products which in turn cause high radiation fields within operating nuclear power plants, and thereby necessitate the hiring of excessive numbers of repair and maintenance workers.

RESPONSE

The concerns about operating personnel receiving radiation exposure and being exposed to the decontamination solution are synonymous. Since the spent decontamination solution contains radioactivity, exposure to the solution will result in exposure to radiation. The design of the system is such that personnel should not have direct physical contact with the radioactive decontamination solution. Personnel working near such solutions will wear protective clothing, including face masks, to further minimize the possibility of contamination. The licensee is committed to comply with limiting radiation exposure to personnel to within the limits specified in 10 CFR Parts 20.101 and 20.103. The licensee is also committed to meet the objective of limiting the radiation exposures to as low as reasonably achievable (ALARA) level in accordance with 10 CFR Section 20.1(c).

QUESTION

7a. According to a letter dated March 13, 1979, from Mr. A. David Rossin (System Nuclear Research Engineer, Commonwealth Edison), thirty workers will be needed during the presently proposed 100-hour project. And although I was told by Mr. Paul Pettit of the DOE that his agency is not concerned about the toxicity of the Dow solvent itself during the decontamination operation, what hazards may it pose to workers when it is in combination with radioactive materials?

RESPONSE

Although there is no demonstrated synergistic interaction between the Dow Chemical NS-1 solvent and radiation exposure, the ALARA consideration for radiation exposure should be sufficient to limit the exposure to the Dow Chemical NS-1 solvent. The licensee has submitted the plans and has committed to maintain the radiation exposure to personnel to ALARA. The NRC staff has reviewed the ALARA plan and concluded that the ALARA objective can be met by the proposed plan of actions.

QUESTION

7b. What procedures are to be taken to make certain that the radionuclide-chelating agent is totally contained and will not in fact come in contact with the workers? What is the radiation dose expected per hour at one meter from the reactor containment vessel, the effluent piping, the evaporation and solidification equipment, and the drums preparatory to and during shipping? What shielding will be erected to protect the workers?

RESPONSE

The licensee is committed to comply with radiation exposure limits to operating personnel pursuant to 10 CFR Part 20. In addition, the licensee is committed to design features and operating procedures such that radiation exposure to plant personnel will be maintained ALARA. Since radioactivity is contained in the decontamination solution, contact exposure to the solution will also be kept at a minimum.

The radiation dose varies depending on local equipment geometry, plate-out distribution and self shielding factors. The radiation at one meter from a reactor system component during the decontamination process is generally less than that during normal operation and is expected to be in the several Rads per hour range. The radiation near evaporation and solidification equipment should not be more than an order of magnitude higher. These kinds of dose rates are not uncommon at radwaste equipment during routine operation. However, it should be noted that personnel access to those areas is not expected because of remote control features.

The objective of the decontamination process is to reduce the total radiation exposure to plant personnel. The decontamination will remove the major source of radioactivity encountered by workers during operation and maintenance of the plant and, thus, significantly reduce personnel exposure in performing these activities. It is estimated that the saving in radiation exposure to personnel over the next 10 years is 10 times the radiation exposure to personnel expected for performing the decontamination operation.

Date: