ENVIRONMENTAL REPORT

OF

THE CURRENT DECOMMISSIONED STATUS OF DRESDEN 1

Docket No. 50-10

prepared for

COMMONWEALTH EDISON COMPANY

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1. SUMMARY

This document addresses the environmental aspects of the current decommissioned status of the Dresden Unit 1 Nuclear Power Plant (hereinafter Dresden 1). The unit is a dual-cycle boiling water moderated and cooled reactor designed by the General Electric Company. Dresden 1 was the first nuclear plant built by private industry. It was a cooperative effort by Commonwealth Edison Company (CECo) and the Nuclear Power Group, which included six other electric utilities.

A Decommissioning Plan for Dresden 1 has been prepared (Ref. 1). The Plan describes the proposed decommissioning of the plant by mothballing, the current description of the unit, the primary safety considerations evaluated, and the basis for selection of decommissioning by mothballing. The Plan will be referred to for descriptions of the plant status and proposed decommissioning configuration to the maximum extent possible so as to minimize repetition.

The environmental information contained herein is intended to assist the US NRC in its evaluation of the Decommissioning Plan for Dresden 1. Facility and site operational environmental effects have previously been provided to the US NRC in the Environmental Report for CECo's Dresden Units 2 and 3 (Ref. 2), and will not be repeated here. The environmental information herein only discusses the issues important to decommissioning of Unit 1. Specifically, the report provides a description of the operational alternatives and generic decommissioning alternatives considered in the evaluation of the proposed disposition of the plant, and discusses the safety and environmental effects of temporarily storing the spent fuel on site.

In preparation for decommissioning Dresden 1, CECo removed all fuel from the reactor and stored it in the spent fuel pool. Except as described in the Decommissioning Plan, systems in the Containment, Turbine, Fuel Handling, Radwaste, HPCI, Crib House and Off-Gas Buildings will be drained and secured closed.

This environmental assessment considered three alternatives covering the spectrum of decommissioning choices from the standpoint of environmental impact. These alternatives are:

1. DECON Prompt Removal/Dismantling
2. ENTOMB On-Site Entombment with Delayed Dismantling
3. SAFSTOR Mothballing with Delayed Dismantling

It is our conclusion that neither the DECON (Total Removal) alternative nor ENTOMB (On-Site Entombment) alternative would result in a significant reduction in the environmental impact compared to the SAFSTOR (Mothballing with Delayed Dismantling) alternative. Because Dresden 1 can be safely and inexpensively maintained in dormancy on the shared site with Dresden Units 2 and 3, CECo believes mothballing of Dresden 1 to be the only practical decommissioning alternative. These reasons, as well as the radiological advantages associated with delaying ultimate dismantling of the unit, provide the basis for the choice of the SAFSTOR Plan as the preferred alternative. Based on an evaluation of the safety, feasibility and operational considerations CECo has concluded there are no significant environmental effects from decommissioning Dresden 1 by SAFSTOR.

2. INTRODUCTION

2.1 PLANT HISTORY

The Dresden Nuclear Power Station, which includes Units 1, 2 and 3, is located on a 953 acre site near the confluence of the Des Plaines and the Kankakee Rivers, about 50 miles southwest of Chicago in Grundy County, Illinois. The nearest population center of Morris, Illinois, is located eight miles to the west.

Dresden 1 was a first generation, turnkey, demonstration plant that was the first full-scale privately financed nuclear power plant in the United States. When built, Dresden 1 was the largest single operating nuclear reactor in the world. Initially, it was rated at 180 MWe (net) and was subsequently uprated to 210 MWe.

Dresden 1, owned and operated by Commonwealth Edison, received its construction permit May 4, 1956 and its operating license, DPR-2, November 16, 1959. Commercial power operation between August 1, 1960 and October 31, 1978 generated approximately 15.8 million MWhrs of electricity.

On October 31, 1978, in accordance with Nuclear Regulatory Commission (NRC) directives, CECo suspended operations of Dresden 1 to refuel, perform major system modifications, to add a High Pressure Coolant Injection (HPCI) system, and to perform a major primary system chemical cleaning. Following the Three Mile Island-2 accident, the cost of additional modifications grew to more than $300 million to bring the unit into compliance with federal standards. Company officials concluded that the age of the unit, together with its relatively small size, (compared to the available power at the time), made such an investment impractical. On August 31, 1984, it was announced that Unit 1 would be retired.

In July, 1986, the Dresden 1 provisional operating license was amended to a possession-only status. Amendment No. 36 to operating license DPR-2 continued CECo's authority to possess the facility and its contents, and permitted maintenance of Dresden 1 in its present status. By maintaining the facility in the proposed manner, the safety of the public would be assured. The proposed revised Technical Specifications (Ref. 3) leaves unchanged the current administrative control section governing the Radiation Protection Program; "Radiation control procedures shall be maintained, made available to all station personnel and adhered to. These procedures shall show permissible radiation exposure and shall be consistent with the requirements of 10 CFR 20. This radiation protection program shall be organized to meet the requirements of 10 CFR 20."

2.2 GENERAL PLANT DESCRIPTION

Dresden 1 is a dual cycle boiling water moderated and cooled reactor designed by the General Electric Company. The reactor was fueled with 464 assemblies of slightly enriched uranium dioxide in the form of ceramic pellets clad in Zircaloy rods. Eighty cruciform control blades composed of boron-carbide rods were hydraulically driven into the core for control and shutdown.

The nuclear steam supply system (NSSS) consisted of a steam separating drum, four secondary steam generators, four recirculating pumps, an emergency condenser and unloading heat exchangers. The power system consisted of a General Electric dual-admission turbine unit together with the corresponding support and auxiliary systems that produced a gross electrical output of 210 Megawatts. Heat removed from the condenser was transferred to the circulating water system, and this water discharged to the Illinois River.

The reactor, NSSS, Liquid Poison and Recirculation Water Cleanup Systems are housed inside the Containment Building, a leak-tight, spherical steel pressure vessel. A fuel transfer tube connects the Containment Building with the Fuel Handling Building. The High Pressure Coolant Injection (HPCI) system (never operational) is located in the HPCI Building east of the Containment Building. Liquid waste processing and disposal is performed in the Radwaste Building located east of the Fuel Handling Building. The charcoal adsorbing beds of the Off-Gas system (never operational) are located in the Off-gas Building located north of the Containment Building. The Turbine-Generator systems are located in the Turbine Building.

2.3 APPROACH

The information contained herein includes the current status of Dresden 1. CECo's decision to recommend mothballing with delayed dismantling was based on an evaluation of the decommissioning alternatives of entombment with delayed dismantling and prompt removal dismantling. This report provides the evaluation of environmental effects associated with each decommissioning alternative. The environmental effects included physical, radiological and personnel considerations evaluated by CECo to recommend the SAFSTOR decommissioning alternative.

3. CURRENT DRESDEN 1 STATUS

The Dresden 1 reactor was defueled in 1978. All 464 spent and partially-spent fuel assemblies in the reactor were discharged to the pool. There are currently 672 assemblies stored in the Fuel Storage Pool and 12 assemblies stored in the Transfer Pool. These fuel assemblies will remain in their present storage locations until permanent disposal alternatives are available. In addition, control rod blades, fuel baskets, guide tubes, dummy assemblies, reactor core plugs, encapsulation cans, in-core detectors and fuel racks are stored in the Fuel Storage Pool.

Dresden 1 is currently undergoing routine preparations prior to initiating SAFSTOR. A chemical decontamination of the primary system, completed in September, 1984, removed essentially all of the internal contamination. Tanks containing residual decontamination solvent (NS-1) are scheduled to be emptied and disposed of during the spring of 1988. The spent resin and sludge radwaste tanks of Dresden 1 were emptied of solid waste by June, 1987. The spent resin and sludges were solidified and shipped off-site as solid radioactive waste.

Areas of Unit 1 no longer required to be vital areas have been or are being reviewed with the intent to submit a security plan change to the NRC requesting devitalization. The reactor vessel head will be detensioned and the primary system will be drained. The Containment Building will be cleaned as needed. Analyses are being performed to determine the effects on the Containment Building if no space heating is provided.

The Fuel Handling Building is being cleaned and the pool is to be vacuumed and cleaned. For fuel pool bacteria and chemistry control, hydrogen peroxide is being added to the pool water. Presently, the existing filtration system in the Spent Fuel Pool is not operational and will remain inoperative. A portable demineralizer/filter system is being studied for short term (and possible long term) water chemistry control. The Fuel Handling Building contains operational local radiation monitoring alarms programmed to alarm on high radiation levels. Fuel Building area radiation monitors will remain operational and will alarm in the Main Control Room. In addition, a low water level condition in the Spent Fuel Pool will result in an alarm in the Radwaste Control Room and Main Control Room.

Primary physical security is provided by the Dresden 2 and 3 security force on a 24-hour basis for the duration of the dormancy period. Security during this period is primarily conducted to prevent unauthorized entry. Security detection and notification systems used during plant operations will be used during dormancy. Liaison with local law enforcement agencies will be maintained.

A baseline radiological survey will be taken as a precursor to the safe storage period. Routine quarterly surveys will be established to compare with the baseline survey.

An environmental surveillance program will remain in effect during the dormancy period to prevent releases of radioactivity to the environment. Any such releases will be identified and quantified. The operational monitoring systems at Dresden Units 2 and 3 will provide additional assurance that any releases from Unit 1 will be quickly identified. The environmental surveillance program is a modified/abbreviated version of that performed during normal plant operations. Environmental, radiation, and contamination surveys are being logged in a manner convenient for review, and are being retained for the life of the plant.

3.1 SYSTEMS DRAINED AND DEACTIVATED

During this SAFSTOR dormancy period, portions of the following systems described in the Decommissioning Plan will be drained and deactivated as part of the Dresden 1 safe storage:

Fuel Handling Water System
Main Steam and Condensate
Filters and Waste Demineralizer Tank,
Sludge Handling, Resin Storage and Waste Control,
Other systems

3.2 SYSTEMS REMAINING IN SERVICE

The following systems are expected to remain operational and serviceable during this dormancy period as described in the Decommissioning Plan:

Radwaste Collector Tank,
Waste Neutralizer Tank,
Secondary Steam Generator Collector Tanks,
Turbine Building Floor Drain,
Laundry Waste Treatment System,
River Water Systems,
Service Water System,
Cooling Water System,
Well Water System,
Fire Protection System,
Air Systems,
Plant Heating Systems, and
Reactor Enclosure Air Conditioning Water System.

4. DECOMMISSIONING ALTERNATIVES

CECo's decision to select the SAFSTOR with Delayed Dismantling decommissioning alternative for Dresden 1 was based on an evaluation of operational and decommissioning alternatives. A brief summary of the alternatives evaluated and conclusions reached are discussed herein as part of the environmental assessment.

4.1 CONTINUED OPERATION ALTERNATIVE

CECo considered incorporating the necessary modifications to the plant to meet the new regulatory standards in 1978. The reactor was shut down and the primary system chemically decontaminated to prepare for installation of system modifications. However, following the Three Mile Island Accident in 1979, the additional regulations issued for retrofitting would have cost over $300 million. CECo concluded the age of the unit and the relatively small size did not warrant the investment.

4.2 "ENTOMB" ALTERNATIVE

In this alternative, all fuel assemblies, radioactive fluids, wastes, and certain other selected components are removed. All remaining highly radioactive or contaminated components are isolated.

Under this mode, highly radioactive components (namely, the pressure vessel, reactor internals, and possibly the steam generators) are sealed within a concrete structure. Concrete plugs are poured into all personnel accesses, and piping and cable penetrations to the main biological shield. Concrete covers are also poured over the main refueling floor so that the sealed biological shield would then become the entombment structure. All contaminated material outside the biological shield are removed from the site for burial and subgrade areas are backfilled to grade. All non-contaminated equipment is left in place. The containment structure is not removed since it could provide additional protection in addition to the entombment structure. The license may be converted to a possession-only license for the duration of the dormancy period. Security for the site may be provided by intrusion detection equipment with remote alarms at a central security station.

After a period of dormancy the facility owner would initiate the DECON alternative so the possession-only license could be terminated.

4.2.1 Physical Considerations

Entombment of Dresden 1 would increase vehicular and construction equipment traffic and could interfere with operation of Units 2 and 3 because of their close proximity to Unit 1. The Entombment construction manpower would burden the central security system and facilities, particularly during heavy manpower periods such as refueling and maintenance outages for Units 2 and 3. These effects would increase the cost of decommissioning.

The integrity of the structure must be assured over the time period in which significant quantities of radioactivity remain in the entombed materials. As a minimum, the integrity must be maintained until the year 2017, when Units 2 and 3 are expected to be retired. As a maximum, integrity must be maintained for 100 years which is the NRC's proposed limit discussed in the NRC Proposed Rules for decommissioning power reactors (Ref. 4). A continuing surveillance program would need to be established and implemented for this dormancy period.

Future dismantling and reuse of the site would be more difficult than other decommissioning alternatives. The presence of entombment barriers would add to the complexity of dismantling because these concrete and steel barrier structures will have to be removed when total facility removal becomes necessary.

4.2.2 Radiological Considerations

This alternative would not result in the immediate restoration of the site to its natural state. The inventory of radioactive material remaining under this alternative would approximate that remaining under the SAFSTOR alternative. Although there may be some reduction in maintenance, similar inspection and surveillance would be required.

Radiation exposure during ENTOMB decommissioning would be less than during the DECON alternative, but greater than during the SAFSTOR alternative. Entombment of a facility would be an effective mode of decommissioning if the radioactivity were to decay over a period of approximately 100 years, to an unrestricted access level. However, this would also require the owner utility to maintain site surveillance for that 100 year period. This would further result in the site being unavailable for 100 years for alternate use. An activation analysis was performed for the Unit 1 reactor vessel and internals and showed there is approximately 57.5 curies of Ni-59 (76,000 year half-life) as of January, 1988 which will not decay to unrestricted access levels within the 100 year period.

Decontamination of systems and structures that are to remain in place outside of the entombment barrier would generate more radioactive waste volume than the SAFSTOR alternative, wherein virtually no decontamination would be performed. The inventory of neutron-activated radioactive material would be the same as for SAFSTOR. There would be some reduction in the maintenance required during the dormancy period for ENTOMB as compared to SAFSTOR, the inspection and surveillance requirements would be essentially the same.

4.2.3 Conclusions

Based on the physical constraints of Entombment construction interference with Unit 2 and 3 operations, the additional Entombment manpower burden on the security system and facilities, the continuing maintenance of the Containment Building to ensure its integrity, and the additional difficulty and cost to remove the entombment barrier at dismantling, CECo concluded Entombment was an unacceptable mode for decommissioning Unit 1.

Based on the radiological constraints of the presence of long-lived radionuclides, the additional radiation exposure to workers, and the additional radioactive waste generated during ENTOMB as compared to SAFSTOR, CECo determined Entombment was unacceptable.

4.3 "DECON" ALTERNATIVE

CECo also considered the decommissioning alternative of prompt removal/dismantling (DECON). All materials with radioactivity above unrestricted access levels are removed from the site, thereby yielding unrestricted use of the site for any subsequent purpose. The facility license would be terminated and the site released for unrestricted use. The remaining facilities and structures may then be dismantled and the site made available for alternative use.

DECON requires the removal of all fuel and radioactive material and the removal or decontamination of contaminated equipment and structures. A major effort under the DECON option is the complete removal of the reactor vessel and internals. Because of its size and induced radioactivity, the reactor vessel would be segmented and shipped in commercially available licensed shipping casks to a licensed burial site.

All remaining contaminated parts of the plant are decontaminated or removed from the site to a burial ground. Contaminated and activated concrete surfaces such as the biological shield and the spent fuel pool are removed and shipped to a burial site. Decontamination and/or removal of other plant structures and surfaces is performed as necessary based on the results of detailed radiological surveys and sampling. All contaminated equipment and piping within the Containment Building is removed or decontaminated to acceptable levels. The provisional operating license or possession-only license would be terminated. If desired by the owner utility, the buildings could be demolished. All structures would be removed to a depth of three feet below grade, and backfilled to restore the area.

4.3.1 Physical Considerations

Dresden 1 is situated adjacent to Units 2 and 3. The Unit 1 Containment Building is close to facilities that are required to support continued operation of Units 2 and 3. Dismantling this building and its corresponding radioactive components would represent the same physical constraints as in construction of the entombment barrier: namely, increased vehicular traffic, and additional burdens on security facilities.

Demolition activities would include blasting, wrecking ball demolition, pneumatic/hydraulic drilling, fracturing, and flame cutting. These activities would create shock waves, vibrations, dust, noise and vehicular traffic problems, and could pose industrial safety concerns for Units 2 and 3.

The federal government has not established an operational repository for spent nuclear fuel at this time. There is currently no other place to economically store the Dresden 1 spent fuel. It is likely that even if a federally sponsored Monitored Retrievable Storage facility is available by the year 2003, other nuclear power plants with greater disposal priority needs would be given preference. Even if fuel could be disposed of by the year 2003, the Unit 1 demolition activities would interfere with operation of Units 2 and 3.

4.3.2 Radiological Considerations

Battelle Pacific Northwest Laboratory (PNL) conducted a survey to estimate the residual radioactivity at Dresden 1 in August, 1982 (Ref. 5). The estimate did not include neutron-activated components (reactor vessel and internals), the biological shield, or radioactivity in residues and resins in tanks and pumps.

The results of the radioactive inventory survey by PNL are shown in the Decommissioning Program Plan (Ref.1), Table 5.1, "Residual Radionuclide Concentration in Corrosion Films," Table 5.2, "Residual Radionuclide Inventories in Various Operating Systems," Table 5.3, "Total Residual Radionuclide Inventory," Table 5.5, "Radionuclide Concentrations in Concrete Core Samples," and Table 5.6, "Radionuclide Concentrations in Selected On-Site Soils."

The primary system was decontaminated in September of 1984, resulting in the removal of essentially all of the internal contamination.

Estimates for the neutron-activated components were prepared in 1987 by TLG Engineering, Inc., a consultant to CECo using the ORIGEN2 computer code (Ref. 6). Calculations for the reactor vessel and internals, and biological shield concrete radioactive inventory as of 1987 shown in Table 6.1, "Isotopic Inventory of Neutron-Activated Parts," indicates the inventory in January, 1988 is approximately 623,000 curies.

A Decommissioning Study for Unit 1 was also prepared by TLG Engineering, Inc. in 1985 (Ref. 7). The radiation exposure to workers for the DECON alternative was estimated to be 2,660 manRem. The decommissioning activities associated with cutting and removing primary coolant piping, steam generators, and the segmentation and removal of the reactor vessel and internals, are labor intensive. While maximum precautions would be taken to maintain radiation exposures "as low as reasonably achievable" (ALARA), these activities would result in greater exposures to workers than for either SAFSTOR or ENTOMB.

The Decommissioning Study for Unit 1 also provided estimates for the volume of radioactive wastes generated during decommissioning by DECON. The total waste volume including the disposal containers was estimated to be 10,615 cubic yards of waste. The waste volume generated for DECON is greater than that for either ENTOMB or SAFSTOR.

4.3.3 Conclusions

The physical constraints of the inability to remove and dispose of spent nuclear fuel, and the close proximity of retired Unit 1 to the operating Units 2 and 3 and resulting congestion during decommissioning, led CECo to decide to delay dismantling of Unit 1. The added benefit of reduced occupational exposure is consistent with CECo's ALARA program, and the delayed and reduced radioactive waste generated compared to DECON may provide sufficient time for the development of regional waste burial facilities.

4.4 "SAFSTOR" ALTERNATIVE

In this alternative, all fuel assemblies, radioactive fluids, wastes, and certain other selected components are removed from the reactor core. Areas within the plant needed for surveillance monitoring and maintenance would be cleaned or decontaminated as required to provide access to plant personnel. The license may be converted to a possession-only license for the duration of the dormancy period. The facility is placed in protective storage, and routine monitoring and surveillance are performed. The site security force provides control of access to the facilities.

After a period of dormancy the facility owner would submit a Decommissioning Plan two years prior to initiating the DECON alternative. The Decommissioning Plan would describe the activities to terminate the possession-only license and release the facility for unrestricted access.

As discussed previously, ENTOMB or DECON of Dresden 1 is not feasible because there is no place to dispose of the spent fuel, and the cost of dismantling is not warranted at this time since Dresden 1 is located on an active site where continuing security and monitoring is a small cost relative to the operating costs for Units 2 and 3. Furthermore, the additional congestion that would occur if entombment construction or demolition activities were to be implemented while Units 2 and 3 were operating could significantly affect the safe operation of these units. For these reasons CECo has proposed SAFSTOR followed by delayed DECON be adopted for Dresden 1. Upon retirement of Units 2 and 3, all three units are anticipated to be decommissioned by DECON sequentially.

4.4.1 <u>Physical Considerations</u>

Following cessation of Units 2 and 3 operation, the Containment Building, related systems, and facilities of Dresden 1 can be dismantled safely and economically. Following the removal of all fuel from the site to a federal repository, the need for security at that time would be greatly diminished and delays caused by access and egress limitations would be reduced. Laydown areas could be organized in a systematic manner as Units 2 and 3 facilities become available.

4.4.2 <u>Radiological Considerations</u>

Delaying the removal and dismantling of Unit 1 until Units 2 and 3 ceased operation would provide sufficient time for significant decay of the radioactive inventory. As of September 1979, there were approximately 1,400 curies of Co-60 distributed throughout the primary system (Ref. 8). As of September 1984, the Co-60 decayed to approximately 750 curies. In September 1984, a chemical cleaning was performed on the primary system, removing essentially all of the internal contamination. A very small quantity remains within the primary system at this time.

The radioactive inventory of the reactor vessel and internals will have decayed to approximately 15,810 curies (Refer to Section 6 for complete results of the activation analysis). Delayed dismantling further supports the ALARA principle since radioactivity levels will have decayed during the SAFSTOR dormancy period.

4.4.3 Personnel

The decision to defer dismantling the Dresden 1 Containment Building until Units 2 and 3 cease operation has the additional benefit of the availability of experienced operations and construction personnel to assist in the dismantling activities. Experienced and competent personnel necessary for a major dismantling of a nuclear facility such as Unit 1 would be available from the Unit 2 operating and support staff after Unit 2 has been retired.

4.4.4 Conclusions

Based on the foregoing assessments of the appropriate alternatives as described in the Decommissioning Plan, and the physical, radiological, and personnel considerations, CECo concluded SAFSTOR with delayed DECON as described in the Decommissioning Plan to be the appropriate alternative.

5. ENVIRONMENTAL ASSESSMENT

CECo's decision to recommend SAFSTOR with Delayed Dismantling (DECON) was based on the minimal cost to maintain Dresden 1 in safe storage until Units 2 and 3 are shut down, and the physical constraints associated with decommissioning Unit 1 while Units 2 and 3 are still operating. The environmental effects associated with the recommended alternative are discussed in this section. The assessment provided herein clearly demonstrates that SAFSTOR with Delayed Dismantling of Unit 1 will not cause a significant environmental impact.

5.1 RADIOLOGICAL RELEASES TO THE ENVIRONMENT DURING SAFSTOR

Upon shutdown of Dresden 1, the 464 spent fuel assemblies and associated control rods were transferred to the Fuel Storage Pool in 1978. The total fuel inventory in the Fuel Storage Pool consists of 672 fuel assemblies. As described in the following sections, CECo demonstrated that the fuel can be safely stored in the Pool until a federal repository is available to dispose of the fuel off site.

Similarly, internal surface contamination within piping and components, and neutron activation of the reactor vessel, internals and shield materials will be safely contained during SAFSTOR within the buildings housing those systems.

5.1.1 Spent Fuel Storage

The fuel is stored under water in the Fuel Storage/Transfer Pools. A minimum water level of 18 feet is maintained in the Spent Fuel pool, and routine monitoring is performed periodically, and maintenance is provided as needed.

Purification and filtration of the pool water will be performed as required using a portable demineralization/filtration system, and water chemistry will be checked periodically to maintain pH and chloride concentrations within acceptable limits. These water chemistry conditions will ensure the integrity of the fuel cladding, racks and concrete.

Radiological and physical inspections of Dresden 1 are performed on a routine basis as part of the present overall site Radiological Protection Program. Therefore, radiological releases from the stored fuel during normal conditions of storage is unlikely.

5.1.2 System Contamination

By-product material contamination on internal surfaces of the primary system and reactor auxiliary systems is sealed within the stainless steel system boundaries (piping and components). In September, 1984 a chemical decontamination was performed on the primary system which removed essentially all of the internal contamination. Since most of this contamination is contained in the corrosion film within the piping and components, and is fixed contamination, there is a very low probability of by-product material migration and release to the environment. There is no evidence to date to indicate there has been any by-product material migration.

5.1.3 Vessel/Internals/Concrete Activation

The greatest source of radioactivity in the Containment Building is in the reactor vessel and internals as neutron activation products in the vessel materials. Estimates prepared by TLG Engineering, Inc. in 1987 using the ORIGEN2 computer code (Ref. 6) indicate the total activity in the vessel and internals at shutdown to be approximately 4,029,000 curies; this has decayed to 623,000 Ci in 1988, and the total in 2017 should decay to approximately 15,810 Ci. A detailed breakdown by nuclide within the vessel, internals, and biological shield concrete is shown in Table 6.1, herein. These activation products are an integral part of the vessel and shield materials and will not result in releases to the environment during SAFSTOR.

5.2 ACCIDENTS AND NATURAL PHENOMENA OCCURRENCES

CECo evaluated the effects of potential accidents or natural phenomena on the safe storage of fuel on site during the dormancy period of SAFSTOR. Specifically, CECo retained NUS Corporation to analyze the fuel criticality potential when subjected to a loss of water from the pool, and an earthquake. A summary of the scenario and potential accident results are presented in the following sections.

5.2.1 Criticality Analysis - Loss of Pool Water Accident

NUS evaluated the effects of a loss of pool water in the Fuel Storage Pool (Ref. 9). The evaluation considered fuel criticality due to the loss of pool water and the effects on k-effective for fuel in their normal positions in the pool. The final maximum k-effective is 0.9509 at the optimum water density of 0.15 g/cc with a 95% confidence level. This value meets the ANSI/ANS-57.3-1983 k-effective criteria of 0.98 for dry storage under optimum moderation conditions.

Based on these analyses, CECo concluded a loss of pool water would not cause a criticality configuration in the pool.

5.2.2 Criticality Analysis - Mechanical Failure Accident

NUS also evaluated the case where the fuel geometry changes (due to a seismic event) with a full pool water condition, to cause all 16 fuel assemblies in a rack to form a tight 2 x 8 array without any water space between them. The final maximum k-effective is 0.9015 with a 95% confidence level and it meets the ANSI/ANS-57.2-1983 k-effective criteria of 0.95 for wet storage. A mechanical failure accident with the complete loss of pool water gives a maximum k-effective which is less than that (0.9509) given previously for the loss of pool water accident alone and therefore is not limiting.

5.2.3 Fuel Rod Rupture Analysis - Seismic Event

NUS analyzed the case for a seismic event that causes a complete loss of fuel pool water and all fuel rods to rupture releasing their complete inventory of Kr-85 (estimated to be 360,000 curies in 1987). Using standard dispersion calculations for the gamma dose that would be received at the nearest site boundary (1,450 feet from the spent fuel pool), in unfavorable weather conditions (stability category F with a wind speed of 1 meter per second), and a X/Q value of 3.5 x 10-3, NUS determined that the dose would be less than 1 Rem. One Rem is the Environmental Protection Agency's lower Protective Action Guide (PAG) below which no countermeasures are required to protect the public. Therefore, an earthquake with loss of fuel pool cooling water would lead to a gamma dose which would have a very small effect on the health and safety of the public.

NUS estimated that approximately 800 curies of tritium could escape to the atmosphere if all fuel rods were to rupture. Similar calculations show that any skin dose accumulated at the site boundary would be orders of magnitude below the threshold for any skin damage. If tritium is inhaled, the dose received by the thyroid, whole body, and other organs has a calculated upper bound of about 0.1 Rem, corresponding to the worst case assumption of all the fuel rods rupturing.

Based on these analyses, CECo concluded the fuel could withstand postulated accidents during the SAFSTOR dormancy period.

5.2.4 Site Flooding

The possibility of flooding on this site is remote since the elevation is 516 feet above datum, which is 7 feet above the flood elevation that has been experienced at the Dresden Dam.

5.2.5 Fires

The Dresden 1 Fire Protection System will be maintained operational during SAFSTOR and therefore Unit 1 will be fully protected in the event of a fire. The Fire Protection system will continue to be a local extinguisher program.

5.3 NOISE AND TRAFFIC

The noise and traffic during Dresden 1 SAFSTOR dormancy will be minimal since the primary activity will be from operation of Units 2 and 3. Since only a small number of Unit 1 systems are operating, the noise level will be unnoticeable. There is virtually no traffic associated with Unit 1 during dormancy. The overall effect of Unit 1 remaining in the SAFSTOR mode is insignificant to the environment.

5.4 VISUAL AESTHETICS

There will be no change to the aesthetics of the site, and accordingly, no environmental effect since the Dresden 1 structures will not be removed.

5.5 ADVERSE ENVIRONMENTAL EFFECTS

Because Dresden 1 is located on an active site with Units 2 and 3, there will continue to be restricted public access to the site during SAFSTOR. Accordingly, there will be no additional adverse environmental effects during SAFSTOR.

5.6 RELATIONSHIP BETWEEN SHORT TERM USE AND LONG TERM PRODUCTIVITY

The location of Unit 1 adjacent to operating Units 2 and 3 precludes the practicality of releasing portions of Unit 1 for unrestricted access. Furthermore, because spent fuel is stored in the Unit 1 Fuel Handling Building, the facility structures cannot be released for unrestricted access in the near future. CECo intends to continue to use the site for power generation for the next 18 years of Unit 2 and 3 operation and may extend its life thereafter as permitted by license extension. Consequently, there is no conflict in short-term use versus long-term productivity.

Upon ultimate shutdown of Units 2 and 3, the land and site at Dresden could be released for unrestricted use following total dismantling of all Unit 1, 2 and 3 structures. The economic, radiological and practical considerations associated with the decision to totally dismantle Units 1, 2 and 3 will be evaluated in detail as Units 2 and 3 near the end of their useful lives. The economic factors must weigh the cost of refurbishment of Units 2 and 3 versus the expected life extension that can be achieved relative to future forms of power production. If future power generation technologies require extensive land requirements, total dismantling of the facility may be necessary. Delay of dismantling these units will permit the decay of radionuclides contained in the systems and materials, thereby reducing the radiation exposure to workers. Delay in dismantling will allow more time for technological improvements over the next several decades in the areas of robotics, radiological waste volume reduction, transportation and disposal. These advanced techniques could further reduce radiation exposures, radwaste volume and cost.

5.7 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The proposed decommissioning alternative of SAFSTOR with Delayed Dismantling would not involve the immediate commitment of any significant resources except for the Dresden 1 land area. As noted earlier, this land could ultimately be returned to unrestricted use following decommissioning and dismantling of all structures and backfilling subgrade voids. Delay of dismantling of Dresden 1 would reduce the volume of radioactive waste as compared to DECON, and therefore would reduce the commitment of resources.

5.8 RADIOLOGICAL AND ALARA BENEFITS

Numerous radiological and ALARA benefits result from the continued SAFSTOR status of Dresden 1, followed by eventual DECON. Experience gained from dismantling other utility sites, technological advances in the area of remote handling/robotics, and the handling of radwaste should reduce the radiation exposure to personnel involved in the eventual removal of residual radioactivity and equipment disassembly.

Delaying the final decommissioning (DECON) of Dresden 1 until the Unit 2/Unit 3 retirement date will lower the gamma radiation of the activated steel components in the reactor by a factor of approximately 48.6 (the primary gamma emitter being Co-60 with a half-life of 5.27 years). Likewise, the total activity will be reduced by a factor of 39.4 over the same period. Therefore, a similar reduction in total exposure to decontamination and dismantling workers can be expected.

Advances in the handling, packaging, shipping, and compaction of radwaste should reduce the volume of radioactive waste associated with the dismantling and decontamination.

6. INVENTORIES

Detailed radionuclide concentrations of residual contamination in corrosion films, radionuclide inventories in various operating systems, and total radionuclide inventory are shown in the Decommissioning Program Plan (Ref. 1), Tables 5.1, 5.2, and 5.3, respectively. A preliminary estimate of the inventory of neutron activated parts is shown in Table 5.4, the radionuclide concentrations in concrete core segments is shown in Table 5.5 and the radionuclide concentrations in selected on-site soils is shown in Table 5.6 of the same Plan. An isotopic neutron activation analysis of the reactor vessel and internals was performed by TLG Engineering, Inc. in January, 1988. The results of this analysis are shown in Table 6.1, herein.

TABLE 6.1
ISOTOPIC INVENTORY OF NEUTRON ACTIVATED COMPONENTS
(as of January 1, 1988)

Component	Volume of material, cubic m	Mass of material, kilograms	H-3 Ci	C-14 Ci	Ca-41 Ci	Mn-54 Ci	Fe-55 Ci	Co-60 Ci	Ni-59 Ci	Ni-63 Ci	Zn-65 Ci	Nb-94 Ci	Mo-93 Ci	Tc-99 Ci	Ag-108m Ci	Ba-133 Ci	Eu-152 Ci	Eu-154 Ci	TOTALS Ci
Thermal shield	2.069	16,220.0	28.9	26.2	0.0	13.6	27,612.6	50,068.1	7.1	1,104.2	0.0	0.5	5.1	0.8	0.6	7.3	0.0	0.6	78,870.7
In-core guide tubes	0.019	145.1	3.1	2.8	0.0	1.5	2,960.0	5,367.2	0.8	118.4	0.0	0.0	0.5	0.1	0.1	0.2	0.0	0.1	8,454.9
Turning vane assembly	0.260	2,041.0	2.2	2.0	0.0	1.0	2,081.8	3,774.8	0.5	83.3	0.0	0.0	0.4	0.1	0.0	0.2	0.0	0.0	5,946.4
Turning vane guide post	0.046	362.9	1.9	1.8	0.0	0.9	1,850.8	3,355.9	0.5	74.0	0.0	0.0	0.3	0.1	0.0	0.2	0.0	0.0	5,286.5
Steam deflector support	0.868	6,804.0	0.7	0.7	0.0	0.3	694.0	1,258.4	0.2	27.8	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	1,982.3
Top grid assembly	0.327	2,563.0	13.7	12.4	0.0	6.4	13,071.3	23,701.3	3.4	522.7	0.0	0.2	2.4	0.4	0.3	1.1	0.0	0.3	37,336.0
Core plate	0.368	2,882.0	30.8	27.9	0.0	14.4	29,396.4	53,302.6	7.6	1,175.6	0.1	0.5	5.4	0.9	0.7	2.4	0.0	0.6	83,965.8
Bottom support grid	0.376	2,951.0	31.5	28.6	0.0	14.8	30,100.2	54,578.7	7.8	1,203.7	0.1	0.5	5.6	0.9	0.7	2.5	0.0	0.6	85,976.1
Bottom core support structure	1.114	8,732.0	93.3	84.5	0.0	43.7	89,066.4	161,498.3	23.0	3,561.8	0.2	1.5	16.5	2.7	2.1	7.3	0.0	1.8	254,403.1
Control rod guide tubes	0.440	3,453.0	15.0	13.6	0.0	7.0	14,323.0	25,971.0	3.7	572.8	0.0	0.2	2.6	0.4	0.3	1.2	0.0	0.3	40,911.3
Diffuser basket	0.486	3,810.0	4.5	4.1	0.0	2.1	4,274.8	7,751.3	1.1	171.0	0.0	0.1	0.8	0.1	0.1	0.4	0.0	0.1	12,210.3
CRD housing support tubes	1.203	9,435.0	2.0	1.8	0.0	0.9	1,924.7	3,490.0	0.5	77.0	0.0	0.0	0.4	0.1	0.0	0.2	0.0	0.0	5,497.7
Internal water seal	0.385	3,018.0	0.1	0.1	0.0	0.1	102.7	186.2	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	293.3
Reactor vessel clad	0.722	5,700.4	0.3	0.3	0.0	0.1	250.2	532.3	1.3	191.5	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	976.0
Reactor vessel	10.521	82,788.0	1.3	0.1	0.0	0.3	616.4	91.6	0.1	22.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	732.6
Bioshield steel wall	0.299	2,363.6	0.0	0.0	0.0	0.0	4.7	10.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.4
Bioshield sand	102.584	184,658.0	186.4	0.1	0.0	0.0	17.9	5.7	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	12.7	1.3	224.3
Bioshield concrete	136.802	314,660.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
TOTALS	258.889	652,585.0	416.1	296.8	0.1	107.3	218,348.1	394,943.6	57.5	8,914.2	0.4	3.6	40.2	6.6	5.1	17.9	12.8	5.7	623,086.0

7. CONCLUSION

The foregoing assessment provided the basis for CECo to recommend SAFSTOR with Delayed Dismantling for Dresden 1. Of necessity, the fuel will be stored in the Fuel Handling Building until a federal repository is available for disposal of the fuel. The environmental effects of this alternative are minimal. ENTOMB is not a viable alternative because of the presence of long lived radionuclides.

The SAFSTOR alternative (followed by Delayed Dismantling) can be readily implemented because CECo has extended its Dresden Units 2 and 3 Radiation Protection Program to include Unit 1, and the site security force and detection system incorporates the Unit 1 site as an integral part of the security system.

CECo has demonstrated the spent fuel stored in the spent fuel pool is adequately protected from the effects of natural phenomena. Analyses have shown the fuel will not go critical, nor will it result in a release of radioactive gases that exceeds EPA Protective Action Guides from the effects of loss of pool cooling water and seismic effects on the fuel.

Delaying dismantling until Units 2 and 3 are retired allows the radioactivity in piping and components, and the vessel and associated components to decay to lower levels. This decay reduces the exposure to workers as compared to DECON, as well as the volume and cost of burial of radioactive waste.

Therefore, CECo's recommended alternative satisfies the necessary safety and environmental considerations with no known adverse effects.

8. REFERENCES

1. "Decommissioning Program Plan for the Dresden Nuclear Power Station Unit 1," December, 1987.

2. Environmental Report for Dresden Units 2 and 3.

3. Dresden Unit 1 Technical Specifications (Proposed).

4. "Decommissioning Criteria for Nuclear Facilities," US Nuclear Regulatory Commission, Proposed Rules, Federal Register, Vol. 50, No.28, February 11,1985.

5. "Residual Radionuclide Contamination Within and Around Commercial Nuclear Power Plants," Prepared by Battelle Pacific Northwest Laboratory, NUREG/CR-4289, February, 1986.

6. Croff, A.G. "A User's Manual for the ORIGEN2 Computer Code," ORNL/TM-7175, Oak Ridge National Laboratory, July 1980.

7. "Decommissioning Study for the Dresden Nuclear Power Station Unit 1," prepared by TLG Engineering, Inc., C04-25-001, November, 1985.

8. "Final Report of the Chemical Cleaning of Dresden 1," prepared by IT Corporation and Commonwealth Research Corporation, DOE/ET-34205-34 May 1986.

9. "Criticality Analysis and Source Term Evaluation of Dresden-1 Spent Fuel Storage Pool Accidents," Prepared by NUS Corporation, CD-AnS-87-010, January 15, 1987.

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