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APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Kara M. Broz (signature)

Kara M. Broz

December 14, 1994

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7. Abstract

After review of the options available for current storage of T Plant Fuel the recommended option is wet storage without the use of chillers. A test has been completed that verifies the maximum temperature reached is below the industrial standard for storage of spent fuel. This option will be the least costly and still maintain the fuel in a safe environment. The options that were evaluated included dry storage with and without chillers, and wet storage with and without chillers. Due to the low decay heat of the Shippingport Core II Blanket fuel assemblies the fuel pool temperature will not exceed 100 deg. F.

8. RELEASE STAMP

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PWR Core II Blanket Fuel Disposition

Recommendation of Storage Option Study

Approval Designator
E^{co} SQ

APPROVALS:

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T PLANT MANAGER - MS WRIGHT	DATE	12-13-94

TABLE OF CONTENTS

1.0 OBJECTIVE

The objective of this option study is to determine the most cost effective and schedule conscious method for the current storage of the Shippingport Reactor Core II blanket fuel assemblies. This fuel is also referred to as the PWR Core II fuel. This study will deal with the current storage method only and the best option in meeting a Tri Party Agreement Milestone. Any interim storage or final disposition configuration is outside the scope of this study. The reason is in accordance with the Phase III of the Spent Nuclear Fuel Vulnerabilities Corrective Action Item Number 4-6 the fuel at T Plant long term storage plans will become part of the Hanford Fuel Integrated Management Plan.

1.1 BACKGROUND AND SCOPE

T Plant is located in the northeast corner of the 200 West Area which is located in the center of the Hanford Reservation. The T Plant complex consists of several buildings with the major structure being the 221T building commonly referred to as the T Plant Canyon. The canyon is made of reinforced concrete and is 850 feet long by 68 feet wide and 74 feet high and was built in the mid-1940's. The area inside the canyon consists of the canyon deck and galleries running along the full length of the east side. These galleries are the Electrical (bottom), Pipe(middle) and Operating (top). Above the operating gallery is the crane way where the controls for the bridge crane are located. The canyon deck consists of 40 cells and are grouped together in Sections. Each section consists of 2 cells labeled by the number of section and then based on its orientation as viewed from the gallery side (east side). For example, the left cell in the section number 5 is called 5L, and the right cell in section 12 is called 12R, etc. The first section at the far north end of the building is within the area known as "head end". The head end is separated from the main canyon with the use of a sheet metal wall.

Cell 2R is used as the pressurized water reactor (PWR) Core II Fuel Storage Cell. This cell contains seventy two fuel assemblies (142 5/16" x 7 1/2" square) under water. The water is approximately 19 feet deep and the pool is 27 feet 6 inches long by 13 feet wide by 28 feet deep. The fuel assemblies' radionuclides data is listed in Appendix A as well as in the T Plant Safety Analysis Report (SAR) WHC-SD-007. The pool is constructed of reinforced grey concrete, a membrane, and then white concrete. The pool area has been seismic qualified for an earthquake with a 0.09 g force.

The maintenance and storage of the fuel is supported by several subsystems. One of these subsystems for the pool is a filtration system for cleaning debris from the pool. The filtration system uses a submersible pump to recirculate the pool water through canisters. These canisters are equipped with either ten or three micron filters to remove debris and sedimentation from the pool water. Once a preset differential pressure is achieved the filters are replaced. The filters have shown an ability to control the Cobalt-60 activity within the pool. Another activity that is monitored frequently is Cesium-137. The normal range for the total activity in the pool has been between 1e-5 to 1.5e-4 microcurie per milliliter (uCi/ml). The total activity limit for the pool is 1×10^{-3} uCi/ml. Cobalt-60 has been the majority contributor to the total. Cesium-137 is monitored as the primary indicator to detect any fuel assembly breach. None has been detected in the fuel. The entire filtration system is located within the canyon.

The Ion Exchange Column System is used to maintain the chemistry of the pool water and aids in the filtration of the Cobalt-60. This system recirculates approximately 10 gallons per minute of water through a column filled with resins and charcoal. The following table lists the chemical parameters that are controlled by the use of the Ion Exchange Column.

Variable	Specification Limit	Normal Range
Chloride Ion Concentration	≤ 5 parts per million (ppm)	1 to 2 ppm
Conductivity	≤ 29 umhos/cm	22 to 27 umhos/cm
Phosphate Ion Concentration	< 2 ppm	< 1 ppm
Fluoride Ion Concentration	< 2 ppm	< 1 ppm
Nitrate Ion Concentration	< 2 ppm	< 1 ppm

The pool level is specified per the T Plant Operating Safety Requirements. The minimum level is 15'8" and is based on the shielding properties of the water. The normal operating range for the pool is between 18 and 19 feet. Water makeup is through a raw water supply that is sent through a deionizer prior to being discharged into the pool. The deionizers are replenished when the outlet conductivity is greater than a preset limit as displayed by a local alarm device.

The temperature of the pool is also a parameter that is measured for compliance with the T Plant OSD. The temperature of the pool has been maintained between the normal limits of 42 and 54 °F with the use of a refrigeration system. This system is depicted in Appendix B. The industrial standard for pool storage water temperature has been in this range for various reasons including precluding the growth of algae. The limit has been changed based on the experience of the Morris, IL facility and a recent test conducted by T Plant that successfully demonstrated the feasibility of pool operations without temperature control. Historically, T Plant has maintained the temperature of the water with the use of the chiller system. The chiller system and effects on the storage of the fuel is the discussion of this Option Study. Also discussed in this study is the option of storing the fuel in a dry atmosphere.

1.2 PURPOSE AND NEED

As depicted on Appendix B, the PWR Chiller Flow diagram, raw water is used as the transfer media for the heat generated in the pool to maintain the temperature between 42°F and 54°F. This water is currently being sent to Ditch 216-T-4-2 through T Plant's Chemical Sewer System. This discharge to Ditch 216-T-4-2 will need to cease in accordance with Tri Party Agreement Milestone M-17-41. Although Project W-049H will start to accept all liquid discharge from T Plant, this study will present options and attempt to derive the most cost effective method for dealing with this raw water source to Ditch 216-T-4-2. Although the water does not contact a contaminated portion of the PWR Chiller System it will require treatment as low level waste if it becomes part of the W-049H project. This study will determine the most cost effective and safest method to use for maintaining the fuel assemblies in a safe condition for workers, the environment, and general public.

2.0 SUMMARY

The four options for current fuel storage at T Plant were evaluated. These include wet vs dry fuel storage with chiller equipment or without chillers. All four options could be designed to place the fuel in an environmentally safe condition. However, once cost and schedule impacts are factored in, the most reasonable option has been determined to be where the fuel is stored wet without chillers. The chilling equipment that has been used for the past sixteen years will need to be placed in a zero energy state and the equipment abandoned in place until the facility is decommissioned, or future opportunities are presented to allow for complete system removal.

To stay consistent with the present T Plant OSDs, the corrective action for an outbreak of algae within the PWR Pool without chillers will be for T Plant Engineering to write a corrective action plan. Additional algae has not been detected since the beginning of the Chiller Off Test in May of 1994, so therefore algae is not expected to be a problem. Research has shown that various chemicals do readily exist that can be safely added in batch mode that will kill any potential algae growth in the PWR Pool. The resultant particulate can be filtered out of the water using the existing filtration systems.

3.0 RECOMMENDATIONS AND CONCLUSIONS

3.1 Recommendations

The recommendation of this study is to store the PWR Core II fuel in a water environment without chillers. Numerous reasons exist for this storage option. The following is a list of some of the more important reasons.

The most cost effective since no new equipment will be required and it will remove from service a major maintenance concern within T Plant.

The minimal effort for accomplishment will also be a cost savings and will be beneficial for the schedule compared to the other options.

This method will not have any major affects on operations at T Plant.

We have proven via a test that the fuel has a known heat generation rate and the temperature of the pool has been proven to stabilize below the new industrial standard (Morris, IL) during the hottest period of the Hanford summer time.

The equipment will be abandoned in place to minimize safety concerns regarding removal activities and placed in a zero energy state.

3.2 Conclusions

Once schedule, safety factors and cost were compared the most reasonable method for storage of the fuel is determined to be wet storage and removal of the requirement to maintain the chiller compressor system and reduced pool temperatures.

4.0 UNCERTAINTIES

With the removal from service the Chiller System, the temperature of the pool will fluctuate based on the ambient conditions within the canyon. Conductivity for the pool water has remained consistently between 22 and 27 micro ohms/cm. The industrial standard, Morris Facility, has a conductivity value less than 1 micro ohms/cm. T Plant's higher conductivity will allow for freer movement of electrons and will allow for greater galvanic corrosion. However, the slight temperature rise will only marginally affect this rate. The best way to prevent further corrosion by this means would be to improve the Ion Exchange system to decrease the conductivity within the pool to industrial standards. It is assumed in this option study that the slight increase in temperature will not increase the galvanic corrosion rates to an unacceptable level.

5.0 DESCRIPTION OF ALTERNATIVES AND SOLUTIONS

5.1 Criteria

A. Radiation levels in canyon/ALARA
B. Temperature of Fuel Elements acceptable
C. Cost of operation and maintenance
D. Seismic Qualified
E. Acceptable Safety Risks (minimal)
F. Capable of meeting the TPA Milestone M-17-41.

5.2 Assumptions

Elimination of the water discharge from the current Dunham-Bush PWR Pool Chiller Compressor System is required to support a Tri-Party Agreement . Additional assumptions can be made that the removal of the need for the chillers will provide substantive cost savings in operation of the new drain collection system installed under project W-291H and W-049.

5.3 Alternatives

5.3.1 Wet Pool Storage with New Air Cooled Chillers

A. Description

This system arrangement would be similar to the original PWR Pool Chiller System. The system under consideration would consist of two air cooled compressors pumping an environmentally safe refrigerant through the primary side of two heat exchangers in a closed loop. Two pumps would circulate the water from the pool through the secondary side of the heat exchangers to maintain the water temperature between 42 and 54 °F.

B. Advantages and Disadvantages

1. Advantages

With the pool maintained below 54 °F for the past sixteen years an established history exists that algae growth will not be a problem. The air cooled compressors would prevent water discharge to the environment. With new air cooled system the repair costs would be relatively low. A new system should also be more cost effective to run than the current system relative to the energy consumption. The environmentally safe coolant would also be advantageous for safety of the workers and the environment.

2. Disadvantages

This new system would require an extensive design and review effort. The procurement of the system, installation of the new compressors, and the startup of the units would cost a considerable expense and time investment. Kaiser Engineering preformed some initial design and material identification in March of 1992 with a rough estimate of $106,000. Any of the present affected equipment not compatible will have to be removed and replaced prior to the new system being installed.

C. Production and Programmatic Impacts

The new compressor installation will require factoring into existing FY95 performance schedules. Due to the location near the tunnel the canyon side installation of the system may affect the use of the tunnel for loading and unloading waste containers into the canyon. The proposed location of the chillers them self would be outside on the west side of the 221T facility.

D. Safety Considerations and Impacts

Removal of equipment located in and above the pool will involve an additional risk due to the location over water. Removal of the equipment in the galleries would be difficult due the lack of a permanent rigging equipment and remote location. If any of the canyon equipment is required to be removed/replaced the physical movement of these items while the fuel is in the current storage method will require evaluation for safety impacts. This is due to the concern of material dropping on the fuel elements and the risk of breaching integrity of the assemblies.

E. Environmental Impacts and Permitting Requirements

Impacts would be minimal due to the fact its basically a replacement of existing equipment. Provided the new coolant system will be environmentally safe, the environmental impacts in this area would also be minimal.

5.3.2 Wet Storage with No Chillers

A. Description

This option would maintain the fuel assemblies in water without an active chiller system. This option would allow for the natural convection and evaporative heat loss to maintain a safe pool water temperature. The temperature that the fuel would be stored at would need to be maintained at less than 100 °F in order to comply with the new industry standard.

B. Advantages and Disadvantages

1. Advantages

This system configuration would not include a refrigeration system. This would delete the need for the design, procurement, and associated installation costs for a new system. The costs for maintenance and operation of a refrigeration system would also be excluded. This option would also exclude any costs associated with treatment of liquid discharges if a system similar to the present design for compressors were to be used.

2. Disadvantages

The new industry standard for similar reactor core assembly storage has shown that elevated temperatures less than 100 °F will not adversely effect the fuel being stored however, T Plant chemistry parameters are outside the normal limits set forth in the standard. The overall conductivity of the water is higher than the norm and the limits set forth for pH range is larger than the standard. T Plant method for conductivity control is the use of a Ion Exchange Column. However the flow rate through the column is minimal and has not been adequate to decrease the conductivity even at lower temperatures. T Plant has no system available to control pH so this parameter is simply monitored for compliance with the OSD limits. Since the new plan is to extend the duration of fuel storage at T Plant beyond the original twenty (20) years, a new method of controlling conductivity will need to be investigated especially with elevated pool water temperatures.

The potential is greater for the development of an algae problem at elevated temperatures. This has not been experienced at the industry standard facility. T Plant has a limited experience running the pool at elevated temperatures. T Plant uses unfiltered inlet air to maintain the atmospheric conditions in the canyon similiar to the Morris Facility. No present means exists for controlling algae. A means of controlling the algae is a action Engineering is looking at to develop that would be satisfactory in the water and not adversely affect the fuel assemblies.

C. Production and Programmatic Impacts

This method will cost the least of all the options. It will basically isolate and de-energize the chiller system as it presently exists. The freon and oil and electrical connections will require removal, but the equipment will stay in place until the facility is decommissioned and demolished (D&D). This option will also have the most minimal programmatic effects on the operations at T Plant. All the work of removing the freon, oil and electrical connections is outside the canyon.

D. Safety Considerations and Impacts

By removing all energy sources to the compressors and pumps the equipment will be placed in the safest condition possible. By abandoning the equipment in place there will be no safety concerns with removing the equipment that is located over and in the pool.

E. Environmental Impacts and Permitting Requirements

The freon inside the compressors is not considered a hazardous waste. However, removal of the freon will help comply with the Clean Air Act. The compressor oil will need to be sampled and dispositioned accordingly. The elevated temperature at which the pool will run will not affect the overall temperature of the canyon and therefore will not effect the environment within the canyon.

5.3.3 Dry Storage with New Chilled Air System

A. Description

This option would involve draining the water from the pool and maintaining the fuel in dry storage. A newly designed cooling system would be required to circulate and cool the air flow through the fuel elements. The entire system would be inside the canyon located near the pool for contamination control reasons. The system would maintain the fuel elements at a temperature that is acceptable.

B. Advantages and Disadvantages

1. Advantages

This system design would remove the water based subsystems of the PWR Pool. These include the Ion Exchange Column, the Filtration System and the Chiller Water Pumps. A system like this would remove the sampling requirements for the pool water.

2. Disadvantages

This design would require the most changes to the present system. A new ventilation system would need to be designed, procured and installed into the pool area while the fuel is still being stored. A cooling system would be required that interfaces with the ventilation system. New sampling methods and parameters would need to be developed to ensure the fuel remains intact. Another concern with the dry storage method is the reduction in shielding that is provided by the water.

C. Production and Programmatic Impacts

Due to the large number of modifications to the pool area from this change, the production and programmatic impacts will be significant. The installation of the ventilation system and chiller system will disturb the area around the T Plant Tunnel, which is located in Section 2L. Since this is the area for transloading waste in and out of the canyon it would affect this operation.

D. Safety Considerations and Impacts

The installation of the ventilation ductwork and necessary equipment would be a increased exposure risk. (See Appendix C.) The installation of the ductwork would also probably involve work within the fuel cell. This is another safety concern due to access limitation of the cell area. Unless shielding was added to the top of the fuel cell after installation of the ventilation system the fuel would also increase the general area dose rate around the fuel cell.

E. Environmental Impacts and Permitting Requirements

The environmental impacts involved with T Plant going to a dry storage option for its storage method would be prohibitive in meeting the June 1995 TPA Milestone. The main reason for this would be the NEPA documentation that would be required as the change in the storage method will require the process to be completed. For example, Fast Flux Test Facility has been working on their NEPA paperwork for several years to move the sodium cooled fuel assemblies into a dry storage environment. Another consideration is the Environmental Impact Statement Record of Decision for the spent nuclear fuel program at all DOE complexes. This statement is in the review cycle and is not expected until June 1995. Once the statement is complete, which should indicate where all DOE SNF will be stored, Hanford will need to determine how the fuel Hanford will be responsible for is to be stored on an interim basis. Since this Record of Decision has not yet been completed the potential for long term storage of the Shippingport Core II Fuel at T Plant is still under discussion. Serious thought would be required as to the wisdom of expending the considerable manpower and expense required to develop an interim storage method for the Core II fuel while not knowing if, in fact, T Plant would be that interim storage facility.

5.3.4 Dry Storage with No Chillers

A. Description

This setup would involve draining all the water from the pool and allowing natural convective air currents to cool the fuel elements. The fuel elements would generate the necessary heat to cause natural currents through the elements. These currents would remove the heat from the elements and disperse the heat into the canyon environment to be drawn out with the existing ventilation system.

B. Advantages and Disadvantages

1. Advantages

This arrangement for storing the fuel would require almost zero support systems. The present configuration of the fuel should be adequate to allow natural air movement around the fuel to maintain surface temperatures within allowable values.

2. Disadvantages

The dose rate of the fuel has recently been measured using a Eberline RO-7 with the results shown in Appendix C. Without water for shielding, the dose rate around the pool would increase. Another disadvantage is a new means for sampling the effluent air would need to be developed. This would require a lot of research since no baseline has been developed to compare the results for compliance.

C. Production and Programmatic Impacts

The Tri Party Agreement for cessation of water is June 1995. A large change in production and programmatic plans would be required to ensure a safe and well thought out plan were available to implement this option. This is largely due to the fact that only the basic concepts have been discussed to this point.

D. Safety Considerations and Impacts

The increase dose rates around the pool would be a large safety consideration. The area around the pool is occupied by personnel during routine off loading of waste water to railcars and during transloading operations into the canyon of solid waste containers. The water in the pool also provides an additional means of slowing any material that is accidently dropped into the pool and helps protect the fuel assemblies integrity. This shielding would be lost and would need to be replaced by some means that would not interfere with the natural cooling of the fuel elements.

E. Environmental Impacts and Permitting Requirements

The environmental impacts involved with T Plant going to a dry storage option for its current storage method would be prohibitive to meet the June 1995 deadline. The main reason for this would be the NEPA documentation that would be required. This change in the storage method will require the process to be completed. For example, Fast Flux Test Facility has been working on their NEPA paperwork for years to move the sodium cooled fuel assemblies into a dry storage environment. They still have a considerable way to go to complete this necessary task. Another consideration is the Environmental Impact Statement Record of Decision for the programmatic spent nuclear fuel at all DOE complexes. This statement is in the review cycle and is not expected until June 1995. Once that is complete, which should indicate where all SNF will be stored, Hanford will need to determine how the fuel that Hanford is responsible for will be stored on an interim basis. Since this Record of Decision has not yet been completed the potential for long term storage of the Shippingport Core II Fuel at T Plant is still under discussion. It would be unwise to expend the manpower and cost to develop a interim storage method for the Core II fuel not knowing if in fact T Plant will be the interim storage facility.

The T Plant Safety Analysis Report will also require extensive documentation changes. These changes will require analysis to justify the changes in storage methods and the process used to go from the present wet storage to the new dry storage method. This would be a large undertaking.

6.0 DISCUSSION OF PREFERRED ALTERNATIVE/SOLUTION

The temperature of the pool has been allowed to raise above the limit of 54 °F for the performance of a test involving securing the chiller system. This was accomplished by securing the pumps and compressors and then monitoring the pool temperatures at various locations. The heat up rate of the approximately 50,000 gallons of pool water and the final equilibrium temperature were the major concern during the performance of this test. Also being monitored very closely is the potential growth of algae within the pool at the elevated temperature. Recent calculations have recently shown the Heat Generation rate of 100 watts per assembly. This value has been verified by testing. The temperature of the PWR pool achieved a maximum of 87.4 degrees Fahrenheit during the hottest portion of the summer. All chemical parameters were within limits.

Although a detailed cost analysis was not performed by this option study it is very evident that remaining in a wet storage without chillers is the most economical choice. The main reason for this conclusion is that this work would have to be done to perform the other options and since no new equipment will need to be designed, procured and installed under this option those costs are eliminated.

7.0 APPENDIXES

A. Fuel Assemblies Radionuclides
B. Flow Diagram of PWR Pool Subsystems
C. Dose Rates of PWR Fuel

8.0 RECOMMENDED OPTION WITH JUSTIFICATION AND SCHEDULE

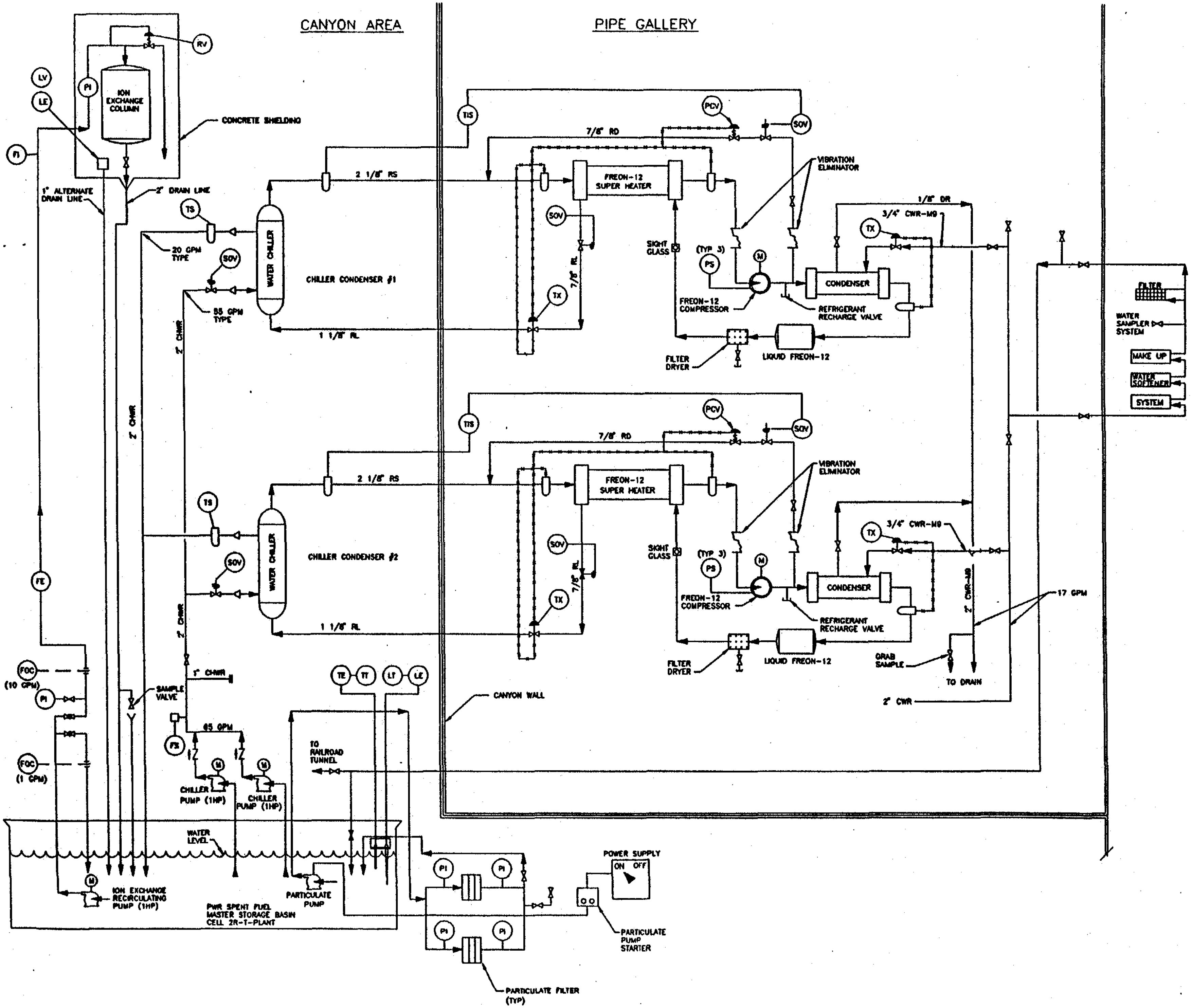
The recommended option from this study is to store the Shippingport Core II Fuel in a wet environment without chillers. This option is the most cost effective and has been proven acceptable by actual testing and calculations to demonstrate meeting the new industrial standard for temperature limits. The present schedule for implementation is to deactivate the compressors and pumps of the present system by March 30, 1995. An engineering work plan will be completed by the end of the calendar year 1994. This work plan will outline the necessary actions to deactivate the present system and ensure the safest and environmentally compatible system for storage of the PWR Core II fuel.

APPENDIX A
PWR Core II Fuel Assembly Data

Radionuclides Content - PWR-2 Blanket Assembly*

Radionuclides	Curies per Assembly
^{85}Kr	8.2×10^{2}
^{90}Sr	7.5×10^{3}
^{90}Y	7.5×10^{3}
^{106}Ru	1.4×10^{3}
^{106}Rh	1.4×10^{3}
^{125}Sb	1.5×10^{2}
^{125}Te	4.1×10^{1}
^{134}Cs	4.3×10^{2}
^{137}Cs	9.5×10^{3}
^{137}Ba	8.7×10^{3}
^{144}Ce	1.5×10^{3}
^{144}Pr	1.5×10^{3}
^{147}Pm	8.5×10^{3}
^{151}Sm	2.4×10^{1}
^{154}Eu	7.9×10^{1}
^{155}Eu	4.3×10^{1}
TOTAL CURIES	4.9×10^{4}

* Decayed to 1978, four years post reactor discharge



APPENDIX B

WHC-SD-WM-ES-330
page 16 of 17

APPENDIX C
DOSE RATES OF PWR FUEL ON CONTACT
All Reading in R/hr

Columns of Fuel Assemblies

Depth	North Wall	1	2	3	4	5	6	7	8	9	10
Top											
1 foot	200				120						60
2 feet	380										
3 feet	490				300		40				
4 feet											
5 feet	600				300		130				240
6 feet											310
7 feet	670				250		200				290
8 feet											70
9 feet	270				100		80				
10 feet	30				50		30				30

These readings are taken from the cat walk area on the west end of the fuel assemblies. The Eberline RO-7 is an order of magnitude instrument and is not normally calibrated due to the high range of readings.

The readings along the north wall are higher due to the fact the probe was able to be closer to the fuel assemblies. The other readings are taken at the centerline of the assembly columns. The support structure prevented the probe from coming within contact of the assemblies.