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EPA Superfund Record of Decision:

Oak Ridge Reservation (USDOE)
Molten Salt Reactor Experiment (MSRE) Facility
Oak Ridge, TN
7/7/1998

OU #41

DOE/OR/02-1671&D2

Record of Decision for Interim Action to Remove Fuel and Flush Salts from the Molten Salt Reactor Experiment Facility at the Oak Ridge National Laboratory, Oak Ridge, Tennessee

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Prepared for the
U.S. Department of Energy
Office of Environmental Management

Environmental Management Activities at the
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831
managed by
Bechtel Jacobs Company LLC
for the
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under contract DE-AC05-98OR22700

PREFACE

This *Record of Decision for Interim Action to Remove Fuel and Flush Salts from the Molten Salt Reactor Experiment Facility at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/02-1671&D2) was prepared in accordance with requirements under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980. The U.S. Department of Energy, U.S. Environmental Protection Agency, and the state of Tennessee agree here to select the action for removing fuel and flush salts and placing the salt in a more controlled storage condition until final disposition of the salt is arranged. Work on this task was performed under Work Breakdown Structure 1.4.12.6.2.01 (Activity Data Sheet 3700, "Molten Salt Reactor Experiment D&D Support"). This document presents a description of the selected remedy, which includes removing flush salt and fuel salt from their respective storage containers in the Molten Salt Reactor Experiment facility, removing uranium from the salts, treating the uranium to form an oxide for safer storage, placing the uranium oxide into storage, containerizing the fuel and flush salts without uranium, and temporarily storing this salt at the Oak Ridge National Laboratory until final disposition of the salt. This document relies on and is consistent with information in the *Feasibility Study for Fuel and Flush Salt Removal from the Molten Salt Reactor Experiment at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/02-1559&D2), the *Interim Action Proposed Plan for Fuel and Flush Salt Disposition from the Molten Salt Reactor Experiment, Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/02-1601&D3), and *Evaluation of the U.S. Department of Energy's Alternatives for the Removal and Disposition of Molten Salt Reactor Experiment Fluoride Salts* prepared by the National Research Council in 1997.

ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
Be	beryllium
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
Ci	curie
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FS	feasibility study
ft	foot
g	gram
HF	hydrogen fluoride
kg	kilogram
km	kilometer
lb	pound
Li	lithium
m	meter
MSRE	Molten Salt Reactor Experiment
NEPA	National Environmental Policy Act of 1969
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
ppm	parts per million
ROD	record of decision
TDEC	Tennessee Department of Environment and Conservation
TRU	transuranic
U	uranium
UF_4	uranium tetrafluoride
WIPP	Waste Isolation Pilot Plant
Zr	zirconium

PART 1. DECLARATION

SITE NAME AND LOCATION

U.S. Department of Energy
Oak Ridge Reservation
Molten Salt Reactor Experiment Facility—Building 7503
Molten Salt Reactor Experiment Decontamination and Decommissioning Support
Oak Ridge, Tennessee

STATEMENT OF BASIS AND PURPOSE

This record of decision (ROD) presents the selected interim remedial action for addressing fuel and flush fluoride salts from three drain tanks formerly used as part of the Molten Salt Reactor Experiment (MSRE). The tanks are located in the MSRE facility (Building 7503) at the Oak Ridge National Laboratory (ORNL) on the U.S. Department of Energy (DOE) Oak Ridge Reservation (ORR). Remediating the MSRE facility is a high priority because of the unacceptable risk associated with the highly radioactive salt stored in the drain tanks. The location, condition, and age of the equipment connected to the tanks and the chemistry of the salt make control of safety factors difficult. The objective of this interim action is to reduce potential on- and off-site risk from the salt.

This interim action was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (42 *United States Code*, Sect. 9601 et seq.) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (40 *Code of Federal Regulations* 300). The ROD is based on the Administrative Record for this site.

DOE issues this document as the lead agency. The U.S. Environmental Protection Agency (EPA) and the Tennessee Department of Environment and Conservation (TDEC) are support agencies as parties to the Federal Facility Agreement (FFA) for this response action. DOE and EPA have jointly selected the remedy for the MSRE fuel and flush salts removal. TDEC concurs with the selected remedy.

ASSESSMENT OF THE STUDY AREA/OPERABLE UNIT

A streamlined risk assessment was conducted to determine whether current or future remedial actions are necessary to protect human health and the environment if current institutional controls are removed. The scenarios considered include on- and off-site receptors. The risk assessment demonstrates that without institutional controls the salts in the MSRE drain tanks pose an unacceptable risk to human health and the environment now and in the future. Thus a response action is required to address the salt stored in the three drain tanks at the MSRE facility. The objective of this interim action is to reduce current potential on- and off-site risk from the salts, pending final action.

Actual or threatened releases of hazardous substances from the MSRE facility that are not addressed by implementing the response action selected in this ROD may present an unacceptable risk to public health, welfare, and the environment.

DESCRIPTION OF SELECTED REMEDY

The selected interim remedial action includes melting and chemically treating the salt in the drain tank cell, separating the uranium from the salts, transferring the uranium to the ^{233}U repository at ORNL, packaging the residual salt, and placing the salt in interim storage at ORNL until arrangements are made for final disposition. Specific details and methods for this interim remedial action will be included in the remedial design and remedial action plans. As the salt melts in a drain tank, the molten salt will be treated with hydrogen fluoride (HF) to balance salt chemistry. The uranium in the salts will then be removed from the salt and converted to an oxide that is chemically stable and compatible with long-term storage at the ^{233}U repository at ORNL Building 3019 and managed as a part of the existing ^{233}U repository inventory. The residual salt will be stabilized/packaged to control fluorine gas generation and the containers placed in interim storage. The location of interim storage will be at an existing storage facility at ORNL. Placement of the salt for its final disposition will be documented in a subsequent final CERCLA decision document and, as appropriate, a National Environmental Policy Act of 1969 (NEPA) decision document. These future decisions will incorporate full public participation and will be based on the existing feasibility study (FS).

After removal of salts from the MSRE drain tanks, the tanks and associated equipment will be managed in place as part of the facility maintenance program. The storage tanks and reactor components will be addressed as part of a subsequent decontamination and decommissioning (D&D) action of the building.

STATUTORY DETERMINATIONS

This interim action protects human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate requirements (ARARs), and is cost-effective. Within its limited scope, this interim action uses permanent solutions and alternative treatment technologies to the maximum extent practicable by removing the salts from the MSRE drain tanks, treating the salts to remove the uranium, and stabilizing/packaging the salts for final disposition. Therefore, the selected interim remedy satisfies the statutory preference for remedies employing treatments that reduce toxicity, mobility, or volume as a principal element. Disposal and, if necessary, further treatment of MSRE salts after the uranium has been removed will be performed as part of another action. This interim action addresses the principal threat from criticality or release of contaminants into the environment posed by the salts stored in the MSRE drain tanks. Removal of radioactive salts will permit the remaining structures to be included in a later action. Because this is an interim action ROD, review of this facility will continue as DOE develops final remedial alternatives for D&D of Building 7503.

APPROVALS

6/22/98

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U.S. Department of Energy
Oak Ridge Operations

Date

6/24/98

Earl C. Leming, Director
U.S. Department of Energy Oversight Division
Tennessee Department of Environment and Conservation

Date

7/7/98

Richard D. Green, Director
Waste Management Division
U.S. Environmental Protection Agency—Region 4

Date

PART 2. DECISION SUMMARY

SITE NAME AND LOCATION

The MSRE site is located in Roane County, Tennessee, on the DOE ORR approximately 1 km (0.6 miles) south of the ORNL main plant across Haw Ridge in Melton Valley. The ORNL main plant is approximately 24 km (15 miles) west of Knoxville, Tennessee, and 16 km (10 miles) southwest of the Oak Ridge, Tennessee, business center (Fig. 2.1).

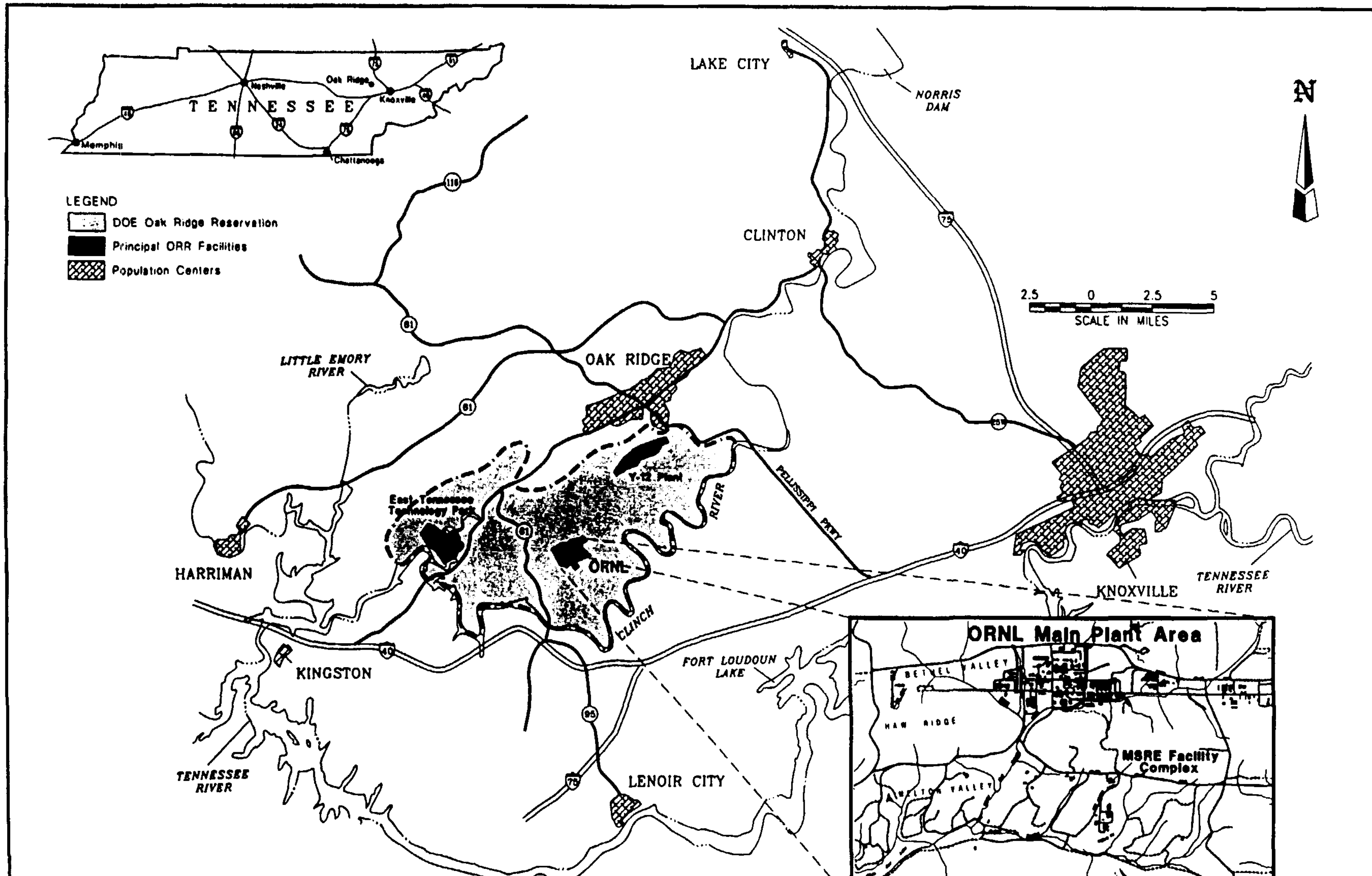
The MSRE reactor and associated components are located in cells beneath the floor in the high-bay area of Building 7503. The MSRE site with Building 7503 and other support buildings are located at the intersection of Melton Valley Road and High Flux Isotope Reactor Access Road (Fig. 2.2).

SITE DESCRIPTION, HISTORY, AND ENFORCEMENT ACTIVITIES

Building 7503 was constructed in 1951 to contain the Aircraft Reactor Experiment and expanded in 1955 for the Aircraft Reactor Test, which was canceled in September 1957. In 1961, experimentation on a molten salt reactor was revived at MSRE to develop a commercial molten salt breeder reactor. Adjacent buildings supported the MSRE operation. The reactor, using ^{235}U as fuel, achieved criticality on June 1, 1965. In August 1968, the ^{235}U fuel was replaced with ^{233}U. The reactor operation permanently shut down December 12, 1969.

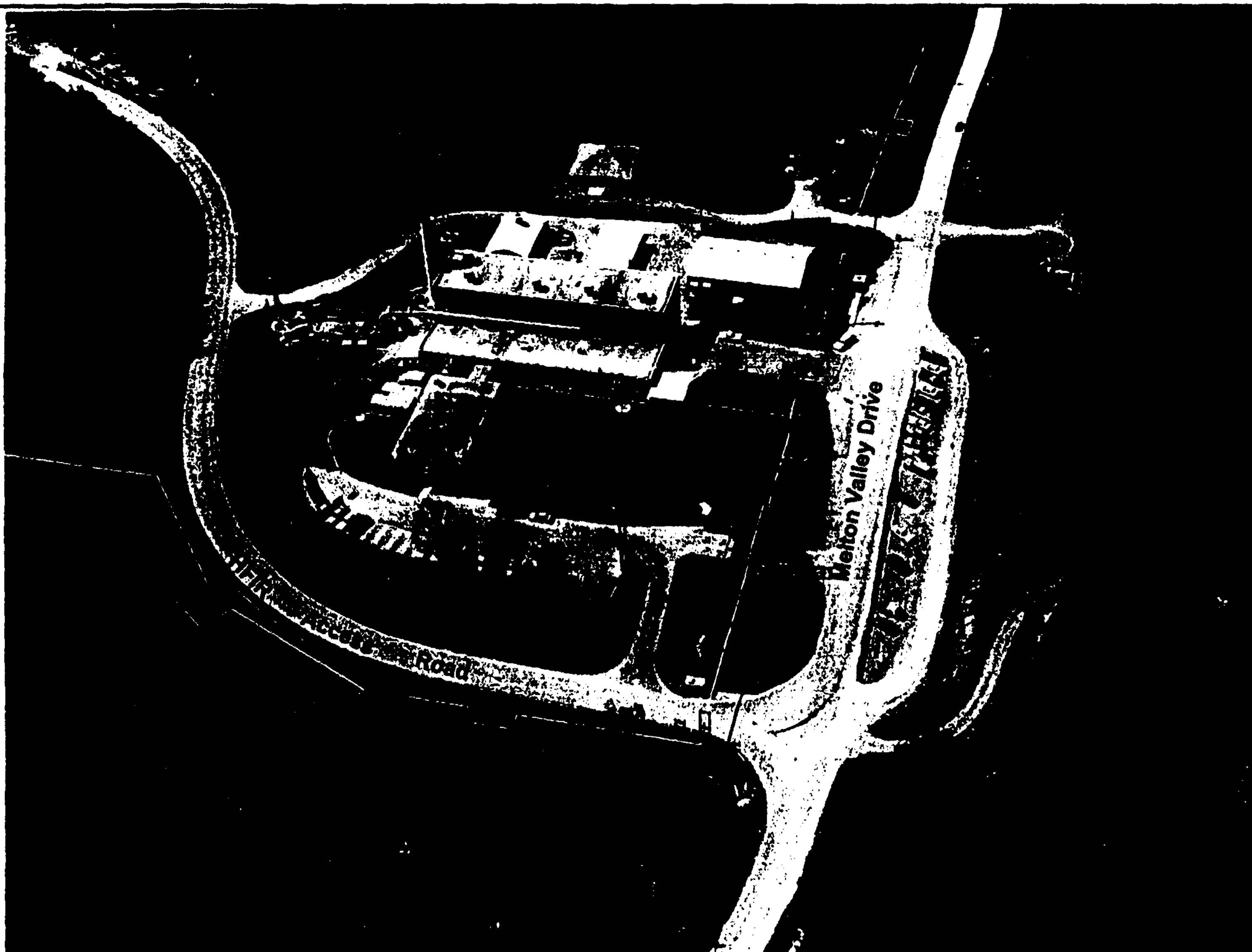
The MSRE reactor loop consisted of a reactor vessel, primary heat exchanger, pump, associated piping, and an off-gas system (Fig. 2.3). During operation, the fluoride salt mixture containing uranium fuel was heated to a liquid state. The molten salt was transferred from the fuel drain tanks into the reactor circuit and criticality would occur in the reactor vessel. Fuel salt, further heated by the nuclear reaction, exited the reactor vessel to the heat exchanger to transfer excess heat to a secondary fluoride coolant salt. When the reactor was shut down, fuel salt was removed from the reactor circuit by allowing it to drain by gravity back into the fuel drain tanks. To remove residual fuel salt from the reactor circuit, molten flush salt was circulated through the reactor circuit and returned to the flush salt drain tank. At the time operations ceased, the fuel and flush salts were allowed to cool and solidify in the drain tanks.

The fluoride salt used for the fuel and flush salts in MSRE is generally similar except for the uranium fuel and other radionuclide content differences. After shutdown, the fluoride fuel salt and possibly the flush salt released fluorine and uranium hexafluoride gases into the drain

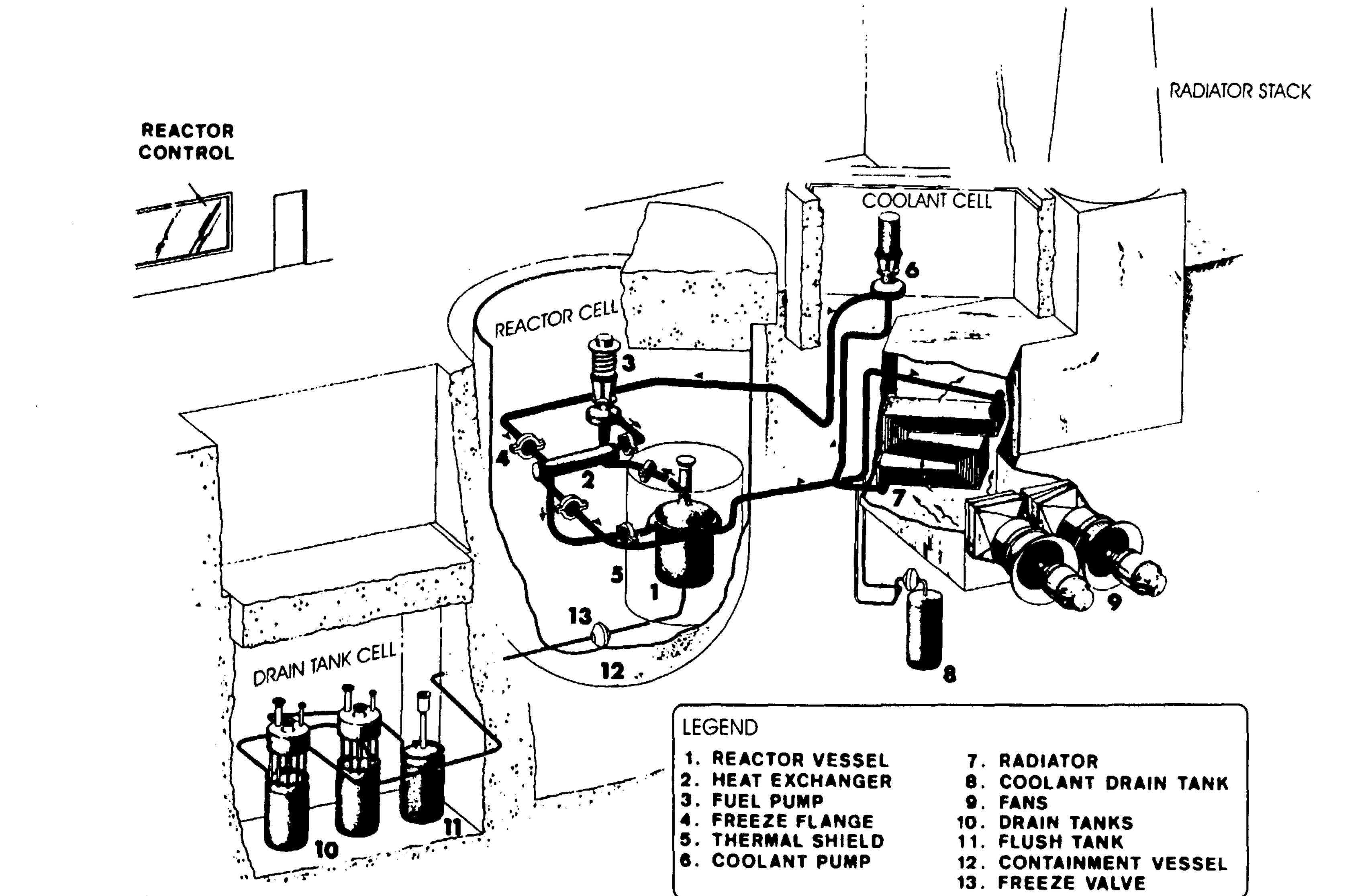


MODIFIED FROM DOE 1993.

JE	Fig. 2.1	**DOE Oak Ridge Reservation and vicinity** DOE - ORNL, Molten Salt Reactor Experiment - Oak Ridge, Tennessee	DOCUMENT ID 35H830 0086-40 / MSRE	DRAWING ID: 97-14236DWG	DRAWING DATE: FEBRUARY 10, 1998 SB



JE **Fig. 2.2**	**Aerial photograph of the MSRE site** DOE - ORNL, Molten Salt Reactor Experiment - Oak Ridge, Tennessee	DOCUMENT ID: 35H830 0086-50 / ROD	DRAWING ID: 97-15471.CDR	DRAWING DATE: FEBRUARY 10, 1998 SB



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JE Fig. 2.3	**Simplified MSRE flow diagram of primary and secondary reactor circuits** DOE - ORNL, Molten Salt Reactor Experiment - Oak Ridge, Tennessee	DOCUMENT ID: 35H830 0086-50 / ROD	DRAWING ID: 97-15472.CDR	DRAWING DATE: FEBRUARY 10, 1998 SB

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tank head spaces and associated off-gas system. Fluorine generation was expected based on knowledge about the chemical stability of fluoride salt. An annealing process was part of shutdown procedures between 1971 and 1989. This process heated fuel salt to below melting temperatures to force the fluorine in the salt matrix to recombine before it would migrate from the salt. It appears that during the annealing process, unknown to operators, uranium hexafluoride gas was formed and liberated from the salt.

In 1994, investigation of the MSRE site indicated that anomalous levels of uranium hexafluoride and fluorine gases were present throughout the off-gas piping connected to the fuel and flush salt drain tanks. In addition, uranium had migrated through the off-gas system to an auxiliary charcoal bed that resulted in a criticality concern because of the quantity of uranium detected. Interim corrective measures were immediately taken to ensure the safety of workers and personnel. Shortly afterwards, documentation of actions taken and continuing actions were included in a CERCLA time-critical removal action memorandum. A plan was then developed for remediating the MSRE site to reduce the risk presented by the continuing presence of the fuel and flush salts in storage at MSRE. Planners organized mitigation of the migrated MSRE uranium (as uranium hexafluoride) and fluorine gas into three separate CERCLA actions.

Time-Critical Removal Action. This CERCLA action, approved in July 1995 (DOE 1995), is completed. The interim corrective measures provided risk reduction for employees and workers at MSRE by addressing various aspects of containment, nuclear criticality control, and chemical reaction prevention. A reactive gas removal system, installed in 1996 as part of the time-critical action, continues to remove and trap uranium hexafluoride and fluorine gases from MSRE off-gas piping.

Non-Time-Critical Removal Action. Removal of the uranium deposit and associated fluorine contaminated charcoal from the auxiliary charcoal bed was approved as a CERCLA non-time-critical removal action (DOE 1996). Removal of uranium and fluorine contaminated charcoal is planned for completion in February 1999. This action will eliminate the potential of a criticality accident or chemical reaction in the charcoal bed cell and reduce the risk to human health and environment from exposure to the toxic and radioactive uranium.

Remedial Action. This ROD for interim action focuses on removal of fuel and flush salts from the MSRE drain tanks to eliminate the major source of contaminants for the MSRE site. Potential sources of uranium hexafluoride and fluorine gases will be eliminated from the drain tanks thereby reducing the risk to workers, employees, and the public. Contaminants that remain at the MSRE site following this interim action and their associated risks will be addressed in a subsequent CERCLA action. The fuel and flush salts from MSRE will be treated to reduce risks during storage while awaiting shipment for final disposition.

HIGHLIGHTS OF COMMUNITY PARTICIPATION

The interim action proposed plan for the MSRE site was released to the public in December 1997. This document is part of the Administrative Record for this decontamination and decommission action, which is maintained at the DOE Information Resource Center, 105 Broadway Avenue, Oak Ridge, Tennessee 37830. Notice of availability for this plan and other documents in the Administrative Record was published in *The Knoxville News-Sentinel* December 22, 1997, *The Oak Ridger* December 22, 1997, *The Roane County News* December 24, 1997, and *The Clinton Courier-News* December 24, 1997. The public comment period was held between December 23, 1997, and January 30, 1998. A public meeting held January 14, 1998, to discuss the proposed plan resulted in verbal comments. Two written comments were received during the public comment period. Responses to the written comments and verbal comments from the public meeting relating to this interim action are presented in Part 3, "Responsiveness Summary," of this document.

At the request of DOE, the National Research Council formed a committee of distinguished scientists and engineers in the spring of 1996 to review alternatives for removal and disposition of MSRE fluoride salts. The first of two public meetings held by the committee convened September 9 and 10, 1996, in Oak Ridge at the Garden Plaza Hotel. This meeting was advertised in local newspapers and was well attended by the public. The second public meeting was held October 8, 1996, in Washington D.C., to respond to questions previously raised by panel members. In February 1997, the National Research Council released their report (NRC 1997). Recommendations made in the report are consistent with alternatives presented in the FS and support the interim action approach recommended in the proposed plan and selected in this ROD.

SCOPE AND ROLE OF THE SITE INTERIM REMEDIAL ACTION

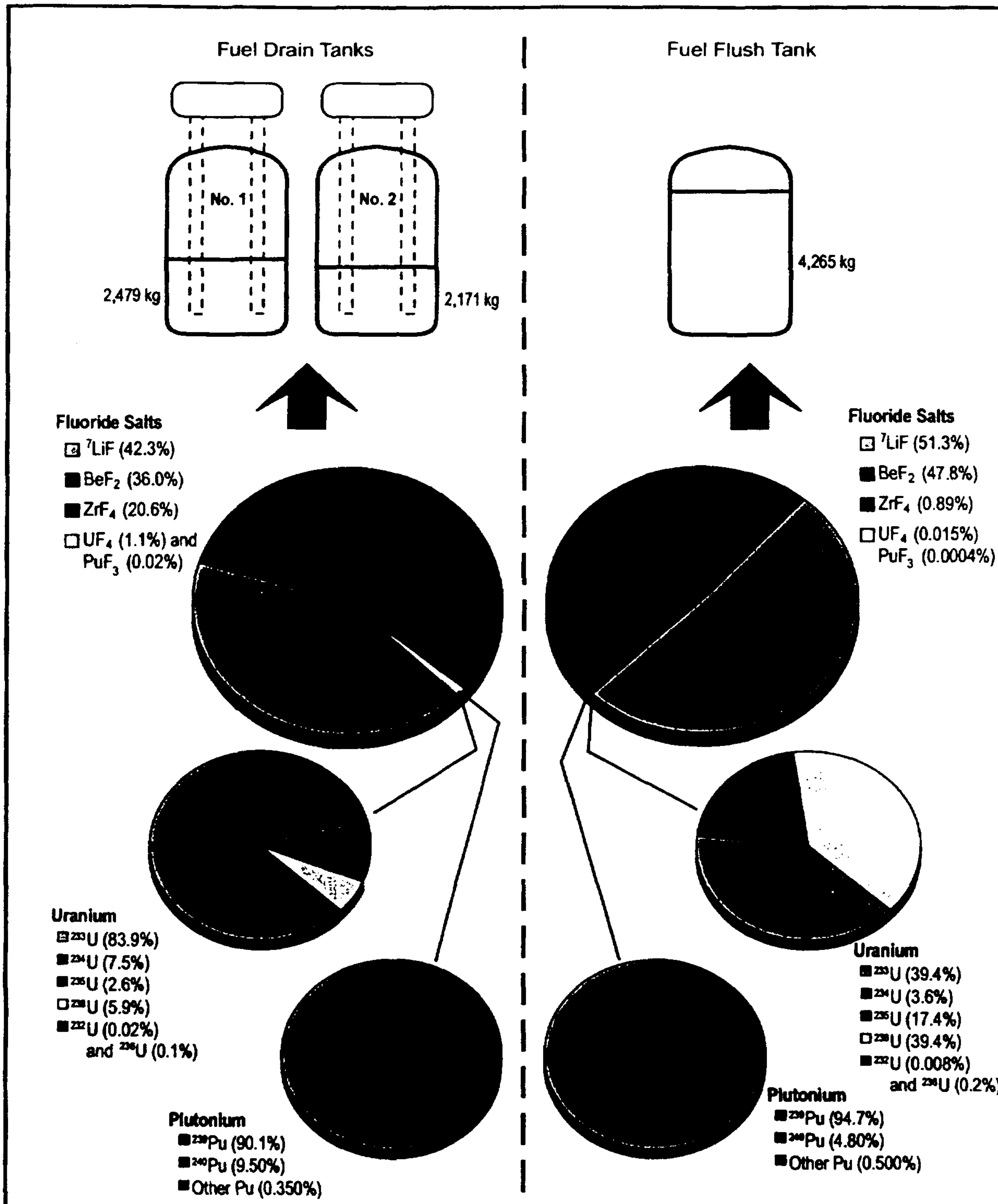
The scope of this interim remedial action is to remove the fuel and flush salts from the drain tanks, separate the uranium from the fuel and flush salts, convert the uranium to an oxide for storage as part of the existing ^{233}U repository inventory, stabilize/package the residual salt, and place the residual salt in interim storage until an end-point location is selected for final disposal. This interim action will eliminate the risk of a criticality incident and the hazards associated with uranium hexafluoride and fluorine gas release at the MSRE site. Decontamination and demolition of Building 7503 and the MSRE reactor components will be performed as part of a later, separate CERCLA final action. Ongoing management and final disposition of the uranium oxide will be determined pursuant to the program for managing the existing ^{233}U repository inventory (rather than further CERCLA action).

SUMMARY OF SITE CHARACTERISTICS

This remedial action addresses the two contaminated waste salts at the MSRE site—fuel salt and flush salt. The fuel and flush salts are stored in tanks in the drain tank cell below the floor of Building 7503. The fuel salt is divided between two drain tanks, and the flush salt is stored in one flush drain tank. All three tanks are similarly constructed; however, the fuel drain tanks are equipped with steam domes and thimbles to remove heat produced by radioactive decay. Heat production within the fuel salt is no longer a concern.

Both salts are composed of Li, Be, and Zr fluoride salts. The fuel and flush salts differ in the amount of fuel and fission products contained in each, and the fuel salts have a higher percentage of zirconium. The flush salt contains a small amount of the fuel and fission products because it was used to flush residual fuel salt out of the reactor and the associated piping system after the fuel salt was drained into the storage drain tanks. It is estimated that the flush salts contain approximately 500 g (1.1 lb) or 2.9 Ci of uranium and 13 g (< 0.1 lb) or 1 Ci of plutonium. Figure 2.4 describes the proportions of salts constituents at the end of reactor operation. Table 2.1 lists the salt weight, volume, and density, and Table 2.2 lists the principal isotopes in the salts after irradiation in the reactor. The mass of uranium in the fuel and flush salts shown in Table 2.2 [approximately 37.5 kg (82 lb)] represents the amount of uranium [1.1 percent of the fluoride salts as uranium tetrafluoride (UF_4)] that was transferred to the drain tanks at the end of reactor operation. Since reactor shutdown, uranium has migrated from the fuel salt to the drain tank head space, off-gas system, and an auxiliary charcoal bed in the form of uranium hexafluoride. The current mass of uranium in the fuel salts is calculated to be approximately 20 kg (44 lb) (0.6 percent of the fluoride salts as UF_4).

Fluorine liberation from the salts has left metallic Li, Be, and Zr in the salt and created a net reducing condition in the salt. As a result the potential exists for uranium to precipitate during the melting process. The present reducing potential of the stored salt is latent because the metal is essentially immobile; however, once the salt is heated to melting temperatures, the reduction reaction may proceed. During melting, the reducing potential could cause up to 12 kg (26 lb) of uranium metal to precipitate and/or diffuse into the tank wall. This could result in a



Note: Does not include the ~2.7kg of fissionproducts.

Fig. 2.4

Composition of fuel and flush salts by weight percent

DOE - ORNL, Molten Salt Reactor Experiment - Oak Ridge, Tennessee

DOCUMENT ID: 35H830 0086-50 / R00	DRAWING ID: 97-15473.CDR	DRAWING DATE: FEBRUARY 17, 1998 SR

2. **Compliance with Applicable or Relevant and Appropriate Requirements**

On-site interim remedial actions under CERCLA are required to comply with only those ARARs specific to the interim action being implemented.

Alternative 2 would not trigger any location-specific ARARs because this alternative would not affect any sensitive resources. Water quality standards and Safe Drinking Water Act maximum contaminant levels (MCLs) (which could be ARARs for the groundwater and the springs during a final action) and other chemical-specific ARARs are outside the scope of this interim action because no actions will be taken to alter contamination levels. The final action for this site will be taken as part of the Upper EFPC ROD, which will address Union Valley groundwater. MCLs will be ARARs for setting cleanup goals for that action. Chapter 1200-1-13-.08(3)(a).(iv) of TDEC final Rule, "Inactive Hazardous Substance Site Remedial Action Program," effective February 19, 1994, requires institutional controls whenever a remedial action does not address concentrations of hazardous substances that pose or may pose an unreasonable threat to public health, safety, or the environment. This rule, however, is applicable to actions "...consistent with a permanent remedy..." and is not applicable to this interim action. Alternative 2 is an administrative remedy for an interim action and, therefore, there are no location-, chemical-, or action-specific ARARs pertaining to the proposed actions.

A statutory requirement under CERCLA [Sect. 121(b)(1)] requiring protection of human health and the environment would not be met by the no action alternative without some assurance that exposure pathways would remain incomplete in the future.

BALANCING CRITERIA

3. **Long-Term Effectiveness and Permanence**

For Alternative 2, long-term effectiveness is evaluated for the period beginning when initial institutional controls (i.e., executing license agreements) are implemented per this interim action ROD and ending when final remedial actions are implemented per the Upper EFPC CA ROD. The interim actions include notification by property owners of use or change of use of surface water or groundwater, prohibition of any unacceptable actions, and annual title searches and notifications by DOE as a due-diligence measure to identify undisclosed changes in ownership and remind owners of their obligations. These actions are considered very effective for this interim period.

Table 2.1. Primary inventory of stored fuel and flush salts, MSRE site, ORNL, Oak Ridge, Tennessee

Tank	Salt weight (kg)	Salt volume (m^3)	Salt volume (% of tank volume[a])	Salt density (g/cm^3 at 26°C)
Fuel salt				
Fuel Drain Tank 1	2,479	1.0	44	2.48
Fuel Drain Tank 2	2,172	0.9	39	
Total fuel salt in drain tanks	4,650	1.9	NA	
Flush salt				
Fuel Flush Tank	4,265	1.9	82.5	2.22[b]
Total				
All three tanks in the DTC	8,915	3.8	NA	NA

Source: Table 3 of Williams, D. F., G. D. Del Cul, and L. M. Toth. 1996. *A Descriptive Model of the Molten Salt Reactor Experiment After Shutdown: Review of FY 1995 Progress*, ORNL/TM-13142. Oak Ridge National Laboratory, Chemical Technology Division, Oak Ridge, TN., and Table 1 of ORNL. 1993. *Request for Nuclear Safety Review and Approval, MSRE Fuel and Flush Salt Storage*, Committee NSR No. 0039WM00013A. Oak Ridge, TN. The weight and volume estimates shown are those that best correspond to process history. ORNL (1993) provides a range of weights for the fuel and flush salts, the minimum of which corresponds to the weights in the above table. The maximum weight for the fuel salt is < 5 percent higher than the minimum; the maximum for the flush salt is < 1 percent higher.

[a]See Table B.2 of U.S. Department of Energy. 1997b. *Feasibility Study for Fuel and Flush Salt Removal from the Molten Salt Reactor Experiment at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1559&D2. Oak Ridge, TN.
[b]See also Table 8.1 of Thoma, R. E. 1971. *Molten Salt Reactor Program: Chemical Aspects of MSRE Operations*, ORNL-4658, UC-80-Reactor Technology. Oak Ridge, TN.

°C = degrees Celsius
cm = centimeter
DTC = drain tank cell
g = gram
kg = kilogram
< = less than
m = meter
MSRE = Molten Salt Reactor Experiment
NA = not applicable
ORNL = Oak Ridge National Laboratory
% = percent

nuclear criticality and the inability to remove the uranium from the drain tanks. The presence of zirconium in the salts may lessen the amount of uranium that is reduced. To prevent the uranium from precipitating and/or diffusing into the tank walls, the previously liberated fluorine will be replaced by bubbling HF through the salt during a gradual melting of the salt.

Table 2.2. Activity of principal isotopes in the fuel and flush salts, MSRE site, ORNL, Oak Ridge, Tennessee

Atomic no.	Symbol	Mass no.	Half-life	Activity (Ci) (December 1994)
		Fission products		
38	Strontium	90	28.5 years	7,550
39	Yttrium	90	2.7 days	7,550
40	Zirconium	93	1.5 E6 years	0.3
43	Technetium	99	2.1 E5 years	0.5
51	Antimony	125	2.73 years	1.0
52	Tellurium	125	58 days	0.3
55	Cesium	137	30 years	6,290
56	Barium	137*m*	2.6 m	5,940
61	Promethium	147	2.62 years	50.3
62	Samarium	151	90 years	121
63	Europium	152	13.3 years	1.5
		154	8.8 years	4.7
		155	4.96 years	9.3
			Total for fission products (2,711 g)	27,500
		Uranium isotopes[a]		
92	Uranium	232	70 years	135
		233	1.59 E5 years	302
		234	2.45 E5 years	17.4
			Total for uranium isotopes (37,548 g)	454.4

Atomic no.	Symbol	Mass no.	Half-life	Activity (Ci) (December 1994)
		Actinide decay daughters		
81	Thallium	208	3.05 m	50
82	Lead	209	3.25 hours	0.7
		212	10.6 hours	139
83	Bismuth	212	1.01 hours	139
		213	45.6 m	0.7
84	Polonium	212	45 seconds	89.1
		213	4 μs	0.7
		216	150 ms	139
85	Astatine	217	32 ms	0.7
86	Radon	220	55.6 seconds	139
87	Francium	221	4.9 m	0.7
88	Radium	224	3.66 days	139
		225	14.8 days	0.7
89	Actinium	225	10 days	0.7
90	Thorium	228	1.9 days	139
		229	7,300 years	0.7
			Total for actinide daughters (5.49 g)	979
		Transuranium and other isotopes[a]		
94	Plutonium	238	87.7 years	0.92
		239	24,110 years	41.7
		240	6,540 years	15.3
		241[b]	14.4 years	270
95	Americium	241	433 years	21.5
			Total for transuranics (737 g)	349.4

Table 2.2. (continued)

Source: Table 6 of Williams, D. F., G. D. Del Cul, and L. M. Toth. 1996. *A Descriptive Model of the Molten Salt Reactor Experiment After Shutdown: Review of FY 1995 Progress*, ORNL/TM-13142. Oak Ridge National Laboratory, Chemical Technology Division, Oak Ridge, TN. The principal isotopes listed are those with a current activity > 0.1 Ci. The total activity and weight for each isotope grouping includes other isotopes not listed here.

[a]Uranium and plutonium inventory values (except ^{232}U) are derived from isotopic analysis and are 3 to 5 percent lower than those calculated by Bell, M. J. 1970. *Calculated Radioactivity of the Molten Salt Reactor Experiment Fuel Salt*, ORNL/TM-2970. Oak Ridge National Laboratory, Oak Ridge, TN. All other projections are derived from the Bell discharge inventory.
[b]Plutonium-241 is not a TRU waste element because its half-life is < 20 years.

Ci = curie
g = gram
> = greater than
< = less than
m = meter
μs = microsecond
ms = millisecond
MSRE = Molten Salt Reactor Experiment
no. = number
ORNL = Oak Ridge National Laboratory
TRU = transuranic
U = uranium

SUMMARY OF SITE RISKS

Analysis shows that actual or threatened releases of hazardous substances from this site, if not addressed by the preferred alternative or another active measure, present a current or potential threat to public health, welfare, or the environment.

HUMAN HEALTH RISK

The streamlined risk assessment for the MSRE site evaluated two scenarios. A near-term scenario postulates an exposure that could occur in the next 100 years after institutional controls are lost. The other scenario postulates an exposure that could occur beyond 100 years. Included on the risk assessment are only contaminants of potential concern with a credible exposure pathway and long enough half-life to cause significant exposure if released. For the near-term scenario, a release to the environment (air) from a failure in the off-gas piping connected to the drain tanks was postulated. Contaminants of potential concern evaluated for this scenario included fluorine gas, uranium hexafluoride gas, and HF gas. For the second scenario, a criticality event was assumed to occur because of a failure in the drain tank cell and drain tanks. Contaminants of potential concern were postulated as being fission-product gases generated by a criticality event. Both scenarios evaluated the consequences to:

- an on-site receptor 100 m (328 ft) from the MSRE site and
- an off-site receptor 1,200 m (3,900 ft), the distance to the nearest public road, from the MSRE site.

The exposure pathways quantified in this assessment were based on the conceptual site model. The pathways included (1) a release of fluorine, uranium hexafluoride, and HF gases because of an off-gas piping failure, which results in passerby exposure through the inhalation and immersion pathways (near-term scenario) and (2) a criticality accident caused by a failure of the drain tank cell and drain tanks resulting in passerby exposure from inhalation and immersion in a cloud of radioactive gas (long-term scenario). No other exposure pathways were evaluated. Based on EPA guidance for streamlined risk assessments, there is no need to evaluate all pathways when risk is clearly exceeded by one exposure pathway.

The streamlined risk assessment showed that most of the estimated risks were above the 1×10^{-4} limit and were therefore unacceptable. For the near-term scenario, estimated risk for the on-site receptor is 5×10^{-1} and ranges from 3×10^{-3} to 2×10^{-2} for the off-site receptor. For the long-term scenario, the estimated risk for the criticality pathway is 1×10^{-2} for the on-site receptor and 3×10^{-5} for the off-site receptor.

ECOLOGICAL RISK

The ecological risk assessment evaluated the potential for adverse effects on the environment from exposure to contaminants in the MSRE drain tank cell. In the future, a potential breach in a drain tank and a failure of the drain tank cell could contaminate groundwater and surface water at nearby unnamed tributaries to White Oak Creek. The contaminated groundwater would adversely affect terrestrial plants and wildlife. Thus failure of the fuel flush tank or fuel drain tanks and the drain tank cell would adversely impact terrestrial plants and wildlife. This scenario would also pose a risk to aquatic communities in nearby tributaries. Aquatic receptors could be directly exposed by contact with and ingestion of contaminated water and sediment. Terrestrial wildlife could also ingest contaminated surface water. Terrestrial flora could be exposed to contaminated groundwater through root uptake.

DESCRIPTION OF ALTERNATIVES

An interim action alternative to reduce the risk posed by the fuel and flush salts at the MSRE facility was developed and presented in the interim action proposed plan (DOE 1997a). Use of this interim action will result in (1) reducing the risk at the MSRE facility and (2) completing an action that is common in the alternatives that consider the ultimate disposition of the salt for disposal.

The alternatives developed in the FS were prepared for an action that ideally would be carried to completion with no delays. However, the locations identified in each alternative for final salt disposition are currently not operational. Decisions about waste acceptance cannot be made until locations for salt disposition are operational. As a result, none of the alternatives developed in the FS can be fully implemented at this time. Selection of a disposal location for MSRE salts must wait until one or both of the disposal facilities are opened and questions about the acceptance of MSRE salts for disposal can be evaluated. In the interim, fuel and flush salts will be removed from the MSRE facility. Uranium will also be removed from the salts and managed as part of the existing ^{233}U repository at ORNL. The salt remaining after the uranium removal process will be stored until it is shipped to a disposal location.

Five alternatives were developed in the FS to remove and dispose of the fuel and flush salts (DOE 1997b). The alternatives consisted of a no further action alternative and four action alternatives. The alternatives as presented in the FS are:

- Alternative 1: No Further Action,
- Alternative 2: Disposal at Waste Isolation Pilot Plant as Transuranic Waste,
- Alternative 3: Disposal at the National Repository as Spent Nuclear Fuel,
- Alternative 4: Disposal at the National Repository as High-Level Nuclear Waste, and
- Alternative 5: Disposal at a Combination of Sites as High-Level Nuclear Waste and Low-Level Nuclear Waste.

The no further action alternative was evaluated as not meeting the purpose and the objectives of this remedial action and therefore was not considered further. The four action alternatives (Alternatives 2-5) each began by removing the salts from the MSRE facility and then taking the actions necessary to transfer the salts to the designated end point for disposal. The end-point locations for disposal of the salts or components of the salts are either the Waste Isolation Pilot Plant (WIPP) in New Mexico as a defense-related transuranic (TRU) waste or a national repository as either spent nuclear fuel or high-level nuclear waste. A decision now to select a location for disposal of the MSRE salts could not be made with certainty that waste acceptance criteria would be met. Evaluation and selection of a location for disposal of the MSRE salt will be documented subsequently when an end-point location for disposal of the salt is identified.

Another consideration for the MSRE site interim remedial action to remove salt from the fuel and flush salt drain tanks is that removal can be completed without precluding the ultimate disposal options. As indicated in each action alternative, removal of the fuel and flush salt from the storage cell drain tanks is the first activity necessary for ultimate disposal of the salt. This remedial action will include the salt in all three drain tanks, starting with the flush salt drain tank which contains less radionuclides than either of the fuel salt drain tanks. Melting the salt in a drain tank will start with a small volume and increase slowly until all the salt is molten. To chemically rebalance the salt, HF will be introduced into the molten salt as it melts. Uranium will be separated from the molten salt using to the extent possible the same process and equipment used to remove ^{235}U in 1968. Fluorine gas will be added to the molten salt to oxidize UF_4 into uranium hexafluoride gas which will be trapped as it passes through vertical columns packed with sodium fluoride. The salt with the uranium removed will be moved from the drain tanks into storage containers. The salt, which still contains a large quantity of radionuclides, will then be stabilized/packaged to capture fluorine gas which may be generated. (The waste containers will be placed in shielded casks for interim storage.) The casks will be set in an existing storage facility at ORNL and managed there until final disposition is arranged.

INTERIM ACTION ALTERNATIVE

The MSRE interim remedial action activities are consistent with the FS salt disposal alternatives. This action reduces risk and at the same time proceeds toward the end point of fuel and flush salts disposal. Implementation of this interim action will not preclude any of the four action alternatives from future consideration.

The ARARs developed in the FS have been reviewed and those pertinent to the interim action are identified and presented in Tables 2.3 and 2.4.

SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

Implementation of the interim action would address the identified risks associated with current conditions at the MSRE site. By separating uranium from the fuel and flush salts, converting it to an oxide, packaging it in criticality-safe containers, and storing it in a facility designed for the storage of ^{233}U, risks associated with the release of uranium hexafluoride are eliminated and risks of a nuclear criticality are managed in accordance with applicable standards. By stabilizing/packaging the residual salt, fluorine gas generation can also be managed. This action would allow DOE to defer decisions regarding further treatment and disposal of the salt to a later date.

The comparative analysis using the nine CERCLA criteria for this interim remedial action includes the no further action alternative and the interim action. Table 2.5 summarizes the evaluation of the no further action alternative and this interim action (i.e., removal of salt, separation of uranium, and interim storage of salt).

Table 2.3. ARARs for proposed activities, MSRE site, ORNL, Oak Ridge, Tennessee

Action	Requirement	Applicability	Citation
	Location-specific		
Alteration/destruction of historic resources	Action(s) that will affect such resources must adhere to the DOE-ORO Memorandum of Agreement (May 6, 1994). When alteration or destruction of the resource is unavoidable, steps must be taken to minimize or mitigate the impacts and to preserve data and records of the resource	Any action that will impact historic resources—**applicable if there will be alteration or modification**	National Historic Preservation Act of 1966 (16 USC 457a-w); Executive Order 11593; 36 CFR 800; DOE-ORO Programmatic Agreement (May 5, 1994)
	Chemical-specific		
Release of radionuclides during removal and storage activities	DOE will carry out all DOE activities to ensure that radiation dose to individuals will be ALARA	Release of radionuclides into the environment—**TBC**	DOE Order 5400.5(I.4) (proposed as 10 CFR 834)
	Exposures to members of the public from all radiation sources shall not cause an EDE to be > 100 mrem (1 mSv)/year		DOE Order 5400.5(II.1a) (proposed as 10 CFR 834)
	Management of TRU waste shall be conducted in such a manner as to provide reasonable assurance that the combined annual dose equivalent to any member of the public in the general environment resulting from discharges of radionuclide material and direct radiation from such management shall not exceed 25 mrem/year to the whole body and 75 mrem/year to any critical organ	Handling and management of TRU waste—**relevant and appropriate**[a,b]	40 CFR 191.03(b)
	Exposures to members of the public from all radiation sources released into the atmosphere shall not cause an EDE to be > 10 mrem (0.1 mSv)/year	Point source discharge of radionuclides into the air from a DOE facility—**applicable**	40 CFR 61.92; Rules of the TDEC 1200-3-11-.08
	Radiological emission measurements must be performed at all release points that have a potential to discharge radionuclides into the air in quantities which could cause an EDE in excess of 1% of the standard (0.1 mrem/year). All radionuclides which could contribute > 10% of the standard (1 mrem/year) for the release point shall be measured		40 CFR 61.93; Rules of the TDEC 1200-3-11-.08

Table 2.3. (continued)

Action	Requirement	Applicability	Citation
	Action-specific		
Characterization of TRU waste	TRU waste must be evaluated to determine the kinds and quantities of TRU radionuclides present before storage	Generation of TRU waste—**TBC**	DOE Order 5820.2A (III.3b)
Radionuclide-contaminated material; on-site storage	External exposures to the waste and concentrations of radioactive material which may be released into the environment must not exceed an EDE of 25 mrem/year to any member of the public	Storage of uranium after separation from salt—**TBC**	DOE Order 5820.2A (II.3a)
Temporary storage of fuel/flush salts as a TRU waste pending disposal	TRU waste shall be segregated or clearly identified to avoid commingling of the waste with high-level, low-level waste or other noncertified TRU waste	Temporary storage of TRU wastes at generating sites—**TBC**	DOE Order 5820.2A (II.3.e)
	TRU waste storage areas must be protected from unauthorized access		
	TRU waste must be monitored periodically to ensure that wastes are not releasing their radioactive constituents		
	TRU waste storage areas must be designed, constructed, maintained, and operated with a contingency plan to minimize the possibility of fire, explosion, or accidental release of radioactive components		
	TRU waste storage areas must be operated in a way to maintain radiation exposures to ALARA		
	Management of TRU waste shall be conducted in such a manner as to provide reasonable assurance that the combined annual dose equivalent resulting from discharges of radionuclide material and direct radiation from such management shall not exceed 25 mrem/year to the whole body and 75 mrem/year to any critical organ	Handling and management of TRU waste—**relevant and appropriate**[a,b]	40 CFR 191.03(b)
Interim storage/disposal of LLW generated from the separation process (i.e., PPE, wipes, contaminated hardware)	Compliance with the pertinent WAC for the storage facility	Storage/disposal of LLW—**TBC**	DOE Order 5820.2A (III.3.e)

Table 2.3. (continued)

[a]10 CFR 834.109 (proposed rule) requires that management of radioactive waste not exceed an EDE of 25 mrem/year from all exposure pathways. When promulgated, this rule will be legally applicable.
[b]DOE Order 5400.5, Chapter II 1(c)(1), requires that TRU waste management and storage activities at facilities other than disposal facilities not cause members of the public to receive, in a year, a dose equivalent > 25 mrem to the whole body or a committed dose equivalent > 75 mrem to any organ.

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
DOE = U.S. Department of Energy
EDE = effective dose equivalent
\> = greater than
< = less than
LLW = low-level (radioactive) waste
mrem = millirem
MSRE = Molten Salt Reactor Experiment
mSv = millisievert
ORNL = Oak Ridge National Laboratory
ORO = Oak Ridge Operations
% = percent
PPE = personal protective equipment
TBC = to be considered
TDEC = Tennessee Department of Environment and Conservation
TRU = transuranic
USC = *United States Code*
WAC = waste acceptance criteria

Table 2.4. Evaluation of the no further and preferred alternatives using the nine CERCLA criteria, MSRE site, ORNL, Oak Ridge, Tennessee

Criteria	Evaluation	
	No further action alternative	Preferred alternative
Threshold criteria		
Overall protection of human health and the environment	Poor. Existing controls will eventually be inoperable and release of radioactive materials from the salts would occur	Good. Salts will be removed and placed in a safer, more stable configuration. This will reduce the potential for an accidental release and allow for easier control of F_2 gases. The uranium fuel will be separated and stored in an existing repository. This will eliminate generation of UF_6 gases
Compliance with ARARs	Poor. Compliance over the long-term questionable	Yes. The proposed action complies with ARARs
Balancing criteria		
Long-term effectiveness	Poor. Tanks containing salts will eventually fail and release radioactive materials from the salts	Good. Removes the principal threat from the MSRE facility by appropriately packaging the salts and storing the packages in an appropriate facility. Removal of the salt is a permanent action
Reduction of contaminant toxicity, mobility, or volume through treatment	Poor. Does not reduce toxicity, mobility or volume through treatment	Good. Treatment to separate the uranium from the salts reduces toxicity of the salts and mobility is reduced by converting uranium hexafluoride to uranium oxide. Volume is only incrementally reduced because it is a small percentage of the total volume of the salt
Short-term effectiveness	Good. The current controls collect uranium hexafluoride and fluorine gases	Moderate. During activities of this alternative, risks from radiation and contamination exposure associated with potential release will increase to workers and the public as the salt is heated, removed, and containerized; however, safety analysis and appropriate precautions will be implemented to reduce and control the risks
Implementability	Good. Reactive gas removal system in place and operational	Moderate. The action is difficult yet feasible. Removal has been accomplished previously, but not under current conditions. Interim storage will be at an existing storage facility at ORNL
Cost	Poor. The present worth of operations and maintenance for 70 years is $70 million to maintain institutional and engineering controls	Good. The total capital costs present worth of this action is $39.3 million
Modifying criteria		
State acceptance		The state of Tennessee and EPA are parties with DOE to the FFA and have considered this action as presented in the feasibility study and proposed plan before approving this ROD
Community acceptance		The interim action proposed plan was presented to the public for review between December 23, 1997, and January 30, 1998, and no changes in the plans resulted based on the comments that were received. Comments tended to support the proposed interim action. Stakeholders also participated in review of the documents

ARAR = applicable or relevant and appropriate requirement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
$ = dollar
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
F_2 = fluorine
FFA = Federal Facility Agreement
MSRE = Molten Salt Reactor Experiment
ORNL = Oak Ridge National Laboratory
ROD = record of decision
UF_6 = uranium hexafluoride

Table 2.5. Estimated uranium in the salts before and after separation, MSRE site, ORNL, Oak Ridge, Tennessee

	Before uranium separation			After uranium separation		
	Concentration (ppm)	Mass (kg)	Activity (nCi/g)	Concentration (ppm)	Mass (kg)	Activity (nCi/g)
Fuel						
^{233}U	3,600	16.8	34,800	42	0.2	412
Total uranium	4,301	20	55,250	50	0.233	654
Flush						
^{233}U	46	0.2	450	20	0.08	192
Total uranium	117	0.5	673	50	0.214	289

g = gram
kg = kilogram
MSRE = Molten Salt Reactor Experiment
nCi = nanocurie
ORNL = Oak Ridge National Laboratory
ppm = parts per million
U = uranium

THE SELECTED REMEDY

The interim action remedy selected for the MSRE fuel and flush salts remediation is to remove the salt in a chemically stable form, separate the uranium from the salts and store it separately as part of the existing ^{233}U repository inventory, place the salt in containers, and store the containerized salt until disposal is arranged. This action will employ the activities common to the first steps in the removal and disposition of the fuel and flush salts for the four action alternatives presented in the FS. The final action required for salt disposal will be documented in a subsequent final CERCLA decision document and, as appropriate, in a NEPA decision document.

Removal of salt from the drain tank cell will require new corrosive resistant equipment to add heat and control the salt chemistry. To the extent possible, existing drain tanks and other equipment will be examined and repaired for reuse, but requirements for operating the apparatus remotely and adding HF to the melting salt exceed the original equipment capability. The goal of the project is to remove 99 percent of the salts from each drain tank. This will reduce the uranium mass left in each tank to below criticality safe limits.

The separation of uranium from the fuel and flush salts will use the same process and, to the extent practicable, the same equipment used to remove ^{235}U in 1968. This process involves adding fluorine to the molten salts. Uranium hexafluoride gas is liberated from the salts and then trapped on vertical columns packed with sodium fluoride. The goal is to reduce the residual uranium concentration in the salts to below 50 ppm. Depending on salt chemistry, it may be possible to reproduce the results achieved in 1968 (26 ppm). Table 2.6 shows the estimated ^{233}U and total uranium concentrations before and after the separation process.

Uranium must be converted to uranium oxide to be placed in storage at the ORNL repository. Although this conversion process is common in the uranium industry, a modification tailored to a small scale, remote chemical operation will be applied to this application. The chemically stable converted uranium will be packaged in suitable containers and prepared for storage with similar packages in a ^{233}U repository in Building 3019. Storage of this separated uranium will result in approximately 17 kg (37 lb) of ^{233}U added to the 500 kg (1,100 lb) of ^{233}U currently stored at the facility.

Once the uranium is separated from the salts, the residual salts will be poured into storage containers (approximately 48 containers for the fuel and flush salt), and chemically stabilized/ packaged to capture fluorine gas which may be generated and to meet transportation requirements for eventual shipment to a disposal area. Because a disposal facility is not available to make waste acceptance determinations or to receive waste, the waste packages will be loaded into shielded casks for interim storage. These casks will be placed in interim storage at an ORNL operating storage facility. At present, facilities for remote handled waste include the RH-TRU bunkers (Bldgs. 7883 and 7855), shielded storage well (e.g., 7827), and shielded concrete vaults set on pads (e.g., 7842A). If adequate and appropriate capacity does not exist in one of the above facilities, a pad may be constructed or extended within the existing boundaries of SWSA 5 or SWSA 6 specifically for the storage of MSRE salt residue waste casks. Final definition of the shielded cask and storage site will be completed as part of the remedial design.

Total capital cost (present worth) to implement these interim activities is $39.3 million and the annual operation and maintenance cost (present worth) are expected to be zero. The total capital cost includes only the activities discussed in this section. Costs associated with interim storage are not borne by this project; the $10,000 yearly costs are borne by other DOE-funded programs. Other activities such as transportation to an end point disposal location identified in the original four action alternatives are not included in this cost. Table 2.6 presents the schedule for these activities.

Decisions concerning treatment and disposal of the salt is delayed to a later date. This has the advantage that these decisions could be based on better information as waste acceptance

Table 2.6. Interim remedial action schedule, MSRE site, ORNL, Oak Ridge, Tennessee

	Start	Finish
Melt and transfer salts for processing	July 2000	May 2002
Separate uranium from salt	October 2000	February 2003
Transfer uranium to ^{233}U repository	October 2000	February 2003
Stabilize and package salt	October 2000	February 2003
Interim storage of salts	October 2000	Undetermined
Remedial action report	February 2003	May 2003

Notes: Dates include operations. The durations do not include design, construction, etc.

MSRE = Molten Salt Reactor Experiment
ORNL = Oak Ridge National Laboratory
U = uranium

criteria are developed and finalized for the national repository and WIPP, new treatment technologies emerge, and further development is completed for existing treatment technologies presented in the FS.

STATUTORY DETERMINATIONS

Section 121 of CERCLA establishes several statutory requirements and preferences, including compliance with ARARs. CERCLA requires the remedy (1) be cost-effective; (2) be protective of human health and the environment; (3) use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (4) use treatment that permanently reduces the toxicity, mobility, or volume of hazardous substances. Interim remedial actions under CERCLA are required to attain only those ARARs specific to the action being implemented, and the above criteria apply to the selection of a final remedy. The selected interim action satisfies the above criteria.

This interim action provides short- and long-term protection of human health and the environment through removal of a contaminant source and limitation of the potential spread of contamination. This action will comply with all ARARs. The action is cost-effective. The action uses treatment to remove and stabilize uranium for storage in the ^{233}U repository at ORNL and is permanent within the scope of the action because it removes the fuel and flush salts from the MSRE facility. The proposed action also reduces the potential contaminant release and is therefore appropriate as an interim action.

EXPLANATION OF SIGNIFICANT CHANGES

A review of all comments resulted in no significant changes to the remedy originally identified in the proposed plan as the interim action alternative.

REFERENCES

DOE (U.S. Department of Energy). 1997a. *Interim Action Proposed Plan for Fuel and Flush Salt Disposition from the Molten Salt Reactor Experiment, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1601&D3. Prepared by Jacobs Environmental Management Team, Oak Ridge, TN.

DOE. 1997b. *Feasibility Study for Fuel and Flush Salt Removal from the Molten Salt Reactor Experiment at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1559&D2. Prepared by Jacobs EM Team, Oak Ridge, TN.

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DOE. 1995. *Oak Ridge National Laboratory Molten Salt Reactor Experiment Facility Time Critical Removal Action Memorandum Report*. Prepared by Lockheed Martin Energy Systems, Inc., Oak Ridge, TN.

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RESPONSIVENESS SUMMARY

The *Interim Action Proposed Plan for Fuel and Flush Salt Disposition from the Molten Salt Reactor Experiment, Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE 1997a) was released for public review December 22, 1997. The comment period for the public to consider the alternatives developed for interim remediation of MSRE was announced in local newspapers to begin December 23, 1997, and end January 30, 1998. The notice of availability for this plan and other documents in the Administrative Record was published daily in *The Knoxville News-Sentinel* and *The Oak Ridger* December 23, 1997, and biweekly and weekly in *The Roane County News* and *The Clinton Courier-News* December 24, 1997. A public meeting was held in Oak Ridge January 14, 1998. This public meeting was also announced in newspapers January 11 and 12, 1998.

Through newspaper announcements and other public relations efforts, DOE invited the public to participate in the review of plans being recommended for interim remediation of MSRE. The interim action proposed plan and other related documentation in the Administrative Record were made available for review at the DOE Information Resource Center, 105 Broadway Avenue, Oak Ridge, Tennessee. Written comments from the public could be received at the Information Resource Center or sent to Ms. Margaret Wilson, DOE FFA Manager. DOE also accepted written comments at the public meeting and responded to verbal comments. A transcript of the public meeting is included in the Administrative Record.

DOE received two written comments during the public comment period. Responses to these comments are included here. In addition, verbal comments that address the current remedial action plan are included here to supplement the initial DOE response made at the public meeting. Public comments and DOE responses that were made at the public meeting and which do not address the plan for interim action are not included here.

LETTER 1

***Comment*: DOE and ORNL have approached the plan for MSRE fuel and flush salt disposition in a thoughtful, forthright and honorable way.**

Response: The support of the proposed plan is appreciated.

LETTER 2

Comment: **After review of the documents concerning the interim action proposed plan for fuel and flush salt disposition and attending the public meeting, I fully concur with the decision to select the preferred limited alternative which includes removal and interim storage of the fuel and flush salts. I also studied the National Research Council report that evaluated the alternatives for MSRE fuel and flush salts removal and disposition. This report only solidified my opinion that the proposed plan was the correct one.**

I was pleased that TDEC and EPA approved the proposed plan. I am concerned that the regulatory process for approvals is not open to the public like the DOE decision process. I would like to be part of the regulatory process to gain knowledge of their reasoning and have the opportunity to discuss the reasons for decisions with the regulators.

Response: The support of the proposed plan is appreciated. Your desire for greater involvement with TDEC and EPA has been discussed with these agencies. The following, provided by EPA, reaffirms support of public involvement and provides recommended avenues to become involved in the CERCLA decision process.

The regulatory process for selecting CERCLA response actions is open to the public. TDEC and EPA review and comment on all documents prepared in support of CERCLA response actions. TDEC and EPA correspondence is always available to the public. TDEC and EPA participate in all formal public meetings and many information workshops. Additionally, TDEC and EPA are represented on the Oak Ridge Site-Specific Advisory Board. Public involvement in the regulatory process may be achieved through any of these means, as well as by direct oral or written communications to TDEC and/or EPA representatives.

The public is an integral part of the regulatory process. Community acceptance of response action decisions is one of the nine CERCLA remedy selection criteria that must be evaluated for all remedial actions. However, as regulatory agencies providing oversight of the ORR, TDEC and EPA must consider DOE proposals independently and then either concur or not concur with those proposals. TDEC and EPA will provide the basis for their concurrence or nonconcurrence and are available to discuss those decisions with the public.

SUMMARY OF COMMENTS FROM THE PUBLIC MEETING

Comment 1: **Three meeting participants commented that the proposed interim action plan is appropriate and includes a reasonable approach for removing the salt from the MSRE. In addition, even though the proposal does not include a recommendation for final disposal of the salt, it is the correct action to take because it reduces the risk of a release of contaminants to the environment; and that the plan provided for due precautions to solve a complex problem.**

Response 1: The support of the proposed plan is appreciated.

Comment 2: **Three meeting participants raised concerns about an alleged nuclear criticality accident at the MSRE and alleged past releases/contamination incidents.**

Response 2: Previous investigations determined that there has not been a criticality accident at the MSRE, and that contamination incidents were minor and limited to two workers in the facility. It is acknowledged, however, that there is the risk for a nuclear criticality accident and substantial releases to the environment/public of fluorine gas and radioactive contamination associated with the salts in the MSRE drain tanks. This is the reason that instead of the No Action alternative, the proposed plan is to remove the salt from the drain tanks, remove the uranium from the salt, stabilize/package the salt to control fluorine generation, and place the salt containers in interim storage.

Comment 3: **Suggestions for alternate remediation options were stated during the public meeting by different commenters. These various options are presented with a brief response.**

(A) Has including the salt in the privatization initiative for transuranic waste treatment after it is removed from MSRE been considered?

(B) Suggest melting the salt and placing it into containers for storage as spent nuclear fuel. This would get it out of the way so you can go ahead and decontaminate and decommission the MSRE building. But you will still have the fluorine problem wherever you store the salt, and that may not be a job you want to do.

(C) Suggest fluorination to remove the uranium from the reactor and mix this uranium with depleted uranium from K-25, denature the uranium, and make the uranium

safe. Then after that precipitate the uranium with either ammonia or sodium hydroxide and make orange cake, and dispose of the orange cake in the burial grounds.

(D) [This idea was presented as not necessarily practical.] Suggest placing one or two hundred tons of crushed limestone in the cell (containing the fuel and flush salt storage tanks) to fill it. That would take care of uranium hexafluoride, excess fluorine, and probably would take care of a rising water table.

Response 3:

(A) Yes, inquiries about including the MSRE salts in the privatization project have been made; however, because the salts are unique in their chemical make-up with very little similarity to other wastes at ORNL, inclusion of the salts is no longer considered.

(B) The suggestion to containerize and store the material as SNF implies not removing the uranium before containerization. This was evaluated in the FS and discussed with the state of Tennessee and EPA. It was determined that removing the uranium from the salt during the current operations would be a small incremental cost to the project. Not removing the uranium, however, may prevent future disposal at WIPP or prevent processing at INEEL for future disposal at the National Repository. (Note: the work plan will address generation of fluorine during interim storage.)

(C) The quantity of uranium (^{233}U) that will be removed from the MSRE fuel and flush salts is a very small amount compared with the quantity already stored in the ^{233}U repository. The process required to complete the suggested blending is not insignificant. Application of the suggested process to address only the uranium from the fuel and flush salt would be inordinately complicated and costly. The more appropriate implementation of this suggestion is to address all of the ^{233}U in the repository. Treatment of the repository inventory is beyond the scope of this action.

(D) This interim remedial action is interim in part because it is only the first action for the D&D of Building 7503, and this is the first action in removing, storage and disposition of the fuel and flush salts. Before Building 7503 and MSRE can be decontaminated and decommissioned, the fuel and flush salts must be removed. The salts cannot be left in place not only because uranium hexafluoride and fluorine gases are liberated, but also because of the hazards associated with and the regulatory guidance for disposition of spent nuclear fuel and/or TRU waste. Leaving the fuel and flush salt in Building 7503 is not a viable option under these circumstances, even if crushed limestone would be an effective temporary or permanent cover.