Mr. Michio Sakurada
Director for International Affairs on Nuclear Power Safety
Agency for Natural Resources and Energy
Ministry of International Trade and Industry
1-3-1, Kasumigaseki
Chiyoda-Ku, Tokyo 100, Japan

Dear Mr. Sakurada:

This letter is a solicitation to establish potential Japanese interest in participating in the Dry Cask Storage Characterization Program, and to enlist your help in arranging meetings with representatives from my staff and program contractors. At these meetings, details of the research program and the proposed cooperation will be presented to interested parties in Japan. We would appreciate your help in holding internal discussions in Japan regarding the proposed cooperation, and also in providing the name of a contact to Mr. Roger M. Kenneally of my staff with whom he can arrange a meeting to discuss the proposed cooperation.

Recently, Mr. Kenneally met with Mr. Mizumachi, Deputy Director General, Institute of Nuclear Safety (INS), Nuclear Power Engineering Corporation, at the U.S. Nuclear Regulatory Commission (NRC) Headquarters and discussed NRC's regulations, guidance documents, and research programs addressing dry cask and spent fuel storage issues. Mr. Kenneally also accompanied Mr. Mizumachi to two of our National Laboratories to tour the facilities and discuss ongoing research programs.

Utilities have developed independent spent fuel storage installations as a means of expanding their spent fuel storage capacity on an interim basis until the geologic repository is available to accept spent fuel for permanent storage. The NRC promulgated Part 72 to the Code of Federal Regulations (10 CFR) for the independent storage of spent nuclear fuel and high-level radioactive waste outside reactor spent fuel pools. The license term for a spent fuel storage facility is currently limited to 20 years, and a few licenses are approaching this limit. In preparation for possible license renewal, the NRC and the nuclear industry are developing the technical basis for extended storage in existing sites. Verification of past performance of selected components of these systems is required as part of that technical basis.

Beginning in the mid-1980's, a dry cask storage demonstration program for commercial spent nuclear fuel has been underway at the U.S. Department of Energy's Idaho National Engineering and Environmental Laboratory (INEEL), Test Area North (TAN) facilities. The program tested a variety of dry storage cask designs primarily for ease of use, heat transfer, shielding, and their ability to keep fuel isolated. Several of the casks used in this demonstration still contain a full load of spent fuel so that up to 15 years of storage has been achieved to date. Because these casks have been in use for such a substantial amount of time, information about the current condition of the casks and the contained fuel would be of great potential use in establishing a technical basis for dry cask storage system license renewal.

The NRC, in cooperation with the Electric Power Research Institute (EPRI), and the U.S. Department of Energy Offices of Civilian Radioactive Waste Management (DOE-RW) and Environmental Management (DOE-EM) is participating in a cooperative research program to perform a visual inspection of two dry storage casks and their contents (Task 1), and detailed evaluations of the fuel rods (Task 2). Enclosed is a description of the cooperative research program. The program is structured around a “Base Program” for which the current participants have expressed the intention to provide adequate funding, and “Options” that could be incorporated into the program if additional funding is available; for instance, through the inclusion of additional participants. The casks selected for evaluation are the Gesellschaft fuer Nuklear Service Castor-V/21, a metal cask containing 21 spent PWR fuel assemblies from the Surry nuclear plant, and the BNFL Fuel Solutions VSC-17 concrete storage cask containing 17 canisters of 2-to-1 consolidated spent PWR fuel from the Surry and Turkey Point nuclear plants. The fuel in both casks has been out of the reactor for approximately 20 years. The fuel in the Castor-V/21 cask has been in continuous storage in the cask for nearly 15 years; the fuel in the VSC-17 cask has been in dry storage for a similar total amount of time, the last approximately nine years being continuously stored in the VSC-17 cask.

Because of the common interest in dry cask storage characterization worldwide, the significant information to be derived from this Program, and in consideration of the large scope of effort and cost associated with such research, the NRC considers this program area to be appropriate for collaborative interest by other parties within and outside the United States.

The NRC and EPRI have signed an agreement to work together to determine the long-term integrity of dry storage cask systems and spent nuclear fuel under dry storage conditions. The agreement establishes a Program Steering Committee that sets the workscope and budget for this project. Representatives from both Department of Energy Offices are also part of the Program Steering Committee. The agreement also provides for the inclusion of additional organizations, including governmental agencies and private entities in the United States and other countries under the same terms and conditions. Once minimum funding has been provided, new participants in the agreement will have the right to appoint a person to the Program Steering Committee with the same rights and responsibilities as the existing members of the Committee. The workscope presented in the enclosure represents the plan in effect as of November 1999. It is anticipated that some modification to the workscope will occur as new participants join the program, and as we continue to learn the condition of the cask and fuel from the initial work. Thus, new organizations joining the program will have ample opportunity to provide future program direction.

The estimated cost for the Base Program described in the enclosure (Tables 1 and 3) is $3 million; $1.6 million for Task 1 (cask inspections) and $1.4 million for Task 2 (fuel rod examinations). The schedule for Task 1 is April 1999 to December 2001, the schedule for Task 2 is November 1999 to December 2001. It is estimated that the cost for similar evaluations of one canister in the VSC-17 cask (Tables 2 and 4 of the enclosure) would be approximately the same amount. As of November 1999, the Castor V/21 cask has been moved to the TAN Hot Shop, opened, and all assemblies and cask internals visually inspected. Removal of the 12 rods from one assembly for shipment to ANL is about to commence.

The NRC belives the proposed international cooperation offers a great deal of opportunity for Japanese participation to effectively leverage its resources and also provides an excellent value due to the large program being sponsored by the existing participants. We would appreciate any comments you may have on the schedule or technical aspects of the program, and look forward to an early favorable response to Japanese participation in the Dry Cask Storage Characterization Program.

For additional information please contact Mr. Roger M. Kenneally at:

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Sincerely,

Michael E. Mayfield, Acting Director
Division of Engineering Technology
Office of Nuclear Regulatory Research

Enclosure: Cooperative Research Program
on Dry Cask Storage Characterization

cc: Kenji Goto, MITI
Wataru Mizumachi, NUPEC

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Enclosure

COOPERATIVE RESEARCH PROGRAM
ON
DRY CASK STORAGE CHARACTERIZATION

COOPERATIVE RESEARCH PROGRAM
ON
DRY CASK STORAGE CHARACTERIZATION

INTRODUCTION

Most nuclear power plants in the United States were not originally designed with a storage capacity for the spent fuel generated over the operating life by their reactors. Utilities originally planned for spent fuel to remain in the spent fuel pool for a few years after discharge, and then to be sent to a reprocessing facility. Since reprocessing has been eliminated, and no other option for spent fuel disposition currently exists, utilities expanded the storage capacity of their spent fuel pools by using high-density storage racks. This has been a short-term solution with many utilities having reached, or soon will reach, their spent fuel pool storage capacity (Fisher and Howe, 1998). Utilities have developed independent spent fuel storage installations as a means of expanding their spent fuel storage capacity on an interim basis until the geologic repository is available to accept spent fuel for permanent storage.

The Nuclear Regulatory Commission promulgated 10 CFR Part 72 (Title 10, 1999) for the independent storage of spent nuclear fuel and high-level radioactive waste outside reactor spent fuel pools. Part 72 currently limits the license term for an independent spent fuel storage installation to 20 years from the date of issuance. Licenses may be renewed by the Commission at the expiration of the license term. Applications for renewal of a license should be filed at least two years prior to the expiration of the existing license. In preparation for possible license renewal, the Nuclear Regulatory Commission, Office of Nuclear Material and Safeguards, Spent Fuel Project Office, is developing the technical basis for renewals of licenses and Certificates of Compliance for dry storage systems for spent nuclear fuel and high-level radioactive waste at independent spent fuel storage installation sites. These renewals would cover periods from 20 to 100 years, and would require development of a technical basis for ensuring continued safe performance under the extended service conditions. An analysis of past performance of selected components of these systems is required as part of that technical basis. The components include the spent fuel and all structures, systems, and components with functions important to safety. The safety functions, which apply for normal, off-normal, and accident -conditions are as follows: maintain subcriticality, maintain confinement, ensure that radiation rates and doses to workers and the public do not exceed acceptable levels and remain as low as reasonably achievable, maintain retrievability, and ensure heat removal as needed to meet the safety requirements.

Other government agencies and nuclear industry organizations have a mutual interest in performing research on dry cask storage characterization. Therefore, to conserve the limited government and nuclear industry resources, the NRC, the Electric Power Research Institute (EPRI), and the DOE Offices of Civilian Radioactive Waste Management (DOE-RW) and Environmental Management (DOE-EM) are cooperating in a research program to determine the long-term integrity of dry cask storage systems and spent nuclear fuel under dry storage conditions.

Beginning in the mid-1980's a dry cask storage demonstration program for commercial spent nuclear fuel has been underway at the DOE's Idaho National Engineering and Environmental Laboratory (INEEL), Test Area North (TAN) facilities. The program tested a variety of dry storage cask designs primarily for ease of use, heat transfer, shielding, and their ability to keep fuel isolated. Several of the casks used in this demonstration still contain a full load of spent fuel so that up to 15 years of storage has been achieved to date. Because these casks have been in use for such a substantial amount of time, information about the current condition of the casks and the contained fuel would be of great potential use in establishing a technical basis for dry cask storage system license renewal.

The intent of the ongoing cooperative research program is to perform a visual inspection of one or two dry storage casks currently at the TAN facilities and their contents (Task 1), and detailed examinations of the fuel rods (Task 2). These tasks are described in more detail below.

The casks at the TAN facilities selected for evaluation are the Gesellschaft fuer Nuklear Service Castor-V/21 nodular cast-iron cask containing 21 spent PWR fuel assemblies from the Surry nuclear plant, and the BNFL Fuel Solutions

VSC-17 ventilated concrete storage cask containing 17 canisters of 2-to-1 consolidated spent PWR fuel from the Surry and Turkey Point nuclear plants. The fuel in both casks has been out of the reactor for approximately 20 years. The fuel in the Castor-V/21 cask has been in continuous storage in the cask for nearly 15 years; the fuel in the VSC-17 cask has been in dry storage for a similar total amount of time, the last approximately nine years being continuously stored in the VSC-17 cask. The participants are contracting with the INEEL for Task 1 activities; and the Argonne National Laboratory (ANL) for Task 2 activities. Both tasks have identified a “Base Program” for which the current participants have expressed the intention to provide adequate funding, and “Options” that could be incorporated into this cooperative program if additional funding is available; for instance, through the inclusion of additional participants.

The data from this program will be used to determine how the casks and spent nuclear fuel have behaved under extended dry-storage conditions and will be used by each participant to independently develop applicant or regulatory positions.

OBJECTIVES

The objectives of the Dry Cask Storage Characterization Program are to (1) determine the long-term integrity of dry storage cask systems and spent nuclear fuel under dry storage conditions, and (2) provide data to establish the technical bases and criteria for evaluating the safety of spent-fuel storage and transportation systems, and for extending dry cask storage licenses.

TASK 1 - VISUAL EXAMINATION OF CASK, CASK INTERNALS, AND FUEL

Castor-V/21 Cask. The Castor-V/21 cast-iron/graphite material exhibits good strength and ductility and provides effective gamma shielding. Polyethylene rods incorporated into the cask wall provides neutron shielding. The cask weighs approximately 100 tons when loaded with spent fuel. The external surface consists of heat transfer fins oriented circumferentially around the cask surface. The fuel basket within the cask is configured to hold 21 pressurized water reactor spent fuel assemblies and is constructed of stainless steel and borated stainless steel for criticality control. The Surry spent fuel assemblies are of the standard Westinghouse 15x15 rod design. The cask is closed with two lids having both elastomer and metallic O-rings to seal the cask cavity from the environment. The cask was closed and sealed in August 1985.

Castor-V/21 Performance Tests. The purpose of the 1985 tests, performed at the TAN cask test facility, was to demonstrate the thermal, shielding, and operational performance of the Castor-V/21 cask. The fuel assemblies were characterized using in-basin ultrasonic examinations and video scans. After testing, selected fuel assemblies were videotaped and photographed, and smear samples were collected. The results of these examinations revealed no indication of any failed fuel before or after the Castor-V/21 cask performance test. The testing and analysis are described in Reference 1.

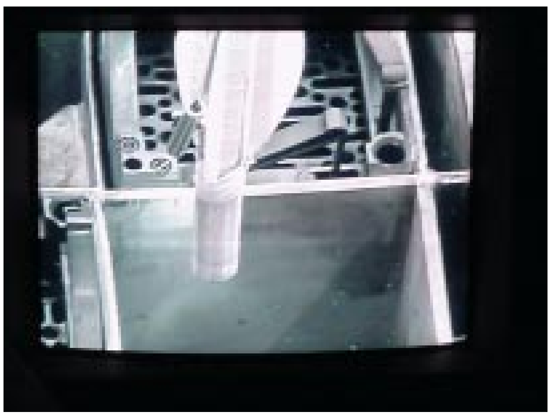
VSC-17 Cask. The VSC-17 spent fuel storage system is a passive device for storing 17 assemblies/canisters of irradiated nuclear fuel. The VSC-17 system consists of a Ventilated Concrete Cask (VCC) and a Multi-Assembly Sealed Basket (MSB). Decay heat, generated in the spent fuel, is transmitted through the containment wall of the MSB to a cooling air flow. Natural circulation drives the cooling air vertically through an annular path between the MSB and the VCC.

The cask weighs approximately 110 tons when loaded with17 canisters of consolidated fuel. The concrete cask is a one-piece cylindrical structure which provides structural support, shielding, and natural convection cooling for the MSB. The bulk of the shielding is provided by a thick concrete wall. The air inlet and outlet vents are steel-lined penetrations that are non-planar paths to minimize radiation streaming. The internal cavity of the reinforced concrete cask is formed by a steel cylindrical liner and a flat bottom plate.

VSC-17 Performance Tests. Performance tests of the VSC-17 cask containing consolidated pressurized water reactor spent fuel from Virginia Power's Surry Nuclear Power Plant and Florida Power and Light's Turkey Point Nuclear Power Plant were used to demonstrate the thermal, shielding, and operational performance of the cask. The testing was also performed at the TAN cask test facility. These tests were conducted in 1991 as part of a larger demonstration of the ability to consolidate and store spent fuel rods under dry conditions. The Surry and Turkey Point fuel that was consolidated and then put into the VSC-17 cask had been in storage in other dry storage casks at the TAN facilities for several years prior to consolidation. The testing and analysis are described in Reference 2.

Work Scope. Task 1 of the current cooperative program involves the visual inspection of the Castor-V/21 cask described above, and its contents. The visual inspection is to look for signs of degradation in the cask or the fuel that may have occurred during dry storage. Specifically, Task 1 involves the movement of the Castor-V/21 cask from its storage area to the TAN facility; obtaining temperature readings of the cask exterior and performing a radiation survey; video and photographic inspection of the casks, seals, selected fuel assemblies or canisters and fuel rods; and returning the casks to storage.

A summary of the proposed scope of work is provided below. Table 1 identifies activities that are included in the Castor-V/21 Base Program and Options; Table 2 identifies activities that are included in the VSC-17 Options. Currently, only the Base Program is being funded. Inspection of the VSC-17 cask has been deferred pending availability of sufficient funding.



The work scope includes fabrication or purchase of necessary equipment, development of procedures and training, movement of the casks, and use of the TAN facilities (Hot Shop and Hot Cell) to perform the following activities: (a) temperature readings of the cask exterior; (b) radiation survey; (c) gas sampling of the cask interior prior to opening, (d) video and photographic inspections of the cask support pad, (e) video and photographic inspections of the cask exterior, (f) video and photographic inspections of the cask interior (Fig. 1), (g) video and photographic inspections of the cask seal, (h) mechanical property evaluations of the cask seals, (i) general video and photographic inspection of all fuel assemblies (Fig. 2) and canisters, and a detailed evaluation of up to five fuel assemblies and five canisters (Note: canister inspection is currently a non-funded option), (j) video and photographic inspections of 12 fuel rods selected from one fuel assembly in the Castor-V/21 cask, and 12 fuel rods from each of two canisters in the VSC-17 cask (Note: VSC-17 rod inspection is currently a non-funded option), (k) obtaining and analyzing crud and smear samples, (l) installation of thermocouple lances and long-term monitoring of cask internal temperature, and (m) installation of gamma and neutron detection devices and long-term monitoring of radiation levels. A list of assemblies, canisters, and fuel rods selected for inspection shall be provided to all participants for review and approval.

Fig. 1. Inspection of Castor-V/21 Fuel Basket

Fig. 2. Inspection of Castor-V/21 Fuel Assembly

The fuel rods removed from the assembly will then be packaged and shipped to ANL for additional testing described below in Task 2. After testing has been completed at ANL, the fuel rod segments and other material will be returned to the TAN facilities for permanent storage. This Task includes activities associate with the transportation of the fuel rods to ANL-W for Task 2 evaluations and the return of the fuel rod segments and other material from ANL-W and ANL-E to the TAN facilities for permanent storage.

Participants may obtain consultants to assist in the selection of fuel assemblies, canisters and rods. Participants may also have consultants present during the examinations of the cask and contents to provide on-the-spot guidance and recommendations about this aspect of the evaluations to ensure the best possible data are obtained. There is no cost to this program for the consulting services obtained by the participants.

Deliverables. Final reports of the inspection of the Castor-V/21 and VSC-17 dry cask storage system and stored nuclear fuel. Video tapes and photographs of the inspection of the Castor-V/21 and VSC-17 dry cask storage system and stored nuclear fuel.

TASK 2 - SPENT NUCLEAR FUEL EVALUATION AND CHARACTERIZATION

Task 2 of this cooperative program involves the non-destructive, destructive, and mechanical examinations of dry-stored spent nuclear fuel elements that will provide quantitative and qualitative information concerning the integrity of the fuel. Examples of the type of information that will be obtained include: in-situ creep; percentage of fission gas release, internal rod pressure; oxide thickness, hydride morphology and orientation, residual cladding thickness, cladding microstructure; hydrogen content; creep rates, breakaway temperature; tensile strengths; and ductility.

This evaluation and characterization effort will build on the expertise and experience obtained from the NRC sponsored High-Burnup Cladding Metallurgy Program at the ANL (East facility).

A summary of the scope of work is provided below. Table 3 identifies the activities that are included in the Castor-V/21 fuel evaluations, base program and options; Table 4 identifies the activities that are included in the VSC-17 fuel evaluation options. Currently, only the Base Program is being funded.

Work Scope. In addition to the main tests involved in Task 2 (described below), the Task 2 work scope also involves activities associated with the receipt of the fuel rods, development of necessary procedures, testing, transhipment of fuel rod segments between ANL-West and ANL-East, and ANL-East and TAN facilities. The main activities involved in Task 2 are to test the fuel rods – primarily the cladding – for signs of degradation during long-term dry storage. The detailed activities are (a) profilometry, (b) fission gas release, (c) rod sectioning (cut rods, identify axial and azimuthal orientation), (d) metallography, (e) cladding hydrogen analysis, (f) creep tests, (g) cladding stress-rupture tests, (h) cladding tensile tests, and (i) transmission electron microscopy.

Participants may obtain consultants to assist in the selection of fuel assemblies, canisters and rods. Participants may also have consultants present during the examinations of the cask and contents to provide on-the-spot guidance and recommendations about this aspect of the evaluations to ensure the best possible data are obtained. There is no cost to this program for the consulting services obtained by the participants.

Deliverables. Final reports of the examination and characterization of the spent nuclear fuel stored in the Castor-V/21 and VSC-17 casks.

ESTIMATED COST AND SCHEDULE

The estimated cost for the Base Program described in Tables 1 through 4 is $3 million; $1.6 million for Task 1 (cask inspections) and $1.4 million for Task 2 (fuel rod examinations). The schedule for Task 1 is April 1999 to December 2001, the schedule for Task 2 is November 1999 to December 2001. It is estimate that the cost for similar evaluations of one canister in the VSC-17 cask would be approximately the same amount.

CURRENT PROGRAM STATUS

As of November 1999 the Castor V/21 cask has been moved to the INEEL, TAN Hot Shop, opened, and all assemblies and cask internals visually inspected. Removal of the 12 rods from one assembly for shipment to ANL is about to commence.

ADDITIONAL PARTICIPATION

The Options identified in Tables 1 through 4 represent activities that could be incorporated into this cooperative program if additional funding became available. The additional work presented in the Options was identified by the existing funding organizations as contributing an increasing amount of useful data to support the technical basis for extended dry storage.

The NRC and EPRI have signed an agreement to work together to determine the long-term integrity of dry storage cask systems and spent nuclear fuel under dry storage conditions. The agreement establishes a Program Steering Committee that sets the work scope and budget for this project. Representatives from both DOE-RW and DOE-EM are also part of the Program Steering Committee. The agreement also provides for the inclusion of additional organizations, including governmental agencies and private entities in the United States and other countries under the same terms and conditions. Once minimum funding has been provided, new participants in the agreement will have the right to appoint a person to the Program Steering Committee with the same rights and responsibilities as the existing members of the Committee. The work scope presented in this paper represents the plan in effect as of November 1999. It is anticipated that some modification to the work scope will occur as new participants join the program, and as we continue to learn from the initial work, the condition of the cask and fuel. Thus, we anticipate that new organizations joining the program will have ample opportunity to provide future program direction.

REFERENCES

1. *The Castor-V/21 PWR Spent-Fuel Storage Cask: Testing and Analyses*, Electric Power Research Institute Report: EPRI NP-4887, November 1986[1].

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[1]EPRI reports may be obtained from the Program Steering Committee member from the Electric Power Research Institute.

2. *Performance Testing and Analyses of the VSC-17 Ventilated Concrete Cask*, Electric Power Research Institute Report: EPRI TR-1000305, May 1992[1].

Table 1
Base Program and Options for Castor-V/21 Evaluations

Task		Base Program	Options		
			1	2	3
1.1	Equipment	X			X
1.2	Procedures and Training	X			X
1.3	Hot Cell/Shop Fee	X			X
1.4	Inspection of Cask and Internals				
	(a) exterior temperature readings	X			
	(b) radiation survey	X			
	(c) gas sampling of cask interior prior to opening	X			X
	(d) video/photographic inspection of cask support pad	X			
	(e) video/photographic inspection of cask exterior	X			
	(f) video/photographic inspection of cask interior	X			
	(g video/photographic inspection of the cask seals	X			
	(h) mechanical property evaluations of the cask seals				X
	(i) general video/photographic inspection of all fuel assemblies, and a detailed evaluation of up to five fuel assemblies	X			
	(j) video/photographic inspection of 12 fuel rods from the designated assembly	T11			
	(k) analyze crud and smear samples.	X			
	(l) installation of thermocouple lances and long-term monitoring of cask internal temperature				X
	(m) installation of gamma and neutron detection devices and long-term monitoring of radiation levels				X
1.5	Transportation to/from ANL, INEEL/INTEC	X			X
1.6	Consultants	---			---
1.7	Final Report	X			X
1.8	Program Management	X			X

Table 2
Base Program and Options for VSC-17 Evaluations

Task	Base Program	Options		
		1	2	3

1.1	Equipment	---	X	X	X
1.2	Procedures and Training	---	X	X	X
1.3	Hot Cell/Shop Fee	---	X	X	X
1.4	Inspection of Cask and Internals				
	(a) exterior temperature readings	---	X		
	(b) radiation survey	---	X		
	(c) gas sampling of cask interior prior to opening	---	X	X	X
	(d) video/photographic inspection of cask support pad	---	X		
	(e) video/photographic inspection of cask exterior	---	X		
	(f) video/photographic inspection of cask interior	---	X		
	(g) video/photographic inspection of the cask seals	---	X		
	(h) mechanical property evaluations of the cask seals	---		X	X
	(i) general video/photographic inspection of all fuel canisters, and a detailed evaluation of up to five fuel canisters	---	X		
	(j) video/photographic inspection of 12 fuel rods from the designated canister	---		P15	P9 and P15
	(k) analyze crud and smear samples.	---		X	X
	(l) installation of thermocouple lances and long-term monitoring of cask internal temperature	---		X	X
	(m) installation of gamma and neutron detection devices and long-term monitoring of radiation levels	---		X	X
1.5	Transportation to/from ANL, INEEL/INTEC	---	X	X	X
1.6	Consultants	---	---	---	---
1.7	Final Report	---	X	X	X
1.8	Program Management	---	X	X	X

Table 3
Base Program and Options for Castor-V/21 Fuel Evaluations

Task		Base Program	Options		
			1	2	3
2.1	Transportation	X			
2.2	Procedures and Approvals	X			
2.3	Rod Sectioning	3 rods	3 rods		3 rods

2.4 Examinations and Characterizations				
(a) profilometry	12 rods	12 rods		12 rods
(b) fission gas release	4 rods	6 rods		9 rods
(c) metallography	3 locations on 2 rods	3 locations on 3 rods		4 locations on 3 rods
(d) cladding hydrogen analysis	3 locations on 2 rods	3 locations on 3 rods		3 locations on 3 rods
(e) creep tests	4 samples on 2 rods	4 samples on 3 rods		4 samples on 3 rods
(f) cladding stress-rupture tests	---	3 samples on 2 rods		3 samples on 3 rods
(g) cladding tensile tests	3 samples on 2 rods	3 samples on 3 rods		3 samples on 3 rods
(h) transmission electron microscopy	1 rod	> 1 rod		> 1 rod
2.5 Final Report	X	X		
2.6 Program Management	X	X		
2.7 Consultants	---	---	---	---

Table 4
Base Program and Options for VSC-17 Fuel Evaluations

Task	Base Program	Options		
		1	2 P15 Canister	3 P15 and P9 Canisters
2.1 Transportation	---	---	X	X
2.2 Procedures and Approvals	---	---	X	X
2.3 Rod Sectioning			2 rods	4 rods
2.4 Examinations and Characterizations				
(a) profilometry	---	---	12 rods	24 rods
(b) fission gas release	---	---	6 rods	12 rods
(c) metallography	---	---	4 locations on 2 rods	4 locations on 4 rods
(d) cladding hydrogen analysis	---	---	3 locations on 2 rods	3 locations on 4 rods
(e) creep tests	---	---	4 samples on 2 rods	4 samples on 4 rods
(f) cladding stress-rupture tests	---	---	3 samples on 2 rods	3 samples on 4 rods
(g) cladding tensile tests	---	---	3 samples on 2 rods	3 samples on 4 rods
(h) transmission electron microscopy	---	---	> 1 rod	> 2 rods
2.5 Final Report	---	---	X	X
2.6 Program Management	---	---	X	X
2.7 Consultants	---	---	---	---