U.S. NUCLEAR REGULATORY COMMISSION
Office of Nuclear Material Safety and Safeguards
Spent Fuel Project Office

INSPECTION REPORT

Docket No.:	72-1007
Inspection Report:	72-1007/98-202
Certificate Holder:	Sierra Nuclear Corporation One Victor Square Scotts Valley, CA 95066
Inspection Locations:	Arkansas Nuclear One, Russellville, Arkansas Palisades Plant, Covert, Michigan
Dates:	March 17-20, 1998 April 20-24, 1998 May 14, 1998
Inspectors:	A. Howe, Team Leader, Spent Fuel Project Office K. Battige, Spent Fuel Project Office M. Anderson, Idaho National Engineering and Environmental Laboratory S. Doctor, Pacific Northwest National Laboratory D. Jackson, Office of Research (Technical Advisor)
Approved by:	Susan Frant Shankman, Deputy Director Transportation, Safety, and Inspection Directorate Spent Fuel Project Office Office of Nuclear Material Safety and Safeguards

Enclosure

EXECUTIVE SUMMARY

NRC Inspection Report 72-1007/98-202

On March 17-20, 1998, the U.S. Nuclear Regulatory Commission (NRC) performed an announced inspection at the Arkansas Nuclear One (ANO) nuclear power plant in Russellville, Arkansas. The purpose of the inspection was to assess the feasibility of volumetrically examining, via ultrasonic testing (UT), the structural-lid closure weld on the multi-assembly sealed basket (MSB) for the Ventilated Storage Cask (VSC)-24 dry spent fuel storage system manufactured under Certificate of Compliance No. 72-1007.

This inspection was continued on April 20-24, 1998, at the Palisades Plant in Covert, Michigan. NRC held an exit meeting on April 24, 1998, at Palisades. On May 14, 1998, NRC conducted a telephone conference call to provide observations on a document submitted May 1, 1998. On June 12, 1998, the VSC-24 Owners Group submitted a revised document in response to NRC's observations. The VSC-24 Owners Group includes the VSC-24 vendor, Sierra Nuclear Corporation, and licensees using the VSC-24 system - Consumers Power (Palisades), Entergy/Arkansas Power & Light (ANO), and Wisconsin Electric Power Company (Point Beach).

The team observed a successful demonstration of a UT technique to examine the structural-lid closure weld on a mockup of the MSB. This demonstration confirmed the feasibility of UT for both future loading operations and for previously loaded MSBs. Expected field conditions were accurately simulated. Potential dry cask storage safety impacts have been identified and there were adequate controls in place to ensure that site-specific safety reviews will be performed. For Palisades, the team found the dose estimates for workers and offsite to be within Safety Analysis Report predictions.

The team concluded that the UT system (time-of-flight diffraction) was both sensitive and capable of operation in the expected field conditions. The technique gave reasonable assurance that flaws important to structural integrity would be reliably detected and that flaws located along the weld would be length and depth sized with adequate accuracy.

Actions by the VSC-24 Owners Group to standardize the UT process, including a guideline document for UT examinations, provided a good basis to ensure consistent, reliable, and accurate examinations of VSC-24 casks at all sites. Enlistment of the Electric Power Research Institute Non-Destructive Examination Center to independently administer the UT personnel qualification program was a good initiative by the VSC-24 Owners Group.

LIST OF ACRONYMS USED

ALARA	As Low As Reasonably Achievable
ANO	Arkansas Nuclear One
ANOVA	Analysis of Variance
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
BNFL	British Nuclear Fuels Limited
CFR	U.S. Code of Federal Regulations
CoC	Certificate of Compliance
EPRI	Electric Power Research Institute
MSB	Multi-assembly Sealed Basket
MTC	MSB Transfer Cask
NDE	Nondestructive Examination
NDT	Nondestructive Testing
NMSS	Office of Nuclear Material Safety and Safeguards
NRC	Nuclear Regulatory Commission
PISC	Programme for the Inspection of Steel Components
P-Scan	Projection Image Scanning Technique
QA	Quality Assurance
RMS	Root Mean Squared
SFPO	Spent Fuel Project Office
SNC	Sierra Nuclear Corporation
TOFD	Time-of-Flight Diffraction
UT	Ultrasonic Testing
VCC	Ventilated Concrete Cask
VSC	Ventilated Storage Cask

INSPECTION PROCEDURES

Inspection Procedure 60851 "Design Control of ISFSI Components"

PERSONS CONTACTED

The team held entrance meetings on March 20, 1998, and April 21, 1998, to present the scope and objectives of the NRC inspection. On April 24,1998, the NRC held an exit meeting with Sierra Nuclear Corporation (SNC) and VSC-24 Owners Group management to present the preliminary findings of the inspection. Key individuals present at the entrance or exit meetings and principal contacts are listed in Table 1.

Table 1
Persons Contacted

C. Haughney	NRC, Acting Director, Spent Fuel Project Office (SFPO)
S. Shankman	NRC, Acting Deputy Director, SFPO
A. Howe	NRC, SFPO
K. Battige	NRC, SFPO
D. Jackson	NRC, Office of Research
J. Melfi	NRC, Resident Inspector, Arkansas Nuclear One (ANO)
J. Lennartz	NRC, Senior Resident Inspector, Palisades
M. Anderson	Idaho National Engineering and Environmental Laboratory
S. Doctor	Pacific Northwest National Laboratory
K. Moeckel	SNC, Licensing Manager
S. Fisher	British Nuclear Fuels Limited (BNFL)
C. Jones	BNFL
J. Knowles	BNFL, Senior NDT Engineer
J. Dosa	ANO, Licensing Engineer
R. Edington	ANO, General Manager
C. Fite	ANO, Acting Licensing Director
M. Harris	ANO, Technical Assistant
D. Hicks	ANO, Radiation Protection
R. Kellar	ANO, Dry Fuel Project Manager
J. McWilliams	ANO, Manager Modifications
K. Panther	ANO, NDE Level III
J. Ray	ANO, NDE Supervisor
A. South	ANO, Licensing Specialist
J. Vandergrift	ANO, Director, Quality
D. Williams	ANO, Engineering
P. Williams	ANO, Engineering
C. Zimmerman	ANO, Unit 1 Manager
M. Banks	Consumers Energy, Chemistry & Radiation Services manager
J. Broschak	Consumers Energy, Dry Fuel Storage Program Manager
D. Engle	Consumers Energy, Licensing Engineer
J. Flaherty	Consumers Energy, Dry Fuel Storage, Engineering
P. Flenner	Consumers Energy, Licensing
J. Hanson,	Consumers Energy, Director of Staffing
R. Humphrey	Consumers Energy, NDT UT Level III
D. Jones	Consumers Energy, NPAD
S. Leblang	Consumers Energy, Health Physics Lead Dry Fuel Storage
D. Morse	Consumers Energy, Dry Fuel Storage Quality Lead

Table 1
Persons Contacted, Continued

T. Palmisano	Consumers Energy, Site Vice President, Palisades
J. Schmid	Consumers Energy, Dry Fuel Storage Engineer
D. Smedley	Consumers Energy, Licensing Supervisor
K. Smith	Consumers Energy, Dry Fuel Storage Project Manager
S. Smith-Torp	Consumers Energy, Dry Fuel Services Group
E. Zernick	Consumers Energy, Dry Fuel Storage Engineering Lead
J. Becka	Wisconsin Electric, Senior Engineer, Dry Fuel Storage Group
M. Holtzmann	Wisconsin Electric, Dry Fuel Storage Project Manager
D. Hunt	Wisconsin Electric, NDE Level III
M. Elo	Sargent & Lundy/Dry Fuel Storage - Palisades
J. Flaherty	Sargent & Lundy/Dry Fuel Storage - Palisades
T. Boyers	Structural Integrity Associates, Consultant UT
H. Gustin	Structural Integrity Associates
L. Nottingham	Structural Integrity Associates
J. Wallace	Structural Integrity Associates, Quality Assurance Manager
K. Kietzman	Electric Power Research Institute (EPRI), Charlotte
R. Bouck	NDE Specialist, EPRI, Charlotte

REPORT DETAILS

1. Inspection Objectives and Scope

The Nuclear Regulatory Commission team inspected a mockup demonstration for ultrasonic testing (UT) of the structural-lid closure weld on the Ventilated Storage Cask (VSC)-24 multi-assembly sealed basket (MSB). The team observed the demonstration, reviewed selected documents, and interviewed personnel.

2. Background

Between March 1995 and March 1997, licensees at Palisades, Arkansas Nuclear One (ANO), and Point Beach experienced four incidents where cracks were discovered in either the weld between the shield-lid and the MSB shell or the weld between the structural-lid and the MSB shell. This cracking was found by the helium leak test or dye penetrant examination performed during cask loading. The MSB shell, shield lid, and the weld form part of the confinement boundary for the VSC-24 dry spent fuel storage system, are manufactured under Certificate of Compliance (CoC) No. 72-1007, and are designated as important to safety.

In response to the NRC Confirmatory Action Letter, CAL 97-7-001, issued on May 16, 1997, the VSC-24 Owners Group proposed to demonstrate the feasibility of performing UT to volumetrically examine the structural-lid-to-MSB-shell weld on a full diameter, partial height mockup of the MSB that had preinserted flaws. The VSC-24 Owners Group includes the

VSC-24 vendor, Sierra Nuclear Corporation (SNC), and licensees using the VSC-24 system - Consumers Power (Palisades), Entergy/Arkansas Power & Light (ANO), and Wisconsin Electric Power Company (Point Beach).

In March 1998, the VSC-24 Owners Group demonstrated the Projection Image Scanning Technique (P-Scan) examination method at ANO. During that demonstration, two transducers failed because of excessive wear of the wear-face. The VSC-24 Owners Group suspended the P-Scan demonstration and ultimately discontinued pursuit of the P-Scan method. Concurrent with the P-Scan option, the VSC-24 Owners Group developed the time-of-flight diffraction (TOFD) system. As described below, the team inspected the TOFD system in April 1998 and based its findings regarding UT feasibility on the TOFD system.

3. Inspection Results

3.1 Mockup Demonstration

3.1.1 Scope

The team reviewed the mockup demonstration to evaluate the adequacy of the mockup and the overall feasibility for performing UT. The team reviewed the records for mockup fabrication to verify that its construction met quality ass ance (QA) requirements. The team also evaluated differences between the mock-up and field conditions, methods to access the MSB, radiation controls, and safety assessment.

3.1.2 Observations and Findings

The VSC-24 Owners Group constructed a full diameter partial height MSB mockup specifically designed for the UT demonstration. The team observed the following regarding the construction of the mockup:

- Palisades performed a baseline UT examination of the structural-lid-to-shell weld on the mockup before flaw insertion. This scan revealed unintentional welding-related flaws in several areas. These areas were avoided during the intentional flaw insertion process. One area was removed for metallurgical examination; it revealed lack of fusion and a lack of penetration under the lip of the structural lid (as expected for a joint with a backing bar).

- A contractor for the VSC-24 Owners Group, specializing in flaw insertion, installed 33 flaws of various known sizes, orientations, and locations within the structural-lid-to-shell weld.

- The contractor performed manual UT, after flaw insertion, to identify and repair any conditions introduced by the insertion process, that would affect subsequent UT detection and sizing of flaws. The team noted that several flaws were successfully reworked and rescanned in accordance with the flaw insertion contractor's procedures. In addition, Palisades conducted a UT scan of the mockup after flaw insertion as a part of its receipt inspection program.

- The flaw insertion process and actual flaw sizes (flaw truth) for MSB mockup, CE DFS-001, were documented in the contractor's "Flawed Specimen Documentation for Consumers Energy Palisades Dry Fuel Storage Mockup," dated January 30, 1998.

The team determined that the inserted flaws met the intent of American Society of Mechanical Engineers (ASME) Section XI, Appendix VIII, and the mockup was constructed according to the design. Documentation for the mockup met the contractor's utility-approved QA program.

The MSB mockup was placed in a full-diameter, partial-height MSB transfer cask (MTC) to simulate the configuration for the loading process. Figure 1, in the accompanying attachment, shows the configuration of the MSB in the MTC and the TOFD scanning device. The team did not identify any significant differences between the mockup and the design of an actual MSB/MTC that would affect UT examination in the field.

The team observed acquisition of a complete set of data on the MSB/MTC mockup. UT of the MSB structural-lid weld was performed with the MSB in the MTC in its normal configuration for loading including the shielding shims in the MSB/MTC gap. For data acquisition, the MSB was heated to greater than 200°F to demonstrate operation at the elevated temperatures expected after the minimum 200°F weld postheat. Radiological controls were simulated to demonstrate methods to keep dose as low as reasonably achievable (ALARA) and control contamination. This demonstration accurately simulated expected field conditions and confirmed the feasibility of UT of the structural-lid weld for future loading operations.

The VSC-24 Owners Group also simulated examination methods for loaded MSBs in the ventilated concrete cask (VCC). A hydraulically operated lifting rig, to lift and lower the shield ring located in the MSB to VCC gap area, as shown in Figure 2, was demonstrated on an actual VCC, shield ring, and unloaded MSB. This lift rig was designed and fabricated to American National Standards Institute N14.6-1993, American National Standard for Radioactive Materials, "Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More." The VSC-24 Owners Group successfully demonstrated installation, operation, and removal of the TOFD scanning device on a full diameter mockup of the VCC, MSB, and shield ring.

The team evaluated the potential safety impacts of the proposed UT process. For UT of the structural-lid weld during loading, the MSB/MTC configuration is the same as for welding. For previously loaded MSBs, access to the MSB structural-lid weld while in the VCC involved removal of the VCC weather cover and lifting the shield ring. VMSB 98-001, Revision 1, "Guideline Requirements for the Time-of-Flight Diffraction Ultrasonic Examination of the VSC-24 Structural Lid to Shell Weld," identified potential impacts to safety that will require site-specific safety evaluations in accordance with 10 CFR 72.48. Those impacts included lifting the shield ring, dose to workers, offsite dose for UT in the VCC, and thermal or temperature considerations. The team noted that VMSB-98-001, Revision 1, did not consider temporary operation of the VCC with the weather cover removed. Weather cover removal was included in VMSB-98-001, Revision 3. Based on its review, the team concluded that the potential safety impacts were identified and that there were adequate controls in place to ensure that appropriate site-specific safety reviews are performed.

The estimated dose to workers and offsite dose consequences will be evaluated on a site-specific basis. For UT examination at Palisades, the estimated dose to workers was 0.079 person-rem for UT during loading and 0.305 person-rem for UT of a loaded MSB in the VCC. These estimates were based on historical dose rate measurements and without temporary shielding. The cumulative contribution to the annual offsite dose for examining 25 loaded casks on the storage pad was estimated at 0.004 rem and assumed an administrative limit on the general area dose rates of 0.250 rem per hour. The team found the dose estimates, both to workers and offsite, to be reasonable and within those predicted in the Safety Analysis Report. Additional measures to maintain dose ALARA, such as temporary shielding, should result in lower actual dose.

3.1.3 Conclusions

The team concluded that the mockup satisfactorily duplicated the configuration of an actual MSB/MTC. The UT demonstration accurately simulated expected field conditions and confirmed the feasibility of UT of the structural-lid weld for future loading operations. For previously loaded MSBs, the VSC-24 Owners Group successfully demonstrated installation, operation, and removal of the TOFD scanning device on a full diameter mockup of the VCC, MSB, and shie' : ring. Potential dry cask storage safety impacts have been identified and there were adequate controls in place to ensure that site-specific safety reviews will be performed. For Palisades, the team found the dose estimates for workers and offsite to be within Safety Analysis Report predictions.

3.2 Time-of-Flight Examination Method

3.2.1 Scope

The team assessed the UT methodology proposed for the examination of MSB structural lid closure welds. This included reviewing the TOFD technique, UT system calibration, witnessing UT equipment operation, selection of the proper ultrasonic signals to be captured during data acquisition, and the TOFD data analysis and data interpretation. The team reviewed four data sets from UT scans performed on implanted weld flaws in the MSB mockup to determine the accuracy and repeatability of the technique for flaw detection and flaw sizing. Of the four data sets, three were from scans performed prior to the team's arrival at the site and the fourth constituted the data from the scan that NRC observed. All data was acquired with the temperature of the mockup at, or above, 200°F. The first data set was acquired while the mockup was un-coated. All other data was taken after the coating normally used on the VSC-24 was applied.

3.2.2 Observations and Findings

The VSC-24 Owners Group provided background presentations on the TOFD technology and then conducted all aspects of the TOFD inspection procedure beginning with calibration and proceeding through the final step of data interpretation. The TOFD technique was developed about 20 years ago and its effectiveness has been qualified through numerous studies[1], including the Defect Detection Trials[2] and Programme for the Inspection of Steel Components (PISC)[3]. TOFD depends on the scattering (diffraction) of the ultrasonic sound waves (insonifying ultrasound) from the extremities or tips of flaws. By measuring the arrival times of these diffracted waves, the through-wall location and size (length and depth) of the flaws can be determined.

The demonstration was performed using Palisades procedure SI-UT-105, Revision 0, "Time -of-Flight Diffraction Ultrasonic Examination of VSC-24 Dry Fuel Storage Cask Structural Lid to Shell Weld." This procedure was based on a procedure prepared by the TOFD equipment contractor. Demineralized water was used as a couplant to transfer the ultrasonic energy from the transmitter into the weld and to transfer the flaw scattered ultrasonic energy to the receiver.

The team observed portions of a typical set-up routine for a single transmit and receive transducer pair (called a pitch-catch pair). The transducer calibration was performed in a 200°F water bath to simulate mockup temperature conditions. The spacing between transducers in the pitch-catch pair and amplitude responses from known reflectors (surface notches) were verified on appropriate reference blocks during this calibration. In addition, the team observed the procedure for calibrating the optical encoder used to verify the circumferential position of the scanning device. The team found the methods used for calibrating the system adequate to provide a consistent and reliable inspection.

To ensure that adequate UT data is collected and the entire weld volume is imaged, the procedure calls for set-up of a time window that begins before the arrival of the direct (lateral) sound wave and continues beyond the time of arrival of the back surface (wall) reflected wave. The team verified that the UT examiners properly implemented their procedure to collect the proper UT signals.

During the initial scans, mockup temperatures were above 230°F. This caused the water couplant to boil and reduce the signal-to-noise ratio of the data. For temperatures less than the boiling point of water, the TOFD system produced high quality signals with low noise level. The VSC-24 Owners Group revised its procedures to administratively limit the temperature to less than 200°F during data collection.

The UT equipment was easy to install on the VSC-24 and the inspections could be conducted quickly since scanning only involved movement in one direction (rotation of the transducers around the circumference of the closure weld). The UT examiner viewed

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1 Murgatroyd, R.A., et-al, 1990. *Flaw Characterization using the TANDEM and TOFD Techniques In Reactor Safety Research, The CEC Contribution, edited by* W. Krischer. pp.477-488, Elsevier Science Publishing Co., New York, NY.

2 *The UKAEA Defect Detection Trials*, Birchwood, Warrington, UK, 7-8, October 1982. Proceedings published in *Brit. J. NDT*, July 1983 - February 1984, Vols. 25 and 26.

3 *Ultrasonic Inspection of Heavy Section Steel Components: The PISC II Final Report*, 1988. edited by Nichols, R. W. and Crutzen, S. Elsevier Science Publishing Co., New York, NY

the TOFD data as it was collected to verify that it was of high quality. Several scans (or a single scan using multiple transducers) were required to provide high sensitivity for reliably detecting flaws located at any depth in the weld and to reliably detect flaws oriented along the weld and across the weld.

The TOFD technique was very sensitive and detected both implanted flaws and naturally occurring welding flaws. From the inventory of 30 implanted flaws and naturally occurring flaws, the team selected a set of flaws for the analysts to demonstrate data analysis and interpretation using SI-UT-105 and a personal computer workstation. The team was satisfied with the analysts' ability to correctly interpret data and size flaws but observed that there are specific skills required to successfully perform this data analysis and interpretation that are not fully detailed in procedure SI-UT-105. However, to qualify as a data analyst, each analyst candidate will be required to demonstrate proficiency in data analysis and interpretation during a performance demonstration process. Qualification of personnel is discussed further in section 2.3.2 of this inspection report. Additionally, from discussion with NDE specialists present during the inspection, the team understands that a revision to SI-UT-105 to add detail to the procedure and include an analysis flow chart is under consideration by the VSC-24 Owners Group.

Regarding TOFD accuracy and reliability, the team observed that 100 percent of the implanted flaws were detected during each of the four data acquisition runs. The VSC-24 Owners Group provided tabulated data sets consisting of length and through-wall [depth] values for each of the implanted flaws, as characterized by the UT analysts. This application of the TOFD technique employs two sizing strategies: 1) the measurement [in time] of diffracted flaw tip signals from a 60° refracted longitudinal wave with, or without, the presence of a disturbance in the lateral surface wave; and 2) the measurement [in time] of diffracted flaw tip signals from a 52° refracted longitudinal wave in conjunction with the response from the backwall of the inspection area. The first (60°-lateral) strategy is used for flaws in the upper one-third of the weld and the second (52°-tip-to-backwall) for flaws in the lower two-thirds of the weld.

The VSC-24 Owners Group performed a simple regression analysis for each data set, and appropriate sizing strategy. The analysis compared reported flaw sizes against actual values. The team reviewed this information and noted the cumulative average error, in terms of root mean squared (RMS) inches, for the two sizing methods. The RMS values are given in Table 2.

Table 2 - Reported RMS Flaw Sizing Error Values (inches)

Sizing Method	Data Set 1		Data Set 2		Data Set 3		Data Set 4	
	Length	Depth	Length	Depth	Length	Depth	Length	Depth
60°	0.18*	0.15	0.19*	0.12	0.09*	0.13	0.15*	0.14
52°		0.08		0.06		0.05		0.03

*Length data combined for both sizing methods

The overall error from the regression analysis indicates that for length sizing method, and the 52°-tip-to-backwall depth sizing method, accuracy levels were consistent with the UT characterization standard[4] used for commercial nuclear power plant components (length within 0.75-inch RMS and depth within 0.125-inch RMS). With respect to the 60°-lateral method, the results indicate error values slightly higher than those currently prescribed by ASME Section XI Code. However, the 60°-lateral sizing method consistently oversized the through-wall depth of flaws located in the upper portion of the weld; this suggests that flaws located in this region will be evaluated in a conservative manner. Further independent analysis by the inspection team is discussed below.

The team independently performed an analysis of variance (ANOVA) on the four data sets to better understand the overall error through decomposition into specific categories, and provide a tool to determine if the UT technique produced repeatable data. The combined RMS error and bias, along with the variability contributions (Sigma) from three sources: 1) flaw-to-flaw variations; 2) UT analyst variations; and 3) random components of the sizing error from the ANOVA, are given in Table 3.

Table 3 - ANOVA for Combined Data Sets

Sizing Method	Flaw Dimension	RMS	Bias	Sigma - Flaw	Sigma - Analyst	Sigma - Random
60°	Depth	0.132	0.124	0.030	0.011	0.032
	Length	0.137	-0.012	0.067	0.000	0.122
52°	Depth	0.044	0.021	0.022	0.007	0.032
	Length	0.166	0.041	0.089	0.012	0.135

Notes: 1 - Depth is through-wall extent.
2 - All values are reported in inches.
3 - Does not include transverse flaws.

An ANOVA is conducted by creating a matrix with the rows representing the different analysts (data-sets) and the columns representing the different flaws. The value recorded in the matrix for a given flaw and a given data-set is the difference between measured value and the true size. Data is entered in this manner for all flaws and all data-sets for statistical analysis. Since the flaw size has been removed, the flaw-to-flaw variability (Sigma-flaw) looks at the errors from column to column. In a similar manner, the data set variability (Sigma-analyst) looks at the errors from row to row. The random error (Sigma-random) then is the remaining error not accounted for by these two factors.

The team made the following observations from the ANOVA data:

- The variation in sizing all the flaws within a data-set (Sigma - Flaw) was small when

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compared with the cumulative average error (RMS error).

- The variation in sizing among the data-sets (Sigma-analyst) were small when compared with the RMS error.
- There was a large (relative to RMS) bias for the 60°-lateral technique.
- Random variations were consistently the largest error contribution to the overall error.

From these observations, the team concluded that the reported values for length and depth of each flaw were generally consistent and therefore flaw sizing is consistent and repeatable. The large bias for the 60°-lateral technique systematically oversized flaws (conservative) in the depth characterization when used to size flaws located in the upper one-third of the weld. Overall, the accuracy of the TOFD technique met the intent of ASME Section XI, Appendix VIII.

3.2.3 Conclusions

The team concluded that the UT system (time-of-flight diffraction) was both sensitive and capable of operation under expected field conditions. The technique gave reasonable assurance that flaws important to structural integrity would be reliably detected and that flaws located along the weld would be length and depth sized with adequate accuracy.

3.3 UT Examination Process Controls

3.3.1 Scope

The team reviewed the UT examination process controls taken by the VSC-24 Owners Group to ensure that personnel are qualified (to take data and/or interpret data) and that site-specific UT procedures will be developed, qualified, and implemented to ensure consistent, reliable, and repeatable results.

3.3.2 Observations and Findings

The VSC-24 Owners Group has taken significant actions to standardize the UT process and ensure that the UT methods developed and demonstrated will be consistently implemented at each site using the VSC-24 system. First, the VSC-24 Owners Group enlisted the Electric Power Research Institute (EPRI) nondestructive examination (NDE) Center's involvement in UT procedure development and personnel qualification. The EPRI NDE Center has recognized expertise in the area of UT examination and personnel qualification. The team considers EPRI involvement to be a very beneficial enhancement to the UT process.

The VSC-24 Owners Group initiated construction of an additional mockup for procedure qualification and personnel performance qualification demonstration. Information on the nature of the imbedded flaws in this mockup will be maintained secure.

The VSC-24 Owners Group prepared guideline document VMSB 98-001, Revision 3, "Guideline Requirements for the Time-of-Flight Diffraction Ultrasonic Examination of the VSC-24 Structural Lid to Shell Weld." This document was created by the VSC-24 Owners Group to codify actions taken to standardize the UT process.

VMSB 98-001, Revision 3, addresses flaw acceptance criteria development and references calculation CPC-06Q-301, "Allowable Flaw Size Definition for VSC-24 Dry Storage Cask Structural Lid to Shell Weld" as the basis for the flaw acceptance criteria. A flaw disposition flow chart provides a good functional outline for the overall process of examining the weld and properly addressing any flaws that are found. However, the team noted that the discussion, in VMSB 98-001, Revision 3, of two inputs related to the flaw size calculation differed with a similar discussion in a separate letter (SNC98018) from SNC to NRC dated June 11, 1998. This issue was discussed with SNC on June 17, 1998, and SNC stated that VMSB 98-001, Revision 3, would be updated to ensure consistency. This difference does not affect the team's conclusions regarding the adequacy of the UT process controls described in the remainder of VMSB 98-001.

As previously discussed in Section 3.1.2, VMSB 98-001 describes potential impacts to safety that will require site-specific safety evaluations in accordance with 10 CFR 72.48.

The guideline document specified criteria for procedure qualification and approval that included a full demonstration of the process. Acceptance criteria for flaw detection, length, and depth sizing were also given. The team observed successful detection and sizing of circumferentially oriented flaws. UT of flaws oriented across the weld (transverse orientation) showed that detection is reliable. However, the guideline document requires that flaw depth sizing show that inside surface-connected flaws do not extend into the upper 25 percent of the weld volume. The existing mockup does not have flaws that can test this requirement. The VSC-24 Owners Group and the EPRI NDE Center were aware of this situation and stated that this aspect of the procedure would be qualified before examining actual MSB welds. The team was satisfied with this resolution.

The guideline document requires that modification of an approved procedure that alters an essential variable requires requalification. The examination procedure essential variables were listed in an attachment to the guideline document. These requirements were comparable to ASME Section XI Appendix VIII.

VMSB 98-001 specified requirements for qualification and certification of NDE technicians performing the examination. Specifically, personnel must be qualified and certified Level II or Level III UT technicians in accordance with American Society for Nondestructive Testing (ASNT) Recommended Practice No. ASNT-SNT-TC-1A, "Personnel Qualification and Certification in Nondestructive Testing," 1984 Edition. They must complete a minimum 40 hours training on the TOFD method, including 8 hours specific to the VSC-24. Qualification, via performance demonstration, will be independently administered by the EPRI NDE Center, a recognized industry group, in accordance with EPRI test protocols. The candidates for qualification will not have prior knowledge of the flaw characteristics as a second mockup will be constructed and flaw information will be maintained secure. For flaw detection, personnel will be required to detect at least 80 percent of a minimum of 10 flaws. For flaw sizing, personnel will be required to detect at least 80 percent of a minimum of 10 flaws, and size them in accordance with the requirements of VMSB-98-001, Sections 8.1.1 and 8.1.2. These performance criteria for flaw detection and sizing were consistent with the intent of ASME Section XI, Appendix VIII. Qualification is limited to three years for Level II personnel and five years for Level III personnel. A complete performance demonstration is needed to renew qualification. These requirements were consistent with industry practice (ASNT-SNT-TC-1A).

3.3.3 Conclusions

Actions by the VSC-24 Owners Group to standardize the UT process and the guideline document for UT examinations, VMSB 98-001, provided a good basis to ensure consistent, reliable, and accurate examinations of VSC-24 casks at all sites. The team found that enlistment of the EPRI NDE Center to independently administer the personnel qualification program was a good initiative by the VSC-24 Owners Group.

4. Overall Conclusion

The team observed a successful demonstration of a UT technique to examine the structural-lid closure weld on a mockup of the MSB. This demonstration confirmed the feasibility of UT for both future loading operations and for previously loaded MSBs. Expected field conditions were accurately simulated. Potential dry cask storage safety impacts have been identified and there were adequate controls in place to ensure that site-specific safety reviews will be performed. For Palisades, the team found the dose estimates for workers and offsite to be within Safety Analysis Report predictions.

The team concluded that the UT system (time-of-flight diffraction) was both sensitive and capable of operation in the expected field conditions. The technique gave reasonable assurance that flaws important to structural integrity would be reliably detected and that flaws located along the weld would be length and depth sized with adequate accuracy.

Actions by the VSC-24 Owners Group to standardize the UT process, including a guideline document for UT examinations, provided a good basis to ensure consistent, reliable, and accurate examinations of VSC-24 casks at all sites. Enlistment of the Electric Power Research Institute Non-Destructive Examination Center to independently administer the UT personnel qualification program was a good initiative by the VSC-24 Owners Group.

5. Exit Meeting

The team presented the inspection results to SNC and the VSC-24 Owners Group management on April 24, 1998. SNC acknowledged the findings presented.

Attachment: Figures

FIGURES

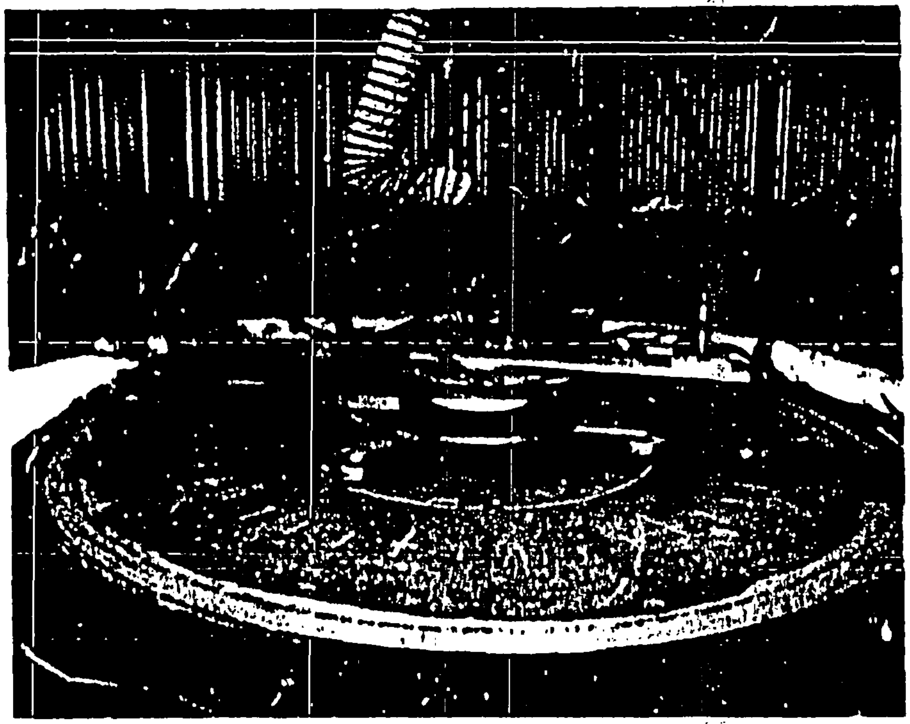

Figure 1. Configuration of the MSB in the MTC and the TOFD scanning device

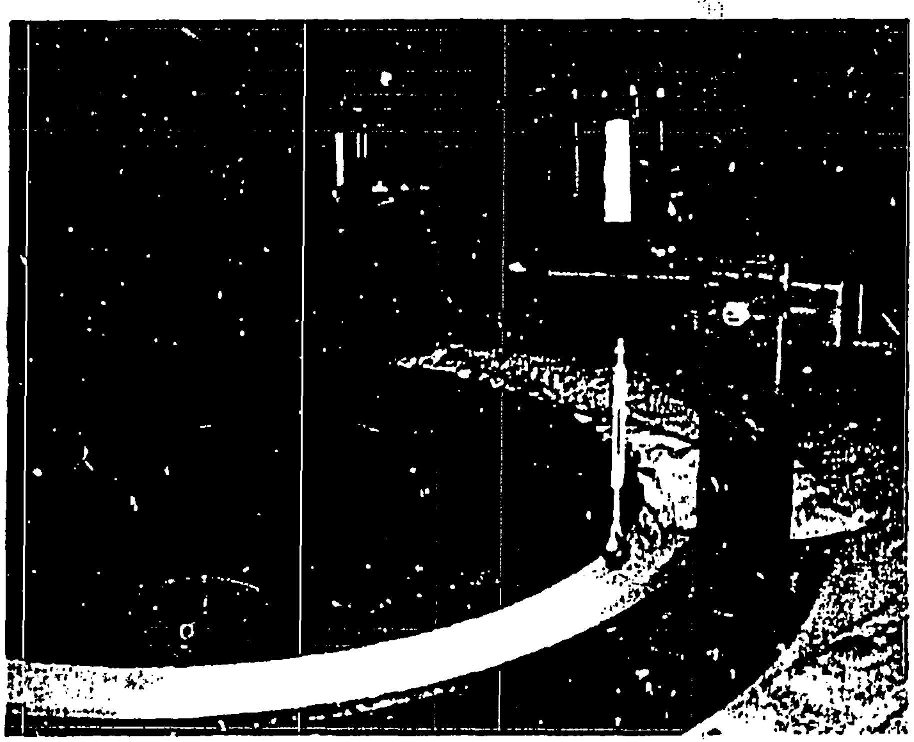

Figure 2. VCC shield ring lift rig