

ALARA AND DECOMMISSIONING - THE FORT ST. VRAIN EXPERIENCE

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ABSTRACT

The Fort St. Vrain Nuclear Generating Station, the first and only commercial High Temperature Gas Cooled Reactor to operate in the United States, completed initial fuel loading in late 1973 and initial startup in early 1974. Due to a series of non-nuclear technical problems, Fort St. Vrain never operated consistently, attaining a lifetime capacity factor of slightly less than 15%. In August of 1989, the decision was made to permanently shut down the plant due to control rod drive and steam generator ring header failures. Public Service Company of Colorado elected to proceed with early dismantlement (DECON) as opposed to SAFSTOR on the bases of perceived societal benefits, rad waste, and exposure considerations, regulatory uncertainties associated with SAFSTOR, and cost. The decommissioning of Fort St. Vrain began in August of 1992, and is scheduled to be completed in early 1996. Decommissioning is being conducted by a team consisting of Westinghouse (engineering and contract support), MK-Ferguson (craft) and Scientific Ecology Group (radiation protection). Public Service Company of Colorado as the licensee provides contract management and oversight of contractor functions.

An aggressive program to maintain project radiation exposures As Low As Reasonably Achievable (ALARA) has been established, with the following program elements: temporary and permanent shielding; contamination control; mockup training; engineering controls; worker awareness; integrated work package reviews; communication; special instrumentation; video camera usage; robotics application; and project committees. To date, worker exposures have been less than project estimates. From the start of the project through February of 1994, total exposure has been 98.666 person-rem, compared to the project estimate of 433 person-rem and goal of 347 person-rem. The presentation will discuss the site characterization efforts, the radiological performance indicator program, and the final site release survey plans.

INTRODUCTION

Background

Decommissioning of commercial nuclear generating stations has been initiated in the United States with the dismantling of the Fort St. Vrain Nuclear Generating Station. Fort St. Vrain is owned and was operated by Public Service Company of Colorado (PSC) and is located on a 2,798 acre site approximately 35 miles Northeast of Denver, Colorado.

Fort St. Vrain is unique in the United States as it is a High Temperature Gas Cooled Reactor. The facility was rated at 842 MWth and 330 MWe. Significant Milestones for the facility are as follows:

Construction initiated in 1968

Construction completed in 1973

Initial nuclear criticality was achieved in 1974

Unit committed to commercial operation in 1979

Stipulation & Settlement Agreement removes facility from rate base 1986

PSC informs NRC that facility will be shutdown not later than June 30, 1990

Decision by PSC to terminate facility operations August 29, 1989

Possession Only License Issued 1991

Decommissioning/dismantlement activities begin August 1992

In response to the historical reduced levels of generation at Fort St. Vrain (FSV), the Colorado Public Utilities Commission instituted penalties against PSC in 1986 which reduced the revenues that could be recovered from its customers. As a result of unfavorable plant operating performance, Fort St. Vrain did not produce adequate revenues to offset expenses during 1987-1989. In August 1989, following plant shutdown due to control rod drive problems, significant cracking was discovered in the steam generator main steam outlet piping assemblies. Due to these problems along with other "mechanical" and "financial" concerns PSC decided not to restart the plant.

DECON Versus SAFSTOR Decision

PSC initially filed a Preliminary Decommissioning Plan based on the SAFSTOR decommissioning option. Following a conceptual dismantlement study that verified that the technology existed to dismantle the reactor vessel, PSC elected to pursue the DECON (early dismantlement) option. Several major considerations were associated with this decision, including:

Future regulatory risks and standards could not be quantified

Low Level Radioactive Waste (LLRW) disposal rates will continue to escalate

Significant personnel knowledge will be lost by waiting the 55 year SAFSTOR time period

No significant reduction in LLRW volume occurs during the 55 year SAFSTOR

Dismantlement provides for a significant reduction in future liability

Projected Radiological Conditions and LLRW Inventories

Activation Analysis and Site Characterization activities yielded project LLRW Classification estimates, project curie estimates, and project dose rate estimates for the Prestressed Concrete Reactor Vessel (PCRV) as presented in Tables 1 through 3.

TABLE 1
DECOMMISSIONING
WASTE CLASSIFICATION PREDICTIONS

CLASS	VOLUME (CUBIC FEET)
A	79,157
B	20,279
C	636
TOTAL	100,072

TABLE 2
ESTIMATED CURIE TOTAL AT FSV
(Three Years After Shutdown)

NOTE: The systems listed below are those systems which are known to be contaminated, or experiencing on-going maintenance, defueling and component removal which may transfer contamination to other systems and/or locations.

System No.	System	Total Curies	
		From Activation	From Loose Contamination ⁽¹⁾
11	PCRIV and Internal Components	7.94 E+05	2.54 E+02
12	Controls Rods and Drives	1.84 E+04	N/A
13	Fuel Handling Equipment	N/A	8.95 E-03
14	Fuel Storage Facility	N/A	2.08 E-02
16	Auxiliary Equipment	N/A	9.05 E-03
17	Reactor Removable Reflector	4.82 E+05	N/A
21	Primary Coolant	N/A	6.01 E+01
22	Secondary Coolant	N/A	5.68 E+03
23	Helium Purification	N/A	9.33 E-01
61	Decontamination Systems	N/A	1.06 E-05
62	Radioactive Liquid Waste	N/A	4.06 E-05
63	Radioactive Gas Waste	N/A	8.15 E-05

(1) Includes an estimate of loose surface contamination due to activated corrosion products.

TABLE 3

**PCR V DOSE RATES ESTIMATES IN AIR
AT 5 YEARS AFTER SHUTDOWN**

RADIAL	GAMMA DOSE RATE R/Hr
All components (from large side reflector to PCR V concrete)	9.7E + 01
Large side reflectors removed (from spacers to PCR V concrete)	2.3E + 02
From core barrel to PCR V concrete	2.1E - 02
PCR V liner and concrete only	8.8E - 03
PCR V concrete only	4.5E - 03
22" PCR V concrete removed	6.3E - 06
24" PCR V concrete removed	3.4E - 06
AXIAL UP	
All components (from Kaowool insulation to PCR V concrete)	1.7E - 01
PCR V liner and concrete only	4.4E - 01
PCR V concrete only	1.7E - 01
32" PCR V concrete removed	7.6E - 06
34" PCR V concrete removed	4.4E - 06
36" PCR V concrete removed	2.6E - 06
AXIAL DOWN	
All Components (from core support blocks to core support floor)	6.1 - 02
PCR V liner and concrete only	2.5E - 01
PCR V concrete only	1.8E - 02
20" PCR V concrete removed	5.3E - 06
22" PCR V concrete removed	2.7E - 06

INITIAL SITE CHARACTERIZATION

The initial characterization of the Fort St. Vrain site began in April, 1991, approximately 16 months prior to the start of decommissioning. The duration of the site characterization program was 9 months, and approximately 20,000 person-hours were utilized. Key elements of the program included background determination, steam system characterization, auxiliary systems characterization, structural and environmental characterization, and development of isotopic scaling factors. An aggressive radiological monitoring program typically translates into a large number of measurements, and the site characterization program was no different - over 25,000 direct measurements were taken. State of the art instrumentation was utilized which provided for the use of a microprocessor linked with a relational database and a bar coding system. The data from the site characterization fills 15 volumes and served to help determine the project scope and remediation alternatives. Were there any surprises? Yes, contamination was found in several systems which had not been previously suspected of being contaminated.

ALARA PROGRAM ELEMENTS

The key elements of the Fort St. Vrain decommissioning ALARA program are as follows:

AGGRESSIVE SHIELDING PROGRAM

- worker involvement
- radiation protection involvement
- engineering analysis on site
- inspection/approval by ALARA group

CONTAMINATION CONTROL

- liberal use of stripcoat
- hydrolazing operations
- use of glove bags/shrouds
- use of drippans, dams and rinsing
- worker awareness

MOCKUP TRAINING PROGRAM

- classroom training held prior to field mockup
- mockups are videotaped
- small models used in classroom
- field mockups require demonstration of proficiency

RADIOLOGICAL ENGINEERING CONTROLS

- plant ventilation (20,000 acfm)
- work platform ventilation (17,000 acfm)
- local or portable ventilation
- box containments with ventilation attached

ALARA AWARENESS PROGRAM

- employee ALARA suggestion program**
- ALARA included in general training program**
- ALARA newsletter and posting of exposure goals**
- ALARA briefings and worker "toolbox" sessions**
- reviews of work in progress and exposure investigations**

INTEGRATED WORK PACKAGE REVIEWS

- engineering/ALARA personnel work jointly on packages**
- RP hold points/field sign offs incorporated**
- ALARA must approve all revisions**

COMMUNICATIONS

- hand-held radios/headsets**
- paging/intercom systems**

SPECIAL INSTRUMENTATION

- automated alarming digi-dose system with alarms/visual signals**
- remote monitoring devices with alarms and visual readouts**
- underwater sampling/monitoring equipment**

VIDEO CAMERA USE

- aids in supervisory inspections**
- reduces exposures for visitors and plant tours**
- allows monitoring of work in progress from low dose areas**

PROJECT COMMITTEES

- ALARA and Decommissioning Safety Review Committee (DSRC)**
- review high exposure tasks**
- review project performance indicators**
- discuss project concerns**
- include all plant work groups**
- field working level personnel are included**

RADIOLOGICAL PERFORMANCE INDICATOR PROGRAM

The following areas are included in the program:

PERSON-REM

An exposure estimate was developed for each work task involved in the decommissioning. In addition the project establishes aggressive goals for each work task. The exposure estimates and goals are compared to the actual exposure for the period of interest (month, year, or project to date).

SOLID RADIOACTIVE WASTE

The volume of waste shipped to waste processors or the disposal site are tracked by type of shipment (cask, van, boxes, etc.) for the period of interest. Total volume sent to the disposal site is compared to our contractual limit at the disposal site of 140,000 cubic feet for the entire decommissioning project.

PERSONNEL CONTAMINATION EVENTS

Goals for clothing and skin contaminations are established, and actual performance for the period of interest is compared to the goals. In addition, a measure of contaminations per unit time in radiological control areas is compared to similar data for light-water reactors.

RADIOLOGICALLY CONTROLLED AREA DATA

Time spent in radiologically controlled areas and number of respirators issued are tracked for the period on interest.

ALARA SUGGESTIONS

The number of suggestions received and implemented for the period of interest are tracked.

POSITIVE BIOASSAY RESULTS

The number of positive whole body counts and tritium analyses are evaluated for the period of interest.

RADIOLOGICAL OCCURRENCE REPORTS

The number of radiological occurrence reports are evaluated for the period of interest.

A typical performance indicator report is presented in Table 4.

TABLE 4
SUMMARY OF FEBRUARY PERFORMANCE INDICATORS

PERSON-REM			
	Estimate	Goal	Actual (to date)
Month (Feb.)	6.5	5.2	5.086 ⁽¹⁾
1994 (Jan-Feb)	12.0	9.6	9.249 ⁽¹⁾
Total Project	433	347	98.666 ⁽²⁾

(1) Based on TLD and DIGI Results

(2) Based on TLD and DIGI Results and adjustments for past TLD read corrections

SOLID RADWASTE VOLUME PROCESSED AND SHIPPED	
Thru (Feb.)	6,974 ft ³
Projected (Mar.)	4,000 ft ³
Project Total to Date	76,104 ft ³ *

* As of June 1, total adjusted to include volume of waste sent to SEG for volume reduction

RADIOACTIVE MATERIAL SHIPPING UPDATE (1992/1993 TOTALS)				
1992 TOTALS				
Shipment Type	Number	Weight (lbs)	Volume (ft³)	Activity (Ci)
Vans	11	NA	6264	7.10
Casks	38	NA	4245	8671.20
SEG Shipments	1	37340	2080	34
Totals	50	37340	12589	8678.64
1993 TOTALS				
Vans	5	NA	3,727	6.13
Casks	77	NA	12,503	22,405.03
Concrete Boxes	36	NA	22,167	68.34
SEG Shipments	11	404,460	18,144	4.26
Totals	129	404,460	56,541	22,483.76

TABLE 4

SUMMARY OF FEBRUARY PERFORMANCE INDICATORS - Continued

1994 RADWASTE SHIPPING TOTALS				
Vans	0	NA	0	NA
Casks	26	NA	4894	3131.27
Concrete	0	NA	0	0
SEG Shipments	2	35,850	4894	.29
Total Thru 2-28	28	35,850	6974	3131.56

PERSONNEL CONTAMINATION EVENTS		
Period	Clothing	Skin
Month (Feb.)	2	0
1994	2	0
Total Project	36	12

RADIOLOGICALLY CONTROLLED AREA DATA		
Period	RCA Person Hours	Respirators Issued
Month (Feb.)	9,861	85
1994	21,017	96
Total Project	202,796	1,725

ALARA SUGGESTIONS		
Period	Received	Implemented
Month (Feb.)	6	4
1994	9	7
Total Project	157	114

TABLE 4

SUMMARY OF FEBRUARY PERFORMANCE INDICATORS - Continued

POSITIVE BIOASSAY RESULTS		
Period	Whole Body Counts	Tritium Analysis
Month (Feb.)	0	0
1994	0	0
Total Project	0	0

RADIOLOGICAL OCCURRENCE REPORTS	
Month (Feb.)	8
1994	10
Total Project	60

FINAL SITE RELEASE SURVEY

The final site release survey plan was submitted to the Nuclear Regulatory Commission (NRC) in February of 1994. The NRC has given a preliminary indication that they will be able to perform their initial review in about six weeks time. We hope to begin performing limited final release surveys in the third or fourth quarter of 1994.

CONCLUSION

Fort St. Vrain is one of the very first large scale reactor decommissioning projects to be undertaken in this country. An aggressive multi-faceted ALARA program has contributed to very impressive radiological performance indicators to date. Public Service Company of Colorado and our decommissioning contractor team are looking forward to a successful conclusion to the project in the early 1996 time frame.

Author Biography

Ted Borst, CHP, is the Facility Support Manager for Public Service Company of Colorado at the Fort St. Vrain Nuclear Station. Mr. Borst also serves as the Radiation Protection Manager at Fort St. Vrain. Apart from his radiation protection responsibilities, Mr. Borst is also responsible for the training, emergency preparedness, security, and document control programs at Fort St. Vrain. Before joining Public Service Company of Colorado, Mr. Borst worked for Battelle Pacific Northwest Laboratories as a research scientist, where he worked on an assortment of Department Of Energy and Nuclear Regulatory Commission sponsored projects. Previously Mr. Borst served as a health physicist for the Nuclear Regulatory Commission, performing compliance inspections out of the Region III office. He has B.S. in Physical Sciences and an M.S. in Radiation Biology, both received from Colorado State University. Mr. Borst is Certified by the American Board of Health Physics.

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