THE 4TH INTERNATIONAL TOPICAL MEETING ON
NUCLEAR THERMAL HYDRAULICS, OPERATIONS AND SAFETY
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SURVEYS OF EMBEDDED PIPING FOR SHOREHAM LICENSE TERMINATION

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ABSTRACT

In planning the decommissioning of the Shoreham Nuclear Power Station (SNPS) in Wading River, N.Y., it was determined that the cost of removing contaminated floor drain piping was prohibitive. The piping is typically embedded approximately four feet deep in reinforced concrete, often below structural I-beams. A decision was made to develop remote survey devices ("pipe crawlers") that would allow SNPS to decontaminate and survey embedded piping within NRC free release limits. Pipe crawlers currently in use at SNPS are able to traverse multiple 45 and 90 degree bends while maintaining all detectors in the required geometry (less than 1 cm detector to surface distance). The following aspects of this project will be presented:

* System classification and cost-benefit analysis.
* Overview of system decontamination.
* Pipe crawler mechanical and electrical development.
* Detector backgrounds and MDA's.
* Additional devices and techniques.
* NRC position on crawler use.
* SNPS results to date.

I. SHOREHAM DECOMMISSIONING OVERVIEW

The Shoreham Nuclear Power Station (SNPS) operated at low power for several short runs between 1985 and 1987. A radiological characterization of the site was completed in June of 1990. The SNPS Decommissioning Plan, submitted to the NRC in December 1990, identified several contaminated systems for removal. Although the liquid radioactive waste collection system was one of those slated for removal, it became evident that the cost of removing embedded drains would be prohibitive. Much of the piping was embedded up to depths of 6' and in some cases located below embedded I-beams. Research on a decontamination/ survey project began in the fall of 1991. The NRC approved the SNPS Decommissioning Plan in June of 1992. In parallel with other Decommissioning activities, the decontamination and surveys of embedded piping began in October of 1992 and February of 1993, respectively. Currently the decommissioning work is approximately 90% complete, while the Embedded Piping Project is 93.5% complete. NRC license (possession only) termination for SNPS is expected in December 1994.

II. SYSTEM CLASSIFICATION AND COST BENEFIT ANALYSIS

Based on the SNPS radiological characterization results, which included the opening and surveying of over 300 system components, systems were categorized for full or partial removal as shown in Figure 1 (next page). The liquid radioactive waste system (G-11) warranted total removal based on contamination levels (up to 200,000 disintegration per minute per 100 cm2). However, two factors prevented this from occurring. Namely, the cost of total removal and project management's desire to continue to use the system to collect non-radioactive industrial waste water. A cost-benefit analysis was performed that showed potential for a considerable cost savings via the decontamination/survey option. (See Figure 2). It should be noted that the cost estimate for removal is considered low since additional costs to remove piping embedded below vertical walls and permanent components were not considered. This analysis triggered the development of both comprehensive pipe decontamination techniques and pipe survey devices. (The overall quantities and removal costs for SNPS embedded piping are shown in Figure 3).

III. SURVEY DEVICE DESIGN REQUIREMENTS

The two governing site release documents in use at SNPS are Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors, and NUREG 5849 (DRAFT), Manual for Conducting Radiological Surveys in Support of License Termination.

EMBEDDED PIPING COST - BENEFIT ANALYSIS

DECON / SURVEY OPTION	
TOTAL LENGTH	8,652 Feet
COSTS:	
Materials	$ 156,000.
Pre Decon Survey	$ 110,000.
Hydrolazing	$ 438,000.
Final Survey	$ 278,000.
TOTAL PROJECTED COST	$ 984,000.
REMOVE / SHIP OPTION	
TOTAL WEIGHT	107,900 lbs
COSTS:	
Removal	$ 9.233 Million
Ship to VR	$ 71,610
TOTAL PROJECTED COST	$ 9.304 Million

Figure 2

Survey instrumentation had to be sensitive enough to detect radioactivity below the established limits while being able to stand up to several demanding physical requirements. The key desired qualities were:

* Ability to quantify surface contamination levels below Reg. Guide 1.86 limits
  (5000 dpm/100 cm2 average and 1000 dpm/100 cm2 removable).

* Ability to traverse multiple 90 and 45 degree pipe bends.

* Remote read out capability.

* Durability in harsh environment.

IV. DETECTORS AND PIPE CRAWLERS

Two types of detectors were considered and tested. Custom made NAI detector/photo, multiplier assemblies provided excellent qualitative feedback. However, their limited range, inability to quantify and locate contamination and their susceptibility to background fluctuations made them a second choice. Conventional GM 'frisker' probes (HP-260 and Aptec 126) provided an established detector for meeting the required MDA's. The vehicle for travel inside the pipe is called a "pipe crawler". It is unique in that mounted with varying numbers of GM probes, the pipe crawler can traverse multiple pipe bends while maintaining all detectors within 1 cm of the pipe surfaces.

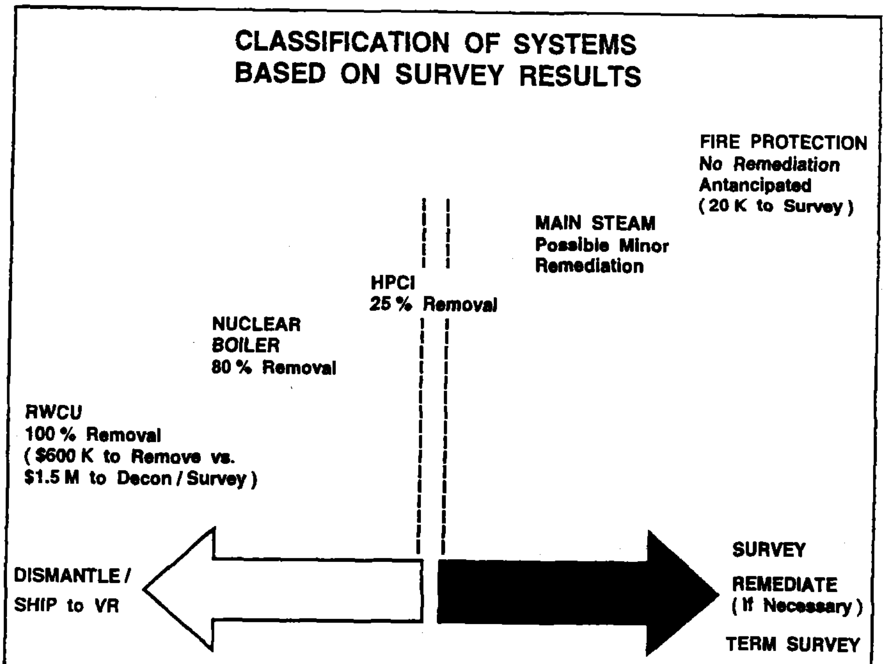


Figure 1

Essentially, a free release type survey can be performed.

Radiological data from the crawlers is collected on a microprocessor based Eberline ESP-2 survey meter. Data from up to 500 survey locations can be stored in memory and down loaded to the SNPS Termination Survey Database. Furthermore, individual detectors may be electronically isolated via a multi-switch junction box to pinpoint the location of contamination.

Each pipe crawler (See Figure 4) has daily control chart and background checks performed on it as required by NUREG 5849. Background checks are performed using permanent or cut "clean" piping from non-radiologically controlled areas. Figure 5 is a photograph of an 8 inch pipe crawler. Pipe crawlers that are 8" and larger utilize pneumatic controls to retract and extend detector probes. This assists in negotiating 45 and 90 degree elbows.

V. ADDITIONAL DEVICES AND TECHNIQUES

As pipe crawlers began to be used in the field, several other supporting devices/ techniques were employed.

A. Shoreham In-situ Radiological and Visual Acute Examination (SIRVAE) System.

During the piping decontamination phase, the need for visual inspection capabilities was apparent due to the number of interferences (e.g. debris, welds) was identified. The SIRVAE system utilizes a lighted, 1.25" diameter, high resolution camera which proved invaluable as an aid in the debris removal process. The camera can be coupled with a control module, VHS recorder, video logger, foot encoder and even the crawler itself. The combination shown in Figure 6 allows surveys to be taken while maintaining a video record of the pipe run. Location, radiological data, technician etc. can also be encoded for storage on Super VHS tapes. The video image is particularly valuable in that it verify's that the pipe run was clean and dry at the time of survey.

B. Hydrolazing

State-of-the-art hydrolazing equipment, including the latest spin-jet and self-traveling tips were used to reduce SNPS embedded piping to below Reg Guide 1.86 limits. Several lessons were learned concerning this detailed type of hydrolazing, however they are outside the scope of this paper.

VI. NRC POSITION ON PIPE CRAWLER DEVICES

The NRC and its contractors for site Termination Survey Confirmation (Oak Ridge Associated Universities), have reviewed the pipe crawler development and implementation techniques on several occasions. Their response has been enthusiastic, stating that "this type of device has been needed for a long time". The use of the pipe crawlers for official termination surveys has been included in the NRC approved SNPS Termination Survey Plan.

VII. CURRENT STATUS

As of this writing, over 13,830 feet of embedded piping have been surveyed. This will result in cost savings of millions of dollars to Long Island rate payers. Additionally, building floors and water collection systems will remain intact, allowing structures to be effectively reused in non-nuclear capacities.

It is evident that "pipe-crawlers" may become significant, cost-effective devices in future decommissioning work.

(Illustrations: Robert Yetter)

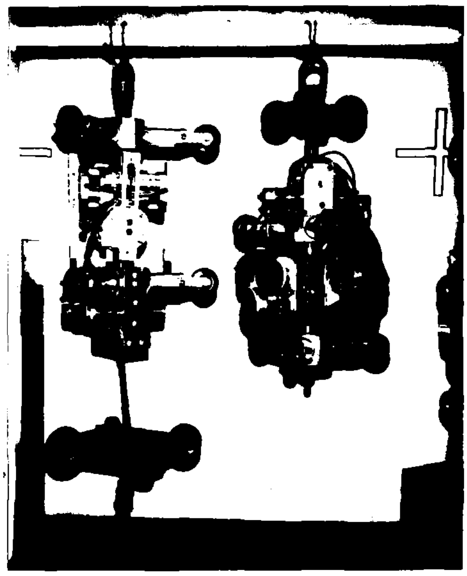


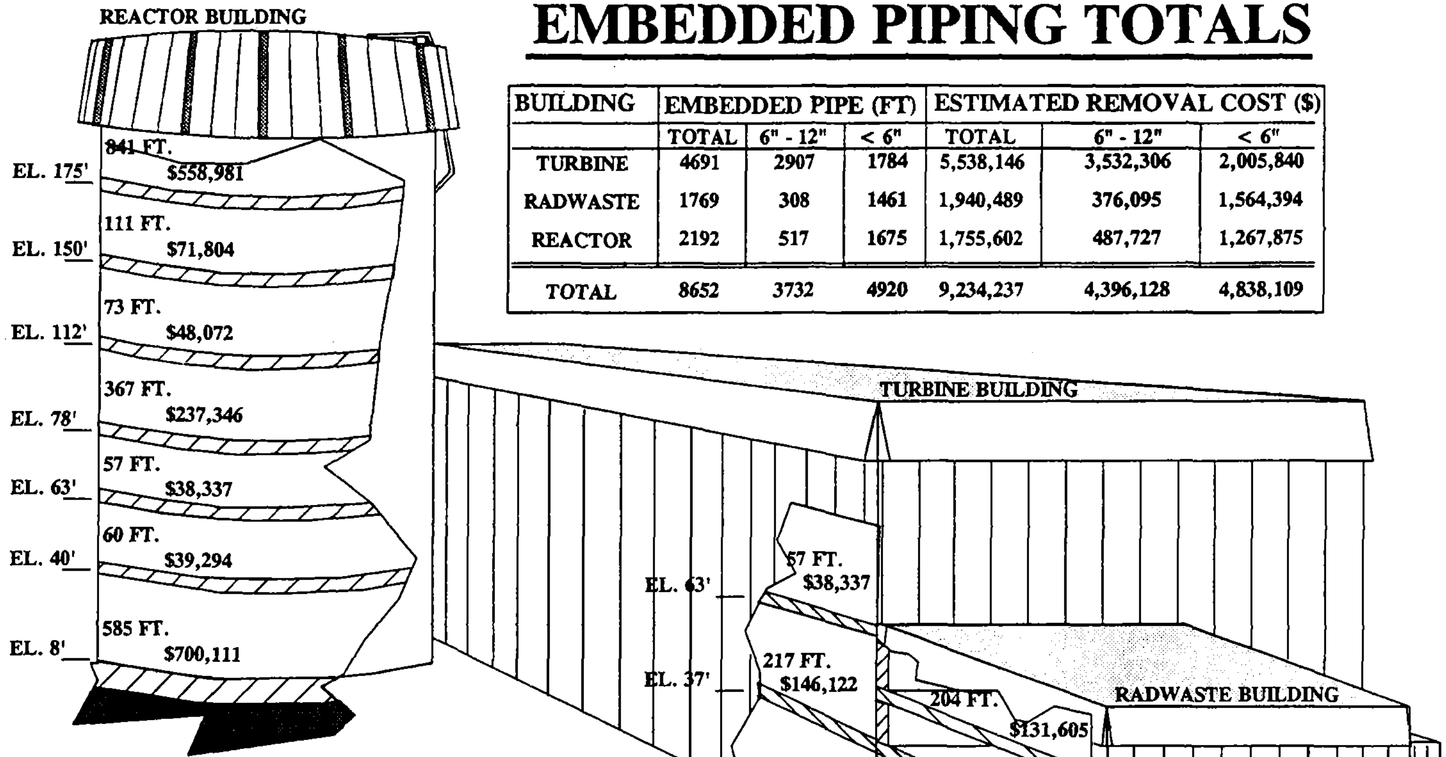
FIGURE 5

Piping Dia. (ID), (in)	Detector Assembly (eff. area) [1]	Bkgnd [2]	Efficiency 4π [3] (area adjusted) [4]	Detection Sensitivity (dpm/100 cm^2)
12	4 - FT126 GMs (504 cm^2)	350 cpm	0.058 (0.295)	210
10	8 - HP260 GMs (124 cm^2)	165 cpm	0.166 (0.206)	210
8	6 - HP260 GMs (93 cm^2)	130 cpm	0.152 (0.141)	270
6	9 - HP260 GMs (140 cm^2)	210 cpm	0.148 (0.207)	230
4	6 - HP260 GMs (93 cm^2)	165 cpm	0.134 (0.124)	340
3	4 - HP260 GMs (62 cm^2)	80 cpm	0.156 (0.097)	310
2	1 - HP190A (end window)	13 cpm	0.006 [5]	2000
1.5	1 - HP190A (end window)	17 cpm	0.005 [5]	2800

FIGURE 4

EMBEDDED PIPING TOTALS

BUILDING	EMBEDDED PIPE (FT)			ESTIMATED REMOVAL COST ($)		
	TOTAL	6" - 12"	< 6"	TOTAL	6" - 12"	< 6"
TURBINE	4691	2907	1784	5,538,146	3,532,306	2,005,840
RADWASTE	1769	308	1461	1,940,489	376,095	1,564,394
REACTOR	2192	517	1675	1,755,602	487,727	1,267,875
TOTAL	8652	3732	4920	9,234,237	4,396,128	4,838,109



GROUND FLOOR VS. HIGHER ELEVATIONS

EMBEDDED GROUND FLOOR PIPING (FT) = 6480

REMOVAL COST = $7,805,970

6" - 12" PIPING (FT) = 3317

<6" PIPING (FT) = 3163

EMBEDDED HIGHER ELEVATION PIPING (FT) = 2172

REMOVAL COST = $1,428,267

6" - 12" PIPING (FT) = 415

<6" PIPING (FT) = 1751

FIGURE 3

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Shoreham Decommissioning Radioactive Waste Management Overview

Nicholas S. Lizzo (Shoreham NPS)

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Decontamination of the Shoreham Reactor Pressure Vessel Bowl

Nicholas S. Lizzo (Shoreham NPS)

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Waste Packaging Systems and Shipment Planning for Intact Control Rod Blades and Fuel Channels

Nicholas S. Lizzo (Shoreham NPS)

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Engineering Requirements for the Planning and Execution of Reactor Pressure Vessel and Internals Segmentation and Contaminated Systems Removal in Decommissioning the Shoreham Nuclear Power Station

Wann-Joe Sun
Joseph DeFrancesco
Thomas S. Cardile(Shoreham NPS)
Charles W. Adey (S&W)

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Background Determination in the Decommissioning of the Shoreham Nuclear Power Station

Bruce Mann
Mendel Beer(Shoreham NPS)
Richard K. Liang (S&W)
Robert Shropshire(BNL)

Session 17
Recent Nuclear Power Station Decommissioning Experiences in the USA-II

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Licensing Aspects of the Decommissioning of the Shoreham Nuclear Power Station

M. Siva Kumar (Shoreham NPS)

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Spent Fuel Disposal Options in the Decommissioning of LWRs

Sheldon I. Shreiner(Shoreham NPS)
Jack D. Rollins (J. Rollins)