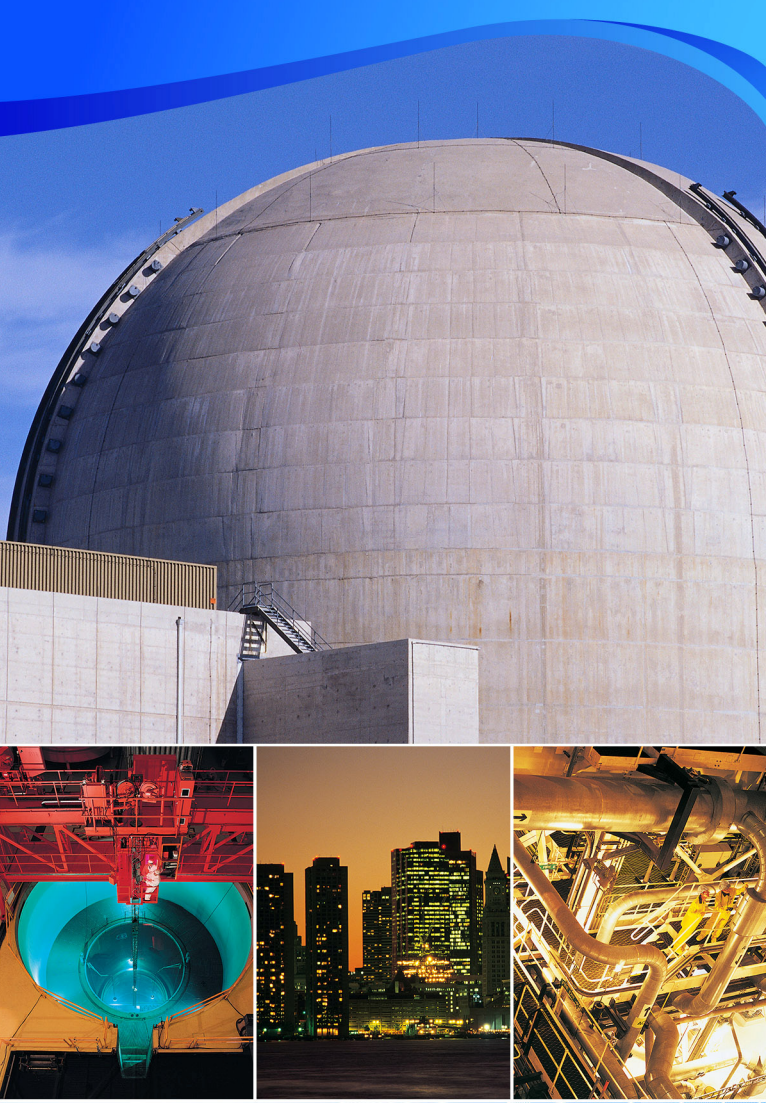

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Applicability of ALARA Lessons Learned from Decommissioning Projects to Operating Plants

2009 ISOE North American ALARA Symposium/ EPRI Radiation Protection Conference

January 12-14, 2009

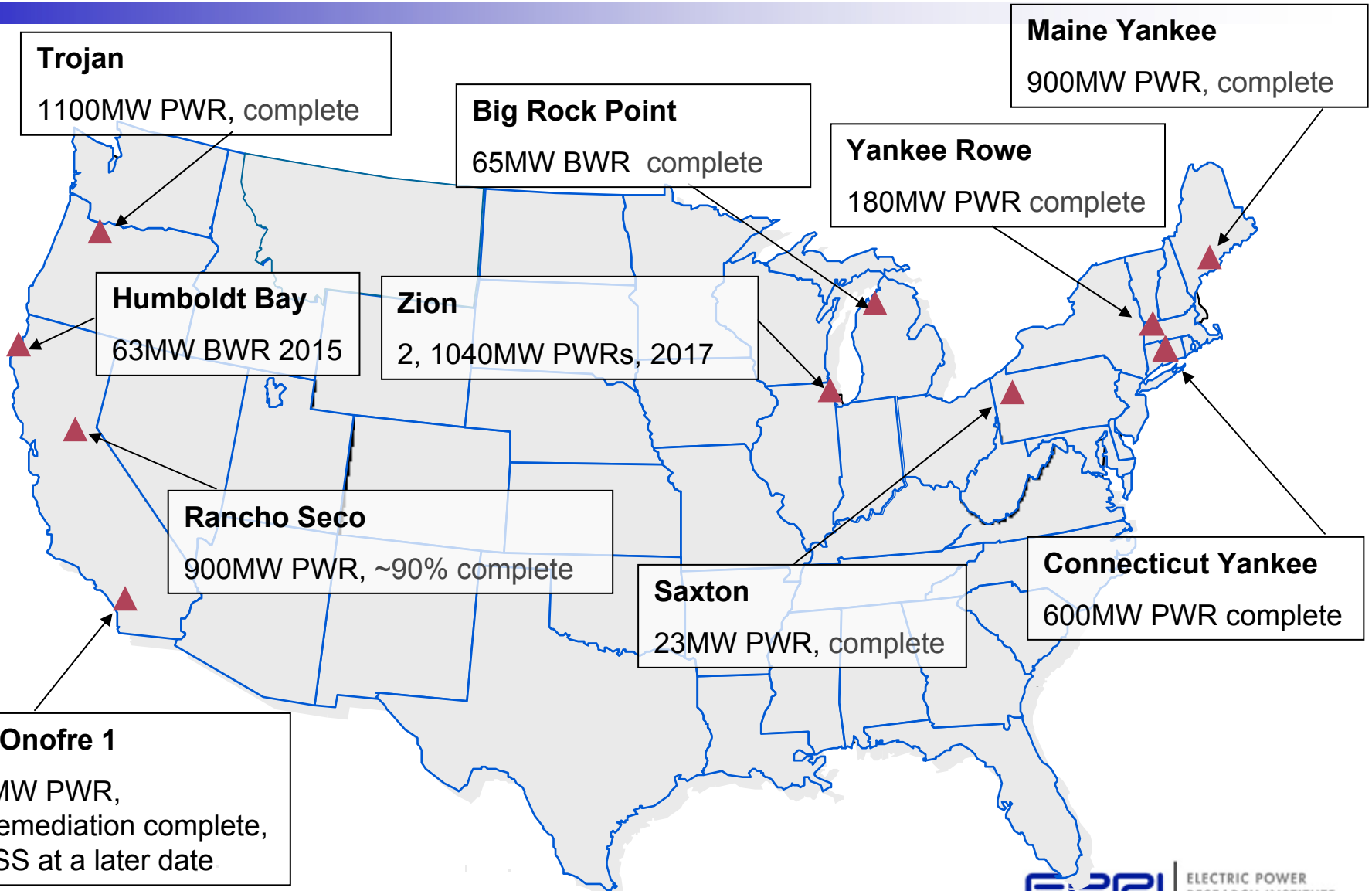
Rich McGrath
EPRI

Discussion Topics

- Decommissioning Projects Compared to Operating Projects
- Decommissioning Chemical Decontamination Experience
- Typical Uses of Robotics in Decommissioning
- The Benefits of Benchmarking Previous Experience

10 US Decommissioning Plant Status

fuel in dry storage at most sites



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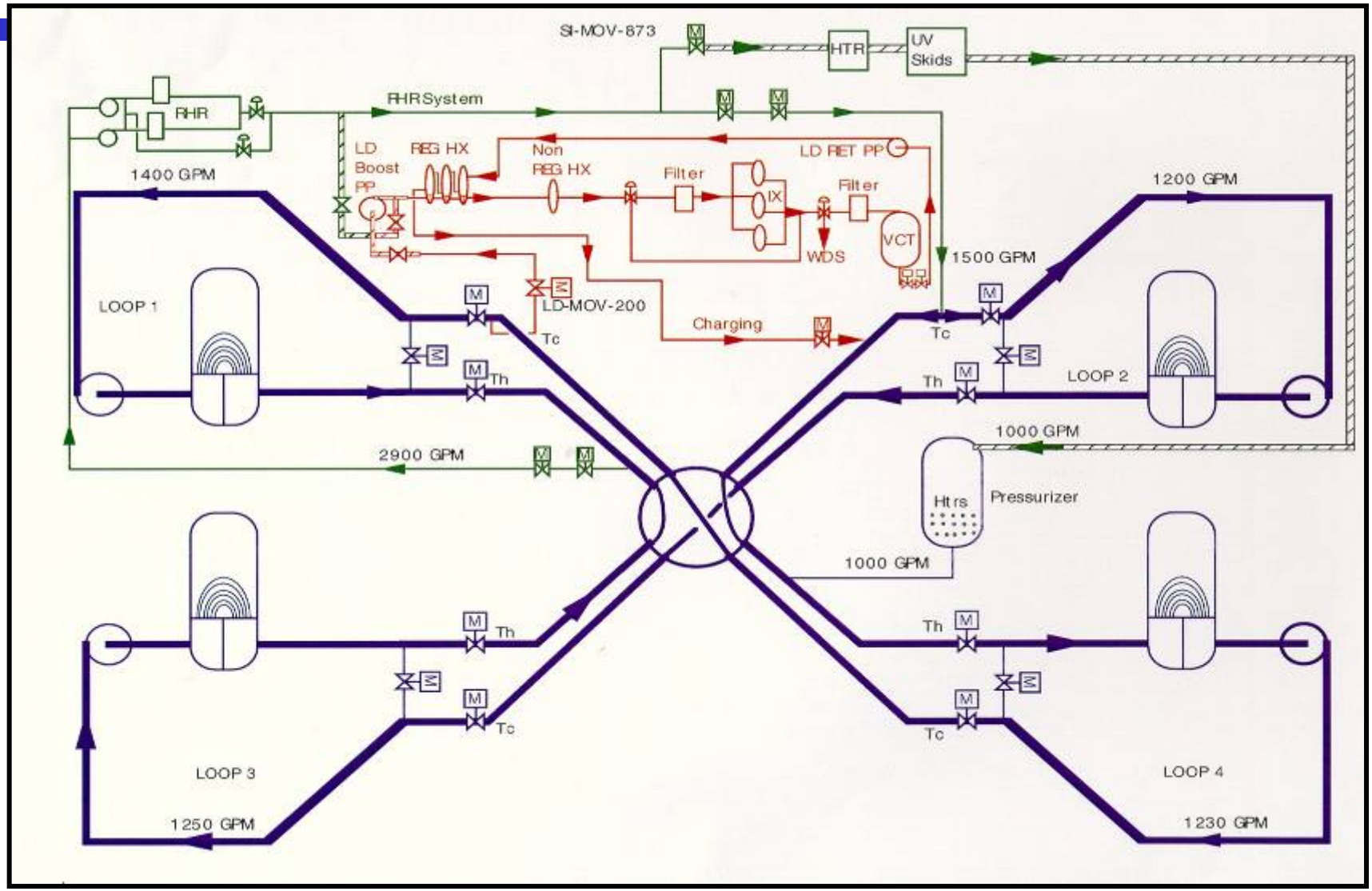
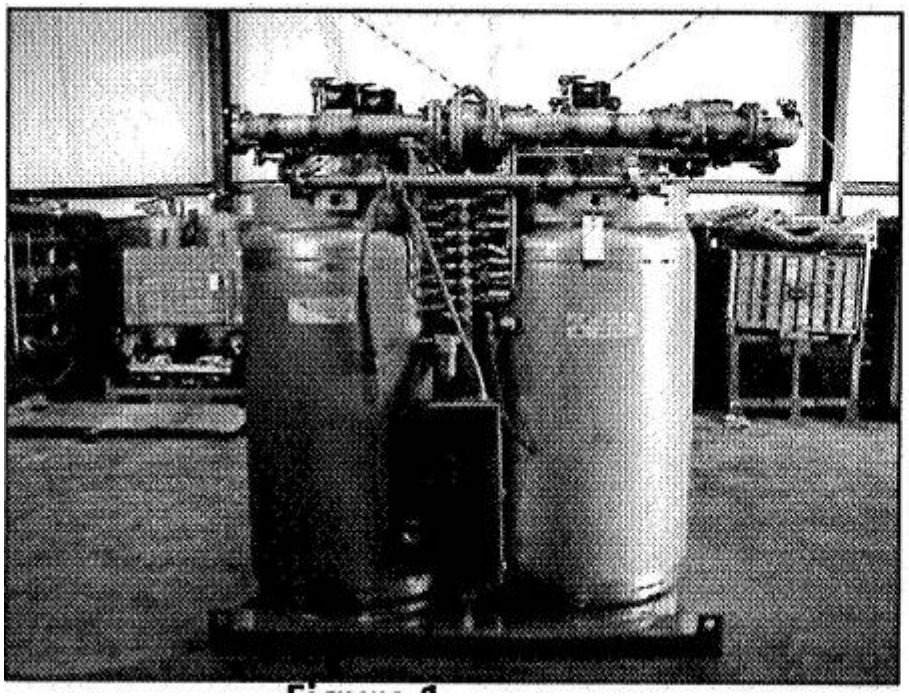
Decommissioning vs. Operating ALARA

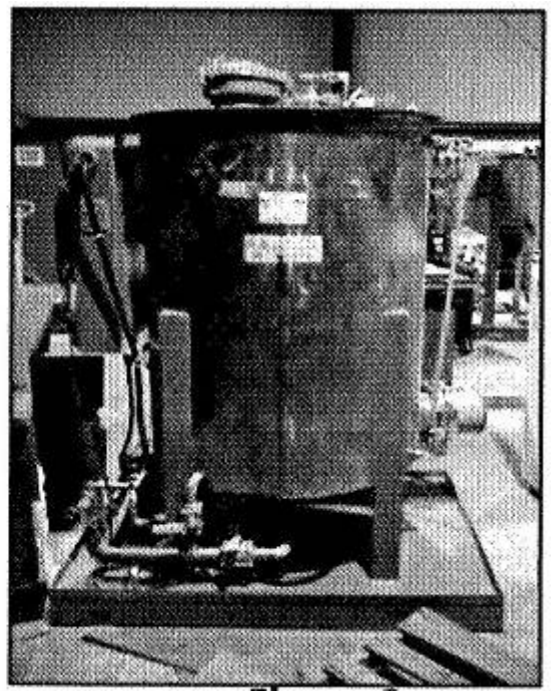
- Operating Plant Projects (High Dose):
  - In Service Inspection (incl. S/G Inspections)
  - Piping Modifications
  - Occasional Large Projects (i.e., S/G Replacements)
- Decommissioning Projects (High Dose):
  - Movement of Fuel to Dry Storage
  - Removal of All Contaminated Systems
    - Primary Systems Components (Includes Reactors, S/G)
    - Other Piping Systems and Components
  - Decontamination of Highly Contaminated Structures
- Decommissioning Involves a Huge Number of RWP Hours

Scope of Typical Full System Decon (FSD) – PWR (Connecticut Yankee)

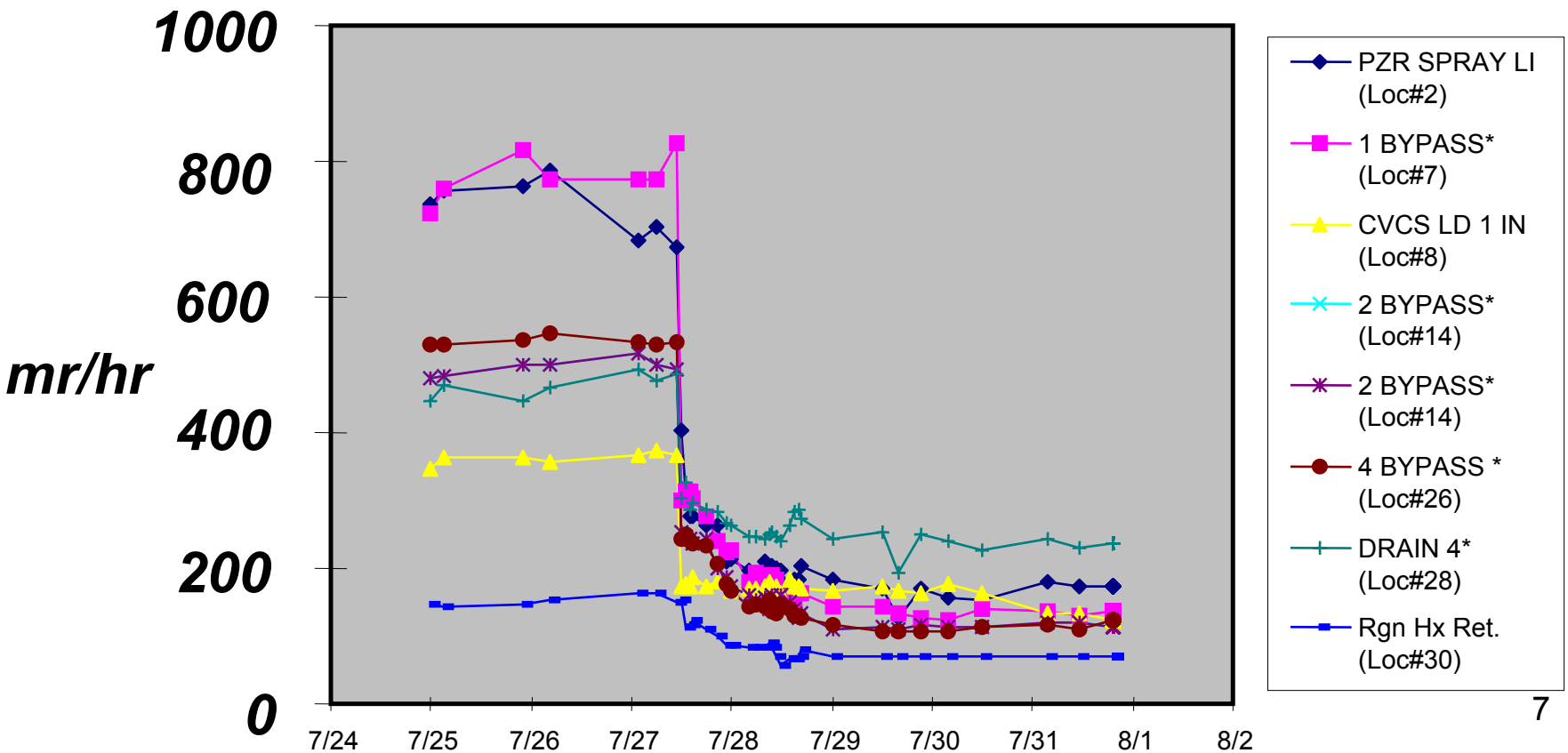


Temporary Equipment for FSD





Reactor Coolant System Exposure Rate Reduction



Comparison FSD at PWRs

Plants	Surface Area (m^2)		Metal Removed	Activity (Ci)	Resin Waste	DFs	
	SS	Inconel	(Kg)	Co-60	(ft3)	RCS	Aux Sys.
Indian Point-2 (1995)	6000	14,000	128	3906	1770	7.9	5.8
Connecticut Yankee (1998)	1,997	929	182	129	115*	17.6	9.8
Maine Yankee (1998)	465	139	307	99	537	8.7	44.8
Stade - Germany (2007)	5,000	12,000	231	630 (total)	540	47.8	17.9
Zorita - Spain (2007)	894	2,313	234	714	462	29.4	33.1

*Volume required by the process. Additional volume created to avoid GTCC waste due to high alpha levels in oxide film.

Improvements in Full System Decons

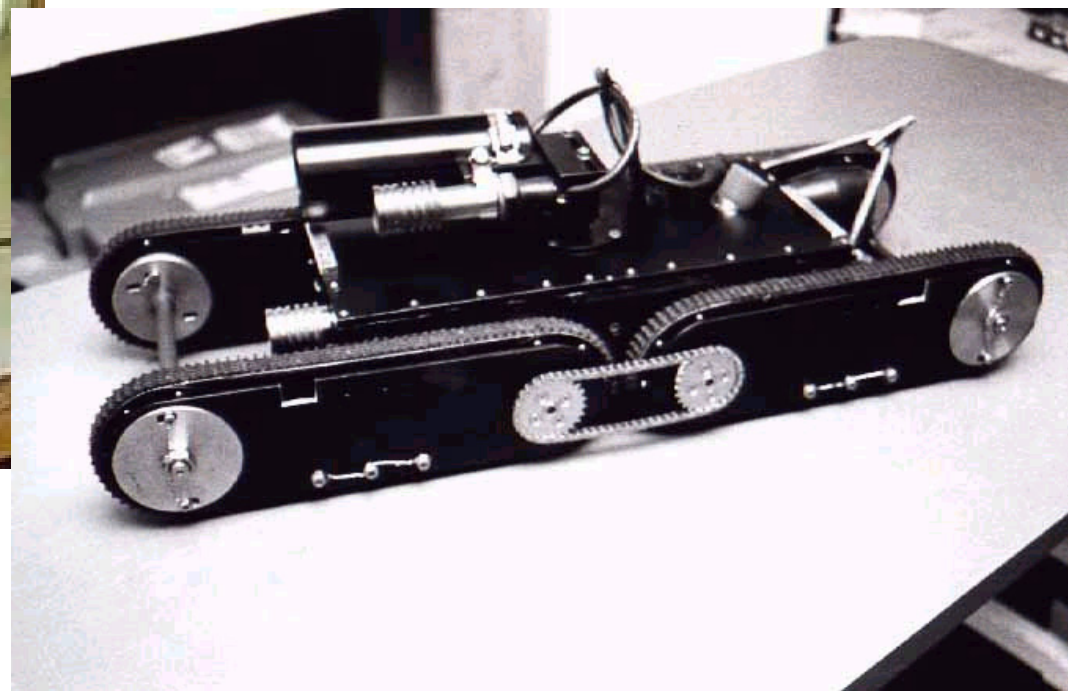
- Improvement from Indian Point 2 Decon
  - Average Radwaste Volumes Reduced by 77 %
  - Average Decontamination Factors Have Increased by 3.4 Times (7.8 to 26.1)
- Estimated Dose Savings:
  - Indian Point-2: 3,500 Rem (Over 5 cycles)
  - Connecticut Yankee: 1,197 Rem (For Decommissioning)
- Typical FSD Duration: 10 days
- Could be performed During 10 year ISI
- Performed at European Operating Plants

Many Robots from Non-Nuclear Applications Can Be Adapted to Radiological Work

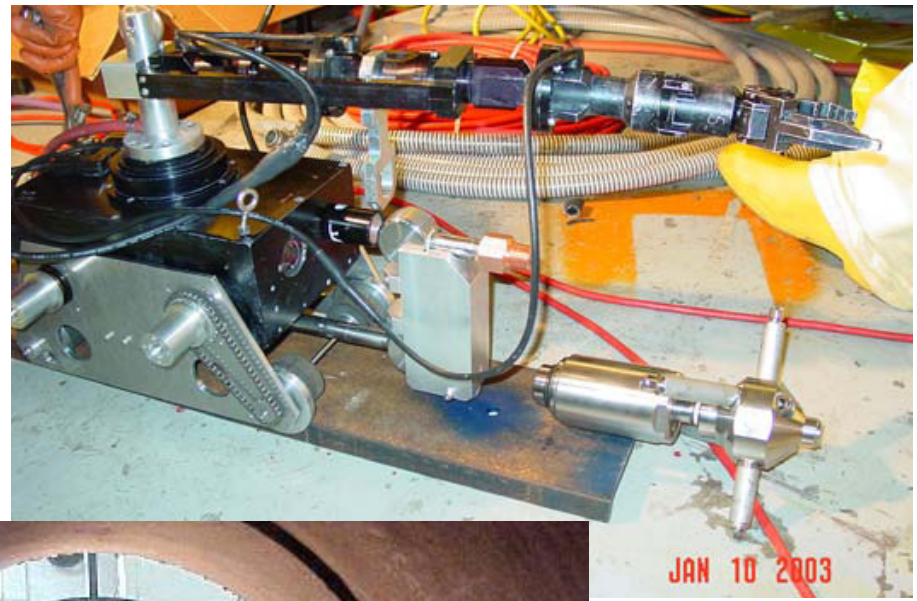
Remote control console

Robot Designed to Survey and Map Chernobyl

ROV Technologies Scarab I and II (Camera and Survey Equipment)



Pipe Crawler for Hydrolyzing/Survey of CY Fuel Transfer Tube (Bottom Right Photo is Mock-up)



Mock-up Testing for Grasping and Placement of Highly Radioactive Thermal Sleeves

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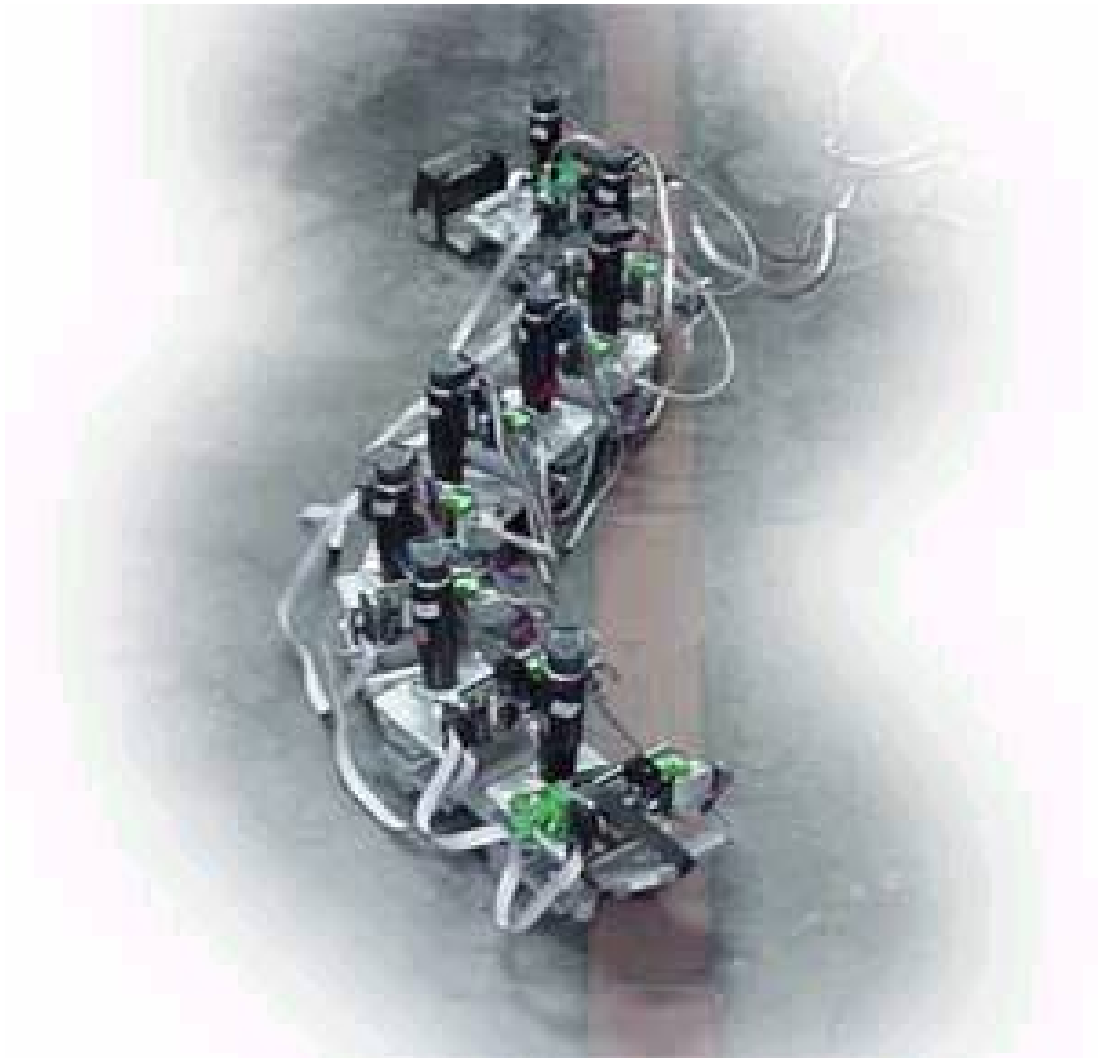
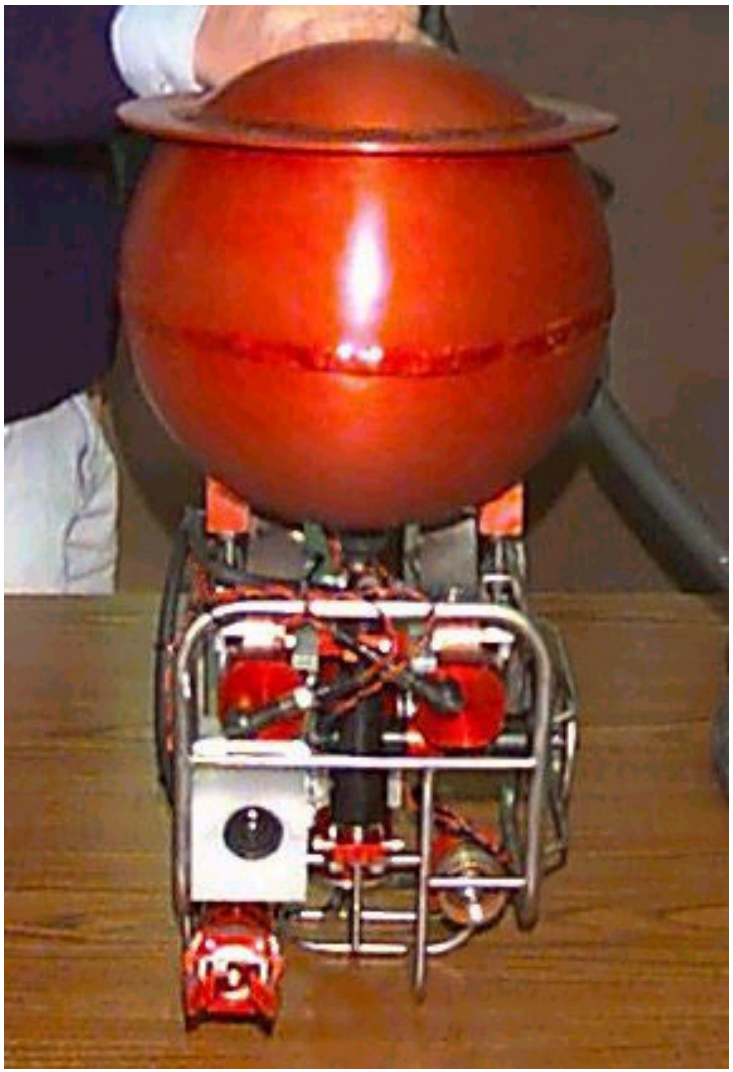
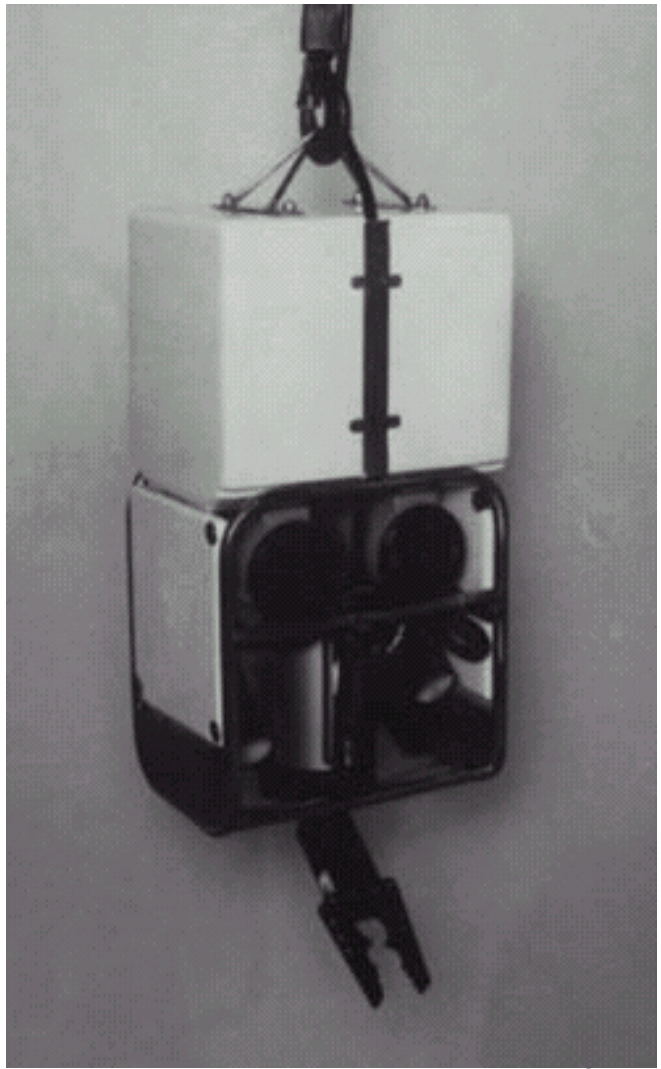
Robug III Serpentine Robot Crawls into Nuclear Work Area



ROV Technologies Mini-Sub and Sub with Gripper (Underwater Survey and Inspection)

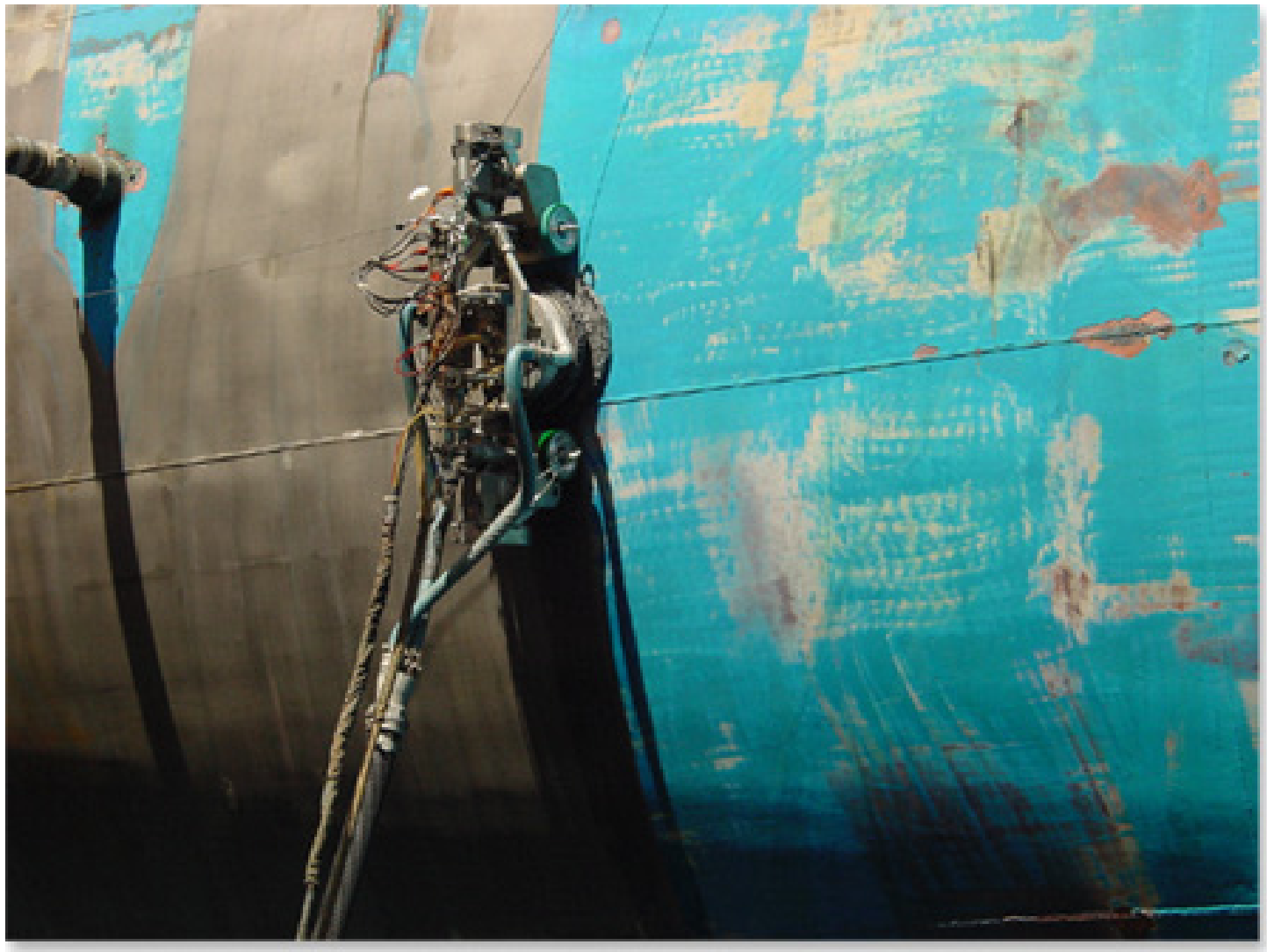




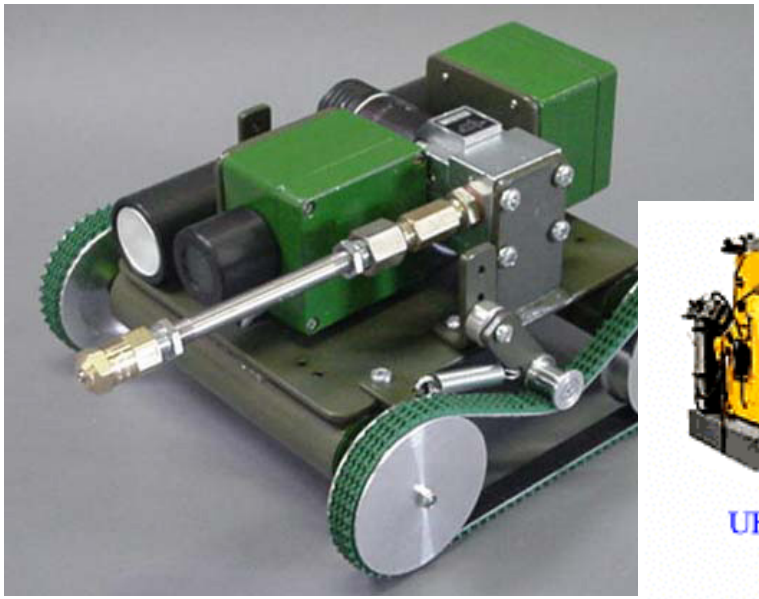
Track-Mounted Remote Cutting and Welding Equipment Welding Reactor Vessel Canister at CY

Partitioning of CY Steam Generator Performed with a Track-Mounted Cutter

Magnetic Crawler Removing Paint from Ship Hull

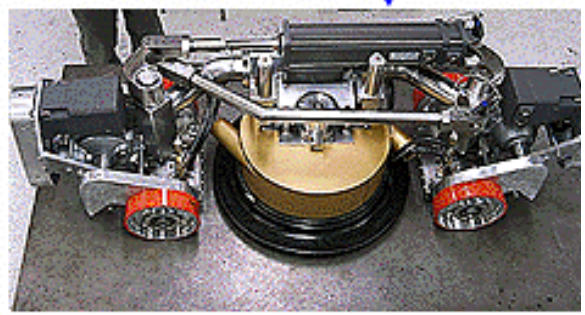


Small and Large Hydrolyzer Systems



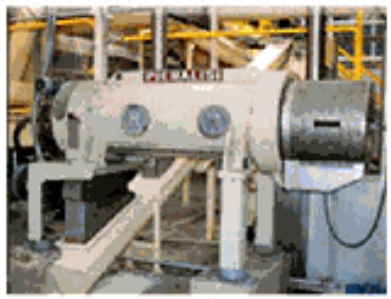
UHP Water Pump

38,000 PSI Water



Robot

Wastewater & Debris

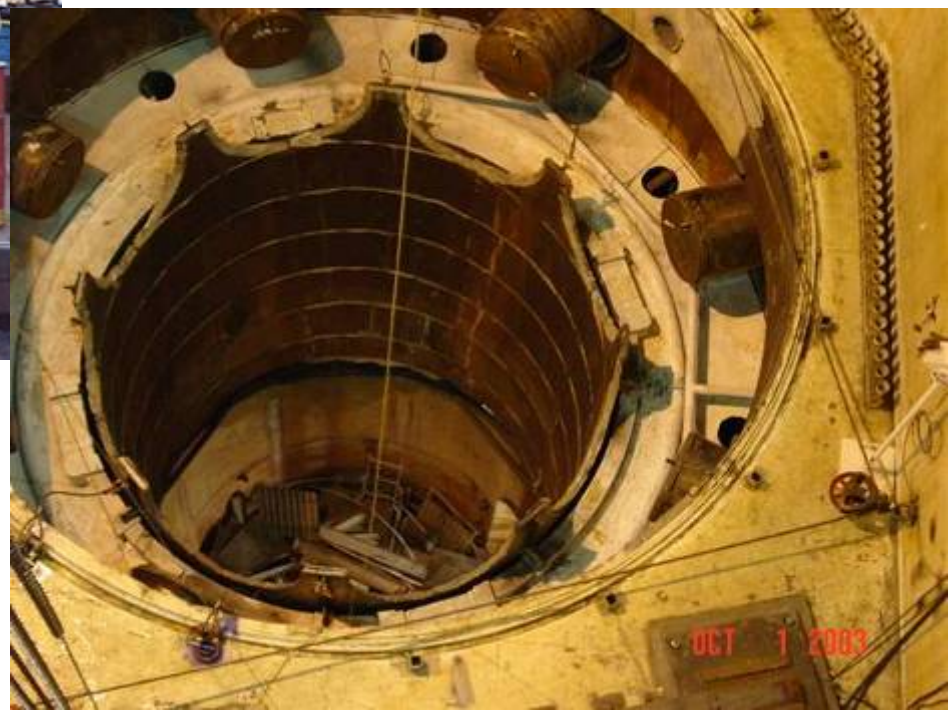


Vacuum & Filtration

Example on A Multi-Use Robot at CY

L.A. Grant Model GMM-1400 Robotic Arm Used at CY with Saw and Electromagnet

Mock-up Testing and Work Location for Cutting of CY Neutron Shield Tank



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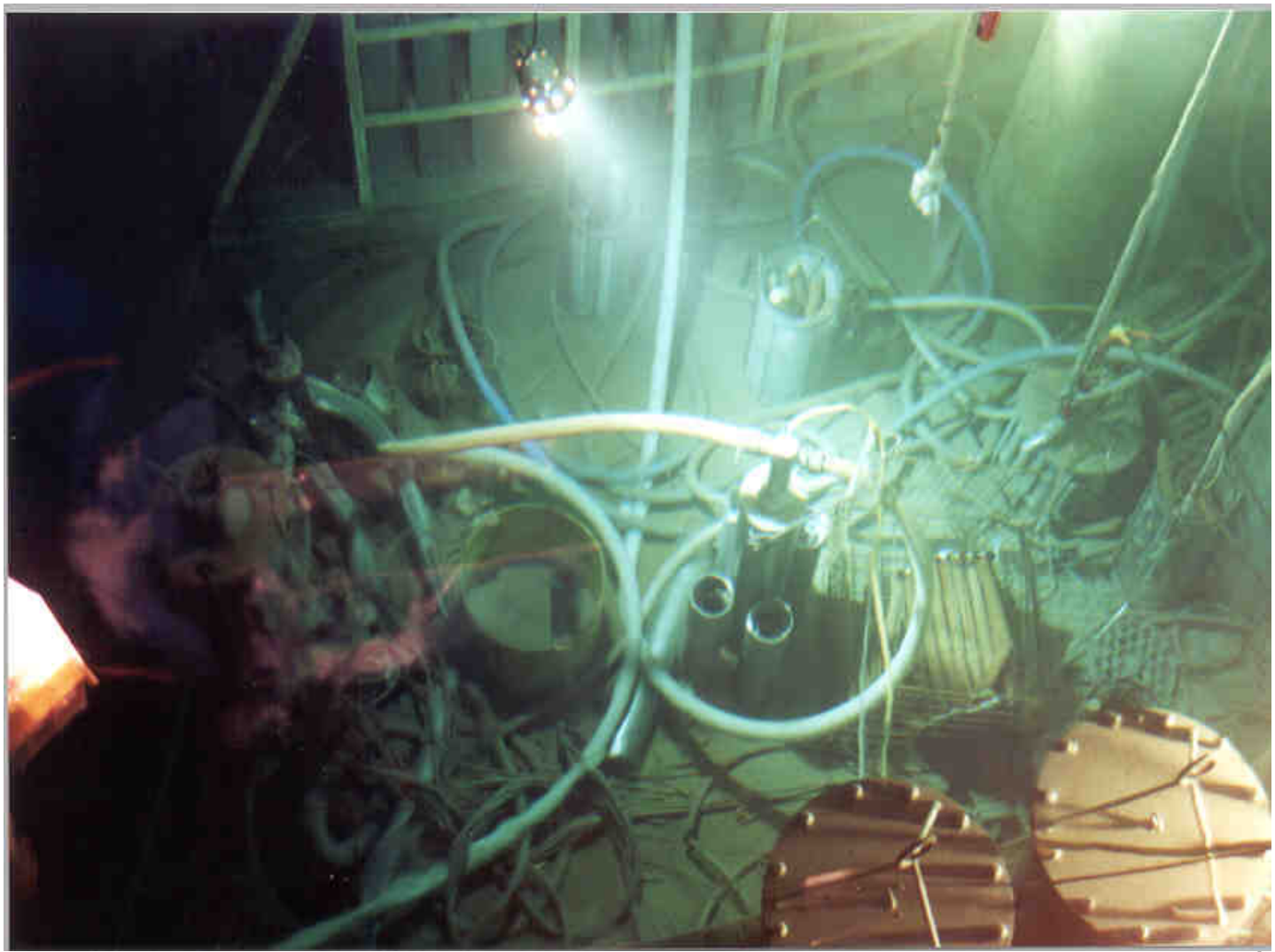
Refueling Cavity at End of CY Reactor Internals Segmentation Project: Cleanup with Robotic Arm



Grant Robotic Arm Vacuuming Reactor Cavity Floor and as Used to Perform Underwater Cutting

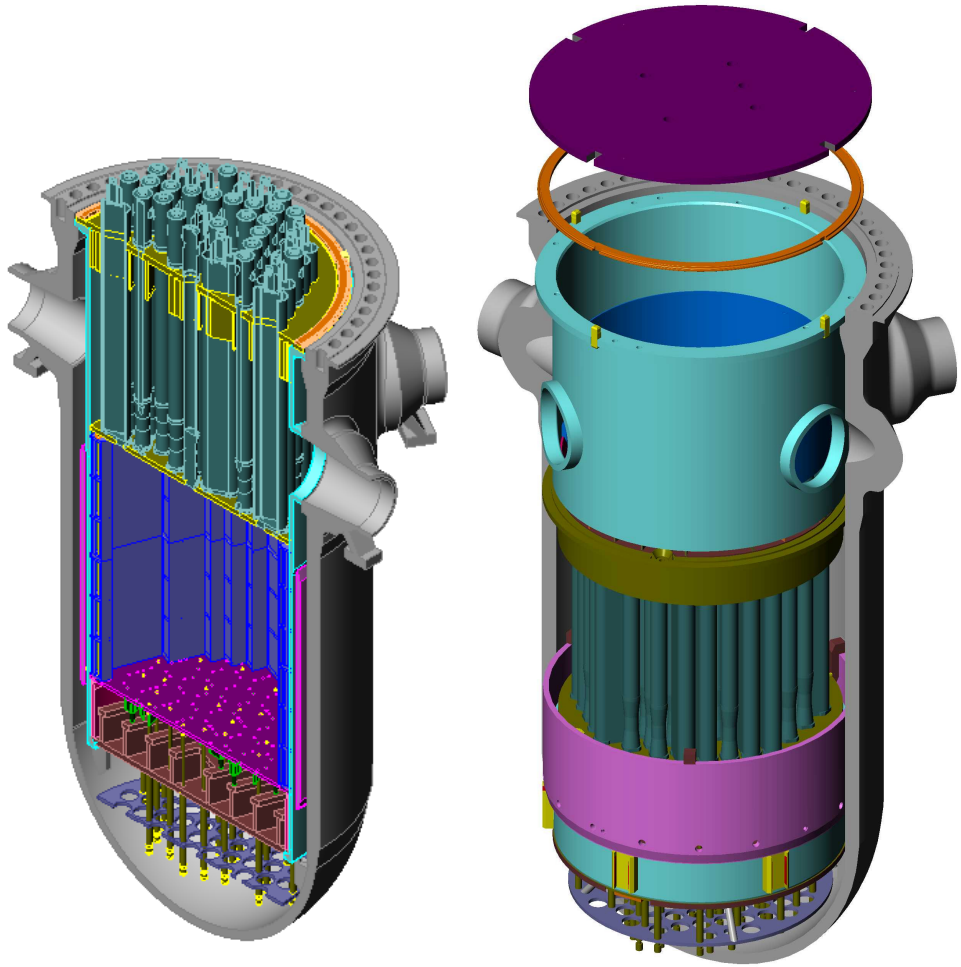
Grant Machine Hydrolyzer Head and Remote Control Station

Benefits Derived From the Use of Multi-Purpose Robots in Decommissioning

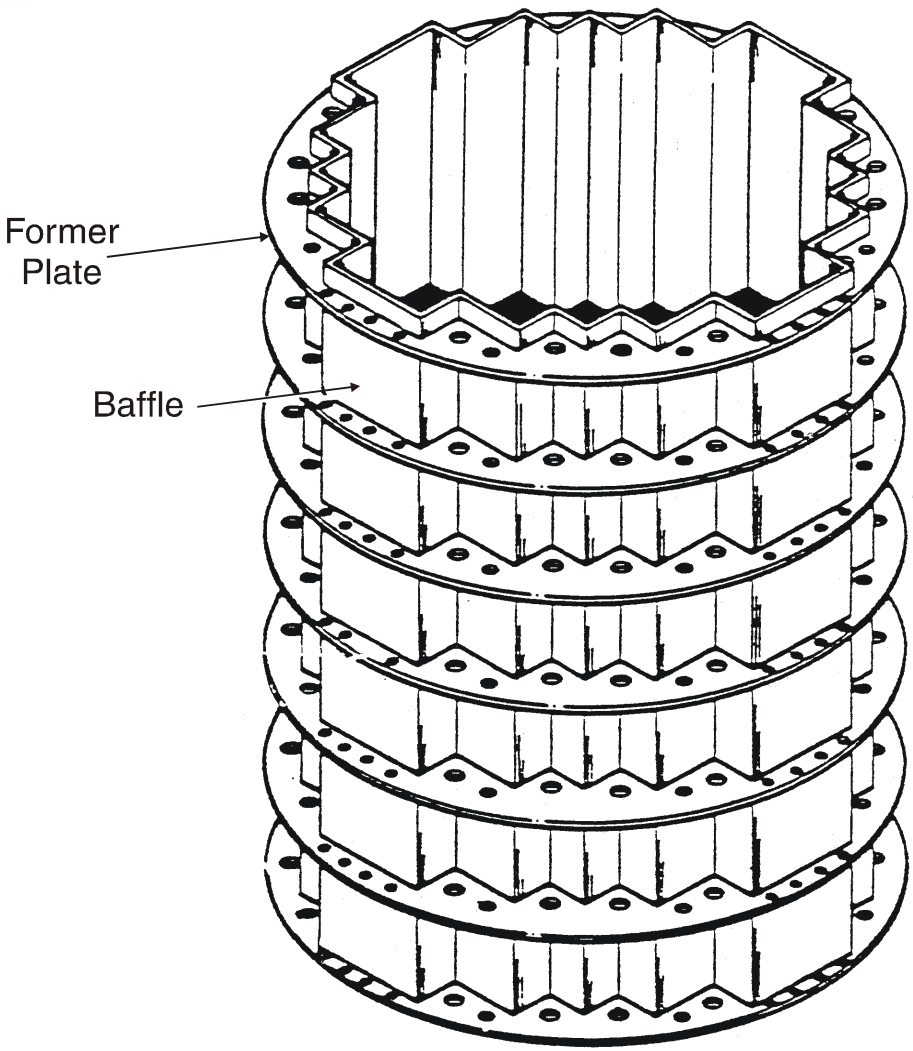
- Efficiently Dismantle Systems, Structures, and Components
- Minimize Proximity and Duration of Exposure to Radioactive and Hazardous Materials
- Minimizes the Risk and Consequences of Personnel Error in Hazardous Environments
- Potentially Same Benefits for Operating Plants

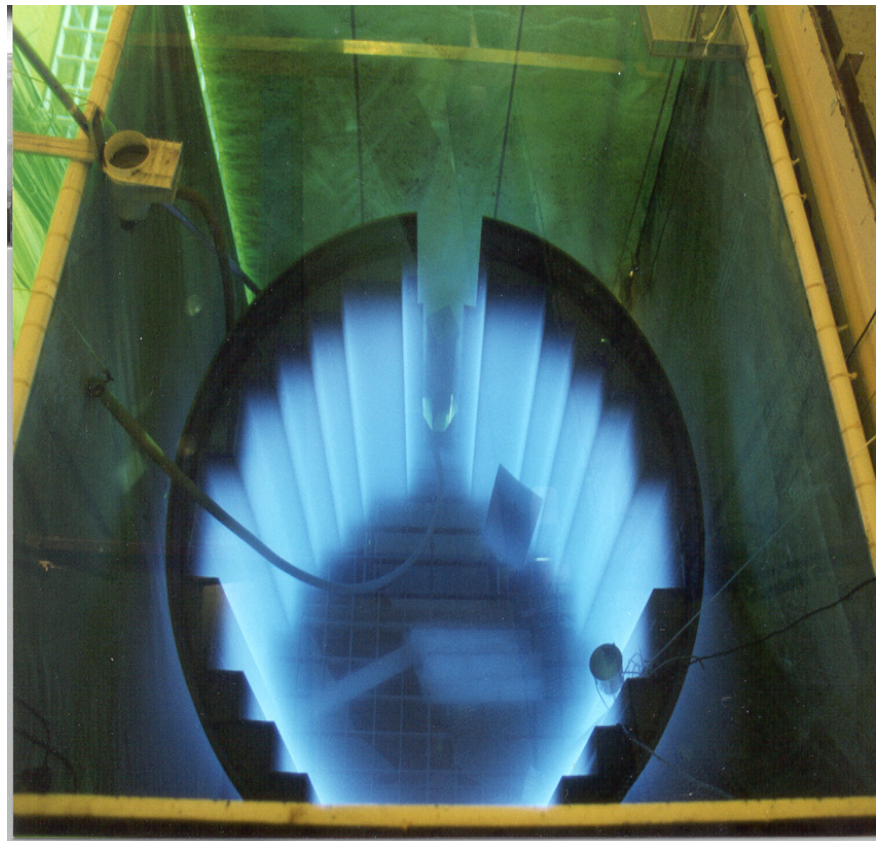
Overview of Reactor Internals Segmentation

- Upper Guide Structure, Upper Core Barrel and Core Support Structure packaged with Reactor Vessel
  - Package Limits
    - 1000 Tons
- Mid-core region segmented and packaged:
  - Land disposal of Class A
  - Class B/C Stored on Site Until Disposal Available
  - ISFSI for GTCC
- Contact Dose Rate Up to 1.0E04 R/hr

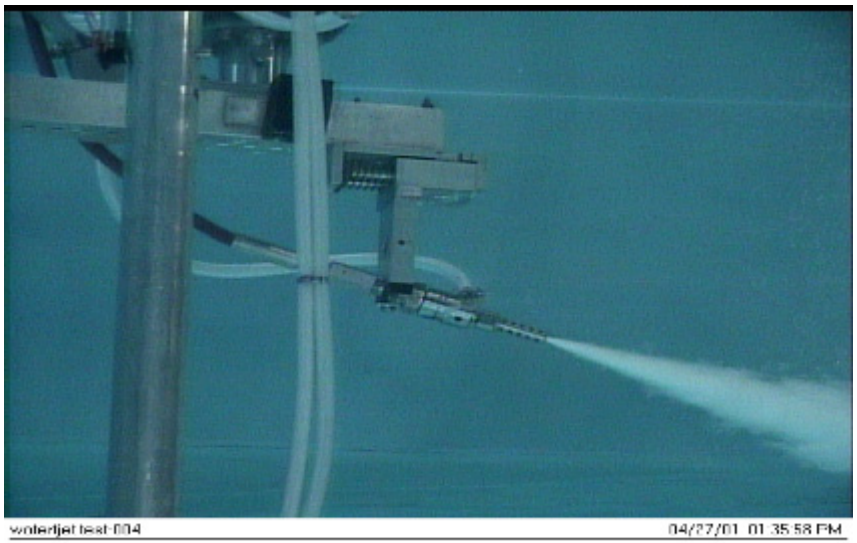


Core Baffle Assembly at CY

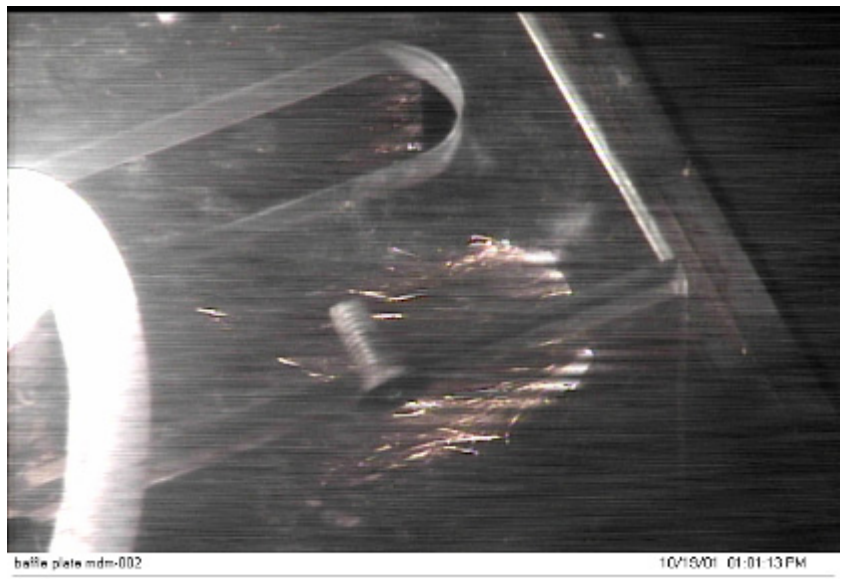




Cutting Technologies

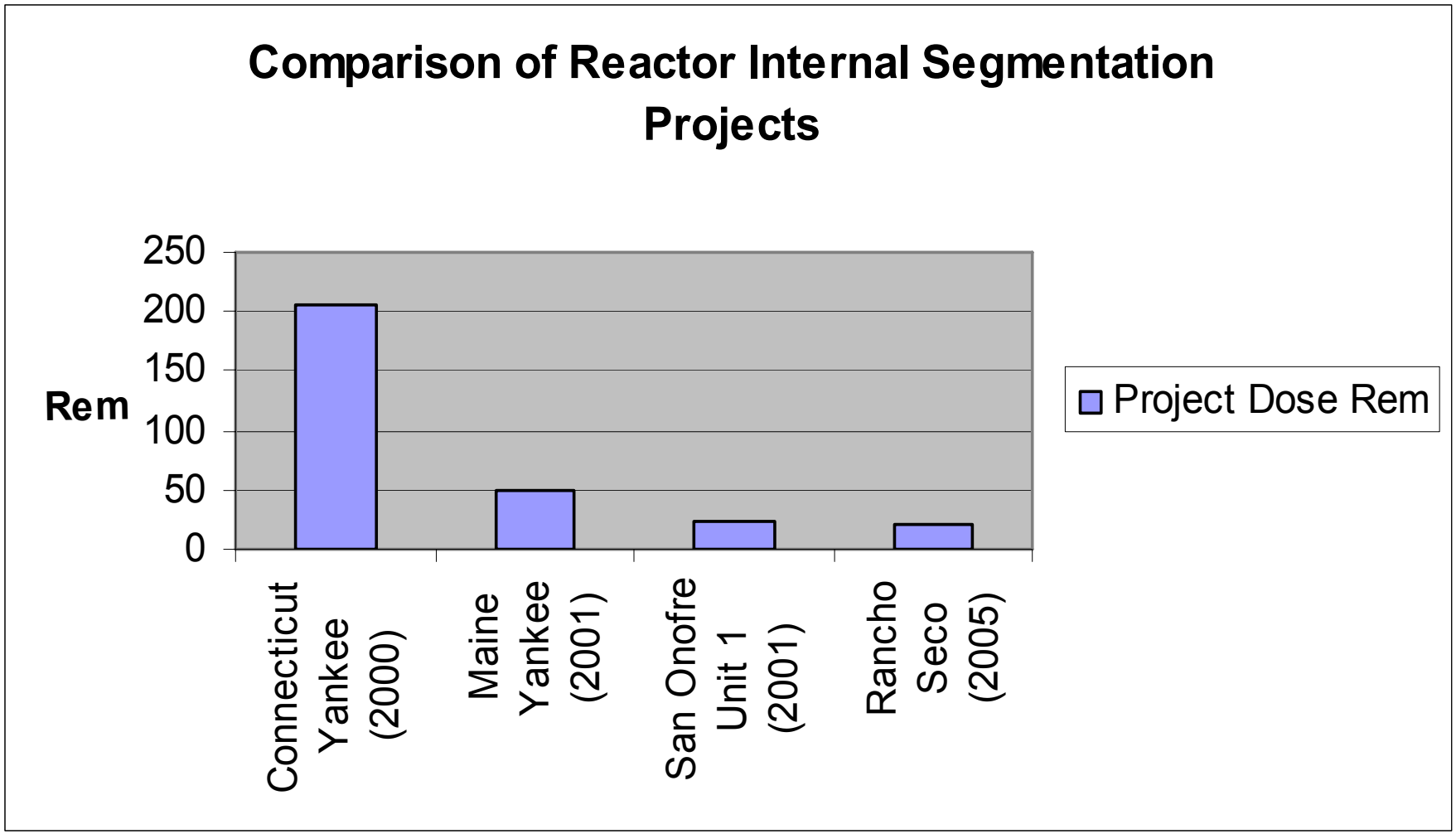


Abrasive Water Jet

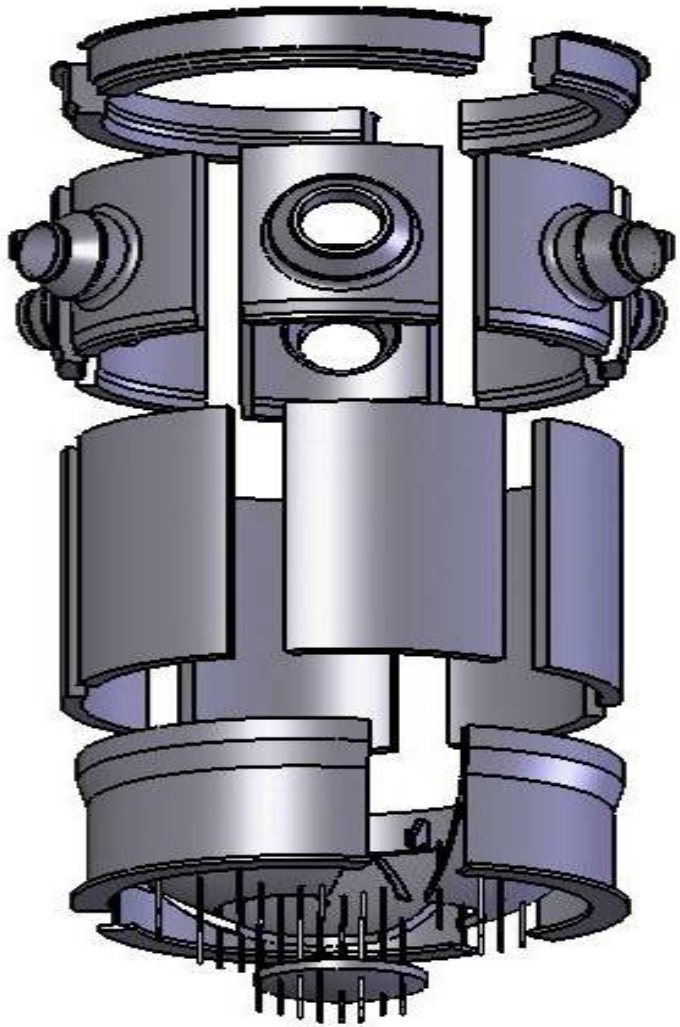


Metal Disintegration Machining

Benefits of Benchmarking Previous Experience



Rancho Seco Reactor Vessel Segmentation



		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
			Q.A.		
		MATERIAL	COMMENTS		
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APPLICATION		DO NOT SCALE DRAWING			

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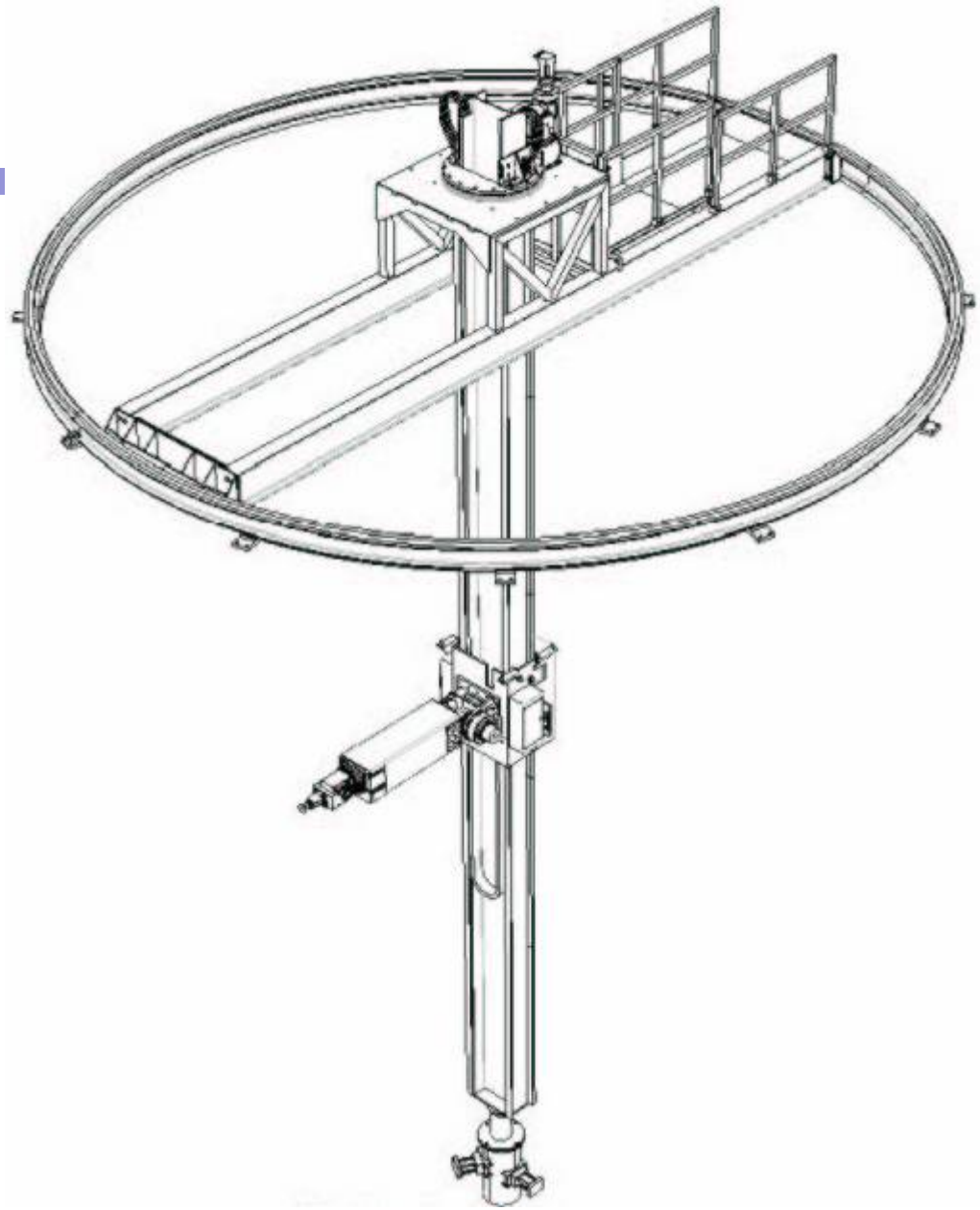
Rancho Seco Reactor Vessel Cutting Plan

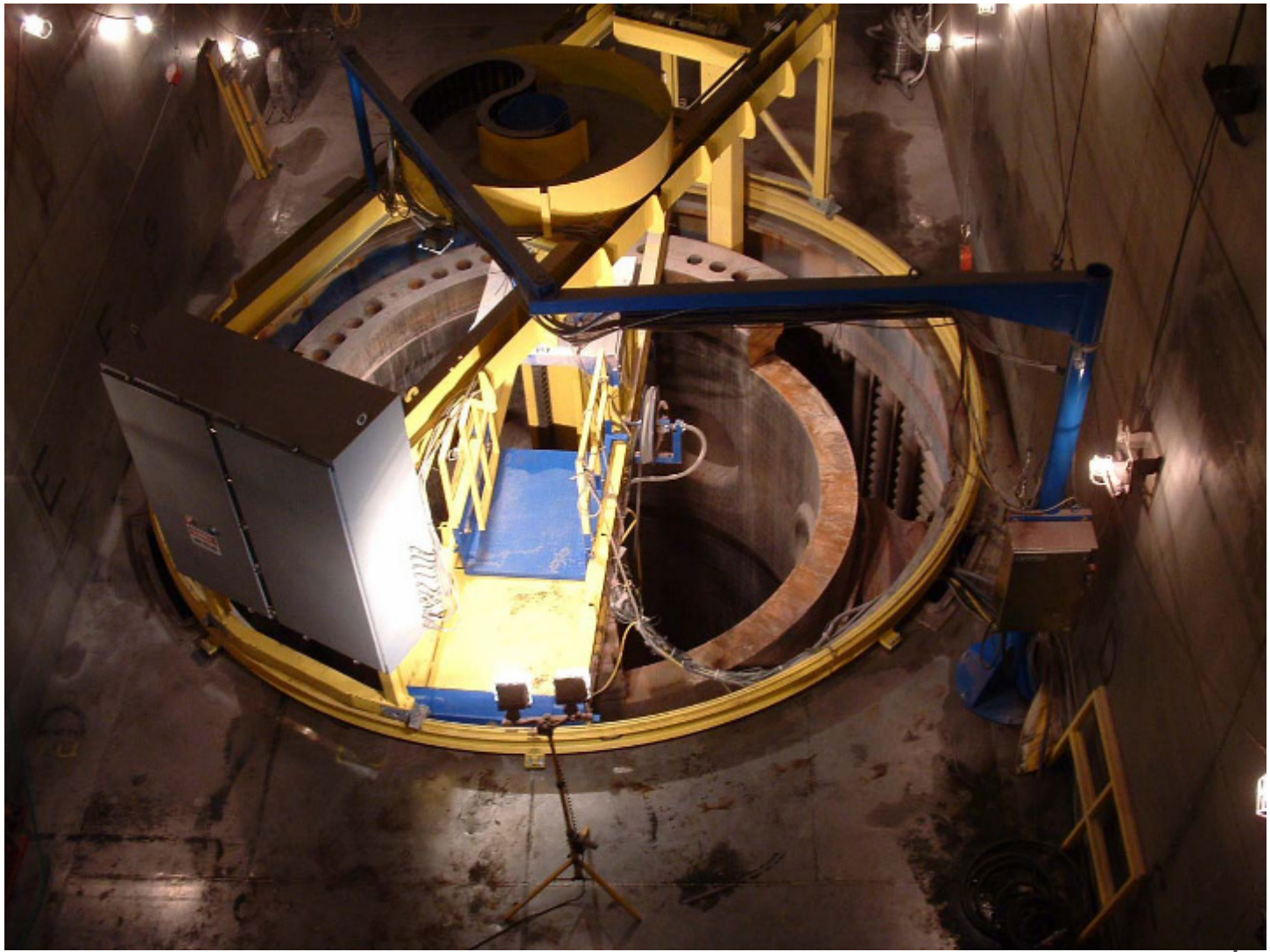
SIZE A | DWG NO Attachment 2 | REV

SCALE: 1/16 | WEIGHT: | SHEET 1 OF 1

Waterjet Manipulator



Segmenting Rancho Seco Reactor Vessel



Decommissioning Lessons Learned with Operating Plant Applicability

- Full System Chemical Decontaminations Can Result in Very Large Exposure Savings with Small Impact on Refueling Outage
- Robotics and Remote Controlled Equipment can Greatly Reduce Cost, Help Avoid Overexposures
- Mutli-Use Machines Can Increase the Cost-Benefit Ratios for Remote Controlled Equipment
- Fully Test Remote Equipment Prior to RCA Use
- Benchmarking Previous Experience Can Greatly Save Exposure

EPRI Reports with Additional Information

- Application of Non-Nuclear Robotics to Nuclear Industry Decommissioning ***(EPRI Report # 1009571, 2004)***
- Evaluation of the Decontamination of the Reactor Coolant Systems at Maine Yankee and Connecticut Yankee ***(EPRI Report # TR-112092, 1999)***
- Connecticut Yankee Decommissioning Experience Report ***(EPRI Report # 1013511, 2006)***
- Reactor Pressure Vessel Internals Segmentation Experience Report ***(EPRI Report #1003029, 2007)***
- Rancho Seco Reactor Vessel Segmentation Experience Report ***(EPRI Report #1015501, 2008)***