



UNIT 4 BOILER 6

Pickering 'A' HOT PARTICLE RECOVERY – THE JOURNEY

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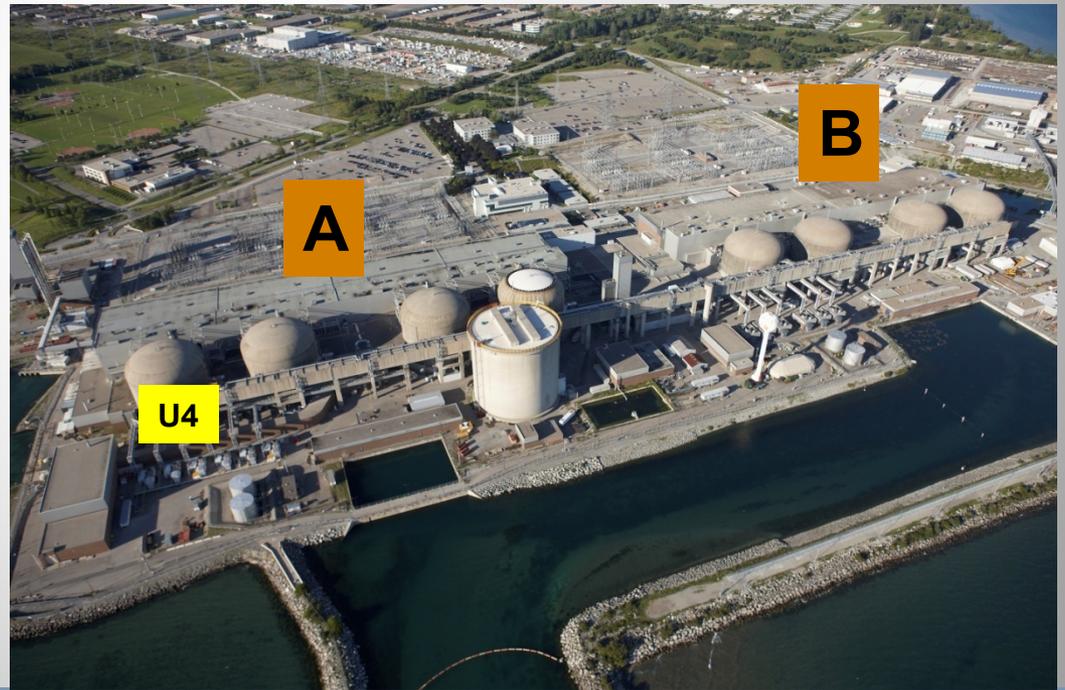
Health Physicist Pickering 'A' Radiation
Protection



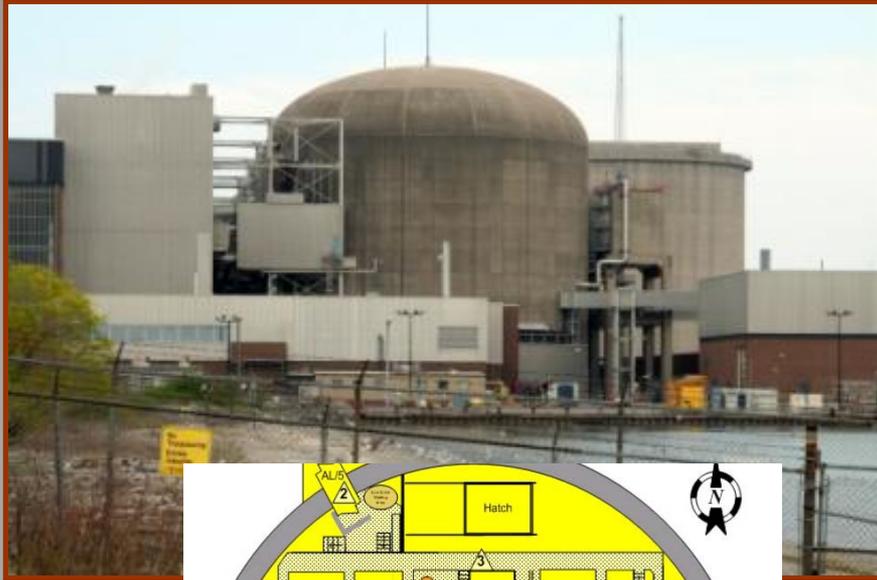
HOT PARTICLE RECOVERY

PICKERING NUCLEAR GENERATING STATION 'A'

Pickering, Ontario, Canada
(30 Minutes From Downtown Toronto)
Operating Since 1971



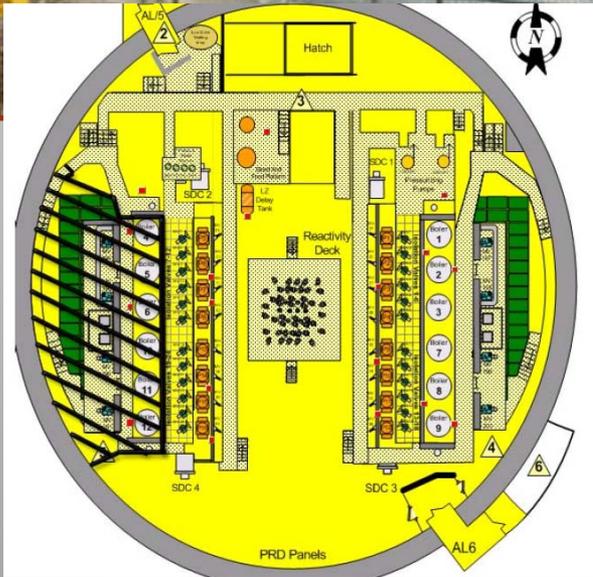
HOT PARTICLE RECOVERY



Pickering 'A' - Unit 4

September 2008

➤ **Unit is Shut Down For a Forced Outage**



➤ **Routine Leak Search in Boiler Room Commences**



HOT PARTICLE RECOVERY



Rad Tech Discovers Gamma Field of 500 mrem/h in an area that is typically 2 mrem/h. Later discovered that a worker doing the leak search had a peak EPD Rate of 4900 mrem/h.



Surveys were devised to pinpoint location of Hot Spot in a maze of pipe work and boilers (steam generators) approximately 80 feet by 20 feet.

Surveys identified the source of the unusually high dose rate was coming from the cold leg drain line at the bottom of Boiler 6.



Survey Results

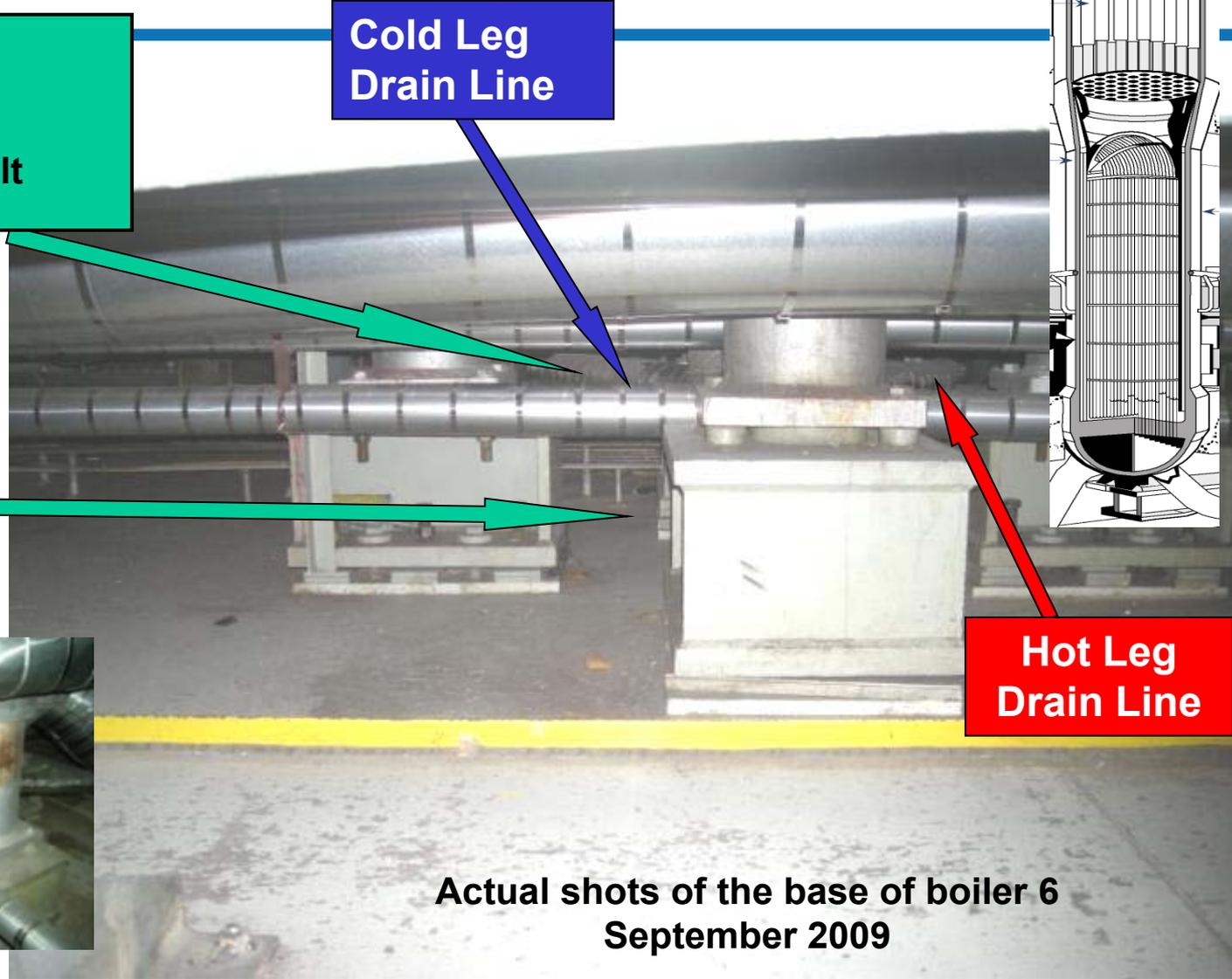
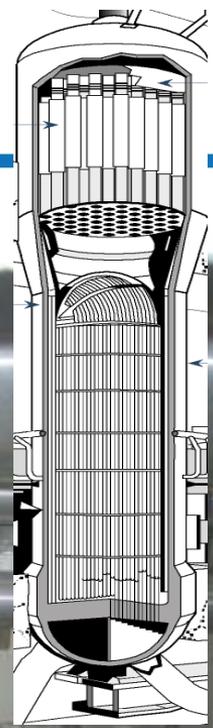
500 rem/h @ 30cm
(measured)

35 Curies of Cobalt
(Estimated)

**Cold Leg
Drain Line**

**350 to 500
rem/h JUST
BELOW HOT
LEG DRAIN
LINE**

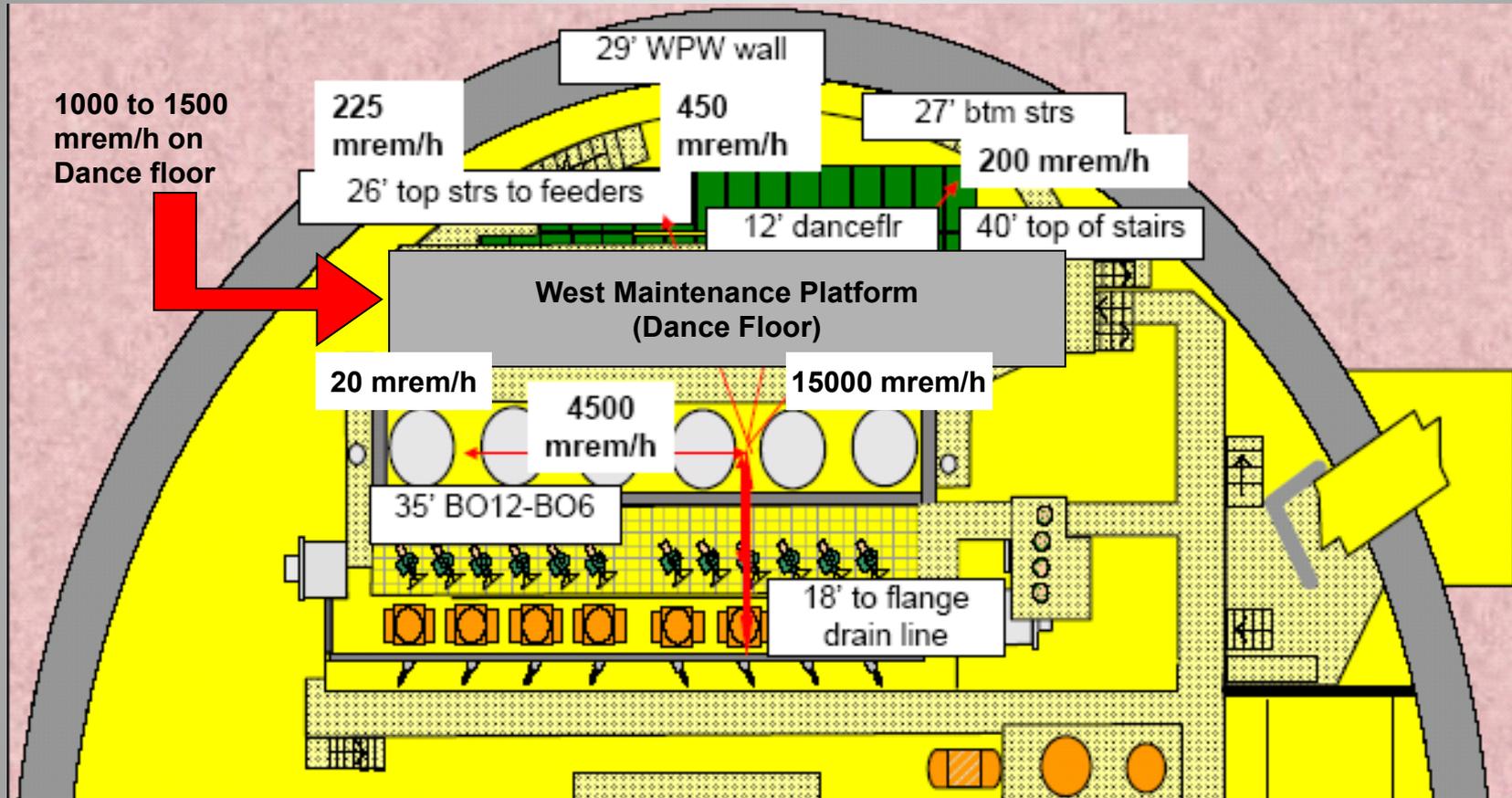
**Hot Leg
Drain Line**



Actual shots of the base of boiler 6
September 2009

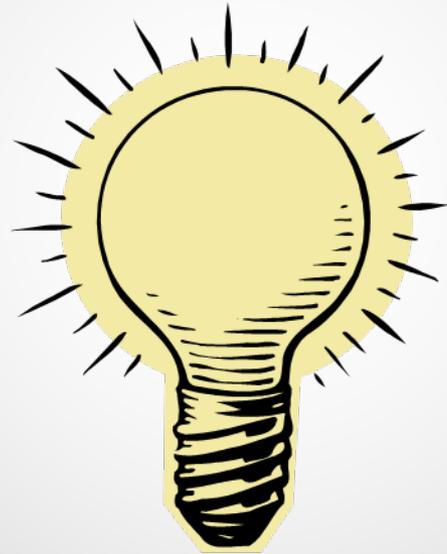


Survey Results



HOT PARTICLE RECOVERY

**How Can We Retrieve This Particle and
How Do We Control the Area Around the
Particle ?**



PROBLEMS WITH RETRIEVING and DEALING WITH THE PARTICLE

- Personnel can't get to within 10 ft of the area. General Fields are 3.5 rem/h at that distance
- Dose Rates at working distance are 300 to 500 rem/h
- Securing the Area and Calming the Fears of Station Personnel
 - Area is very congested and tight for space.



HOT PARTICLE RECOVERY

Examples of Barricades Erected



ADMINISTRATIVE CONTROLS AND WARNINGS

- **Immediate Communiqués To Station Staff-** Message relayed through daily meetings and logs. (Outage and Plan of the Day Meetings and warnings put in Shift Manager and ANO logs.
- **Op Memos on File** – Establish parameters and guidelines for performing work in RB. This includes during regular outages, forced outages, and potential on power entries.
- **Educate Station Staff** – Presentations and briefing cards prepared for pre-jobs. Update JHSC members immediately.
- **Access Desk Briefings** – Package established for briefing all station staff before entering RB.



What were the problems?

- Poor rad tech response to initial findings. **What could be done to correct these casual behaviours? What measures can be implemented to avoid this again in the future?**
- Station Staff did not respond to EPD alarms. Forensic audit of EPD dose rate alarms after the fact revealed 6 dose rate alarms between Saturday night until barriers were erected on Monday morning. Unusually high. **What actions are needed to avoid this in the future?**
- No official forum to document actions in detail every step of the way. Critical information when dealing with CNSC, WANO later. **How can this be captured?**



What were the problems (continued)?

- Robust barriers around the area of boiler 6 weren't established until the next forced outage on November 9. Reliance on regular access control procedures and barriers. **Were they robust enough?**
- Ops Memos had to be updated frequently due to conflicts with station procedure and restrictive and rigid wording in the memo. It was difficult to find the balance between safety and production.
- Communiqués at the beginning used words like; 'death, lethal, killed.' Be careful on wording as to not cause unnecessary panic among station staff. **What wording could have been used instead?**
- Staff station did not understand at first the debris location and its' ability to continue travel to other parts of the PHT system. **What could be done sooner to quell these fears?**



The Execution

Plan must utilize distance as a primary dose control method.

Dose is too high to utilize time.

Shielding would interfere with extraction methods



Solution

Robotics to Be Utilized

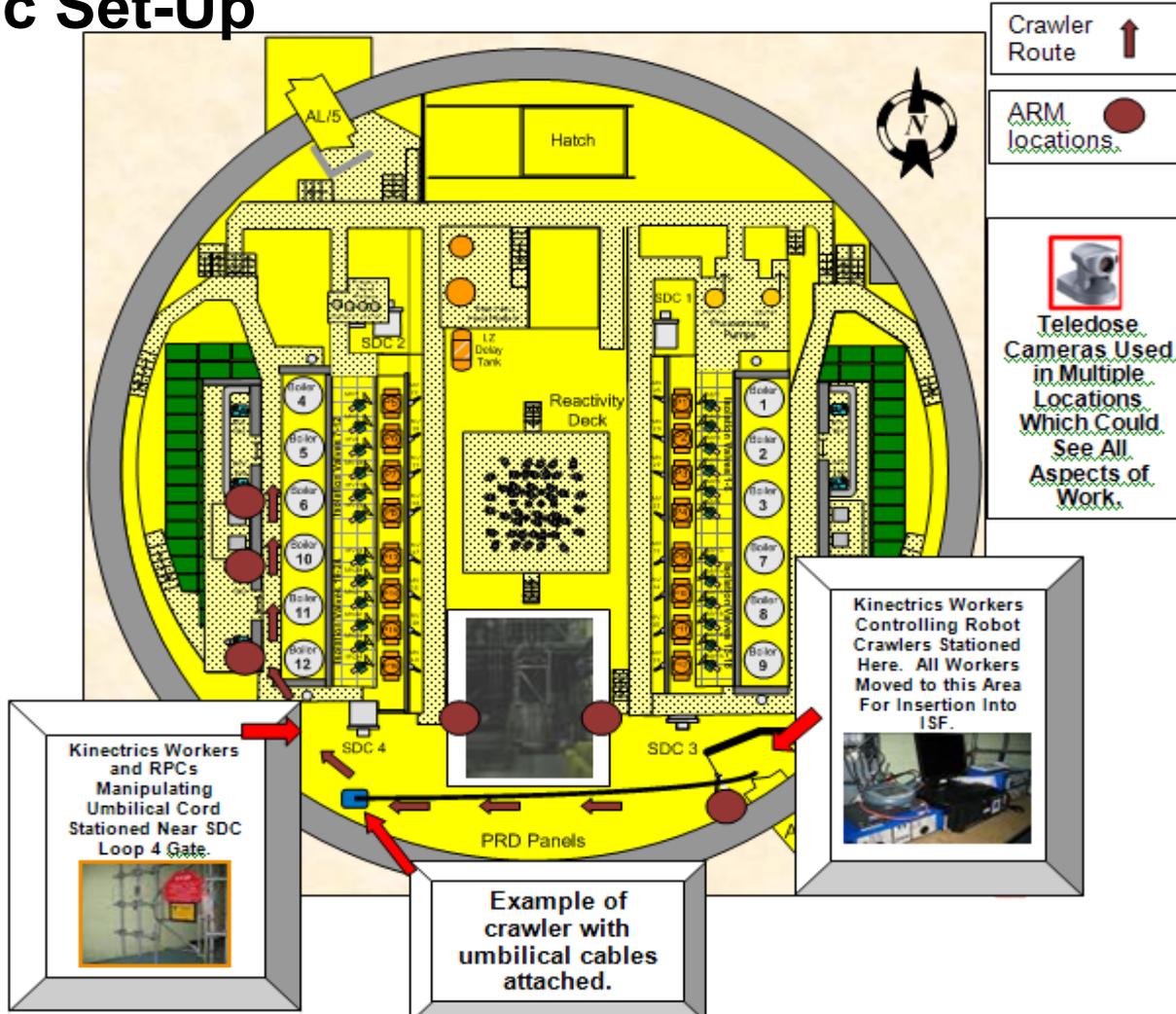
Plan is to Go Under the Boilers, Create an Ice Plug and Cut Out the Particle

Then transport remotely to an in station flask (ISF)



HOT PARTICLE RECOVERY

Basic Set-Up

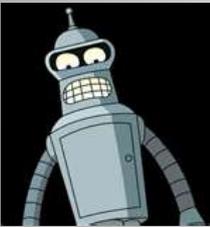


HOT PARTICLE RECOVERY



MEET THE ROBOTS!!

Robots on this page were not available due to prior work commitments, being destroyed, distance to travel, some were too hostile or the fact that we found out they were fictional!



HOT PARTICLE RECOVERY



Gamma Camera Cart

Used to Find and Triangulate Source Location Before Cut and During Ice Plug Formation

WALL-E



HOT PARTICLE RECOVERY



Insulation Removal Robot

Used to cut
insulation and
refitted with other
tools to remove it.

Mater



Contingency Robot

Used to assist and save the other robots if they got stuck or couldn't complete a cut. Used for insulation removal.



Optimus Prime





HOT PARTICLE RECOVERY



Freeze Cut Cart Robot

This robot equipped with freeze jacket. Clamps onto pipe, creates ice plug, cuts, caps, and transports to a intermediate flask.



Step 1 – Remove Insulation



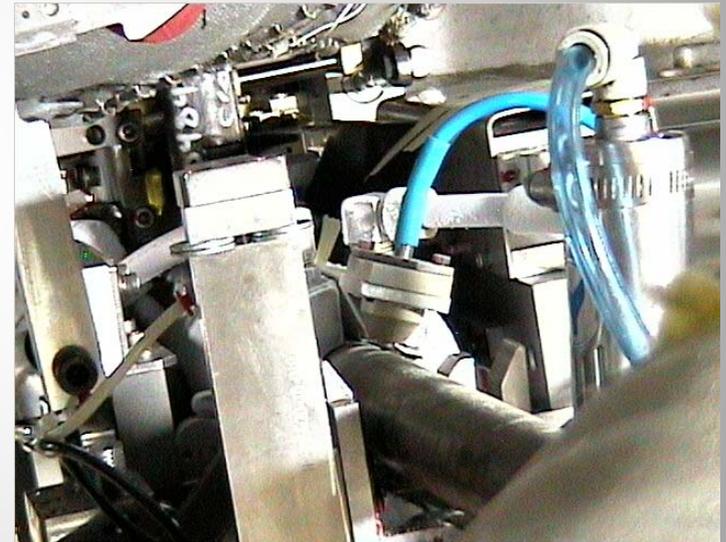
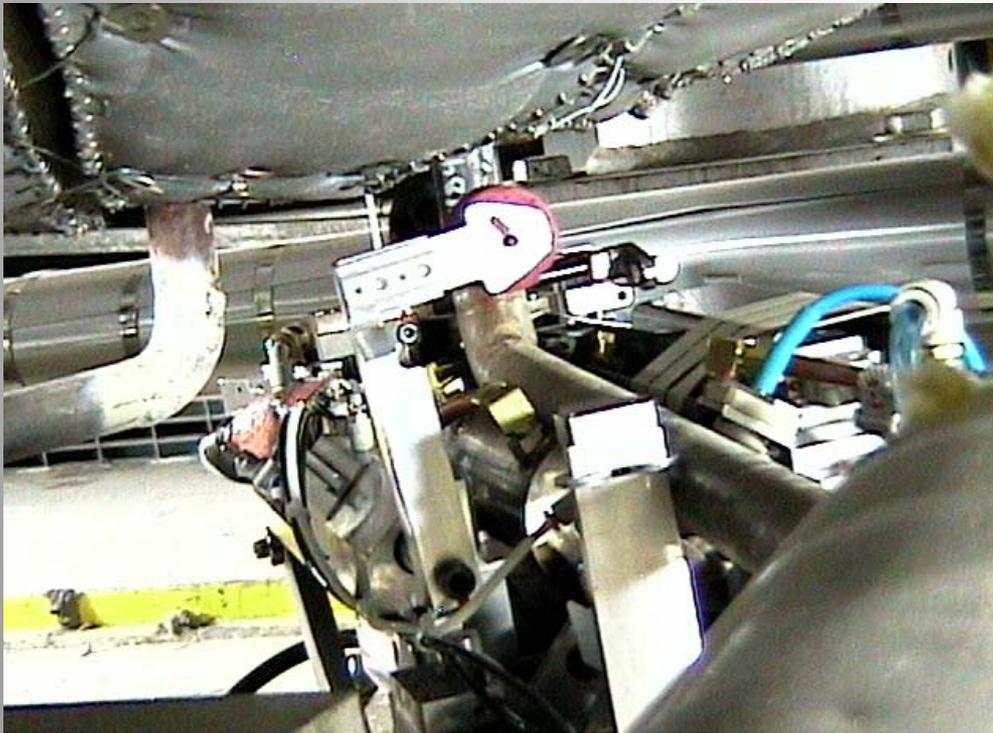
Insulation Removal Continued...



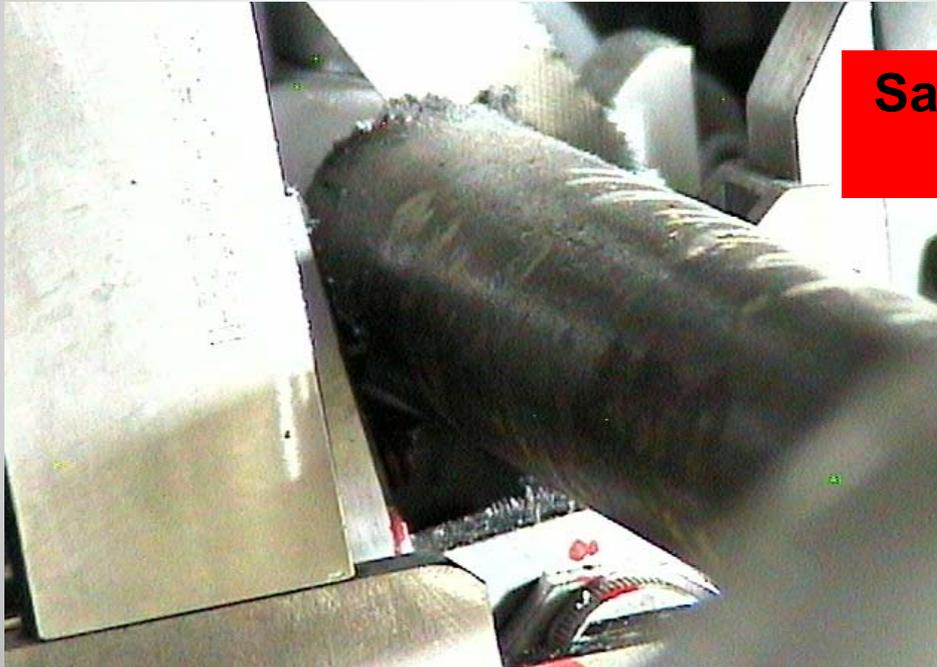
Step 2 - Verify Source



Step 3 - Freeze and Cut Pipe Section



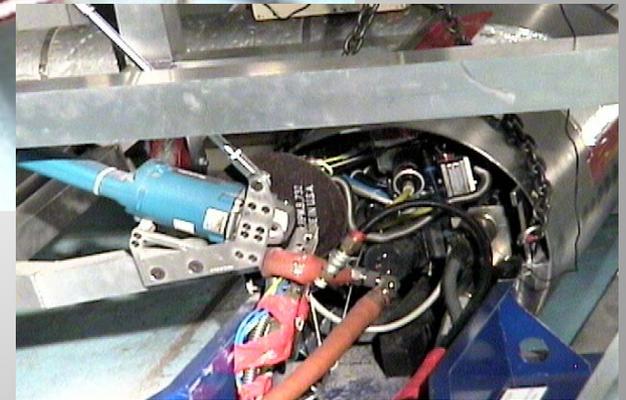
Freeze and Cut Pipe Section Continued...



**Saw Blade Making
Final Cut**



Step 4 -Transport Cut Piece to Intermediate Flask



Step 5 - Deposit Into Instation Flask

- 6 mrem/h @
1m from ISF
on the sides

-Initially 18
rem/h beam
coming from
top of open
ISF.

-After lead
shot fields cut
to 7 mrem/h



Step 6 - Secure and Shield in the ISF



Lead Shot Being Poured In By Can with Shoot



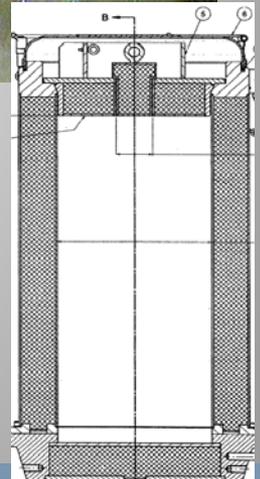
Bleed Filter Can Lid Being Put On



Securing Shield Plug on ISF



ISF buttoned up and particle safely stowed away



Dose Received From Work

-Total Dose From Execution in Unit 4 was 163 mrem. Job ran 3 days late. Only 12 mrem to crew securing flask.

-Average Dose Rate Workers Were in was <5mrem/h.

-Highest Peak Rate to Worker was a momentary 200 mrem/h

RADS - 31489-B6 HotSpt

Name	ED #	Dose	Rate	Dose Al	Rate Al	Status	Age
CASIMIR MARC T	58334	7	0	300	2000	OK	00:39
TAYLOR NEIL T -	60829	6	1	300	2000	OK	00:02
HILL IAN T - Tr	66025	7	1	300	2000	OK	00:08
SUESSMAN CARL T	72699	6	0	300	2000	OK	00:02
VAN BOVEN T T -	671514	8	11	300	2000	OK	00:03
SIM DEREK T - T	25153	5	0	300	2000	OK	00:04
BURANY STEPHEN	686730	5	0	300	2000	OK	00:09
VERZILOV YURY T	12373	0	0	300	2000	OK	00:03
HUSSEY CECIL T	26739	1	0	300	2000	OK	00:03
COTE STEPHANE T	30097	0	0	300	2000	OK	00:01
HAMILTON TONY T	30203	0	0	300	2000	OK	00:01
BURTON DONALD T	33127	0	0	300	2000	OK	00:03
CORBIN GLEN T -	33406	1	0	300	2000	OK	00:07
LANGLOIS MICHAEL	37642	0	0	300	2000	OK	00:02
HOOPER MARK T -	58167	1	0	300	2000	OK	00:02
GLOVER CHRIS T -	96181	0	0	300	2000	OK	00:02
JONES CHRIS T -	671582	0	0	300	2000	OK	00:02
SCOTT RODGER T -	672784	1	0	300	2000	OK	00:04
MCALPINE DAVID T	672912	0	0	300	2000	OK	00:13
DESJARDINS DAVIE	673760	0	0	300	2000	OK	00:01

RADS - 31155

Name	ED #	Dose	Rate	Dose Alar	Rate Alar	Status	Age	Comme
ARM - ISF East	55524	46671	12	50000	2000	OK	00:01	
Boiler 6 & 10	670594	226546	7	500000	50000	DOSE	00:04	
Boiler 5 & 6	57546	94426	7	500000	50000	DOSE	00:02	
ARM - ISF West	687035	8158	5	50000	2000	OK	00:00	
Boiler 11 & 12	25488	2386	9	500000	50000	OK	00:00	
ARM - SDC HX3	687284	289	2	50000	2000	LOST	18:56	

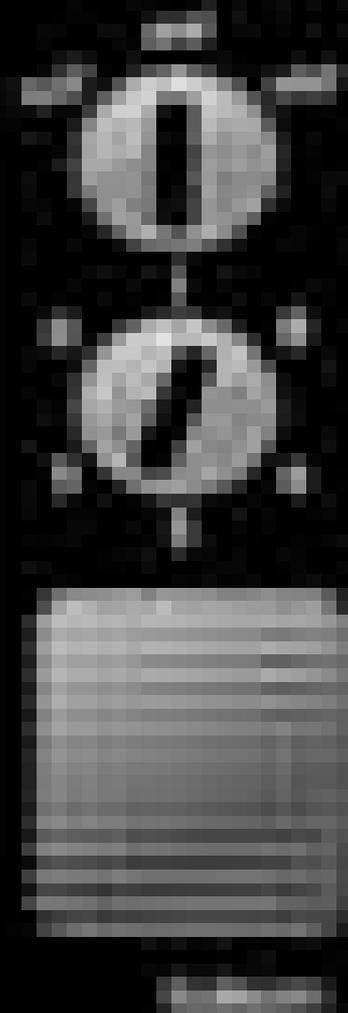
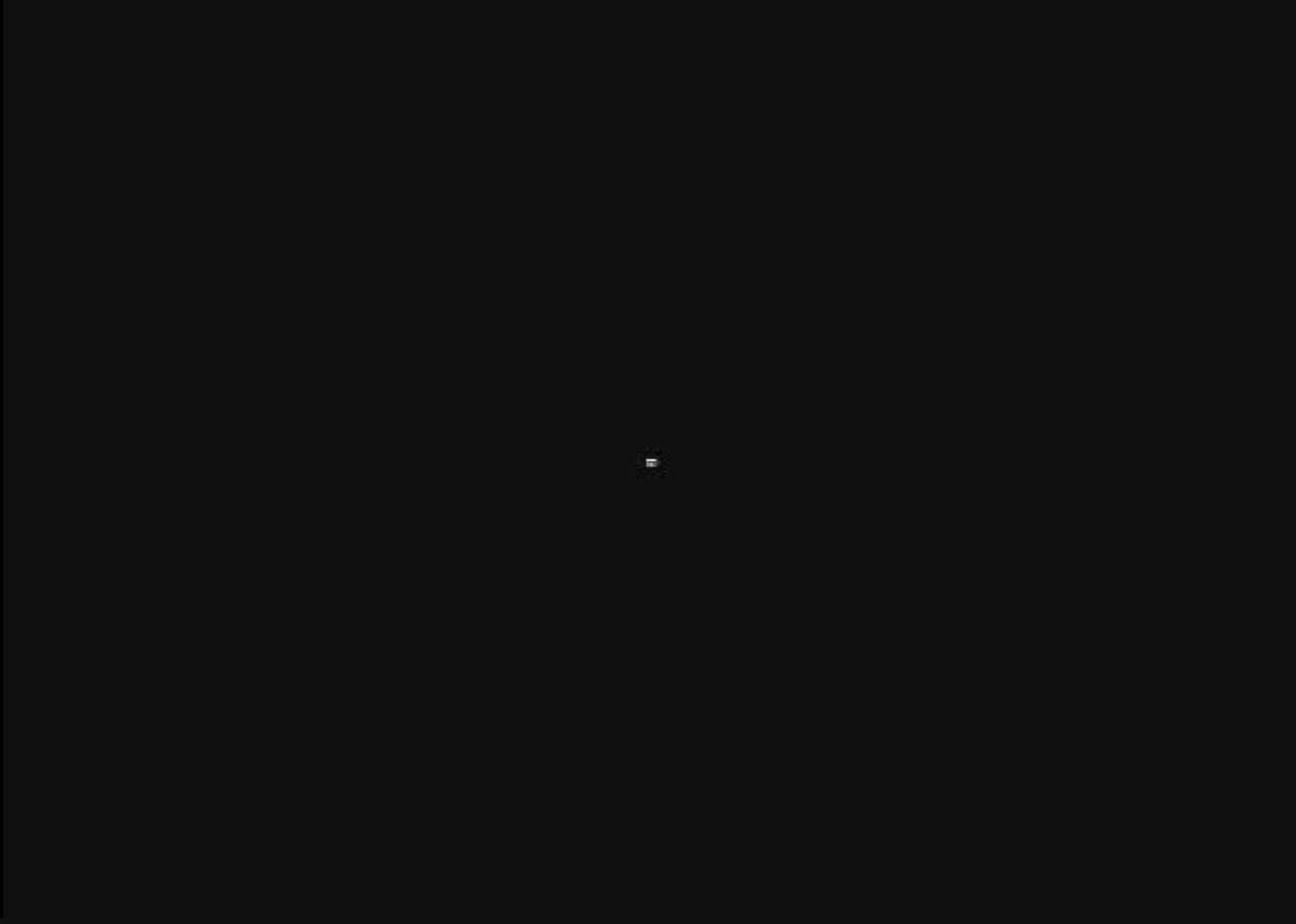


Safely in the Flask!

We went
'Fission' and
This Was the
Big 7 Ton 
Tuna we
Snagged!! It
took 20
months but
we finally
reeled him in!



HOT PARTICLE RECOVERY



Discussion!



HOT PARTICLE RECOVERY



Pickering - Unit 4 - Boiler 6 - September 2008

