Memorandum

SURRY POWER STATION 5/24/02

Unit One 2001 Reactor Head Inspection and Repair
Critique and Lessons Learned

This critique documents post-job review comments and lessons learned from the Unit One Reactor Head Inspection and Repair Project. Unit One was removed from service on 10/14/01 @ 0035 hours and returned to service on 12/8/01 @ 1559 hours, 55.6 days. The project was projected at 7.953 Man-Rem for bare head inspection only. The project expanded to under head inspection when indications of leakage on ten potential CRDM penetrations were discovered. Modifications were performed to six CRDM Penetrations. The final exposure was 162.898 Man-Rem. This included 3.605 Man-Rem for photogrammety on Unit One for future reactor head replacement. The table at the end of the report details the exposure by RWP and major task.

A Dominion and Framatome debrief was held on 11/28/02 with key personnel involved in the project. Post-job reviews were also held with work supervision for each RWP utilized during the project. VPAP-2102 requires that a post-job summary and critique be presented for Station ALARA Committee review and approval for tasks expending 10 Man-Rem or greater. The post-job review and debrief comments were used to develop the critique. The Framatome managers debrief performed on December 11, 2001 is attached to ensure all lessons learned information is available for review in one location.

Project Lead, Project Management and Scheduling:

Dominion assigned a corporate project lead to both the North Anna Power Station (NAPS) and Surry inspection projects. NAPS was scheduled as the first inspection and the project lead dedicated his time to NAPS leaving Surry with little guidance. The mind set was to wait and learn from NAPS. This left Surry with little to no project leadership and guidance. Nuclear Site Services stepped up and joined ALARA in preplanning insulation, shroud and shield wall removal and replacement. A Surry project lead was assigned approximately 10 days prior to the outage when Framatome was contracted to replace Westinghouse when the NAPS inspection was extended.

- Assign a project lead well in advance of project start date. It is critical to have a person start focusing the station early.
- Set up a project team that supports the whole project. (I.e. RP, Construction, Maintenance, Engineering, etc.)
- Need team on days and nights for continuous motion and adequate turnover.
- Engineering was the lead department on the project. Maintenance has the structure built into the department for oversight of large contractor groups. Maintenance also has the worker skill and expertise for problem resolution. Maintenance should be incorporated into the management team to assist in oversight of the contractor group and have active involvement in work scope and problem resolution.
- The timing for the performance of the bare head inspection should be investigated for future outages. The best time and place for this inspection may well be while the reactor head is still on the vessel. That may impact the outage schedule but may help facilitate equipment onload. The correct place for this in future outages should be assessed.

- NSS provided support when requested, but the team felt that in the future a person should be full time assigned for support (NSS or Maintenance). This would afford the assigned person the ability to look ahead to upcoming evolutions and pre-stage any required services such as fire watch, flame permits, power requirements, etc.
- Extra radiation dose was expended due to the loss of efficiency in the repair process. There is an economy of scale efficiency gain when multiple penetrations are repaired since a single evolution (such as boring) can be done on all penetrations. With the complications from penetration S1-27 and other tooling problems, this efficiency both in time and in dose was lost.
- There is room for improvement in the Framatome procedures for contingency planning. Many of the problems encountered required Nonconformance Reports (NCRs) and were not contingency steps in the procedures.
- Framatome, Health Physics, ALARA and NSS performed the pre-job walk down that enabled the team to know where equipment would be staged prior to moving it into containment. The walk down was considered a success.
- There was a general consensus that when major obstacles were reached, the team did well to proceed parallel on other tasks. For example, when the cutting tool was stuck on penetration S1-27, the repair evolution was commenced on S1-18.
- The whole repair team needs to be close together so that important people can easily be reached. The configuration of having the crew trailers in the construction side parking lot and the control trailer inside the protected area near the administration building was far from ideal.
- Equipment demobilization can be accomplished at significantly less exposure without the reactor head in the basement. Equipment demobilization is always a major focus item for outage management at the conclusion of an outage, and efforts should be made to see if a better ALARA method for removing equipment that does not impact the outage schedule could be developed.

Radiological Protection:

- There were no Dominion Health Physics hold points written into any of the procedures. Consider having Dominion HP personnel in the review process of certain procedures in the future.
- The dose extension process is very cumbersome. For high dose jobs like this involving contract staff, ultimately dose extensions should be expected and the process should be evaluated to simplify the dose extensions. Jefferson Labs in Newport News could be contacted to read TLD's. This would provide a quick turn around on having a worker's actual dose, (a component of the dose extension process).
- The Digital Alarming Dosimeters (DADs) underpredicted the actual dose measured by TLD's. This resulted in a conservative correction factor and also resulted in the need to retain a dose "buffer" for any person making trips under the reactor head. In effect, this reduced the amount of radiation dose any worker could receive and increased the number of personnel required for the job.
- The frequent need for special dosimetry should be evaluated. Possibly fewer under head entries could be done with special dosimetry or maybe its use could be eliminated altogether.
- A de-contamination plan needs to be established in advance for future evolutions. The decontamination of equipment and the release limits for equipment should have been worked out in advance.

Decontamination of Reactor Head:

Two decontamination efforts were performed on the underside of the reactor head to reduce dose rates. The effort yielded a 50 percent reduction in contact and general area dose rates. Decontamination of the top of head was concentrated to localized areas designated by engineering.

Under Head Decon:

- Apply foam between the head flange and the headstand to contain water and contamination.
- Decon until results are obtained. Stopping and re-setting up later expends additional exposure. Surry's second decon was performed until no additional black oxidation was observed.
- Surry filtered the second decon water through a 10 micron and a 1 micron filter prior to discharging to the sump.
- Ensure schedule allows adequate time for decontamination.

Top of Head Decon:

- Have steam and hot water-cleaning equipment available.
- Have engineering representative on job site to monitor and direct cleaning efforts to prevent repeat cleaning.
- Catch trough was attached to the head to capture and contain the top of head decon water. Water was pumped from the trough to the sump. The trough did not contain the water well during the 2002 U2 bare head inspection washdown.

Temporary Shielding:

The entire reactor headstand area was incorporated into the shield plan and hot particle area. The walls included a labyrinth arrangement to provide low dose work areas within the hot particle area and a locked gate for locked high radiation access control. The control booths were shielded with double layers of blankets including the roof to lower dose rates to less than 2 mRem/hr. The inspection required removal of the headstand water shields. The stand was shielded with lead blankets attached to a cable supported by the o-ring support brackets.

- Another radiation dose success was the shield booths set up for equipment. The only drawback was the shield booths were set up specifically for the ARAMIS (NDE) equipment and not for the repair equipment due to the repair crew was not onsite and available during the setup walk down. The repair crew required the booth to be disassembled and reassembled in a different area due to cable lengths. In future campaigns, the shield booths should be set up to accommodate both NDE and repair campaigns.
- The shield walls and shielding should have some kind of access door put in so that equipment can be taken in and out of the hot particle zone easier.
- Radiation exposure could have been reduced by re-arranging the access door, configuration and layout of shield walls, shield booths, and general area access. This becomes a non-issue from an adequate work area standpoint if cables are lengthened to setup the control booth and other equipment in a low dose area.

Ventilation:

Over 300 entries were made under the head. There was no airborne activity recorded outside the shroud area during bare head inspection or outside the head stand during under head inspection and repair. Air samples of >1000 DAC were recorded under the head during grinding and repair work. No uptakes were received during bare head or under headwork.

- Two 2000-CFM HEPA systems were attached to the top of the head region and two 2000-CFM HEPAs were attached to the reactor headstand providing 4000-CFM ventilation flow to each region during work.
- HEPA hoses were attached to top hats that could be moved from one ventilation opening to another based on work location.
- No airborne activity existed outside of the reactor headstand.

- The ventilation that was used for the various evolutions was a success but the ducting was inadequate (it kept collapsing). Ventilation in general was a good exposure reduction and contamination control method.
- Ventilation hoses should be routed in racks to keep them off of the floor, prevent collapsing and allow for rolling scaffold movement.

Protective Clothing:

Protective clothing was a concern not only from a radiological standpoint but also from a worker comfort standpoint. It was extremely important that the workers could perform their tasks efficiently and with good communications. Power Air Purifying Hoods (PAPHs) were utilized for respiratory protection. The hoods pleased the workers for comfort and allowed the use of headsets under or over the hood. No uptakes of radioactive material were received.

- Single PCs with cool suits for outer hot particle clothing was used.
- PAPH hoods for under head work provided increased mobility, visibility, and comfort. The hood protection factor is 1000.
- Above head area should be cleared from hot particle if possible to allow bare head inspection personnel to work without hot particle clothing.
- Framatome performs the barehead inspection at the head shroud area. Brooks performs the inspection remotely from a control trailer outside of containment. This lowers the need to clear the area from hot particle.

Scaffolding:

Rolling scaffold was used on unit one and built prior to the head being set on the stand. This saved significant exposure for building scaffolds for bare head inspection. The scaffolds were used several times for L-5 CRDM travel housing removal and photogrammetry. Scaffolds for the Unit Two bare head inspection were built on the 47' elevation and craned into the cavity. Shield booths were built on the back of the scaffold and shielded after the scaffolds were placed in the cavity. Framatome used the booths during the crawler portion of the inspection. Brooks does not require the shielding due to the remote inspection technique used.

- Rolling scaffold was a success however post job comments stated it was in the way during the repair process. The resolution is to preplan and organize the equipment layout to prevent interference and capture more real estate to provide room for the large amount of equipment. Without the rolling scaffolds plan scaffold platforms would have been removed and rebuild approximately five times to support work.
- Lessons learned from U1 and implemented into U2 – shield booth built on back end of platform provided low dose area during video inspection.
- U2 scaffold was built on the operating deck and lowered into position with the crane.
- Brooks does not need the shield booths during the inspection because crawler operation is performed from outside the containment.

Real Estate and Area Set Up:

Many concerns were raised due to the amount of equipment staged on the –27' elevation to support the inspection and repairs. Additionally, the repair equipment was not available prior to setting the head on the stand. This required a separate head lift to remove the inspection equipment and setup the repair equipment. Both sets of equipment would not fit (if it were available) with the current cable lengths provide by Framatome, 50' from center of the headstand.

- Capture as large an area as possible to handle the large amount of equipment. Plan the hot particle area layout to ensure interference from equipment is minimized.
- Provide a gate in the shield wall for large equipment moves.
- Shield as much area as practical and cover the remaining areas to prevent on lookers and to isolate the hot particle area.
- Shield the control booths on top and sides if control area can not be positioned in a low dose area.
- Maximize cable lengths. Surry was restricted to 50' of cable. Require minimum of 150'.
- Do not remove equipment from the work area until after the reactor head is set in the cavity. This allows the hot particle area and equipment to be decontaminated in a much lower dose rate field and use of the crane for removal. This exposure saving item was addressed in the 1600 meeting. Framatome was still directed to remove the equipment by hand prior to head set. It is estimated that 0.800 to 1.000 Man-Rem was expended on equipment removal.
- There should be cable racks pre-made for the containment basement for these evolutions. Both NDE and repair evolutions had many cables strewn all over the containment basement and were undoubtedly in the way. If cable racks can be set in advance, these areas can be kept cleaner.
- Bundling of cables was a lesson learned from NAPS and an ALARA Requirement. Language barriers may have contributed to cables not being bundled.
- Onload of reactor head inspection equipment was not integrated into the refueling equipment onload. The RHR pump motor was not located until just prior to the closing of the hatch. ALARA consistently raised concerns about equipment not being onloaded and ALARA Requirement to complete the installation of shield walls prior to head lift. Outage schedule was priority and head was lifted without completion of all of the shield walls. This required installation of wall and shielding in a 75-150 mRem/hr. verse a 20-35 mRem/hr. dose rate area. The RHR motor was blocked in by shield walls and Framatome equipment and required additional exposure to move.
- The outage and containment coordinator should be notified well in advance of the start of the project of the equipment layouts required. This would help prevent the containment coordinator staging a piece of equipment in an area where personnel may be working.
- Some Framatome equipment had short cable lengths (particularly NDE equipment). If the cable lengths can be increased, the personnel operating the equipment can be staged more remotely and the total exposure reduced.

Communications and Cameras:

Framatome and the WCC had direct communications at all times. Bartlett Nuclear assisted RP with additional equipment and personnel to accomplish this task. Communication issues occurred frequently with interference, loss of power and headset failures. However, no entries were allowed until issues were resolved. Framatome, RP and Bartlett worked well together to provide excellent communications for the work team.

- Preplan and allocate money to incorporate the best communications system possible. Communications is critical throughout the process. Ensure communications is established between workers, HP technicians in the field, the control booth, the control trailer and the RP Work Control Center. Do not leave any group out of the loop.
- The group felt strongly that future efforts should include cameras with laser pointers to help reduce the potential for setting up equipment on the wrong nozzle. The independent verification process utilizing the video and audio connections prevented work on the wrong penetration, but a laser pointer on the camera would help reduce (or potentially eliminate) dose spent lining up on the wrong location.
- Project should have 360-degree camera views for entire project.
- There were head set communication problems throughout the job. A multi-channel system that interfaces with Framatome and the Work Control Center needs to be obtained. The interface between the two systems sometimes rendered part of the communications non-functional.
- The clean headsets that were purchased by Framatome and put in the hot particle zone were not controlled well.
- Different communication methods should be investigated and any equipment purchased up front. For example, smaller ear mount microphones vice bulky headsets. (The PAPH manufacturer has already been consulted about redesign of the hood to accommodate hard hats, headsets, etc.)

Mockups:

Several mockups were held both onsite and offsite at the Framatome facility. Surry also participated in the Westinghouse/PCI mock up and visited Oconee Nuclear Station to observe their project mockup.

- Insulation removal/demolition mockup built on site.
- All phases of Framatome work was mocked up utilizing the ½ head onsite mockup provided by Framatome.
- Provide RP personnel to assist with mockup and require practice in full Dress out gear.
- Champher weld grinding was practiced in the pipe shop. Workers commented that this mockup was very beneficial and provide valuable practice time to hone skills in grinding angles.
- Cutting tool removal – hydraulic jack methods were tested and practiced on the mockup.
- FME plug removal was practiced and efficiencies gained in this process.
- Photogrammetry target setup and placement was practice including keyway placement of the targets.
- Nozzle welding and cutting was practiced on the mockup.

UT and PT:

UT was performed using the ARAMIS system provided by Framatome. Leveling problems occurred due to the head stand floor was not level and would give under the equipment weight. Ten penetrations had manual PTs performed to verify/identify indications of cracking. Total under head inspection expended 32.820 Man-Rem. Manual PTs expended 23.007 Man-Rem.

- Station welders who did the grinding on the J-groove weld indications had to do the grinding by removing the safety guard. For future grinding evolutions, a different grinder that is suited to the job should be obtained.
- The welders performed several "quick look" liquid penetrant tests by spraying developer on the weld while grinding. This resulted in some radiation dose savings, as the welders were able to tell quickly if further grinding was required and is considered a success.
- Remote tooling should be developed for each evolution to reduce the large amount of entries under the reactor head.
- A remote flapping tool for prepping the J-groove welds should be developed. Future campaigns could result in J-groove weld liquid penetrant tests and remote flapping would reduce the dose for this evolution.
- The most efficient method for manual liquid penetrant tests should be established. There was some discussion about whether "spreading out" the dose among multiple NDE technicians was the best ALARA means of reducing the total exposure for the evolution.
- If J-groove weld manual liquid penetrant tests are required during future campaigns, the iterative process for grinding out indications should be eliminated. Engineering should determine the maximum depth of grinding that can be performed prior to doing any liquid penetrant tests, and when grinding commences, the welds should be ground to the maximum depth. This will ultimately reduce the total radiation dose for any manual grinding (and also reduce the number of liquid penetrant tests performed, also reducing the total dose).

CRDM Repair:

A total of six CRDM penetrations were modified using the Framatome process. Several incidents of misalignment on the wrong penetration occurred. All were identified by the verification process and WCC prior to any work being performed on an incorrect penetration. All penetrations were re-labeled and a laser pointer was implemented. Total exposure for penetrations modifications was 112.613 Man-Rem.

- A second reactor head lift was required for the Unit 1 repair equipment onload. This went very smoothly and allowed mobilization of equipment without the reactor head being in the containment basement (a significant radiation source). Utilizing a second head lift should be evaluated for future NDE/repair campaigns.
- The Westinghouse EDM tool that was used for thermal sleeve cutting required two cuts to remove the thermal sleeve. This obviously doubled the number of cuts required and effectively doubled the dose for performing this work. Westinghouse is evaluating changing the design of the tool so that it can cut at a higher elevation.
- The manual honing process worked well and resulted in less radiation dose than the automated honing tool during guide sleeve cutting. Framatome should investigate the design of their tooling.
- There needs to be a large orientation map located at the reactor headstand. There were no adequate maps at the headstand area to allow workers to get oriented prior to entry under the reactor head.
- Fire watch personnel received 1 Man-Rem for this task. With the extensive video and audio equipment and the shield booths and shield walls, this dose should have been lower. Safety and Loss Prevention should investigate methods to have fire watch personnel perform their tasks remotely and for less radiation exposure. One method is to give a waiver for fire watch requirements based on the actual amount of consumables under the head. A second method would be to fire watch qualify the control booth personnel.
- The chemical etching that was performed was not expected as part of the original job scope and expended extra radiation exposure. The etching was required to resolve dimensional discrepancies, but was nonetheless not accounted for in the original projection.
- The under head decontamination effort was a success, especially considering the number of entries required under the head. Efforts should be made to see if additional measures could be taken to further reduce the dose rates.

- The nozzle rolling went fairly smoothly but was not done on all penetrations in question. The need to change tooling and perform nozzle rolling out of sequence resulted in more radiation exposure than projected for that activity.
- A lesson learned during the evolution was that physically changing the cutting tool head (from cutting to beveling) under the reactor head resulted in less radiation dose than lowering the tool and changing the cutter at the head stand access hole.
- The welding tool head rebuild that occurred during the outage was a significant success. This dramatically improved the tool performance, which directly results in less time and exposure since the tool head doesn't have to be handled as frequently. The handling of the tool head is the expected source of the problems, so further steps should be taken in mock-up training regarding the proper way to handle the welding tool head.
- Consideration should be given to developing some mobile lead shield that can be rolled in place when tool head change outs are required. Along the same lines, quick disconnect hoses should be investigated so the tool head in question can easily be removed and staged in a low dose area for repair or change out.
- The J-groove weld remnant grinding resulted in significant radiation exposure. A remote tool to perform this grinding should be developed.
- Practicing the manual grinding in the mock-up was successful in reducing the total radiation exposure for this evolution.
- The ½" less chamfer grinding that was achieved analytically allowed significant radiation dose savings.
- One of the components of the Abrasive Water Jet tooling failed repeatedly (roller ball nut). An o-ring problem also caused significant tooling down time. Both of these issues resulted in more exposure for the evolution (not to mention significant tool down time). A time should have been preset for removal of the AWJ tool head to a low dose area since much of the tool head work was done adjacent to the reactor head stand.
- The ambient temper bead weld process requires multiple temperature readings after the welding is complete. A remote temperature-monitoring gun should be employed for this to reduce the number of trips required under the reactor head.
- The FME plug may need to be re-designed by Framatome.
- There were several issues where the plug was not installed in the right location or was difficult to remove.

Tool Retrieval:

The cutting tool became lodged on the first cut in penetration S1-27. Efforts to retrieve the tool from under the head expended 13.304 Man-Rem. An additional 6.783 Man-Rem was expended removing the L-5 CRDM travel housing, and thermal sleeve to remove the tool head.

- There was 13+ Man-Rem expended trying to get the stuck tool and partial thermal sleeve out of penetration S1-27. It was proposed that maybe an earlier decision point to stop attempts and disassemble from the top should have been established. There were steps in the process where radiation dose limits were set (i.e., 3 Rem was the maximum set for initial tool removal attempts), but there was some uncertainty on whether these limits were clearly communicated to dayshift management personnel.
- The shielding that can be done on the top of the reactor head should be evaluated if this evolution is required in the future. Enhancements may not be possible due to interference problems with the existing machinery for cutting the canopy seal weld and machining the top of the reactor head, but it should be investigated for future evolutions.
- The machining that was performed on the lathe in the refurb. building was hampered by the difficulty of rigging the housing into the lathe. This resulted in additional exposure since it resulted in handling the housing several times. This should be looked at closely since it may be a significant issue when new reactor heads are obtained.

- The new canopy seal weld had a flaw that required a manual repair. This manual repair was not in the original dose estimates.
- The pictures that were taken during the pre-job walk down were very helpful in showing areas of interference that needed to be removed, locations where scaffolding was required, etc.

Photogrammety:

- Mockup of target setup and placement.
- Evaluate placing targets on magnetic strips then place on reactor head flange instead of placing them on tape.
- Snap on clips were designed for installing targets remotely on upper internals drive shafts.
- Do not allow any activity to interfere with or break sequence of target placement or removal in the reactor cavity. Loss of concentration cost exposure.

RWP #	Activity	Exposure
2103	Decon	0.056
	HP Support	0.664
	Video Inspect	2.504
	Scaffold	0.338
	Insulation Removal	0.389
	Support Activities	0.725
	Final Bare Head Decon	0.423
	Insulation Replacement	1.572
	As left video	0.406
		7.077

RWP 01-2-2103 - Bare Head Inspection

RWP Projection:	6.389	Man-Rem
Actual Exposure:	7.077	Man-Rem
110.8 %		

RWP #	Activity	Exposure
2107	Decon Under Side of Head	1.818
	Liq. Pent. Test. 3 Welds	2.365
	Cut Lead Screw	1.214
	Grind Indication #65	1.678
	Escort Foreign Nationals	0.699
	Modify Head Stand	0.433
	UT Testing	3.915
	Man. Pt of 7 Welds 10/31D/S	4.675
	Man. Pt of 7 Welds 10/31N/S	5.885
	Man. Pt of 6 Welds 11/1 D/S	3.130
	Man. Pt of 6 Welds 11/1 N/S	5.274
	Misc. Support/Equip setup	1.734
		32.820

RWP 01-2-2107 - Under Head UT/PT

RWP Projection:	31.598	Man-Rem
Actual Exposure:	32.820	Man-Rem
103.9 %		

2109	Reactor Head Lift/Set - 2nd Lift	0.482	**RWP 01-2-2109 - Rx. Hd. Nozzle Mods.**
	Set up MOMAN	0.938	RWP Projection: 116.191 Man-Rem
	Remove/Install Guide Tubes	13.203	Actual Exposure: 112.613 Man-Rem
	Manual Honing	2.221	96.9 %
	Guide Sleeve Cutter Extraction	13.304	
	Nozzle Rolling	5.696	6 Nozzles Modified
	Nozzle Machining/Beveling	17.461	
	Nozzle Welding	10.869	
	Post Weld Grinding	22.133	
	NDE/AWJ Remediation	11.660	
	Equipment Removal	0.804	
	Westinghouse EDM Support	3.666	
	Etching	1.694	
	Scaffold/Construction Support	0.375	
	Visitor Escorts	0.254	
	Decon Support	0.509	
	HP Support	2.981	
	Supervisory Support	0.700	
	Misc. Eng, QC, NDE Support	3.663	
		112.613	

2110	Elect. Remv/Repl IRPI coils	0.558	**RWP 01-2-2110 - L5 CRDM Travel Housing Removal**
	HP Support	0.281	RWP Projection 8.756 Man-Rem
	Decon Support	0.062	Actual Exposure 6.132 Man-Rem
	Mech Remv/Repl Shroud	1.498	70.0 %
	Rigging/scaffold support	0.252	
	Set up equipment	0.027	5 IRPI/CRDM Coil Stacks Removed
	Sever CRD	0.083	
	Remove CRD	0.137	
	Prep of nozzle 27	0.041	
	Weld area preparation (on head)	0.615	
	Weld area preparation on CRD	0.345	
	Remove/replace Guide Sleeve	0.926	
	CRD Canopy Welding	1.190	
	Equipment Remv - Misc. Support	0.117	
		6.132	

2112	Rig CRDM into/out of Lathe	0.381	**RWP 01-2-2112 - Machine L5 CRDM Travel Housing**
	Machine CRDM	0.217	RWP Projection 0.730 Man-Rem
	HP/Decon Support	0.024	Actual Exposure 0.651 Man-Rem
	Misc Support	0.029	89.2 %
		0.651	
			Travel Housing Removed From Ctmt. and Machined on Lathe in Refurb. Bldg.

2112	Eng/Framatome Photo G	2.914	**RWP 01-2-2113 - Photogrammetry of Rx. Head**
	HP Support	0.207	RWP Projection 2.979 Man-Rem
	Maint - Remv Stud Hole Plugs	0.455	Actual Exposure 3.605 Man-Rem
	Construction Support	0.029	121.0 %
		3.605	
			Rx. Hd. Photographed while Hd. was on stand

Task Summary		
RWP 01-2-2103 - Bare Head Inspection	7.077	Man-Rem
RWP 01-2-2107 - Under Head UT/PT	32.820	Man-Rem
RWP 01-2-2109 - Rx. Hd. Nozzle Mods.	112.613	Man-Rem
RWP 01-2-2110 - L5 CRDM Travel Housing Removal	6.132	Man-Rem
RWP 01-2-2112 - Machine L5 CRDM Travel Housing	0.651	Man-Rem
RWP 01-2-2113 - Photogrammetry of Rx. Head	3.605	Man-Rem
	162.898	Man-Rem

Presented by: ____________________________
Leonard E. Rollings
Station ALARA Coordinator

Approved by: ____________________________
Thomas Sowers
Chairman, Station ALARA Committee

The following debrief was held on December 11, 2001 by the Framatome management team. It is being provided in its entirety in this critique for additional information and lessons learned. Some information will be repeat data from the above ALARA post-job/critique.

Debrief Participants:

NAME	POSITION/CO.	PHONE
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Matt Adams	Mgr Site Engineering/Dominion	757-365-2006
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Tim Steed	Mgr RP/Dominion	757-365-2010
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Delano Hodges	CTMT/Yard Coordinator/Dominion	757-365-2922
Jim Keithley	Supv HP Operations/Dominion	757-365-2069
Terry Gillespie	Supv Nuclear Construction Civil/Mech/Dominion	757-365-2021
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Debrief Notes:

1. Dominion: QA/QC involvement by Dominion was minimal. Was this a problem? Framatome: Have seen full spectrum of involvement at other utilities. More QA/QC would have slowed the process down.
2. Dominion: NCR review & disposition process was not well defined. Who should review and disposition NCRs? How much involvement should Dominion have? Framatome: System employed here was typical of that used at other utilities. The process works best when the utility allows Framatome's technical support group to resolve the issues without interference. More utility involvement would have slowed the process down.
3. Unit 2 RVH inspection in the cavity worked well and should be the goal.

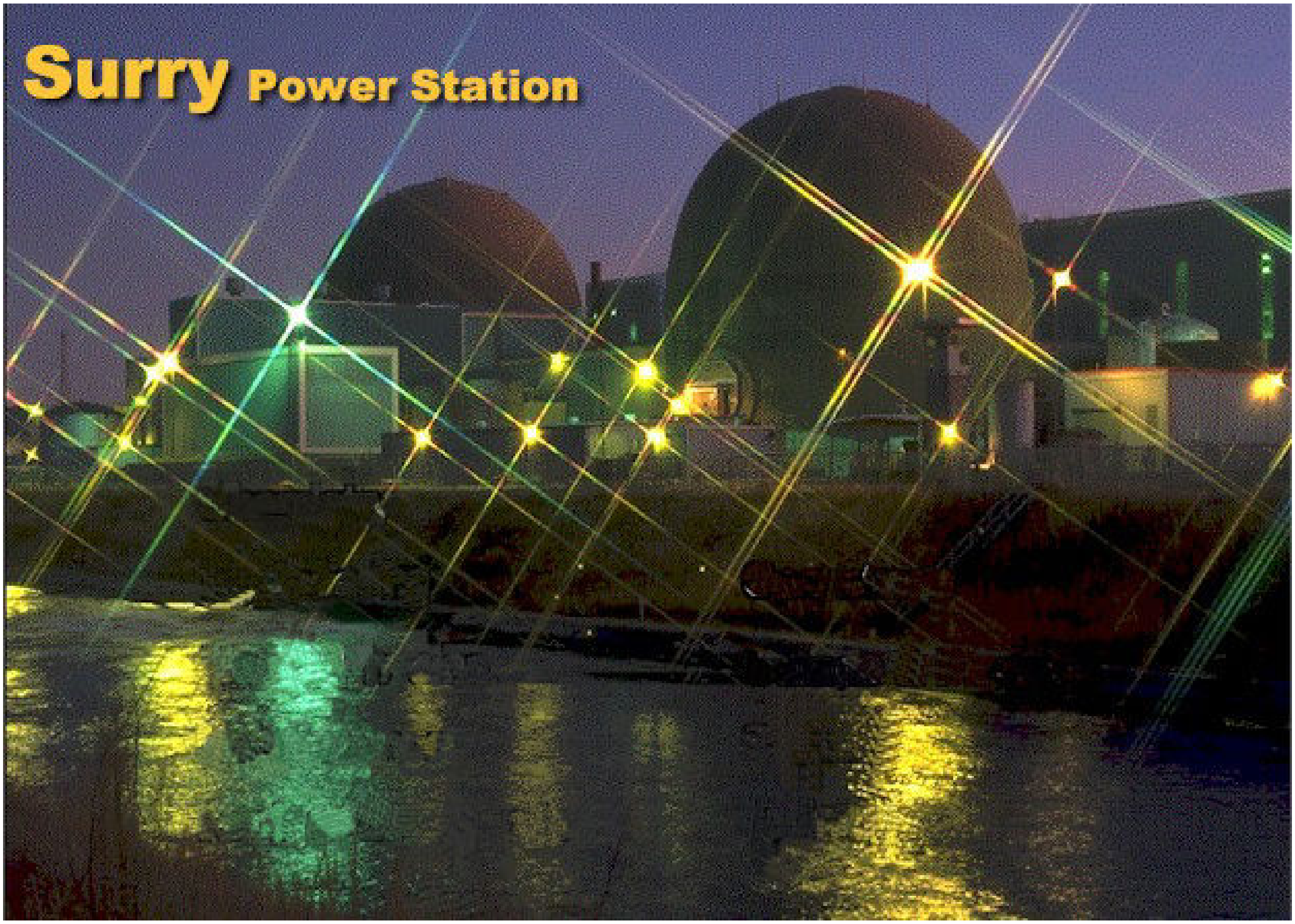
4. Dominion: We used our own procedure and people to perform the qualified visual inspection. Was this a problem? Framatome: No, except the project team was not informed ahead of schedule and had made arrangements to perform the inspection with Framatome people.
5. Dominion: Overall the project's pre-planning effort was poor. A station lead should have been identified earlier. The size of the project demanded a larger organization than a single project lead.
6. Framatome: The use of TLDs in the protected area was not well communicated to Framatome people. Need to better emphasize this point in training.
7. Dominion: Even though Dominion communicated the need to remove all Turkey Point head maps from the site following a problem with their during the qualified visual inspection, Framatome failed to do so.
8. Dominion: Positively identifying individual head penetrations through markings (e.g. paint, clips, labels, etc.) would have been beneficial and should be considered in the future.
9. Dominion: Framatome's Human Performance program was poor. Event free performance tools such as self-checking, peer checking, coaching, questioning attitude, clear communications, etc. were not effectively used. Dominion's Engineering organization typically is more aware of latent errors than active errors. Overall Human Performance was poor.
10. Framatome: Dominion needs better controls over power supplies inside containment. Loss of power was a recurring problem. Dominion: A large (500 amp) temporary generator was set up in containment, but not fully utilized. Need to make better use of reliable generator power in the future.
11. Dominion: The qualified visual inspection video was of poor picture quality. Framatome needs to improve still image resolution. The record of the visual inspection would have been more acceptable on DVD format instead of the supplied VHS tapes.
12. Framatome: Huge benefit to have somebody like Don Anderson (HP) on the team to quickly resolve issues.
13. Dominion: The Surry containments are generally smaller than those at other utilities. Framatome needs to supply a better defined list of incoming equipment with dimensions.
14. Dominion: Large power pack on 18' elevation was a problem.
15. Dominion: Consumable materials and equipment often bypassed receipt inspection at the warehouse by being shipped directly to the Framatome trailers. This was a violation of contractual agreements.
16. Dominion: There were numerous problems associated with setting up on the wrong penetration. Need a better way to positively identify the penetration being worked on before dose is needlessly spent. Under-head cameras with laser pointers could be very beneficial at eliminating these types of errors. The use of S/G paint, soap stone, head maps, or other means need to be fully explored and implemented.
17. Dominion: The many chaotic cable/hose runs associated with this job challenged personnel safety and a made house keeping a "nightmare". Need to better organize the many cables into trays, or other. Longer cable runs would also be beneficial in allowing more convenient routes along walls.
18. Dominion: Need Framatome equipment decontamination plans well in advance. 50,000 dpm (?) is too low for this type of equipment. Would like to ship as-is.
19. Dominion: Had a lot of problems with communications (head sets). If the RWP is going to require communications, they should work. Need to develop a wireless communications system (Mark Fisher/Dominion has our capabilities).
20. Framatome: Dose extension process was cumbersome and time consuming.
21. Framatome: Need audio video system in crew trailer to improve communications and readiness. Would like to have different trailers side-by-side instead of scattered throughout the site. Carolyn Clay/Dominion may be able to help with audio-video setup.
22. Dominion: UT blade probe design had interference problems in the nozzle's annular region. Design of Surry head penetrations was not typical. Nozzles had a more blunt radius rather than the expected counter bore. Framatome: Most issues were resolved. Cutting out the CRDM guide

sleeves early on would have eliminated the delivery problems associated with the blade probes. Framatome: In the process of developing a bottom-up rotating UT probe system capable of interrogating the weld. System will see first use at Millstone. With rotating probe would be able to better understand head and J-groove weld thickness and configuration. Shallow cracks in the weld may not show up with rotating probe. Rotating probe is also considerably faster than blade probes.

23. Dominion: There was not enough UT expertise on nights. The French crews appeared to be reluctant to make any adjustments without the day shift lead approval. This delayed or interfered with job progress.
24. Dominion: Language barrier was a problem with the French crews. Need to make more use of translators in the future.
25. Dominion: French crews were not familiar with American radiological protection standards. Overseas workers need to be better trained on how American regulations differ from theirs. The French exhibited poor rad control practices.
26. Dominion: 24/7 coverage was a problem with the French crews (overtime limits). Framatome needs to work out scheduling problems well in advance to ensure 24/7 coverage is not impacted.
27. Dominion: Framatome ALARA lead changed three times during the job. Man-hour projections were difficult. Need to provide better continuity in the future.
28. Dominion: Need to improve capabilities of under head camera to allow for close up visual inspections - ALARA (e.g., Penetrant Tests).
29. Dominion: Need to develop reliable means for performing automated Penetrant Tests - ALARA. Framatome: Prototype system has been developed and will be tested at Millstone.
30. Dominion: Need to develop reliable tooling for performing automated grinding of rejectable indications and remnant weld chamfer - ALARA.
31. Dominion: The RX headstand sub-floor was flexing due to the shifting weight of the ARAMIS manipulator. This flexing caused misalignment of the tool head and UT blade probes. Need metal stiffener plates installed on the sub-floor. The sub-floor was also angled to one side to provide for drainage. This angle also caused parallelism problems with the tool head and blade probes. ARAMIS needs to be set and leveled before the head is placed on the stand. If ARAMIS equipment is not used, the need for stiffener plates may not be required.
32. Dominion: Need to split out a separate project team whenever we encounter major problems. For example, the stuck tool in penetration 27 consumed the entire team's attention for a long period of time. This effort diverted resources from the core business and delayed the project. Framatome: At what point does a problem need to be split out into a separate project? Who is going to decide that? We need to involve the utility in problem resolution earlier. Need more depth in Framatome's site organization than just "one deep". The different crews need to be structured and trained to think as a team, not as separate competing units.
33. Dominion: Framatome needs to understand and correct the root cause(s) of the stuck sleeve cutting tool and many other equipment problems and communicate the results to us. Framatome: Not enough time to prepare for Surry job after Crystal River. Bottom-up tool delivery was a first at Surry. Next time, Framatome needs more lead time to adequately prepare for the job.
34. Dominion: The problem with repeated plastic bushing failures in the nozzle boring tool were apparently known to Framatome before the job started and Framatome had not taken adequate corrective actions before the start of the job.
35. Dominion: An elevator was not available for UT inspections adjacent to Part/Length rods, thus necessitating the cutting of the P/L screw at one location. Framatome should make sure one of these elevators is available next time around. Framatome: Done.
36. Dominion: The need for etching the bored out nozzles took everybody by surprise (high dose job). Need better communications in the future. Framatome: The use of a rotating UT probe would have averted the need for manual etching.

37. Dominion: Framatome needs to apply some rigor to mock-up training. Training should be better structured and better documented.
38. Dominion: Abrasive Water Jet (AWJ) equipment failed repeatedly due to relatively minor design problems. Framatome needs to address these problems and prevent a repeat next time around.
39. Dominion: Framatome needs to develop automated means of grinding the remnant welds (dose intensive job), or develop an imbedded flaw technique. The short life of the Framatome repair is a problem.
40. Dominion: 2nd head lift effort went well, but should be avoided in the future.
41. Dominion: Housekeeping was a big problem during the whole job. Collection of debris generated from boring penetrations needs to be better controlled (metal chips were reading 100 mR/hr). Housekeeping efforts need to be more proactive. Too much equipment, cables and hoses in a cramped area prevented good housekeeping. Cabling was a "nightmare". Need to bundle them up in the future, tie them up and place them in cable trays off the floor (if possible). Chaotic cable runs took a lot of floor space and made area unsafe.
42. Framatome: Dominion should work out fire watch exception requirements, or qualify Framatome people as fire watches. Camera could be used to fulfill continuous surveillance requirement. Need to fix this problem.
43. Dominion: Framatome generated an enormous amount of trash. Framatome: The contractual arrangements require Dominion to dispose of all radwaste.
44. Dominion: DADs were under predicting dose. Wrong TLD fade factors may have been used.
45. Dominion: Need a Framatome person assigned to handle overall job logistics.
46. Dominion: HEPA use was a success.

Dominion: In the future, turnovers between day shift and night shift need to be combined to include both Framatome and Dominion leads. The turnovers



Unit one Reactor Head Nozzle Repair

FTI RADIOLOGICAL ENGINEERING

JOSEPH F. MILLS
PETER A. ECONOMOU

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1.0 EXECUTIVE SUMMARY

Framatome-ANP (FRA-ANP) was contracted to perform a bare head video inspection and an under head UT/ECT inspection of the Surry Unit one Reactor Head Control Rod Drive Mechanism (CRDM) nozzles. Based on the results of these inspections and the subsequent penetrant testing performed by Dominion Generation, a total of six nozzles were identified for repair.

This report details a summary of the project, and a breakdown in each activity of the repair process and the dose associated with that activity.

2.0 PROJECT SUMMARY

Containment repair activities began on October 28,2001 with the removal of a partial length control rod lead screw under the head. This rod was removed using a porta-band saw. While the dose for this activity was performed under RWP 01-1-2107, the work was done to allow access for the FRA-ANP tool stand (MOMEN) and for performance of penetrant testing (PT). The dose expended for this work was 1.212 man-rem.

The repair of CRD nozzle required the following general steps:

- Remove the guide sleeve
- Machine the nozzle
- Weld in the new pressure boundary
- Grind the weld
- Perform Water Jet Remediation
- Perform PT on weld
- Weld in new guide sleeve

Initial plans included performing each repair step (“Batching”) on all repair locations before moving to the next step. This would reduce the number of tool changes required, and thus reduce exposure.

Honing of the guide sleeves commenced on 11/1/01. The multi-functional tool was used for this operation. Two locations required manual honing as the tool would not reach the desired location due to the configuration of the head.

On completion of honing all repair locations, the guide sleeve cutter was installed in location #27. The cutter stalled out during the cutting operation. Over the next several days, several attempts were made to extract the tool using either a jack or by manual force. All attempts failed and on 11/8/01 management decided to remove the Control Rod Drive Mechanism and guide sleeve from the top.

While the attempts on cutter extraction were occurring, Westinghouse was brought in to sever the remaining guide sleeves using an EDM process. Since the EDM tool would not reach the cut location required for nozzle repair, two EDM cuts were needed to remove the guide sleeve. Manual honing was performed in four of the repair locations prior to EDM. Manual honing was performed using a honing tool on an extension shaft so that the worker could stay as low as possible under the head.

During the EDM process, work progressed on Nozzle 18. Since this nozzle did not have a guide sleeve, machining and welding were done in parallel with the EDM process. The decision to perform the work in this fashion was done with the knowledge that it would increase the total job exposure as more tool change outs would be required.

Shortly after midnight on 11/8, a final attempt was made to remove the cutter from location 27. The jacking tool had been redesigned and the crew had been trained on the equipment in the mockup. The tool moved about 9 inches and stopped. Management then decided to remove the CRD from this location and remove the guide tube with the cutter. In preparation for this, the cutter shaft was severed to remove the tool from the location. This cleared the area under the head to continue repair activities on the remaining locations while the CRD was being removed from location 27. Removal of the CRD was performed in parallel to repairs on the remaining nozzles.

While setting up for roll expansion of nozzle 40, a final check of the drawing dimensions to the actual dimensions was performed. A discrepancy was noted between the actual “F” dimension and the drawing (5015149E). This discrepancy affected locations 47,65, and 69. The decision was made to set up for machining nozzle 40 prior to rolling the remaining nozzles so that the Non Conformance Report (NCR) could be resolved. This decision was made with the knowledge that performing the repairs in this fashion would increase the total job exposure.

During the machining operation on nozzle 40, both MOMEN and the machining tool failed. The raising and lowering mechanism in MOMEN had become clogged with chips from the cutting operation, and a shear pin had failed in the machine tool. The MOMEN was changed out with the one from the mockup, and new pins were manufactured from a stronger material. While the pins were being made, locations 65 and 47 were rolled.

After completion of repairs, machining continued while preparations were being completed to remove the CRD from location 27. On 11/11, the CRD canopy seal was cut and the post machining PT on locations 69, 65, 40, and 47 were performed. Welding commenced on location 69 while the CRD was removed from location 27.

During the welding operation on location 69, there were two unsuccessful attempts to remove the guide sleeve from location 27. The sleeve was removed on 11/13 at about the same time welding completed on location 69. MOMEN was then set up for rolling and then machining of location 27, machining completed on 11/14 at ~2200.

Once machining was complete on 27, welding continued on all remaining nozzles. Welding completed on 11/17 at about 2300. The remote weld tool was converted to the remote grind tool configuration on night shift 11/18. Post weld grinding completed on 11/20.

Post weld UT followed the grinding operation and proceeded with minimal difficulties in about 12 hours. Water Jet remediation of the welds followed UT, and was completed at 0200 on 11/24. While the tooling changes were being performed, the manual chamfer grinding of the repair locations was performed on nozzles that had been repaired. Grinding on all nozzles was complete at 0500 on 11/24.

The final repair operation was welding in of the new guide sleeves pieces in locations 65, 69, 40, and 47. A new guide sleeve was installed in location 27 from the top of the head. All welded locations were checked for free path with a gage. Location 65 required some honing to allow gage to move freely in the sleeve. All repairs were completed by 1100 on 11/26.

3.0 EXPOSURE ESTIMATE SUMMARY

The initial repair estimate (rev 1) submitted to Surry called for the repair of one nozzle and was included in the estimate for the inspections. Surry had awarded the contract for repair one week before the start of their outage. While the ambient weld repair was a certified process, it had never been performed on a Westinghouse head. Tooling and procedures had to be developed in parallel with the estimate to meet station demands. This revision was given to Surry ALARA with the understanding that revisions would be required as the tooling and procedures were developed. After the start of repair activities on 11/1, several more revisions were made. Table 3.1 summarizes the revisions.

Table 3.1 Surry Reactor Head Nozzle Repair Estimate Revisions

Revision	Date	Estimate (man-rem)	Reason for revision
1	10/12/2001	21.008	Initial estimate. Included bare head, ARAMIS, and ACFM inspections, and repair of one nozzle
2	10/15/2001	18.048	Change in under head dose rate due to first under head decon.
3	10/30/2001	42.079	Changed dose rates to reflect actual survey data after second head decon, Added some new work areas, added activities based on receipt of the repair traveller. Increased scope to repair of two nozzles
4	10/30/2001	36.321	Removed the inspections from the estimate.
5	11/2/2001	79.826	Estimate to include a total repair of 5 Nozzles, removal of Rolling NDE from job scope (1.272 manRem saved), tool maintenance increased due to additional nozzle repairs, addition of manual honing.

Revision	Date	Estimate (man-rem)	Reason for revision
6	11/4/2001	109.437	Estimate revised to include a total of 6 nozzles for repair and to include estimate for extracting the guide sleeve cutter from location #27. Estimate also includes dose from added steps to prep tubes prior to Westinghouse EDM and after extraction of tool from location #27, and changed the times repeat on various activities to reflect the machining and welding of nozzle 18 before starting the repairs on the remainder of the nozzles. (This allows work to progress while EDMing the remaining guide sleeves.)
7	11/9/2001	111.095	Estimate revised to allow for cutting the severing tool and guide sleeve above the funnel at location #27 and to allow for rolling/machining of nozzle 40 independent of the others. Boroscope and flapping of nozzle 27 removed from scope. (Work performed under CRD replacement RWP)
8	Not Issued	114.847	Estimate revised to include dose for end prepping guide sleeves under the head. Also, added 1.627 additional rem for welding in the guide tubes. All but .811 of the estimate for removal and installation of the guide tubes was spent in honing and tube removal. Adding 1.677 to the estimate will bring the total for guide sleeve welding back to what the tasks were originally estimated for. Removed the dose for boroscope inspection of 27 nozzle. This was done on RWP 2110 (CRD removal estimate). Added the guide sleeve test weld activities to the estimate.

Table 3.2 summarizes the major repair task exposure estimate and the actual exposure for that activity. Revision 7 (last issued) is used for the estimate. Table 3.3 summarizes the estimate and actual exposure for the removal and replacement of the CRD in location 27.

Table 3.2 Surry Reactor Head Nozzle Repair Exposure Estimate vs. Actual

Task Description	Estimated Exposure	Actual Exposure	% Estimated Exposure
Set up MOMAN	2.400	0.938	39%
Remove/Install Guide Tubes	6.748	13.203	196%
Manual Honing	1.416	2.221	157%
Multi-Functional Tool Maintenance	0.504	0.000	0%
Guide Sleeve Cutter Extraction	15.255	13.304	87%
Nozzle Rolling	3.816	5.696	149%
Nozzle Machining/Beveling	14.184	17.460	123%
Nozzle Welding	7.884	10.869	138%
Post Weld Grinding	39.798	22.133	56%
NDE/AWJ Remediation	18.324	11.660	64%
Equipment Removal	0.576	0.833	145%
Westinghouse EDM Support[1]		3.666	
Etching[2]		1.694	
Nozzle 27 prep[3]	0.150		
Total All Tasks	**111.055**	**103.678**	**93%**

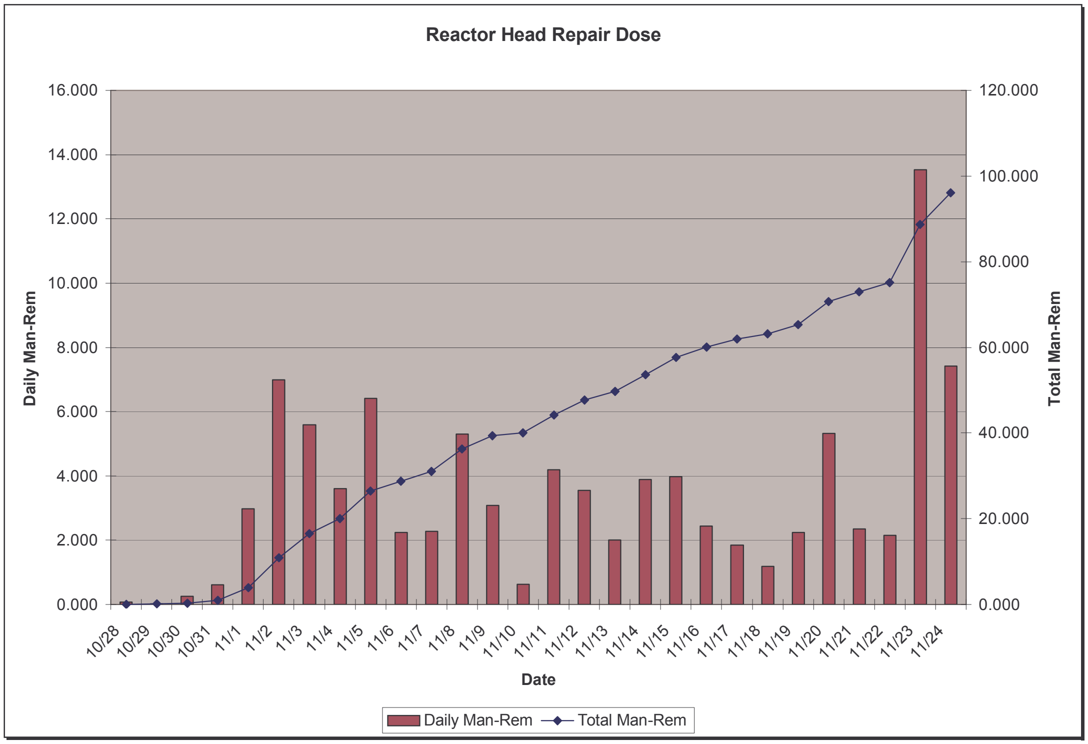
Notes

1. No estimate was done by FRA-ANP for the Westinghouse work. This estimate was supplied by Westinghouse
2. Estimate for etching performed by Station ALARA and not included in repair estimate
3. Nozzle 27 prep was estimated in the repair RWP, however work was performed under the RWP for the CRD removal/replacement.

Table 3.3 CRD Removal/Replacement Exposure Estimate vs Actual

Task Description	Estimated Exposure	Actual Exposure	% Estimated Exposure
Set up equipment	0.080	0.027	33.8%
Sever CRD	0.505	0.083	16.4%
Remove CRD	0.950	0.137	14.4%
Inspect nozzle	0.075	0.041	54.7%
Weld area preparation (on head)	1.066	0.615	57.7%
Weld area preparation on CRD	0.562	0.562	100.0%
Remove/replace Guide Sleeve	1.135	0.926	81.6%
CRD Canopy Welding	1.070	1.190	111.3%
Equipment Removal	0.032	0.004	12.5%
Total:	**5.474**	**3.585**	**65.5%**

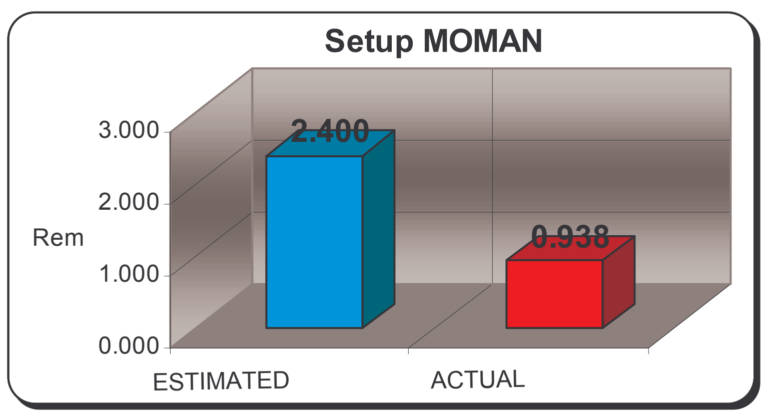
The graphs below detail daily dose and total dose for the repair work.



4.0 TASK SUMMARY

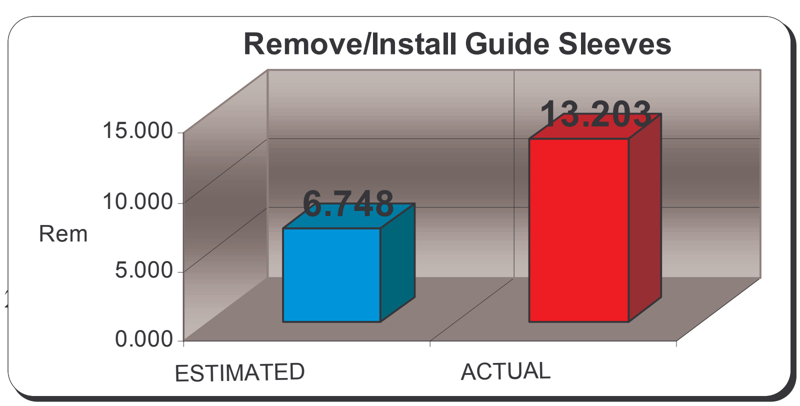
This section reviews the major actual job processes and the associated personnel exposure. Lessons learned from these tasks will be noted in section 5.0.

Setup of Moman



While this activity was called Moman Setup, it contains exposure for the entire repair setup. 2.400 person rem was allotted for these activities, while only 0.930 was spent in the setup. Most of the setup was performed outside of the head stand area to reduce exposure.

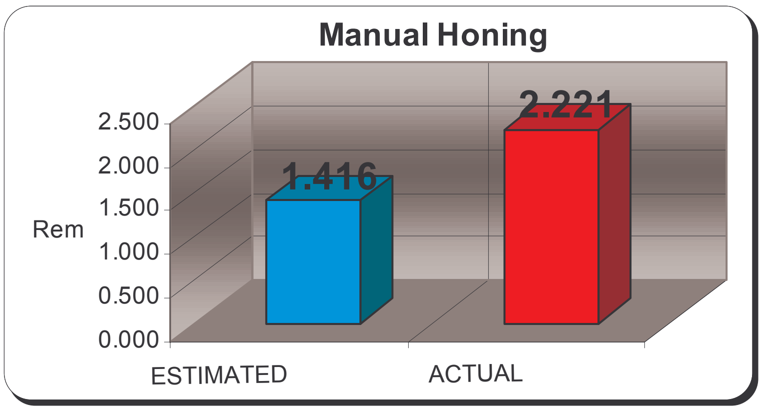
Remove/Install Guide Sleeves



This activity included honing and cutting of the_guide sleeves, end prep of the remaining portion of the sleeve in the nozzle, and welding of the new guide sleeve segment in the nozzle. The tools used for the honing and cutting required maintenance that was not estimated for. Honing of all guide sleeve cut locations and setup on the first cutting location cost 5.882 Rem, or 87% of the estimate for the entire removal and installation process. Once the cutter lodged on the first cut location, dose for cutter removal was tracked under a separate activity. Although the guide sleeve welder worked well, the welding operation cost 7.014 Rem. Also, 0.229 rem was spent prepping the ends of the guide sleeves to allow for good fit-up.

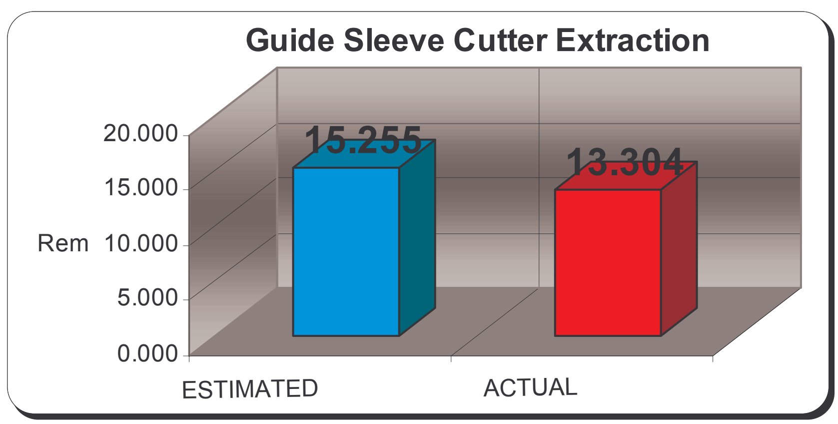
Manual Honing

Once the decision was made to use the EDM process for sleeve removal, the sleeves required honing in the location of the EDM cuts. Since the honing tool could not be set to the required depth, manual honing was necessary. An extension shaft was used with the manual-honing tool so that the operator could stay on the floor to perform the operation. Honing took longer than expected and cost 2.221 Rem.



Guide Sleeve Cutter Extraction

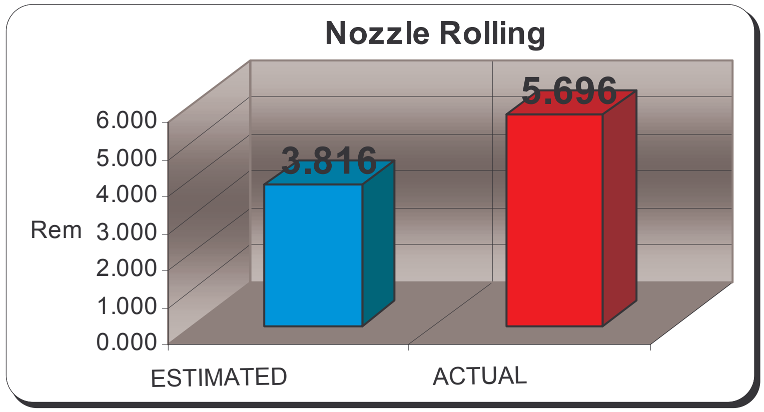
This activity was not initially planned, but became necessary once the cutter would not release from the sleeve. Initial attempts to remove the cutter were tracked under the guide sleeve removal/replacement activity but were later moved to the extraction activity when it became apparent that the cutter would not be easily removed. The initial attempt at removal was made by trying to back out the cutter blades and lowering the tool. 2.732 man-rem was expended in this attempt. At this point, the focus was changed from trying to save the tool to removing the tool. Two attempts were made to remove the tool by hammering it down. The first cost 1.150 man-rem and the second expended 0.482 man-rem.



The next removal plan was to jack the tool out. Initially two attempts were made using shims and two porta-powers. This, however, proved to be dose intensive as the workers had to hold the shims in place until the jacks engaged them with the nozzle and the tool. These attempts cost an additional 4.994 man-rem. At this point a jacking tool was designed and built on site. This tool would minimize the number of entries under the head. Mock up testing and training on the tool further helped in reducing exposure for the next attempts. Also, as a result of the testing, an electric hydraulic pump replaced the manual pumps. This helped in reducing the time required to raise and lower the jacks. The attempt to jack out the tool with the hydraulic jack failed to move it more than 9 inches. While the attempt failed, the planning, testing, and training at the mockup was helpful in keeping crew exposure minimal. 1.774 man-rem was spent in this last attempt.

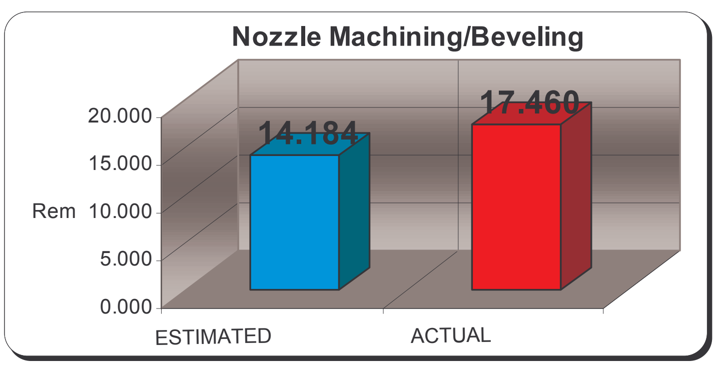
Nozzle Rolling

Nozzle rolling was the first step in the actual nozzle repair process. Initially, all the repair locations were to be rolled prior to any machining, however, after the cutting tool became lodged in location 27, Nozzle 18 was rolled to allow repair work to proceed while the guide sleeves were removed in the other locations. After nozzle 18 was machined, locations 40, 47, 65, and 69 were to be rolled. However, a discrepancy was found between the actual measurements and the repair drawing. This discrepancy affected locations 40, 47, 65, and 69. These locations were rolled at a later date. Location 27 was rolled separately after machining and welding all other locations. While the estimate revisions accounted for the increase in tool change outs, more dose was spent rolling nozzles than what was allotted. In part this was due to measurements taken on the nozzles the night that the discrepancy in measurements was discovered, and in part due to the insertion of FME plugs that were not covered in the estimate.



Nozzle Machining and Beveling:

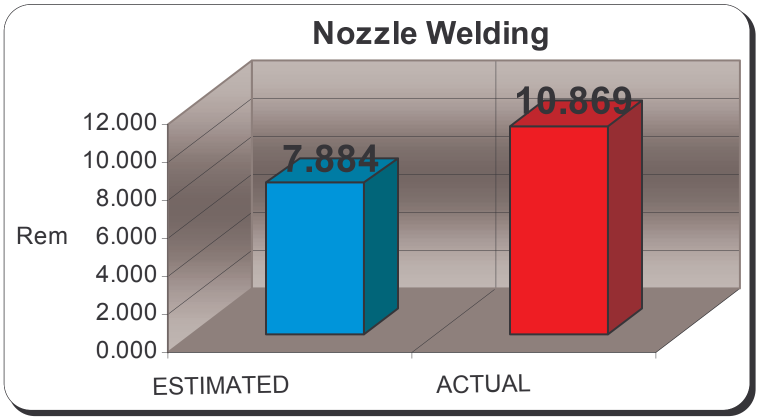
Nozzle machining followed the same sequence as rolling. The increase in tool change outs were factored in to the estimate revisions, however actual dose was greater than the estimate. Reasons for this include more cutter change outs than anticipated, and equipment



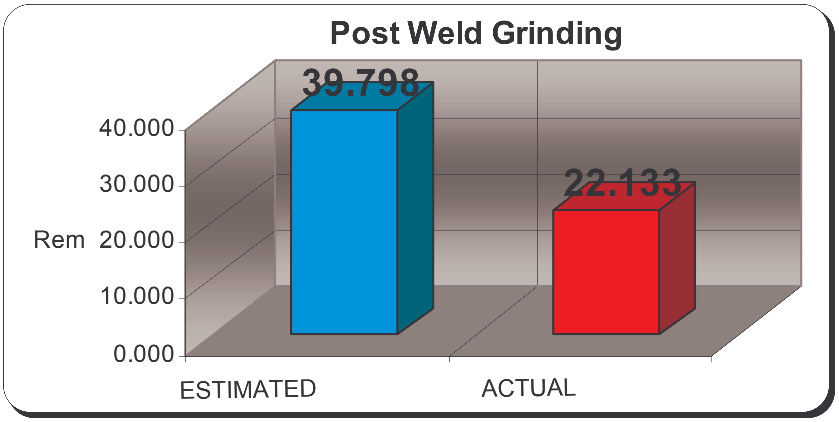
failures. Chips collecting in the MOMEN pulley system caused MOMEN to fail more than once. The machining tool also snapped a pin. A replacement was machined from a stronger material. The failure of the machining tool and the time it took for the repair prompted the change over to rolling. The swap out from machining to rolling and back to machining increased the dose for the Machining evolution.

Nozzle Welding

The welding task exceeded the dose estimate. While the change in sequence is responsible for some of the increase, tool failure and repair were also responsible. Tungsten change outs were also underestimated. The first nozzle alone accounted for the number of change outs for all the nozzles. Also, the wire change outs were not estimated for in this activity.



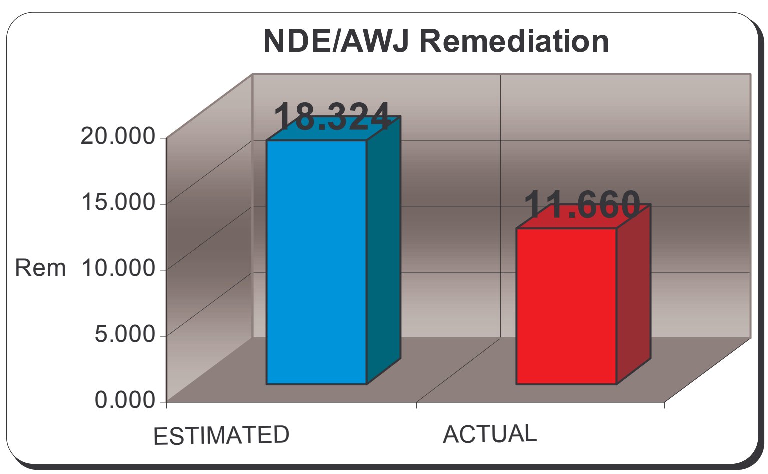
Post Weld Grinding



Post weld grinding included both the machine grinding of the weld and the chamfer grinding of the old weld. All welds were machined ground in sequence, so the only entries made under the head were to move to a new location and to change grind stones on the cutter head. No mechanical problems were experienced with the equipment but refurbishment was required. This work was performed in the basement of containment for 1.136 man-rem.

Chamfer grinding of the old weld was estimated at a little over an hour per weld or 35.100 man-rem. Chamfer grinding of the old weld was necessary to reduce the size of the assumed flaws that would be left in services. Engineering was able to perform additional calculations to increase the allowable size of the remaining weld and therefore reduce the grinding required. Crews performing the grinding received mockup training. Each individual performing the grinding was required to grind a test piece to the proper dimension prior to their entry under the head. These two factors were the reason for the relatively low dose for this evolution. The average dose per nozzle was 2.807 man-rem, with a range from 1.856 man-rem on nozzle 27 to a high of 5.007 man-rem on nozzle 69.

Post Weld Grinding



The NDE portion of this activity included the final PT and the UT of the weld. The PTs were performed by hand and required multiple entries under the head. The UT was performed using a Framatome ANP designed tool that was attached to MOMEN and delivered a UT probe to the region of interest. UT was accomplished in about 9 hours at a cost of 3.755 man-rem. Penetrant Testing of the nozzles cost 2.858 of the total dose received for this activity. The Abrasive Water Jet (AWJ) remediation accounted for the rest of the dose or 5.057 man-rem. There was 8.730 man-rem estimated for the AWJ process. The AWJ tooling required extensive work both before use, and during remediation. While most of the repair was performed in the lower dose of the basement and the next elevation above, this work accounted for approximately 2 man-Rem in exposure.

5.0 LESSONS LEARNED

The following sections document the ALARA/Rad Safety lessons learned from the Nozzle Repair work at Surry Unit 1, as related to each specific task or group. Please note that some items discussed are common to several tasks. Where possible, dose expended as a result of a problem encountered is quantified. Specific recommendation(s) to prevent reoccurrence are listed after the discussion of the situation. While dose savings for good practices is harder to quantify, the overall result of 88% of the goal speaks directly to the effectiveness of these practices.

5.1 Repair Setup and Equipment Removal

Facilities set up and location challenged the efficient performance of the team. Both the crew trailer and the management trailer were located outside of the back gate, a good 10-minute walk to the RCA entrance, and a 15-minute walk to the control trailer. No effective means of portable communication (radios, cell phones) was available for use by the Leads when moving between the various job locations. Consequently, information in the field was slow in reaching the Leads. The situation improved once the inspection completed demob from the control trailer and the repair task lead was able to move there, howerver, this still created communications problems with the crew on the hill.

Setup for the repair activities were performed after the head had been set on the stand for the ARAMIS inspection. At the time of the head lift, no repair activities were anticipated, therefore, no consideration was given to setting up the headstand area for repair. Also, Dominion Power had not issued a contract for repair until one week prior to the outage. Consequently, repair equipment was not on site in time to be staged in the basement prior to setting the head. This necessitated a second head lift. While the second head lift added to the total dose of the project, it actually saved dose for subsequent activities as it allowed some equipment to be setup in lower dose areas.

A new opening was cut into the headstand to accommodate cabling and equipment. The opening proved to be invaluable for the repair work.

The O-ring storage boxes were left in the area because of the early head lift. These containers used valuable real estate and were a hindrance to the movement of equipment.

The High Rad Gate to the headstand area was not placed in the best place for exposure control. RP had to watch the gate in a higher dose area rather than behind the shield wall built at the control station. Consideration should be given to this in future outages when setting up for extensive work under the head.

In some cases, equipment had to be placed in higher dose areas because of limitations of the cables. The cables on Framatome ANP equipment is set up for work on B&W heads. If more Westinghouse headwork is performed, cable length should be taken into consideration.

While some repair equipment arrived in Sea Land containers, most was in boxes. This increased the time necessary for packing and unpacking equipment.

Recommendations:

- Require the site to provide adequate office/crew break space near the work area. These spaces should be provided with the means to provide good communication between the field and the office/control/crew areas.
- Review the site set up plan and schedule to allow for timely equipment setup and to determine the optimum location of control stations, lay down areas, and access points.
- Review the cable lengths on all tooling to allow greater flexibility in setting up equipment at Westinghouse plants.
- Load all nozzle repair equipment in Sea Land containers. This will expedite the removal and packing process and reduce work load at the equipment hatch.

5.2 Mockup Training

Mock up training conducted on site was at first not very structured, but got better as the outage progressed.

Crews were trained for the repair activities on B&W RV Heads in Lynchburg, but training for the bottom up approach required for the Westinghouse plants was not performed until the crew reached site. This resulted in additional dose. Plug insertion and removal was a case in point: On 11/13 a worker made an entry to install the plug in nozzle 27. He received 415 mR and was not able to accomplish the task. Another worker had to perform the task. A different style of plug was used for this location, and the worker(s) performing this task should have refreshed their training in the mockup prior to entering containment. On another occasion two workers received 351 and 301 mR respectively trying to remove a plug

Clean equipment for mock up training was also used as spares for the containment work. Both the clean MOMEN and the welder were eventually taken in to the building to replace broken equipment. While we were able to get a clean MOMEN, another welder could not be built in time to support the outage. Because of the lack of clean tooling, we were forced to move the mockup to a contaminated area to provide mockup training.

The mockup used was built to the specifications for a B&W head. The nozzle guide sleeves and funnels were added to represent a Westinghouse head. The headstand the mockup rested on was also built to the height of a B&W headstand. While new supports were built to the correct height for a Westinghouse stand, they were not delivered in time and therefore not used for mockup training.

Recommendations:

- Typically the task leader would assign this responsibility to one of the more experienced crew members, however knowing the process, and teaching the process are entirely different things. Some formalized training on how to conduct a training session would help these people to be successful.

- Require refresher training for those tasks that are infrequently performed. Task Leaders and ALARA Engineers should be looking ahead of the work to identify where additional training is needed.
- Dedicate a set of repair equipment for mock up training. This is a lessons learned from generator services. While the initial outlay may be expensive, the savings in more efficient work crews will pay off over time.

5.3 Audio and Video

The audio setup presented a continual challenge throughout the repair task. The Framatome ANP system did not match up well with the site Radiation Protection system and as a consequence the volume in the workers headsets was never very loud. To make matters worse, PAPH hoods and hardhats were used, and some of the RP technicians insisted on putting the headsets outside of the hood. This practice continued despite bringing in new headsets and setting up a cleaning process.

The video system worked well, however, the stand for the general area camera under the head kept getting knocked over and eventually this destroyed the camera. The stand was not designed to work as needed because no provision had been made for stands.

Recommendations:

- Purchase headsets that can be worn under hard hats. This will help in preventing the headsets from slipping off the back of the neck.
- Allow enough time pre-outage to work with the site in integrating the audio systems so that volume problems or other issues can be avoided.
- Review the video system to be used for headwork and design/purchase a stand that will be adequate for the work.

5.4 Tooling Issues

Most of the tools used for the repair activities had failures. In large part this was due to heavy use during the outage season. The Surry repair was a last minute addition to the schedule, and most of the equipment arrived directly from Crystal River without the benefit of a refurbishment.

Along with tool failures, design issues were noted in the guide sleeve cutter, the machining tool, MOMEN and the AWJ Remediation tool. The guide sleeve cutter failed on the first guide sleeve. The Machining Tool had to have a shear pin machined from a stronger material. This work was done on site in the customer’s machine shop. MOMEN has a couple of failures during machining due to chips clogging the pulley mechanism. A blanket was thrown over the top of the mast to help reduce this clogging. AWJ had several technical problems that dogged the crew both before the process and again during the work.

On the plus side, the UT tool performed flawlessly after some initial start up problems. The UT work finished in approximately 12 hours.

Machine honing guide tubes cost 4.5 man-rem and had to re-done by hand as the tool would not access all of the needed location. Hand honing expended 2.221 man-rem.

Recommendations:

- Perform a root cause analysis on the guide sleeve cutting tool failure to determine the reasons for this tool's failure
- Review the design of the AWJ Remediation tool to correct the inherent problems with the system
- If MOMEN is to be used again, a chip cover must be installed over the mast to keep chips from inside the mast.
- Incorporate a video feature in the weld tool to allow for remote re-zeroing of the weld head.
- Place some emphasis in training on changing out tungstens by lowering the tool rather than removing it from under the head stand.
- Investigate reasons for the large number of tungsten change outs.
- Develop a tool functional check out sheet for each tool. This sheet should be used by the control trailer operator and the worker prior to the tool being installed. Check out should include the proper position of each valve and/or switch, a check of any tool lengths or other measurements, and a complete functional check of the tool.
- Review design of the FME plug. While the problems with inserting and removing the plugs seemed to be a training issue, the design could possibly be simplified.
- Purchase and calibrate remote reading pyrometers. These are used at Surry Station. The are hand held sensors that measure the temperature using infrared. This will allow the worker to stay at the entrance to the headstand or on the floor rather than climb up to the nozzle to take the reading. If possible, the device could be integrated with the weld machine with a remote readout at the control station.
- If MOMEN is used again for a Westinghouse head, hand honing should be performed on the guide tubes as it cost less dose than the machine.

5.5 Other Issues

- There were two instances where workers started to install a tool in an incorrect location. While there was a process in place to prevent a process being performed on the wrong location, the check was done after the tooling had been installed. The removal and reinstallation cost dose. To prevent reoccurrence, a laser pointer was used at the head stand entrance by the worker to point to the nozzle. This was verified on camera by the control trailer. This laser pointer should be built into the camera to allow the control trailer to train the pointer on the correct location. Additionally, for multiple repair locations, a color-coded system should be used using different colored paint. Paints for generator work are currently approved for primary systems and could be used in this application as well.
- The change out of ALARA Engineers at the beginning of the job, while may have made sense from a business perspective, hurt the project overall. The new Engineer needed time to learn both the schedule and process and did not have the benefit of involvement from the beginning. This practice should be avoided in the future.
- Turnover meetings were very informal and not structured. Frequently there were two or three conversations going on at the same time. Turnovers should be more formal, with

a representative from each group giving status, and the Task/Shift Leader going over the plan for the up coming shift.

- The difficulties encountered with the guide sleeve cutter impacted the process, the schedule, and crew dose. The leads and supervisors were actively involved in the attempts at removal, and as a consequence were out of dose near the end of the job. Since the work was being performed in the 4th quarter, most of the leads were up against the yearly limit. The site took a rather large buffer from the limit so extensions were either not available or so small as to be insignificant. If we were required to perform repairs on Unit 2 most of the leads would have had to be changed out. The reason for the large buffer was a TLD/DAD mismatch experienced by Surry. The DADs were experiencing about a 20-25% under response.