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Advanced Test Reactor Sub-Core Internals Inspection Report

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ABSTRACT

Between November 10 and November 15, 2005, the Advance Test Reactor (ATR) Life Extension Program (LEP) conducted the ATR Reactor Sub-core Internals Inspection. Components of the ATR sub-core region were visually inspected and video recorded in order to assess aging effects.

All or portions of the ATR sub-core components identified in DOP-7.10.72, "ATR Reactor Vessel Internals Aging Inspection," were inspected. The completeness of the inspection for individual components varied depending on several factors including camera access to the component location within the reactor, the capabilities of the camera used, and the impact of the radiation fields encountered within the reactor vessel.

The inspection did not reveal any anomalies for the instrument thimbles, the reactor outlet piping, the flow distribution tank, the inlet flow baffle, the core support tank, the reactor vessel, and the thermal shield. Minor anomalies, including corrosion, nicks, dings, general pitting, and "growth," were observed in the aluminum cover plates and support structures, the flow hat assemblies, the irradiation facilities and support structures, the spent fuel can assemblies and support structures, and the core reflector tank.

The reflector support tank was observed to have signs of corrosion and was reviewed by a material/corrosion specialist. At the completion of the inspection, no restrictions for the continued operation of the reactor were noted by Operations and Engineering Management.

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TABLES

ACRONYMS

ATR	Advanced Test Reactor
BEA	Battelle Energy Alliance
DOE	U. S. Department of Energy
DOP	detailed operating procedure
FY	fiscal year
GBSB	gear box support beam
ICARE	Issue Communication and Resolution Environment
ICP	Idaho Cleanup Project
INL	Idaho National Laboratory
LEP	Life-Extension Program
MCA	material condition assessment
OSCC	outer shim control cylinder
RTC	Reactor Technology Complex
RWP	radiological work permit

Advanced Test Reactor
Sub-Core Internals Inspection Report

1. Introduction

The Advanced Test Reactor (ATR) began operation in 1967. For over 35 years the ATR has provided irradiation testing of nuclear fuels and materials. The need for the ATR to support nuclear research is large and growing. The ATR is slated to play a vital role in developing new nuclear power technologies. The ATR Life Extension Program (LEP) (formerly known as the long-range operating plan) has been established to execute various activities to be completed to ensure continued operation of the ATR.[a]

One goal of the ATR LEP is to assess and manage aging issues. A Material Condition Assessment (MCA) plan[b] directs the overall plant aging assessment and management process. MCA activities address aging issues for the facility and allow for actions to be taken to preclude impacts to safety, availability, and programmatic interests that can result from undetected or unresolved material degradation. One task under the FY-2006 LEP MCA work scope is the ATR Sub-core Internals Inspection, which is the genesis of this report.

2. Project Description

In order to conduct the ATR Sub-core Internals Inspection, a detailed operating procedure (DOP)[c] (see attachment 1) was developed. This procedure provided instructions for inspecting and documenting the condition of reactor components in the sub-core region of the reactor (from elevation 82.5 to 68 ft), roughly defined as the area from the top of the thermal shield/inlet flow baffle to the reactor vessel bottom head, and from the reactor vessel interior surface to the exterior of the reactor internal support structure (reflector tank, reflector support tank, flow distribution tank, and core support tank) (see Figures 1 and 2).

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a. INL/EXT-05-00045, "Advanced Test Reactor Life Extension Program"

b. PLN-155, "Advanced Test Reactor Material Condition Assessment Plan"

c. DOP-7.10.72, "ATR Reactor Vessel Internals Aging Inspection""

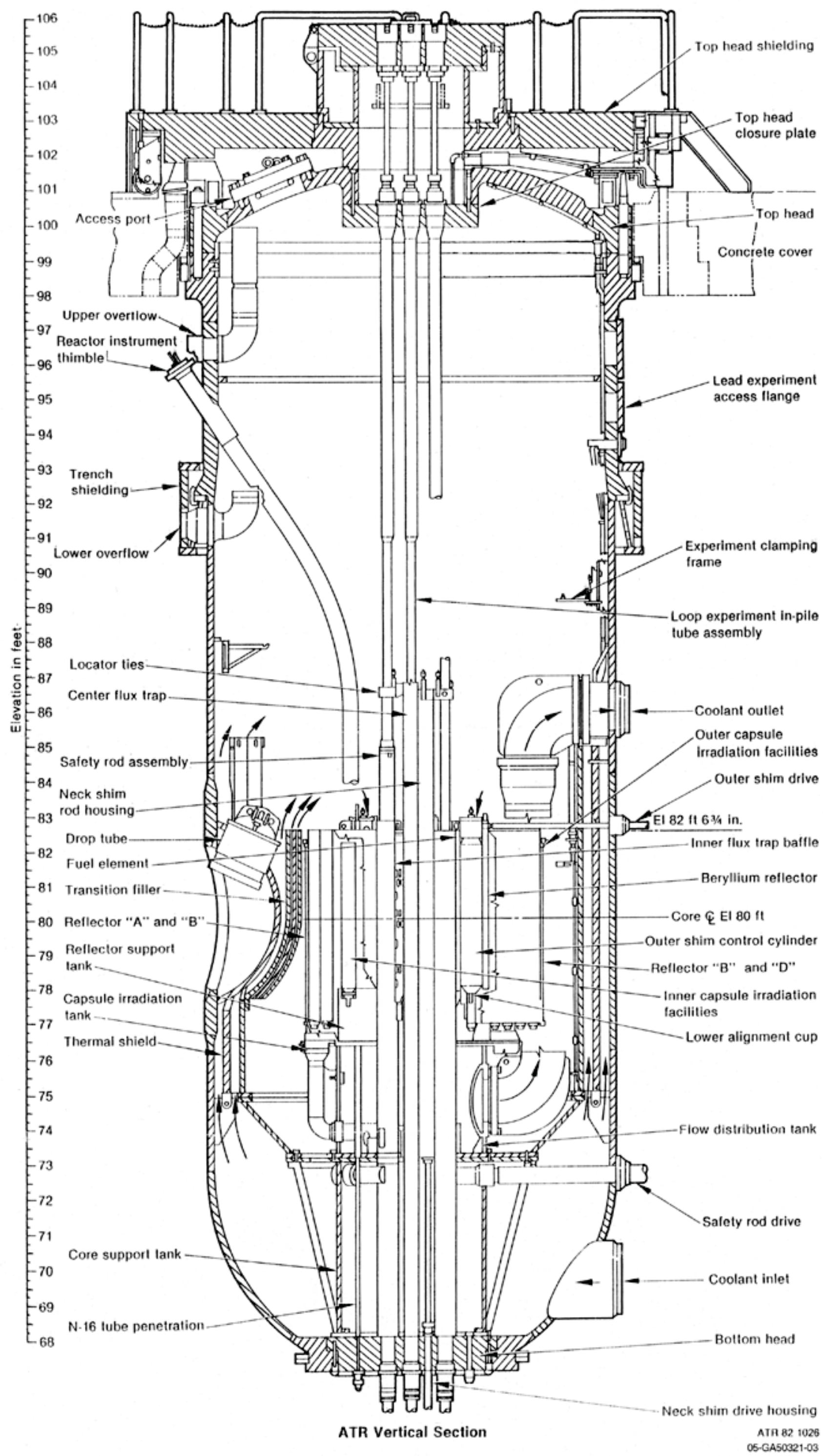

Figure 1. ATR vertical section.

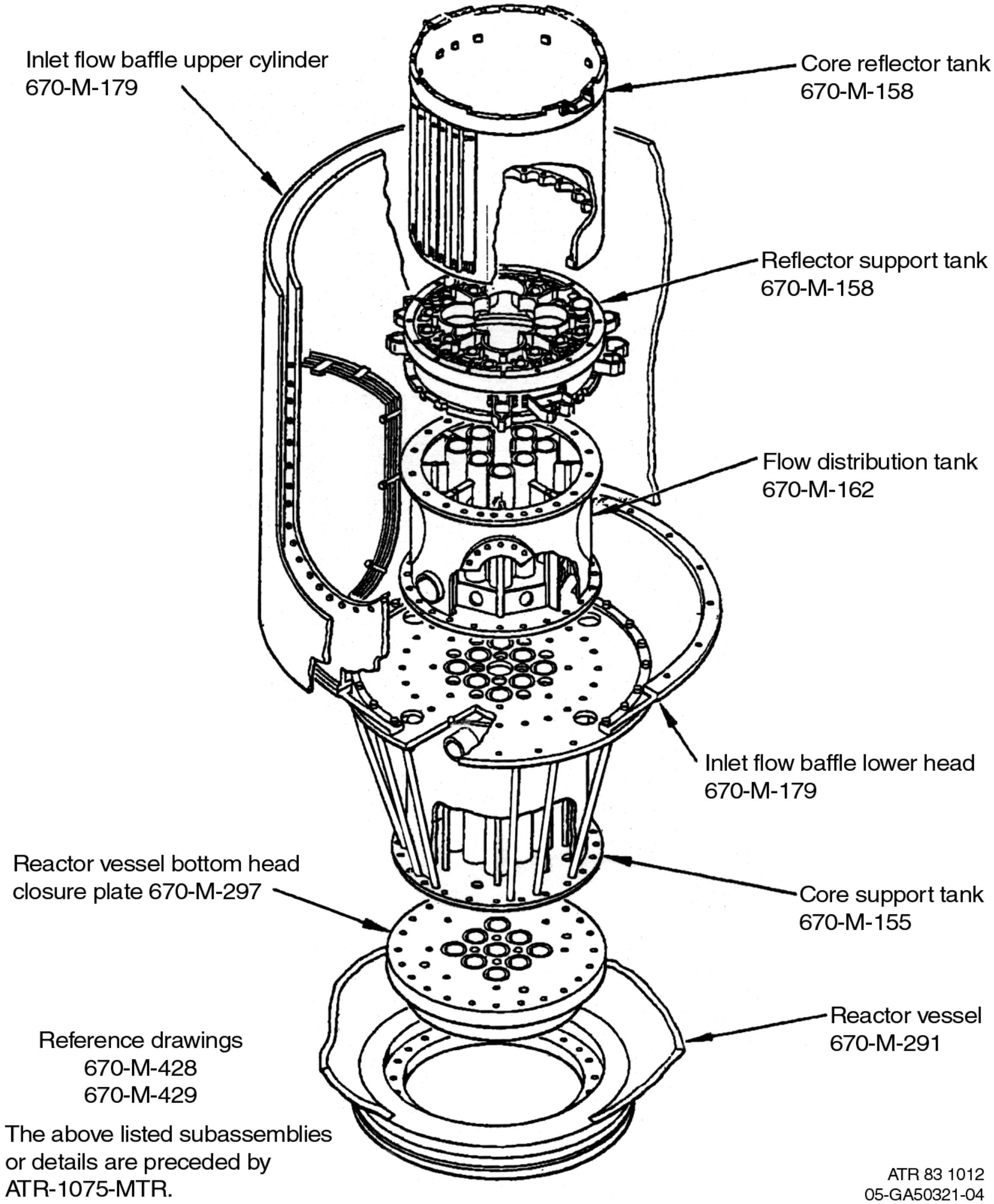

Figure 2. ATR reactor internal support structure.

The reactor structures to be inspected, using closed-circuit television per the DOP, include the following:

- Reflector tank to inlet flow baffle aluminum cover plates and support structure
- 10% flow hole flow hats and retainer clamps
- Inlet flow baffle upper cylinder and lower head interior surfaces
- Flow distribution tank exterior surface
- Core support tank exterior surface
- Reactor primary coolant flow pipes exterior surfaces
- Reflector support tank exterior surfaces
- Instrument thimbles, thimble supports, and thimble exhaust line exterior surfaces
- North and south outer irradiation facilities and associated flow pipes
- East and west spent fuel storage cans and associated supports
- Core reflector tank exterior surfaces
- Reactor vessel thermal shield and support brackets
- Inlet flow baffle upper cylinder exterior surfaces
- Reactor vessel inner surface from the 82.5 ft elevation down to the 68 ft elevation.

The DOP further directs engineering personnel to document any anomalies, including erosion, corrosion, cracking, discoloration, loose bolting, or damage, found either during the inspection or upon review of the video recordings[d] of the inspection.

d. DVD #1–8, "ATR LEP Sub-Core Inspection Outage 136A," November 10–15, 2005.

2.1 Reactor and Reactor Sub-Core Access

The ATR reactor vessel is a stainless steel vessel approximately 34 ft tall and 12 ft in diameter. The top half of the reactor interior contains the upper portions of the instrument thimbles and the experimental in-pile tubes but is otherwise open space filled with primary cooling water (see Figure 1). The lower half of the reactor vessel, or sub-core region, contains the components to be inspected. The sub-core region has limited open space between the reactor components and is covered by aluminum plates and expanded metal grating to prevent unwanted items from entering the sub-core region.

DOP-7.10.72 provides two options for accessing the reactor vessel to inspect the sub-core region internal components: (1) by removing the entire reactor vessel head plate or (2) by going through the five refueling ports located in the reactor top head. The reactor vessel head would be off during a Core Internal Change-out while refueling port access would be used during normal operations. The refueling ports are 20 by 40-in. elliptical openings, equally spaced in the cover head, and located on the north, northeast, southeast, southwest, and northwest positions (see Figure 1).

Once a camera is lowered through one of the refueling ports, the camera can be maneuvered in the upper half of the reactor vessel to visually inspect the components located at the top of the sub-core region. In order to access the remaining sub-core components in the lower half of the reactor vessel, the camera(s) must go through the expanded metal grating, and the flow hat openings, or have one or more of the cover plates removed to visually inspect and video the remaining components (see Photo 1).

2.2 Scheduled Work Dates

The ATR Reactor Vessel Internals Aging Inspection was scheduled for the dates between November 10 and November 15, 2005 (136A-1 outage). The inspection was estimated to take 30 hours to complete and was submitted for scheduling to be conducted during three 10 hour day shifts. However, due to conflicts in the outage schedule, the project was scheduled for Thursday, November 10, from 1700 to 2400 hours, Friday, November 11, from 0700 to 1700 hours, and Tuesday, November 15, from 1700 to 2400 hours, with Monday, November 14, from 1700 to 2400 hours available if necessary. Since the ATR operators and RadCon support personnel work 12 hour shifts that run from 0700 to 1900 hours, the three evening work shifts, or swing shifts, included an operator shift change.

Due to the shift change occurring in the middle of the work shift on Thursday and Tuesday, the available work time between 1700 and 2400 hours was generally expected to be only five hours due to lost time as the shift change was made and a second pre-job brief was conducted. Therefore, the final work schedule included the Monday swing shift to compensate for the work time lost due to the shift changes. The work was subsequently scheduled for Thursday, November 10, from 1700 to 2400 hours, Friday, November 11, from 0700 to 1700 hours, Monday, November 14, from 1700 to 2400 hours, and Tuesday, November 15, from 1700 to 2400 hours.

2.3 Potential Radiation Impacts and Procedure Work Sequence

DOP-7.10.72 was written to be worked step by step through the procedure but does allow for some sections to be worked out of order.

Comments from both the Idaho Cleanup Project (ICP) remote systems and ATR operations personnel indicate that using a camera in high radiation fields (1000 R/hr or greater) can produce "sparkle" (an increase in small colored dots of light on the video image) and that exposure to high radiation fields can cause "browning" of the camera lens, the lighting lens, and the fiber optic cable thereby reducing the optical clarity of the camera. The highest areas of radiation are estimated to be at the top of the reflector tank from the gear box support beams, and generally higher radiation fields are expected in the south end of the reactor. This was taken into consideration for evaluating the order in which the DOP sections were worked.

The first part of the inspection, Sections 4.5 through 4.20, was conducted using the ATR standard in-tank camera located at a distance of 4 to 6 ft above the sub-core area. Previous use of the in-tank camera has shown this height sufficient to avoid video "sparkle" or camera/lighting lens "browning." Because there was no anticipated impact from the high radiation fields and because this was the most accessible area, this task was conducted first.

The second part of the inspection, Sections 4.21 through 4.43, required that the borescope be lowered through the open flow hats or through the area of the removed aluminum cover plates, both of which would bring the borescope in close proximity to the gear box support beams and increased radiation fields. In the third part of the inspection, Sections 4.57 through 4.65, the borescope was maneuvered through the expanded metal grating, which is farther from the gear box support beams than the flow hats. The thermal shield and inlet flow baffle walls also provided additional shielding for the camera.

Based on this information, the decision was made to initiate the borescope work in the areas of lowest radiation and work toward the areas of higher radiation. Therefore, the work in Sections 4.57 through 4.65 was moved ahead of the work in Sections 4.21 through 4.43. This change in the procedure working sequence would, it was decided, maximize the use of the borescope before its abilities degraded to where it might no longer allow an adequate visual inspection of components.


Reactor Vessel
Outlet Flow Pipe
Expanded Metal Grating
Inlet Flow Baffle
Instrument Thimble
Flow Hat
North Irradiated Facility
Aluminum Cover Plate
67-5184

Photo 1.

2.3.1 Procedural Steps for Day One

The first part of the inspection covers the reactor components addressed in Sections 4.5 through 4.20. Sections 4.17 through 4.20 of the procedure contain steps to remove some of the reflector tank to inlet flow baffle aluminum cover plates. Removal of the cover plates allows inspection of the cover plate support structure as well as access to components below the cover plates covered in Sections 4.21 through 4.48.

Due to the uncertainty of successfully removing the aluminum cover plates and to having the option of inspecting the ATR reactor internal support structure and other components covered in Sections 4.21 through 4.48 via the flow hats, a decision was made not to remove the aluminum cover plates for this portion of the inspection. Removal of one or more cover plates per Section 4.18 would be attempted if there was available time after the rest of the inspection had been completed.

2.3.2 Procedural Steps for Day Two

The components targeted for inspection on day two were covered in Sections 4.57 through 4.65. These sections are located at the end of the DOP but were moved forward for the reasons stated above in Section 2.3.1 of this report. The DOP provided two options for conducting the inspection of the core support tank and the lower reactor vessel covered in Sections 4.44 through 4.48: (1) by going through the 10% flow holes in the top of the core support tank top head or (2) by going through the space between the reactor vessel wall and the thermal shield or the space between the thermal shield and the inlet flow baffle.

The decision was made to conduct this part of the inspection by going through the space between reactor vessel wall and the thermal shield because this space provided easier access, rather than trying to reach the four 7-in. flow holes, and would keep the borescope farther from the anticipated areas of higher radiation. A second reason was that this would move up the inspection time for the core support tank and the inlet flow baffle and thermal shield. The exterior of the core support tank, the thermal shield and inlet flow baffle, and the thermal shield joints were identified as key elements of the inspection and therefore given a higher priority.

2.3.3 Procedural Steps for Day Three

The day three inspection activities covered Sections 4.21 through 4.43, located in the middle of the DOP. Again, this portion of the inspection was conducted last so that the borescope would not be subjected to the higher radiation fields until the end of the inspection.

2.3.4 Procedural Steps for Day Four

Day four was scheduled for completing any unfinished sections of the inspection activities and to attempt to remove and replace one or more of the aluminum cover plates addressed in Sections 4.17 and 4.18, and 4.49 and 4.50.

2.4 Camera Equipment

2.4.1 Crestone Products RCS-3100 Underwater Zoom Color TV Camera

The standard ATR in-tank camera is the RCS-3100 underwater zoom color TV camera. This camera offers small size, high resolution, high sensitivity, and a very large (72:1) zoom range incorporating both an 18:1 optical zoom with an additional 4:1 electronic zoom. The optical zoom range provides full resolution with a horizontal in-air field of view range from 48 degrees to 2.7 degrees. Underwater, the horizontal field ranges from 35.6 degrees to 2.03 degrees. In the zoomed-in position, the full resolution underwater horizontal field size at 20 ft distance is only 0.74 ft.

The camera is supplied with a high resolution (greater than 470 TV lines) S-video format. It features remote zoom control, automatic or remote focus control, and automatic or remote manual iris control. An onscreen display is provided for zoom position and other function settings.

The RCS-3100 is also equipped with an electronic shutter with a range from 1/4 second to 1/10,000 second. When in the 1/4 second position, the integration provides a minimum scene illumination requirement of only .20 lux. Without integration, the minimum scene illumination is still a low 3.0 lux. This low light capability allows color imaging with minimal lighting requirements, and provides greater in-air and underwater viewing ranges with standard lighting. The camera housing is fabricated of 300 series stainless steel, utilizing a non-browning fused quartz viewing window, and is rated for underwater operation to 200 ft (see Attachment 2).

The RCS-3100 camera dimensions are 6.20 in. wide (side to side) and 5.22 in. long (front lens assembly to under water assembly). This camera also has a Lexan cover attached over the camera and light assembly to provide positive capture of any potential loose part or broken lens. The Lexan cover sits flush on the camera lens and expands the camera size to approximately 6.70 in. wide and 5.47 in. long.

The RCS-3100 was used to conduct the inspection on the upper core surfaces because of the ATR operators' familiarity with the camera equipment and its operation and because of the camera's ability to provide an adequate inspection from a location in the reactor where "sparkle" from the radiation field was not experienced.

The RCS-3100 was mounted to an in-tank handling tool that is supported and suspended from the outside rim of the refueling ports. The in-tank handling tool includes extendable rods that are suspended from the center pivoting ball of a mounting bracket. The mounting bracket is designed to mount to the sides of the refueling ports. The handling tool allows the camera to be manually raised and lowered to the desired depths into the reactor and can be rotated 360 degrees to the desired location. The camera handling tool can be fixed at a desired depth and angle, providing a stable support for the camera.

2.4.2 Everest XLC1000 LongSteer® Pro Plus

The borescope chosen for the inspection was the Everest XLC1000 LongSteer® Pro Plus inspection system. This borescope is a fully articulating video borescope with a length of 60 ft. The probe uses a patented pneumatic articulation method to achieve full articulation even if the insertion tube is not fully unrolled. A removable probe spool lets you use only the working length that you need to successfully accomplish the inspection.

The borescope features interchangeable probes, full-motion video recording, defect measurement, an Integrated Temperature Warning System, and an integrated color LCD in the hand-piece. The XLC1000 does not have an optical zoom but does have a 3X digital zoom and automatic and manual exposure (0.34 ms to 12 seconds). The camera has a titanium housing and is waterproof to 33.5 ft.[e]

The borescope has the ability to articulate 360 degrees horizontally and 135 degrees vertical (straight down to 135 degrees up). A joy stick controls the articulation of the borescope lens. The borescope's manual exposure allows the camera to provide video with limited lighting conditions. The borescope cable is 60 ft in length and 0.50 in. in diameter, which meets the requirements to pass through the expanded metal grating and have the reach to extend the approximate 20 ft from the reactor top plate to the expanded metal grating and the approximate 30 ft from the reactor top plate to the reactor bottom.

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e. Everest VIT website, www.everestvit.com/index.html, December 2005.

3. Conducting the ATR Sub-Core Internals Inspection during the 136A-1 Outage

All inspection work was initiated by conducting a pre-job briefing. The pre-job briefing included ATR operations personnel (1-2), ATR radiological control personnel (1-2), ATR Engineering (1), ICP remote systems personnel (2), and LEP project personnel (1). The pre-job brief outlined the scope of the work to be completed and the specific tasks to be undertaken that shift. The pre-job brief also reviewed the associated job safety analysis (JSA-DOP-7.10.72) and detailed the radiological controls required per the applicable radiological work permit (RWP 31004585).

3.1 Thursday, November 10, 2005

3.1.1 Process

On Thursday, November 10, 2005, the Crestone Products RCS-3100 camera was used to conduct the inspection of the reactor components addressed in Sections 4.5 through 4.20 of DOP-7.10.72. The inspections and tests in these sections include the reflector tank to inlet flow baffle aluminum cover plate inspection and operational tests of the cover plate fasteners inspection, the 10% flow hats and retainer clamps, and the reactor primary coolant flow pipes exterior surfaces that extend above the cover plates. Also inspected were the two short instrument thimbles (T-6 and T-7), the thimble supports, and thimble exhaust line exterior surfaces, the top of the north and south outer irradiation facilities, and the interior of the east and west spent fuel storage cans.

The initial inspection during the day shift was conducted with the ATR standard in-tank camera set up in the north refueling port using the long-handled camera tool. Utilizing the north refueling port only, the camera was used to conduct an inspection of the components in Sections 4.5 through 4.20. The use of only one refueling port allowed only a limited view of the cover plates and other components covered in Sections 4.5 through 4.9, primarily due to the number of obstructions encountered within the reactor, such as the thimbles, experimental loop piping, and outlet flow pipes. It was also difficult to maintain a frame of reference to identify the component that was being inspected since most of the components have similar or identical components in close proximity.

Operators also tested the operability of a couple of the aluminum cover plate fasteners. Conflicting information had been relayed on whether the cover plates were removable and whether an attempt had ever been made to try to remove any of them. INL drawings indicated that sixteen of the plates contain spring actuated locking fasteners.[f] The drawings indicate that depressing the fasteners and rotating them 90 degrees would release them from cams located in the adjacent cover plate or cover plate support structure, thereby allowing the cover plate to be picked up via a lifting lug on the cover plate.

In the northeast quadrant, a 3/4-in. socket was put on an in-tank handling tool to test a couple of the cover plate fasteners. The socket was placed over a cover plate fastener; the fastener was depressed, rotated 90 degrees, and returned to its original position. This was then repeated on a second fastener. The tests conducted on the cover plate fasteners indicated that they could be depressed and rotated to release or secure them to the adjacent cover plate or cover plate support structure. No attempt was made at this time to remove a cover plate, but an attempt was scheduled for the final day of the inspection, time permitting. This concluded the work for the end of the day one day shift.

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f. INL drawings 120369 and 120374 through 120377.

After the shift change, the inspection of the upper reactor vessel components was conducted by placing the camera and handling structure in the north refueling port and using the camera to inspect the reactor components directly below that refueling port. To inspect the cover plates, plate fasteners, irradiation facility upper surface, outlet flow pipe exterior surface, and spent fuel storage cans, a methodical approach was used, starting at the north edge of the northeast reactor quadrant and working south and east.

The inspections were conducted by relocating the camera in a clockwise fashion, through the northeast, southeast, southwest, and northwest refueling ports. The northeast and northwest quadrants were both inspected from the north refueling port.

3.1.2 Results

The inspection found nicks, dings, mild corrosion, and some pitting on the reflector tank to inlet flow baffle aluminum cover plates, the 10% flow hats, and the flow hat retainer clamps. Some minor corrosion was found on the east and west spent fuel storage cans and a small amount of "crud" was observed in the bottom of the storage cans.

Based on the limited view of the lower 1 ft of short thimbles T-6 and T-7 and their support brackets and exhaust lines, no anomalies were noted. No anomalies were noted for the portions of the primary coolant outlet flow pipes located above the aluminum cover plates.

Estimates of the percentage of each component visible during inspection are displayed below in Table 1 for each reactor quadrant. The estimated percentage is a subjective evaluation based on a review of the video. The value listed under "% visible per quadrant" in the tables reflects the portion of those components visible in that quadrant. Most components are located entirely within one quadrant, but several components such as the north and south irradiation facilities and the east and west spent fuel storage cans lay in more that one quadrant. In those cases, the value for the percentage visible in the table represents only that portion of the component in the specified quadrant.

Table 1. ATR sub-core reactor components inspected on day one.

Reactor Component Description	% Visible per Quadrant			
	Northeast	Southeast	Southwest	Northwest
Aluminum Cover Plates	80–100	80–100	80–100	80–100
10% Flow Hats	40–60	40–60	40–60	40–60
Outlet Flow Pipe	40–60	40–60	40–60	40–60
North Irradiation Facility (top surface)	80–100	NA	NA	80–100
South Irradiation Facility (top surface)	NA	80–100	80–100	NA
East Fuel Storage Facility	40–60	40–60	NA	NA
West Fuel Storage Facility	NA	NA	40–60	40–60
Thimble T-6 (bottom 1 foot, support, and exhaust)	NA	20–40	NA	NA
Short Thimble T-7 (bottom 1 foot, support, and exhaust)	NA	NA	60–80	NA

Overall, the inspection of the reactor component covered in Section 4.5 through 4.20 provided a quality inspection and covered the majority of the components. Specific components that were only partially inspected include the smaller cover plates between the thimbles, portions of the cover plates directly under the outlet pipe flanges, the underside of the outlet flow pipes, the sides of the flow hats, and the interior sides of the spent fuel cans.

After the first day, the reactor components covered in Sections 4.5 through 4.20 had been inspected. Testing and inspection of the flow hat and flow hat retainer clamp operability covered in Sections 4.11 through 4.16 had not been completed. This work was deferred to day three when the flow hats would be used to access the reactor area below the cover plates. The removal of the cover plates addressed in Sections 4.17 through 4.20 was also deferred until later in the inspection due to potential risks in performing new activities in the reactor with an unknown probability of success.

3.2 Friday, November 11, 2005

3.2.1 Process

On Friday, November 11, 2005, the borescope was used to inspect the components in Sections 4.57 through 4.65 and Sections 4.44 through 4.48 of DOP-7.10.72. These sections include the reactor vessel interior surface, the thermal shield exterior and interior surfaces (including the batten strips, nuts, and bolts), the thermal shield support brackets, the inlet flow baffle exterior surface, the core support tank exterior surface, and the reactor vessel primary coolant inlet flow pipes. These components are accessed through the expanded metal grating that covers the area between the interior of the reactor vessel wall and the interior of the inlet flow baffle upper section.

The expanded metal grating has a support structure that divides the grating into 42 sections that line the interior of the reactor vessel. Each of the 42 sections is approximately 8 in. wide. The expanded grating extends from the reactor vessel interior surface, past the thermal shield, to the interior edge of the inlet flow baffle (see Photo 1). The space between the reactor vessel interior surface and the thermal shield exterior surface is approximately 3 1/2 in. wide, and the space between the interior of the thermal shield and the exterior of the inlet flow baffle is approximately 4 1/4 in. wide.[g]

The inspection was started in the north end of the reactor by maneuvering the borescope through the expanded metal grating between the reactor vessel and the thermal shield between the transition filler assembly and the drive shaft housing for outer shim control cylinder (OSCC) N3&4. A hollow extendable aluminum tool was used to locate the borescope over the openings in the expandable grating. The borescope was inserted through the extendable aluminum tool, which provided a rigid support for directing the borescope through the expandable metal grating.

The four thermal shield sections and the four upper inlet flow baffle sections are all joined at 45 degrees from the north, east, south, and west directions utilizing batten strips on the interior of the thermal shield and the interior of the inlet flow baffle. The batten strips were secured with bolts. The nuts for the thermal shield batten strip bolts were located on the exterior of the thermal shield. The bolts used on the inlet flow baffle did not use nuts but were secured into threaded holes in the inlet flow baffle wall sections. Jack screws were placed between the reactor vessel and thermal shield and between the thermal shield and the inlet flow baffle.

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g. INL reference Drawing 120371 Zone 6/A.

The second borescope insertion was made in the second grating section clockwise of the northeast thermal shield joint. The inspection proceeded clockwise around the reactor vessel in the space between the vessel wall and the thermal shield, making insertions approximately two grating sections from each thermal shield joints in both directions, clockwise and counterclockwise. Three additional drops at the due east, south, and west locations were made. Each of the drops in the outer annulus space proceeded below the thermal shield wall to inspect the lower reactor vessel and core support tank structures. After the lunch break, or approximately half way through the day's inspection activities, a drop in the picture quality of the camera was noticed as well as a drop in the fiber optic light output. There was also a noticeable increase in the random movement of the borescope, possibly due to natural convection currents in the primary coolant.

Once the last camera insertion was completed between the transition filler assembly and northwest thermal shield joint, a similar pattern was used in a counter clockwise direction to inspect the annulus between the thermal shield and the inlet flow baffle. The inspection of the interior thermal shield and the exterior of the inlet flow baffle did not extend beyond the thermal shield except to provide additional inspection of the thermal shield support brackets and did not include a due west, south, or east drop.

In the last camera insertion of the day, the borescope was lowered into the eastern most spent fuel storage basket in the east spent fuel storage rack to inspect the walls and bottom of the storage basket. Significant sparkle was observed as the borescope came closer to the top of the spent fuel storage facility, and then diminished as the borescope was lowered into the storage facility. The borescope provided a good visual inspection of the interior of the storage facility.

3.2.2 Results

For this portion of the inspection, no anomalies were noted for the core support tank exterior surface, the reactor vessel interior surface, the inlet flow baffle upper cylinder exterior, the thermal shield exterior and interior surfaces, the thermal shield support structures, or the support structure welds.

An estimate of the percentage of the components visible in each quadrant is displayed below in Table 2.

Table 2. ATR sub-core reactor components inspected on day two.

	% Visible per Quadrant			
Reactor Component Description	Northeast	Southeast	Southwest	Northwest
Reactor Vessel Interior Surface	60–80	80–100	80–100	60–80
Thermal Shield Exterior Surface	80–100	80–100	80–100	80–100
Thermal Shield Interior Surface	40–60	80–100	80–100	40–60
Thermal Shield Support Brackets (12)	80–100	80–100	80–100	80–100
Inlet Flow Baffle Exterior Surface	40–60	40–60	40–60	40–60
Core Support Tank Exterior Surface	80–100	80–100	80–100	80–100

The inspection activities of the reactor component covered in Section 4.44 through 4.65 provided a quality visual inspection and video; the borescope had access to all the areas and provided video of the majority of the components. While the access to the areas covered in Sections 4.44 through 4.65 was good and the borescope did provide a good visual inspection, the borescope did have limitations that impacted the inspection activities.

The video provided by the borescope was limited to the area illuminated by the fiber optic lighting. In the spaces between the reactor vessel wall and the thermal shield and between the thermal shield and the inlet flow baffle cylinder, the light provided by the fiber optics was reflected sufficiently to illuminate the majority of the viewing area (approximately 10–20 in^2.).

When the borescope was located below the thermal shield, the increased distance from the camera lights to the surface of the reactor components dispersed the light so that the camera had to be within a few inches of the component to be inspected. Also, because of the change in lighting conditions, the borescope was most effective when used with the manual exposure setting. The remote systems personnel had to continually adjust the exposure setting to maximize the picture quality.

Another limitation of the borescope was that the camera was constantly moving. Because the borescope is essentially a camera head attached to a flexible cable, it did not have any rigid support other than the structures in the reactor vessel. The operators did a good job of minimizing the camera movement but it did require constant adjustment of the pneumatic controls to hold the camera in one location for any extended period of time.

At the end of day two, the inspection of the areas and components identified in Sections 4.57 through 4.63 and Sections 4.44 through 4.47 was complete.

3.3 Monday, November 14, 2005

3.3.1 Process

On Monday, November 14, 2005, the borescope was used to inspect the components covered in Sections 4.22 through 4.43. These components included the inlet flow baffle interior surface, including the batten strips and bolt heads, the inlet flow baffle lower head, the cover plate supports, the reflector tank exterior surface, the reflector support tank exterior surface, the flow distribution tank, the reactor vessel inlet flow pipes below the cover plates, the long thimbles, thimble support brackets, the thimble exhaust, the exterior surfaces of the north and south irradiation facilities and outlet piping, and the east and west spent fuel storage cans, supports, and outlet piping. The operation of the flow hat retaining clamps and flow hat lid hinge operation covered in Sections 4.11 through 4.16 was also inspected.

Access to the areas between the inlet flow baffle and the core tanks assembly was through the 10% flow hats located on cover plates 691, 1522, 1523, and 1524 (see attachment 3, Drawing #120369). The refueling ports in the reactor vessel top plate are located above the flow hats and provide a straight line for the borescope to the flow hats. Based on a review of reactor interior drawings, the most unobstructed drops to the bottom of the inlet flow baffle lower head by the borescope were through the flow hats on cover plates 696 and 691. However, access to the flow hat on cover plate 696 was not possible due to the installation of an ATR In-vessel Post Accident monitoring system (IVPAMS) monitor located directly on top of the flow hat retainer clamp.

The order of the camera insertions through the flow hats on cover plates was 1523, 1522, 691, and 1524. This order of inspection was chosen to first inspect the areas in the north of the reactor that were anticipated to have lower radiation fields. The hollow handling tool was not used during this portion of the inspection. The borescope was maneuvered and held in place manually. Each of the camera insertions through the flow hats were assisted by an additional standard reactor vessel drop light to provide additional lighting for the borescope.

The borescope was used to inspect the removal of the flow hat retainer clamps and to open the flow hats. The borescope provided pictures similar in quality when compared to the standard in-tank camera but was harder to maintain in position due to the lack of a rigid support structure. The borescope was also able to provide an inspection of the sides of the flow hat structures.

During the inspection of the flow hat on cover 691, when the retainer clamp was removed and an attempt was made to open the flow hat lid, the hinge pin for the lid appeared to be gone and the flow hat lid separated from the rest of the flow hat. The borescope was lowered to the surface of the protective cover plates in the vicinity of the flow hat hinge and allowed an inspection of the hinge, the flow hat lid, and the surrounding area in search of the missing hinge pin. No hinge pin or portion of the hinge pin was found. The apparent cause of the lid failure appeared to be erosion due to vibration induced by primary coolant flow. The flow hat hinge pin failure had been discovered previously and a final resolution of the problem was addressed and documented in two Facility Change Forms in 1979–80.[h,i]

An additional light was dropped through the flow hat to support the borescope and, when properly located, provided sufficient lighting to conduct the inspection. Due to the primary coolant outlet flow pipes being located directly beneath the flow hats on cover plates 1521, 1522, and 1524, there was limited space below the flow hat opening where the borescope had a 360 degree field of view. As the camera and light were positioned lower into the sub-core region, the outlet flow pipe would force the camera and light to one side or the other into a much narrower space. It was difficult at times to get both the camera and light to lower on the same side of the primary coolant outlet flow pipe. If the light and camera were on opposite sides of the outlet flow pipe, the outlet pipe essentially blocked the light to the camera.

Once both the light and camera were below the bottom of the outlet flow pipe, the camera was able to inspect the lower portions of the flow distribution tank, the underside of the primary coolant outlet flow pipes, the irradiation support structures and outlet piping, and the inlet flow baffle lower head.

Access to the components via the flow hats was also reduced to about 50% of the area in each quadrant. The flow hats allowed only one point of access, the borescope did not have the capability to maneuver laterally, and the primary coolant outlet flow pipes acted as a barrier that isolated half of each quadrant from view by the borescope. This prohibited inspection of most of the components between the spent fuel storage cans and the primary coolant outlet flow pipe. The portions of the components that were accessible for inspection included portions of the reflector tank, the reflector support tank, the flow distribution tank, and the inlet flow baffle cylinder interior.

3.3.2 Results

Based on a limited inspection of the components, no anomalies were noted on the instrument thimbles, the reactor primary coolant outlet flow pipes, the flow distribution tank exterior, the inlet flow baffle upper cylinder interior surfaces, or the inlet flow baffle lower head upper surface. Some minor corrosion was noted on the cover plate support structures, the lower flange of the reflector tank, the north and south irradiation facilities perforated plates, and the east and west fuel storage facility exterior support structures. The reflector support tank was noted as having substantial signs of corrosion present and was recommended for evaluation by a corrosion specialist. Estimates of the percentage of the components visible are displayed below in Table 3 for each of the reactor quadrants.

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h. Facility Change Form, Facility Change No. 7.1.1-4, "ATR Protective Cover Flow Hat," November 26, 1979.

i. Facility Change Form, Facility Change No. 7.1.1-5, "ATR Flow Hat Clamping Mechanism," February 12, 1980.

Table 3. ATR sub-core internal components inspected on day three.

Reactor Component Description	% Visible per Quadrant			
	Northeast	Southeast	Southwest[a]	Northwest
Inlet Flow Baffle Upper Cylinder Interior	40–60	20–40	40–60	40–60
Inlet Flow Baffle Lower Heat Upper Surface	40–60	20–40	40–60	40–60
Reflector Tank Exterior	40–60	20–40	40–60	20–40
Reflector Support Tank Exterior	40–60	20–40	40–60	20–40
Flow Distribution Tank Exterior	40–60	40–60	40–60	40–60
Reactor Outlet Flow Piping Exterior	60–80	20–40	40–60	60–80
West Spent Fuel Storage Ext Can and Support	NA	NA	0–20	0–20
East Spent Fuel Storage Ext Can and Support	0–20	0–20	NA	NA
South Irradiation Facility	NA	20–40	60–80	NA
North Irradiation Facility	80–100	NA	NA	80–100
Cover Plate Support Structures	0–20	0–20	0–20	0–20
Thimble T-1	40–60	NA	NA	NA
Thimble T-2	20–40	NA	NA	NA
Thimble T-3	0–20	NA	NA	NA
Thimble T-4	NA	0–20	NA	NA
Thimble T-5	NA	20–40	NA	NA
Thimble T-8	NA	NA	40–60	NA
Thimble T-9	NA	NA	20–40	NA
Thimble T-10	NA	NA	NA	60–80
Thimble T-11	NA	NA	NA	0–20
Thimble T-12	NA	NA	NA	0–20

[a] Includes inspection conducted on Tuesday, November 15, 2005.

The overall quality of the inspection for the components addressed in Sections 4.22 through 4.43 was poor concerning video quality, as well as access to the components. The video quality was poor due to some apparent "browning" of the camera lens and the fiber optic light so that there was a decrease in picture quality and amount of light. Of the approximately four hours of video taken, only about half provides any useable video.

3.4 Tuesday, November 15, 2005

3.4.1 Process

On Tuesday, November 15, 2005, the standard in-tank camera and borescope were used to inspect the operability of the remaining flow hats and flow hat retainer clamps located on cover plate 1521 that had not been inspected on the previous day. In addition, an attempt was made to remove two of the aluminum cover plates and inspect the components below that plate. The hollow handling tool was not used during this portion of the inspection and the borescope was maneuvered and held in manually.

The inspection of the flow hat and flow hat retainer clamp on cover plate 1521 was initiated with the support of two ATR operators. The operators released the retainer clamp and opened the flow hat. One operator had to leave to attend to other duties and the remaining operator was left to close the flow hat lid and replace the retaining clamp. After considerable effort the operator was unable to reinstall the locking devices on the retainer clamp.

Replacing the flow hat retaining clamps requires that two in-tank handling tools be used simultaneously. One hook tool is used to hold the retainer clamp in place and the second tool with the socket head is used to depress and turn the locking "J" clamps used to secure the retainer clamp. This operation was left until after shift change so that two operators would be available for securing the retainer clamp.

After the shift change, the operators were instructed to replace the flow hat retaining clamp and then evaluate the location of the removable cover plates, their associated fasteners, and any structures that hindered their attempt to release the cover plate fasteners and remove and relocate one or more of the cover plates. The cover plates 1521 through 1524 were not removed at this time because they were directly below a set of two outer shim drive rods that contained parts that overlapped an inch onto these plates.

It was also pointed out that the removal of the cover plates adjacent to the spent fuel storage rack would provide the best opportunity to inspect components that had not been accessible via the flow hats on the previous day. After the operators had an opportunity to evaluate the cover plates, the observation was made that the fasteners on the eight cover plates, located on each side of the four outlet flow pipes, were difficult to reach because they were partially obstructed by the outlet flow pipe flanges.

An attempt was made to remove plate 1517, which was adjacent to the outlet flow pipe in the southwest quadrant. The fasteners were successfully released and the cover was lifted so that the fasteners were clear of the securing cams and holes. However, the plate could not be moved out of the way as its removal was obstructed by a shim drive rod on one side and the outlet flow pipe and an IVPAMS device on the other. It appeared that the plate might be removable if the IVPAMS device was removed or relocated, and/or the outer shim drive rod was removed.

Cover plate 691 was successfully removed and the borescope was lowered into the reactor to inspect the components in that area. An additional drop light was also lowered to provide increased lighting.

3.4.2 Results

The inspection of the area under cover plate 691, although primarily a duplication of the inspection of the southwest quadrant previously inspected using the flow hat in the same plate (see Table 3), provided better accessibility to the components inspected, improved the coordination between the camera and drop light, and improved the area lighting due to the additional in-tank drop lights located above the cover plates. The values for the percentage of the components visible between the southwest and southeast quadrant in Table 3 are in part due to the additional inspection conducted with cover plate 691 removed. No additional anomalies were noted above and beyond those noted during the inspection on Monday, November 14, 2005.

4. Conclusions

4.1 General Conclusions

The ATR Sub-Core Internals Inspection was completed over 4 days between November 10 and November 15, 2005, during the 136A-1 outage. All or portions of all the ATR sub-core internal components were inspected. The completeness of the inspection for individual components varied depending on various factors including camera access to the component location within the reactor, lighting, the capabilities of the camera used, and the impact of the radiation fields encountered within the reactor vessel. The inspection provided video of the components addressed in DOP-7.10.72, with mixed results.

No anomalies were noted for the instrument thimbles, the reactor outlet piping, the flow distribution tank, the inlet flow baffle, the core support tank, the reactor vessel, and the thermal shield. Minor anomalies including corrosion, nicks, dings, general pitting, and “growth” were observed in the aluminum cover plates and support structures, the flow hat assemblies, the irradiation facilities and support structures, the spent fuel can assemblies and support structures, and the core reflector tank.

The reflector support tank was observed to have indications of localized corrosion or surface anomalies. An ICARE was submitted to have the reflector support tank video reviewed by a material/corrosion specialist to determine what action, if any, should be taken. A metallurgist concluded that this corrosion was galvanic in nature and was creating the conditions for pitting (ICARE 39268). ATR Operations and Engineering reviewed and accepted, in DOP-7.10.72, this condition for continued operations without restriction. Inspection criteria should be developed to evaluate the condition of the reflector support tank in subsequent sub-core internals inspections to get a better understanding of the corrosion mechanism.

At the completion of the inspection, no restrictions for the continued operation of the reactor were noted by Operations and Engineering Management.

One ancillary objective was completed when one of the aluminum cover plates was successfully removed and replaced, which in future inspections could provide better access for the inspection of the components in Sections 4.22 through 4.43 of the DOP. Additional conclusions that apply to the cameras used and other operational conditions are provided below.

4.2 RCS-3100

Overall, the inspection of the reactor component covered in Section 4.5 through 4.20 using the RCS-3100 standard in-tank camera provided a good quality visual inspection and video. Some components could only be partially inspected because the camera is too large to be dropped between adjacent thimbles and between the thimbles and the outlet flow pipes, thereby prohibiting the camera from inspecting some of the cover plate surfaces and the underside of the outlet flow pipes located above the cover plates.

4.3 XLC1000 Borescope

The XLC1000 borescope (maximum diameter of 0.50 in.) easily accessed the openings in the expanded metal grating that covers the area between the reactor vessel and the inlet flow baffle upper section. The borescope provided adequate optical characteristics and range to inspect the components covered in Sections 4.44 through 4.65.

Due to the length of cable required to reach the target areas, the diameter and rigidity of the borescope cable, and the areas of open space being inspected, the borescope had the tendency to “float,” making it difficult to keep the camera in any one position. This, and the limited viewing area provided by the borescope’s fiber optic light, made it difficult to relocate areas of interest after the borescope had moved or “floated” beyond that point. In addition, the borescope/fiber optic cable is shipped and stored coiled to reduce size. When the borescope was unrolled prior to use, a manual attempt was made to straighten the cable as much as possible, especially the last couple of feet at the camera lens end of the cable. After these efforts, the cable end still retained a slight curve (approximately 5–10 degrees). The curve remaining in the camera cable impacted the ability to maneuver the camera when it was free-floating.

4.4 Access and Lighting

Access to the reactor sub-core components varied greatly depending on the location of the component to be inspected and the camera used to conduct the inspection. The components located at the top of the sub-core region inspected on day one were generally accessible by using the standard in-tank camera. The additional drop lighting in the reactor was more than adequate for the standard in-tank camera to conduct the inspection. The standard in-tank camera was operated at a height of 4 to 6 ft above the sub-core region. At this camera operating height, no “sparkle” or “browning” was observed by the camera. However, at this operating height the in-tank camera could not inspect the sides of the flow hats because the flow hat lids overlapped the sides, blocking the view.

The inspection had good access to the areas between the reactor vessel wall, the thermal shield, and the inlet flow piping; the borescope was dropped through the holes in the expanded metal grating that covered those components. The light provided by the borescope fiber optics was sufficient to conduct the inspection; however, the borescope fiber optic lighting provided light for only a fraction of the camera’s field of view. An ATR drop light was located over the grating to try to increase the light in the inspection area. The drop light provided minimal improvement in the areas just below the expanded metal grating but did not provide any additional light in the area below the thermal shield.

Using the borescope and entering the sub-core region via the expanded metal grating provided good access to the lower reactor vessel interior (below elev. 75), the thermal shield support structures, and the core support tank. The lighting provided by the fiber optic cable was minimally sufficient to conduct the inspection in this region around the core support tank. To obtain an adequate visual of the component to be inspected required that the borescope be located within a few inches of the component, and in many cases a longer manual exposure setting was necessary to maximize the light available. While increasing the exposure time of the borescope provided a clearer picture it also increased the difficulty of maintaining the picture because of the random movements of the free-floating camera. Little or no “sparkle” was experienced during the inspection of the components in these sections. The borescope experienced a noticeable deterioration in picture quality over the approximate five hours of this portion of the inspection—primarily a darkening of the video picture.

Access to the lower core tank sections between the core tank assembly and the inlet flow vessel through the flow hats was not sufficient to allow inspection of a significant portion of the reflector tanks, the reflector support tank, the flow distribution tank, the outlet flow pipes, the thimbles and their support brackets, and the exterior of spent fuel storage cans. The flow hats in cover plates 1521 through 1524 are located directly above the outlet flow pipes and presented a significant obstruction to inspecting the components in these areas.

Each of the camera drops through the flow hats were assisted by a drop light to provide additional lighting for the borescope. The drop light, when located in close supporting proximity, provided a considerably larger camera viewing area. However, it was difficult to coordinate the drop light with the borescope. An ideal location for the drop light was close enough to provide good lighting (1–2 ft), above, behind, or below the borescope's field of vision. When the drop light was too close (less than 1 ft) the light would wash out the picture, or reflect glare off the stainless steel. It was also difficult to get the borescope and drop light located on the same side of the outlet flow pipe when lowered to the side or below the pipe. This obstructed the majority of the light provided by the drop light and made it more difficult to position the camera and drop light to provide an adequate inspection.

The borescope was used to inspect the removal of the flow hat retainer clamps and to open the flow hats. The borescope provided pictures similar in quality when compared to the standard in-tank camera but was harder to maintain in position due to the lack of a rigid support structure.

Removal of thirteen of the aluminum cover plates (all but 679, 683, and 961) is not feasible due to obstructions presented by the gear box drive shafts, the IVPAM monitors, the outlet flow pipes, and also due to limited access to all the cover plate fasteners using the refueling ports.

The inspection of the area under cover plate 691, although primarily a duplication of the area previously inspected using the flow hat in the same plate, provided better access to the components inspected, improved the ability to coordinate the camera and drop light, and increased the area of visibility due to the additional light provided by the drop lights above the cover plates.

5. Recommendations

The only action recommended to be taken for any of the components inspected via the ATR Sub-Core Internals Inspection concerned the reflector support tank, which was observed to have “substantial” signs of corrosion. An ICARE was submitted to have the reflector support tank video reviewed by a material/corrosion specialist to determine what action, if any, should be taken. A metallurgist concluded that this corrosion was galvanic in nature and was creating the conditions for pitting (ICARE 39268). ATR Operations and Engineering reviewed and accepted, in DOP-7.10.72, this condition for continued operations without restriction. Therefore, inspection criteria should be developed to evaluate the condition of the reflector support tank in subsequent sub-core internals inspections to get a better understanding of the corrosion mechanism.

As for the inspection procedure, the following recommendations are suggested because they could increase the success of future inspections by improving the accessibility of the reactor components or enhance the capabilities of the cameras that were used.

For the reactor components located at the top of the sub-core area, using a borescope or smaller camera could provide a more complete inspection of the cover plates that were partially blocked by the outlet flow pipes and experiment thimbles by allowing access to the area between the obstructions located above the cover plates and by getting closer to the cover plates. The camera will experience some “sparkle,” however, as it gets closer to the gear box support beams (GBSB) and other sub-core components.

The borescope’s field of vision was limited by the amount of light produced by the borescope’s fiber optic light when accessing the sub-core region through the expanded metal grating. Additional lighting in the area below the expanded metal grating and in the area of the core support tank would improve the borescope’s viewing area, improving the camera’s optical abilities and reducing the time it would take to complete the inspection.

To improve the inspection of the core tank area between the core tanks and the inlet flow baffle, removing the aluminum cover plates would provide improved access and the ability to provide additional lighting. In order to remove the cover plates, it may be necessary to remove the reactor top head instead of using the refueling ports. This would improve access to the cover plate fasteners. Additionally the removal of the OSCC drive shaft would improve the ability to remove cover plates 1521, 1522, 1523, and 1524. Removal of the IVPAMS monitors located above the plates 727, 969, and 1517 would be required in order to remove those cover plates. Removal of the reactor top head and gear box drives are prerequisites for conducting a reactor core internal change-out (CIC); therefore it would be advantageous to coordinate ATR Sub-core Internals Inspections with future CIC work.

Attachment 1

Idaho National Laboratory

ATR REACTOR VESSEL INTERNALS AGING INSPECTION	Identifier: DOP-7.10.72 Revision: 0 Effective Date: 11/08/05 Page: 1 of 36

Reactor Technology Complex	Technical Procedure	USE TYPE 1	Change Number: 123325

Manual: RTC - DOP-7.0 – ATR Detailed Operating Procedures Manual
Document Owner: Plant Engineering

CYCLE NO. and/or DATE	WO, WR, or LETTER NO.	
136A-1 / 11-10-05	N/A	
EXPERIMENT NO./LOOP DESIGN	COMPLETED DOP REVIEWED	
	Date	Initials
N/A	12/19/05	K

PROCEDURE REVIEW REQUIREMENTS PER SP-10.2.2.3					
DISCIPLINE	REVISION	CHANGE	DISCIPLINE	REVISION	CHANGE
ATR OPERATIONS	X	X	INDUSTRIAL SAFETY	•	•
NUC OPS MAINTENANCE	N/A	N/A	QUALITY	•	•
EXPERIMENTS	N/A	N/A	ENVIRONMENTAL	N/A	N/A
SYSTEMS ENGINEERING	X	X	RADCON	•	•
NUCLEAR SAFETY ENG	•	•	INDUSTRIAL HYGIENE	N/A	N/A
TRAINING	N/A	N/A	RTC HOT CELLS/LRMS	N/A	N/A
SORC	N/A	N/A	RTC FSS	N/A	N/A
TSR REVIEW	N/A	N/A	EMERGENCY PREPAREDNESS	N/A	N/A
LIFE EXTENSION PROGRAM	X	•			
* QR SHALL DETERMINE THE NEED FOR THESE REVIEWS BASED UPON THE SCOPE OF THE CHANGE					
A JOB SAFETY ANALYSIS WAS DEVELOPED FOR THIS PROCEDURE IN ACCORDANCE WITH A DETERMINATION MADE USING MCP-3562.					

For Use by Operations

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REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	11/08/05	All	See DAR 123325.

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1. INTRODUCTION

1.1 Purpose

This procedure provides instructions for inspecting and documenting (videotaping) the condition of the following reactor structures using the closed-circuit television (CCTV) system in support of the ATR Life Extension Program:

- Reflector tank to inlet flow baffle aluminum cover plates and support structure
- 10% flow hole flow hats
- 10% flow hat retainer clamps
- Inlet flow baffle upper cylinder and lower head (interior surfaces)
- Core support tank (exterior surfaces)
- Flow distribution tank (exterior surfaces)
- Reactor outlet flow pipes (exterior surfaces)
- Reflector support tank (exterior surfaces)
- Instrument thimbles, thimble supports, and thimble exhaust lines (exterior surfaces)
- North and south outer irradiation facilities and associated flow pipes
- Spent fuel storage cans and associated supports
- Core reflector tank (exterior surfaces)
- Reactor vessel thermal shield and support brackets
- Inlet flow baffle upper cylinder (exterior surfaces)
- Reactor vessel inner surface from 82.5-ft elevation down to the 68-ft elevation.

1.2 Scope and Applicability

This procedure is performed periodically, as the ATR Facility ages, to identify any reactor component deterioration and to allow assessment of impact on the ATR Facility lifetime.

This procedure directs a Safety Class activity.

2. PRECAUTIONS AND LIMITATIONS

2.1 Reactor top work may increase worker exposure to heat stress and injury due to fatigue caused by extended periods of heavy work during refueling and incore manipulations. In order to protect workers from injury and exposure, the job supervisor and coworkers shall monitor each other with particular attention placed on fatigue and overheating symptoms. The reactor top prejob brief shall include heat stress and ergonomic considerations with a review of heat stress symptoms and proper ergonomic lifting techniques. Workers shall use proper ergonomic lifting technique when using loaded tools in the reactor tank. Job supervisors shall rotate workers out of the area, or to a less demanding task as appropriate, to prevent heat stress, excessive physical fatigue, repetitive stress injury, and cumulative trauma to soft tissue. The job supervisor shall ensure personnel are available to provide drinking water for reactor top workers. Prior to work, ensure the reactor vessel inlet temperature is less than 110°F. [JSA-DOP-7.10.72]

2.2 Radioactive contamination hazards exist when working in reactor tank. Wipe up spills to prevent contamination spread. Allow tools to drain before storage, and sleeve tools prior to storage. Wipe down tools and lights as they are removed from the tank. Follow RCT direction to maintain the work area contamination levels ALARA. [JSA-DOP-7.10.72]

2.3 Continuous RCT coverage is required to remove equipment from the reactor tank or canal. [JSA-DOP-7.10.72]

2.4 Continuous RCT coverage is required when moving irradiated components to prevent uncontrolled radiation exposure. [JSA-DOP-7.10.72]

2.5 Slip and fall hazards exist on the reactor top, canal parapet, and on the floor area during work. The job supervisor is to brief workers to raise awareness of specific hazards. Workers shall wipe up spills and maintain an orderly work environment. [JSA-DOP-7.10.72]

2.6 Inspect portable electrical equipment for damage prior to use; verify electrical inspection is current. Use ground fault circuit interrupters (GFCIs) and test once per shift before use. [JSA-DOP-7.10.72]

2.7 Work on the reactor top with shield blocks rolled back, any refueling port covers removed, and the reactor tank at the upper drain requires appropriate safety measures to protect from drowning while working over dangerous equipment. [JSA-DOP-7.10.72]

2.8 Turn the camera lighting off to prevent overheating of the lamps when changing refueling ports if working through the reactor top head.

2.9 All workers will minimize contact of reactor tools and camera equipment with anti-C clothing to reduce contamination potential.

3. PREREQUISITES

3.1 Planning and Coordination

WARNING

Conventional fall protection under the following conditions does not increase worker safety. Operators require continuous mobility in order to perform incore manipulation. Working with fall protection gear, coupled with different surface evaluation, increases fall and tripping hazards, thereby degrading overall safety, including safe nuclear fuel handling. [JSA-DOP-7.10.72]

3.1.1 IF work is on the reactor top with:

A. The shield blocks rolled back

B. Any refueling port covers removed

C. Reactor coolant level at the upper drain

THEN establish nonconventional fall protection as follows:

3.1.1.1 Establish controlled access zone (CAZ) on the reactor top. Use of established boundaries for RadCon, cleanliness control, or security is acceptable.

3.1.1.2 Operators, support workers, and supervision directly engaged with incore manipulations or fuel-moving activities may provide safety-monitoring functions for each other.

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3.1.1.3 Supervisors shall ensure the safety monitors are competent to recognize fall hazards. The safety monitors shall mitigate falls by intervention. The duties include warning coworkers of unsafe conditions, which may increase the fall potential with particular attention placed on tripping hazards and body position, and providing rescue assistance in the event of a fall.

3.1.1.4 Supervisors shall use the reactor top prejob briefing to inform workers of safety monitor duties and of fall and drowning hazards associated with reactor top work.

3.1.2 IF work is performed on the reactor top inside the CAZ, other than incore manipulations or fuel movement, or in conjunction with incore manipulations or fuel movements,
THEN designate an individual as the safety monitor for fall protection. Ensure the safety monitor is competent to recognize fall hazards. The safety monitor shall mitigate falls by intervention. The duties include warning workers of unsafe conditions, which may increase the fall potential with particular attention placed on tripping hazards and body position, and providing rescue assistance in the event of a fall.

3.1.3 This job requires a radiological work permit (RWP) to be issued per MCP-7, "Radiological Work Permit."

3.1.4 Supervision shall use the reactor top prejob brief to inform workers of safety monitor duties and of fall and drowning hazards associated with reactor top work.

3.1.5 The reactor is in an outage condition.

3.1.6 The reactor is defueled. [JSA-DOP-7.10.72]

3.1.7 The refueling ports or the reactor top head are off.

3.2 Special Tools, Equipment, Parts, and Supplies

A. Closed circuit TV and recorder system with videotape

B. Camera shield blocks/extension/right-angle or zoom lens

C. Long camera handling tool

D. Fiber optic CCTV system

E. Rope hoist

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F. Standard ATR handling tools

G. Shepherd's crook or similar retrieval device.

3.3 Field Preparations

3.3.1 All fuel elements have been discharged to the canal, with required dummy elements installed in transition positions.

3.3.2 Verify that a prejob briefing has been held. [JSA-DOP-7.10.72]

3.3.3 Verify shepherd's crook or similar retrieval device is staged at the work area in easy reach.

3.3.4 Verify ring buoys are available and note the location in the prejob briefing.

3.4 Approvals and Notifications

3.4.1 Plant Engineering personnel have been notified.

3.4.2 Approval to perform this procedure has been obtained from the shift supervisor.

Shift supervisor signature ____________ Date 11-10-05

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4. INSTRUCTIONS

Procedure Started: Cycle 136A-1 Time 1656 Date 11-10-05

4.1 General

4.1.1 Verify each shift that PREREQUISITES (as applicable) are met and PRECAUTIONS AND LIMITATIONS have been reviewed.

Signature/Date/Time	Signature/Date/Time
[signature] 11-10-05/1721	[signature] 11/14/2005 1703
[signature] 11-16-5/2007	[signature] 11-14-05 1945
S. Cole/11-11-5/0745	[signature] 11/15/05 1515
	[signature] 11-15-05 2000

4.1.2 IF, during the performance of this procedure, it is necessary to N/A step(s),
THEN mark steps "N/A" in accordance with MCP-2241, "Reactor Programs Supplement to MCP-2985, Chapter XVI, Operations Procedures."

[initials] 4.2 Inspect the standard in-vessel CCTV camera for loose/damaged parts.

[initials] 4.3 Configure the CCTV camera for inspection of the reflector tank to inlet flow baffle aluminum cover plates, support structure, 10% flow hats, and hat retainer clamps.

4.3.1 Install the camera zoom attachment.

4.3.2 Attach a short extension to the camera to facilitate connection to an intank handling tool.

4.3.3 Attach intank handling tool(s) to facilitate inspection.

NOTE: *Engineering personnel must be present during the inspection.*

[initials] 4.4 Verify that the TV and recording equipment are on and ready to start inspection.

NOTE: *In the subsequent inspections, note any anomalies, erosion, corrosion, cracking, discoloration, loose bolting, damage, and so forth.*

[initials] 4.5 Visually inspect the upper surface, securing bolts, 10% flow hats, and flow hat retainers of the reflector tank to inlet flow baffle aluminum cover plates.

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4.6 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

4.7 Inspect the interior of the east and west spent fuel storage cans.

4.8 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

NOTE: *Instrument thimbles T-6 and T-7 (short thimbles) end approximately 1-1/2 ft above the core and are clamped to T-5 and T-8 respectively.*

4.9 Inspect the bottom 1 ft of instrument thimbles T-6 and T-7, the support clamps attached to thimbles T-5 and T-8, and the thimble exhaust lines.

4.10 Document the results of this inspection in Appendix B. (If no anomalies are noted, then so state.)

NOTE: *Steps 4.11 through 4.51 will be repeated for each quadrant (NE, SE, SW, and NW) and signed off as complete in Step 4.52.*

4.11 Select the quadrant of reactor vessel internals to be inspected.

4.12 Remove the retainer clamp from the 10% flow hat in the reflector tank to inlet flow baffle aluminum cover plate in that quadrant.

4.13 Inspect the retainer clamp for damage and operability of the retainer "J" bolts.

4.14 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

NOTE: *The 10% flow hats are hinged at one end.*

4.15 Inspect the 10% flow hat in the selected quadrant for damage and operability.

4.16 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

NOTE: *The 10% flow hat may be left in the open position and the open one used for the camera inspection in lieu of, or in addition to, Steps 4.17 and 4.18.*

4.17 Unbolt the reflector tank to inlet flow baffle aluminum cover plates in the selected quadrant.

4.17.1 Attach a 3/4-in. socket to an intake handling tool.

4.17.2 Extend the handling tool to the top of one of the fasteners on an aluminum cover plate to be removed and place the 3/4-in. socket over the fastener.

4.17.3 Depress the fastener until the fastener locking pin releases from the cam.

4.17.4 Rotate the intank handling tool and fastener 90 degrees, or until the locking pin is free of the cam, and release the pressure on the fastener.

4.17.5 Repeat Steps 4.17.1 through 4.17.4 for remaining fasteners on the cover plate to be removed.

4.18 Remove the reflector tank to inlet flow baffle aluminum cover and place in temporary intank storage.

4.18.1 Lower the retrieval device over the cover plate to be removed, using a hook tool or similar retrieval device, and place hooking device into the cover plate lifting lug.

4.18.2 Lift the cover plate up to free the unlocked fasteners from the cover plate support structures and place in temporary intank storage.

4.19 Inspect the reflector tank to inlet flow baffle aluminum cover plate support structure for cracked welds and any other damage or anomalies.

4.20 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

NOTE: *For the following inspections it is permissible to swap camera heads or use a handheld long camera handling tool as needed to provide the best inspection and videotaping.*

4.21 Position the 2-ton crane over the selected quadrant.

4.22 Attach the rope hoist to the 2-ton crane.

4.23 Attach the long camera handling tool to the rope hoist.

4.24 Attach the CCTV camera to the long camera handling tool.

NOTE: *If the outer shim control cylinder gearbox support beams are in place (that is, have not been removed) the high radiation field will cause the CCTV camera to wash out. Keep the camera as far away from the radiation source as reasonable.*

4.25 Lower the CCTV camera through the reflector tank to inlet flow baffle aluminum cover plate support structure.

MASTER

NOTE: *The inspections in Steps 4.26 through 4.43 may be done in any order as long as the results are documented in Appendix B following each inspection.*

4.26 Inspect the core reflector tank exterior surface accessible in selected quadrant.

4.27 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

4.28 Inspect accessible surfaces of the outer irradiation facility (OIF) in selected quadrant, OIF support structure, and OIF outlet pipe.

4.29 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

NOTE 1: *Instrument thimbles T-1, -2, -3, -4, -5, -8, -9, -10, -11, and –12 are full length thimbles and extend to the bottom of the reflector support tank and are clamped to the wall of this tank.*

NOTE 2: *The short instrument thimbles T-6 and T-7 were previously inspected in Step 4.9.*

4.30 Inspect the instrument thimbles, thimble supports, and thimble exhaust lines, accessible in selected quadrant, below the 82-ft elevation.

4.31 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

4.32 Inspect the reflector support tank exterior surface accessible in selected quadrant.

4.33 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

4.34 Inspect the reactor outlet piping from the flow distribution tank to the reactor vessel wall accessible in selected quadrant.

4.35 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

4.36 Inspect the flow distribution tank exterior surfaces accessible in selected quadrant.

4.37 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

4.38 Inspect the exterior surfaces and associated supports of the spent fuel storage cans accessible from selected quadrant.

4.39 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

4.40 Inspect the inlet flow baffle upper cylinder interior surface accessible from selected quadrant.

4.41 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

4.42 Inspect the inlet flow baffle lower head upper surface accessible from selected quadrant.

4.43 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

NOTE 1: *The fiber optic CCTV system is used during the following inspections.*

NOTE 2: *An access to the core support tank and reactor vessel interior surface below the 73-ft elevation is via the 10% flow holes in the inlet flow baffle lower head.*

4.44 Inspect the core support tank exterior surface accessible from selected quadrant.

4.45 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

NOTE: *In the next step pay particular attention to bottom head area and inlet piping welds.*

4.46 Inspect the reactor vessel interior surface below the 73-ft elevation accessible from selected quadrant.

4.47 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

4.48 Remove the camera equipment and any standard ATR handling tools from the inspection area.

NOTE: *Step 4.52 may be completed prior to Steps 4.49 and 4.51.*

4.49 Replace the reflector tank to inlet flow baffle aluminum covers for selected quadrant.

4.49.1 Lower the retrieval device over the cover plate to be replaced, using a hook tool or similar retrieval device, and place hooking device into the cover plate lifting lug.

4.49.2 Move the cover plate to its installation position, line up the fasteners with the cover plate support structure cams, and lower into position.

4.50 Bolt the reflector tank to inlet flow baffle aluminum cover plates in the selected quadrant.

4.50.1 Attach a 3/4-in. socket to an intank handling tool.

4.50.2 Extend the handling tool to the top of one of the fasteners on an aluminum cover plate to be removed and place the 3/4-in. socket over the fastener.

4.50.3 Depress the fastener until the fastener locking pin is below the bottom of the cam.

4.50.4 Rotate the intank handling tool and fastener 90 degrees or until the locking pin is locked in the cam and release the pressure on the fastener.

4.50.5 Repeat Steps 4.50.1 through 4.50.4 for remaining fasteners on the cover plate to be replaced.

4.51 Reinstall the retainer clamp on the 10% flow hat in the reflector tank to inlet flow baffle aluminum cover plate.

4.52 Perform inspections in the remaining quadrants by repeating Steps 4.11 through 4.51.

_____ First quadrant inspections completed

_____ Second quadrant inspections completed

_____ Third quadrant inspections completed

_____ Fourth quadrant inspections completed

4.53 Carefully wipe down the CCTV camera.

4.54 Disconnect the CCTV camera from the long handling tool and bag the camera.

MASTER

4.55 Disconnect the long-camera handling tool from the rope hoist; sleeve and place in the tool storage rack.

4.56 Disconnect the rope hoist from the 2-ton crane; bag and place in storage.

NOTE 1: *The fiber optic CCTV system is used during the remaining inspections.*

NOTE 2: *Access to the remaining inspection areas (that is, reactor vessel thermal shield, inlet flow baffle upper cylinder exterior surface, and/or the reactor vessel interior surface below the 85-ft elevation) is via the inlet flow plenum diamond shaped grating. It will be necessary to pass the fiber optic camera down, through the grating in several locations to complete each inspection.*

NOTE 3: *The inspections in Steps 4.57 through 4.66 may be done in any order as long as the results are documented in Appendix B following each inspection.*

NOTE 4: *The next two inspections can be done concurrently.*

NOTE 5: *The inspections in Steps 4.57 through 4.66 may be done prior to Steps 4.17 through 4.56.*

NOTE 6: *An access to the core support tank and reactor vessel interior surface below the 73-ft elevation is via the open space between the inlet flow baffle and thermal shield or between the thermal shield and the reactor vessel wall.*

DAP 4.57 Inspect the exterior surface of the inlet flow baffle upper cylinder. Pay particular attention to the areas where each of the four sections of the cylinder bolt together.

DAP 4.58 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

DAP 4.59 Inspect the interior surface of the vessel thermal shield. Pay particular attention to the areas where each of the four sections of the thermal shield bolt together.

DAP 4.60 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

NOTE: *The next two inspections can be done concurrently.*

DAP 4.61 Inspect the exterior surface of the vessel thermal shield. Pay particular attention to the areas where each of the four sections of the thermal shield bolt together. Also pay attention to the thermal shield supports.

DAP 4.62 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

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DGP 4.63 Inspect the interior surface of the reactor vessel below the 85-ft elevation. Pay particular attention to the welds that attach the thermal shield supports to the vessel wall.

DGP 4.64 Document the results of this inspection in Appendix B. (If no anomalies were noted, then so state.)

DGP 4.65 Carefully wipe down and bag the fiber optic CCTV camera and cable.

DGP 4.66 WHEN the inspection is complete for all positions,
THEN remove the tab button from recorded videotape cassette(s) to prevent video information from being erased.

DGP 4.67 Record time, date, cycle, and "ATR Life Extension Program" on each tape cassette.

4.68 Operations and Engineering Management: Give approval to operate the reactor with any restrictions noted below. Review the results of the inspections.

Restrictions (if none so state): NO RESTRICTIONS.
NOTE: A MATERIAL/CORROSION SPECIALIST SHOULD LOOK AT THE VIDEO OF THE REFLECTOR SUPPORT TANK AND DETERMINE WHAT ACTION, IF ANY SHOULD BE TAKEN. DGP

[signature] Operations Management

[signature] 12/15/05 Engineering Management ICARE IS being entered for this comment

Procedure Completed: Signature [signature] Time 1345 Date 12/19/05

5. RECORDS

Records Description	Uniform File Code	Disposition Authority	Retention Period
Executed copies of procedures or operations forms	7301	A17-32-a EPI	Retained until item is removed from service.

NOTE: *Records identified with an epidemiological stamp (EPI) must not be destroyed.*

MASTER

6. REFERENCES

29 CFR 1926, Subpart M, Fall Protection

JSA-DOP-7.10.72

INL/EXT-05-00045, "ATR Life Extension Program"

LRD-14111, "Fall Protection"

MCP-7, "Radiological Work Permit"

MCP-2241, "Reactor Programs Supplement to MCP-2985, Chapter XVI, Operations Procedures"

7. APPENDIXES

Appendix A, Figures
Appendix B, Inspection Data Sheet

Appendix A

Figures

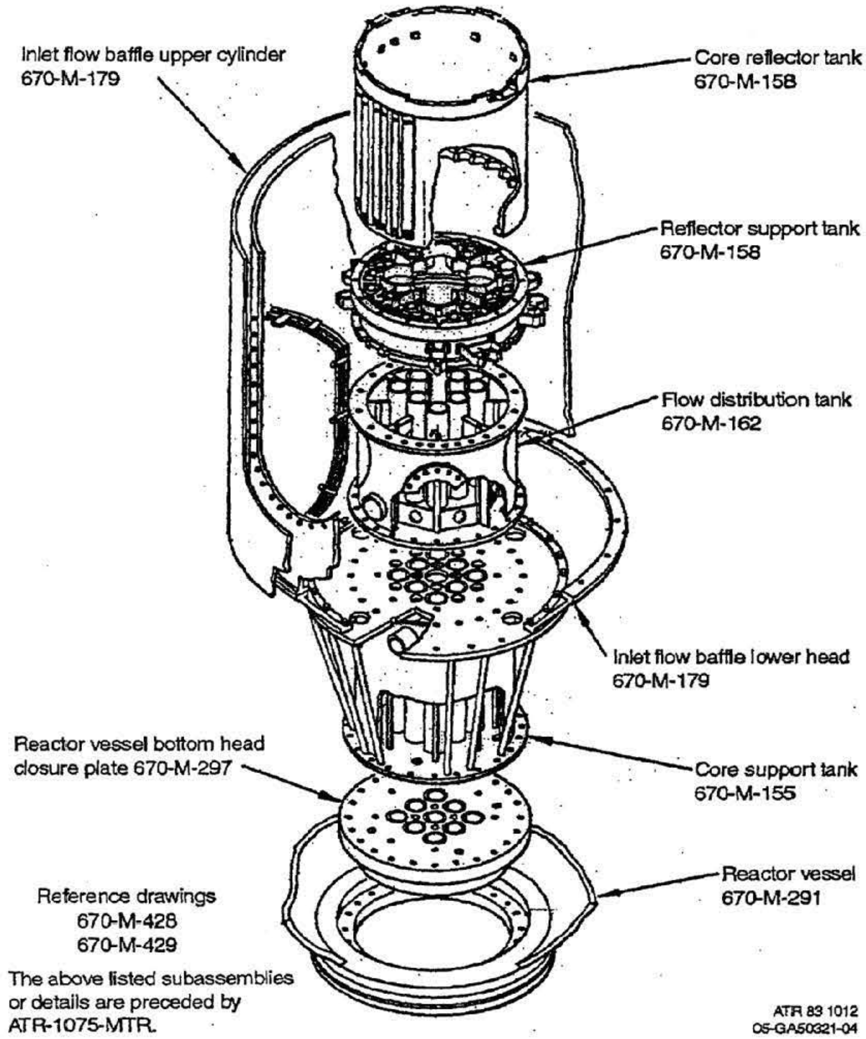

Figure A-1. ATR reactor internal support structure.

MASTER

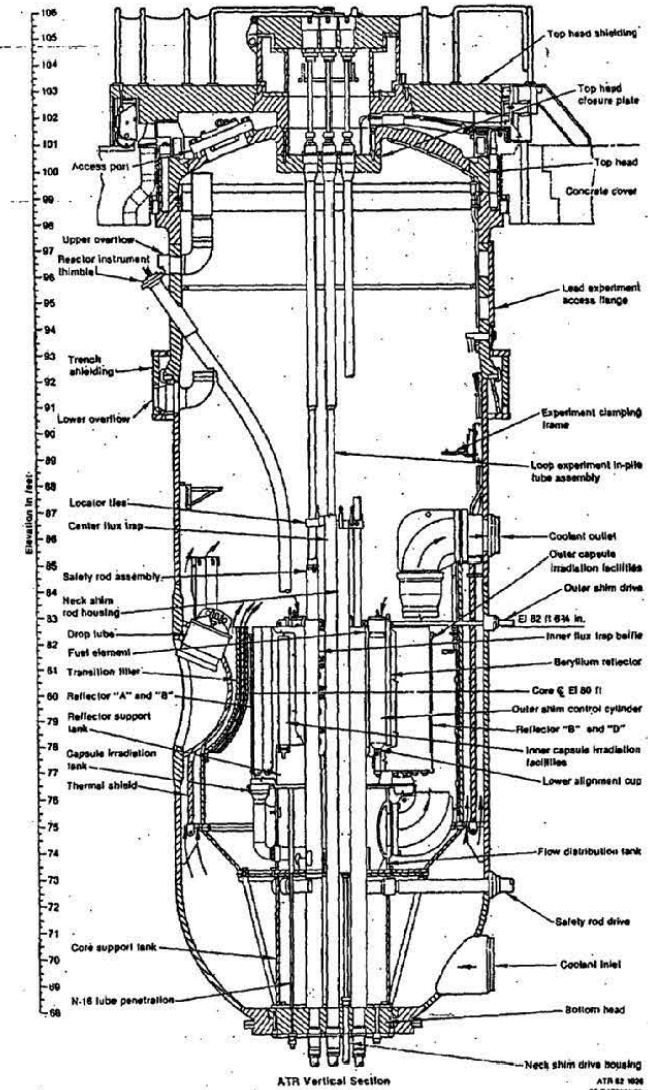

Figure A-2. ATR vertical section.

Appendix A MASTER

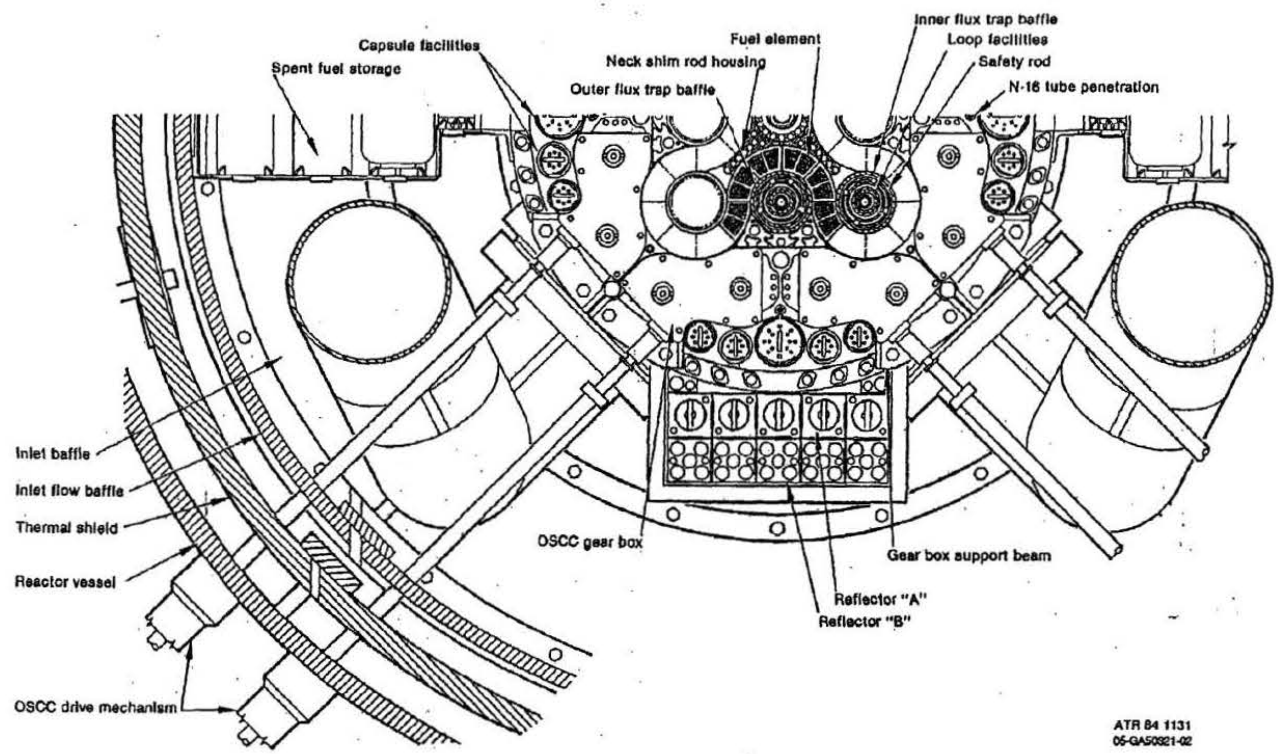

Figure A-3. Reactor cross section. (Elevation 83 ft 9 in.)

MASTER

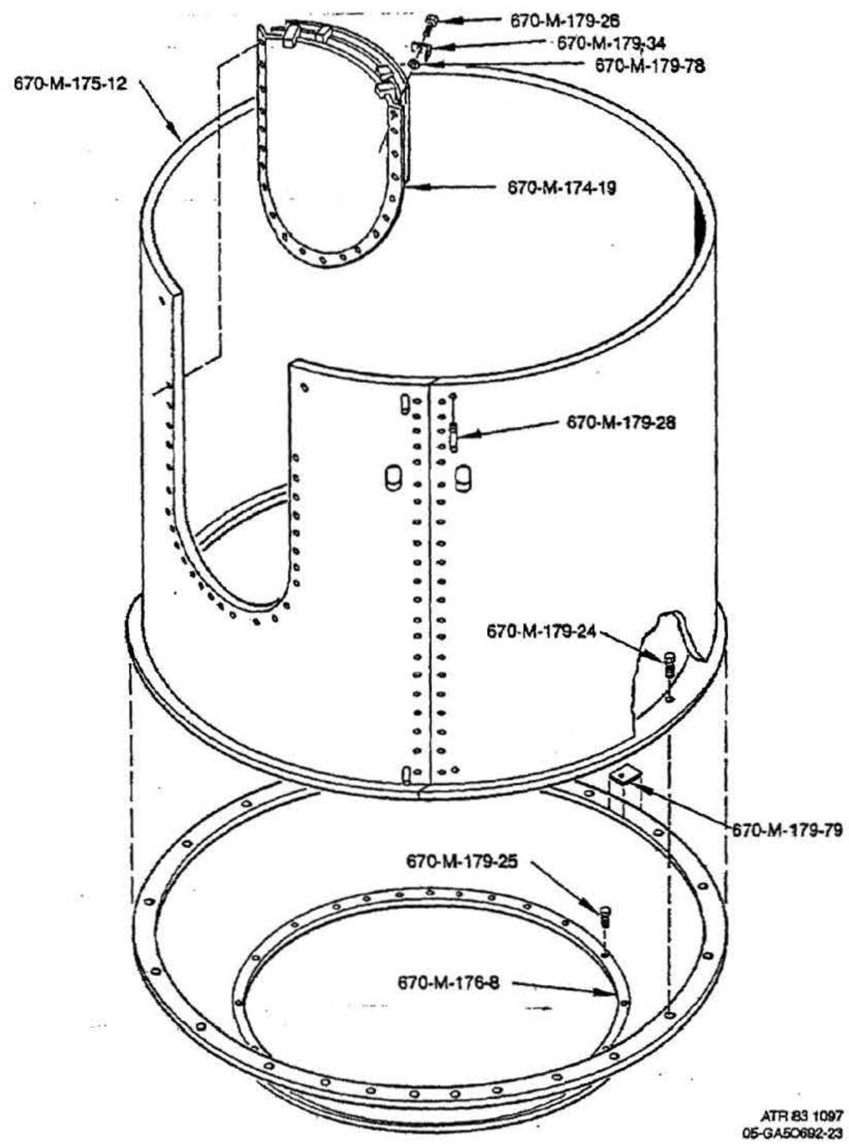

Figure A-4. Thermal shield and inlet flow baffle assembly.

MASTER

Appendix A

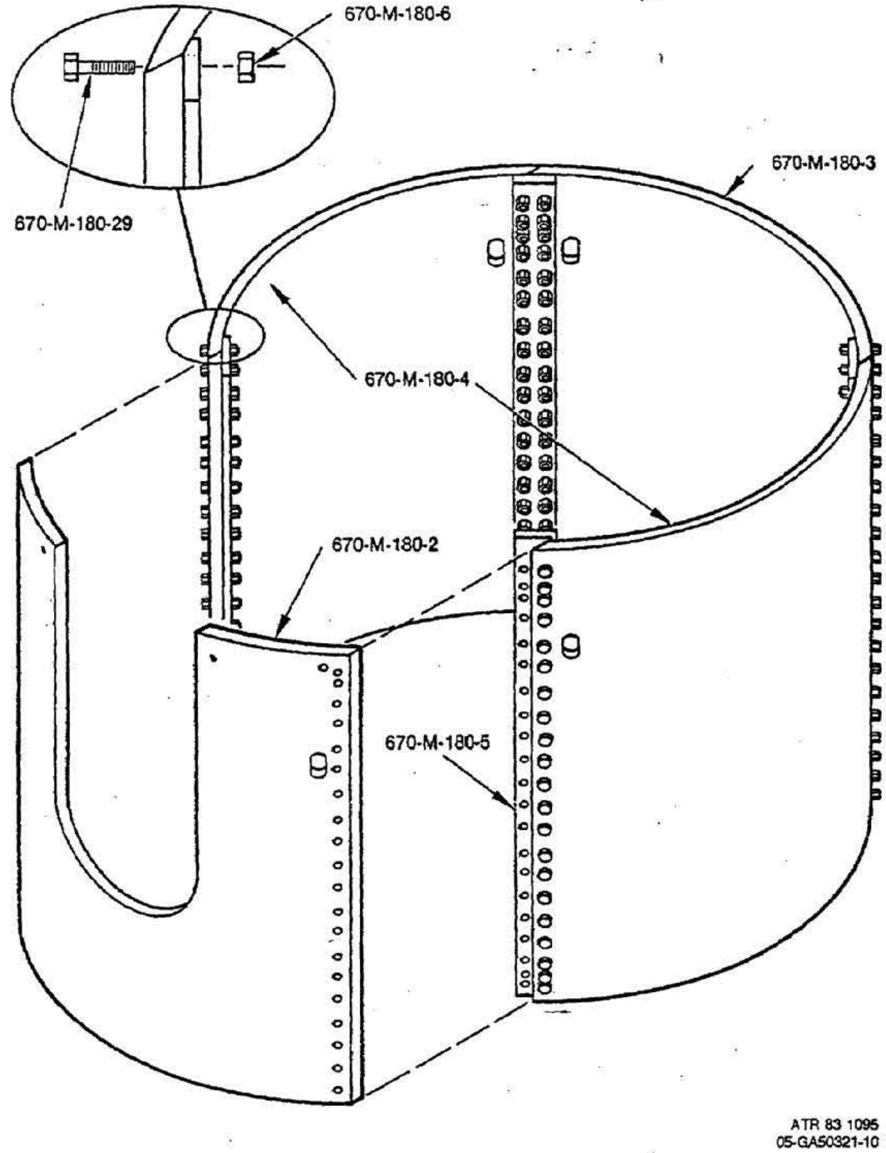

Figure A-5. Thermal shield assembly 670-M-180-1.

Appendix A

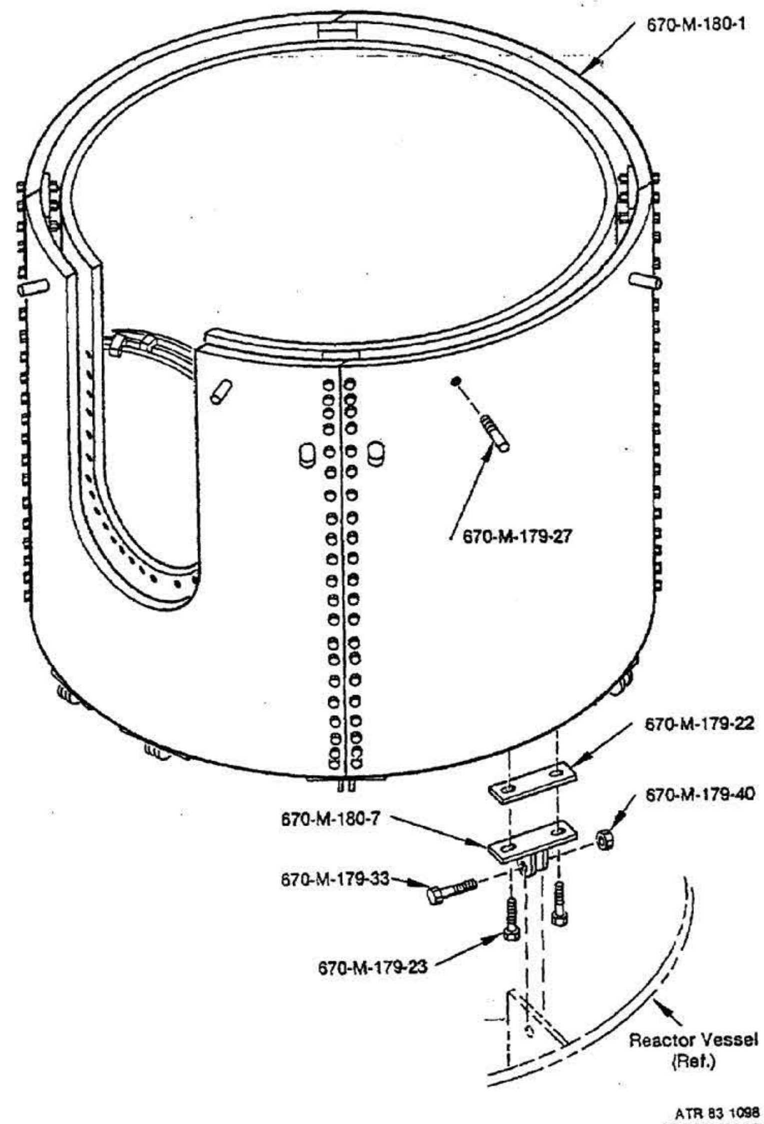

Figure A-6. Inlet flow baffle upper cylinder assembly 670-M-175-12.

MASTER Appendix A

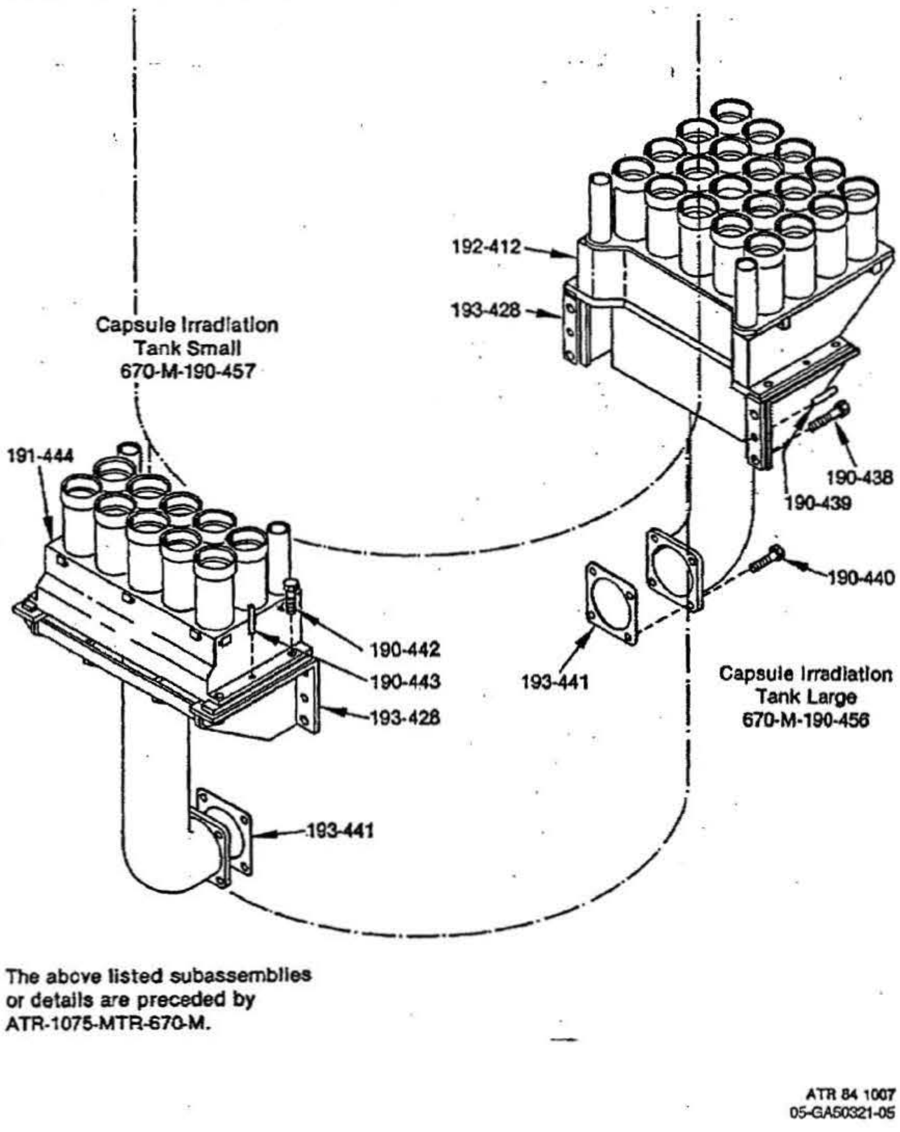

Figure A-7. Capsule irradiation tanks arrangement 670-M-190-455.

MASTER Appendix A

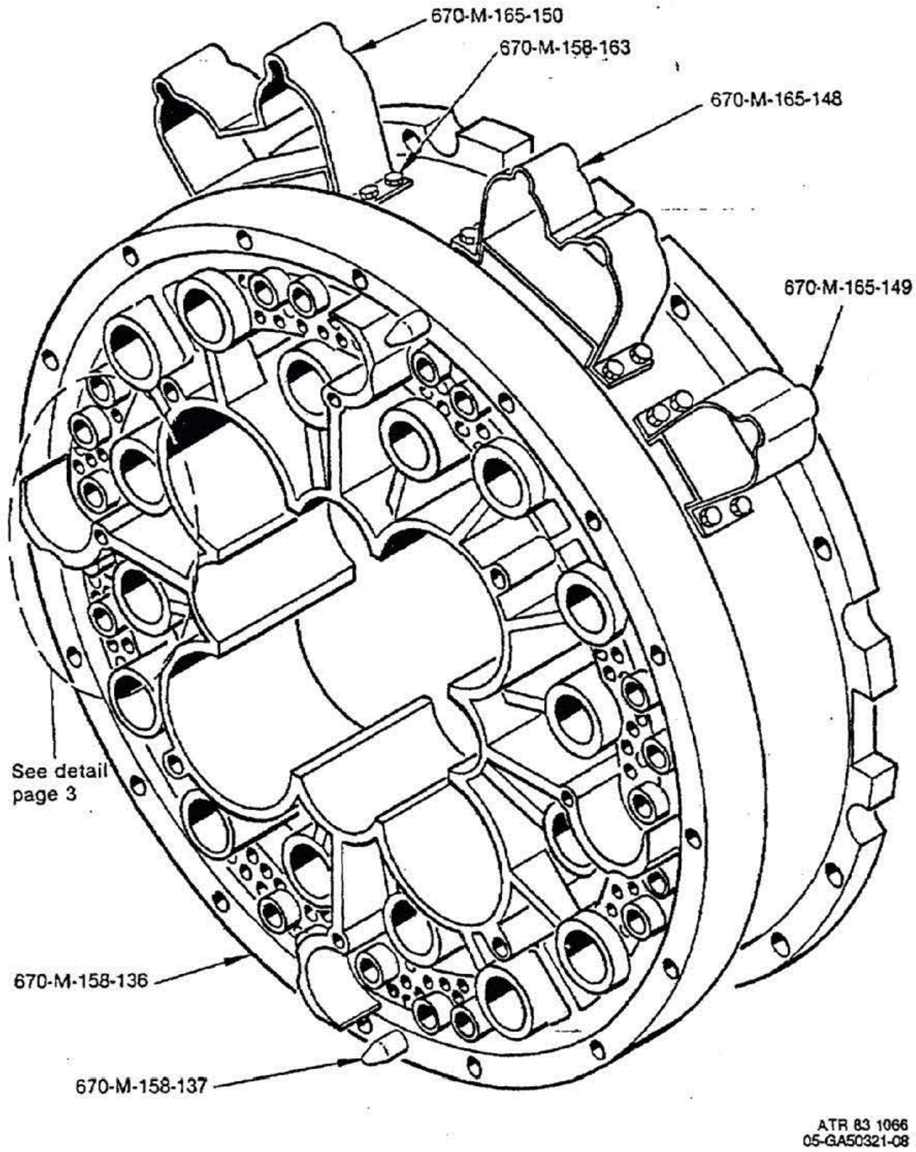

Figure A-8. Reflector support tank assembly 670-M-158-135.

MASTER

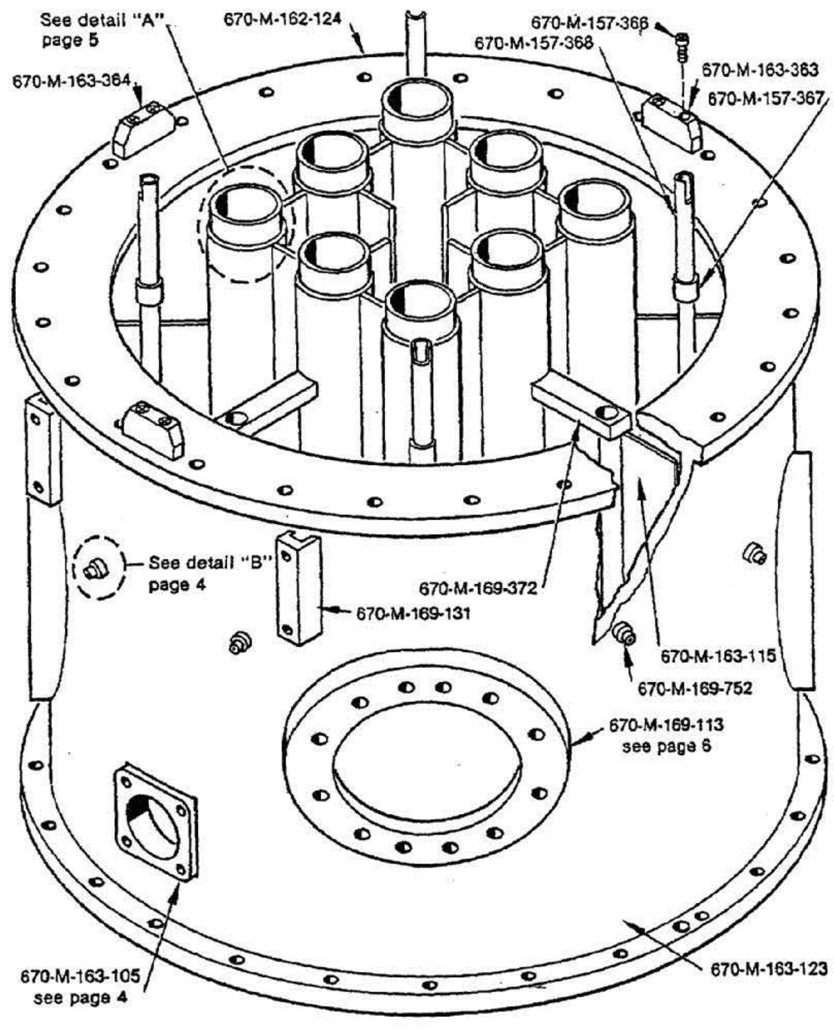

Figure A-9. Flow distribution tank assembly 670-M-162-126.

MASTER Appendix A

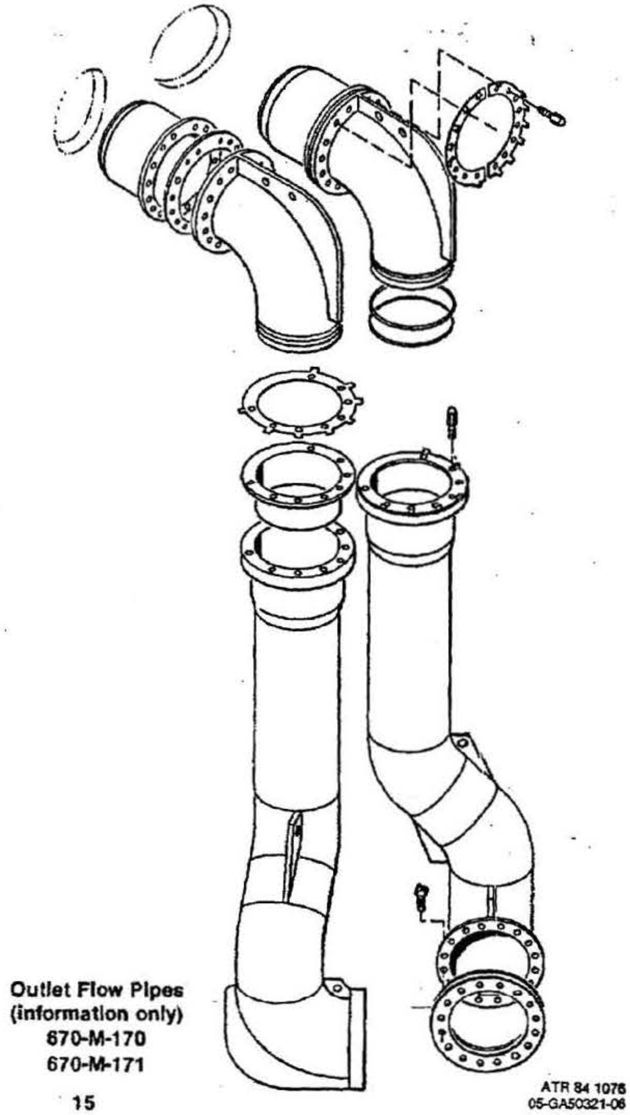

Figure A-10. Outlet flow pipes (information only) 670-M-170, 670-M-171.

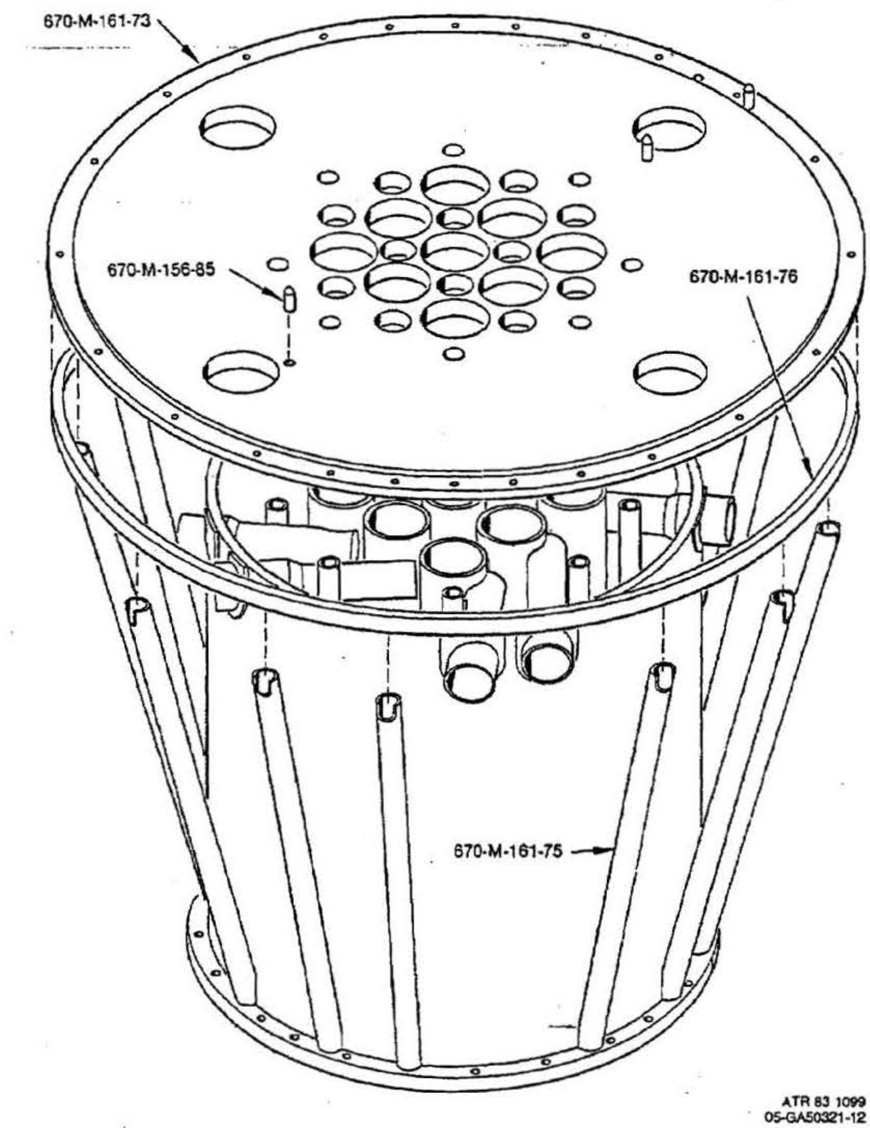

Figure A-11. Core support tank assembly 670-M-161-71.

 Appendix A

Appendix B

Inspection Data Sheet

1. Reflector Tank to Inlet Flow Baffle Aluminum Cover Plates

95% OF UPPER SURFACE INSPECTED - GENERAL NICKS AND DINGS FROM INTANK TOOL WORK - GENERAL MILD CORROSION - SOME PITTING CORROSION ON ALUM LIFTING BAILS ON COVER PLATES - ALSO SOME "GROWTH" OBSERVED

2. East Spent Fuel Storage Can Interior

GENERAL INSPECTION OF INTERIORS REVEALED ONLY MINOR MATERIAL CORROSION - MINOR BLOCKAGE OF HOLES IN BOTTOM OF CANS OBSERVED - GENERAL "CRUD" OBSERVED IN BOTTOMS OF CANS - SOME "GROWTH" OBSERVED - OBSERVABLE STRUCTURE FINE

3. West Spent Fuel Storage Can Interior

GENERAL INSPECTION OF INTERIORS REVEALED ONLY MINOR MATERIAL CORROSION - MINOR BLOCKAGE OF HOLES IN BOTTOM OF CANS OBSERVED - GENERAL "CRUD" OBSERVED IN BOTTOMS OF CANS - SOME "GROWTH" OBSERVED - OBSERVABLE STRUCTURE FINE

4. 10% Flow Hat Retainer Clamp

4.1 Northeast Retainer Clamp

MINOR CORROSION NOTED GENERALLY - GENERAL NICKS AND DINGS OBSERVED

4.2 Southeast Retainer Clamp

MINOR CORROSION NOTED GENERALLY - TWO DIFFERENT TYPES OF RETAINER CLAMPS USED - INDICATORS ON CLAMPS ALL POINT TOWARD CENTER OF REACTOR - GENERAL NICKS AND DINGS OBSERVED

MASTER

4.3 Southwest Retainer Clamp

MINOR CORROSION NOTED GENERALLY - TWO DIFFERENT TYPES OF RETAINER CLAMPS USED - INDICATORS ON RETAINER CLAMPS ARE INCONSISTANT WITH SOUTHEAST - GENERAL NICKS AND DINGS OBSERVED

4.4 Northwest Retainer Clamp

MINOR CORROSION NOTED GENERALLY - GENERAL NICKS AND DINGS OBSERVED

5. 10% Flow Hat

5.1 Northeast Flow Hat

GENERAL PITTING IN ALUMINUM COMPONENTS. LIDS PGR IS LOOSE AT HINGE. FLOW HAT HOLD DOWN CLAMPS PGR HAS GENERAL PITTING.

5.2 Southeast Flow Hat

GENERAL PITTING IN ALUMINUM COMPONENTS. LID IS LOOSE AT HINGE. FLOW HAT HOLD DOWN CLAMP HAS GENERAL PITTING.

5.3 Southwest Flow Hat

Flow Hat in Plate 691 - Upon removal of the flow hat clamp the cover for the flow hat fell off it appears that a small portion of the pin still remains in the cover signs of erosion are present.

MASTER Appendix B

5.4 Northwest Flow Hat

GENERAL PITTING IN ALUMINUM COMPONENTS. LID IS LOOSE AT HINGE.

6. Reflector Tank to Inlet Flow Baffle Cover Place Support Structure

6.1 Northeast Support Structure

LIMITED INSPECTION. THE STRUCTURE THAT WAS INSPECTED LOOKED SOLID. SOME MINOR SIGNS OF CORROSION ARE PRESENT. STRUCTURE IS IN A LOWER FLOW REGION OF THE VESSEL.

6.2 Southeast Support Structure

LIMITED INSPECTION. THE STRUCTURE THAT WAS INSPECTED LOOKED SOLID. SOME MINOR SIGNS OF CORROSION ARE PRESENT. STRUCTURE IS IN A LOWER FLOW REGION OF THE VESSEL.

6.3 Southwest Support Structure

LIMITED INSPECTION. THE STRUCTURE THAT WAS INSPECTED LOOKED SOLID. SOME MINOR SIGNS OF CORROSION ARE PRESENT. STRUCTURE IS IN A LOWER FLOW REGION OF THE VESSEL.

6.4 Northwest Support Structure

LIMITED INSPECTION. THE STRUCTURE THAT WAS INSPECTED LOOKED SOLID. SOME MINOR SIGNS OF CORROSION ARE PRESENT. STRUCTURE IS IN A LOWER FLOW REGION OF THE VESSEL.

MASTER Appendix B

7. Core Reflector Tank Exterior

GOOD CONDITION. SOME MINOR SIGNS OF CORROSION PRESENT ON LOWER FLANGE. LIMITED INSPECTION.

8. North Outer Irradiation Facility

LIMITED EXTERIOR INSPECTION. SOME MINOR SIGNS OF CORROSION PRESENT ON PERFORATED PLATE.

9. South Outer Irradiation Facility

LIMITED EXTERIOR INSPECTION. SOME MINOR SIGNS OF CORROSION PRESENT ON PERFORATED PLATE.

10. Instrument Thimbles

10.1 T-1

PORTION ABOVE ALUM COVER PLATES, NO ANOMALIES NOTED

10.2 T-2

LIMITED VIEW - PORTION ABOVE COVER PLATES, NO ANOMALIES NOTED

MASTER Appendix B

10.3 T-3

PORTION ABOVE ALUM. COVER PLATES; NO ANOMALIES OBSERVED

10.4 T-4

PORTION ABOVE ALUM. COVER PLATES, NO ANOMALIES NOTED

10.5 T-5

LIMITED VIEW - PORTION ABOVE ALUM. COVER PLATES, NO ANOMALIES NOTED

10.6 T-6

LIMITED VIEW - PORTION ABOVE ALUM. COVER PLATES, NO ANOMALIES NOTED

10.7 T-7

PORTION ABOVE ALUM. COVER PLATES, NO ANOMALIES NOTED

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Appendix B

10.8 T-8

LIMITED VIEW – PORTION ABOVE ALUM. COVER PLATES, NO ANOMALIES NOTED

10.9 T-9

LIMITED VIEW – PORTION ABOVE ALUM. COVER PLATES, NO ANOMALIES NOTED

10.10 T-10

PORTION ABOVE ALUM. COVER PLATES, NO ANOMALIES NOTED

10.11 T-11

LIMITED VIEW - PORTION ABOVE ALUM. COVER PLATES, NO ANOMALIES NOTED

10.12 T-12

PORTION ABOVE ALUM. COVER PLATES, NO ANOMALIES NOTED

MASTER

Appendix B

11. Reflector Support Tank Exterior

LIMITED EXTERIOR INSPECTION. SUBSTANTIAL SIGNS OF CORROSION PRESENT. THIS COMPONENT SHOULD BE LOOKED AT BY A CORROSION SPECIALIST. THIS COMPONENT IS LOCATED IN A LOWER FLOW REGION OF THE VESSEL.

12. Reactor Outlet Piping Exterior

LIMITED EXTERIOR INSPECTION. NOTHING NOTEWORTHY TO REPORT.

13. Flow Distribution Tank Exterior

LIMITED EXTERIOR INSPECTION. NO ANOMALIES NOTED.

14. East Spent Fuel Storage Can Exterior and Support Structure

LIMITED INSPECTION. SUPPORT STRUCTURE SHOWS SOME SIGNS OF MINOR CORROSION. * INSIDE OF STORAGE CANS SHOW SIGNS OF CRUD BUILD-UP AND HOLE BLOCKAGE.

15. West Spent Fuel Storage Can Exterior and Support Structure

LIMITED INSPECTION. SUPPORT STRUCTURE SHOWS SOME SIGNS OF MINOR CORROSION. * INSIDE OF STORAGE CANS SHOW SIGNS OF CRUD BUILD-UP AND HOLE BLOCKAGE.

16. Inlet Flow Baffle Upper Cylinder Interior

LIMITED INSPECTION. NO ANOMALIES NOTED.

17. Inlet Flow Baffle Lower Head Upper Surface

LIMITED INSPECTION. NO ANOMALIES NOTED.

18. Core Support Tank Exterior Surface

LIMITED INSPECTION. NO ANOMALIES NOTED.

19. Reactor Vessel Interior Surface Below the 73-ft Elevation

LIMITED INSPECTION. NO ANOMALIES NOTED.

20. Inlet Flow Baffle Upper Cylinder Exterior

LIMITED INSPECTION. NO ANOMALIES NOTED.

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Appendix B

21. Vessel Thermal Shield Interior Surface

LIMITED INSPECTION. NO ANOMALIES NOTED.

22. Vessel Thermal Shield Exterior Surface and Support Structure

LIMITED INSPECTION. NO ANOMALIES NOTED.

23. Reactor Vessel Interior Surface Below the 85-ft Elevation and the Thermal Shield Support Structure Welds

LIMITED INSPECTION. NO ANOMALIES NOTED.

MASTER

Appendix B

Attachment 2

RCS-3100 ZOOM UNDERWATER COLOR TV CAMERA

OPERATING AND MAINTENANCE MANUAL

CUSTOMER ASSISTANCE

If you have any questions during installation or operation of this equipment, or if you encounter problems which are not covered by this manual, please contact our agent or stocking distributor in your area, or contact us directly by phone or fax.

Crestone Products, Inc.
572 W. Oak Hills Drive
Castle Rock, CO 80104
Phone: (303) 790-2474
Fax: (303) 790-2967

R. J. Electronics
10656 Oak Drive SE
Salem, OR 97306
Phone: (503) 362-4733
Fax: (503) 362-4754

GENERAL DESCRIPTION

The RCS-3100 Underwater Zoom Color TV Camera offers very small size as well as high resolution and high sensitivity and very large (72:1) zoom range incorporating both an 18:1 optical zoom range with an additional 4:1 electronic zoom. The optical zoom range provides full resolution with a horizontal in-air field of view range from 48 degrees to 2.7 degrees. Underwater, the horizontal field ranges from 35.6 degrees to 2.03 degrees. In the zoomed-in position, the full resolution underwater horizontal field size at 20 feet distance is only 0.74 feet.

The camera is supplied standard with a high resolution (greater than 470 TV lines) S-video format. It features remote zoom control, automatic or remote focus control, and automatic or remote manual iris control. An onscreen display is provided for zoom position and other function settings.

It is also equipped with an electronic shutter with a range from ¼ second to 1/10,000 second. When in the ¼ second position, the integration provides a minimum scene illumination requirement of only .20 lux. Without integration, the minimum scene illumination is still a low 3.0 lux. This low light capability allows color imaging with minimal lighting requirements, and provides greater in-air and underwater viewing ranges with standard lighting.

The camera housing is fabricated of 300 series stainless steel, utilizes a non-browning fused quartz viewing window, and is rated for underwater operation to 200 feet.

INSTALLATION AND OPERATION

When you receive the RCS-3100 camera, unpack it carefully and inspect for any shipping damage. Please contact Crestone Products, Inc. or R J. Electronics if any damage is noted.

Operational Check

After unpacking, an operational check should be made prior to installation of the RCS-3100 camera. The following procedure is recommended:

CRESTONE
PRODUCTS INC.

1. Make sure the power cord to the controller is NOT plugged into the 120 VAC power source, and the control unit is turned off.
2. Connect the control cable to the camera and to the controller. Before

plugging the underwater connector into the camera, make sure the O-ring is properly located in the camera bulkhead connector, and one is around the plug body of the mating connector. Also make sure the O-rings and sealing surfaces are clean and lightly lubricated with silicon grease or other O-ring lubricant.

3. Connect the power cord of the controller to 120 VAC. Connect the video monitor, and turn on the controller.
4. Operate the zoom and focus controls.

Installation

The RCS-3100 camera can be mounted in any orientation, and is designed to run continuously either in air or underwater. Mounting clamps should hold the camera securely without distortion of the stainless steel housing.

If the camera is to be mounted on a pan and tilt unit, the installation should provide adequate clearance for the camera and interconnecting cable. To minimize torque requirements, the camera should be mounted as close as possible to both axes of the pan and tilt.

Operation

The RCS-3100 camera can be operated continuously in air or underwater to depths up to 200 feet. Remote controls include power on-off, zoom & auto focus on-off.

MAINTENANCE

Maintenance for the camera system is limited to cleaning and maintenance of the O-ring seals, cleaning the housing, and window, and replacement of component parts such as the internal video camera/lens module.

To avoid scratching the quartz window, it should only be cleaned with alcohol or with a mild soap and water. Use only a soft cloth or lens tissue. The housing is made of stainless steel, and can be cleaned with soap and water or alcohol.

The video camera module is attached to the rear end plug, and will slide out as a unit when the end plug is removed.

Camera Module Replacement

1. Remove rear end retaining ring.
2. Remove rear bulkhead and attached camera assembly. If necessary, insert two 6-32 screws in bulkhead to assist in removal.
3. Remove the two 6-32 pan head screws attaching the mounting plate to the rear bulkhead.
4. Remove the two flat head screws in the mounting plate which attach to the camera module.
5. Disconnect the three camera module connectors: power (black and red wires), primary (brown, yellow and red wires), and ribbon connector (blue violet, orange and yellow).
6. Connect the three connectors to the new camera module.
7. Mount the new camera module using the original mounting and standoff screws.
8. Attach the mounting plate to the rear bulkhead with the two #6-32 pan head screws (use removable thread locking compound).
9. Check and lubricate the O-ring and O-ring sealing surfaces.
10. Slide the module into the housing, push into place and replace the retaining ring.
11. Install #6-32 screws in the rear bulkhead and rotate the rear bulkhead until the lens is aligned with the viewing window.

Both housing O-rings and the connector O-rings should be inspected on a yearly basis, and replaced if any damage is noted, or if flattening has occurred.

RCS-3100

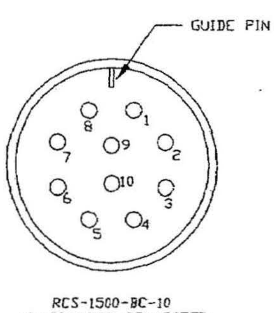
ZOOM UNDERWATER COLOR TV CAMERA

PARTS LIST

1.	HOUSING 50-10	1
2.	REAR END PLUG 50-11	1
3.	FRONT END PLUG 50-12	1
4.	MOUNTING PLATE 50-4 (mod)	1
5.	QUARTZ WINDOW 50-5	1
6.	72:1 ZOOM VIDEO MODULE	1
7.	CONNECTOR 11-5	1
8.	CONNECTOR INSERT LEMO 10 PIN	1
9.	REGULATOR 8 VOLT L7808CV	1
10.	CAPACITOR 4.7 MFD, 50V	1
11.	CAPACITOR 22 MFD, 16V	1
12.	SCREW 6-32 X 1/8 PAN (MTG PLATE)	2
13.	SCREW 4-40 X 5/16 FH (REGULATOR)	1
14.	SCREW m2 x 12 FH (CAM MTG.)	3
15.	4-40 NUT (REGULATOR)	1
16.	STANDOFF 0.25 x .35 LONG CL #2.56	3
17.	O-RING 2-039 BUNA N 70 SH (HOUSING)	2
18.	O-RING 2-018 (CONNECTOR)	1
19.	O-RING 2-015 (CONNECTOR)	1
20.	RETAINING RING UR-275-S (HOUSING)	2
21.	RTV 88 WINDOW POTTING	

CONNECTOR DIAGRAM

UNDERWATER CONNECTOR	FUNCTION	WIRE COLOR
1	SIGNAL GROUND	BROWN
2	"Y" SIGNAL	YELLOW
3	NC	
4	UP/DN DISPLAY	BLUE
5	POWER 12-24 VDC	ORANGE
6	POWER AND LENS GROUND	BLACK (2 WIRES)
7	"C" SIGNAL	RED
8	IRIS/SHUTTER CONTROL	VIOLET
9	FOCUS/ZOOM CONTROL	ORANGE
10	AUTOFOCUS INDICATOR	YELLOW



RCS-1500-BC-10
UNDERWATER CONNECTOR
(FACE VIEW)

SPECIFICATIONS

VOLTAGE	12-24 VDC internally regulated
SENSOR	¼ INCH CCD
HORIZONTAL RESOLUTION	GREATER THAN 470 TV lines
FORMAT	S-VIDEO STANDARD
MINIMUM SCENE ILLUMINATION	3.0 LUX WITHOUT INTEGRATION .20 LUX WITH INTEGRATION
S/N RATIO	MORE THAN 50 dB
OUTPUT IMPEDANCE	75 Ohms
ZOOM	72:1 REMOTE CONTROLLED 18:1 OPTICAL ZOOM (4.1MM TO 73.8MM)
FOCUS	REMOTELY CONTROLLED OR AUTOMATIC
IRIS	REMOTELY CONTROLLED OR AUTOMATIC
WINDOW MATERIAL	Non-browning fused quartz
TEMPERATURE RATING	0 – 50 degrees Centigrade
CONNECTOR	RCS-1501-BC-10 (stainless steel)
DEPTH RATING	200 feet underwater
HOUSING DIAMETER	2.93 inches maximum
BODY DIAMETER	2.80 inches
HOUSING LENGTH	4.55 inches
SHORTEST FOCUS DISTANCE	WIDE ANGLE: 10mm TELEPHOTO: 800mm
IN-AIR FIELD OF VIEW	48 TO 2.7 degrees horizontal
UNDERWATER FIELD OF VIEW	35.6 to 2.03 degrees horizontal

WARRANTY

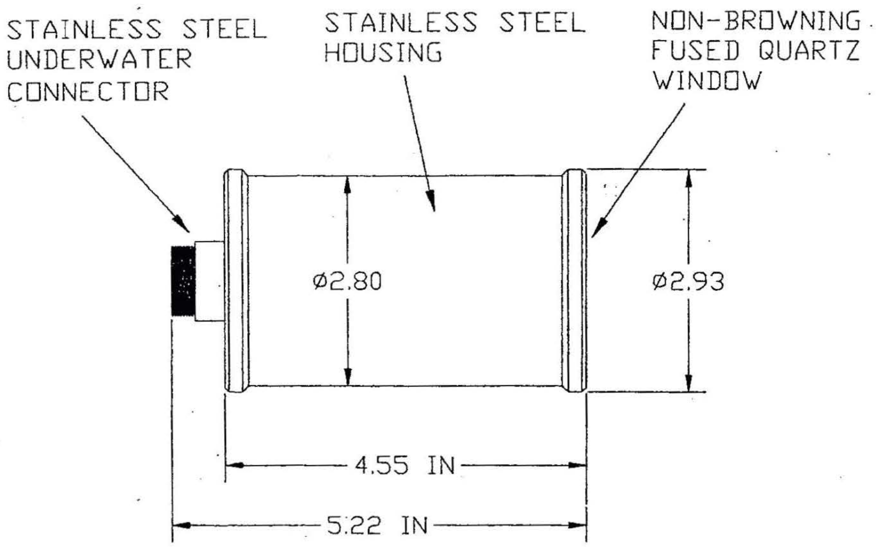
Crestone Products, Inc. will repair or replace, without charge, any merchandise proved defective in material or workmanship for a period of one year after the date of shipment. Crestone Products will warranty all replacement parts and repairs for 90 days from the date of shipment. All goods for warranty work shall be sent freight prepaid to us at 572 W. Oak Hills Drive, Castle Rock, Colorado 80104.

Repairs made necessary by misuse, alteration, normal wear, or accidents are not covered under this warranty. Crestone Products is not liable for any incidental or consequential expenses or liability incurred by the customer as a result of field repair, installation, or any other reason.

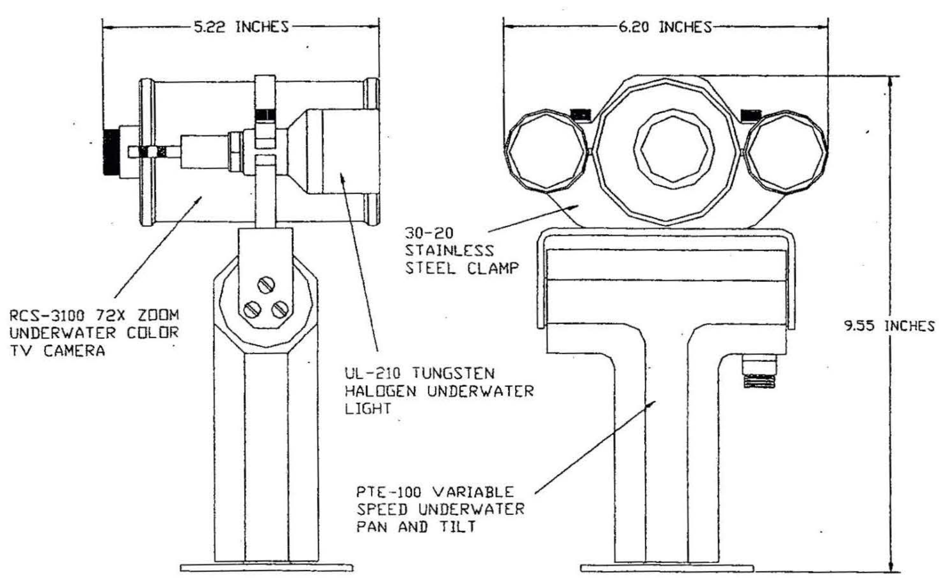
The above warranty is in lieu of any other expressed or implied warranty, condition, or guarantee by Crestone Products, Inc.

RCS-3100 ZOOM UNDERWATER COLOR TV CAMERA

DIMENSIONAL DRAWING



PTE-100 WITH RCS-2100 CAMERA AND UL-220 LIGHTS



Attachment 3