Duke Power
A Duke Energy Company

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May 1, 2003

U.S. Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555-0001

Subject: Duke Energy Corporation (DEC)
McGuire Nuclear Station Unit 2
Docket Number 50-370
Request for Additional Information (RAI); Procedure for Straightening an Irradiated Fuel Rod(TAC NO. MB7536)

Reference: (1) DEC letter to NRC, dated January 31, 2003 and (2) NRC letter to DEC, dated April 4, 2003

This letter provides additional information that was requested by the NRC staff in reference #2 cited above. The NRC staff's questions and DEC's responses are provided in Attachment 1. Attachments 2, 3 and 4 are copies of the "Framatome ANP Bent Rod Straightening" presentation, "Fuel Rod Degas Tool and Straightener Test Plan" and "Procedure for Straightening of a MK-BW Fuel Rod", respectively. Please note that the procedure is a draft, which will be revised with lessons-learned from the upcoming demonstration to be conducted at Lynchburg, Va., scheduled for June 2003.

DEC requests approval of the LAR by August 1, 2003, as previously stated in the January 31, 2003 LAR submittal. Please contact Norman T. Simms of Regulatory Compliance at 704-875-4685 with any questions with respect to this matter.

Very truly yours,

D. M. Jamil

Attachments

A001

xc:

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Dhiaa M. Jamil, being duly sworn, states that he is Vice President of McGuire Nuclear Station; that he is authorized on the part of Duke Energy Corporation to sign and file with the U.S. Nuclear Regulatory Commission these revisions to the McGuire Nuclear Station Facility Operating License No. NPF-17; and, that all statements and matters set forth therein are true and correct to the best of his knowledge.

Dhiaa M. Jamil, Vice President
McGuire Nuclear Station
Duke Energy Corporation

Subscribed and sworn to before me on May 1, 2003.

Deborah S. Rome
Notary Public Deborah S. Rome

My Commission Expires: December 19, 2004

ATTACHMENT 1

Radiological Considerations

Question # 1

Given the potential for fuel rod breakage during handling and straightening, and the resultant potential for gross failure and dispersal of fuel pellets or fragments, describe the containment system(s) employed to limit the contamination of the general spent fuel pool (and associated cooling, filtering and makeup systems) during the fuel puncturing and straightening evolutions. For example, are the filter pore sizes sufficiently small to ensure the capture of very small particulates before they cross-contaminate the spent fuel pool cooling system?

Response

During the fuel rod puncturing evolution, the fission product gases will be confined within the gas collection tube. No fuel pellets or fragments are expected to escape the fuel rod during this evolution process. Any fuel pellets or fragments that might escape during a potential gross failure of the fuel rod during the straightening evolution would be captured in a safety tray located directly below the equipment on top of the spent fuel storage racks. Very small particulates that might be suspended in the spent fuel pool water would eventually be extracted by filters and the demineralizer in the Spent Fuel Pool Cooling system (KF).

The KF system is normally in service with one pump that serves both cooling and purification. Flow rates are typically 2300 gpm total with 2000 gpm flowing through a fuel pool heat exchanger and 300 gpm flowing through a pre-filter (available in 40 microns), demineralizer and post-filter (available in 2 microns) loop. Additionally, a skimmer pump and filter (available in 2 microns) provides optical clarity to the pool by removing impurities from the surface water.

Some activity currently exits in the pool water due to a few damaged spent fuel assemblies and crud typically present on spent fuel assemblies. There are no specific means to prevent contamination of the cooling or purification loops. The KF pumps take suction from approximately four feet below pool level and returns cooled and purified water to the pool six feet above the spent fuel storage racks. The skimmer pump takes approximately 70 gpm from the pool surface through a skimmer trough and returns to the pool two feet below water level.

Question # 2

Describe the extent of station health physics technician (HPT) involvement and job coverage (continuous or intermittent) during the following evolutions (phases) of the project: 1) pre-job planning/briefings, 2) fuel rod movement, penetration and plenum gas collection, and 3) job site and equipment cleanup.

Response

Radiation Protection (RP) supervision and a minimum of one RP technician covering the activities will attend a demonstration of job evolutions (mockup) to be performed in Lynchburg, scheduled during the month of June 2003. The RP technician covering the work will be involved in all aspects of pre-job planning and briefings.

A work job coverage plan (JCP) will be developed by RP supervision and the RP technician covering the work. The JCP will be broken down into the different phases of work and will explain radiological job coverage requirements, survey requirements, RWP requirements, radiological hold points, and occupational experience. SER 3-01 will be emphasized in the JCP.

RP General Supervision will review and approve the JCP. The plan will be routed to all crews participating in the work evolution for review. RP involved in job coverage will be trained and briefed on the JCP. The entire fuel rod recovery team, including RP and decontamination crew, will be briefed on the job coverage plan with pre-job briefs taking place prior to all work activities.

Radiation Protection will perform a cross disciplinary review of the Maintenance Procedures that are to be utilized. The RP technician covering job activities will be qualified to ETQS task RP-091 (Job coverage for Spent Fuel Transfer and Storage Locations). A specific RWP will be written for all phases of fuel pin work, and special instructions on the RWP will include RP hold points and job coverage requirements.

All work will be included in the daily RP risk assessment process as directed by RPMP 7-5 Rev.001. Higher risk activities will be tracked as high risk with all other evolutions covered as medium risk. A risk assessment pre-job briefing will be held prior to the beginning of any phase or change of work scope. These meetings are conducted by RP supervision and RP technician and work crew members will be in attendance. The RP technician will be providing continuous coverage for all work evolutions including fuel assembly movement, all evolutions involved with fuel pin removal, straightening, depressurization, storage, and job site and equipment clean up.

Question # 3

Describe the types of radiation surveys and when these will be performed by the HPTs providing job coverage. For example, will the HPT: 1)check external radiation levels of and contamination on materials or equipment removed from the pool: 2) survey for external radiation levels from equipment as it breaks the surface of the pool, to detect unexpected sources of high radiation?

Response

Digital dose rate monitors will be installed in the work area for the work crew. RP hold points will be established with predetermined dose rate and ED setpoints. Air sampling activities will be performed during all work evolutions. These air samples will be analyzed for beta/gamma, including alpha air activity per SH/0/B/2000/008. Airborne tritium sampling will also be included. Additional monitoring will be performed by EMF42 (Spent Fuel Pool Ventilation). A 3090 will be used to perform underwater surveys. Vacuum and/or underwater washing of material will be evaluated and discussed in the job coverage plan. Monitoring requirements and dose rate limit for vacuum filters will also be addressed in the job coverage plan. All equipment/items being removed from the spent fuel pool are required to be sprayed down as they are being removed (RP ETQS task RP-091).

The RP technician will be monitoring all items as they break the water's surface with a teletector. No item will be lifted beyond the surface of the water, if it is above a predetermined dose rate. Once items have been remotely surveyed, and at an acceptable level, the items will be taken to a lay down area to perform a detailed survey. This will include open/close window ion chamber readings, area hot particle scans, and contamination surveys. All smears will be counted for beta/gamma and alpha contamination per SH/0/B/2000/004 and SH/0/B/2000/008. Contamination surveys will be performed at varying intervals in the Spent Fuel Pool as determined by the JCP. Operating experience will be included in the JCP that emphasizes the importance of adequate survey methods and hot particle evolutions.

Question # 4

Discrete hot particles (fuel and/or activated corrosion and wear products) of sufficient activity to cause significant shallow-dose equivalent and whole body, deep dose exposures can be present in spent fuel pools. Describe the survey program for identifying hot particles, and if found, minimizing their potential spread. For example, how will the licensee ensure that workers decontaminating (wiping down) the special equipment used during this project (prior to packaging and shipment or storage) are protected from unexpected hot particle doses?

Response

A portion of the Refueling Floor of the Spent Fuel Pool area will be established as a contaminated area with the flooring covered by oil/tacky cloth. A Hot Particle Zone (HPZ) will be established over the travel path from the Spent Fuel Pool to the lay down area for all items removed from the Spent Fuel Pool. Walls will be built for the HPZ Radiation Control Zone (RCZ) and sticky pads will be placed in strategic spots inside and outside of the RCZ. The JCP will include direction for change out of the outer layer of floor covering and sticky pads as necessary.

Open window ion chamber scans will be performed on all material removed from the Spent Fuel Pool as well as the travel path. Masslin/tacky roll surveys will be performed inside and outside the RCZ at varying intervals during removal of equipment from the Spent Fuel Pool as determined in the JCP. All items will have a particle search performed before any worker begins decontaminating an item, and particle scans will be performed on workers at regular intervals. Continuous RP coverage will be provided during all work activities.

All workers inside the HPZ will be dressed with an additional outer layer of disposable protective clothing. An evaluation will be made to determine if multi-badging is necessary for workers in direct contact with materials removed from the Spent Fuel Pool. To minimize potential of discrete radioactive particles (DRPs), vacuuming and/or underwater washing of material will be evaluated and addressed in the JCP. The JCP will include a dose rate and contamination limit with direction to take items to the decon pit for further decontamination as necessary, and RP hold points will be established for discovery of any DRP above certain dose levels. The JCP will direct necessary precautions for retrieval of any DRP, and will address removal of items from the Spent Fuel Pool and hot particle controls as discussed in SER 3-01. RP will be present to survey all rags/decon materials during use, and all protective clothing and trash removed from the area would be labeled from Hot Particle Zone and trashed.

Question # 5

Describe what training, including the worker training required by 10 CFR Part 19, will be provided to the station staff, relative to fuel rod handling, puncturing and straightening.

For example, will this training for plant staff personnel include lessons learned by the contractor relative to the contractor's past experience in these infrequent evolutions?

Response

The current understanding is that the vendor will actually conduct the work activity with limited station support (Job Sponsor, crane, equipment handling, etc) with RP support being provided by Station RP staff. All personnel including vendors will be qualified radiation workers.

The RP personnel supporting this work activity will be trained and qualified to tasks RP-90 (High Exposure Job Coverage) and RP-91 (Spent Fuel Handling Operations). These tasks ensure the RP technicians possess the proper skills and knowledge to adequately cover this work. Both tasks contain appropriate operating experience related to spent fuel work including irradiated components, discrete radioactive particles, and Kr-85 gas releases due to fuel pin depressurization events.

In addition to this training, a mockup demonstration will be conducted at the vendor facility (currently planned for 6/4/2003) which will be attended by an RP supervisor and RP specialist from McGuire. Information from this demonstration as well as any operating experience the vendor has to provide will be gathered and used in the development of the RP job coverage plan for this activity. The vendor will be given an opportunity to review the plan and will be held accountable to the plan elements. The job coverage plan will include a detailed description of the work activity, RWP requirements, radiological hold points, Fuel Building access restrictions, dose estimate, operating experience, and pre-job briefing checklists for all work activities determined to be medium or high risk activities in accordance with RPMP 7-5 (Radiation Protection Risk Assessment Process). The pre-job briefings will include worker and RP expectations in the event of an unusual occurrence such as a Kr-85 release during the course of the work activities. In accordance with RPMP 7-5, all personnel directly involved in the work activity will be required to attend the pre-job briefings prior to conducting work.

Reactor Systems Considerations

Question # 1

Provide a list of known precedents for this evolution. Additionally, describe how previous lessons learned for this type of maintenance will be covered in the procedures and training for McGuire Unit 2.

Response:

Framatome ANP has over 25 years of experience in fuel inspection, fuel repair, and the development of specialized processes and tooling. There are several examples of first-of-a-kind projects that are similar in scope and complexity. Recent examples include:

- the development of a fuel assembly-handling tool for fuel assemblies subject to top nozzle separation due to stress corrosive cracking of the guide thimble sleeves.
- the development of consolidation processes and tooling to conduct failed fuel rod consolidation into reconfigured fuel assemblies at Yankee Rowe Nuclear Station, where rods were stored in various configurations and structures.
- the development of fuel rod end cap removal of failed fuel rods to support hot cell evaluation that minimized the risk of rod transport at the Oconee Nuclear Station while maintaining strict SNM accountability.

Additionally, Framatome ANP frequently performs complex fuel rod inspections for post irradiated examination, fuel failure root cause examinations, and fuel assembly reconstitution and recaging operations where the risk of fuel rod separation commands highly trained personnel, specialized tooling and contingency planning and processes.

All of these examples of successful first-of-a-kind and routine evolutions evolved from sound practices and core competencies. As part of Framatome ANP's QA program and standard operating practices, lessons learned are reviewed and incorporated into procedure and process revisions, product development and improvement, and personnel training programs. This, coupled with engagement and communication with operating plant personnel and management, ensures that associated risks are evaluated to the best of Framatome ANP's ability when engaging in non-routine processes and infrequent practices.

Question # 2

Provide a detailed description of the current state of the fuel rod. Describe the amount of damage the fuel rod previously incurred including the following: 1) the angle of the bend, 2) the axial location of the bend, 3) any measured or calculated thinning of the cladding due to the bend, and 4) any other pertinent information which classifies the extent of damage.

Response:

Figure 1 provides a schematic of the current profile of the bent rod. The angle of bend of the fuel rod is approximately 90 degrees with a bend radius of ~6 inches. The upper portion of the rod is approximately 24 inches with the lower section being about 126 inches.

Thinning of the cladding due to the bend is determined to be very minimal due to the internal support provided by the fuel pellets. In addition, the bend radius has no noticeable "crimps" or discontinuities. As reported in the licensing submittal, the bent fuel rod has experienced one cycle of operation with a burnup of 20.46 GWD/MTU. Material properties of Zircaloy 4 fuel cladding change as a result of irradiation. These changes include an increase in the cladding yield and ultimate strength and a decrease in ductility. In addition, the cladding experiences oxidation and hydrogen pickup as a result of the reactor environment. These changes are noted in the response to question 3.

Any further degradation of the cladding during the straightening process is accommodated by the controlled degassing of the fuel rod to ensure that no accidental gas release occurs in addition to use of a safety tray to collect any solid material that may be disbursed.

Question # 3

During the performance of the proposed evolution, the potential exists for the cladding of rod I-14 to fail. Since preventing the failure of the cladding will substantially limit both the dose received by the workers and the potential for a criticality accident, the staff requests the licensee to provide a mechanical analysis of the stresses that must be applied to straighten the rod, the predicted failure stress, and the methodology or controls that will be provided to prevent exceeding the fracture point of the cladding. Additionally, the staff requests the licensee to provide a list of criteria used to make the judgment that the rod could be straightened without breaking.

Response:

As reported in the licensing submittal, the bent fuel rod has experienced one cycle of operation with a burnup of 20.46 GWD/MTU. The estimated clad oxide thickness is less than 20 microns, which corresponds to less than 100 ppm hydrogen pickup. This amount of cladding oxide and hydrogen does not alter the clad cross section and load carrying capability appreciably. The reduction in base metal thickness is ~ 12.5 microns (0.0005 inch), or ~2% of the wall thickness. The hydrogen content is well below the 600 to 700 ppm range, which results in possible hydrogen embrittlement concerns for loading at low temperatures. The estimated yield strength and ultimate strength of the irradiated cladding are ~88 ksi and 100 ksi respectively. The estimated ductility is ~2.2% uniform elongation.

While no clad failure occurred during the initial bending of the fuel rod, the strain energy applied during bending is evaluated to be greater than that of the irradiated fuel rod clad. Accounting for the inertia and stiffness effects of the fuel pellet, the strain energy capability of the fuel rod increases, which may account for the clad remaining intact during the initial bend. The same increase in the cladding strain energy capability would exist for the straightening of the bent rod.

Subsequent straightening of the rod will induce approximately the same levels of strain energy into the cladding. Although no clad fracture occurred during the initial bend, fracture of the cladding cannot be precluded, given the low ductility of the irradiated cladding. Thus the bent fuel rod straightening process accounts for this possibility through the following:

- The fuel rod will be degassed before any straightening occurs. The controlled release minimizes the potential release of rod gases and dose exposure. The estimated dose to an operator, if the rod failed even without degassing, is determined to be very low.

- The straightening of the fuel rod will be performed on a safety tray that will be located on the spent fuel pool storage racks. In the event of possible clad fracture, the safety tray is utilized to ensure no disbursement of solid material and to maintain control and accountability of rod pieces. In addition, some crimping or localized deformation is expected during clad fracture since the cladding total elongation is ~6%. This local deformation will aid in the containment of the fuel pellets within the cladding. Following rod straightening, the fuel rod will be stored in a failed rod capsule where no further exercising of the cladding will occur. This capsule is stored in a failed rod basket.

Collected solid and gaseous materials will be processed with appropriate site systems and procedures.

- The straightening of the fuel rod is performed in a controlled manner through regulated pressure and speed and by an established stroke length in the actuator of the pneumatic arm, which bends the rod. The rod is fixtured to ensure no slippage during the straightening process and to provide a consistent rod loading.

- Prior to actual rod straightening, a full demonstration and qualification of the complete process will be performed by Framatome-ANP, including rod handling and fixture verification, rod puncture and degassing, rod straightening, and post-straighten rod disposition .

- McGuire Nuclear Station will provide reactor engineers services for oversight during the straightening process and to provide qualified radiation protection personnel for this campaign.

Question # 4

The damage to the fuel rod occurred while being inserted into the assembly recage template during the reconstitution of fuel assemblies. A contractor technician failed to follow approved procedures and attempted to force the rod into the template resulting in severe bending of the rod. Due to the infrequency of rod straightening evolutions and the importance of training for infrequent evolutions, the staff requests the licensee provide information describing the following: 1) the training provided to the personnel responsible for performing the maintenance, 2) the supervisory oversight to be provided, and 3) the controls implemented to limit the potential for additional damage to the rod.

Response:

The tooling and process approach to be deployed are founded on Framatome ANP's extensive experience, sound engineering judgment, augmentation of proven processes, and thorough testing of tools and processes prior to implementation in the field. This scope of work will be handled as a first-of-a-kind process, in accordance with the Framatome ANP QA program requirements. Even though the mechanics of rod securing and rod puncturing for degassing are proven techniques, this rod straightening evolution will employ specific applications and constraints required to successfully straighten the rod. A full wet mockup of the rod condition will be employed to conduct process and tooling qualification, and to support personnel training/qualification prior to onsite implementation. Several fuel rod samples will be developed that emulate the shape of the irradiated bent fuel rod. Additionally, a test will be conducted on a full-length rod sample that will be cold worked at the bent location to try and achieve similar rod embrittlement conditions as compared to the actual rod. The tooling will be deployed in mockup conditions that closely emulate the onsite environment. A procedure will be developed and qualified to control the work activity. It will address critical cautions and hold points, and detail conditions for foreseen contingencies should certain emergent conditions arise during the evolution. The process shall be repeated several times to study the behavioral characteristics of the rod and the straightening process and to allow functional operation by the technicians qualifying to execute the task. Safeguards will be implemented to control the unlikely event of rod separation. These safeguards include:

- The speed of the rod straightening tool will be controlled to prevent unintended rod behavior
- Ample underwater camera viewing will be utilized to monitor all operations
- A safety skirt will be utilized to surround the rod to maintain control and accountability of rod pieces should the rod separate, and a proven rod storage capsule will be utilized for long-term rod storage within a rod storage basket once the rod is straightened
- Should the rod separate, the same rod storage capsule will be utilized for all of the rod segments and pieces

Additionally, a pre-job briefing will be held with all McGuire Nuclear Station personnel assigned to this task. The briefing will address the risks associated with the operation, safeguards that are in place, the radiological conditions that could arise and the safety of all personnel. Individual responsibilities will be fully disclosed to facilitate understanding by all personnel executing the task and management expectations will be clearly communicated.

Throughout the process qualification and during site implementation, engineering and supervisory oversight will be engaged from both Framatome ANP and Duke Energy General Office and McGuire Nuclear Station Reactor Engineering.

Question # 5

During the performance of this evolution, the potential exists for the cladding of rod I-14 to fail. A significant failure of the cladding can result in a release of fuel to the spent fuel pool. The staff requests the licensee to provide an evaluation of the potential for an inadvertent criticality assuming the worst possible release of fuel to the spent fuel pool. Additionally, the staff requests the licensee to justify any assumptions used in the evaluation.

Response

In 1996, Duke Power evaluated the criticality consequences of loose fuel pellets that have escaped a fuel rod due to some type of cladding breach. In this calculation (DPC-1553.12-00-0004, Rev. 0), 26.6 kg UO_2 of unirradiated 5.0 wt % U-235 fuel pellets, the amount contained in 10+ fuel rods, were considered, arranged in a spherical homogeneous mixture of UO_2 and unborated water, with varying water/fuel ratios to bound the optimum k_{eff}. This spherical mixture was modeled with a large unborated water reflector, and was thus isolated from interactions with any other fuel. The maximum 95/95 k_{eff} observed in these cases was 0.9512. The results of this calculation were consistent with NUREG/CR-0095 published subcritical mass limits of ~35 kg UO2 (homogeneous mixture) and ~ 31 kg UO_2 (heterogeneous mixture) for an enrichment of 5.0 wt % U-235. Since rod I-14 contains less than 2 kg UO_2 at less than 5.0 wt % U-235, there is not a sufficient quantity of fissile material in this single fuel rod to form a critical mixture.

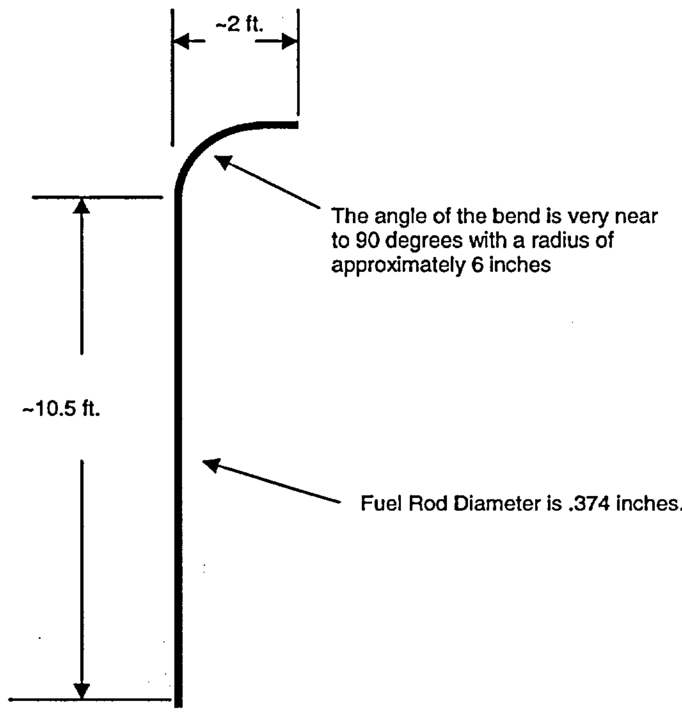
Question # 6

The licensee stated that temporary procedure FS-139, "Procedure for Degassing and Straightening of a Mk-BW Fuel Rod", will be used by Framatome ANP to perform the maintenance on fuel rod I-14 of fuel assembly V27. Due to the potential for additional damage to occur to the fuel rod which could result in a loss of fuel cladding integrity, the staff requests the licensee to make available a copy of temporary procedure FS-139.

Response

The draft procedure, FS-139 "Procedure for Straightening of a MK-BW Fuel Rod," is included with this submittal as Attachment 3. Please note that the procedure will be revised to include the degassing process and lessons-learned from the demonstration.

Figure 1 - Bent Rod Configuration at McGuire Unit 2



ATTACHMENT 2

FRAMATOME ANP
BENT ROD STRAIGHTENING

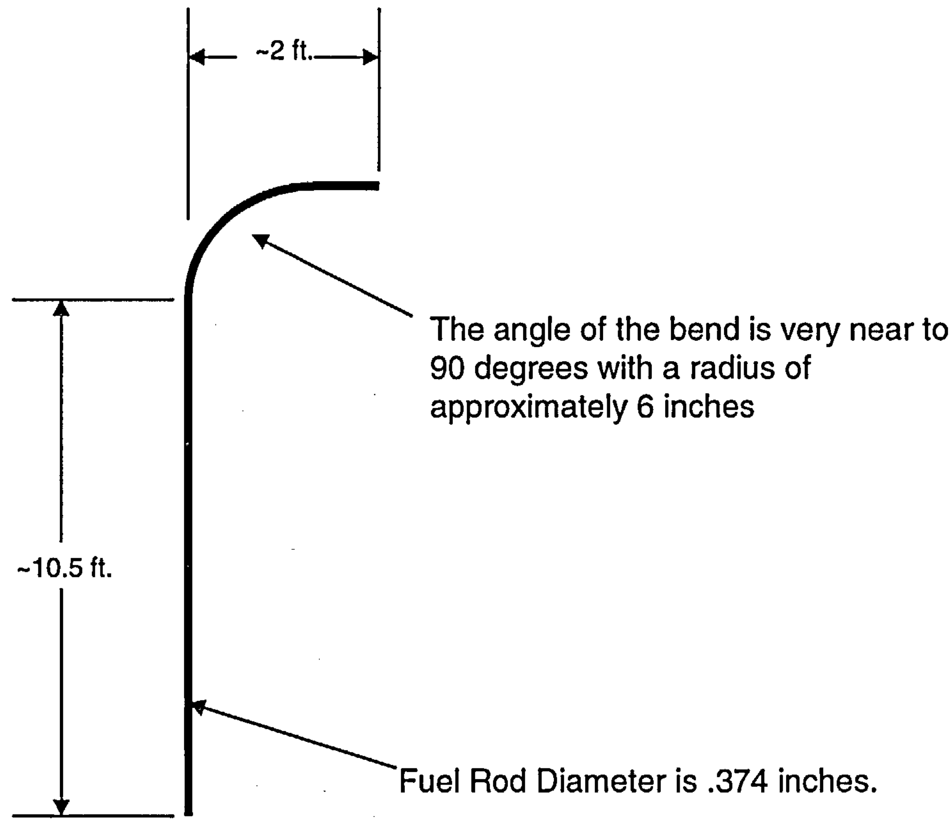
System Presentation

For

DUKE ENERGY

FRAMATOME ANP

Bent Rod Configuration at McGuire Unit 2



NOTE: Current rod location is cell SS-4 in the MNS Unit 2 SFP.

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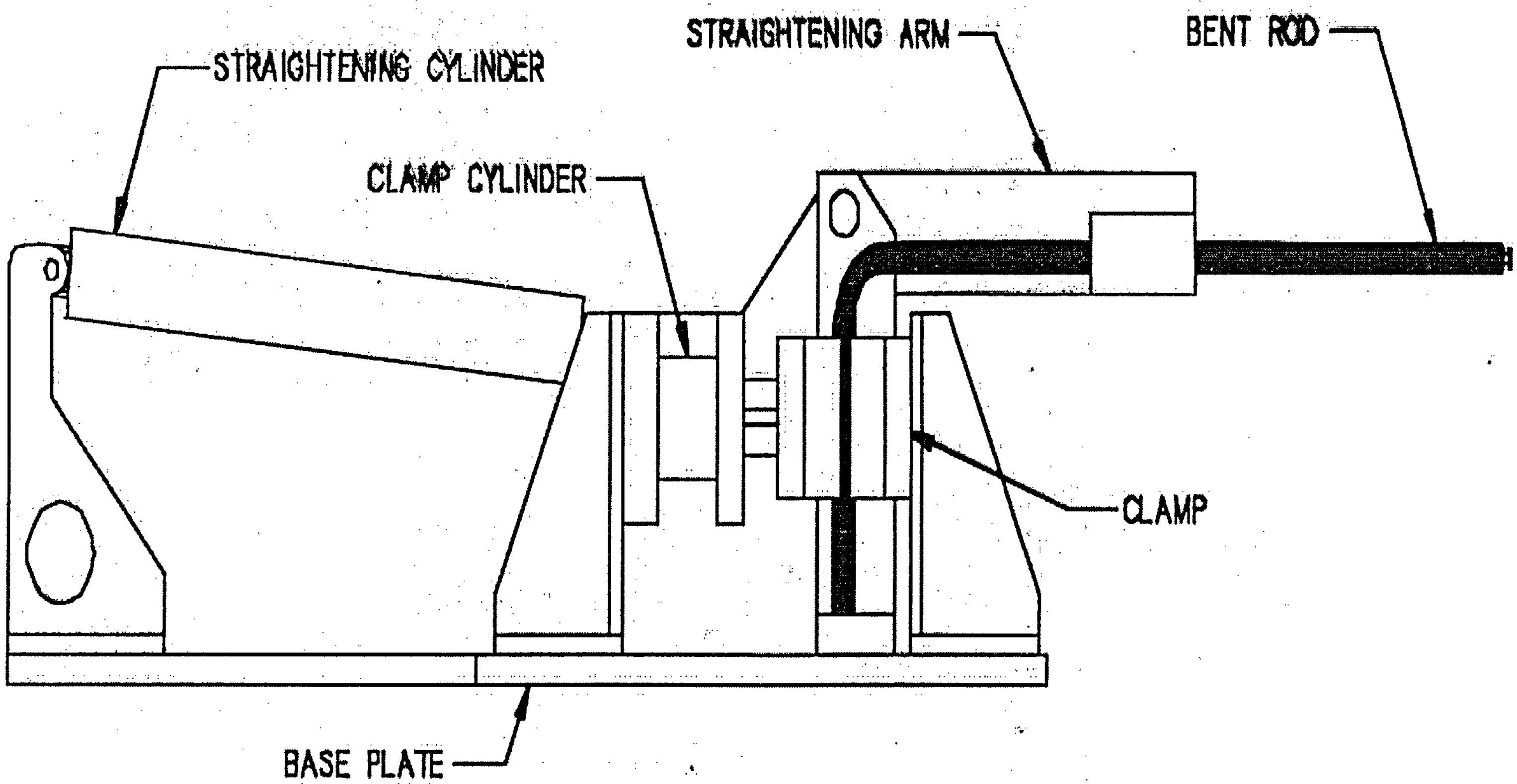
Fuel Rod Straightener



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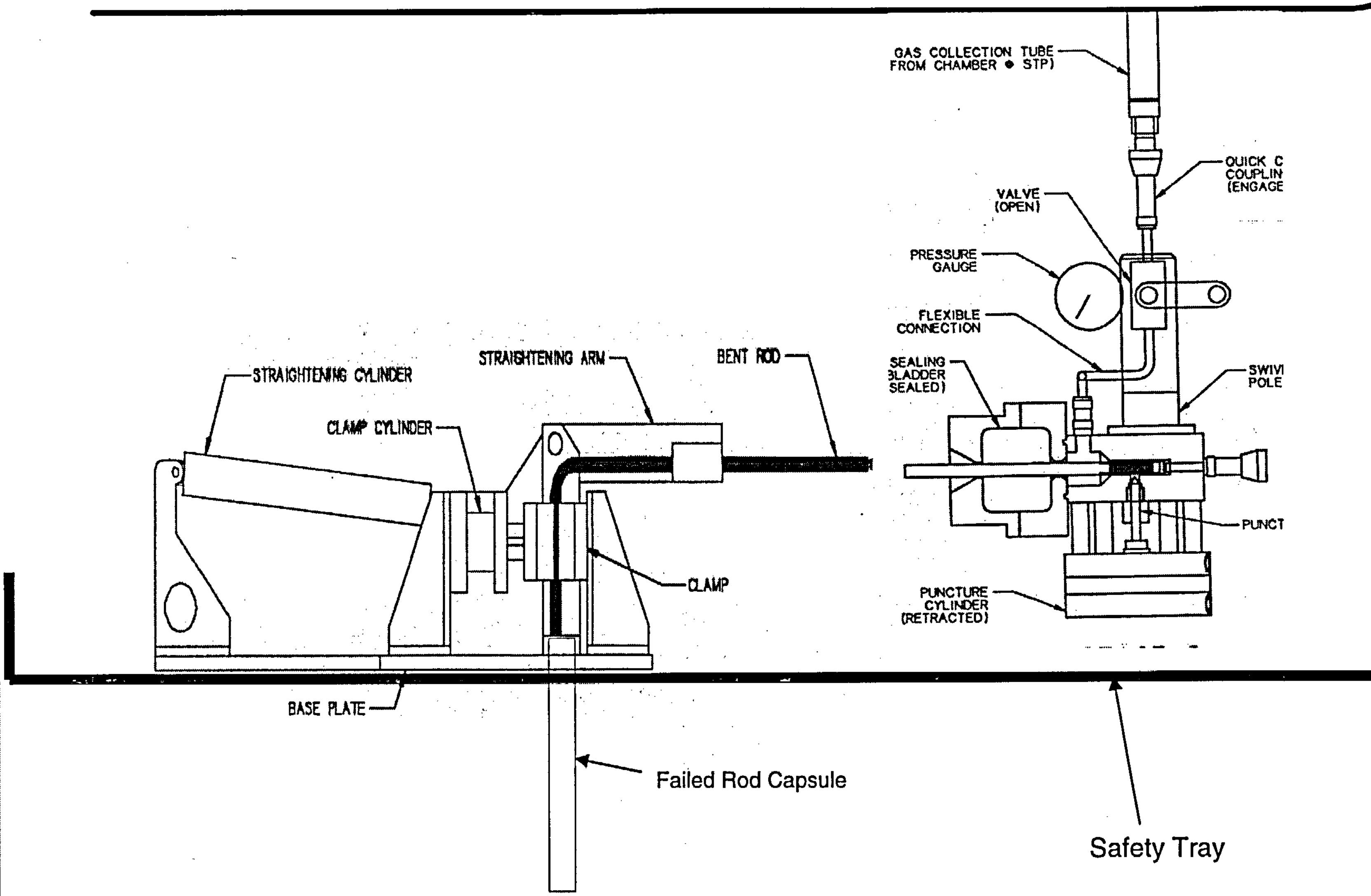
McGuire 2 Bent Rod Repair Sequence of Events

Equipment Set-up

- Control equipment set-up on SFP bridge and clean area adjacent to SFP.
- Rod Straightener and safety tray placed onto SFP storage rack.
- Rod Degassing tool and gas collection tube positioned into SFP.
- Failed Rod capsule placed into the rod straightener.

Fuel Rod Degas and Straightening Lay-out



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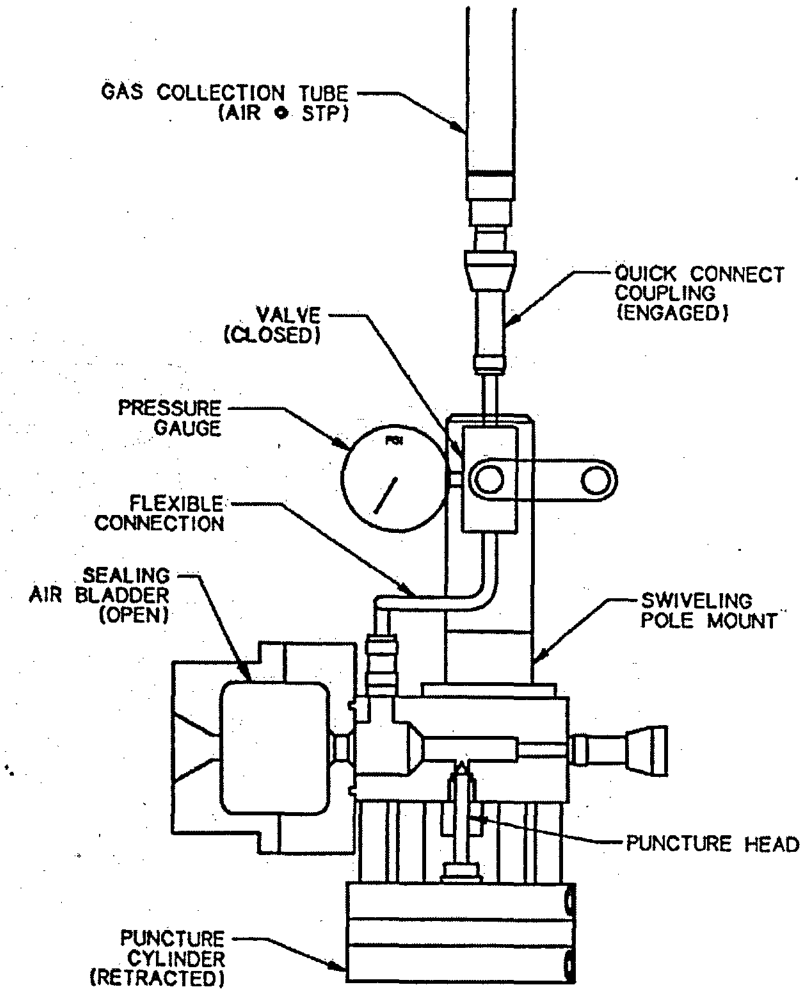
Rod Degas Process

- •Failed rod Capsule in Rod Straightener.
- •Bent fuel rod placed in rod straightener
- •Degas tool in "Ready State".

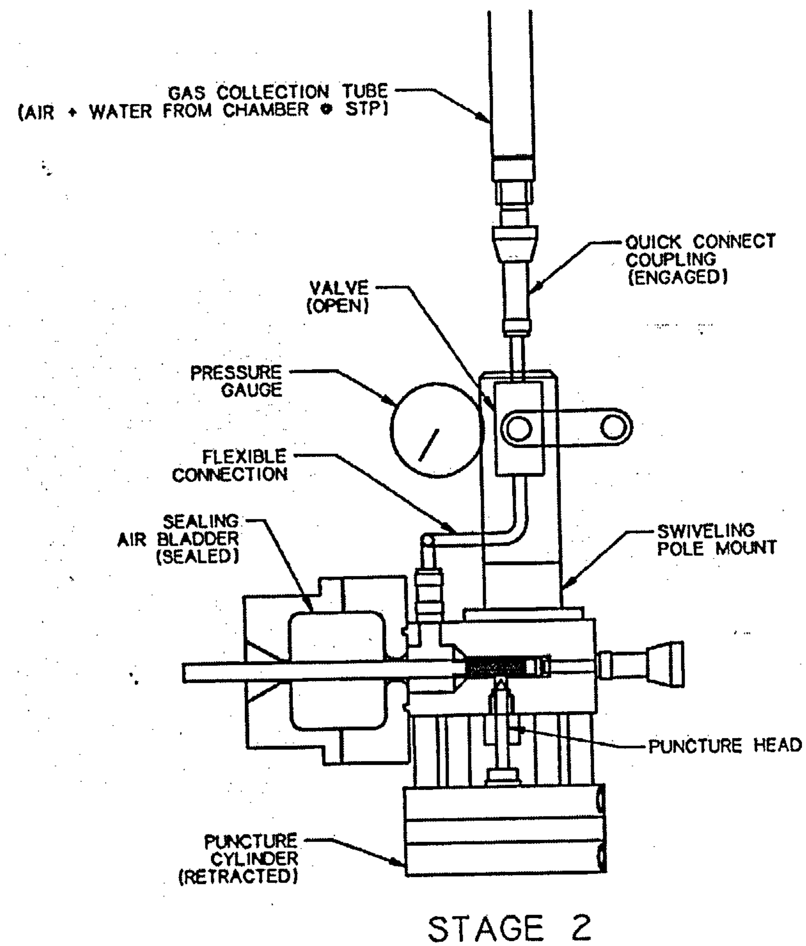


STAGE 1

FRAMATOME ANP

Rod Degas Process

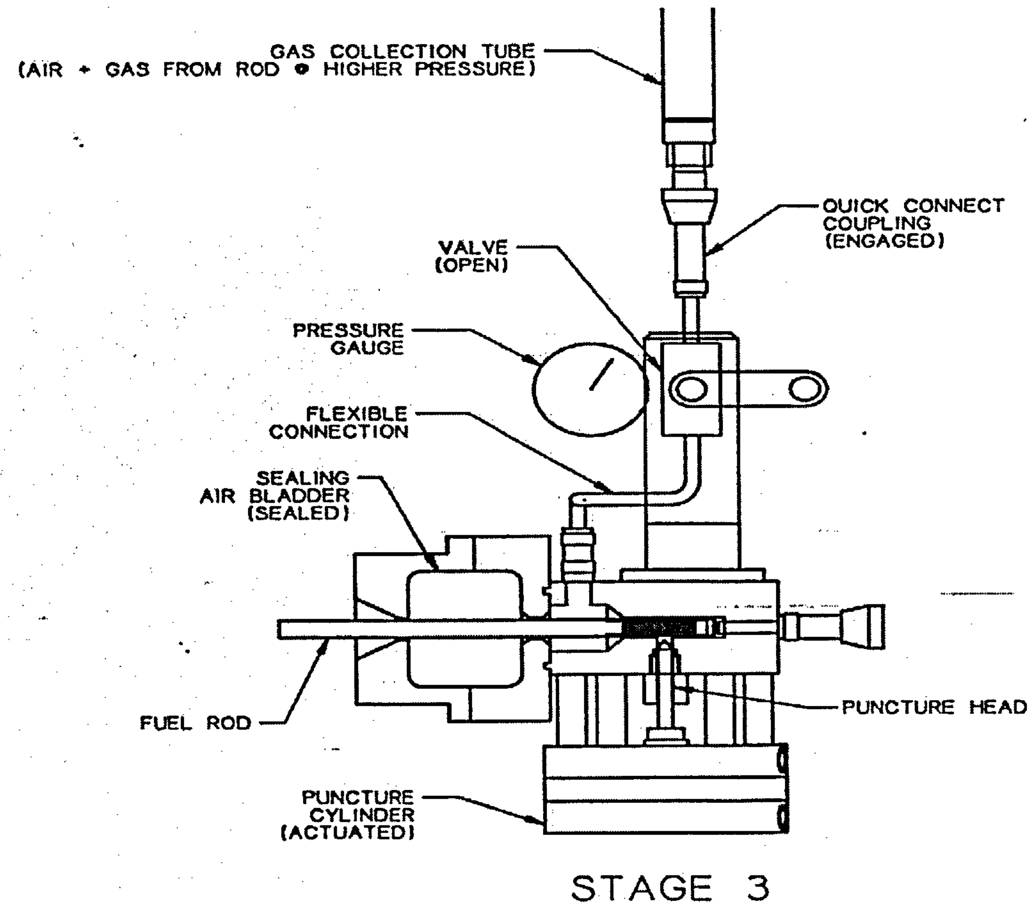
- Degas tool slid onto top end of fuel rod and straightener.
- Rod seal on Degas tool inflated.
- Collect tube valve is open



FRAMATOME ANP

Rod Degas Process

- Puncture head is activated
- Gas collected in tube



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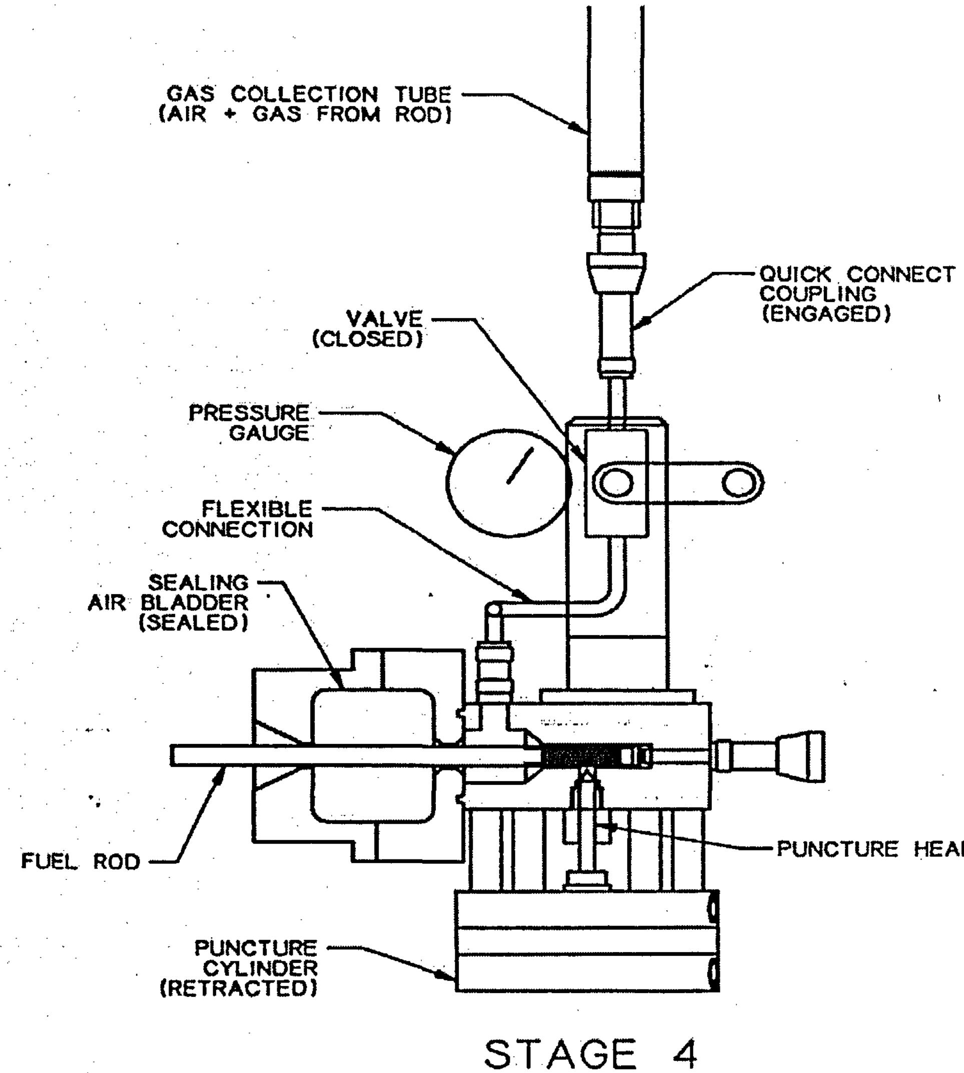
Rod Degas Process

- Gas Collection tube valve closed
- Puncture head is retracted.
- Fuel rod straightening can occur with the degasser still attached to the fuel rod.



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Fuel Rod Straightening Process

•Fuel Rod clamped just below bend.

•Straightening arm engages on fuel rod.

•The straightening arm cylinder pressure is slowly increased. This will straighten the fuel rod to a mechanical hard-stop.

•Straightening arm is released.

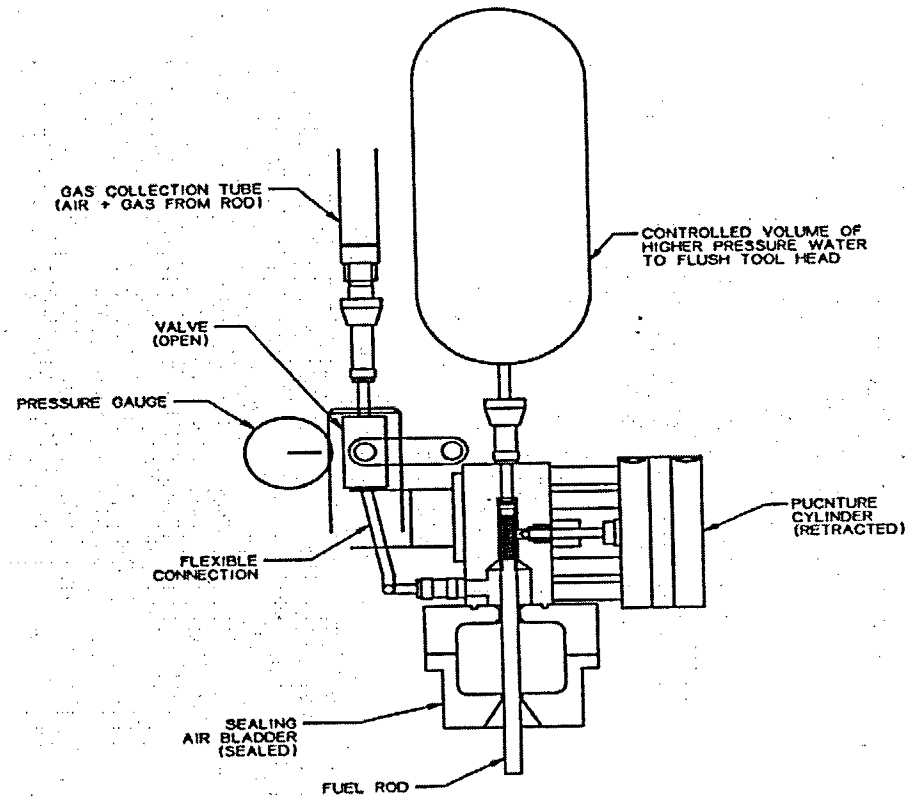
After Degassing:

•Fuel rod is grappled with the single rod handling tool after degassing process is complete.

•Rod clamp is released and fuel rod is maneuvered into the failed fuel capsule.

Rod Degas Process

- With collection valve open, high pressure water purges Degas tool.

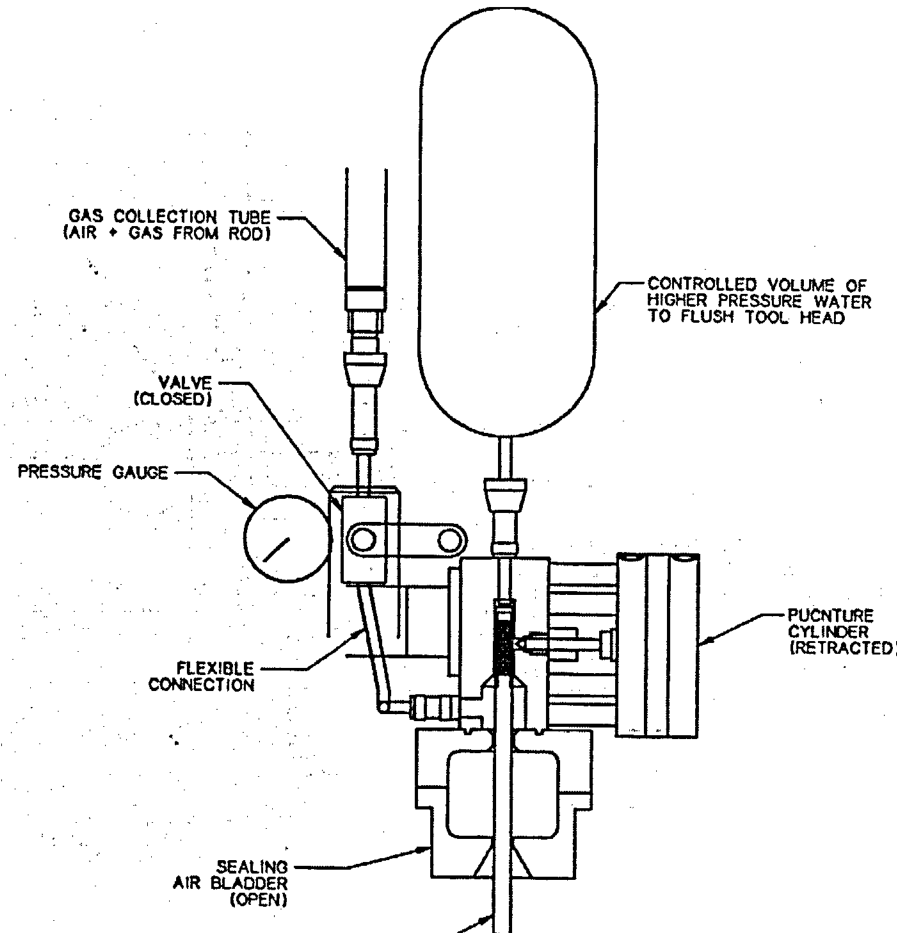


STAGE 6
(AFTER ROD STRAIGHTENING)

FRAMATOME ANP

Rod Degas Process

- •After purge, collection valve is closed.
- •The fuel rod sealing bladder is opened

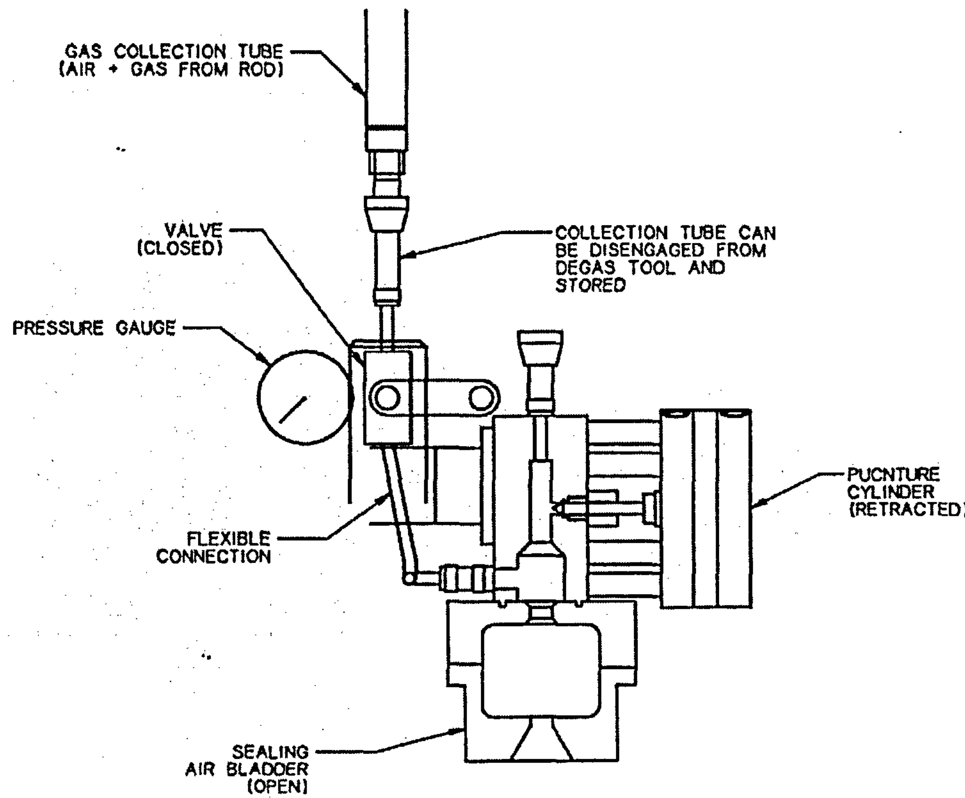


STAGE 7
(AFTER ROD STRAIGHTENING)

FRAMATOME ANP

Rod Degas Process

- Purge canister is removed from degas tool.
- Gas collection tube is removed and a safety cap installed on the end.
- Gas collection tube stored in FFRC.
- Fuel rod pushed into Capsule on straightener.
- Cap placed on rod capsule, straightened fuel rod placed into FFRC.



STAGE 8
(AFTER ROD STRAIGHTENING)

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Rod Degas Risk

Results for Mark B & BW, 3 to 5% Enrichment

All values in Rem

Whole-body Doses

Burnup	Time after shutdown - hrs			
(GWD/MTU)	100	500	1000	10,000
16	1.44E+00	1.65E-01	1.31E-02	1.85E-03
30	1.04E+00	1.20E-01	1.11E-02	2.73E-03
46	8.42E-01	9.92E-02	1.06E-02	3.70E-03
60	7.30E-01	8.71E-02	1.05E-02	4.39E-03

Thyroid Doses

Burnup	Time after shutdown - hrs			
(GWD/MTU)	100	500	1000	10,000
18	1.59E+02	3.77E+01	6.28E+00	5.71E-14
30	8.91E+01	2.11E+01	3.50E+00	3.20E-14
48	1.46E+02	3.47E+01	5.76E+00	5.25E-14
60	2.80E+02	6.65E+01	1.10E+01	1.01E-13

Skin Doses

Burnup	Time after shutdown - hrs			
(GWD/MTU)	100	500	1000	10,000
18	3.63E+00	5.51E-01	1.81E-01	1.39E-01
30	2.75E+00	5.37E-01	2.70E-01	2.31E-01
48	2.37E+00	5.70E-01	3.53E-01	3.12E-01
60	2.16E+00	6.01E-01	4.12E-01	3.70E-01

Calculations supported by Framatome ANP document number: 51-1225258-00, and memo to J.D. Gale from M.A. Rutherford for 30 sec. Integrated dose from fuel pin rupture.

Fuel Rod Degas / Straightening Contingencies

- Fuel rod straightener positioned onto safety tray in event of rod failure.
- Gas collection tube is oversize for gas volume.
- The Degas tool remains on the rod during straightening
- Purge tank to expel any remaining fuel rod gas.

FRAMATOME ANP

McGuire 2 Bent Fuel Rod Status

Framatome ANP Completed Items:

- -Fuel Rod Straightener
- -Rod Degas Tool
- -Gas Capture Tube
- -Test Procedure
- -Equipment Design Review
- -Bench Testing Completed on Rod Samples

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McGuire 2 Bent Fuel Rod Status

Incomplete Items:

-Calculation to better determine the gas pressure and volume of gas in the bent rod.

-No underwater testing has been performed

-Degas Purge Canister

-Unresolved Safety Question (USQ-DUKE)

-NRC Notification

-Approval from MNS Operations Review Committee (RADCON concerns)

-Plant License (does it permit work)

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McGuire 2 Bent Rod Repair Schedule

Crew Travels	Day 1
Equipment Set-up	Day 2
Job Briefing	Day 3
Rod Degassing	Day 3,4
Rod Straightening	Day 3,4
Possible Gas Activity Measurements	Day 4
Equipment Decon/Packing	Day 4,5
Prepare and Ship Equipment	Day 5
Crew Travels	Day 6

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McGuire 2 Bent Rod Support

- 3 Framatome-ANP personnel
- Reactor Engineering / DUKE GO
- Radiation Protection (at all times)
- Fuel Handlers for fuel movement / bridge positioning
- Decon personnel during equipment teardown / packing

ATTACHMENT 3

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1.0 Scope

To test the Fuel Rod Degas tool and the Fuel Rod Straightener for proper and safe operation. Verify the degas tool will puncture the fuel rod and capture the released gas. Verify the fuel rod straightener can manipulate a bent (90 degrees) Mk-BW fuel rod to a configuration that will allow the fuel rod to be inserted into a .625 inch diameter storage tube.

2.0 Equipment

The following are some of the tools needed for the testing of the Fuel Rod Degas tool and Fuel Rod Straightener:

Fuel Rod Degas Tool Assembly
Fuel Rod Straightener Assembly
Mk-BW Retrievable Failed Rod Capsule
Degas Collection Tube Assembly
Mk-BW Fuel Rod Mock-up
Mk-BW Pressurized Fuel Rod
Degas Pressure Flush Canister

3.0 Test Plan

This test will be performed in two stages. The first stages will be the straightening of the Mk-BW Fuel Rod Mock-up and its insertion into a storage tube similar to that, which is being used at the McGuire Nuclear Station. The second stage of this test plan will be the degassing of the Mk-BW Pressurized Fuel Rod, the collection of the gas from the rod into the collection tube, the purging of the degas tool, and the interface of the degas tool to the Fuel Rod Straightener.

Note: Use Framatome ANP procedure FS-139 as a guide for setup and operation of the fuel Straightener and the degas tool.

3.1 Perform the test of straightening the fuel rod using the fuel rod straightener assembled per the Framatome ANP drawing 1226038-D.

3.1.1 Procure a full-length section of Mk-BW cladding, fill with silicon sand, and seal at both ends of the cladding.

3.1.2 Bend the fuel rod approximately two (2) feet from one endcap until it is bent to a ninety (90) degree angle. This can be accomplished by holding the mock-up fuel approximately three (3) feet from an endcap and holding the other endcap with your other hand and bending the rod until your hands are approximately twelve (12) inches from each other.

3.1.3 Secure a Retrievable Failed Rod Capsule from a mezzanine and ensure the lower surface of the capsule upper-end cap is flush with the floor of the mezzanine.

3.1.4 Place the Fuel Rod Straightener on the mezzanine and over the retrievable capsule, through the opening in the base plate of the straightener.

3.1.5 Place the bent Mk-BW Fuel Rod Mock-up into the capsule and align the bend of the fuel rod with the pivot of the straightener. Ensure the short section of the fuel rod sets in the cradle of the straightener, and clamp the fuel rod with the pneumatic cylinder.

3.1.6 Actuate the hydraulic cylinder to extend the pivot cylinder. Continue to extend the cylinder until the pressure starts to exceed 100psi., then release the pressure and retract the pivot cylinder.

Note: The pivot arm should extend thirty (30) degrees past vertical when the pivot cylinder is pressured to 100psi.

3.1.7 Observe the condition of the straightened mock-up fuel rod. Look for crimps or fractures in the cladding. If there are no observable flaws, then release the clamping cylinder and insert the rod fully into the capsule. Monitor the force needed to insert the remainder of the fuel rod. It should easily be inserted with your hand.

3.2 Perform the test to the Degassing of the Mk-BW pressurized fuel rod using the Degas Tool assembled per Framatome ANP drawing 1259721-D. A water tank with the depth of 15 feet will be necessary when testing the system.

3.2.1 Procure a length of Mk-BW fuel cladding twelve (12) inches long and have the appropriate endcaps welded on. Pressurize the fuel rod sample to 250psi.

3.2.2 Place the fuel rod sample in the Degas Tool and inflate the seal around the fuel rod. Place the Degas tool ten (10) feet below the water surface and secure the handling pole to the side of the water tank.

3.2.3 Install the collection tube cradle to the handling pole, and insert the collection tube through the cradle and onto the Degas Tool.

3.2.4 Puncture the sample rod and then release the gas to the collection tube by turning the valve on the degas tool to the open position.

Observe the pressure gauge as the pressure increases in the system. This pressure indicator will give an indication if gas is seeping from the degas tool.

3.2.5 Rotate the Degas tool until the purge valve is facing toward the surface of the water.

3.2.6 Attach the pressure flush canister to the degas tool and verify the correct operation of the flush canister. The pressure gauge on the degas tool should increase, this will signify correct operation of the flush canister.

3.2.7 Close the gas collection valve on the degas tool and deflate the sealing air bladder. Observe for any gas release during the operation. If all gas has not been purged from the system, gas bubbles will be apparent when the fuel rod sample is removed from the degas tool.

3.2.8 Remove the gas collection tube from the degas tool and observe any release of gas.

3.2.9 Remove the degas tool from the water tank and remove the sample rod from the degas tool. Examine the sample fuel rod's puncture mark and the effort required to remove the sample fuel rod from the degas tool. If the sample is hard to remove, then the puncture tool is deforming the rod too much.

3.3 With the fuel rod straightener setting on the mezzanine, place the degas tool on the pivot arm of the straightener and record its fit. The degas tool should be able to slide on the pivot arm and adjust from 9 to 16 inches from the pivot joint of the rod straightener.

4.0 Results

4.1 Record all results from the testing of the fuel rod straightener and the degas the following test plan log. Items of importance include the condition of the fuel rods after straightening and puncturing, the change in pressures observed while puncturing and flushing of the fuel rod, and the gas released during testing of the degas toll shall be recorded.

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4.2 If the fuel rod straightener and the fuel rod degas tool do not operate and work well with Framatome ANP procedure FS-139, then report the results to the DRB.

Test Plan Log

Fuel Rod Straightener Testing:

3.1.4 Does the fuel rod straightener fit over the failed rod capsule with no interference? Explain.

3.1.5 With the bent rod, were there any problems with aligning and clamping the fuel? Explain

3.1.6 What was the actual pressure required to straighten the fuel rod?

3.1.7 Describe the condition and shape of the fuel rod after straightening.

Did it take a significant amount of force to insert the fuel rod into the capsule?

Would a second manipulation of the fuel rod aid in inserting the fuel rod?

Degas Tool Testing:

3.2.3 Was there an air release when the collection tube was installed on the degas tool? How much?

3.2.4 What was the initial pressure on the gauge before puncturing?

3.2.5 What was the resulting pressure after puncturing the sample fuel rod?

3.2.6 What was the final pressure of the gas collection tube after purging? What was the final pressure of the gas collection tube after purging? Was there a gas release from any part of the tool during the purging operation?

3.2.7 Was there a gas release after the sealing bladder was deflated? After letting the system set for five (5) minutes, has the pressure decreased? How much?

3.2.8 Were was there a gas release when the collection tube was removed from the degas tool?

3.2.9 Was it hard to remove the sample fuel rod?

Describe and draw the puncture mark on the fuel rod? Was there any fracturing of the metal around the puncture mark?

Suggestions: Mark any suggestions for the operation of the equipment in the area provided below.

ATTACHMENT 4

FRAMATOME ANP

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PROCEDURE FS-139
REVISION - 0

PROCEDURE FOR STRAIGHTENING
OF
a MK-BW FUEL ROD

02-26-97

Prepared By: ______________________________ ____________

S. E. Morris, Field Services Date

Reviewed By: ______________________________ ____________

D. M. Minor, Field Services Date

Approved By: ______________________________ ____________

A. A. Pugh, Manager, Field Services Date

1.0 APPLICABILITY

FCF Field Services Personnel

2.0 PURPOSE

This procedure details the instructions and requirements for straightening of a Mark BW fuel rod.

3.0 REFERENCES

3.1 FS-083 Fuel Rod Visual Examination

3.2 FS-136 Site Support Requirements for Nuclear Stations

3.3 FS-706 Field Services Temporary Procedure Changes

3.4 FTI 0503-22 FCF Field Services Problem Report (FSPR)

4.0 FORMS

4.1 FOPS-005 FCF Field Services Procedure Acknowledgement

4.2 FOPS-039 Video Recording Log

4.3 FOPS-095 Field Service Temporary Procedure Revision

5.0 EQUIPMENT

Fuel rod straightening requires but is not limited to the following equipment. The use of some items is optional.

5.1 Fuel rod straightener

5.2 Underwater cameras and lights

5.3 Failed rod capsule handling tool

5.4 Pole rack(s)

5.5 Tool handling poles (as required)

5.6 Air grabber tool

5.7 Nitrogen gas bottle pressure regulator

5.8 Failed rod storage basket

5.9 Broken rod container

5.10 Replacement rod tube

5.11 Trash can/waste receptacle

5.12 Debris vacuum system

6.0 PREREQUISITES

6.1 Site requirements are outlined in Procedure FS-136, Site Requirements for Nuclear Stations.

6.2 All personnel involved must be briefed prior to starting work as to the scope and objective of the job.

6.3 A storage container for broken rod segments must be available.

6.4 A storage container for failed fuel rods must be available.

6.5 All personnel working under this procedure must read and understand this procedure and all referenced procedures. Each person must have signed form FOPS-005 indicating their understanding of all applicable procedures.

7.0 PRECAUTIONS AND LIMITATIONS

7.1 Care should be taken to insure nothing is accidentally dropped into the Spent Fuel

Pool (SFP). Notify the FCF Shift Supervisor and site representative if anything is dropped in the pool.

NOTE: If anything is dropped into the pool, retrieval may be performed using the air grabber tool.

7.2 All equipment and tooling shall be thoroughly checked for proper assembly prior to being used or placed in the SFP. All equipment and tooling shall be thoroughly checked for any loose or missing hardware immediately upon removal from the SFP. If it is observed that any hardware is missing from the equipment, immediately notify the FCF Shift Supervisor and site representative.

7.3 If a step in the procedure cannot be completed because of equipment failure or some other reason, stop work and inform the FCF Shift Supervisor and site representative. If procedure changes are necessary, notify the FCF Field Services Manager. Further work may proceed after appropriate administrative approval of the procedure changes per procedure FS-706 consistent with site requirements. If equipment problems are discovered, complete a FCF Field Services Problem Report per FTI 0503-22.

7.4 Follow site Radiation Protection (RP) instructions when handling contaminated equipment and while equipment is being installed and removed from the SFP.

7.5 All crane and bridge operations will be performed by qualified operators.

7.6 The site representative shall be notified immediately of any unusual events or anomalies not covered by the procedure, such as tooling problems, fuel rod handling problems, or other events which could adversely affect the safety or satisfactory completion of the task.

7.7 Handling of irradiated nuclear fuel has the potential to reduce the plant margin of safety. In the event of a handling accident observed or indicated by emergency alarms, place any loads in a safe position and evacuate the area immediately. Contact the control room and notify of the situation.

8.0 EQUIPMENT SETUP

8.1 Install the fuel rod straightener safety tray into the SFP.

8.2 Install the rack camera in the SFP approximately 3 cells from the safety tray.

8.3 Using the failed rod capsule handling tool, install a failed rod capsule without the lid on the fuel rod straightener safety tray, in the receptacle.

8.4 After inspecting the fuel rod straightener for leaks and proper mechanical operation, install the fuel rod straightener onto the safety tray, over the failed rod capsule.

8.5 Connect a 250 psi. nitrogen supply to the control panel. Ensure all regulator are completely backed-off before pressurizing the system.

8.6 Pressurize the system and adjust the pivot cylinder pressure to 20 psi.

8.7 Using the rack camera, verify proper operation of the fuel rod straightener.

8.8 Position the pivot arm of the rod straightener in the start position (cylinder retracted).

9.0 EQUIPMENT OPERATION

9.1 Using air grippers, move the bent fuel rod from its storage tube to the failed rod capsule on the safety tray. Ensure to align the bend of the rod with the pivot joint of the fuel rod straightener.

9.2 Clamp the rod in the fixture and release the air grippers.

9.3 Using the air grippers, position the rod so the fixture will clamp the rod just below the bend. Open and reclamp the rod as needed to position the rod.

9.4 Ensure the pivot cylinder pressure is no more than 20 psi. Actuate the pivot cylinder till it engages on the rod. Verify the positioning with the camera. Reposition the rod as require to align the rod with the pivot arm.

9.5 Gradually increase the pivot cylinder pressure till the rod straightens 30 degrees past vertical position. Do not apply any additional pressure to the cylinder than what is needed to straighten the rod. Monitor the process using the underwater camera.

9.6 Actuate the pivot cylinder to the retracted position.

9.7 Grip the fuel rod with the air grippers approximately 2 inches above the fixture clamp.

9.8 Retract the fixture clamp and push the straightened rod into the capsule.

9.9 Release and regrip the rod with the air grippers as needed till the rod is completely pushed into the failed rod capsule. If the rod can not be completely inserted in the capsule, then repeat step 9.3-9.9 till the rod is completily inserted into the capsule.

9.10 Using the failed rod capsule handling tool, install the lid on the capsule.

9.11 Verify that there are no fuel rod fragments on the safety tray.

10.0 EQUIPMENT REMOVAL

10.1 Remove all equipment and tools from the repair area. Decontaminate all equipment and tools per Procedure FS-136, and pack all equipment in the proper shipping containers as directed by site personnel.

10.2 Remove all trash/debris from the work area and restore the work area to its' original condition.

10.3 Verify that all site procedures and data have been signed and copies retained by FCF.

[END]

RECORD OF REVISIONS

DATE	REVISION NO.	PARAGRAPH	DESCRIPTION
			The Record of Revisions for previous revisions can be found in the Field Services Archive file.
02-26-97			This is the original procedure.