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TO:	FROM:	DATE OF DOCUMENT
Mr. Edson G. Case	Duke Power Co. Charlotte, N. C. 28242 William O. Parker	10/14/77
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DESCRIPTION

Notorized 10/14/77...Trans The Following:

PLANT NAME: OCONEE UNITS 1, 2, & 3

jcm 10/26/77 2p

ENCLOSURE

Consists of report describing the handling history and damage, discusses the planned disposition of the assembly and assesses the potential hazards associated with the Cycle 3 operation of the Unit 1 core, fuel assembly 1D40 which sustained damage to one corner fuel rod while conducting the post irradiation examinations in the spent fuel pool...And also consists of Amendment to Operating Licenses DPR-38, -47, & -55 requesting disposition of one fuel rod from fuel assembly 1D40...

16p

40 ENCL.

FOR ACTION/INFORMATION

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DUKE POWER COMPANY

POWER BUILDING

422 SOUTH CHURCH STREET, CHARLOTTE, N. C. 28242

WILLIAM O. PARKER, JR.
VICE PRESIDENT
STEAM PRODUCTION

TELEPHONE: AREA 704
373-4083

October 14, 1977

Mr. Edson G. Case, Acting Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

RECEIVED
OCT 25 1977
U.S. NUCLEAR REGULATORY COMMISSION
Mail Section

RE: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287

Dear Sir:

During the refueling outage following the Cycle 3 operation of the Oconee Nuclear Station Unit 1 core, fuel assembly 1D40 sustained damage to one corner fuel rod while conducting the post irradiation examinations in the spent fuel pool. No release of radioactive materials occurred as a result of this damage. The attached report describes thehandling history and damage in detail, discusses the planned disposition of the assembly and assesses the potential hazards associated with this action.

Pursuant to 10CFR50.90, an amendment to the Oconee Nuclear Station Facility Operating Licenses DPR-38, -47, and -55 is requested which will permit the disposition of one fuel rod from fuel assembly 1D40 as described in this submittal. It is requested that this approval be granted by November 15, 1977.

Very truly yours,

William O. Parker, Jr.

William O. Parker, Jr.

MST:ge

Attachment

772990124

WILLIAM O. PARKER, JR., being duly sworn, states that he is Vice President of Duke Power Company; that he is authorized on the part of said Company to sign and file with the Nuclear Regulatory Commission this request for amendment of the Oconee Nuclear Station Facility Operating Licenses DPR-38, DPR-47, and DPR-55; and that all statements and matters set forth therein are true and correct to the best of his knowledge.

William O. Parker, Jr.

William O. Parker, Jr., Vice President

Subscribed and sworn to before me this 14th day of October 1977.

Vivian B. Robbins

Notary Public

My Commission Expires:

Feb. 15, 1982

OCONEE NUCLEAR STATION

FUEL ASSEMBLY 1D40

1. INTRODUCTION

During the refueling outage following Cycle 3 operation of Oconee Nuclear Station, Unit 1, fuel assembly 1D40 sustained damage to a fuel rod during handling in the Spent Fuel Pool. The incident resulted in the upper ten inches of a corner rod being bent outward from the assembly at about a 45° angle. No radioactive releases were detected. The assembly is presently suspended approximately two feet above the Spent Fuel Pool floor on a special hoist, pending further disposition.

This report describes the handling history and damage in detail, discusses the current and planned disposition of the assembly, and evaluates the potential hazards associated with the chosen disposition method.

2. HANDLING HISTORY AND DESCRIPTION OF DAMAGE

Since the initial refueling of Oconee 1 in late 1974, a post-irradiation examination (PIE) program has been conducted for Oconee 1 fuel. This work has been performed by the NSSS/fuel vendor, the Babcock and Wilcox Company. The PIE equipment includes a jib crane/hoist and an assembly examination frame known as the line-scan tester (LST). The major features of the LST are illustrated in Figure 1. Using the PIE crane, an assembly is translated into the front cut-out area of the upper plate, secured at the top with locking clamps, and ungrappled from the crane. (This operation is reversed for assembly removal.) Once in the LST, an assembly can be rotated continuously in either direction in order to position various faces of the assembly to where the measurement heads are located (the south wall). Rotation is accomplished manually with a hand crank that drives the lower turntable plate. The upper plate is free-floating and ideally follows the assembly during rotation.

Prior to August 23, 1977, assembly 1D40 had been transferred from the Oconee 1 core to the Spent Fuel Pool and the number of PIE operations had been conducted on the assembly. These were as follows:

1. Assembly 1D40 was grappled (using the PIE crane) and moved from the storage rack to the LST.

2. Several measurements (rod bow, rod diameter and rod-to-rod spacing) were made, during which the assembly was rotated a full 360° clockwise.

3. The assembly was removed from the LST and placed in the storage rack.

4. The assembly was grappled, moved to another test station and gamma-scanned on all four corner rods. (This operation involves lowering and raising the assembly four times at a special storage rack location, with a 90° rotation (on the hoist) between each scan.) Optical periscope visual examination was also conducted at this time.

5. The assembly was installed in the LST, rotated 90° clockwise, and remaining rod spacing measurements were completed in this orientation.

Nothing unusual was noted in any of these operations. The gamma-scan and rod diameter measurements showed no anomalies. The visual examination during gamma-scanning showed nothing unusual. Moreover, the rod spacing measurement (at step 5 above) between the corner rod in question and its neighbor showed a nominal spacing value. Thus, it has been tentatively concluded that the rod was still within the assembly envelope at the end of the test series described above.

On August 23, 1977, the assembly was rotated counter-clockwise in the LST to return it to its original orientation for removal. After about 45° of rotation, difficulty was encountered in going further or returning clockwise. The assembly appeared twisted. At this point a spring test

device was attached to the assembly upper end fitting and manually rotated to assist the lower turntable in completing the rotation counter-clockwise. The spring tester was removed and the grapple attached. In lifting the assembly with the hoist, the assembly (and upper turntable) rotated about 30^{o} clockwise. This misorientation was corrected by rotating the hoist extension bar (attached to the grapple) and holding it in the proper orientation. During translation out of the LST, the assembly appeared to hesitate and exhibited a jerking motion outward. As the assembly cleared the LST, the bent rod was observed and all personnel evacuated the pool area until radiation checks could be made (which later proved negative).

Upon re-entry into the Spent Fuel Pool, the damaged area and the underside of the upper LST plate were visually examined with the television camera and videotaped. Scratches on the plate indicated that the bending of the rod occurred during lifting of the assembly, as the protruding rod top struck the underside of the plate. This explains the tendency for the assembly to rotate during lifting, and the jerking motion during translation outward. There is currently no ready explanation for how the rod came to be outside the upper end grid in the first place, although it apparently happened during the last LST rotation. Broken grid welds and a small area with missing metal can be seen at the grid.

Photographs of the bent rod are shown in Figure 2 (taken from videotape images). These and other portions of the videotape footage show the bend to be uniform, with no sign of crimping or cracks. Figure 3 shows sketches of the rod, with approximate dimensions (scaled from the videotape). There is no evidence of damage to adjacent fuel rods or to the intermediate spacer grid below the bend.

3. IMMEDIATE DISPOSITION

Since the assembly was not suitable for additional service in its present condition, plans were made to insert substitute fuel assemblies for 1D40 and the three symmetric assemblies. Once-burned batch 2 assemblies from Oconee 1 (with similar reactivity) were inserted in the core for cycle 4.

Because of the rod protrusion, it was impossible to set the assembly fully down on the Spent Fuel Pool floor without interference with the storage rack grillage. Also, any attempt to return the rod end to the spacer grid cell could result in breakage. Thus it was decided that, pending further disposition, the assembly would be temporarily left suspended from the PIE crane approximately 2 1/2 feet off the floor (with the uppermost intermediate grid at the rack grillage elevation). The storage rack location is in an area presently inaccessible to the Spent Fuel Pool bridge crane because of limit switch stops. NRC Office of Inspection and Enforcement personnel were advised of the incident and the immediate action taken.

4. FUTURE DISPOSITION

In considering the options available for final disposition of the rod/assembly configuration, the prime consideration was that of maintaining the integrity of the cladding and minimizing the chance of fission product release. Of the various options considered, the most viable was concluded to be withdrawing the bent rod in the Spent Fuel Pool and transporting it offsite to the B&W Lynchburg Research Center (LRC). Other options considered are discussed below.

The possibility of forcing the rod inward to regain the assembly envelope dimensions was discussed previously. This creates a high probability of rod breakage at the bend. Although the amount of strain-hardening at the bend cannot be known with certainty, it must be assumed that the bend area is brittle and no stress should be put on it. The option of storing the assembly in its present configuration in the spent fuel pool, but in a less vulnerable configuration, was also considered. However, this does not solve the problem of the ultimate disposition of a fuel assembly that does not satisfy certain envelope requirements. Finally, the option of shipping the assembly offsite, as is, was evaluated. However, the internal cavity of the shipping cask (even without liner) is a cylinder 13 inches in diameter, which just holds a fuel assembly in the center assuming a liner of nominal thickness. Very little clearance remains for the protruding rod (the protrusion is estimated at five to six inches outward from the assembly face). The rod cannot be rotated inward to any great degree before contacting the adjacent rod, resulting in stress on the bend area. Thus this option was rejected as involving too great a risk of rod breakage.

In support of the decision to withdraw the fuel rod, it should be noted that rod pulling at reactor sites it not uncommon (see references). More recent instances include Surry-1, Zion-1 and Maine Yankee. In addition, burnable poison rods with significant hydriding damage have been withdrawn from fuel assemblies at St. Lucie. Also, B&W has been removing rods from assemblies in the LRC cells as part of the PIE program. This experience will assure that the oprtion is carried out in a safe manner.

5. ROD PULLING METHOD AND DISPOSITION

After considering several methods of removal, an approach was decided upon which best satisfies the criterion of minimum risk of rod breakage. The resulting rod pulling apparatus is illustrated in Figure 4. It consists of a rod gripping assembly, a guide shield and a hand winch with steel cable.

The gripping assembly is shown in detail in Figure 5. It consists of a steel hose clamp (5/8 inch opening) with a pulley attached to the tightening screw. The winch cable is also attached to the hose clamp. A long-handled clamping tool is attached to the gripper assembly and used to position the hose clamp opening over the fuel rod. After removing the clamping pole the host clamp is tightened a few inches below the bend area by means of a rope around the pulley. The positioning and tightening operations are done from the fuel handling bridge while the fuel assembly is above the storage rack, in order to minimize working distance. After gripping, the fuel assembly is lowered into the storage rack and a guide shield is installed.

The guide shield is a right-angle metal plate which is placed over the upper grid skirt area and held in place with ropes. It has a prong which fits into the empty corner grid cell, and provides for a smooth transition past the edges of the upper skirt. This prevents any hang-up of the rod or gripping assembly on the skirt during rod pulling.

After installation of the shield the rod is extracted using the hand winch mounted on the fuel handling bridge. A spring scale mounted on the winch is used to continuously monitor the pulling force. After extraction, the rod is transferred to a storage container (a tube with a funnel lead-in) located in a nearby rack location, and the gripper is removed. At a later date, the rod and container will be shipped to the LRC in a spent fuel assembly shipping cask.

The entire rod pulling operation has been successfully performed several times of a dummy fuel assembly in a simulated pool area at the LRC.

6. HAZARDS AND PRECAUATIONS

Although the rod pulling equipment and the procedure have been developed to minimize the risk of damage, a small but finite probability of an accident remains. (Section 7 analyzes the consequences of the worst-case accident, that of a rod break with resulting release of fission products.) This section analyzes the potential accidents that could occur during the operation, and discusses the precautions that will be taken.

A. Rod Break Due to Bumping - Certain operations will result in objects being brought close to or in contact with the upper part of the fuel rod. There is some concern that the strain-hardened region of the bend may be somewhat brittle. However, the region has already shown itself to be capable of significant strain and impact during the bending and subsequent removal from the LST. Thus, minor contact with the upper portion of the rod is not considered to be a problem. To assure little or no chance of adverse contact, however, all critical operations (such as shield installation, gripper installation, tightening and extraction) will be closely followed through direct and/or TV visual monitoring. All operations will be performed with appropriate cautiousness, using lightweight tools and safety lines where applicable. The hose clamp is free to rotate with respect to the clamping pole, thus it will slip over the upper portion of the rod and past the bend without imparting any significant force. Tightening or loosening the hose clamp (by means of the pulley) puts a small bending moment (about 20 in-lbs) on the rod. However, this is applied below the bend area, and the reaction force is seen below the clamp, thus the bend area will not be affected.

B. Rod Break During Pulling - The two areas of potential concern during this operation are: (a) tensile or bending failure of the rod below the clamp due to the pulling force, and (b) slippage of the clamp upward to the bend area, thus impacting stress at the bend.

It is very unlikely that the rod will fail in tension due to the pulling forces. To date, 38 irradiated rods have been withdrawn at LRC without incident using relatively low pulling forces. Corner rods irradiated through two reactor cycles have been pulled, and the maximum (breakaway) force required of any of the four rods was 91 lbs. This was for the case of any assembly with double end grids top and bottom (total of 10 grids). Assembly 1D40, on the other hand, is a single end grid design, and only one end grid (the bottom) is still gripping the rod. Thus, only 7 grids are holding the rod, so the maximum expected pulling force should be no more than 70% of 91 lbs, or about 64 lbs. Even less may be required because the end grids have the stiffest springs and 1D40 has only one intact, as compared with the four present during the two-cycle tests mentioned above. A force of 65 lbs will produce a cladding axial tensile stress of only about 2000 psi. This compares with a value of about 54,000 psi for the 0.2% yield strength of unirradiated B&W Zircaloy-4 cladding (irradiated yield strength through two cycles is even higher).

Due to the slight angle of pull (about 2° from the vertical), a small amount of rod bending will occur at the top intermediate spacer grid. However, the rod has been shown to take a 45° bend without breaking, so no problem is expected during the pulling operation. Tests on irradiated cladding have shown that it retains about 75% of its as-built ductility (based on decrease in total elongation).

The possibility of clamp slippage during the pulling operation is remote. No sign of slippage has been seen during the dry runs conducted to date. Additional clamping checks have shown that with a pulley rope force of approximately 7 lbs, the clamp will hold without slipping to a force of 150 lbs. Since the pulling force will be limited to 150 lbs, and the expected force is less than half of this, the margin for slipping is quite high. Furthermore, the tests to date have been on unirradiated (relatively smooth) cladding; friction coefficient on irradiated, oxidized, crudded cladding are expected to be higher. As an extra safety feature, any slippage would be detected before the clamp reached the bend area. Since the load is continuously monitored by watching the spring scale, significant slippage would be immediately noted as a sharp drop in pulling force, and the pulling operation would be stopped. The clamp area will be followed with the underwater TV camera to determine whether slippage has occurred. Corrective action (such as repositioning or tightening) would then be taken as necessary.

C. Rod Break During Subsequent Handling - After removal from the assembly, the rod (with clamp still attached) needs to be moved only a few feet to the storage container. Nothing will be in between the two locations that could strike the rod. Changes of dropping the rod are negligible since the entire assembly is being doubly held by the pulling cable and the pulley rope until the rod is in the container. Transport of the container to the shipping cask should also present no problems. To insure that the cask cover will not interfere with the top of the rod, underwater TV will be used to confirm adequate clearance. Once the cover is installed, no adverse effects arise from a rod break (e.g., during shipping), since the LRC can adequately handle any resultant release.

7. ANALYSIS OF ROD BREAK ACCIDENT

Although the probability of fuel rod rupture has been shown to be low, the consequences of such a rupture have been evaluated as the maximum credible accident. Very conservative assumptions have been used throughout the analysis.

The irradiation time of the rod has been conservatively estimated at 930 EFPD, core power at 102% of rated power, and rod peaking factor at 1.65. Other assumptions are based on Regulatory Guide 1.25 and the Oconee FSAR, sections 14.2.2.1 and 14.2.2.4. These are:

1. Fuel rod gap inventory of Kr^{85} is 30% of the total.

2. Fuel rod gap inventory of other noble gases and iodine is 10% of the total.

3. All noble gases and 1% of the iodine in the gap escapes to the spent fuel pool air.

4. Atmospheric dispersion factor is 3.35×10^{-5} sec/m^3 (elevated release).

5. Beta and gamma dose rates (rads/sec) are $0.23\ \overline{E}_\beta\chi$ and $0.507\ \overline{E}_\alpha\chi$, respectively.

The offsite two-hour dose consequences, based on these assumptions, are as follows:

Thyroid dose 5.9×10^{-3} rem,

Whole-body dose 7.3×10^{-6} rem,

Surface body dose 5.5×10^{-5} rem.

These are well below the 10CFR100 guidelines.

In calculating the maximum dose rates at the platform of the Spent Fuel Pool bridge, an infinite cloud volume of 10 m^3 (1.3 m in radius) was used, and assumed to contain all the fission products released. The resulting whole-body gamma dose rates for a decay time of twelve weeks (approximately October 28, 1977) is 168 mr/min.

Because of the close visual monitoring of the entire rod pulling operation (television in addition to normal observation), it is expected that a rod break and the subsequent bubbles from the pressurized rod will be immediately apparent. Adequate time is available for an orderly evacuation of the pool area before personnel exposure is significantly adversely affected.

8. REFERENCES

1. Harris, K. N., Hutchinson, J. J., and Smith, E. H., Onsite Reconstitution of 108 St. Lucie 1 Fuel Assemblies; Trans. ANS, Suppl. 1 to Vol. 26, Conference on Reactor Operating Experience, August 7-10, 1977.

2. Tarby, E. J., Sipush, P. J., and Balfour, M. G., Interim Report, Surry Unit 1 EOC-2 Onsite Fuel Examination of 17x17 Demonstration Assemblies After One Cycle of Exposure; WCAP-8836, Dec. 1976.

3. Crain, H. H., Caye, T. E., and Sipush, P. J., Interim Report, Zion Unit 1, Cycle 1, Fuel Performance, WCAP-8836, Dec. 1976.

4. Fuhrman, N., et al, Evaluation of Fuel Performance in Maine Yankee Core 1, Task C, EPRI-NP-218, Nov. 1976.

Figure 1. Line Scan Test Frame

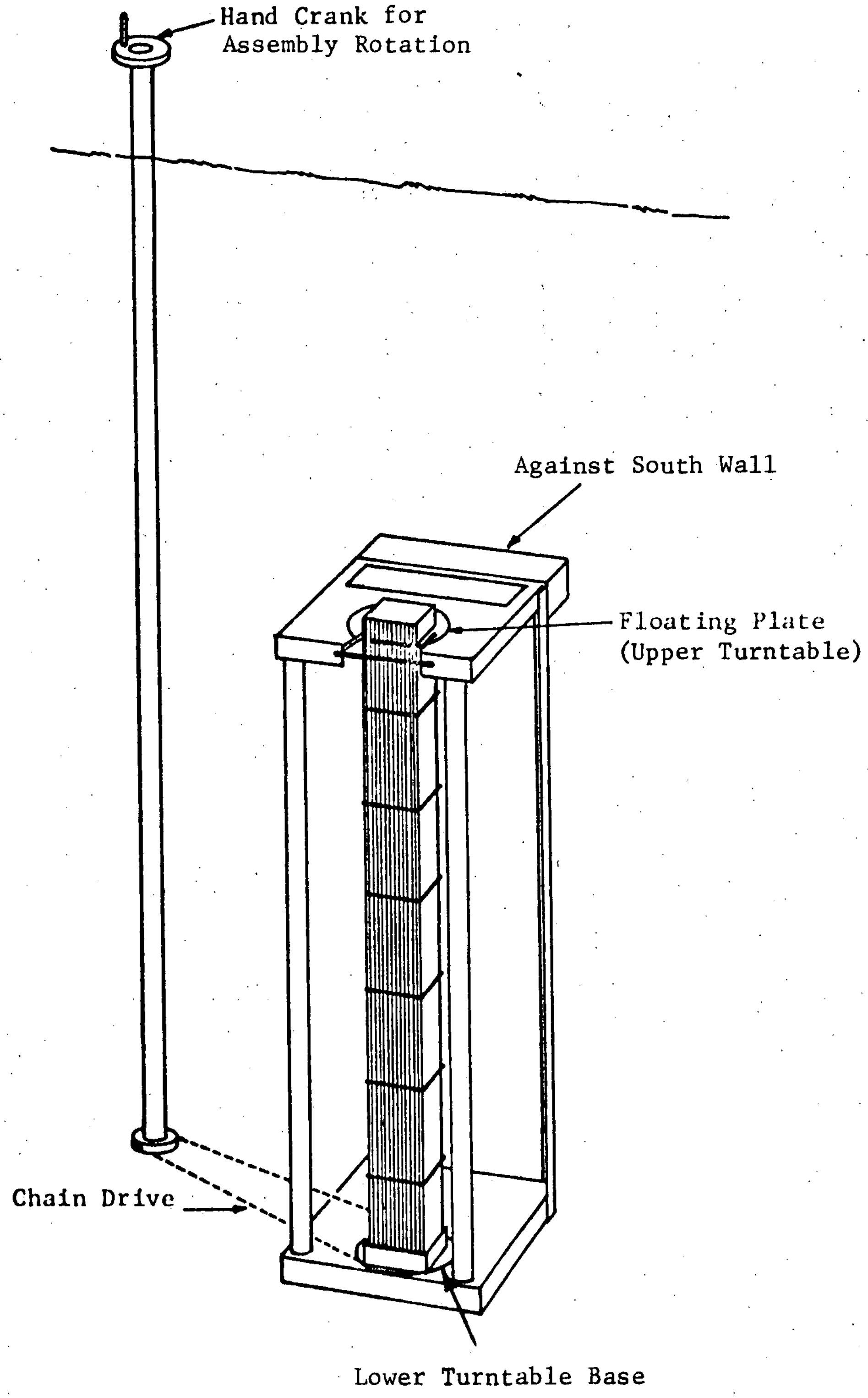
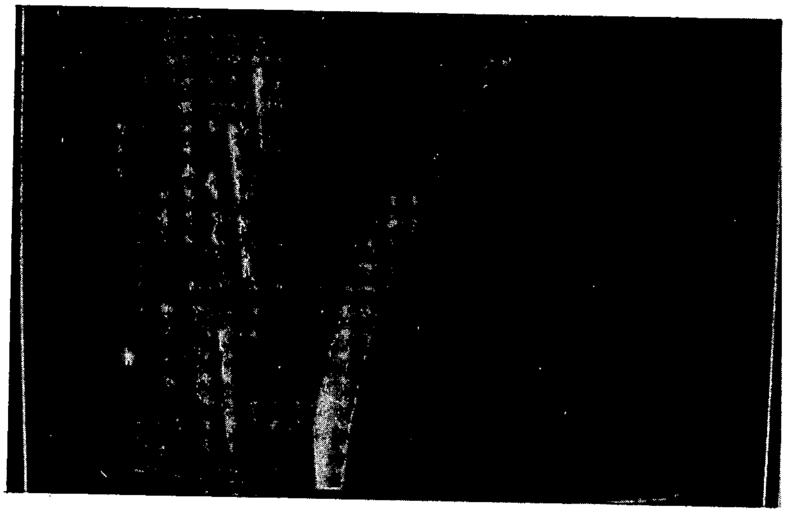
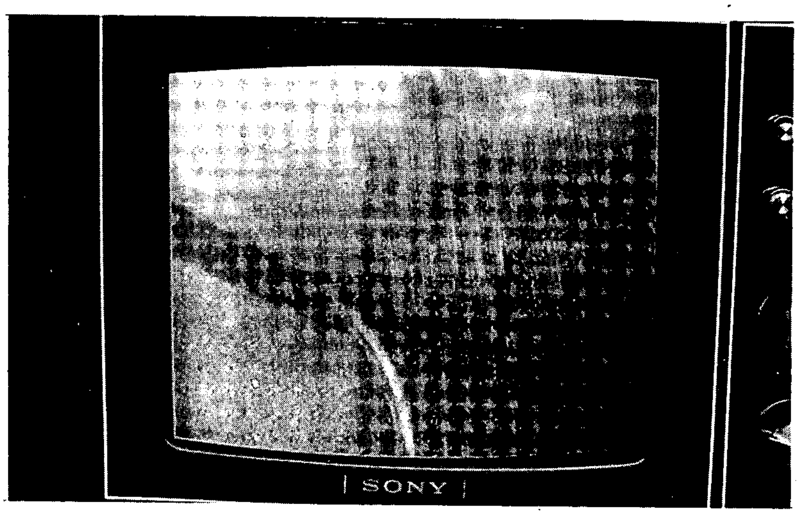


Figure 2. Photograph of Rod Bend Area

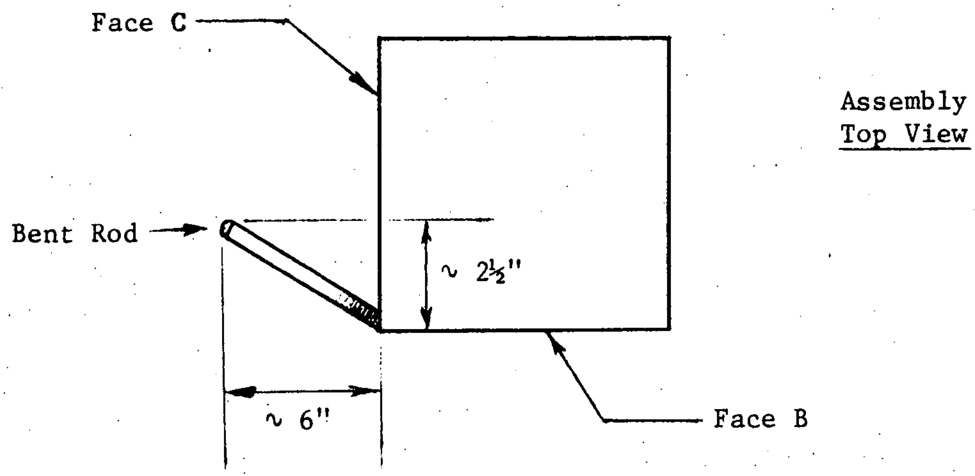


View Along Face C



View Approximately Perpendicular to Face B

Figure 3. Sketches of Damaged Fuel Assembly 1D40



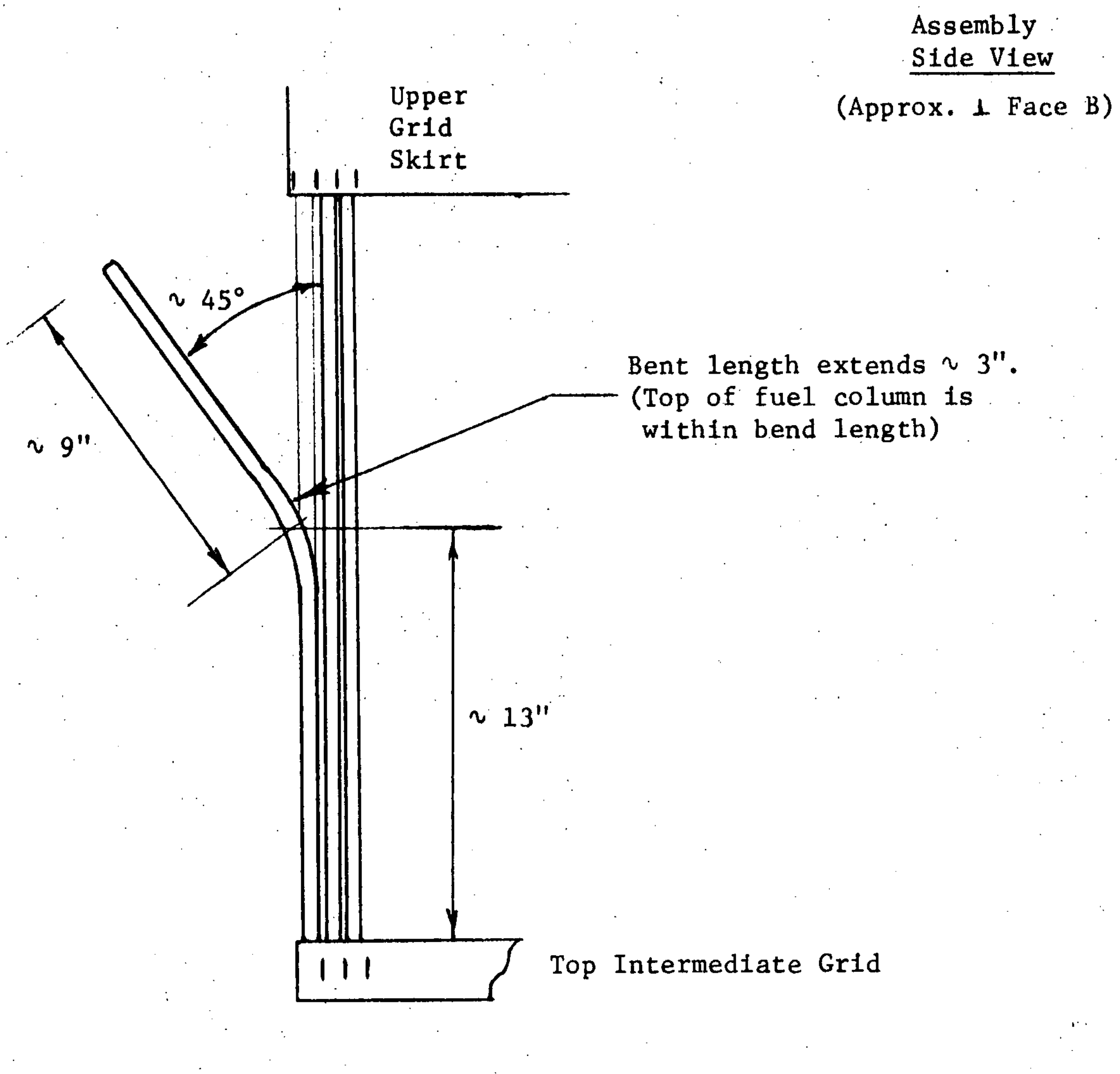


Figure 4. Fuel Rod Pulling Arrangement
(Not to Scale)

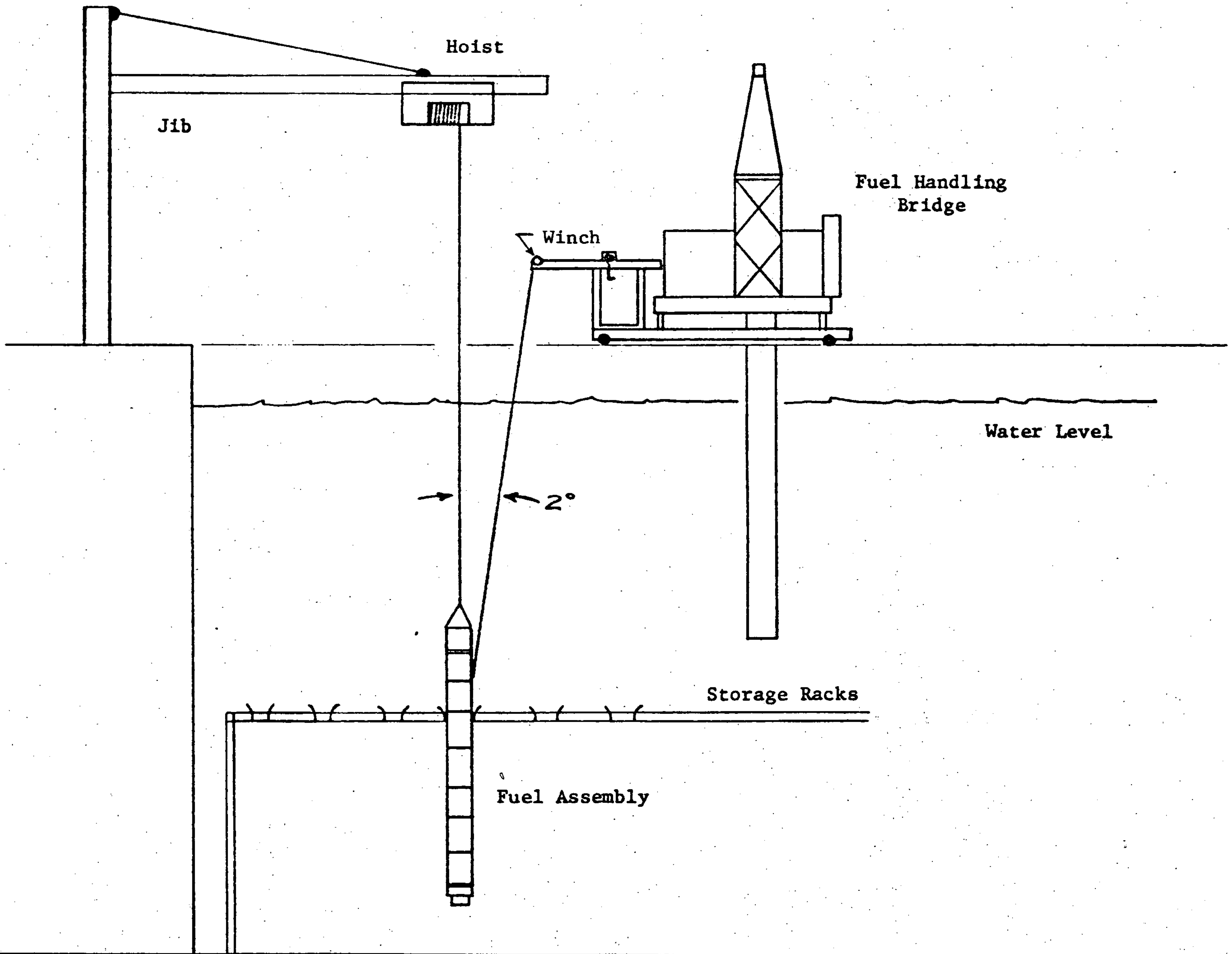


Figure 5. Photographs of Gripping Assembly