**ADVANCED NUCLEAR FUELS** CORPORATION

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S.L. Wu
PDR

November 6, 1990
RAC:131:90

R. C. Jones
Chief Reactor Systems Branch
Division of Engineering and System Technology
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington D.C 20555

Dear Mr. Jones:

Subject: ANF Annual Fuel Performance Report

Reference: Letter, R. C. Jones (USNRC) to R. A. Copeland, (ANF), "Fuel Performance Annual Report," September 20, 1990.

Attached is the Advanced Nuclear Fuels Annual Fuel Performance Report for 1989 as requested in the referenced letter.

Please contact me if there are questions or if further information is needed.

Sincerely,

R. A. Copeland
Manager, Reload Licensing

skm

cc: Dr. S. L. Wu (USNRC)

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ADVANCED NUCLEAR FUELS

1989 FUEL PERFORMANCE

As of December 31, 1989, ANF fuel had been loaded into 47 commercial light water reactors in the United states, Europe, and Asia, including 22 BWRs and 25 PWRs. ANF fuel has also been supplied to the LOFT test reactor.

By the end of 1989, a total of 16,480 fuel assemblies comprising 1,957,723 fuel rods had been irradiated. Of these, 10,521 assemblies were irradiated in BWRs and 5,959 assemblies were irradiated in PWRs. ANF fuel experience is summarized in Table 1. The distribution of ANF fuel versus burnup is shown in Figure 1.

The highest exposures reached by ANF fuel to date are 50.0 GWD/MTU in the Tihange-1 PWR in Belgium, and 41.1 GWD/MTU at the Big Rock Point BWR in Michigan. ANF BWR 9x9 and PWR 17x17 fuel assemblies reached new high burnups during 1989. The highest exposures reached by BWR 9x9 and PWR 17x17 fuel are 40.0 GWD/MTU at Gundremmingen-3 in Germany and 44.0 GWD/MTU at D. C. Cook-2 in Michigan, respectively. BWR 9x9 and PWR 17x17 fuel are more resistant to failure because of reduced linear heat generation rates. Additional benefits are lower fuel temperatures, less fission gas release, decreased pellet-clad interaction and lower clad stresses.

Through 1989 ANF fuel rod integrity remained better than 99.997%. Table 2 provides failure statistics on all ANF fuel rods through December 31, 1989. To access the overall performance of ANF Fuel, ANF uses the INPO Fuel Reliability Indicator (FRI). The FRI for PWRs is the iodine-131 coolant activity level normalized to a standard cleanup system flow rate and corrected for tramp uranium. For BWRs the FRI is determined from the rate of fission gas release measured at the steam jet air ejector. Lower FRI values are qualitatively indicative of fewer failed rods in the core. The FRI distribution for ANF PWR and BWR fuel is shown in Figure 2. This information is derived from the 1989 yearly average for each reactor that operated with ANF fuel in the core. The information shown in Figure 2 indicates that ANF fuel performed to the

industry standard in 1989. ANF did not have any fuel failures attributed to design or manufacturing in 1989. The five-year trend in the ANF FRI indicates a continued improvement in fuel performance.

During 1989, leaks in cladding attributable to causes other than fuel design or manufacturing were found to be from trapping or lodging of debris from the coolant stream where it could cause fretting of the cladding.

ANF standard cladding continued to show good corrosion performance in all reactor environments based on corrosion data collected during 1989. These data were obtained at three PWRs and four BWRs. Beta-quenched cladding reached exposures as high as 39.6 GWD/MTU and exhibited superior corrosion performance in BWRs, particularly in those BWRs which are susceptible to Crud Induced Localized Corrosion (CILC).

Table 3 shows the 1989 status of ANF major fuel surveillance programs.

TABLE 1

SUMMARY OF ANF FUEL

EXPERIENCE THROUGH 12/31/89

A. FUEL ASSEMBLIES

| Reactor Type | In Core Quantity | In Core Max. Burnup GWD/MTU | Discharged Quantity | Discharged Max. Burnup GWD/MTU | Total Quantity |
|---|---|---|---|---|---|
| BWR | 7,674 | 34.4 | 2,847 | 41.1[1] | 10,521 |
| PWR | 1,989 | 45.0 | 3,970 | 50.0 | 5,959 |
| Total | 9,663 | | 6,817 | | 16,480 |

B. FUEL RODS

| Reactor Type | In-Core | Discharged | Total |
|---|---|---|---|
| BWR | 525,862 | 176,686 | 702,548 |
| PWR | 447,902 | 807,273 | 1,255,175 |
| Total | 973,764 | 983,959 | 1,957,723 |

[1] Average of extended burnup rods transferred to a new host fuel assembly.

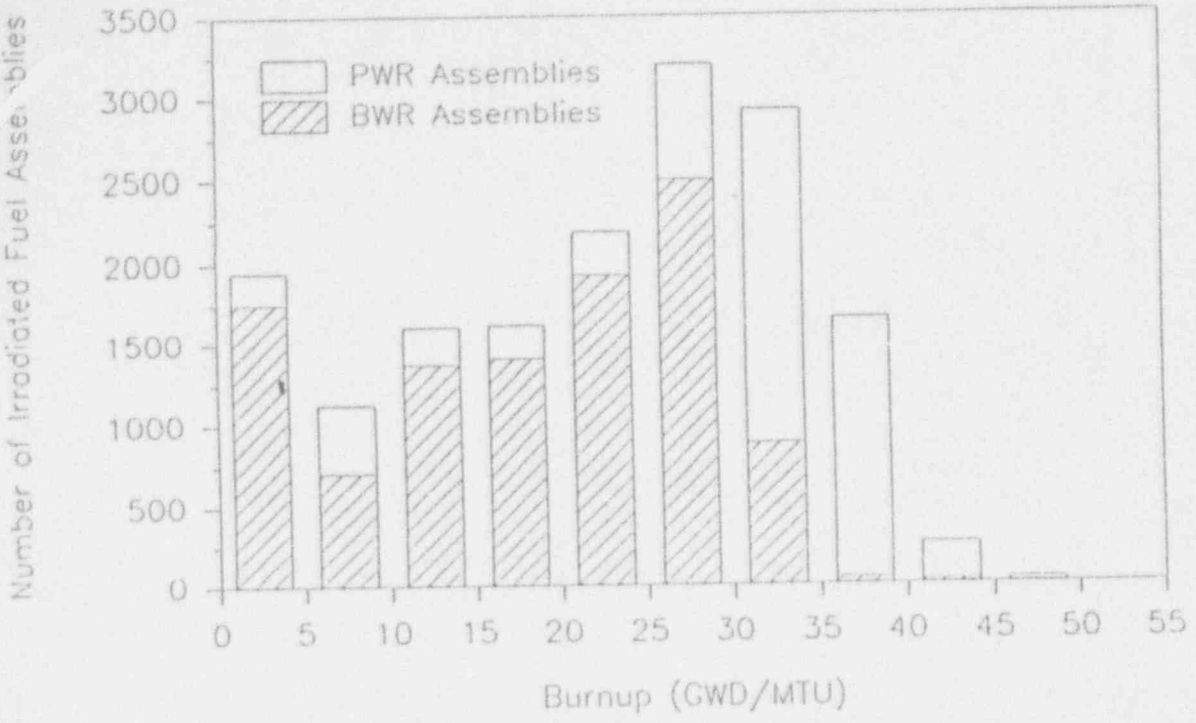
TABLE 2
ANF FUEL ROD FAILURE STATISTICS
AS OF DECEMBER 31, 1989

| | No. of Irradiated Rods | Failed Rods Burnup Less Than Warranted, Fuel Related | | Failed Rods Burnup Less Than Warranted, Core Related | | All Other ANF Failures* | | Total Failures | |
|---|---|---|---|---|---|---|---|---|---|
| | | No. | Rate | No. | Rate | No. | Rate | No. | Rate |
| BWR: | 702,548 | 50 | 0.007% | 98 | 0.014% | 13 | 0.002% | 161 | 0.023% |
| PWR: | 1,255,175 | 16 | 0.001% | 114 | 0.009% | 73 | 0.006% | 203 | 0.016% |
| TOTAL | 1,957,723 | 66 | 0.003% | 212 | 0.011% | 86 | 0.004% | 364 | 0.019% |

* Failures not examined and/or above warranted burnup.

TABLE 3
ADVANCED NUCLEAR FUELS
MAJOR FUEL SURVEILLANCE PROGRAMS
STATUS THROUGH 1989

| Fuel Type | Reactor | No. Operating Cycles Planned (Completed) | Scheduled Program Completion | Interim Inspections Completed |
|---|---|---|---|---|
| 15x15 | Robinson-2 | 5(5) | Complete | 3 |
| 14x14 | Prairie Island-2 | 3(3) | Complete | 1 |
| 8x8 | Oyster Creek | 5(5) | Complete | 5 |
| 11x11 | Big Rock Point | 4(4) | Complete | 3 |
| 14x14 | Ginna | 5(4) | 1990 | 3 |
| 17x17 | Blayais-3 | 4(3) | 1990 | 2 |
| 8x8 | WNP-2 | 4(2) | 1991 | 2 |
| 14x14 | Calvert Cliffs | 3(0) | 1993 | 0 |
| 15x15 | Palisades | 3(0) | 1993 | 0 |
| 9x9 | Hatch-2 | 3(1) | 1994 | 1 |
| 9x9 | Hatch-1 | 3(0) | 1995 | 0 |



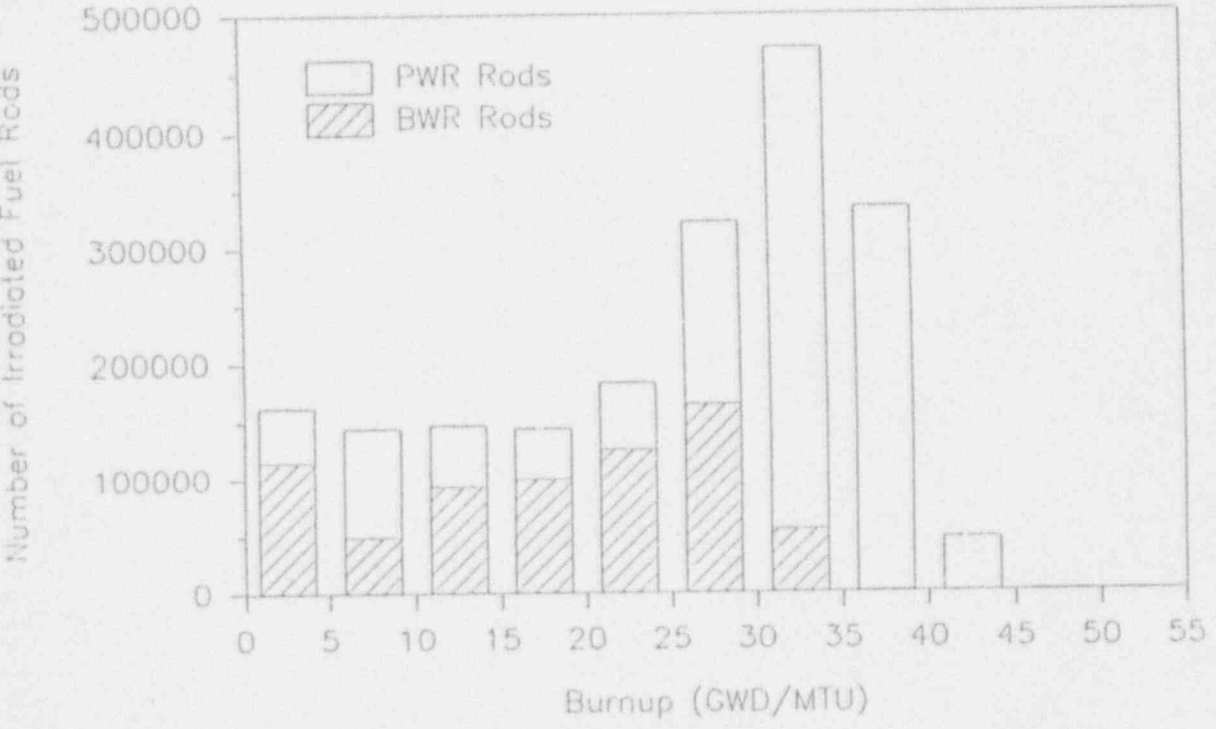




Figure 1 Distribution of Irradiated Advanced Nuclear Fuel by Exposure Through the End of 1989.

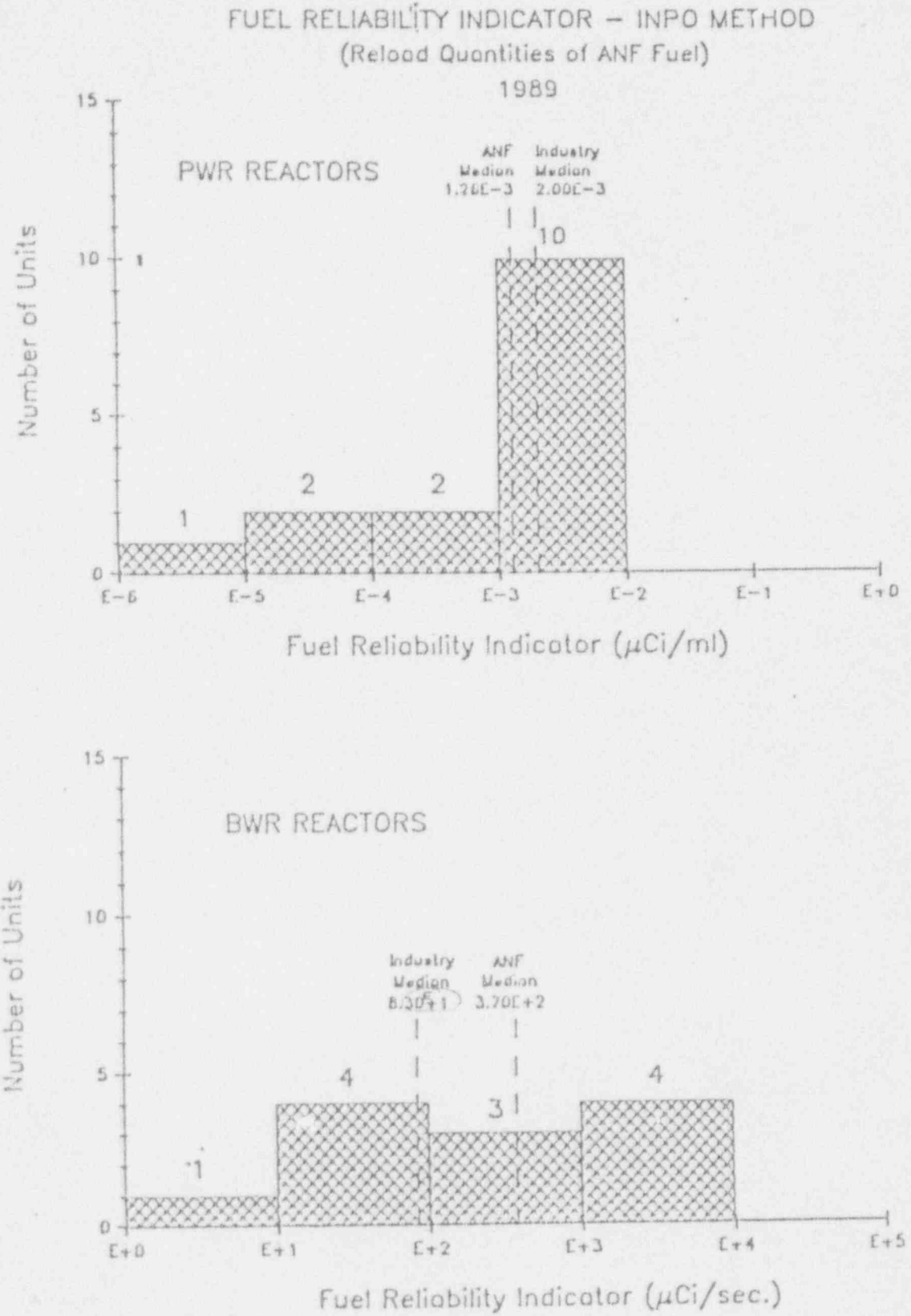

FUEL RELIABILITY INDICATOR – INPO METHOD
(Reload Quantities of ANF Fuel)
1989
PWR REACTORS
ANF Median 1.20E-3
Industry Median 2.00E-3
Number of Units
15
10
5
0
1
2
2
10
1
E-6
E-5
E-4
E-3
E-2
E-1
E+0
Fuel Reliability Indicator (μCi/ml)
BWR REACTORS
Industry Median 8.30E+1
ANF Median 3.70E+2
Number of Units
15
10
5
0
1
4
3
4
E+0
E+1
E+2
E+3
E+4
E+5
Fuel Reliability Indicator (μCi/sec.)

FIGURE 2