CONNECTICUT YANKEE ATOMIC POWER COMPANY

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NOTED MAR 7 1978 L.D.D.

March 6, 1978

Docket No. 50-213

Director of Nuclear Reactor Regulation
Attn. Mr. V. Stello, Jr., Director
Division of Operating Reactors
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

References: (1) V. Stello, Jr., letter to D. C. Switzer dated December 23, 1977.
(2) D. C. Switzer letter to V. Stello, Jr., dated February 15, 1978.
(3) V. Stello, Jr., letter to D. C. Switzer dated December 1, 1977.
(4) NRC Staff Meeting Summary dated January 18, 1978.

Gentlemen:

Haddam Neck Plant
Environmental Qualification of Safety-Related Electrical Equipment

In Reference (1), the NRC Staff discussed its plans to review the environmental qualifications of safety-related electrical equipment as the first topic of the Systematic Evaluation Plan (SEP); the conduct of the SEP had been discussed previously in Reference (3). To initiate the review, the NRC Staff requested CYAPCO to provide within 60 days certain information. (Note that additional time was requested by CYAPCO in Reference (2)). Additional background and interpretation of the requested information was received from the NRC Staff at a January 5, 1978 meeting (see Reference (4)) and during a site visit on January 19, 1978.

In response to the NRC Staff request and in accordance with 10CFR§50.54(f), CYAPCO hereby provides the attached information.

The Attachment summarizes the results of the evaluation conducted by CYAPCO and Northeast Utilities Service Company (NUSCO) to assess the level of environmental qualification of safety-related electrical equipment at the Haddam Neck Plant. This evaluation was performed in accordance with the requests made in Reference (1) and the additional background and interpretations discussed at the two meetings mentioned above.

Based on the results of the evaluation, it is the judgment of CYAPCO that electrical equipment at the Haddam Neck Plant would perform its safety function such that the plant could be safely shutdown following the analyzed events.

Thus, CYAPCO believes that there is reasonable assurance that continued operation of the Haddam Neck Plant would not create undue risk to the health and safety of the public.

Very truly yours,

CONNECTICUT YANKEE ATOMIC POWER COMPANY

D. C. Switzer

D. C. Switzer
President

By: W. F. Fee

W. F. Fee
Vice President

Attachment

STATE OF CONNECTICUT )
) ss. Berlin March 6, 1978
COUNTY OF HARTFORD )

Then personally appeared before me W. F. Fee, who being duly sworn, did state that he is Vice President of The Connecticut Yankee Atomic Power Company, the Licensee herein, that he is authorized to execute and file the foregoing information in the name and on behalf of the Licensee herein and that the statements contained in said information are true and correct to the best of his knowledge and belief.

Sheila M. Oates
Notary Public
My Commission Expires March 31, 1991

ATTACHMENT

DOCKET NO. 50-213

# CONNECTICUT YANKEE ATOMIC POWER COMPANY

# HADDAM NECK PLANT

# ENVIRONMENTAL QUALIFICATION OF SAFETY-RELATED ELECTRICAL EQUIPMENT

MARCH, 1978

In a December 23, 1977 letter[1], the NRC Staff requested that CYAPCO review the level of environmental qualification of safety-related electrical equipment both inside and outside the containment at the Haddam Neck Plant. In response to this request, CYAPCO, Northeast Utilities Service Company (NUSCO), and various other consultants conducted such a review. The results of the review are presented below.

EQUIPMENT OUTSIDE CONTAINMENT

In February, 1975[2], and in various supplements, CYAPCO submitted its revised plans for mitigating the consequences of High Energy Pipe Break (HEPB) outside containment. These revised plans, as described in a December, 1974[3] letter, were necessitated by material availability problems related to the implementation of the CYAPCO original proposal[4]. The original proposal had already been accepted by the NRC (AEC) Staff in March, 1974[5].

In its Safety Evaluation Report (SER), dated July 14, 1977[6], the NRC Staff discussed the results of its review of the revised CYAPCO proposal to provide necessary protection against HEPB. Therein, the NRC Staff concluded, in pertinent part, that the "proposed systems of barriers, restraints, and encapsulation sleeves provide an acceptable basis for satisfying the applicable requirements of NRC General Design Criteria No. 4 . . ." [See Reference (7) for details on GDC No. 4].

CYAPCO has, therefore, concluded that the ability of electrical equipment located outside containment to withstand the limiting environmental conditions has been assessed previously by CYAPCO and NRC Staff and found to be acceptable.

EQUIPMENT INSIDE CONTAINMENT

With regard to safety-related electrical equipment inside containment, two events were considered in the CYAPCO evaluation, since these could result in

the most limiting environmental conditions; these events were the Main Steamline Break (MSLB) and the Loss of Coolant Accident (LOCA), as described in Section 10.3.3 of the Facility Description and Safety Analysis Report (FDSA) and the analyses[8] performed pursuant to the Interim Policy Statement (IAC) of June, 1971, respectively.

MSLB

For the MSLB, CYAPCO has reviewed electrical equipment located inside containment, which is necessary for safe shutdown, as described in Section 10.3.3 of the FDSA and in Section IV of Reference (2). This review has indicated that the equipment noted on Table A-1 would be necessary for safe shutdown and could be subjected to the environment created by a MSLB inside containment.

The environmental conditions to which this equipment would be subjected have also been evaluated by CYAPCO. This evaluation has concluded that the containment pressure following a MSLB would be expected to be less than that following a postulated LOCA. Thus, the containment pressure following a LOCA would be the more limiting environmental condition and should be used to assess equipment qualification.

CYAPCO has also evaluated the average temperature conditions inside containment following a postulated MSLB. Analyses performed for CYAPCO by Teledyne Engineering Services has indicated that the peak average containment temperature expected following a MSLB would be expected to be between 251.7°F and 267.3°F, as shown in Table A-2. Regardless of the specific assumptions, this peak would only exist for short periods of time. The duration of the peak has been confirmed generically and also by "best estimate" analyses conducted by the NRC Staff. It is, therefore, the judgment of CYAPCO that the temperature environment postulated for a MSLB would not be more severe than that postulated for

a LOCA since, (1) the peak temperatures for both events are approximately equal, and (2) the duration of the temperature peak during the MSLB is significantly less than that of the LOCA. Thus, the temperature profile postulated for a LOCA can be used to bound the conditions expected for the MSLB.

LOCA

For the postulated LOCA, CYAPCO has also reviewed equipment located inside containment which is necessary for safe shutdown. This review has indicated that the equipment noted on Table A-1 would be necessary to function and could be subjected to the environment created by the postulated LOCA. Also included with Table A-1 are the functions and service times for this equipment.

The environmental conditions to which this equipment would be subjected has also been evaluated by CYAPCO. The radiation environment used in assessing the qualification of this equipment is given in Table A-3. As noted therein, these levels were determined based upon a realistic assessment of the radiological releases following a postulated LOCA superimposed on the projected radiation levels for the normal operating environment. The realistic assessment of radiological releases following a LOCA was based upon the guidance of NRC Regulatory Guide 4.2; the assessment also considered dose variations due to location, time following LOCA, and whether or not the equipment was exposed to the containment environment.

It is the opinion of CYAPCO that these radiation levels are realistic for equipment environmental qualification based on the excellent performance of the stainless steel clad fuel at the Haddam Neck Plant and, also the fact that the analyses presented in Reference (8) indicate that no fuel melt is expected during a LOCA for the Haddam Neck Plant.

With respect to submergence of electrical equipment, CYAPCO has previously evaluated the potential for flooding of equipment inside containment following a postulated LOCA[9]. The NRC Staff has accepted that evaluation and the recommended actions[10].

Humidity and chemical spray environments have also been considered in the CYAPCO evaluation. Specifically, 100% relative humidity (R.H.) and 1.5% boric acid were evaluated. It should be emphasized, however, at the Haddam Neck Plant, the containment spray system is not expected to be used during a postulated LOCA for control of containment pressure and radiological releases. In fact, no credit has been taken in either type of analysis for the mitigating effects of the spray.

CYAPCO has evaluated the containment pressure response following a postulated LOCA. This evaluation has considered the information obtained from analyses performed in connection with the original design of the Haddam Neck Plant and more recent qualitative and quantitative assessments based on review of generic analyses. It is the judgment of CYAPCO that the pressure in containment following a LOCA would rise to a peak value of approximately 30 - 35 psig within the first ten seconds, remain at the peak value until approximately 1000 seconds into the transient, and then decay to its initial value within 100,000 seconds.

In determining the containment temperature environment following a postulated LOCA, CYAPCO utilized the pressure transient to the extent that, by assuming saturated conditions, the upper bound on temperature is reasonably established. In addition, an engineering assessment of the peak containment temperature was made by representative calculations and by reviewing generic analyses. The result of the overall effort was the confirmation that the containment temperature could be reasonably expected to reach an approximate peak value of 260°F in about the same time as the pressure peak. The temperature profile would follow the pressure profile up to the time of the peak pressure, after which time the rate of decrease in the temperature profile would lag behind the decrease in pressure.

CONCLUSIONS

Electrical equipment which has been deemed necessary by CYAPCO to perform a safety function during the MSLB or LOCA is listed in Table A-1. Only that equipment, which is: (1) necessary for safe shutdown, and (2) exposed to LOCA enviornment, has been included in Table A-1. The CYAPCO evaluation has not identified any non-safety systems which could affect the safety function of equipment listed in Table A-1.

The limiting environmental conditions inside containment have also been evaluated and are described on Page A-1 through A-5 and Table A-3. These conditions are felt to be realistic, yet still have some inherent conservatisms in their derivation. The limiting environmental conditions have been determined based primarily upon consideration of the MSLB and LOCA environments; that is, normal operation has not been a significant contributor to the limits. CYAPCO believes that this is a realistic approach since the normal operating environment would affect electrical equipment in a gradual process. Therefore, any deterioration would be detected early as part of the extensive periodic surveillance, conducted in accordance with routine plant operating and maintenance procedures and Technical Specifications, and, appropriate corrective action taken. Review of plant operations at the Haddam Neck Plant tends to indicate a relatively small number of equipment failures in over ten years of commercial operation.

Finally, CYAPCO has assessed the level of environmental qualification for the indicated electrical equipment by either test and/or analysis. For primary safety-related equipment, these tests and/or analyses have indicated that the electrical equipment at the Haddam Neck Plant is qualified to perform its particular safety function under the environmental conditions which exist during the time period required to operate. Evaluation of the qualification in a radiation environment

for some equipment is continuing, as CYAPCO has not yet been able to obtain the release of data from the particular vendor(s). Even in these cases, the specific equipment is not taken credit for in the accident analyses. For those evaluations which have been finalized, documentation of the qualification test and/or analysis is on file at the NUSCO Engineering Offices.

In conclusion, based on the results of the evaluation, CYAPCO believes that necessary electrical equipment inside containment would perform its safety function under the postulated limiting environmental conditions for the events analyzed.

TABLE A-1

SUMMARY OF QUALIFICATIONS OF ELECTRIC EQUIPMENT SUBJECTED TO LOCA ENVIRONMENT

(T) - Test
(A) - Analysis
} Method of Qualification

HADDAM NECK PLANT

| EQUIP. NO. | EQUIPMENT TITLE | PLANT LOCATION | LIMITING PRESSURE ENVIRONMENT | QUALIFIED | LIMITING TEMPERATURE ENVIRONMENT | QUALIFIED | LIMITING RADIATION ENVIRONMENT | QUALIFIED | HUMIDITY/ CHEMICAL SPRAY ENVIRONMENT EXPOSURE | QUALIFIED |
|---|---|---|---|---|---|---|---|---|---|---|
| **MOV 861 A-D | Reactor Coolant-Loop Injection Valves | Middle Level Outer Annulus Containment | See Page A-5 | YES (T) | See Page A-5 | YES (T) | See Table A-3 | YES (A) | 100%/1.5% Boric Acid in Demin. $H_2O$ | YES (T) |
| MOV 311 | Reactor Coolant Pump Seal Water Return Line Valve | Middle Level Outer Annulus Containment | | YES (T) | | YES (T) | | YES (A) | | YES (T) |
| MOV 312 | Reactor Coolant Pump Seal Water Return Line Valve | Middle Level Outer Annulus Containment | | YES (T) | | YES (T) | | YES (A) | | YES (T) |
| MOV 313 | Reactor Coolant Pump Seal Water Return Line Valve | Middle Level Outer Annulus Containment | | YES (T) | | YES (T) | | YES (A) | | YES (T) |
| MOV 314 | Reactor Coolant Pump Seal Water Return Line Valve | Middle Level Outer Annulus Containment | | YES (T) | | YES (T) | | YES (A) | | YES (T) |
| **MOV 871A | Reactor Core Deluge Valve | Reactor Cavity Containment | | YES (T) | | YES (T) | | YES (A) | | YES (T) |
| **MOV 871B | Reactor Core Deluge Valve | Reactor Cavity Containment | | YES (T) | | YES (T) | | YES (A) | | YES (T) |
| MOV 23 | Reactor Containment Spray Valve | Lower Level Outer Annulus Containment | | YES (T) | | YES (T) | | NOTE 1 | | YES (T) |
| MOV 34 | Reactor Containment Spray Valve | Lower Level Outer Annulus Containment | | YES (T) | | YES (T) | | NOTE 2 | | YES (T) |
| MOV 25-29 | Charcoal Filter Spray Line Valves | Lower Level Outer Annulus Containment | | YES (T) | | YES (T) | | NOTE 3 | | YES (T) |
| **MOV 292B | Charging Flow Stop Valve | Lower Level Outer Annulus Containment | | YES (T) | | YES (T) | | YES (T) | | YES (T) |
| **MOV 292C | Charging Flow Stop Valve | Lower Level Outer Annulus Containment | | YES (T) | | YES (T) | | YES (T) | | YES (T) |
| *MOV 780 | RHR Inboard Stop-Loop #1 Valve | Middle Level Outer Annulus Containment | | YES (T) | | YES (T) | | YES (A) | | YES (T) |
| *MOV 781 | RHR Outboard Stop-Loop #1 Valve | Lower Level Outer Annulus Containment | | YES (T) | | YES (T) | | YES (A) | | YES (T) |
| *MOV 803 | RHR Outboard Stop-Loop #2 Valve | Lower Level Outer Annulus Containment | | YES (T) | | YES (T) | | YES (A) | | YES (T) |
| *MOV 804 | RHR Inboard Stop-Loop #2 Valve | Middle Level Outer Annulus Containment | | YES (T) | | YES (T) | | YES (A) | | YES (T) |
| MOV 200 | Letdown Isolation Valve | Middle Level Outer Annulus Containment | | YES (T) | | YES (T) | | YES (A) | | YES (T) |
| F-17-1,2,3,4 | Containment Air Recirculation Fan Motors | Middle Level Outer Annulus Containment | | YES (T)/(A) | | YES (T)/(A) | | YES (T)/(A) | | YES (T)/(A) |
| **PT 401-1,2,3 | Pressurier Pressure Transmitters | Lower Level Outer Annulus Containment | | NOTE 4 | | NOTE 4 | | NOTE 4 | | NOTE |
| LT 1-1,2,3 | Pressurier Level Transmitters | Lower Level Outer Annulus Containment | | NOTE 5 | | NOTE 5 | | NOTE 5 | | NOTE |

*Used only in small break LOCA (where discharge rate is less than charging rate for a prolonged period of time) and main steam line break in containment for normal cooldown of RCS to 200°F.

**Used for main LOCA and Main Steam Line Break.

TABLE A-1 (Cont'd)

| EQUIP. NO. | EQUIPMENT TITLE | PLANT LOCATION | LIMITING PRESSURE ENVIRONMENT | QUALIFIED | LIMITING TEMPERATURE ENVIRONMENT | QUALIFIED | LIMITING RADIATION ENVIRONMENT | QUALIFIED | HUMIDITY/ CHEMICAL SPRAY ENVIRONMENT EXPOSURE | QUALIFIED |
|---|---|---|---|---|---|---|---|---|---|---|
| ** - | 1000V Control Cable | All Areas Containment | See Page A-5 | YES (A) | See Page A-5 | NOTE 6 | See Table A-3 | YES (A) | 100%/1.5% Boric Acid in Demin. $H_2O$ | YES (A) |
| ** - | 600V Power Cable | All Areas Containment | | YES (A) | | YES (A) | | YES (A) | | YES (A) |
| ** - | Instrument Cable | All Areas Containment | | YES (A) | | NOTE 7 | | YES (A) | | YES (A) |
| - | Mineral Insulated Cable | All Areas Containment | | YES (A) | | YES (A) | | YES (A) | | YES (A) |
| - | Silicon Insulated Hypalon Jacketed Cable | Middle/Lower Level Outer Annulus Containment | | YES (A) | | YES (A) | | YES (A) | | YES (A) |
| - | Charcoal Filter Temp. Detectors (40) | Middle Level Outer Annulus Containment | | YES (A) | | YES (T) | | NOTE 8 | | YES (A) |
| - | Air Solenoids for Car Fan Dampers (8) | Middle Level Outer Annulus Containment | | NOTE 9 | | NOTE 9 | | NOTE 9 | | NOTE 9 |
| - | Terminal Blocks | Lower Level Outer Annulus Containment | | YES (A) NOTE 10 | | YES (A) NOTE 10 | | YES (A) NOTE 10 | | YES (A) NOTE 10 |
| ** - | Containment Electrical Penetrations | Lower Level Outer Annulus Containment | | YES (A) NOTE 11 | | YES (A) NOTE 11 | | YES (A) NOTE 11 | | YES (A) NOTE 11 |

| Equipment No. | Function in Accident |
|---|---|
| MOV 861 A-D | Open to permit safety injection flow to primary loops |
| MOV 311, 312, 313, 314 | Closes to prevent high temperature reactor coolant from flowing through the pressure housing of the RCS pumps |
| MOV 871 A, B | Open to permit safety injection flow directly into the core and recirculation flow during long-term cooling |
| MOV 23, 34 | Used as backup to reduce fission product concentration and containment pressure following LOCA |
| MOV 25-29 | Used as backup for fire protection of charcoal filters |
| MOV 292 B, C | Provides charging flow for core cooling and recirculation flow during long-term cooling |
| MOV 780, 781, 803, 804 | Open to permit RHR flow to allow cooldown of reactor coolant system to less than 200°F following a small LOCA. |
| MOV 200 | Containment isolation of letdown line |
| F-17-1, 2, 3, 4 | Used to effect a rapid depressurization of the containment and to provide for iodine filtration as fission products are released from the core |
| PT 401-1, 2, 3<br>LT 401-1, 2, 3 | Initiate safety injection |
| 1000 V Control,<br>600 V Power, and<br>Instrument Cabling | Provides electrical power, control, and signals to safety related equipment |
| Mineral Insulated Cable | Provides electrical power and control to MOV 25-29 and charcoal filter temp. detectors |
| Silicon Insulated,<br>Hypalon Jacketed Cable | Provides electrical power to containment air recirculation fan motors |
| Charcoal Filter<br>Temp. Detectors | Detects high temperature in charcoal filter banks |

| Equipment No.(Cont'd.) | Function in Accident(Cont'd.) |
|---|---|
| Air Solenoids for CAR Fan Dampers | Shuts air off to actuators which open containment air recirculating fan face dampers and close fan face bypass dampers |
| Terminal Blocks | Provide electrical connections to the individual circuits which utilize the blocks |
| Electrical Penetrations | Provide electrical connections for the individual circuits which utilize the penetrations |

## Service Times of Equipment Inside of Containment Required for LOCA

(A) - Automatic
(M) - Manual

| Equipment | Time of Equipment Service (From Start of Accident) $T_S$ = 0 sec |
|---|---|
| Air Solenoids for CAR Fans Dampers | 1 sec (A) |
| LT-401-1,2,3 | 2.5 sec (A) |
| PT-401-1,2,3 | 2.5 sec (A) |
| MOV 861 A-D | Within 30 sec (A) |
| MOV 871 A, B | Within 30 sec (A) |
| MOV 311, 312, 313, 314 | Within 30 sec (A) |
| MOV 200 | Within 30 sec (A) |
| MOV 292 B, C | Within 30 sec (A) |
| F-17-2, 3 | 30 days (A or M) |
| MOV 23, 34 | Variable (M) |
| F-17-1 and/or -4 | 30 days (A or M) |
| MOV 25-29 | Variable (M) |
| Charcoal Filter Temp. Detectors | Variable (A) |

## FOOTNOTES TO TABLE A-1

Note 1: The evaluation of the level of radiation qualification of this equipment is still in progress in that CYAPCO is currently negotiating obtaining data from the equipment vendor. It should be noted, however, that this equipment is not expected to be used during a postulated LOCA.

Note 2: See Note 1.

Note 3: See Note 1.

Note 4: CYAPCO understands that tests performed at Franklin Research Laboratory on pressure and differential pressure transmitters similar to PT401 and LT401 pressure have indicated the capability to operate (with error) at pressures and temperatures up to 60 psig and 294°F, respectively. This, in conjunction with the fact that within 2.5 seconds from the start of the LOCA, the transmitters will have performed their safety function by generating a signal to initiate safety injection, leads CYAPCO to conclude that the transmitter performance will not be adversely affected by the LOCA environment in the time they are required to function. However, our investigation is continuing into the degree of error which these transmitters exhibited during these tests and its potential effect on the surveillance capabilities of the transmitters subsequent to the MSLB inside containment. Should the results indicate the need to do so, the transmitters would be replaced.

Note 5: See Note 4.

Note 6: The manufacturer has demonstrated from the test results the capability of the cable to perform satisfactory at 260°F for 45 minutes. Control cable is utilized on the following equipments:

| | | |
|---|---|---|
| MOV 861 A-D | MOV 200 | CAR Fan Air |
| MOV 781 A, B | MOV 292 B, C | Solenoids |
| MOV 311, 312, 313, 314 | MOV 23, 34 | |

All of the above equipment, with the exception of MOV 23 and 34 (for which the accident analyses do not take credit), will have completed its safety function within 30.0 seconds after the start of the LOCA. Based on our engineering judgment, CYAPCO believes the cable would be able to perform its safety function since environmental conditions would not be as severe as the test conditions and, thus, would not limit the performance of the above equipment during the time of its required operation.

Note 7: Instrument cable is utilized on the pressurizer pressure and level transmitters. The cable material is similar to the 1000 V control cable. From analyses, it is concluded that the cable performance will not be adversely affected by the accident temperature environment within the first few seconds of the accident, i.e., for the time in which the transmitters are required to function.

Note 8: This equipment has been qualified for a radiation environment of approximately $3.4 \times 10^4$ rads, i.e., the environment to be expected about one hour following a LOCA. However, this equipment is not necessary for safe shutdown; further, as described in Section 3.6.3 of the FDSA, it is not expected to be used following a LOCA.

Note 9: The air solenoids will have completed their safety function about one second following a LOCA. From our analysis, it has been concluded that this equipment would not be adversely affected by the LOCA environment for the time in which it is required to function. Furthermore, these solenoids are fail-safe.

Note 10: A detailed evaluation of the environmental qualification of terminal blocks at the Haddam Neck Plant can be found in References (11), (12), (13), and (14).

Note 11: A detailed evaluation of the environmental qualification of containment electrical penetrations can be found in Reference (15).