New Hampshire
Yankee

Ted C. Feigenbaum
President and
Chief Executive Officer

NYN-91091

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United States Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Document Control Desk

References: (a) Facility Operating License No. NPF-86, Docket No. 50-443

(b) NHY Letter NYN-91010 dated January 24, 1991, "Request for License Amendment; Definitions of Digital Channel Operational Test", T. C. Feigenbaum to USNRC

(c) USNRC Letter dated April 2, 1991, "Seabrook-Technical Specification Digital Channel Operability Test Definition: Request for Additional Information (TAC No. 79742) "G. E. Edison to T. C. Feigenbaum

Subject: Request for Additional Information: Digital Channel Operational Test Definition

Gentlemen:

The additional information regarding the performance of a Digital Channel Operational Test and digital equipment used at Seabrook Station as requested in Reference (c) is provided in the Enclosure. This information does not change the request for a license amendment nor does it affect or change the no significant hazards consideration provided by Reference (b).

Should you have any questions regarding this matter please contact Mr. James M. Peschel, Regulatory Compliance Manager, at (603) 474-9521, extension 3772.

Very truly yours,

Ted C. Feigenbaum

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Enclosure

TCF:JMP/ssl/act

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ENCLOSURE TO NYN-91091

Response to Request for Additional Information
Digital Channel Operational Test Definition

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Request No. 1 Please provide a description of the digital equipment that will be affected by the proposed definition and proposed footnote changes. Include a hardware configuration description and reasons, if any, that the injection of a simulated signal is not practical.

Response:

New Hampshire Yankee utilizes 22 radiation monitors that are governed by the Technical Specifications. Of these 22 radiation monitors, 10 are Class 1E and 12 are non-safety class. The radiation monitors and their classifications are provided in Figure 1. The monitors are part of the Radiation Monitoring (RM) System, manufactured by General Atomic, which contains equipment that organizes radiation monitoring data and presents a centralized display and alarms to the operator. The system consists of three sub-systems:

- Detection system.

  The detection system includes the radiation detectors and the field monitors (RM-80s hereafter called RM-80 monitors) which operate the detector. The RM-80 monitor is a microcomputer controlled electronics system which can control and process up to four individual detectors. The RM-80 monitor can provide local radiation and status indication for four detectors.

- Centralized display and control system for Class 1E radiation monitors.

  The centralized display and control system for Class 1E radiation monitors consists of two control room cabinets (CP-180A and CP-180B) and wiring between those cabinets and the Class 1E monitors. For each Class 1E monitor there is one control/display module (called an RM-23) which is located in either CP-180A or CP-180B, depending on the train A or train B classification of the monitor. These cabinets provide centralized indication and control (in the control room via the RM-23s) for all the Class 1E radiation monitors.

- Centralized display and control system for non-safety class radiation monitors.

  The centralized display and control system for non-safety-class radiation monitors consists of redundant computers (called RM-11 No. 1 and RM-11 No. 2). These computers are connected to all Class 1E and non-safety class RM-80 monitors through communication wiring and provide display on cathode ray tubes (CRT) in the Control Room and at the Health Physics Checkpoint and they provide an input to the Main Plant Computer. Qualified isolators are provided in the communications loop to ensure separation between Class 1E and non-safety class devices. It must be noted however, that control of the Class 1E RM-80 monitors is only available from CP-180A or CP-108B. The RM-11 computers are redundant; if one RM-11 fails, the other RM-11 assumes full system communication load with no loss of capability. The RM-11s are located in the Administration Building computer room. Every two seconds

each RM-80 monitor is polled by the RM-11 computers. The RM-80 monitors respond with existing radiation levels for each detector and codes that describe overall RM-80 monitor and detector status. In this way, the operator is provided with convenient, centralized display for all RM-80 monitors. The display is by way of custom consoles with CRTs, located in the Control Room and at the Health Physics Checkpoint, from which the operator may request various organized displays of the data gathered by the RM-11s.

Eight of the Class 1E RM-80 monitors utilize Geiger-Mueller (GM) detectors which contain signal shaping and preamplifier circuitry within the detector housing. The detected signal is then routed to the RM-80 monitor and into a digital counter chip which decrements by one count for each pulse that it receives. The remaining Class 1E RM-80 monitors, the Post LOCA monitors, do not contain the digital counter chip. These RM-80 monitors convert the extremely small ion chamber current to a digital value directly within the RM-80 monitor by means of an analog to digital converter circuit.

The non-safety class RM-80 monitors receive signals from GM tubes, ion chambers and scintillation detectors. The scintillation detectors require preamplifier/discriminator circuitry within the RM-80 monitor. The preamplifier/discriminators are set up in a gross counting mode with the upper window discriminator inhibited and the low energy window set to meet the low energy sensitivity per the FSAR requirements for that particular RM-80 monitor. The RM-80 monitor operates in the same manner as those connected to GM tubes after the signal passes through the preamplifier/discriminator.

The RM-80 monitor provides signal processing and control for up to four radiation detectors. Besides signal processing, the RM-80 monitor has a wide range of communication, computation and control capabilities. These capabilities are derived from the design of the RM-80 monitor as a microprocessor-based computer (microcomputer).

Each RM-80 monitor is equipped with three communication ports. Two of these communication ports are used in a redundant mode to communicate information between the RM-80 monitor and the RM-11 computers. The third communication port is used on Class 1E RM-80 monitors to communicate with a remote control and display module (RM-23) in the Control Room.

The microcomputer in the RM-80 monitor is controlled by an 8-bit Intel-8085 microprocessor which is supported by a number of specially designed and compatible integrated circuits. The operating system and application programs are all stored in read-only memory (ROM), which is loaded at the factory. Existing detector counts per minute, conversion factors, setpoints, radiation history, and other operator-loaded information, such as RM-80 monitor and detector data base, are held in low-power random access memory (RAM). Information in RAM will be retained by battery backup even if the 120 V AC supply to the RM-80 monitor is lost.

The RM-80 monitor calculates the output of each radiation detector every 600 milliseconds by means of a 16 bit digital counter which counts down from a full to empty register condition. The RM-80 monitor calculates the number of counts received since the last 600 millisecond reading and then performs a calculation to determine the counts per minute (CPM). As the counter nears a zero count it resets and continues to decrement to ensure that the counter is not saturated and that accurate counts are obtained. The CPM which

is displayed and used for alarm purposes is a calculated value which is the counter reading processed through a software smoothing algorithm. The algorithm prevents an unstable display which would occur if only counter contents were used to provide the RM-80 monitor display.

As each "smoothed" radiation value is processed the RM-80 monitor performs a series of checks to verify the value is below the high and alert alarm setpoints. The alarm setpoints are set by Chemistry Department personnel or Health Physics Department personnel depending on the RM-80 monitor's function. These setpoints reside within the RM-80 monitor in a fixed memory location. These locations each have a unique 'address' in RAM (Random Access Memory). The RM-80 monitor performs a comparison every 600 milliseconds of the new radiation value to the high or alert alarm setpoints. If the alarm setpoint is exceeded the RM-80 monitor executes the actions required for the alarm.

The New Hampshire Yankee radiation monitoring system, since it is a digital system, does not experience the phenomenon of setpoint drift that is common to analog systems. The repeatability of alarm setpoints is discussed in the answer to question 3.

Since the setpoints do not drift, and because values located in microcomputer RAM locations are verified on a periodic basis during surveillance testing, the injection of a signal is not required to verify equipment operation. There are three major reasons for performing testing by manipulating the setpoints. One is to minimize the potential damage to the detectors and RM-80 monitors that may occur when the test equipment is connected, such as broken leads. The signal injection method requires either a coaxial or lugged connection to be removed to allow connection of the signal generator which creates the potential for equipment damage. It must also be noted that the utilization of a signal generator does not maintain impedence matching of the circuit. Secondly, some of the RM-80 monitors are located in the radiologically controlled area (RCA). The practice of periodic testing by signal injection is contrary to NHY's As-Low-As-Reasonably-Achievable program for radiation dose control as it requires technicians to spend more time in the RCA. Third, the data base manipulation method does not require the detector to be disconnected from the RM-80 monitor and to be physically removed from service so that the system could not detect radiation. Additionally, since a smoothing algorithm is used in the RM-80 monitor it is exceedingly difficult to inject a signal at the same rate every time such that exact repeatability of a test cannot be assured by the signal injection method.

Request No. 2 — Please provide a description of the surveillance test and a description of the usage of the "user command" that changes the setpoints. Include specifics on the independent software verifications and the computer printout check of setpoints and system functions. If the surveillance procedure itself is provided please highlight and explain the procedure sections that pertain to the NRC questions.

Response:

During the performance of a surveillance test the alarm setpoint of the RM-80 monitor is decreased to a value less than background radiation levels by an I&C technician stationed at a Control Room console. As the setpoint is entered the desired value is displayed to ensure the I&C technician has typed the correct setpoint value. Once the I&C technician has keyed in the correct value he depresses the enter key, the display blanks out and then returns again showing the same value. What actually happens is the keyboard entered value

on the display screen is sent to the RM-80 monitor and the display blanks out while the value is being transmitted to the RM-80 monitor. The RM-80 monitor receives the value, evaluates the format, and stores it in the RAM location reserved for the setpoint. The RM-80 monitor then 'reads' the newly stored value and sends it back to the I&C technician screen. The I&C technician actually sees the value stored in RAM, not just the value he typed. If the storage area in RAM was defective, the value would have been corrupted and the I&C technician would have seen a value return other than that which he had transmitted. Upon completion of this data entry the I&C technician verifies that the RM-80 monitor's alarm software functioned properly by confirmation of system alarms, illumination of lights and the energization of relays controlled by the alarm function.

After verification of the alarm function the I&C technician restores the alarm setpoint value to its original value utilizing the same process as described above. The I&C technician will again verify that the appropriate value is stored in the RAM. A second individual will independently verify that the correct value is stored in the RAM. Additionally, the I&C technician will verify via a computer printout that only the alarm setpoint was manipulated during the surveillance test and that the original value has been appropriately re-entered in the RAM.

Request No. 3 Please provide a basis of the adequacy of the current test as it pertains to testing as much of the system as possible, including the channel input circuitry and any signal conditioning circuitry. Include specifics on the check source and self diagnostics.

Response:

Each GM detector contains a Cl-36 source assembly which automatically energizes every 24 to 72 hours. The source tests the detector and associated amplifier and counter circuitry of the microprocessor in each RM-80 monitor. If the check source test results in no counts or low counts the RM-80 monitor fails and an annunciation occurs in the control room.

The Post LOCA monitors are provided with a continuous 'keep alive' current from a uranium source contained within each detector. The checksource used by these detectors injects a current automatically every 24 hours. The checksource tests all of the circuitry from the detector input to the RM-80 monitor and the associated amplifiers and analog to digital conversion circuitry of the RM-80 monitor.

The checksource circuitry for the scintillation detectors consists of a Cl-36 or Cs-137 source which actuates every 24 hours. The source tests the detector and associated amplifier and counter circuitry of the microprocessor of the affected RM-80 monitor. If the checksource test results in no counts or low counts the RM-80 monitor fails and an annunciation occurs in the Control Room.

During startup testing of the radiation monitoring system each RM-80 monitor was thoroughly tested by a combination of signal injection, source testing, and data manipulation.

Signal injection was performed on each RM-80 monitor during startup testing. The test results are available for review at Seabrook Station. During these tests, pulses or currents were injected into the RM-80 monitors to verify the software algorithms. The software for GM detectors automatically corrects for nonlinearity of the GM tube. In this type of RM-80

monitor the calculation results were verified over the full range of each detector. For Ion chambers, currents were injected over the full range and response was verified to expected response data. For scintillation detectors, pulses were injected and a linear response up to the maximum design specifications was verified.

The startup testing performed at Seabrook Station verified the proper operation of the RM-80 monitor software and provided the baseline data for their operation. Once the proper operation of the software was verified it responded exactly the same every time. No drifting of setpoints or repeatability problems were experienced since the circuits are digital.

Each type of detector was "type" tested using sources up to 1000R to verify the proper operation of detector over-range saturation circuitry. Design flaws on one type of detector were discovered which were corrected by the vendor.

Primary calibrations were performed at Seabrook Station during startup testing of all Class 1E RM-80 monitors and non-safety class RM-80 monitors required by the Technical Specifications. For these RM-80 monitors, sample geometries were designed which were identical to the monitor samplers for liquid monitors. The calibration geometries were sent off to be filled with a National Bureau of Standards (NBS) traceable source material. Airborne monitors were calibrated using an NBS traceable gas. Particulate monitors were calibrated with a filter paper embedded with an NBS traceable source. GM and ion chamber detectors were calibrated on-site with an NBS traceable Shepherd Beam Irradiator. These calibrations established and verified detector conversion factors.

The decision to perform Digital Channel Operational Test (DCOT) testing by setting the alarm setpoint below the background radiation value was based on baseline test data obtained during startup testing and the demonstrated operation of the radiation detectors and RM-80 monitors. The injection of a signal does not prove energy response since the preamplifiers are nonlinear devices and impedance matching of the actual detector to the circuit is not maintained when a signal generator is connected. Since the alarm setpoint is in a fixed memory location it is not necessary to test the actual value of the setpoint. What must be tested is the ability of the RM-80 monitor to enter the alarm software task once the actual radiation value is above the setpoint. By signal injection an actual radiation value is not used and the risk of damaging equipment by lifting leads or injecting the wrong voltage is increased. Additionally, the injection process exposes personnel and equipment to the RCA environment unnecessarily and makes the task more complex than required. Finally, a signal injection test does not provide any additional usable data other than that obtained by lowering the alarm setpoint.

Our present DCOT testing verifies RM-80 monitor operation by setting the alarm setpoint to a value which is less than the actual background radiation value. The RM-80 monitor operation is verified without disabling the RM-80 monitor's ability to respond to any radiation which actually exists since the detector is not physically removed from service.

On a refueling outage basis each channel is calibrated utilizing an NBS traceable source positioned by fixed geometry test apparatus. This type of calibration ensures accuracy and repeatability and provides a much more accurate calibration and check of the system than the signal injection method.

Request No. 4 Please provide specifics on the manufacturer recommendations and current known industry testing practices on this equipment.

Response:

The manufacturer, General Atomic, has reviewed the NHY surveillance testing methodology and agreed that the setpoint change method to test RM-80 monitor response is acceptable. They also stated that the injection method does not provide any additional test data on a periodic basis, but must be performed as an initial check to verify software response. NHY performed the signal injection testing during startup testing.

New Hampshire Yankee contacted several other utilities to determine what types of tests were performed for surveillance and calibration testing of digital equipment. There is no established industry standard and the practice ranges from signal injection all of the time to never using signal injection. The individual plant decisions appear to be based upon the preference of the plant's staff.

FIGURE 1
RADIATION MONITORS

| MONITOR | NOMENCLATURE | TECHNICAL SPECIFICATION | CLASS 1E |
|---|---|---|---|
| 1-RM-RM-6506A | Control Room East Air Intake, Train A | 4.3.3.1 | YES |
| 1-RM-RM-6506B | Control Room East Air Intake, Train B | 4.3.3.1 | YES |
| 1-RM-RM-6507A | Control Room West Air Intake, Train A | 4.3.3.1 | YES |
| 1-RM-RM-6507B | Control Room West Air Intake, Train B | 4.3.3.1 | YES |
| 1-RM-RM-6527A | Containment On Line Purge, Train A | 4.3.3.1 | YES |
| 1-RM-RM-6527B | Containment On Line Purge, Train B | 4.3.3.1 | YES |
| 1-RM-RM-6535A | Fuel Manipulator Crane, Train A | 4.3.3.1 | YES |
| 1-RM-RM-6535B | Fuel Manipulator Crane, Train B | 4.3.3.1 | YES |
| 1-RM-RM-6576A | Containment Post-LOCA Monitor, Train A | 4.3.3.1 & 4.3.3.6 | YES |
| 1-RM-RM-6576B | Containment Post-LOCA Monitor, Train B | 4.3.3.1 & 4.3.3.6 | YES |
| 1-RM-RM-6528 | Plant Vent Stack Wide Range Gas | 4.3.3.10 | NO |
| 1-RM-RM-6503 | Carbon Delay Beds Outlet | 4.3.3.10 | NO |
| 1-RM-RM-6504 | Waste Gas Compressors Discharge | 4.3.3.10 | NO |
| 1-RM-RM-6515 | Primary Component Cooling Water Loop B | 4.3.3.1 & 4.3.3.9 | NO |
| 1-RM-RM-6516 | Primary Component Cooling Water Loop A | 4.3.3.1 & 4.3.3.9 | NO |
| 1-RM-RM-6519 | Steam Generator Blowdown Flash Tank Discharge | 4.3.3.1 & 4.3.3.9 | NO |
| 1-RM-RM-6509 | Waste Liquid Test Tanks Discharge | 4.3.3.9 | NO |
| 1-RM-RM-6526 | Containment Atmosphere | 4.4.6.1a | NO |
| 1-RM-RM-6562 | Fuel Storage Building Ventilation Exhaust | 4.3.3.9 | NO |
| 1-RM-RM-6481 | Main Steam Line Loops 1 & 4 | 4.3.3.1 | NO |
| 1-RM-RM-6482 | Main Steam Line Loops 2 & 3 | 4.3.3.1 | NO |
| 1-RM-RM-6521 | Turbine Building Sump Pumps Discharge | 4.3.3.9 | NO |