TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

400 Chestnut Street Tower II

September 15, 1981

RECEIVED SEP 16 1981 U.S. NUCLEAR REGULATORY COMMISSION

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Ms. Adensam:

In the Matter of the Application of) Docket Nos. 50-390
Tennessee Valley Authority) 50-391

Enclosed for NRC review are TVA's responses to the following questions on Watts Bar Nuclear Plant provided by letter dated August 10, 1981 from R. L. Tedesco to H. G. Parris.

Geology (Enclosure 1)	Seismic (Enclosure 2)	Chemical Engineering (Enclosure 3)
362.37	362.44	281.1
362.38		281.2
362.39		281.4
362.40		
362.41		
362.42		
362.43		

These responses will be incorporated into the Final Safety Analysis Report in Amendment 45.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills

L. M. Mills, Manager
Nuclear Regulation and Safety

Sworn to and subscribed before me
this 15th day of Sept. 1981

Bryant M. Lowery
Notary Public
My Commission Expires 4/4/82

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Enclosures

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ENCLOSURE 1
WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
TVA RESPONSES TO NRC GEOLOGY QUESTIONS

362.37 Question

Cross section - Figure 2.5-3 - cannot locate line of section on Geologic Map of Tennessee. Please clarify - be more specific about the location of the line of section.

Response

The section provided as Figure 2.5-3 is an unpublished section compiled by D. H. Roeder in 1974. This section, when referenced to the Geologic Map of Tennessee, 1966, begins approximately at 36° 32' N, 84° 15' W near Jellico Mountain for point A and trends southeastward to approximately 35° 41' N, 83° 36' W near Curry Mountain for point A'. Roeder, O. E. Gilbert, Jr., and W. D. Witherspoon subsequently published in 1978 a report entitled "Evolution and Macroscopic Structure of Valley and Ridge Thrust Belt, Tennessee and Virginia, "University of Tennessee, Department of Geological Sciences, Studies in Geology 2, Knoxville, 1978. This report, though not containing the exact cross section provided as Figure 2.5-3, contains a folio of 14 cross-sections, two of which--sections 5 and 6--lie on either side of the section depicted on Figure 2.5-3.

362.38 Question:

P. 2.5-17 Para. 2 - Fig. 2.5-9 does not show the Pennington Formation as stated in this paragraph - there are no Mississippian Rocks.

Response:

The referencing of the Mississippian aged Pennington Formation to Figure 2.5-9 is in error. There are no Mississippian aged rocks within a five-mile radius of Watts Bar. The nearest exposure of the Pennington is approximately eight miles to the northwest along the face of the Cumberland escarpment. On Figure 2.5-2, the Pennington would be included as the uppermost unit of the M_3 sequence. Though well depicted on Figure 2.5-2 in the central basin portion of Tennessee, the map scale prohibits depicting these flat-lying units in areas of high relief such as the face of the Cumberland escarpment.

362.39 Question

P. 2.5-21 Para. 5 - Ref's 83 (Milici) was "in press" at time of FSAR writing - please furnish correct ref.

Response:

Milici, R. C., 1975, Structural Patterns in the Southern Appalachians: Evidence for a Gravity Slide Mechanism for Alleghanian Deformation: Geol. Soc. America Bull., v. 86, p. 1316-1320.

362.40 Question:

P. 2.5-22 Para. 3 - Should discuss COCORP reflection findings also - in discussion of thin-skin etc. update the references also for p. 2.5-64 para. 2.

Response:

TVA is aware of the COCORP reflection profiles that have been run in the southern Appalachians. We are on the mailing list for their newsletter and keep abreast of profile interpretations.
To this point, the interpretations have been presented mostly in conference sessions such as the SEG, SSA, and Penrose conferences, all of which TVA attended.

These presentations, and the few published articles that have been written regarding COCORP, support the concept of thin-skinned tectonics for the Appalachians. Brown and others (Ref. 1) and Cook and others (Ref. 2) in their abstracts submitted at the American Geophysical Union National Meeting in Washington, DC, from May 27 to June 1, 1979, in a session on "COCORP and Refraction Studies; Crustal Structure," presented their interpretation that the Blue Ridge and much of the Piedmont are allocthonous and that the Brevard fault zone is rooted to a larger horizontal thrust. Cook and others subsequently published their findings in Geology (Ref. 2).

We feel, however, that the COCORP findings have not yet been sufficiently published upon. We continue to support the thin-skin concept and anticipate that future COCORP and other findings will prove this concept to be factual. However, due to the lack of a significant number of published references in regard to COCORP findings as related to thin-skinned theory, we find no necessity to revise the references listed on page 2.5-64, paragraph 2. The references cited in this paragraph are provided simply to recognize the contrasting theories regarding Appalachian deformation. The dominance of recent research supports the thin-skinned theory.

References:

(1) Brown, L., D. Albaugh, J. Brewer, F. Cook, L. Jensen, S. Kaufman, G. Long, J. Oliver, S. Schilt, and D. Steiner, (Department of Geological Sciences, Cornell University, Ithaca, New York 14853) in Abstracts of American Geophysical Union Annual Meeting, Washington, DC, May-June, 1979.

(2) Cook, F. A., D. S. Albaugh, L. D. Brown, S. Kaufman, J. E. Oliver, and R. D. Hatcher, 1979, Thin-skinned tectonics in the crystalline southern Appalachians: COCORP seismic reflections profiling of the Blue Ridge and Piedmont: Geology, v. 7, P. 563-567.

362.41 Question:

P. 2.5-24 - Para. 1 - Refers to faulting described in 2.4.1 - cannot find it there.

Response:

The reference to 2.4.1 is a typographical error. This sentence should read "...faulting that is described in Sections 2.5.1.1.2, 2.5.1.1.4, and 2.5.1.1.6."

362.42 Question:

P. 2.5-29 Para. 1 - Swingle's cross-section is based on what information that confirms the sole to be at 9,000 ft?

Response:

A review of reference 123 reveals that Swingle has depicted an interpretive cross-section that supports the previous concept of a sole fault above the basement rocks. The use of the term confirms was a poor choice of words.

362.43 Question:

P. 2.5-54 Para 2 - What evidence supports the statement that the faults are confined to the Conasauga Formation and do not intersect any other stratigraphic fm?

Response:

This statement emphasizes that the faults exposed in the powerhouse excavation are confined to the Conasauga bedrock and do not extend upward into the unconsolidated terrace deposits. Discussions supporting this statement are provided from page 2.5-58, paragraph 4 through page 2.5-61, paragraph 5. Photographs supporting this relationship are presented as Figures 2.5-132 through 2.5-136.

212.44 Question

The Giles County Virginia earthquake of 1897 is the controlling earthquake for the seismic design of nuclear plants in the Southern Valley and Ridge tectonic province. Watts Bar Nuclear Plant is located in this province.

Dr. G. A. Bollinger has been conducting research on the Giles County, Virginia seismic zone. He has recently written a report titled "The Giles County, VA Seismic Zone - Configuration and Hazard Assessment" which is to be presented at a conference in September, 1981.

Based on the local seismic activity Dr. Bollinger implies the existence of a buried fault in the Giles County area. He uses the largest extent of the seismic zone, taking into account errors in hypocenter location, in order to calculate a possible maximum earthquake of surface wave magnitude $M_S = 7$ for this zone.

Provide a discussion on any effect this hypothesis has on the following with respect to the Watts Bar Plant:

a) The potential of the 1897 earthquake being associated with this specific geologic structure;

b) The potential of an earthquake up to $M_S = 7.0$ located in Giles County, and any far field ground motion effect (both peak values and response spectrum) at the site from an $M_S = 7.0$ event located in Giles County;

c) The potential of similar seismogenic structures being located near the Watts Bar site, and any effects at the site from earthquakes on these seismogenic structures.

RESPONSE:

Discussion A

TVA recognizes the potential benefits that structurally locating or affixing the controlling earthquake of the Southern Appalachian Tectonic Province to Giles County, Virginia, could have on its facilities. However, we also recognize that both supportive and contradictive data exist in addressing the potential for the May 31, 1897, Giles County, Virginia, MM VIII earthquake having been associated with Bollinger's inferred seismogenic structure.

The following items lend support to such an association:

1. If one accepts Bollinger's inferred fault plane area (80 to 800 km^2) and its estimated potential earthquake magnitude ($M_S = 6$ to $M_S = 7$), the 1897 event ($m_b = 5.8$, $M_S = 5.8$) compares favorably in surface wave magnitude with the hypothetical event that would be caused by rupture along the minimum (80 km^2) fault area.

2. Bollinger (preprint page 3, paragraph 1) alludes to the association by stating that: "The smaller of those areas (80 km^2) could produce an earthquake of a surface wave magnitude (M_S) of 6 which is roughly equivanent to the largest historical shock in the area (May 31, 1897, body wave magnitude (m_b) of 5.8; the equivalent M_S would also be 5.8."

3. Pearisburg, Virginia, the generally accepted epicentral location for the 1897 event, lies within the seismic zone postulated by Bollinger. Though recognizing the uncertainty associated with locating the 1897 epicenter precisely at Pearisburg, it is relevant to note that the meizoseismal areas of Bollinger and Hopper (reference 1) and Law Engineering Testing Company (reference 2) are in Giles County and that Campbell (reference 3) noted that "The shock of May 31 was probably more severe in and about Pearisburg than any other point from which I have information."

Tending to contradict the association of the 1897 event with Bollinger's inferred seismic zone:

1. Bollinger, though possibly alluding to such an association as indicated in 2 above, does not emphatically state in his preprint that he believes his inferred zone is the source of the 1897 event.

2. Four of the 12 microearthquakes (33 percent) detected by Bollinger's network and two of the six felt events (33 percent) relocated by Dewey and Gordon are not within the structure defined by Bollinger. One of the felt events, the November 20, 1969, Elgood, West Virginia, shock ($m_{bLg} = 4.6$, MM VI) occurred some 20 km to the northwest.

3. In deference to the supportive arguments submitted under 3 above, Pearisburg, in 1897, was the area of largest population in Giles County. It could therefore be expected there might be some population bias with respect to intensity assessments.

4. Notwithstanding Bollinger's treatise regarding the geometry of intensity patterns in the Giles County zone (pages 7 and 8), a review of the meizoseismals from the two intensity maps provided as preprint figure 11 strongly suggest that the major areas of meizoseismals are not coincident with Bollinger's inferred N36°E structure.

Bollinger, throughout his report, bases his evaluations on the data in hand. Why he chooses to ignore the meizoseismal orientations, as shown on figure 11, and instead chooses to state, "In either case, we do not know if the trend of highest intensity level was nearer to that of the seismic zone (N36°E) or to that of the regional structural grain (N65°E)," is somewhat contradictory. He appears to be forcing data to fit his hypothesis, when perhaps a lack of association of the 1897 event to his inferred structure is more readily apparent.

In conclusion, although both supportive and contradictive arguments can and will be advanced in regard to the potential for the 1897 event being associated with Bollinger's inferred seismogenic structure, neither can be "proven."

References:

1. Bollinger, G. A., and Hopper, M. G., 1971, Virginia's two largest earthquakes--December 22, 1875, and May 31, 1897: Seismol. Soc. America Bull., vol 61, pp 1033-1039.

2. Law Engineering Testing Company, 1975, Report on evaluation of intensity of Giles County, Virginia, earthquake of May 31, 1897: Marietta, GA, 94 pp.

3. Campbell, M. R., 1898, Earthquake shocks in Giles County, Virginia: Science, vol 7, pp 233-235.

Discussion B

In assessing the potential for an earthquake up to $M_s = 7.0$ being located in Giles County, one should first of all recognize that Bollinger, apparently well aware of the impact that his report could have in regard to the assessment of seismic design for nuclear facilities, stresses throughout his report that he is postulating a "worst case" situation and "not considering seismic risk for engineering purposes."

Though recognizing that Bollinger may have used sound, well accepted, published procedures and equations in his assessment, he does so with a significant number of "qualifiers." This frequent use of qualifiers is apparently intended to stress that the assumptions, postulations, etc., are inferred from the data but not emphatically proven. Examples of such qualifiers in Bollinger's preprint are (underlined):

1. Page 1, paragraph 2, line 2 - . . . fault plane area as an estimator of potential earthquake magnitude and (b) Development of a hypothetical intensity map.

2. paragraph 3, line 2 - . . . possible results depending on initial assumptions and objectives.

3. line 4 - Potential earthquake size: . . . . Hypothetical intensity map . . . .

4. line 7 - . . . postulated . . . .

5. Page 2, entire paragraph 2:

For our primary application (emergency planning), we feel free to postulate a "worst case" situation without regard to the probability of the actual realization of that case and without regard to any engineering design considerations. Note that we are not considering seismic risk for engineering purposes. Also, we are using the term "hazard" in the sense of possible earthquake effects and not the probability of occurrence of any of those effects. Thus, our hazards evaluation would not be directly applicable or appropriate for seismic design criteria for specific sites in the region. Such specific design criteria require detailed studies with the particular needs and requirements for the given site as a basis for the studies.

6. paragraph 3, line 3 - . . . construction of a hypothetical intensity map . . . .

7. paragraph 4, aspect 1 - Use of hypocentral error measures to empirically define maximum and minimum potential fault plane areas. This procedure rests on the subjective judgment as to which particular hypocenters constitute the seismogenic zone.

8. Page 3, paragraph 1, line 3 - . . . that the potential earthquake hazard . . . .

9. line 5 - Specifically, a possible fault plane or zone . . . .

10. line 13 - The larger area could, if slip were indeed to occur over the entire plane, imply an earthquake . . . .

11. line 14 - We have, at this time, no new data regarding the recurrence rates of Giles County seismicity. Thus, we do not know the likelihood of a larger shock actually occurring in that locale. (We are working on this problem but the historical earthquake data base is sparse.)

12. paragraph 2, line 4 - . . . hypothetical intensity map . . . .

13. Page 5, paragraph 1, line 2 - The most likely location of the hypocenter is, of course, at the center of the error ellipsoid.

14. line 4 - However, there is a stated level of probability (68% for HYPOELLIPSE and 90% for JHD) that a given hypocenter could be located anywhere within its error ellipsoid. (underlined in Bollinger's report)

15. line 10 - The range, 80 km^2 to 800 km^2, results from arbitrarily moving the hypocenters inside their error ellipses . . . . (underlined in Bollinger's report)

16. line 16 - Thus, we do not have, at this time, a well-constrained estimate of the area of the Giles County, Virginia, seismogenic zone.

In summary, to paraphrase Bollinger's report using the same or similar qualifiers as he, it appears that he has identified a possible fault based on an assessment of 18 microearthquakes and felt events, a third of which do not fall within the structure. Then, using hypocenter error ellipses for the 8 "usable" events, he calculates a fault plane area range of from 80 km^2 to 800 km^2, recognizing the equal probability of either and stating that he has no well-constrained estimate of the area of the zone.

He then selects the worst case area, assumes slip were indeed to occur over the entire plane and implies an earthquake of $M_s = 7.0$.

Then recognizing the lack of sufficient data to establish recurrence rates for such an event, he generates hypothetical intensity maps of such an event.

As he has stated throughout his report, Bollinger has felt "free to postulate a 'worst case' situation without regard to the probability of the actual realization of that case."

Though appreciating the scientific approach that Bollinger has used in each phase of his report, TVA questions the realization of continually compounding "worst case" upon "worst case." Furthermore, without attempting or desiring to address the probability of all of Bollinger's six or so assumptions being or occurring "worst case," TVA agrees with Bollinger that this report "would not be directly applicable or appropriate for seismic design criteria for specific sites in the region."

It has been TVA's experience that the staff, when presented such segmented and qualified arguments in defense of a "best case" position, is not inclined to accept the parcel, based on its parts. We feel such should be the case on Bollinger's "worst case" report.

The far field ground motion at the Watts Bar Nuclear Plant from a $M_s = 7.0$ earthquake located in Giles County, Virginia, was determined using the results contained in reports by O. W. Nuttli (reference 1), and J. R. Murphy and L. J. O'Brien (reference 2), and by examining strong-motion data from large earthquakes recorded at large distances from the epicenter. The Watts Bar site is located about 250 miles (400 km) from the seismogenic structure proposed by Bollinger.

The peak horizontal and vertical accelerations and velocities using Nuttli's report for a M_s = 7.0 located 400 km away are:

Horizontal acceleration	= 0.013 g
Vertical acceleration	= 0.007 g
Horizontal velocity	= 1.05 in/sec
Vertical velocity	= 0.52 in/sec

The peak horizontal and vertical acceleration from Murphy and O'Brien's report are 0.05 and 0.02 g, respectively.

The results obtained from Nuttli's report are applicable to the central U.S., and the results obtained from Murphy and O'Brien's report are based on worldwide data. Therefore the results obtained from Nuttli's report are more appropriate to the Watts Bar site. The peak values of ground motion from either report are considerably less than the Watts Bar Safe Shutdown Earthquake (SSE) which has a peak horizontal and vertical top-of-rock acceleration of 0.18 and 0.12 g, respectively. The SSE at Watts Bar is based on the Giles County, Virginia, 1897, MM VIII earthquake moved to the site. Examination of Bollinger's intensity maps for the M_s = 7.0 or MM IX earthquake results in a MM V to MM VII for the worst case. Either case is less than the MM VIII used to define the SSE.

Examination of strong-motion data from large earthquake recorded at large distances was performed to determine if the ground motion response spectra used for Watts Bar might be exceeded in the long period range even though the peak values from the M_s = 7.0 earthquake are less than the Watts Bar SSE. The following earthquakes were reviewed:

1. 1952 Kern County - Richter M = 7.7 - Hollywood Storage Basement - Epicentral distance = 119.5 km - Max. horizontal acceleration = 0.055 g

2. 1968 Borrego Mountain - Richter M = 6.5 - San Onofre SCE Power Plant - Epicentral distance = 134.4 km - Max. horizontal acceleration = 0.046 g

3. 1971 San Fernando - Richter M = 6.6

   a. San Onofre Nuclear Power Plant - Epicentral distance = 139.8 km - Max. horizontal acceleration = 0.016 g

   b. San Juan Capistrano - Epicentral distance = 122.6 km - Max. horizontal acceleration = 0.042 g

   c. Anza Post Office - Epicentral distance = 185 km - Max. horizontal acceleration = 0.036 g

   d. Hall of Records, San Bernardino - Epicentral distance = 108.2 km - Max. horizontal acceleration = 0.045 g

4. 1966 Sacramento, Pacific Telephone and Telegraph - Richter M = 6.3 - Epicentral distance = 151.5 km - Max. horizontal acceleration = 0.015 g

5. 1954 El Centro, Imperial Valley Irrigation District - Richter M = 6.3 - Epicentral distance = 149.8 km - Max. horizontal acceleration = 0.028 g

6. 1966 El Centro, Imperial Valley Irrigation District - Richter M = 6.3 - Epicentral distance = 148.1 km - Max. horizontal acceleration = 0.015 g

7. 1968 Southern California Edison, Colton - Richter M = 6.4 - Epicentral distance = 146.2 km - Max. horizontal acceleration = 0.029 g

8. 1968 California - Richter M = 6.4

   a. Engineering Bldg., Santa Anna - Epicentral distance = 173.1 km - Max. horizontal acceleration = 0.013 g

   b. Terminal Island - Epicentral distance = 205.1 km - Max. horizontal acceleration = 0.01 g

   c. J.P.L. Basement - Epicentral distance = 220.3 km - Max. horizontal acceleration = 0.007 g

   d. Millikan Basement - Epicentral distance = 212.9 km - Max. horizontal acceleration = 0.01 g

   e. Pasadena, CIT Athenaeum - Epicentral distance = 212.0 km - Max. horizontal acceleration = 0.01 g

   f. Subway Terminal Basement, Los Angeles - Epicentral distance = 218.8 km - Max. horizontal acceleration = 0.01 g

   g. CMD Bldg. - Epicentral distance = 212.2 km - Max. horizontal acceleration = 0.019 g

   h. Hollywood Storage P.E. Lot, Los Angeles - Epicentral distance = 227.3 km - Max. horizontal acceleration = 0.013 g

9. 1978 Miyagi - Ken - Oki, Japan - M_S = 7.4 - Epicentral distance = > 300 km - Max. horizontal acceleration = 0.002 g
   (No response spectra available)

10. 1970 Off Peru Coast - Magnitude = 7.75 - Epicentral distance = 372 km - Max. horizontal acceleration = 0.106 g

Based on the review of the above earthquakes and their response spectra, their ground motions do not exceed the Watts Bar SSE ground motions. Therefore the far-field ground motion of a M_S = 7.0 earthquake located in Giles County, 250 miles from Watts Bar, does not exceed the present SSE ground motions.

References:

1. Nuttli, O. W., 1979, The Relationships of Sustained Maximum Ground Acceleration and Velocity to Earthquake Intensity and Magnitude: Miscellaneous Report S-73-1, Report 16, U.S. Army Corps of Engineers.

2. Murphy, J. R. and O'Brien, L. J., 1978, Analysis of a Worldwide Strong Motion Data Sample to Develop an Improved Correlation Between Peak Acceleration, Seismic Intensity, and Other Parameters: NUREG - 0402.

Discussion C

There is no significant evidence, either supported by microseismic research or by preferred alignments of historic epicenters, that suggests the existence of seismogenic structures near Watts Bar or for that matter in the entire remainder of the Southern Appalachian Tectonic Province similar to that postulated by Bollinger in Giles County.

Though recognizing that there are localized areas of recurrent historical seismicity such as that around Knoxville - Maryville, Tennessee, insufficient data exists to define a single source structure using postulations such as those made by Bollinger with regard to the existance of a fault, its location, dimensions, orientation, area maximum and minimum, maximum earthquake potential, map of hypothetical intensities or recurrence rate. As addressed under Discussion B, although TVA reviews Bollinger's maximum earthquake potential for the Giles County zone with skepticism as having been derived from the compounding of several "worst case" hypotheses, nevertheless, Bollinger at least had the benefit of the original 12 events from which to make his hypotheses. No such data base exists for other areas of recurrent historic seismicity.

The Knoxville - Maryville area has experienced approximately 30 historic shocks, the largest of which is a lower threshold MM VII. The November 30, 1973, event, the largest recorded event from the area, was an $m_b = 4.6$, MM VI. This area lies approximately 40 miles northeast of Watts Bar, and effects at the plant of a recurrence of events of this magnitude would be well below those of an MM VIII for which the plant is designed.

In order to provide further evidence that seismicity from the Giles County area should not be considered as occurring throughout the tectonic province, TVA in 1979 submitted a report to NRC entitled "Southern Appalachian Tectonic Study." This report defines a marked difference in basement geology between the Giles County area and Watts Bar. Recognizing, as does Bollinger, that earthquakes within the region are hypocentered beneath the decollement, TVA demonstrated by way of gravity, magnetic, and photo-imagery analyses, a marked heterogeneity of the basement throughout the Southern Appalachian Tectonic Province.

In summary, though historic shocks have occurred throughout the tectonic province, no other structure such as that postulated by Bollinger has been defined. Though areas of recurrent seismicity exist, no historic or postulated event has been defined with an intensity that would be greater than that for which Watts Bar is designed.

ENCLOSURE 3

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2

TVA RESPONSE TO NRC CHEMICAL ENGINEERING QUESTION

<u>NRC Question 281.1</u> - Describe the samples and instrument readings and their frequency of measurement that will be performed to monitor the spent fuel pool (SFP) water purity and need for SFP cleanup system demineralizer resin and filter replacement. State the chemical and radiochemical limits to be used in monitoring the SFP water and initiating corrective action. Provide the basis for establishing these limits. Your response should consider variables such as: boron concentration, gross gamma and iodine activity, demineralizer and/or filter differential pressure, demineralizer decontamination factor, pH, and crud level.

<u>TVA Response</u> - The spent fuel pool (SFP) water shall be monitored for various chemical species and activity as listed on Table 1, attached.

The SFP cleanup system consisting of filters, skimmers, and demineralizers shall be maintained to assure maximum allowable chemical and activity levels are not exceeded. Cartridge filter replacement and demineralizer regeneration are performed when either acceptable limits may be exceeded or when differential pressures are too high for proper functioning of the SFP cleanup system. Consult Table 1, attached, for the observable parameters, imposed limits, frequency of monitor, and corrective action when limit points are reached. Table 2, attached, defines the makeup water quality to the SFP.

TABLE Q281.1-1

Observable Parameter	Imposed Limits	Frequency of Monitor	Corrective Action
pH	4.0-8.0	2 x's per month	Add boric acid if too high; add makeup* water if too low
H_3BO_3	2000 ppm as B	2 x's per month	Add boric acid if too low; add makeup water if too high
Cl F	0.15 ppm max. 0.15 ppm max.	1 x per week 1 x per week	Add makeup water or regenerate ion exchanger if too high
Ca Mg	1.0 ppm max. 1.0 ppm max.	1 x per week 1 x per week	Add makeup water or regenerate ion exchanger if too high
Cs-137	0.01 Ci/ml max.	1 x per week when there is fuel in pool	Increase flow or regenerate ion exchanger if too high
Gross $\beta - \gamma$ degassed 15 min (includes iodine activity)	DF $\geq$ 10	1 x per month	Increase flow, replace filters, regenerate ion exchanger as necessary if DF $<$ 10
Filter differential pressure	20 psi	Continuous while demineralizer is in service	Replace filter if too high
Crud level		N/A	N/A

*For makeup water requirements see table Q 281.1-2

WBN

TABLE Q 281.1-2

MAKEUP WATER REQUIREMENTS

pH		6.0-8.0 @ 25°C
Specific conductivity	less than	1.0 μmhos/cm @ 25°C
Cl + F	less than	0.1 ppm
Total solids (excluding boric acid)	less than	1.0 ppm
Suspended solids (< 0.45μ)	less than	0.1 ppm
SiO_2	less than	0.1 ppm
K	less than	0.01 ppm
Na	less than	0.01 ppm
Al, total	less than	0.02 ppm
Ca	less than	0.02 ppm
Mg	less than	0.02 ppm

281.2 (9.3.2) Question:

(a) It is our position that provisions should be made in the process sampling system to purge and drain sample streams back to the system or orgin, or to an appropriate water treatment system, in accordance with acceptance criterion II.2.e in Standard Review Plan Section 9.3.2. Indicate what provisions are available in your process sampling system for meeting this position.

(b) It is our position that automatic isolation valves in the process sampling lines that originate within the containment should fail in the closed position in accordance with acceptance criterion II.2.f in Standard Review Plan Section 9.3.2. Verify that this position is met in the process sampling system.

(c) Provide piping and instrumentation diagrams for the process sampling system.

Response:

(a) The purge and sampling of the process sampling system is being routed to the tritiated drain tank.

(b) The automatic isolation valves in the process sampling lines that originate within the containment are all FAIL - CLOSE.

The Hydrogen Analyzer containment isolation valves are the only exception, they FAIL-OPEN.

(c) Drawings of the sampling system were provided informally (TVA drawings 47W625-1 thru -14 and 47W610-43-1 thru -7).

281.4 **Question:**

(TMI II.B.3)

Provide information that satisfies the attached proposed license conditions for post-accident sampling.

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WBN P-45

SAFETY EVALUATION
BY THE OFFICE OF NUCLEAR REACTOR REGULATION
WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2
TENNESSEE VALLEY AUTHORITY
DOCKET NOS. 50-390/391

NUREG-0737, II.B.3 - Post Accident Sampling Capability

REQUIREMENT

Provide a capability to obtain and quantitatively analyze reactor coolant and containment atmosphere samples, without radiation exposure to any individual exceeding 5 rem to the whole body or 75 rem to the extremities (GDC-19) during and following an accident in which there is core degradation. Materials to be analyzed and quantified include certain radionuclides that are indicators of severity of core damage (e.g., noble gases, iodines, cesiums and non volatile isotopes), hydrogen in the containment atmosphere and total dissolved gases or hydrogen, boron and chloride in reactor coolant samples in accordance with the requirements of NUREG-0737.

To satisfy the requirements, the application should (1) review and modify his sampling, chemical analysis and radionuclide determination capabilities as necessary to comply with NUREG-0737, II.B.3, (2) provide the staff with information pertaining to system design, analytical capabilities and procedures in sufficient detail to demonstrate that the requirements have been met.

EVALUATION AND FINDINGS

The applicant has committed to a post-accident sampling system that meets the requirements of NUREG-0737, Item II.B.3 in Amendment , but has not provided the technical information required by NUREG-0737 for our evaluation. Implementation of the requirement is not necessary prior to low power operation because only small quantities of radionuclide inventory will exist in the reactor coolant system and therefore will not affect the health and safety of the public. Prior to exceeding 5% power operation the applicant must demonstrate the capability to promptly obtain reactor coolant samples in the event of an accident in which there is core damage consistent with the conditions stated below.

1. Demonstrate compliance with all requirements of NUREG-0737, II.B.3, for sampling, chemical and radionuclide analysis capability, under accident conditions.

2. Provide sufficient shielding to meet the requirements of GDC-19, assuming Reg. Guide 1.4 source terms.

3. Commit to meet the sampling and analysis requirements of Reg. Guide 1.97, Rev. 2.

4. Verify that all electrically powered components associated with post accident sampling are capable of being supplied with power and operated, within thirty minutes of an accident in which there is core degradation, assuming loss of off site power.

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5. Verify that valves which are not accessible for repair after an accident are environmentally qualified for the conditions in which they must operate.

6. Provide a procedure for relating radionuclide gaseous and ionic species to estimated core damage.

7. State the design or operational provisions to prevent high pressure carrier gas from entering the reactor coolant system from on line gas analysis equipment, if it is used.

8. Provide a method for verifying that reactor coolant dissolved oxygen is at < 0.1 ppm if reactor coolant chlorides are determiend to be > 0.15 ppm.

9. Provide information on (a) testing frequency and type of testing to ensure long term operability of the post accident sampling system and (b) operator training requirements for post-accident sampling.

In addition to the above licensing conditions the staff is conducting a generic review of accuracy and sensitivity for analytical procedures and on-line instrumentation to be used for post-accident analysis. We will require that the applicant submit data supporting the applicability of each selected analytical chemistry procedure or on-line instrument along with documentation demonstrating compliance with the licensing conditions four months prior to exceeding 5% power operation, but review and approval of these procedures will not be a condition for full power operation. In the event our generic review determines a specific procedure is unacceptable, we will require the applicant to make modifications as determined by our generic review.

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Response:

Item 1. In compliance with the requirements of NUREG-0737, II.B.3, TVA is implementing a postaccident sampling facility (PASF) capable of sampling and analyses of reactor coolant and containment air as well as providing for grab samples to be taken for offsite analyses. The equipment has been furnished by Sentry Equipment Company. TVA is also providing a radchem laboratory for radiological and chemical analyses.

Item 2. Sufficient shielding shall be provided to meet the requirements of GDC-19 (assuming NUREG 1.4 source terms). A design criteria document is being drafted by TVA to ensure this.

Item 3. It is the intent of TVA to meet the requirements of sampling and analysis outlined in Reg. Guide 1.97, revision 2.

Item 4. ~~Our~~ TVA design documents stipulate that all equipment in the PASF which may be required to be operational during postaccident operations shall have access to two independent offsite power supplies. Consequently, all electrically powered components associated with postaccident sampling are capable of being operationally restored within 30 minutes of an accident involving core damage in the event of loss of one source of offsite power.

Item 5. Containment isolation valves shall be environmentally qualified in accordance with the requirements in IEEE Standard 323-1974, which includes qualification documentation, as stated in NUREG-0588.

Item 6. ~~Our~~ TVA procedure for relating radionuclides in reactor coolant to extent and kind of core damage is in accordance with the requirements in Reg. Guide 1.97. TVA has the capability to quantify in less than two hours (1) noble gas radionuclides which suggest fuel cladding failure, (2) iodine and cesium isotopes which correlate to high fuel centerline temperatures, and (3) nonvolatile isotopes which indicate fuel melting. We utilize gamma spectroscopy with other standard radiochemical methods to accomplish this.

Item 7. High-pressure carrier gas, associated with the gas chromatograph, cannot enter the reactor coolant system. The online gas analysis equipment has a parallel interface with the containment atmosphere sample panel. (Note: there is a clear distinction between online equipment and inline equipment. The latter is in constant contact with the process fluid to be sampled and analyzed. Online equipment can remotely sample, transfer, and subsequently analyze the fluid without continued interfacing with the process fluid.)

Item 8. Online analysis of dissolved oxygen (DO) and chlorides in the reactor coolant can be performed in the 0.1 to 20 ppm range for both species. However, for DO levels less than 0.1 ppm, a laboratory analysis is required.

Item 9a. TVA design documents state the design life of all major components, equipment, and instrumentation shall be 40 years and be able to survive an accident dose in accordance with Reg. Guide 1.97. Items designed for postaccident service shall also be designed to remain functional in postaccident environments for at least three years. Insofar as testing frequency, only routine standardization of test equipment according to manufacturers' recommendations are necessary.

Item 9b. TVA design documents indicate the capability to perform a complete set of postaccident sampling and analyses, to verify equipment readiness, and to train personnel without affecting normal power production maneuvers. (Operator training for PAS is being provided by NUS, who has been subcontracted by the PAS vendor, Sentry Equipment Company.)
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