NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 2.4.13 GROUNDWATER

REVIEW RESPONSIBILITIES

Primary - Site Analysis Branch (SAB)

Secondary - None

I. AREAS OF REVIEW

Data presented in the applicant's safety analysis report (SAR) on local and regional groundwater reservoirs are reviewed to establish the effects of groundwater on plant foundations. Other areas reviewed under this plan include identification of the aquifers and the type of onsite groundwater use, the sources of recharge, present and future withdrawals, an evaluation of accident effects, monitoring and protection requirements, and design bases for groundwater levels and hydrodynamic effects of groundwater on safety-related structures and components. Flow rates, travel time, gradients, and groundwater levels beneath the site are reviewed, as are seasonal and climatic fluctuations, or those caused by man, that have the potential for long-term changes in the local groundwater regime.

II. ACCEPTANCE CRITERIA

For SAR Section 2.4.13.1: a full, documented description of regional and local groundwater aquifers, sources, and sinks is required. In addition, the type of groundwater use, wells, pump and storage facilities, and the flow requirements of the plant must be described. If groundwater is to be used as an essential source of water for safety-related equipment, the design basis for protection from natural and accident phenomena must compare with Regulatory Guide 1.27 guidelines. Bases and sources of data must be adequately described.

For SAR 2.4.13.2: a description of present and projected local and regional groundwater use must be provided. Existing uses, including amounts, water levels, location, drawdown, and source aquifers must be discussed and should be tabulated. Flow directions, gradients, velocities, water levels, and effects of potential future use on these parameters, including any possibility for reversing the direction of groundwater flow, must be indicated. Any potential groundwater recharge area within the influence of the plant and effects of construction, including dewatering, must be identified. The influence of existing and potential future wells with respect to groundwater beneath the site must also be discussed. Bases and sources of data must be described and referenced.

For SAR Section 2.4.13.3: dispersion characteristics and dilution capability of the groundwater environment with respect to existing and future users must be described for both operating and accident conditions. Estimates and bases for coefficients of dispersion and dilution, groundwater velocities, travel times, gradients, permeabilities, porosities, and groundwater or piezometric levels between the site and existing or future users must be described and be consistent with site characteristics. Potential pathways of contamination to groundwater users must also be identified. Sources of data must be described and referenced.

For SAR Section 2.4.13.4: the need for and extent of procedures and measures to protect groundwater users, including monitoring programs, must be discussed. These items are site-specific and will vary with each application.

For SAR Section 2.4.13.5: the design bases (and development thereof) for groundwater-induced hydrostatic loadings on subsurface portions of safety-related structures, systems, and components must be described. If construction dewatering is critical to the integrity of safety-related structures, the bases for subsurface hydrostatic loadings assumed during construction and the dewatering methods to be employed must be described. In addition, if wells are proposed for safety-related purposes, the hydrodynamic design bases (and development thereof) for protection against seismically-induced pressure waves must be described and be consistent with site characteristics.

III. REVIEW PROCEDURES

The review sequence is shown on Figure 2.4.13. Local and regional groundwater conditions are reviewed by comparing the applicant's description with reports by the U. S. Geological Survey (USGS), other agencies, and professional organizations. Other branches with related review responsibilities will be notified of any applicable groundwater data and analyses. If onsite groundwater use and facilities are safety-related, the criteria of Regulatory Guide 1.27 are applied.

The staff will compare the applicant's description of present and projected local and regional groundwater use, existing users, including ambient use, water levels, location, and drawdown with information and data from references. Drawdown effects of projected future groundwater use, including the possibility for reversing the groundwater flow, will be evaluated and may be checked by independent calculations. Construction effects, including dewatering, on potential recharge areas may also be evaluated.

Independent calculations will be made of the dispersion and dilution capabilities and potential contamination pathways of the groundwater environment under operating and accident conditions with respect to existing and future users. The needs and plans for procedures, measures, and monitoring programs to protect groundwater users will also be reviewed based upon the site-specific groundwater features. Design bases for groundwater-induced hydrostatic loadings on subsurface portions of safety-related structures are reviewed and compared with independent check calculations to determine whether the data base used is adequate to reflect any potential future changes which can be induced by variations in precipitation, or by the construction of future wells and reservoirs.

Any missing data, information and analyses necessary to conduct the above reviews and evaluations will be requested in first-round questions. Responses will be evaluated, and if necessary, computer programs for groundwater models (e.g., Refs. 2 and 5) may be used to determine the effects of changing groundwater conditions on site safety, and of accidents on regional and local groundwater supply. Staff positions will then be developed and supplied to the applicant.

The above reviews are performed only when applicable to the site or site region. Some items of review may be done on a generic basis.

IV. EVALUATION FINDINGS

For construction permit (CP) reviews, the findings will consist of a statement of the applicant and staff estimates of groundwater levels associated with safety-related structures, and where applicable, groundwater flow directions, gradients, velocities, effects of potential future use on these parameters, and the effects of an accident on existing and future users. If the estimates are similar, staff concurrence in the applicant's estimates will be stated. If the staff predicts substantially more conservative groundwater conditions for which the proposed plant may be adversely affected, a statement of the staff bases will be made. If groundwater conditions do not constitute design bases, the findings will so indicate.

For operating license (OL) reviews of plants that have had detailed groundwater reviews at the CP stage, the CP conclusions will be referenced. In addition, a review of groundwater history since the CP review will be indicated and note of any changes in groundwater conditions or usage will be made. If no CP groundwater review was undertaken, of the scope indicated herein, this will be indicated.

A sample CP statement follows:

> "Groundwater is available at the site in low to moderate yields from the following four aquifers listed by increasing depth below the surface: (1) the unconfined water-table aquifer consisting of the A and B formations, (2) the confined C-Upper D aquifer, (3) the confined upper D aquifer, and (4) the confined middle D aquifer. Groundwater in the A-B town aquifer generally moves toward the local streams; whereas, in the deeper confined aquifers, groundwater generally moves toward centers of pumping. At the present, saltwater intrusion into the aquifers at the site is not evident as a result of brackish water movement from the E Bay, the F Canal, or G Bay.
>
> "The applicant plans to use groundwater during plant operation at a continuous rate of 140 gpm, of which 100 gpm will be used for demineralized water requirements, and 40 gpm will be service water for drinking, washing, and filling the fire protection storage tanks. The source of this supply will probably be the A-B aquifer, for which the applicant has conducted pumping tests at two locations. The applicant has indicated he may utilize another deeper aquifer for this supply, and has agreed to supply additional pumping test data to the staff for evaluation if another aquifer is chosen. This is acceptable to the staff.

"Precipitation is the source for groundwater recharge to the A-B aquifer. The recharge area for this aquifer lies to the southwest of the plant site and extends beyond the City of H. No major recharge areas for the lower confined aquifers are believed to exist in the vicinity of the site.

"A water-table design level of 65 feet MSL (15 feet below plant grade) was selected by the applicant to determine hydrostatic loadings on safety-related structures. The staff concurs that this level is conservative since the highest measured water table elevation at the plant site following an extremely rainy season was 63.4 feet MSL."

V. REFERENCES

In addition to the following, references on methods and techniques of analysis, published data by federal and state agencies, such as USGS water supply papers, will be used as available.

1. J. D. Bredehoeft and G. F. Pinder, "Digital Analysis of Areal Flow in Multiaquifer Groundwater Systems: A Quasi Three-Dimensional Model," Water Resources Research, Vol. 6, No. 3, pp. 883-888 (1970).

2. "Finite Element Solution of Steady State Potential Flow Problems," HEC 723-G2-L2440, Corps of Engineers (1970).

3. T. A. Prickett and C. G. Lonnquist, "Selected Digital Computer Techniques for Groundwater Resource Evaluation," Bulletin 55, Illinois State Water Survey, Urbana, Illinois (1970).

4. D. B. Cearlock and A. E. Reisenauer, "Sitewide Groundwater Flow Studies for Brookhaven National Laboratory, Upton, Long Island, New York," Battelle Pacific Northwest Laboratories, Richland, Washington (1971).

5. K. L. Kipp, D. B. Cearlock, A. E. Reisenauer, and C. A. Bryan, "Variable Thickness Transient Groundwater Flow Model--Theory and Numerical Implementation," BNWL-1703, Battelle Pacific Northwest Laboratories, Richland, Washington (1972).

6. D. R. Friedrichs, "Information Storage and Retrieval System for Well Hydrograph Data--User's Manual," BNWL-1705, Battelle Pacific Northwest Laboratories, Richland, Washington (1972).

7. K. L. Kipp and D. B. Cearlock, "The Transmissivity Iterative Calculation Routine--Theory and Numerical Implementation," BNWL-1706, Battelle Pacific Northwest Laboratories, Richland, Washington (1972).

8. S. W. Ahlstrom, R. J. Serne, R. C. Routson, and D. B. Cearlock, "Methods for Estimating Transport Model Parameters for Regional Groundwater Systems," BNWL-1717, Battelle Pacific Northwest Laboratories, Richland, Washington (1972).

9. R. C. Routson and R. J. Serne, "One-Dimensional Model of the Movement of Trace Radioactive Solutes Through Soil Columns: The PERCOL Model," BNWL-1718, Battelle Pacific Northwest Laboratories, Richland, Washington (1972).

10. R. C. Routson and R. J. Serne, "Experimental Support Studies for the PERCOL and Transport Models," BNWL-1719, Battelle Pacific Northwest Laboratories, Richland, Washington (1972).

11. K. L. Kipp, D. B. Cearlock, and A. E. Reisenauer, "Mathematical Modeling of a Large, Transient, Unconfined Aquifer with a Heterogeneous Permeability Distribution," Paper presented at the 54th Annual Meeting of the American Geophysical Union, Washington, D.C., April 1973.

12. D. L. Schreiber, A. E. Reisenauer, K. L. Kipp, and R. T. Jaske, "Anticipated Effects of an Unlined Brackish-Water Canal on a Confined Multiple-Aquifer System," BNWL-1800, Battelle Pacific Northwest Laboratories, Richland, Washington (1973).

13. Regulatory Guide 1.27, "Ultimate Heat Sink," Revision 2.

14. Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Revision 2.

15. W. H. Li and F. H. Lai, "Experiments on Lateral Dispersion in Porous Media," Jour. Hydraulics Division, Proc. Am. Soc. Civil Engineers, Vol. 92, No. HY6 (1966).

16. W. H. Li and G. T. Yeh, "Dispersion of Miscible Liquids in a Soil," Water Resources Research, Vol. 4, pp. 369-377 (1968).

17. D. R. F. Harleman, P. F. Mehlhorn, and R. R. Rumer, "Dispersion-Permeability Correlation in Porous Media," Jour. Hydraulics Division, Proc. Am. Soc. Civil Engineers, Vol. 89, No. HY2, pp. 67-85 (1963).

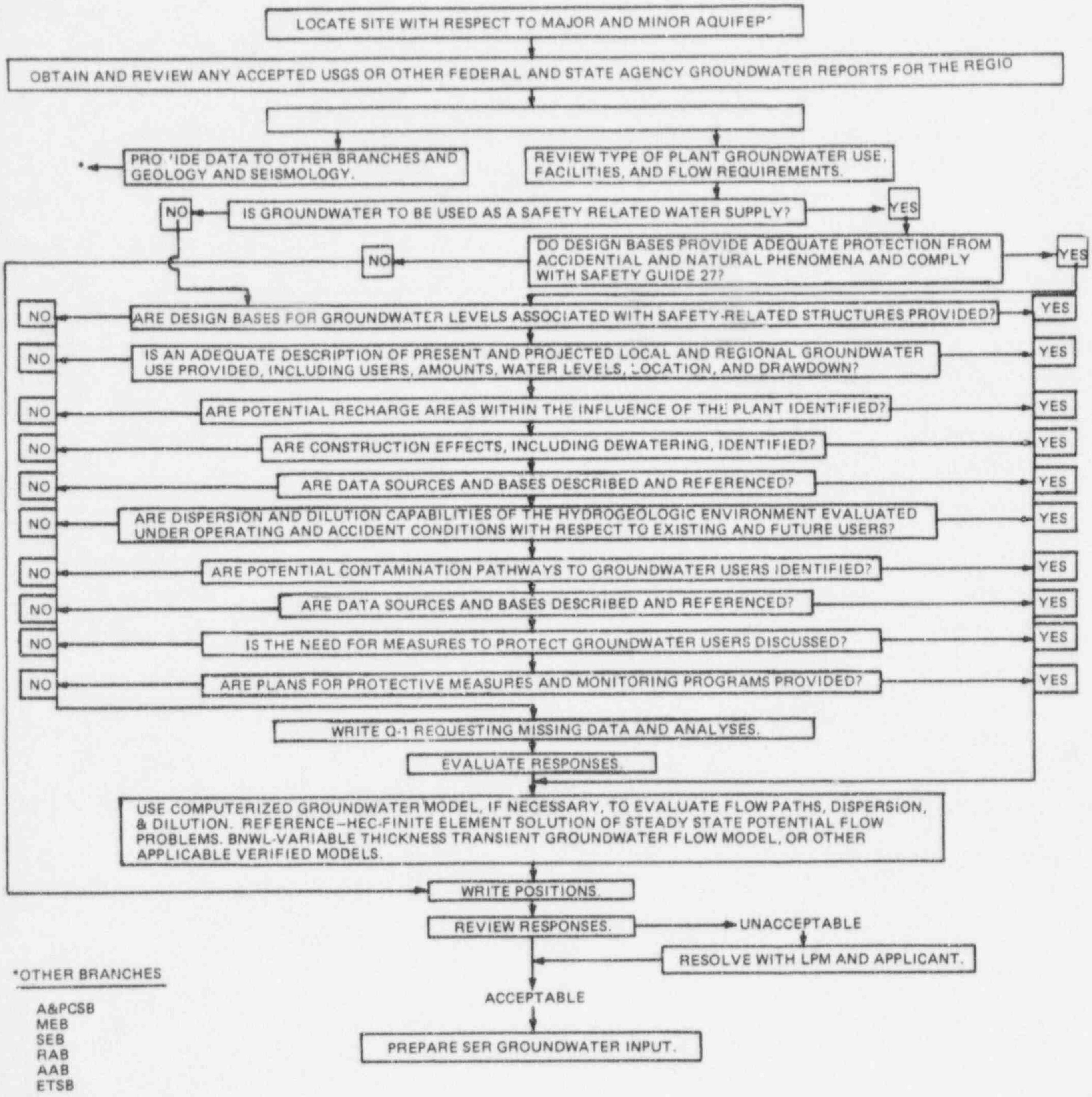
18. L. E. Addison, D. R. Friedrichs, and K. L. Kipp, "The Transmissivity Iterative Programs on the PDP-9 Computer--A Man-Machine Interactive System," BNWL-1707, Battelle Pacific Northwest Laboratories, Richland, Washington (1972).

19. "Fundamentals of Transport Phenomena in Porous Media," International Association for Hydraulic Research, Elsevier Publishing Company, New York (1972).

20. D. K. Todd, "Ground Water Hydrology," John Wiley & Sons, Inc., New York (1959).

FIGURE 2.4.13

STANDARD REVIEW PLAN 2.4.13
GROUNDWATER



*OTHER BRANCHES

A&PCSB
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SRP 2.4.14