RELATED CORRESPONDENCE

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'82 SEP 22 A11:07

OFFICE OF SECRETARY
DOCKETING & SERVICE
BRANCH

September 20, 1982

DOCKET NUMBER 50-329 OL/OM
PROD. & UTIL. FAC. 50-330 OL/OM

Mrs Barbara Stamiris
5795 N River Road
Rte 3
Freeland, MI 48623

Dear Mrs Stamiris

Attached hereto are Consumers Power Company's Response to Stamiris Interrogatories dated August 30, 1982. In addition, please note the following:

1. Regarding Interrogatory 18, the Company previously objected to the portion pertaining to "costs to ratepayers." A response to the balance of the interrogatory is supplied.

2. The following have been interpreted as document requests, a response to which will be provided in the allotted 30-day time period:

   Numbers 2, 17, 21, and 23
   under Contention 1b and c;

   Number 8 under Contention 6;

   Number 3 under Contention 3;

   Number 7 under Contention 4, and

   a portion of Number 9 under
   "additional QA interrogatories".

3. Questions 6-11 under Contention 1b and 1c were subject to previous objections.

4. Various interrogatories, such as Numbers 22 and 19, refer to "defective welds". For purposes of these interrogatories, we assume the reference is to the reactor pressure vessel beltline welds made from WF-70 material. Those welds are not defective; the use of the phrase "defective weld" makes the questions argumentative.

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5. Questions pertaining to Contention 3, which we presume refers to Stamiris Contention 6 as described by the Board in the Prehearing Conference Order, are arguably irrelevant to Contention 6. That contention alleges that the NRC Risk Assessment fails to account for the effect of dewatering on groundwater relationships. The questions go beyond potential impacts of groundwater relationships on the NRC's Risk Assessment. Although we have provided responses to these questions, we do not waive any objections as to the relevancy of these lines of inquiry to the contention.

Very truly yours

James E Brunner

James E Brunner

oc0982-0237a100

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CONSUMERS POWER COMPANY (Midland Plant, Units 1 and 2)	Docket No 50-329 OM 50-330 OM Docket No 50-329 OL 50-330 OL

September 13, 1982

AFFIDAVIT OF DAVID A SOMMERS

My name is David A Sommers. I am a Section Head in the Midland Safety and Licensing Department. In this capacity, my responsibilities are supervising and coordinating the review of environmental licensing and radiological safety issues for the Midland Project.

I am primarily responsible for providing a response(s) to Interrogatory I, Questions 1, 2 and 3 concerning Barbara Stamiris contention 1b. To the best of my knowledge and belief, the above information and the responses to the above interrogatory(ies) are true and correct.

David A Sommers

Sworn and Subscribed Before Me This 17th Day of Sept 1982

Pamela J. Griffin
Notary Public
Jackson County, Michigan

My Commission Expires Sept 8, 1984

mi0982-0057b168

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CONSUMERS POWER COMPANY (Midland Plant, Units 1 and 2)	Docket No 50-329 OM 50-330 OM Docket No 50-329 OL 50-330 OL

September 13, 1982

AFFIDAVIT OF ASHISH D SARKAR

My name is Ashish D Sarkar. I am the Section Head of Cost Engineering. In this capacity, my responsiblities are to estimate, forecast and monitor the total capital cost and other costs associated with the Midland Nuclear Project.

I am primarily responsible for providing a response to Interrogatory I, Questions 4, 5, 12, 13 and 18 (in part) concerning Barbara Stamiris contentions 1b and 1c. To the best of my knowledge and belief, the above information and the responses to the above interrogatory is true and correct.

Ashish D. Sarkar.

Sworn and Subscribed Before Me This 17th Day of Sept 1982

Pamela J. Griffin
Notary Public
Jackson County, Michigan

My Commission Expires Sept 8, 1984

mi0982-0057c168

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of
CONSUMERS POWER COMPANY
(Midland Plant, Units 1 and 2)

Docket No 50-329 OM
50-330 OM
Docket No 50-329 OL
50-330 OL

September 15, 1982

AFFIDAVIT OF HARVEY W SLAGER

My name is Harvey W Slager. I am the Materials Engineering Section Head in the Midland Design Production Department. In this capacity, my responsibilities are to evaluate the materials used at the Midland Plant.

I am primarily responsible for providing a response to Interrogatory I, Questions 14, 15 (in part), 16 and 19 (in part) concerning Barbara Stamiris Contention 1c. To the best of my knowledge and belief, the above information and the responses to the above interrogatory are true and correct.

Harvey W. Slager

Sworn and Subscribed Before Me This 17th Day of September 1982

Pamela J. Griffin
Notary Public
Jackson County, Michigan

My Commission Expires Sept 8, 1984

mi0782-0162q100

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CONSUMERS POWER COMPANY (Midland Plant, Units 1 and 2)	Docket No 50-329 OM 50-330 OM Docket No 50-329 OL 50-330 OL

September 14, 1982

AFFIDAVIT OF ARTHUR L LOWE, JR, PE

My name is Arthur L Lowe, Jr, I am an Advisory Engineer (Materials) in the Engineering Section of B&W-NPGD. In this capacity, my responsibilities are materials for nuclear steam supply systems.

I am primarily responsible for providing a response to Interrogatory I, Questions 15 (partial) and 20. To the best of my knowledge and belief, the above information and the responses to the above interrogatory are true and correct.

Arthur L Lowe Jr P.E.

Sworn and Subscribed Before Me This 14th Day of September 1982

Pamela J. Shiffer
Notary Public
Jackson County, Michigan

My Commission Expires Sept 8, 1984

mi0982-0057n168

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CONSUMERS POWER COMPANY (Midland Plant, Units 1 and 2)	Docket No 50-329 OM 50-330 OM Docket No 50-329 OL 50-330 OL

September 10, 1982

AFFIDAVIT OF PHILIP C WEBB

My name is Philip C Webb. I am Senior Staff Engineer in the Midland Project Administration Department. In this capacity, my responsiblities are coordination with Dow Chemical Company in administration of the contract for steam service.

I am primarily responsible in part for providing a response to Interrogatory I, Question 18 concerning Barbara Stamiris Contention 1c. To the best of my knowledge and belief, the above information and the responses to the above interrogatory are true and correct.

Philip C Webb

Sworn and Subscribed Before Me This 7 Day of [illegible] 1982

Pamela J. Griffin
Notary Public
Jackson County, Michigan

My Commission Expires Sept 8, 1984

mi0982-0054o168

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CONSUMERS POWER COMPANY (Midland Plant, Units 1 and 2)	Docket No 50-329 OM 50-330 OM Docket No 50-329 OL 50-330 OL

September 15, 1982

AFFIDAVIT OF A(DOLPH) J BIRKLE

My name is A John Birkle. I was the Materials Section Head of the Engineering Services Department in the time frame under discussion. In this capacity, my responsiblities were to provide material engineering services during various phases of electric plant projects during design, construction and start-up; I also assisted in the quality assurance effort in that time period including shop audits on the Midland B&W reactor vessel.

I am primarily responsible for providing a response to Interrogatory I, Questions 19 (in part) and 22 concerning Barbara Stamiris Contention 1c. To the best of my knowledge and belief, the above information and the response to the above interrogatory are true and correct.

A John Birkle

Sworn and Subscribed Before Me This 17th Day of Sept 1982

Pamela J. Griffin
Notary Public
Jackson County, Michigan

My Commission Expires Sept 8, 1984

mi0982-0235a100

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CONSUMERS POWER COMPANY (Midland Plant, Units 1 and 2)	Docket No 50-329 OM 50-330 OM Docket No 50-329 OL 50-330 OL

September 15, 1982

AFFIDAVIT OF KENNETH R KLINE

My name is Kenneth R Kline. I am the Manager of Administration, Midland Project. In this capacity, my responsibilities are Project Budgeting, Contract Administration, Special Studies, Records Management and Other Administrative duties.

I am primarily responsible for providing a response to Interrogatory I, Question 25 (in part). To the best of my knowledge and belief, the above information and responses to the above interrogatory is true and correct.

Kenneth R. Kline

Sworn and Subscribed Before Me This 15 Day of September, 1982

Barbara R. Townsend
Notary Public
Jackson County, Michigan

My Commission Expires September 8, 1984

mi0982-0057r168

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of
CONSUMERS POWER COMPANY
(Midland Plant, Units 1 and 2)

Docket No 50-329 OM
50-330 OM
Docket No 50-329 OL
50-330 OL

September 10, 1982

AFFIDAVIT OF RONALD C BAUMAN

My name is Ronald C Bauman. I am the Manager of the Midland Design Production Department. In this capacity, my responsiblities are to manage the affairs of the department, and to supervise the heads of the various department technical sections.

I am primarily responsible for providing a response to Interrogatory I, Question 25 concerning Barbara Stamiris Contention 1c. To the best of my knowledge and belief, the above information and the responses to the above interrogatory are true and correct.

Ronald C Bauman

Sworn and Subscribed Before Me This 14th Day of Sept 1982

Pamela J. Griffin
Notary Public
Jackson County, Michigan

My Commission Expires Sept 8, 1984

mi0982-0054p168

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of
CONSUMERS POWER COMPANY
(Midland Plant, Units 1 and 2)

Docket No 50-329 OM
50-330 OM
Docket No 50-329 OL
50-330 OL

September 15, 1982

AFFIDAVIT OF DERK J VOKAL

My name is Derk J Vokal. I am the Production Section Head, Midland Site Management Organization, Consumers Power Company. In this capacity, my responsibilities are supervision of field engineers during the construction phase of Midland Nuclear Plant.

I am primarily responsible for providing a response to Interrogatory I, Questions 24 and 26 (in part) concerning Barbara Stamiris contention 1b. To the best of my knowledge and belief, the above information and the responses to the above interrogatory are true and correct.

Derk J. Vokal

Sworn and Subscribed Before Me This 16 Day of September 1982

Valene D Eastman
Notary Public
Midland County, Michigan

My Commission Expires March 26, 1983

VALENE EASTMAN
Notary Public, Midland County, Mich.
My Commission Expires Mar. 26, 1983

mi0982-0057p168

Barbara Stamiris

INTERROGATORY I

RE COST/BENEFIT: CONTENTION 1b and 1 c

Questions

1. Explain in detail the "prompt removal/dismantlement decommissioning plan for Midland. Describe any special procedures or equipment which will be used to protect the workers and the environment from radiation. Include estimates of length of time to complete the job and the condition of the plant site upon completion.

2. Provide documents which form the basis for the decommissioning plan described in 1 above.

3. To what extent if any will Midland's decommissioning be affected by soils remedial measures such as underpinning supports, dewatering equipment, or others?

4. Explain in detail how the $235 million (1984 dollars) decommissioning estimate was derived for Midland. Include breakdown of costs for the component steps described.

5. What does CPC calculate Midland decommissioning costs to be as a % of its projected lifetime production cost savings? Explain this calculation.

6. To what extent is the Midland decommissioning financing, and collection plan based upon the Big Rock and Palisades models? Explain any differences if they exist.

7. Explain in detail the method CPC proposes to finance and collect Midland decommissioning costs until the year 2000. Include explanations of inflation allowances, interim use of money collected by CPC, liquidity of these assets, and method of guaranteeing availability of money when needed for decommissioning.

8. Provide documents which form the basis for the financing and collection plan described in q. 7.

9. If Big Rock and Palisades' combined $111 million decommissioning cost in 1980 dollars (MP 6/81-50M, 62-51912 CPC decommissioning pamphlet) results in the collection of $526 million (exhibit A/S-1, MPSC case 6150) by the year 2000, what amount is estimated to be collected for Midland by the year 2000 according to your plan? Explain these calculations.

10. Does the $235 million estimate represent the full amount to be collected according to your decommissioning plan described in the last part of your pamphlet cited above, if not, explain why it shouldn't.

11. a) According to current laws, explain the federal income tax rate and manner by which CPC will be taxed for decommissioning money collected early. b) What are these tax amounts projected to total through the year 2000 on the decommissioning amounts projected in q. 9? c) Will money be collected from ratepayers above and beyond amounts estimated in q. 9 to support these CPC tax expenditures? If so explain and estimate these added ratepayer contributions.

12. What was the projected life expectancy for Midland units 1 & 2 respectively.

13. Explain in detail how the 66% lifetime capacity factor is derived for Midland. Does this estimate take into account any expected differences between Unit 1 & Unit 2 operating capacity, pressure, or temperature limitations due to the defective beltline weld in Unit I? Explain these differences if they exist.

14. Explain in detail the apparant discrepancy in the EFPY estimates for Unit I operation appearing on pages 5-19 and C-10 of the SER?

15. What is the EFPY estimate you are currently using for Unit I? Explain any differences between this estimate and those submitted for the SER.

16. Explain in detail the apparant discrepancies between flux properties on SER p. 5-19 and FSAR section 5.3.1.6.1.3 for surveillance samples and actual beltline material samples. Provide the calculations and other documents which form the basis of this explanation.

17. Provide documents relating to reduced operating capacity or life expectancy of Unit I.

18. Explain any contingency economic plans for shorter life expectancy of Unit I in terms of electrical production and related costs to ratepayers, and in terms of inability to produce steam for Dow according to contractual obligations what will happen if Unit I must shut down after 10 years?

19. Has CPC considered performing preventative rather than remedial thermal annealing or other corrective measures for defective reactor welds prior to plant operation to avoid the safety and economic costs associated with post operative radiation? If yes, explain. If not, why not.

20. Explain in detail the method of performance and frequency of inspections planned by the B & W Owners Group Surveillance program for monitoring reactor weld fracture toughness and other weld conditions? How does this program protect against the possibility of sudden failure?

21. Provide documentation for B & W program above.

22. Explain in detail when and how CPC first became aware of the defective weld material--or the questionable quality of weld material in their reactors.

23. Provide all documents and correspondence sent and received regarding the reactor vessel weld properties prior to the installation of the reactors at Midland.

24. When were the Unit I and Unit II reactors installed (give month and year)?

25. Were Unit I and Unit II reactors ever switched from their originally planned containments? If yes, explain why.

26. Did any confusion in identification of Unit I and Unit II reactors ever occur. If so explain when and how this occurred, what occurred and how it was resolved.

Responses

1. At this time, there is no comprehensive decommissioning plan for Midland, although a generic prompt removal dismantling plan was used for the purpose of estimating the decommissioning costs. As identified in Section 5.8 of the Environmental Report (ER-OLS), a decommissioning plan will be submitted to the NRC in accordance with 10 CFR 50.82 at an appropriate time prior to terminating the operating license. This plan will factor in the experience gained from the then previous plant decommissionings and then existing technology.

As noted in Section 5.8 of the ER-OLS, Consumers Power Company has tentatively chosen the prompt removal/dismantling method for the Midland Plant. The basic approach to this generic method is as follows: A two-year planning period prior to plant shutdown will be necessary to prepare the final decommissioning plan and to receive the appropriate NRC approval. After plant shutdown, all loaded fuel and spent fuel will be shipped offsite to the appropriate federal repository. A comprehensive plant radiation survey will be performed to assure the protection of plant workers and the public. All highly contaminated systems will be drained, flushed and chemically decontaminated. Highly contaminated structures, such as is likely with the reactor building inner concrete walls and floors, will be decontaminated to preclude significant radioactive releases to the public during final demolition. Solid and liquid radwaste generated during decommissioning will be shipped offsite to appropriate radwaste repositories. After final decontamination, and after all contaminated plant piping, equipment and structures have been removed, final plant demolition will be performed. Finally, as stated in the ER-OLS, the cooling pond and associated dikes will be filled and leveled as necessary to restore the area to the previously existent drainage and suitable for uses permitted by township zoning ordinances. It is expected that the total decommissioning of the Midland Plant using this generic method will take approximately four years from the time of cessation of power production to complete restoration of the plant site to its original state.

2. As identified in Section 5.8 of the ER-OLS, the decommissioning cost estimate was based on the following two documents:

a. Smith, R I: Konzek, G J; and Kennedy, W E: Technology, Safety and Costs of Decommissioning A Reference Pressurized Water Reactor Power Station, Battelle Pacific Northwest Laboratories, NUREG/CR-0130 (June 1978).

b. Manion, W J and LaGuardia, T S: An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives, Atomic Industrial Forum, Inc, AIF/NESP-009 (November 1976).

3. The soils remedial measures will have an insignificant impact on the Midland Plant decommissioning effort compared to the decommissioning of the other major plant structures. Where underpinning supports must be removed, start-of-the-art demolition techniques are presently available. The dewatering equipment will be removed or capped as required. All other plant features incorporated as a result of the soils remedial measures will likewise have insignificant impact on the decommissioning effort.

4. The $235 million (1984 dollars) decommissioning estimate is a conceptual estimate for immediate dismantling of the Midland Plant, Units 1 & 2 at the end of its useful life. The breakdown of cost as shown in the Midland Plant Environmental Report, Revision 11, Table 5.8-1 is as follows.

Activity	Estimated Costs in Millions
Mobilization, Demobilization and Temporary Facilities	$ 4.8
Supplies, Power, Contractor Services, Nuclear Insurance	23.6
Equipment	5.4
Staff Labor	33.2
Demolition Services	54.9
Disposal (Radioactive Waste)	46.6
Overheads	16.3
Subtotal - Decommissioning	$184.8
Evaporator, Diesel Generator, Administration, Service Water and C.W. Structure Demolition	8.9
Site Specific Restoration	41.9
Rounding	(0.6)
Total Decommissioning, Demolition and Site Restoration	$235.0

The estimate is derived from a similar study for Palisades Nuclear Plant Decommissioning cost, which was based on Battelle Pacific Northwest Study and Atomic Industrial Forum Study (as referenced in response to Question 2 above). However, adjustments were made to include the decommissioning of two units at the Midland site as opposed to a single unit at Palisades, specific bulk quantities for Midland Plant and the site specific demolition and restoration costs. The Midland estimate was escalated for inflation to reflect 1984 dollars.

5. A study to determine the projected production cost savings for the first 34 years of plant operation was performed in 1980 to fulfill the requirements of the Public Utilities Regulatory Policies Act (PURPA). A 34-year value was tentatively chosen for accounting purposes. (At the time the calculations were performed, this figure approximated the values used for Big Rock and Palisades Plants, which was the best estimate available. The thirty-four year figure differs from the actual expected operating life of 40 years for Midland Plant.) If the ratio of the production cost savings from this study is used to compare the present worth of estimated decommissioning costs (also on a 34-year basis), it will result in a figure less than 1%. If the calculations were performed for 40 years, we would expect decommissioning costs to be a lower percentage of production cost savings than the one resulting from the 34-year calculations, though not by a significant amount.

The details of the calculation are shown below:

o Sum of the Present Worth (PW) of the projected production cost savings at 11.51% discount rate for 34 years (in 1984 $)	= $8,600 million
o Decommissioning costs (in 1984 $)	= $ 235 million
o Escalated decommissioning cost at 7.5% per year escalation rate for 34 years	= $2,748 million
o Present Worth (PW) of the decommissioning cost at 11.51% discount rate (in 1984 $)	= $ 68 million

$$\% = \frac{\text{PW of the Decommissioning Cost}}{\text{Sum of the PW of Production Cost Savings}} = \frac{68}{8,600} = 0.8\%^{*}$$

= Less than 1%

*All costs are based on the parameters as of 1980.

12. The projected operational life expectancy for both Midland Units 1 and 2 is 40 calendar years. Typically, all plant design parameters are based on expected operating life.

13. The lifetime capacity factor based on CP Co's comments to Draft Environmental Statement (DES) and as shown in the FES was derived by using the results of an inhouse computer program and future projections of plant availability. This program models the operation of Midland Plant and calculates the projected electric energy output for Units 1 & 2. For commenting on the Draft Environmental Statement, this program was run for the years 1983 through 1996. Results of this and a projection for beyond 1996 through 2017, were used to arrive at the 66% capacity factor. Net electric outputs used in calculating the capacity factor for Midland Unit 1 are 537 MW through 1989, 539 MW from 1990 through 1994 and

465 MW thereafter, while Midland Unit 2 is 808 MW through 1994 and 811 MW thereafter.

Primary inputs to this program are the nuclear steam supply system and turbine generator random outage rates. These outage rates are based on a 1980 report that analyzed historical NRC capacity factor data and its application to the Midland Plant. Other data for input consists of unit capabilities, thermal power levels, refueling outage requirements and steam sale changes and are Midland specific.

The estimated capacity factor of 66% does not account for any expected differences between Unit 1 and Unit 2 operating capacity, pressure or temperature limitations due to the lower circumferential beltline weld in Unit 1.

14. Neither Pages 5-19 nor C-10 contain EFPY estimates for Unit 1 operation, they contain EFPY estimates for reaching the 50 ft-lbs Upper Shelf Energy criterion. That is, both of these pages contain estimates for the number of Effective Full Power years (EFPY) when the material at 1/4 of the vessel wall thickness will accumulate the neutron fluence which will result in lowering of the Charpy V notch Upper Shelf Energy (USE) to 50 ft-lbs. Neither current nor the anticipated regulations require discontinuation of operation when material falls below the 50 ft-lb USE level.

The reason for the apparent discrepancy in the EFPY estimates is described in the SER. The estimate on Page C-10 is based on a proprietary report BAW-1511P "Irradiation-Induced Reduction in Charpy

Upper Shelf Energy of Reactor Vessel Welds" (October 1980). The estimate on Page 5-19 is based on "BAW-1511P and surveillance material data submitted by other licensees" (emphasis added).

BAW-1511P reports on the analysis of drop in Upper Shelf Energy exhibited by 37 sets of operating power plant surveillance capsule data. This analysis developed a correlation between the combination of chemical composition and fluence and drop in upper shelf energy. (This correlation is an average or mean correlation.) The chemical composition for the Midland Unit 1 lower circumferential beltline weld (WF-70) has been evaluated to determine the fluence at which this average correlation would predict reaching the 50 ft-lb level. That fluence which corresponds to the 15.1 EFPY estimate is 5 X 10^{18} n/cm^2 reported on Page C-10 of the SER.

The "surveillance material data submitted by other licensees" referred to on Page 5-19 are contained in B&W Reports BAW-1697, "Analysis of Capsule OC111-B from Duke Power Company Oconee Nuclear Station, Unit 3" (October 1981) and BAW-1699, "Analysis of Capsule OCII-A from Duke Power Company's Oconee Nuclear Station, Unit 2" (December 1981) (Note these data were not available when BAW-1511P was published). Both of these reports provide irradiated Charpy V notch data for WF-209-1 weld metal which, based upon its chemical composition, should be highly similar to the WF-70 weld in Midland Unit 1. These reports show that the WF-209-1 exhibits an Upper Shelf Energy of 49 ft-lbs at a fluence of 3.12 X 10^{18} n/cm^2 (BAW-1697) and 48 ft-lbs at a fluence of 3.37 X 10^{18} n/cm^2 (BAW-1699). Based upon this supplemental data (on a chemically similar weld) and on the average predictions of BAW-1511P, page 5-19 estimated 3 X10^{18} n/cm^2 for when the WF-70 would reach the 50 ft-lb USE level.

15. Consumers Power estimates 32 EFPY as the estimated life of the plant (32 EFPY corresponds to 40 calendar years using a conservative 80% utilization factor) and 15.1 EFPY is the estimate for when the Unit 1 lower beltline weld material at the 1/4 vessel wall thickness position will accumulate a fluence (of 5 x 10^{18} n/cm^2) which results in a drop in Upper-Shelf Energy to the 50 ft-lb level. The value of 5 x 10^{18} n/cm^2 is demonstrated as a conservative estimate by data obtained from actual WF-70 weld metal removed from the nozzle belt forging of Midland Unit 1 and irradiated in a test reactor program. The results of this program demonstrated that the weld metal WF-70 does not drop below the 50 ft-lb level for fluences to 9.0 x 10^{18} n/cm^2. The 5 x 10^{18} n/cm^2 estimate is consistent with the estimate on Page C-10 of the SER and is inconsistent with the estimate on Page 5-19 of the SER and the 5 x 10^{18} n/cm^2 estimate is conservative when compared to test reactor data. It is apparent that the test reactor data were not considered in the estimates which appear in Chapter 5 of the SER.

It is important to note that reaching the 50 ft-lb upper-shelf energy does not represent a condition which limits plant operation. Neither the existing version of 10 CFR 50 Appendix G nor the proposed revision to 10 CFR 50 Appendix G (Federal Register, November 14, 1980) nor the draft Revision 1 to NUREG 0744 require cessation of operations upon reaching the 50 ft-lb level. In each case additional fracture toughness data and analyses are required, and volumetric examination is required by the existing Appendix G and NUREG 0744. If those actions do not demonstrate safe operability of the plant, thermal annealing is permitted to restore the Upper-Shelf Energy of the material.

16. The information in the SER and the FSAR do not represent discrepancies. The SER is describing the weld material which is being irradiated as a portion of the B&W Owner's Group program which is described in BAW-1543 "Integrated Reactor Vessel Material Surveillance Program." This material is fabricated from the same heat of filler metal and the same lot of flux as those used in fabricating the Midland Unit 1 lower circumferential beltline weld. Therefore, both the Midland lower circumferential beltline weld and the non-beltline weld referred to in the SER have the same weld procedure identification number WF-70.

The FSAR describes a material which was fabricated from the same heat of filler metal but a different lot of flux than that used in WF-70 welds. (Flux is a granular mineral compound which is used to shield the molten weld pool from the atmosphere. In general, the flux used in this case (Linde 80) does not significantly contribute to the fracture toughness properties of a weld.) This material is identified by weld procedure identification number WF-209-1 and due to its similarity in chemical composition to WF-70 welds this material was selected for inclusion in most of the Midland Unit 1 surveillance capsules in lieu of WF-70. As is described in Table 16.4.4-5 in the Technical Specifications in the FSAR, a limited amount of WF-70 material will be irradiated in the Midland Unit 1 surveillance capsule program. The inclusion of WF-209-1 was made in order to conserve scarce WF-70 material when sufficient amounts of WF-70 material were being irradiated in the B&W Owner's Group program.

In summary, the SER and FSAR are describing different materials. The SER describes the WF-70 material being irradiated in the B&W Owner's Group program (same heat of filler metal, same lot of flux as the Midland WF-70 material). The FSAR describes the WF-209-1 material which will be irradiated in the Midland surveillance capsule program (same heat of filler metal but different lot of flux from the Midland WF-70 material).

Information such as the preceding does not result from calculations. The document which provides the filler wire heat number and the flux lot numbers for WF-70 and WF-209-1 is Table 5 on Page B-20 of a proprietary B&W report, BAW-1511P, entitled "Irradiation-Induced Reduction In Charpy Upper-Shelf Energy of Reactor Vessel Welds," dated October 1980.

18. If Unit 1 is unable to produce steam to Dow, CP Co is contractually obligated to furnish steam from Unit 2. In the unlikely event of the necessity of shutting down Unit 1 after 10 years, Unit 2 is expected to be used to produce both electricity and steam.

19. On at least two occasions, Consumers Power has considered removing the Midland Unit 1 lower reactor vessel circumferential beltline weld and replacing it with material which would be less susceptible to loss of fracture toughness due to neutron irradiation. In the early 1970's while the vessel was in the fabrication shop, consideration was given to replacing the weld material and it was decided to not replace the material. In 1977 while the vessel was at the Midland site another

evaluation was made on the desireability for replacing the weld material. In both cases, it was decided to leave the weld in the vessel.

In both cases, replacing the weld material was not considered to be a safety question because it was recognized that the effects of irradiation can be conservatively predicted and where those predictions indicate that the plant might become unsafe at some future date, actions can and will be taken to avoid the unsafe conditions. Replacement of the weld material was considered to avoid possible economic costs, such as restrictive pressure-temperature limitations, additional analyses, or thermal annealing. In the early 1970's the conclusion was reached that leaving the weld in the vessel was the most cost-effective course of action, but we have been unable to find any documentation explaining the reasons for this conclusion. The Company's reasons for not replacing the weld material in 1977 are documented in a memorandum from G S Keeley dated June 14, 1977.

Thermal annealing as a preventative measure, prior to operation is not an effective measure to ameliorate the effects of irradiation on material fracture toughness.

20. The B&W Owners Group Surveillance Program for monitoring reactor weld fracture toughness and other weld conditions are described in the two attached reports: (1) BAW-1474 "B&W User's Group Program for Evaluation of Reactor Vessel Material Properties" December 1977; and (2) BAW-1543 "Integrated Reactor Vessel Material Surveillance Program," November 1981.

The surveillance programs for the Midland units will provide timely information and data with which to monitor the behavior of the materials in the reactor vessel prior to the time that the materials in the vessels will actually experience the conditions.

The Owners Group program provides further protection against the possibility of sudden failure by: (1) obtaining additional data on the behavior of irradiation effects on materials properties which provides better techniques for assessing irradiation damage in all reactor vessel materials; (2) benchmarking of fluence analytical procedures and techniques to insure better accuracy in the determination of fluence on reactor vessels; and (3) development of conservative fracture mechanics analytical techniques. It is anticipated that these activities will be completed significantly before corresponding conditions in the actual Midland units.

Thus, the Owner's Group Program will define the behavior of the vessel materials significantly before any improbable conditions which could lead to failure of the vessel. Regulations require that the operational limitations of the vessel be established based on all available data such that the vessel is maintained in a condition of ductile fracture toughness. This will insure that the condition of the vessel will protect against the possibility of failure.

The sudden failure of a reactor vessel is an extremely remote possibility because current regulations do not permit the operation of a reactor vessel at conditions where sudden failure could occur.

22. A memorandum dated October 4, 1971 from A J Birkle to G S Keeley shows that Consumers Power was aware that the Midland Unit 1 lower circumferential beltline weld might, as a result of its chemical composition, be more sensitive to neutron irradiation damage than other weld materials.

Apparently, Consumers Power became aware of this situation based upon a combination of Naval Research Laboratory data on the effects of residual elements on fracture toughness of irradiated material and input from B&W on the levels of residual elements in the lower circumferential beltline weld. The 1971 Birkle memorandum is the earliest record that we have found documenting CP Co's awareness of this issue.

24. The Midland Unit 1 Reactor Pressure Vessel was installed on June 30, 1978.

The Midland Unit 2 Reactor Pressure Vessel was installed on May 17, 1978.

25. B&W assigned Nuclear Steam System (NSS) contract numbers NSS 12 and NSS 13 to each of the Midland Units. Originally, all of the NSS 12 components were intended for Midland Unit 1 and all of NSS 13 components were intended for Unit 2. In 1973 it was decided to switch unit construction sequence (build Unit 2 first) and to install the NSS 12 components in Unit 2 and the NSS 13 components in Unit 1. In 1977 it was decided to switch the NSS 12 and NSS 13 Reactor Vessels and Closure Heads so that the NSS 12 Reactor Vessel, Closure Head and Core Support Structure are in Midland Unit 1 with the balance of the Unit 1 being

NSS 13 components (eg, primary coolant piping, steam generators, pressurizer and reactor coolant pumps).

The switch of unit construction sequence in 1973 was based on an analysis which demonstrated that it was more desirable to complete Midland Unit 2 before Unit 1 because the higher electrical output from Unit 2 was required for system reserve and; Dow Chemical Company preferred to have Unit 2 operating and demonstrated to be operable before receiving steam from Unit 1 and retiring Dow's own steam generation capacity and; the detailed design of the process steam system was not adequately advanced to support operation of Unit 1 before Unit 2.

The reasons for the switch in 1977 are documented in a March 2, 1977 letter from R C Bauman which states, "This change will allow maximum time to finalize the reactor vessel surveillance program and to resolve metallurgical questions concerning the two relatively high copper content welds in the NSS (NSS 12) reactor vessel."

26. There is no confusion in the identification of the Unit I and Unit II reactor pressure vessels. Each reactor vessel is assembled from a number of parts (eg, shell sections, nozzles, flanges, plates). Each part is identified with a unique part identification number prior to assembly into the reactor vessel. A portion of that unique part number is the contract number (ie, 12 and 13). A number of these part numbers are still visible on the assembled vessel and therefore we have verified that the Unit 1 vessel is the NSS 12 vessel and the Unit 2 vessel is the NSS 13 vessel. In particular the Unit 2 vessel has been visually examined at the outside of the vessel below the flange elevation. A

portion of the interrupted dot die identification number at this elevation reads 620-0013-51. The 51 identifies the component as the reactor vessel and the 0013 identifies the contract as NSS 13.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CONSUMERS POWER COMPANY (Midland Plant, Units 1 and 2)	Docket No 50-329 OM 50-330 OM Docket No 50-329 OL 50-330 OL

September 20, 1982

AFFIDAVIT OF ALAN J BOOS

My name is Alan J Boos. I am employed by Bechtel Power Corporation as the Assistant Project Manager for the Midland project. In this capacity, I assist the project manager in fulfilling his overall responsibility for Bechtel's work on the Midland project.

I am primarily responsible for providing a response to Interrogatory II, Questions 1, 2, 3, 4, 5, and 6, concerning Barbara Stamiris' Contention 6. To the best of my knowledge and belief, the above information and the responses to the above interrogatory are true and correct.

Sworn and Subscribed Before Me This 20 Day of September, 1982

Notary Public
Washtenaw County, Michigan

My Commission Expires November 30, 1982

BEVERLY A. BOOS
NOTARY PUBLIC, WASHTENAW CO., MICH
MY COMMISSION EXPIRES NOV. 30, 1982

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CONSUMERS POWER COMPANY (Midland Plant, Units 1 and 2)	Docket No 50-329 OM 50-330 OM Docket No 50-329 OL 50-330 OL

September 16, 1982

AFFIDAVIT OF NEAL SWANBERG

My name is Neal Swanberg. I am a Project Engineer for Bechtel Associates Professional Corporation. In this capacity, I am presently responsible for engineering design for the remedial soils work for the Midland site.

I am primarily responsible for providing a response to Interrogatory II, Question 9, concerning Contention 6 of Mary Sinclair. To the best of my knowledge and belief, the above information and the responses to the above interrogatory are true and correct.

Neal Swanberg

Sworn and Subscribed Before Me This 16 Day of Sept 1982

Beverly A. Bross
Notary Public
Washtenaw County, Michigan

My Commission Expires November 30, 1982

BEVERLY A. BROSS
NOTARY PUBLIC, WASHTENAW CO., MICH
MY COMMISSION EXPIRES NOV. 30, 1982

mi0982-0231b100

County of Midland

State of Michigan.

I, Walter J. Lee, as Project Manager at the Midland, Michigan site of Consumers Power Company for the Babcock & Wilcox Company, B&W Construction Company, am responsible and knowledgeable as to answers set forth in relation to questions #1, 4, 6, and 7 of the Quality Assurance Sinclair contention 6 and do certify and swear that the answers so stated are accurate and true to the best of my knowledge.

Sworn to and subscribed before me this 14 day of September, 1982.

Valene D. Eastman, Notary

VALENE EASTMAN
Notary Public, Midland County, Mich.
My Commission Expires Mar. 26, 1983

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CONSUMERS POWER COMPANY (Midland Plant, Units 1 and 2)	Docket No 50-329 OM 50-330 OM Docket No 50-329 OL 50-330 OL

September 16, 1982

AFFIDAVIT OF DONALD M TURNBULL

My name is Donald M Turnbull. I am the Assistant Manager, Administration & Special Projects, of the Midland Project Quality Assurance Department. In this capacity, my responsibilities include the conducting of certain investiga'ions for the Midland Project Quality Assurance Department.

I am primarily responsible for providing responses to Interrogatory II questions 1 through 8 concerning Sinclair Contention 6. To be best of my knowledge and belief, the above information and the responses to the above interrogatories are true and correct.

Donald M. Turnbull.

Sworn and Subscribed Before Me This 16th Day of Sept 1982

Patricia A Puffer
Notary Public
Bay County, Michigan

My Commission Expires 3-4-86

Barbara Stamiris

INTERROGATORY II

RE QUALITY ASSURANCE: SINCLAIR CONTENTION 6

Questions

1. If a plant worker has a safety concern, what is the chain of reporting open to him? Describe the workings of this internal reporting system.

2. In reporting a safety concern to the NRC would a plant employee be free to provide the NRC with back up site work documentation without the permission of Bechtel or CPC superiors?

3. If the answer to q. 2 is no, how does this affect the necessary free flow of information to the NRC?

4. Does CPC, Bechtel or any subcontractor encourage workers with safety related complaints to keep the problems "in house" as opposed to going to the NRC? Explain.

5. If a plant worker has pursued the internal QA reporting system, and gone to the NRC, but still feels his safety concerns have not been properly addressed, is he free to go to the public with those concerns as an employee or CPC, or Bechtel--as an ex-employee of CPC or Bechtel? If not, explain why.

6. What records are kept of worker safety related complaints, reports of violations of QA procedures allegations, or use of internal reporting system described in q. 1 above? (I am interested in the incidence of reporting, not the reports themselves.)

7. Provide a list of former plant employee names and forwarding addresses who left in 1981 or 1982 and had reported a complaint about improper QA/QC procedures, made use of the internal reporting system described in q. 1, or filed an allegation.

8. How long has the MPQAD internal allegation form been in existence? Is this form made available to all plant workers--how? Please provide a copy.

9. The Midland Daily News (8/26/82) reported a Suit against Bechtel by Ronald Corto charging job loss due to QA reporting. Why were coreholes being drilled into structures--name all structures into which coreholes were drilled? Provide documents related to QA procedures for this drilling and to the Carto allegations.

Responses - Consumers Power Company

1. A Consumers Power Company worker at the Midland Plant, who has a safety concern, has several ways in which to make his concern known. The first, and the most frequently used, is directly to his own supervisor. This is an informal chain and is not documented.

A second way in which a worker could make his concerns known, would be to bring them to the attention of a QC inspector or a QA engineer, and ask that person to write a nonconformance report on the subject.

A third way is through the Quality Report form, which is available to all crafts in the Craft Change House, and in the hall of the Bechtel Administration Building, and which is publicized by posters in other areas of the Plant. These forms may be completed, and then dropped into padlocked drop boxes, which are emptied twice a week by MPQAD personnel. This may be done by any person on site - not just Consumers Power Company employees.

One particular MPQAD Supervisor is assigned responsibility for evaluating the validity of the complaints or concerns, and for assigning responsiblity for further investigation where warranted. Those which concern the quality of safety related equipment are investigated by MPQAD personnel, and each step in the investigation is documented. Those which do not concern the quality of safety related equipment may still be handled, but the progress of the work, and the final disposition, are not documented.

A fourth way is through the resident NRC inspector, whose telephone number at the site is listed in the site telephone directory, and whose home telephone is listed in the Midland telephone directory. His office is centrally located in the power block area, and shielded from view from the Consumers Power and the Bechtel Administration offices. He is frequently out and around the site, where he talks to workers and foremen alike.

The Midland telephone directory also lists the telephone number of the Region III Office in Glen Ellyn, should anyone want to make a report directly to them.

2. To the best of our knowledge, a case such as is described in this question, involving a Consumers Power Company employee, has not occurred at the Midland Site.

If, to support an allegation, a Consumers Power Company employee who had legally obtained a document, other than an original of an essential record, were to turn it over to the NRC without the Company's permission the employee would not be terminated for that act. He could, however, be terminated for other acts. This is not to imply that he would not be instructed on how to handle such a case in the future.

It should be noted that the NRC may look at any documents they like, other than documents protected by the attorney-client privilege or otherwise privileged, on the site, and that an employee need only advise them of the existence of one which he feels they should see. It is not necessary for him to remove Company owned property to accomplish his objectives.

3. We do not believe that the free flow of information to the NRC is compromised in any way, by Consumers Power Company policies.

4. Consumers Power Company does encourage workers to report safety related complaints "in-house" first. This is so the problem can be corrected expeditiously, and also to preserve the credibility of the Company in the eyes of the NRC and the public.

However, no restraint is placed upon workers in regard to notifying the NRC if they feel that their concerns are not adequately addressed, or if they do not appear to be addressed in a timely fashion.

5. Consumers Power Company has no policy which applies to an employee who chooses to go to the public with his concerns. There is no Company policy or procedure which protects such an employee.

Consumers Power Company has no control over ex-employees, but we would hope that one who had a safety-related concern would advise the Company before going to the public.

Again, this is to permit the most expeditious handling of the matter, and to preserve the credibility of the Company.

6. To answer this question, we must differentiate between an "allegation," which is a term we have applied to those cases in which the report was only verbal, or was made to someone other than a Quality

Assurance person, and those concerns which are reported in Quality Report Forms, as described in the answer to Question 1.

Verbal reports to Consumers Power Company persons other than MPQAD must be reported to MPQAD. Any reports made to MPQAD must be recorded on Allegation Forms, and each step of the ensuing investigation must be recorded. When the investigation is completed, and the file is closed, it is sent to the office of the Manager, MPQAD, in Jackson, for safekeeping and to preserve the anonymity of the alleger. Since the inception of the allegation form, in October 1980, four allegations have been recorded this way.

I have personally talked to several site personnel, including the Consumers Power Company Site Manager, the Consumers Power Company Construction Superintendent, and MPQAD personnel who were on site prior to 1980, and although they say there were probably several cases which, if they occurred today, would be considered to be allegations, they can only recall two. One was the case which is the subject of Question #9, and is dealt with in the response to that question. The other was recalled as an anonymous report made to our Site Management Office about 1975. This was reported to Consumers Power Company Quality Assurance, who investigated it, and resolved it through a nonconformance report.

Complaints which are reported on Quality Report Forms are evaluated by a designated supervisory person in MPQAD. If they are valid complaints about the quality of the installed hardware, those which apply to safety related equipment are assigned to a QA Engineer for investigation. Those which apply to non safety related equipment are forwarded to the Site Management Office for handling.

Since December, 1980, there have been 16 Quality Report Forms received. Eleven of these have been categorized as unrelated to quality. Three were considered useful, but did not apply to safety related equipment. Of the remaining two, one was a question rather than a complaint, and we believe there is a satisfactory answer which will explain that there is no problem. However, documentation is not quite complete on it. The other was just received at the end of August, and investigation is not complete yet.

7. Procedure 15-5 in the PE&C QA Program Procedure Manual, which defines the handling of allegations, promises allegators anonymity and forbids the revealing of their names or addresses without their permission. Therefore, we cannot provide the names and addresses of the four allegers mentioned in our response to Question 6.

Of the two valid quality concerns which were submitted in Quality Reporting Forms, and which applied to safety related equipment, one was signed and the other was not. The one which was signed was submitted by an employee who is still employed by Consumers Power Company. Therefore, there are no names or addresses in this category which fall within the scope of the question.

8. The Quality Report Form, of which a supply of blanks is maintained in a plastic pocket on the posters, and in a plastic pocket on

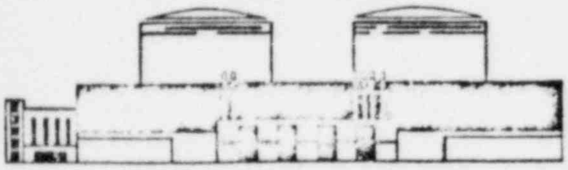
each drop box, has been available since December of 1980, when it was publicized by an article in the house newspaper, 'Midland Reactor.'

The form on which MPQAD personnel document an allegation which is reported to them, has been available since October, 1980. It is not available to plant workers.

Blank copies of both forms are attached.

TOGETHER, we can make Our Plant the BEST.

QUALITY REPORT FORM



Midland Nuclear Plant

YOU NEED NOT SIGN YOUR NAME

If you prefer, you need not sign your name. Information regarding the findings and action taken on your report can be obtained by calling ______________________________.

______________________________ (your name) ______________ (date)

WHERE IS YOUR GROUP LOCATED ON THE SITE?

____

____

____

____

____

____

____

____

____

HOW CAN YOU BE REACHED?

Phone: ______________________ Address: ______________________

____

Please put completed form in any QA dropbox.

Thank you for your concern.

TOGETHER, we can make Our Plant the BEST.

REPORT FORM

Do you know a situation where quality requirements aren't being met?
If you've already told your supervisor or foreman and you still aren't satisfied, fill out this report.

WHAT IS THE PROBLEM?

What do you think should be done about it?

DESCRIPTION:

Please describe the equipment or system you're reporting. Where is it?
(Be specific. If we can't find it, we can't fix it.)

Consumers Power Company

ALLEGATION EVALUATION

PROJECTS, ENGINEERING AND CONSTRUCTION- QUALITY ASSURANCE

QA-68-1

1. Allegation Serial No_______________
2. Who received the allegation?_______________
3. When was the allegation received?_______________
4. How was the allegation received? ie, telephone, face-to-face, by letter?_______________
5. When was the allegation reported to CP Co - QA?_______________
6. Name of the allegator:_______________
7. Who is allegator's employer and what is the allegator's position?

   ____
8. Where can the allegator be contacted?_______________
9. When will the allegator make next contact?_______________
10. Can the allegator's name be used in evaluation of allegation?

    YES ☐ NO ☐

    Allegator's signature:_______________
11. Will the allegator permit his name to be used in reports to the

    NCR? YES ☐ NO ☐

    Allegator's signature:_______________
12. Will the allegator provide details of his allegation to the NRC?

    YES ☐ NO ☐

    Allegator's signature:_______________

    MPQA may document telephone responses to items 10, 11, and 12 by completing the appropriate blocks and initialing and dating the entries.

STANDARD INFORMATION CHECKLIST

1.	Allegation Serial No ______________________	Completed By/Date
2.	Nofity the allegator of the procedure for evaluating allegations.	____________
3.	Explain that if the allegation is validated, an NC type report will be issued and the allegator will be provided with a copy of the NC type report subsequent documentation and the closed NC type report.	____________
4.	Explain that if required by 10CFR50.55(e) or 10CFR Part 21, the nonconformance will be reported to the NCR.	____________
5.	Explain that if evaluation does not substantiate the allegation or if the allegation is not safety related, it will be dropped by QA at that time and he will be so notified.	____________
6.	Explain that the allegator will be provided a copy of the final report.	____________

Signature of the allegator indicates that Items 1, 2, 3, 4, 5 in the checklist above have been explained and understood.

Dated:____________________ Signature:______________________________

Consumers Power Company

QA-67-1

ALLEGATION EVALUATION

PROJECTS, ENGINEERING AND CONSTRUCTION-QUALITY ASSURANCE

Specifics of Allegations

1. Allegation Serial No ______________________________

2. What is the alleged condition? ______________________________

____

____

3. What is the location of alleged condition? ______________________________

____

4. What systems, components, items are affected by alleged condition? _____

____

____

5. For how long has the alleged condition existed? ______________________________

____

6. What requirement was violated by alleged condition? ______________________________

____

____

7. To whom has this condition been previously reported (e.g internally and externally)? ______________________________

8. When was the condition previously reported? ______________________________

____

9. What actions have been taken to resolve alleged condition and by whom have the actions been taken? ______________________________

____

10. Is alleged condition covered by an existing nonconformance (NC) type report? ______________________________

____

11. Prepared By/Date:	12. Condition Reported By-Signature/Date:

Consumers Power Company

ALLEGATION EVALUATION

PROJECTS, ENGINEERING AND CONSTRUCTION-QUALITY ASSURANCE

QA-66-1

1. Allegation Serial No ____________________

2. Does alleged condition affect a Q-listed system/component/item?

   Yes No

3. If "No" to 2, above, forward to Midland Project Management Organization or PM&MP, as applicable, for further evaluation.

4. Does alleged condition actually exist? Yes No

5. If "No" to 4, above, terminate evaluation, enter NA in Blocks 5 through 12, sign Blocks 13 and 14 and distribute.

6. Has the alleged condition previously been documented on a nonconformance-type report? Yes No

7. If "Yes" to 6, above, enter nonconformance-type report identification:

   ____

8. If "Yes" to 6, above, does nonconformance-type report adequately describe alleged condition, is corrective action adequate to resolve the alleged condition, and is corrective action progressing adequately? Yes No

9. Describe any actions taken to resolve inadequacies found in 8, above:

   ____

   ____

10. If "Yes" to 8, above, enter NA in Blocks 11 and 12, sign Blocks 13 and 14 and distribute.

11. Does the alleged conditon constitute a nonconforming condition which has not been previously documented?

12. If "Yes" to 11, above, prepare a nonconformance type document and enter number No____________________.

13. Evaluation Completed By/Date:	14. Evaluation Reviewed by Manager, MPQA or Gen. Supv., QAD-PM/Date:

Responses - Bechtel Associates Professional Corporation

1. If plant workers have a safety concern, they would normally use the direct communication channel with their supervisor. This is the most frequently used method. As this is an informal chain, no documentation of this communication is maintained. If the workers' concern is not resolved by the immediate supervisor, the communication chain upward can be utilized (i.e., worker to foreman; foreman to superintendent; etc...).

If the plant workers' concern about safety is not resolved by the foregoing communication lines, Bechtel has procedures in place for reporting of defects or nonconformances in accordance with 10 CFR 21. Contractors, subcontractors, vendors and suppliers have their own procedures to the extent required for their compliance with 10 CFR 21.

These requirements obligate Bechtel, its contractors, subcontractors, vendors and suppliers to adopt appropriate procedures to ensure that evaluation and reporting of substantial safety hazards are accomplished. Any Bechtel employee who becomes knowledgeable of a deviation or noncompliance that may be considered potentially reportable under 10 CFR 21 is responsible for initiating the evaluation and reporting procedures.

2. Documents that are the property of Bechtel or its client are not available for uncontrolled use by its employees. Nonmanual employees agree upon start of employment to not disclose or use, directly or indirectly, at any time, any information that is the property of Bechtel or its clients unless such disclosure or use is in the course of

employment or has been expressly authorized in writing by Bechtel. Employees also agree to not remove any such information from the premises or possession of Bechtel or its clients unless expressly authorized.

We have not performed a survey of subcontractors to determine their policies in this regard and they may vary. In any case, documents are available to the NRC as described in response to Question 3.

3. Documents are available to the NRC through established channels between the NRC and Consumers Power Company. If the documents are required for NRC inspection of employee allegations, they may be obtained through these channels.

4. We encourage Bechtel employees to bring concerns to their supervisors. In accordance with the provisions of 10 CFR 21, any Bechtel employee who becomes knowledgeable of a deviation or noncompliance that may be considered potentially reportable under 10 CFR 21 is responsible to initiate the reporting action. This provides for a full evaluation of each concern and is necessary for Bechtel to comply with its obligations for reporting under 10 CFR 21.

In addition to posting the procedures associated with 10 CFR 21 in a conspicuous position in accordance with that regulation, Bechtel also posts for employee attention the protections and obligations for employees and employers under the Michigan Whistleblowers' Protection Act. Therefore, although employees are encouraged to follow established procedures for evaluation of safety concerns, they are also informed of their protection against discrimination if they report a violation or suspected violation of federal, state, or local laws, rules, or regulations to a public body. In addition, new federal regulations embodied in 10 CFR 50.7 will become effective on October 12, 1982 requiring posting of employee protection against discrimination.

We encourage subcontractors to bring their concerns to Bechtel. Although we have not surveyed all subcontractors, they are subject to the same federal regulations and state laws noted above and we therefore believe they have policies similar to those described above.

5. An employee or ex-employee of Bechtel is free to go to the public if all other avenues have been pursued and he still feels his safety concerns have not been properly addressed.

6. No records are kept of informal communications between workers and their supervisors. Formal records consist of nonconformance reports and management corrective action reports. As of September 15, 1982, 4,527 nonconformance reports and 59 management corrective action reports have been initiated. These records identify the initiator of the document. They do not necessarily identify the person who first noted the concerns if he was not the initiator.

9. Coreholes may be drilled into structures to provide a penetration for routing of utilities such as piping, tubing, cables or conduit through a concrete wall or slab, to provide anchorage for component supports; or to extract core samples of concrete for inspection or testing.

Coreholes have been drilled in essentially every building in the plant, including:

Containments 1 and 2

Auxiliary Building

Turbine Building

Diesel Generator Building

Evaporator Building

Service Water Pump Structure

Other safety and nonsafety plant structures

Responses - Babcock & Wilcox Company, B&W Construction Company

1. Babcock & Wilcox, B&W Construction Company, has posted on bulletin boards in the Office and Change buildings, Title 10, Chapter 1 Code of Federal Regulations - Energy Part 21 - as guide lines for all personnel to use as a Reporting Method. (See attachment to this answer.)

4. No. This is not and has not been a policy or philosophy of B&W Construction Company. B&W Construction Company agrees with and is committed to the following:

a. Title 10, Chapter 1 Code of Federal Regulations - Energy - Part 21

b. Public Law 93-438: Energy Reorganization Act of 1974.

6. There have been no QA procedures, allegations, or worker safety related complaints reported to the site management of B&W Construction Company.

7. There have been no QA procedures, allegations, or worker safety related complaints reported to the site management of B&W Construction Company.

FOR PERMANENT POSTING

The Babcock & Wilcox Company
10 CFR Part 21
Reporting of Safety-Related Defects and Nonconformance

The Nuclear Regulatory Commission requires directors and responsible officers of certain firms and organizations to report defects in components and failures to comply with regulatory requirements that may result in a substantial safety hazard. The new regulations are identified as: *Title 10 Chapter 1 Code of Federal Regulations – Energy – Part 21.* They apply to firms that:

- Build, operate, or own NRC licensed facilities or conduct NRC-licensed or regulated activities.
- Supply safety-related components for NRC licensed facilities.
- Supply safety-related design, testing, inspecting or consulting services for NRC licensed facilities.

The following documents provide information relative to the reporting of safety-related defects and non-conformance.

	Erection Sites	Copley
A COPY OF 10 CFR PART 21 IS LOCATED	B&W Construction Co. Office	Quality Assurance Manager
A COPY OF B&W'S CORPORATE POLICY REGARDING PART 21 IS LOCATED	B&W Construction Co. Office	Quality Assurance Manager
A COPY OF THE PROCEDURE FOR IMPLEMENTING B&W'S CORPORATE POLICY IS LOCATED	B&W Construction Co. Office	Quality Assurance Manager

Reports shall be made to the jobsite Project Manager.
At Copley, reports shall be made to the Quality Assurance Manager.

Parts of the federal law and regulation concerning this requirement to report safety-related defects and non-compliance are:

LAW

PUBLIC LAW 93-438: ENERGY REORGANIZATION ACT OF 1974

Sec. 206 (a) Any individual director, or responsible officer of a firm constructing, owning, operating, or supplying the components of any facility or activity which is licensed or otherwise regulated pursuant to the Atomic Energy Act of 1954, as amended, or pursuant to this Act, who obtains information reasonably indicating that such facility or activity or basic components supplied to such facility or activity —

(1) Fails to comply with the Atomic Energy Act of 1954, as amended, or any applicable rule, regulation, order, or license of the Commission relating to substantial safety hazards, or

(2) Contains a defect which could create a substantial safety hazard, as defined by regulations which the Commission shall promulgate, shall immediately notify the Commission of such failure to comply, or of such defect, unless such person has actual knowledge that the Commission has been adequately informed of such defect or failure to comply.

(b) Any person who knowingly and consciously fails to provide the notice required by subsection (a) of this section shall be subject to a civil penalty in an amount equal to the amount provided by section 234 of the Atomic Energy Act of 1954, as amended.

(c) The requirements of this section shall be prominently posted on the premises of any facility licensed or otherwise regulated pursuant to the Atomic Energy Act of 1954, as amended.

(d) The Commission is authorized to conduct such reasonable inspections and other enforcement activities as needed to insure complicance with the provisions of this section."

REGULATION

10 CFR PART 21 – JUNE 10, 1977 PURPOSE

"21.1 Purpose – The regulations in this part establish procedures and requirements for implementation of section 206 of the Energy Reorganization Act of 1974. That section requires any individual director or responsible officer of a firm constructing, owning, operating or supplying the components of any facility or activity which is licensed or otherwise regulated pursuant to the Atomic Energy Act of 1954, as amended, or the Energy Reorganization Act of 1974, who obtains information reasonably indicating:

(a) That the facility, activity or basic component supplied to such facility or activity fails to comply with the Atomic Energy Act of 1954, as amended, or any applicable rule, regulation, order, or license of the Commission relating to substantial safety hazards, or

(b) That the facility, activity, or basic component supplied to such facility or activity contains defects, which could create a substantial safety hazard, to immediately notify the Commission of such failure to comply or such defect, unless he has actual knowledge that the Commission has been adequately informed of such defect or failure to comply."

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CONSUMERS POWER COMPANY (Midland Plant, Units 1 and 2)	Docket No 50-329 OM 50-330 OM Docket No 50-329 OL 50-330 OL

September 16, 1982

AFFIDAVIT OF WILLIAM C PARIS, JR

My name is William C Paris, Jr. I am the Supervisor of the Engineering Geology Group for Bechtel Associates Professional Corporation. In this capacity, I am presently responsible for the design of the permanent dewatering system for the Midland site.

I am primarily responsible for providing a response to Interrogatory III, Questions 1, 2 and 3, concerning Contention 3 of Barbara Stamiris. To the best of my knowledge and belief, the above information and the responses to the above interrogatory are true and correct.

William Paris

Sworn and Subscribed Before Me This 16th Day of Sept 1982

Pamela J. Griffin
Notary Public
Jackson County, Michigan

My Commission Expires Sept 8, 1984

mi0982-0231a100

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CONSUMERS POWER COMPANY (Midland Plant, Units 1 and 2)	Docket No 50-329 OM 50-330 OM Docket No 50-329 OL 50-330 OL

September 13, 1982

AFFIDAVIT OF DAVID A SOMMERS

My name is David A Sommers. I am a Section Head in the Midland Safety and Licensing Department. In this capacity, my responsibilities are supervising and coordinating the review of environmental licensing and radiological safety issues for the Midland Project.

I am primarily responsible for providing a response(s) to Interrogatory III, Question 4 concerning Barbara Stamiris contention 3. To the best of my knowledge and belief, the above information and the responses to the above interrogatory(ies) are true and correct.

David A Sommers

Sworn and Subscribed Before Me This 17th Day of Sept 1982

Pamela J. Griffin
Notary Public
Jackson County, Michigan

My Commission Expires Sept 8, 1984

mi0982-0057a168

Barbara Stamiris

INTERROGATORY III

RE EFFECTS OF DEWATERING: CONTENTION 3

Questions

1. Explain in detail the prolonged (40 year) effect of permanent dewatering upon the various subsoil layers and underlying groundwater.

In answering this question:

a. Include explanations of the potential 40 year effects of removal of fines from soil layers, and how this is monitored.

b. Discuss the interrelated effects of one soil layer upon another.

c. Explain the potential 40 year effects of groundwater movement from lower to upper levels during dewatering.

d. Discuss the possible weakening of the "essentially impervious" intermediate clay layer separating the perched ground water from the underly confined aquifiers under artesian pressure. In so doing consider all possible combined effects of a 40 year dewatering system.

e. Discuss the possible after-effects of 40 year dewatering on groundwater movement between upper and lower levels and upon interrelated soil layers, possibly weakened or changed by dewatering.

2. What studies or other data exist concerning prolonged (40 year) effects of dewatering upon subsoils and groundwater relationships?

3. Provide documents upon which answers to q. 1 are based.

4. Did the assurances provided to the NRC for the FES analysis regarding the effects of possible radioactive release to groundwater following a core-melt accident, take into account the effects of prolonged dewatering on subsoil and groundwater conditions? If yes, explain. If not, why not.

Responses

1. The following response discusses the 40 year effect of permanent dewatering upon the various soil layers and groundwater systems at the Midland Site:

1a. The removal of soil particles as a result of 40 years of dewatering will have no significant effect on natural or backfill soil at Midland.

To minimize soil particle removal the gravel pack and well screen were designed in accordance with accepted standards to accomodate the soils to be dewatered (Reference 1). Well screen materials were selected to resist chemical attack and thus prevent corrosion of the screen and subsequent influx of soil particles into the well (Reference 2). Each well was installed under strict specifications and supervised by the contractor's geologist/hydrogeologist as well as inspected by the QA/QC inspection team (Reference 3).

Also, soil partical removal is monitored in a program which consists of two phases. The first phase, performed during well installation, involved sampling during well development. The initial acceptance criteria for each well is 10 parts per million by weight, or less of inorganic nonmetallic soil particles greater than 0.05 millimeters (50 micron) in size. All laboratory tests are performed in accordance with APHA Standards (Reference 4).

Phase two of the monitoring program will be implemented during full scale dewatering system operation. The operational monitoring program will be included as an operating technical specification. The operational soil particle monitoring program consists of sampling and soil particle measurement monthly for the life of the plant. Each well is evaluated for cumulative production of inorganic, nonmetallic soil particles greater than .005 millimeters (5 microns). Normally, only sand-sized particles are measured in water because it is the removal of these larger sized particles in the soil that can create voids (Reference 5). Sand is technically defined as any inorganic solid material coarser than 0.06 millimeters (60 microns).(Reference 6)

To determine the quantity of soil particles removed monthly, each soil particle measurement value is multiplied by the number of gallons of ground water pumped since the last test. The resulting value is the amount of soil particles removed during the month. The monthly soil particle result is added to the cumulative amount of soil particles removed from the well. If a single well is projected to produce more than 1 cubic yard of soil particles over the 40-year plant life, remedial measures will be considered to decrease the soil particle production from the well. The remedial measures could include redevelopment and requalification of the well, replacement or rehabilitation of the screen, reduction of the pumping rate, or complete replacement of the well.

The removal of silt sized particles is not expected to result in the formation of a small void even if one cubic yard is calculated to have been removed, because the silt sized fraction of the natural soils is less than 15% by weight, and the silt is contained within the interstices of the sand grains. If one cubic yard of sand sized particles is removed, a void could occur. In that case a void space would most likely occur at the top of the well screen, regardless of where the material enters the screen, because the filter pack is expected to settle when material is removed. Therefore, a void would occur just below the grout seal at the top of the filter pack, approximately 28 feet below the ground surface. The void would be limited to the area immediately surrounding the well screen because of the in-place density of the natural materials. There would be no weakening of the overlying soil strata because of the grout seal which prevents loosening of soil above the filter pack.

However, removal of one cubic yard of soil particles is not expected to occur because of the limited amount of pumping that is required to intercept and maintain the water levels in the plant fill. The interceptor wells will operate on a regular basis at an average flow rate of 12 gpm per well. Actual soil particle information collected indicates these wells will produce an average of 0.35 ppm of soil particles. Therefore, it is estimated that only 0.25 cubic yards of soil particles will be removed per well over the 40-year life.

The backup interceptor wells will only operate when the primary interceptor wells are not pumping, which should only be during short periods of maintenance. Therefore the amount of soil particles removed from these wells should be negligible.

The area wells are expected to operate only during the first 6 months to remove the water in storage, afterwhich the wells will operate infrequently because the main recharge will be intercepted by the interceptor wells. Therefore the amount of soil particles removed from these wells will also be negligible.

1b. The stratigraphy of the Midland site soil units consists of: backfill clay and sand, lacustrine sand, lacustrine clay, till, and glaciofluvial sand (Reference 7). The permanent dewatering system is designed to dewater the backfill sands around the diesel generator building and auxiliary building railroad bay areas, by pumping from the lacustrine sands which are located immediately beneath the plant fill. These natural sands are in hydraulic contact with the backfill sands (Reference 8). Thus the permanent dewatering wells are screened only in the lacustrine and backfill sands, not in the lacustrine clay and clay till. The water level in the lacustrine sand will be lowered and maintained only 5 to 15 feet below preconstruction levels. As discussed in the response to Question 1c, the glaciofluvial sands are hydraulically isolated from the lacustrine sand by a minimum of 135 feet of lacustrine clay and/or clay till.

The effects of the permanent dewatering system upon plant soils will be negligible. As discussed in the response to Question 1a, soil particle removal is not a concern. Settlement due to dewatering, which is predicted to be no more than 1 inch in the backfill and no more than 0.8 inch for the natural clays (Reference 9) will not effect the integrity of the soil layers.

1c. Groundwater movement from the lower confined glaciolacustrine sand to the upper unconfined lacustrine sand will not occur as a result of operating the permanent dewatering system for 40 years.

The purpose of the permanent dewatering system is to remove and maintain the groundwater levels in the backfill sand around the diesel generator building and auxiliary building railroad bay to prevent liquefaction during an SSE. To accomplish this, the permanent dewatering wells are positioned to intercept seepage from the man-made cooling pond by pumping from the lacustrine sand. The lacustrine sand is isolated beneath the site by the plant area dike (Reference 10) and is separated from the confined glaciofluvial sand by a minimum of 135 feet of lacustrine clay and/or clay till. The permeabilities of these clays represent very low to practically impervious conditions. As discussed in the FSAR (Reference 11), evaluation of hydrographs, from dike ground water quality monitoring wells screened and sealed within the confined glaciolacustrine sand, indicates that changes in the cooling pond level and changes in groundwater levels in the plant backfill due to construction dewatering do not effect groundwater levels in the deep glaciofluvial sands. If the unconfined lacustrine sands were hydraulically connected to the confined glaciofluvial sands, the piezometric surface in the confined aquifer would fluctuate during construction dewatering and with changes in cooling pond level. Therefore, the confined glaciofluvial sands are hydraulically isolated from the unconfined lacustrine sand, and dewatering from the lacustrine sands will not generate upward flow from the confined glaciofluvial sands.

1d. No weakening of the lacustrine clay and/or clay till units, separating the unconfined lacustrine sand from the confined glaciolacustrine sand can occur due to dewatering.

The permanent dewatering system is designed to intercept seepage from the cooling pond and to control groundwater levels in the backfill around the diesel generator building and auxiliary building railroad bay. As discussed in the response to question 1b, the permanent dewatering wells are only screened in the lacustrine sand and/or backfill sand, not the lacustrine clay or clay till. Therefore, no groundwater will be pumped from these clay units and no soil particles can be removed.

1e. As discussed in the responses to Questions 1c and 1d, there will be no groundwater movement between the upper and lower aquifers during permanent dewatering and no "weakening" of the clay layers caused by permanent dewatering. Therefore there can be no "after-effects" caused by permanent dewatering.

2. I am not aware of any other studies or other data which combine the unique features included in the Midland permanent dewatering system design. These unique features include:

a. Interception of recharge from a man-made source (cooling pond).

b. Dewatering from a hydraulically isolated area. The plant site is surrounded by an impervious cutoff system.

c. A detailed operating and monitoring program including soil particle removal, groundwater level, chemical quality, and settlement monitoring activities.

Studies of which I am aware relate only to the removal and depletion of fluids (groundwater and oil) without a recharge source, from areas more extensive than the Midland power block area. Such studies include the groundwater withdrawal in the Houston area and petrochemical withdrawals in the Long Beach area. I am not sure whether or not these studies covered a 40-year time. I am not aware of the details of these studies.

4. Consumers Power Company was not asked nor did it give assurances to specifically support the NRC with respect to their independently and internally generated FES analysis on core-melt accident releases to the groundwater.

building, the drawdown determined for observation well PD-5B would be less than the drawdowns determined from observation wells PD-6, PD-3, and PD-20B (Table 2.4-11B). However, that is not the case. The relative differences in drawdown between these wells is significant when taking into account the proximity of the cooling pond and the pumping rate (0.83 gallons per minute).

Evaluation of the hydrograph and pumping test data in conjunction with the subsurface information indicates that seepage from the cooling pond is entering the plant site at the circulating water intake structure and then traveling to the diesel generator building area and other portions of the plant site.

2.4.13.5.1.2 Dewatering System Design

The design of the permanent dewatering system accounts for the two basic findings of the exploration and testing program: 1) The granular backfill materials are hydraulically connected to the underlying natural sands, and 2) The cooling pond, at elevation 627 feet, is the main source of recharge, and seepage from the pond is occurring primarily at the circulating water intake structure and service water pump structure.

The design calculations for the permanent dewatering system are composed of four components: 44

a. Interceptor Well Design

Calculation of well spacing and pumping rates to intercept seepage from the cooling pond in the circulating water intake structure area

b. Area Well Design

Calculation of the volume of water stored in the sand fill and Unit c sand that must be removed during plant dewatering and a calculation of infiltration from precipitation and normal pipe leakage during plant operation

c. Filter Pack Design

Calculation of filter pack gradation and well screen design based on the grain size of site materials

d. Establishment of Groundwater Level During Operation

Calculation of recharge time following a system failure

The interceptor well system analysis utilized the combined gravity-artesian flow method presented in the Army, Navy, and Air Force dewatering manual.[27] This method of analysis was selected to account for the confining nature of the concrete foundation of the circulating water intake structure.

The calculation is based on an approximation of inflow from a line source (cooling pond) into a slot (interceptor well system) 110 feet from the cooling pond. This hypothetical slot extends along the entire length of the circulating water intake/service water pump structures and continues in a straight line to the condensate tanks for a total length of 380 feet. The results of the analysis indicate that 20 wells, with a 28 foot well spacing, are required to intercept flow and maintain pumping levels of elevation 585 feet in these wells. Each well should produce approximately 10 gpm with the water levels between the interceptor wells at elevation 590 feet and downstream of the wells at elevation 589 feet. Design of the interceptor well system also requires a duplicate or backup interceptor well system to provide nearly uninterrupted service should the primary interceptor well system be shut down for maintenance or repair. Therefore, a total of 40 interceptor and backup interceptor wells are provided in the vicinity of the circulating water intake and service water pump structures (Figure 2.4-46).

The area well dewatering subsystem was designed to fulfill two objectives. The first objective is to remove groundwater from storage to elevation 595 feet within the plant site. The second objective of the area dewatering wells is to intercept infiltration of precipitation and pipe leakage. The average 44
annual precipitation at the site is 29.6 inches (Subsection 2.3.2.1.4). Normal leakage from pipes during plant operations is estimated to be no greater than 1 gpm. The total number of area wells required for area dewatering is estimated to be 24 (Figure 2.4-46).

The filter pack design for the monitoring wells and interceptor, backup, and area dewatering wells used grain size data from the PD series borings (Appendix 2N). A composite of Unit c natural sand grain size curves is presented in Figure 2.4-54. From this figure, a composite Unit c sand grain size curve was selected and utilized for the filter pack design (Figure 2.4-55). The filter pack gradation curve was determined from grain size of the composite curve. A filter pack curve was developed having a curve with a ratio of the 40% grain size to the 90% grain size uniformity coefficient of less than 2.5. The range of acceptable gradation for the filter pack is then ±8% of the ideal filter pack curve. The well screen slot width is equal to the 90% grain size of the filter pack.[28] Verification of the range of grain sizes for the Unit c sand was performed by sampling from pilot holes drilled at selected permanent dewatering and monitoring well locations. Results of gradation analyses on pilot hole samples are presented in Appendix 2M. In order to ensure that the filter pack is functioning properly, a soil particle monitoring program will be in effect during plant operation (Subsection 2.4.13.5.1.6).

Establishment of groundwater level during operation was done using an analytical model that determined optimum maximum operating groundwater level. The diesel generator building was used in the model because it is closer to the recharge source than the auxiliary building railroad bay area, and therefore provides more conservative recharge times. The model is a linearized form of the Boussines equation[29] utilized data from observed groundwater fluctuations as a result of changes in cooling pond level. The optimum maximum operating groundwater level was selected to provide sufficient time to repair the system, in the event of a complete failure, before groundwater levels would reach elevation 610 feet at the critical areas. The optimum operating groundwater level was determined to be elevation 595 feet. The most conservative recharge time, as determined from the model, is approximately 60 days.

2.4.13.5.1.2.1 Groundwater Quality Effects on Dewatering System

Groundwater quality samples were examined during the permanent dewatering exploration program and during the initial operation of the backup dewatering wells. Evaluation of chemical analyses presented in Tables 2.4-12B, 2.4-12C, and 2.4-12D indicates that the groundwater at the site is not scale forming.

The piping material that will be used in the permanent dewatering system is reinforced fiberglass and polyvinyl chloride. 44
Therefore, corrosion is not a problem with these components.

Groundwater quality will be monitored during permanent dewatering operation (Subsection 2.4.13.5.1.6). Water quality will be reevaluated during plant operation.

2.4.13.5.1.3 Verification of Design

To verify design assumptions, two onsite dewatering activities were monitored and a full scale recharge test was conducted.

2.4.13.5.1.3.1 Pumping Test Well PD-20

Test well PD-20, located south of the diesel generator building, was pumped between October 2 and November 13, 1980, to verify the absence of recharge and the effects of dewatering. Comparison of Figures 2.4-43 and 2.4-44 indicates that after pumping 6 weeks at a constant discharge of 2.4 gpm, the water levels south of the diesel generator building declined over 4 feet including the area along the cooling pond (i.e., PD-3, PD-5, PD-5D, PD-6). Similarly, water levels declined over 2 feet at the diesel generator building. Considering the low discharge rate (2.4 gpm) at PD-20, the relatively short duration of the test (6 weeks), and the drawdown limitation at the pumping well (elevation 607 feet), the amount and extent of drawdown is significant and

GROUND WATER AND WELLS

A REFERENCE BOOK
FOR THE
WATER-WELL INDUSTRY

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to reduce the chances of error by designing the well for artificial gravel packing.

The grading of the gravel pack should be based on the layer of finest material in the water-bearing section. A gravel pack selected in this manner does not restrict the flow from the layers of coarsest material because the permeability of the pack would still be several times the permeability of the coarsest stratum. Higher permeability results from the fact the artificially graded gravel is more uniform and cleaner than the coarsest layer of the aquifer.

Cost Factors

We have said that the artificially gravel-packed well is generally more costly than the naturally developed well. Two reasons for this are:

- The larger hole-size required for a gravel-packed well generally costs more per foot.
- Specially graded gravel must be purchased and transported to the job site.

With cable-tool drilling equipment, the first reason is especially valid because doubling the diameter of the well may more than double the cost of drilling. In conventional rotary drilling, it also costs more, as a rule, to drill large diameter holes because heavier and more viscous drilling fluids are needed and higher rates of circulation of drilling fluid must be maintained to raise the cuttings to the ground surface where the hole has a large cross-sectional area.

On the other hand, with reverse circulation drilling equipment, an increase in hole diameter is of little concern. Drilling a 36-inch hole generally costs only slightly more than a 24-inch hole. A larger bit, a larger slush pit, and more gravel are the main items of extra cost. It is sometimes more economical, therefore, to construct an artificially gravel-packed well by this method because the saving in development time may offset the initial extra cost. This is especially true in terrace and alluvial deposits like those found in Oklahoma, Kansas, and Nebraska.

Design of Gravel Pack

The following are logical steps in designing an artificial gravel pack:

1. Construct sieve-analysis curves for all strata comprising the aquifer. Determine the stratum composed of the finest sand and select the grading of the gravel pack on the basis of the sieve analysis of this material. Figure 153 shows the grading of two samples of typical water-bearing material that make up an aquifer 30-ft thick. The finest material lies between 75 and 90 ft. The design of the gravel pack in this example will be based on this stratum. (In some instances, it is good practice to disregard unfavorable portions of an aquifer and use blank tube or pipe at these places between sections of screen positioned in the better parts of an aquifer.)

2. Multiply the 70 per cent size of the sand by a factor between 4 and 6.* Use 4 as the multiplier if the formation is fine and uniform; use 6 if it is coarser and non-uniform. Place the result of this multiplication on the graph as the 70 per cent size of the gravel. In Figure 153, 0.005-inch is the 70 per cent size of the sand between 75 and 90 ft. Using 5 as the multiplier, we have $5 \times 0.005 = 0.025$-inch, the 70 per cent size of the gravel. This is the first point on the curve that represents the grading of the artificial gravel-pack material.

3. Through the initial point on the gravel-pack curve, draw a smooth curve representing a material with a uniformity coefficient of 2.5 or less. This must be done by trial and error. In Figure 153, the curve drawn as a solid

*Use a factor between 6 and 9 where the formation sand has highly non-uniform gradation and includes silt, as commonly occurs in portions of the western states of the United States and in other arid or semi-arid areas of the world.

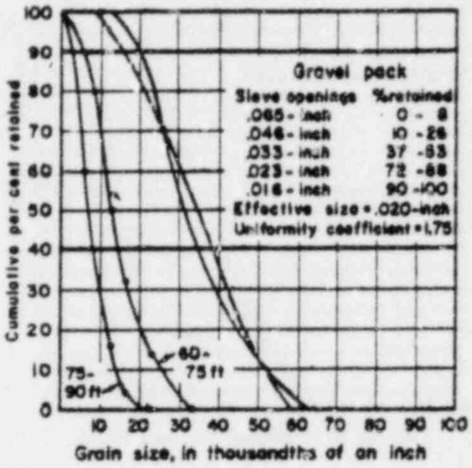

Figure 153. Grain-size curves for aquifer sand and corresponding curve for properly selected gravel pack material.

line has a uniformity coefficient of about 1.75. It could have been drawn somewhat differently, as shown by the dashed line, which has a uniformity coefficient of 2.47. It is better practice to draw the gravel-pack curve so that it is as uniform (low uniformity coefficient) as practical. The material indicated by the solid-line curve is more desirable, therefore, than the material indicated by the dashed-line curve.

4. Prepare specifications for the gravel-pack material by first selecting 4 or 5 sieve sizes that cover the spread of the curve and then set down a permissible range for the per cent retained on each of the selected sieves. This permissible range may be 8 percentage points below and above the per cent retained at any point on the curve. In our example, the largest sieve would have an opening of 0.065-inch. The curve shows zero per cent retained on this sieve, so 8 per cent becomes the maximum permitted for this grain size in the specification. The next smaller size of opening in the most commonly used series of sieves is 0.046-inch. The curve, as drawn, shows 18 per cent retained on this sieve size; 8 per cent is added and subtracted to obtain the permissible range. Thus, on the 0.046-inch sieve, the range is from 10 per cent to 26 per cent. This procedure is repeated until each sieve, previously selected, has been assigned a permissible range. In Figure 153, five sizes of sieve openings are shown to cover the desired gradation of the pack material. Giving the gravel supplier an acceptable range at each of these points makes it possible for him to produce the desired material at reasonable cost. When designing gravel-pack material, the designer should keep in mind local sources of filter sand for rapid sand filters. Firms that produce these materials have large stocks of clean, uniformly graded sands and gravels that readily fit the requirements for gravel packing water wells.

5. As a final step, select a size of well-screen openings that will retain 90 per cent or more of the gravel-pack material. In our example, the correct size of slot opening is 0.020-inch.

If the well designer follows the foregoing steps carefully, sand pumping wells can be avoided because the design is based on the proper ratio between the grain size of the formation and that of the gravel pack. A pack having such a ratio of size, when compared with the formation, will provide mechanical retention of the formation sand and prevent the sand from moving into the gravel envelope and into the well itself.

Gravel-pack material should be clean, with well-rounded grains that are smooth and uniform. These characteristics increase the permeability and porosity of the pack material. With uniform material, less hydraulic separation of the particles occurs while the material is being placed or allowed to settle through a considerable depth of water.

Gravel-pack material consisting mostly of siliceous, rather than calcareous, particles is preferred. Up to 5 per cent calcareous material is a common allowable limit. This is important because of the possibility that acid treatment of the well might be required later. Most of the acid could be spent in dissolving calcareous particles of gravel pack rather than in removing incrusting deposits of calcium or iron. Particles of shale and anhydrite and gypsum in the gravel-pack material are also undesirable.

Thickness of Gravel

Since the design theory of gravel pack gradation is based on mechanical retention of the formation particles, a pack thickness of only two or three grain diameters is all that is actually needed to retain and control the formation sand. Laboratory tests made by Edward E. Johnson, Inc., show that a pack with a thickness of only a fraction of an inch successfully retains the formation particles regardless of the velocity of water tending to carry the particles through the gravel pack. It is recognized, however, that it is impractical to place in a well a gravel pack only a fraction of an inch thick and expect the material to completely surround the well screen. To insure that an envelope of gravel will surround the entire screen, therefore, a thickness of 3 inches is the minimum that is considered practical for installation in the field.

Under most conditions, the upper limit of gravel-pack thickness should be about 8 inches. A thicker envelope does not materially increase the yield of the well and thickness, in itself, does nothing to reduce the possibility of sand pumping because the controlling factor is the ratio of the grain size of the pack material to the formation material. Too thick a gravel pack can make final development of the well more difficult as explained in Chapter 14.

Claims are made that a special advantage of the gravel-packed well is the ability of the pack material to serve as a vertical conduit. Some persons suggest that water from the upper part of an aquifer can easily percolate vertically through the gravel downward to a point of entrance in the well screen. They argue that this makes it possible to screen only the lower part of the aquifer.

The fallacy of this can be shown by the example illustrated in Figure 154. For this situation, the approximate amount of water that may move downward from the upper aquifer to the well screen is easily calculated.

The conduit for transmitting the water is the annular space between the outside of the 12-inch well casing and the 24-inch borehole. This conduit is filled with a highly permeable material—the gravel pack.

The formula for the vertical flow in the gravel pack is:

$$Q = PIA$$

where

Q = vertical flow through the pack material, in gal per day.

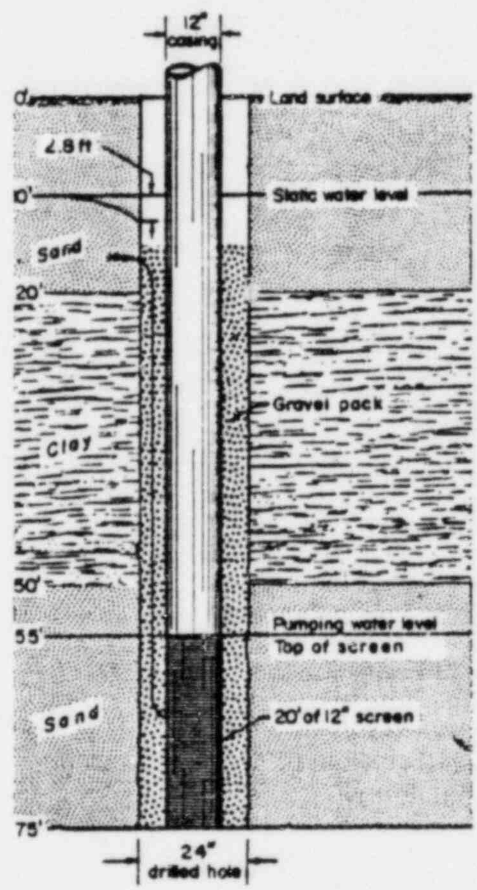

Figure 154. Possible flow of water in gravel pack from upper to lower aquifer is limited.

QUESTION 24

h. The plant blowdown to the cooling pond will contain chlorides, sulfates and other chemicals which may be carried with the recharge and, over an extended period, corrode underground piping, tanks and conduits or clog well screens, well filters and/or the surrounding soils. In addition to corrosion effects, this could reduce the efficiency of the well system and allow ground water levels to rise to an unacceptable level. Provide an analysis of the effects which the cooling pond water chemical constituents will have on the dewatering system and upon underground metal components.

RESPONSE

Analyses of groundwater samples have been made to determine the potential for a reduction in well efficiency due to chemicals contained in the cooling pond water (Table 24-4). 5
These tests indicate that incrustation due to calcium carbonate and iron will occur. However, it is not known what effect plant operation will have on the groundwater quality. Therefore, by maintaining records of groundwater quality, pumping rates, drawdown levels, hours of operation, and power used during plant operation, along with visual observations of pumps, header pipes, etc, the potential for clogging or corrosion will be closely monitored and any corrective action required can be taken immediately. Furthermore, polyvinyl chloride (PVC) well screens, riser pipes, and header pipes, along with siliceous filter pack material, will be used in the installation of the permanent dewatering system. PVC will resist chemical attack by most acids, alkalies, and salts. It also resists fungal and bacterial action. In addition, there is no possibility of galvanic or electrolytic corrosion. Since incrusting minerals are expected to occur, well treatment will be required as part of the routine maintenance of the wells. The type of treatment and degree of maintenance required will depend upon the groundwater quality developed during plant operation.

repair or replacement of defective wells before the groundwater level reaches el 610' at either the DGB or auxiliary building railroad bay areas.

3.2 AREA DEWATERING WELLS

The second subsystem, consisting of 24 area wells distributed over the plant site area, was designed to remove the groundwater stored within the backfill and natural sands and then to maintain the groundwater level (see Figure V-2). This subsystem design utilizes the extensive natural sands underlying the backfill as a drain.

4.0 RECHARGE TIME

Analysis of data from pumping tests and from groundwater level responses to changes in cooling pond level indicates there is time available to repair or even replace the entire system before the design groundwater level would be exceeded at the critical areas. To further verify this conclusion, a full-scale test was performed between February 4 and April 5, 1982, after the groundwater levels had been lowered to el 595' or as low as practical and with the cooling pond at el 627'. The groundwater levels were lowered using only 20 permanent backup dewatering wells, existing construction dewatering wells, selected individual observation wells equipped with self-contained eductors, and temporary dewatering wells. During this test, groundwater level-versus-time curves were plotted to determine the actual recharge time at the DGB and auxiliary building railroad bay areas. The results of this test indicate that groundwater levels rise faster at the DGB than at the auxiliary building railroad bay and that there is at least 60 days' recharge time available to repair or perform maintenance on the dewatering system before groundwater levels would reach el 610' at the DGB (see Figures V-3 and V-4).

Results and progress of the recharge testing program were presented to the NRC staff in Bethesda, Maryland, on February 23 and March 3, 1982, and by telephone communication on April 5, 1982.

5.0 WELL INSTALLATION

On March 23, 1981, the Applicant sent a letter to the NRC staff requesting staff concurrence with the installation of 20 backup interceptor wells. After discussions in April, May, and part of June, the staff agreed to a slightly modified version of the proposal. Staff concurrence at that time included only 12 of the 20 wells, because the staff required additional information regarding soil conditions at the locations of the remaining eight wells. Concurrence regarding the final eight permanent wells was secured on September 2, 1981.

The 20 permanent backup dewatering wells were installed between August 17, 1981, and October 29, 1981, by a dewatering subcontractor. The architect-engineer's geologist/hydrogeologist prepared as-built drawings of each well installation, including well number, location, diameter of hole, total depth, and description of each type of casing; a log of subsurface materials encountered; and a complete compilation of field data obtained during drilling, installation, and developing of the wells including data requested by the NRC.

NRC concurrence to install the remaining permanent dewatering wells (20 interceptor, 24 area, and 6 monitoring) was given on October 22, 1981. The remaining wells are currently being installed in accordance with the same procedures, criteria, materials, methods, supervision, and inspection used for the installation of the 20 permanent backup wells. Construction of the permanent wells is about 65% complete.

6.0 MONITORING SAFEGUARDS

6.1 INITIAL OPERATING PERIOD

Groundwater quality, pumping rates, drawdown levels, and hours of operation will be monitored during the initial operating period so that an operating history of each well is established prior to plant operation. By comparing collected data, any decrease in production efficiency will be detected.

Near the end of the initial operating period, after the groundwater in storage has been removed and the groundwater levels have stabilized at or below el 595', the frequency of monitoring groundwater levels, soil particle content, and water quality will be determined for implementation during plant operation.

6.2 PLANT OPERATION

During plant operation, monitoring procedures will be performed under a quality assurance program. When it is determined by analyzing available data that a well or group of wells is no longer functioning, corrective measures will be taken. These corrective measures may include cleaning the well screens, repairing or replacing screens or any mechanical parts, or installing a new dewatering well, if necessary.

A complete set of replacement parts will be stored onsite for any repair, replacement, or installation that may be required. As a result of the proposed monitoring of the well system, any

Reference 4

STANDARD METHODS

for the Examination of Water and Wastewater

Thirteenth Edition

Prepared and published jointly by:
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Washington, D.C. 20036

PART 200

PHYSICAL, CHEMICAL AND
BIOASSAY EXAMINATION OF
POLLUTED WATERS, WASTEWATERS,
EFFLUENTS, BOTTOM SEDIMENTS
AND SLUDGES

224 C. Total Suspended Matter (Nonfiltrable Residue)

1. General Discussion

The amount of suspended matter removed by a filter varies with the porosity of the filter. A number of the common filters used in water analysis will be found suitable for this purpose. Inasmuch as wastewater treatment plant operations demand less than complete particle removal, the glass filter disk is empirically specified for the determination of suspended matter in wastewater, effluents and polluted water.

In unusual cases, such as special-purpose analyses of certain industrial wastewaters, variations in the procedure may be necessary. For example, if it is desired to exclude material such as oil, the oil may be extracted from the suspended matter on the filter. Any such variations from the standard procedure should be reported with the results.

2. Apparatus

a. Glass fiber filter disks, 5.5 cm * (see also ¶ 3c below).

b. Filter holder: Membrane filter holder, Hirsch funnel, or Buchner funnel. Alternatively, Gooch crucibles may be used (see ¶ 3c).

c. Suction apparatus.

d. Drying oven, for use at 103 C.

e. Muffle furnace, for use at 550 C.

f. Desiccator.

g. Analytical balance.

3. Procedure

a. Preparation of filter disk: Place a glass fiber filter disk in a membrane filter holder, Hirsch funnel or Buchner funnel, with the wrinkled surface of the disk facing upward. Apply vacuum to the assembled filtration apparatus to seat the filter disk. With vacuum applied, wash the disk with distilled water. After the water has filtered through, disconnect the vacuum, remove the filter disk from the apparatus, and dry it in an oven at 103 C for 1 hr (30 min in a mechanical convection oven). If volatile matter is not to be determined, cool the filter disk to room temperature in a desiccator and weigh. If volatile matter is to be determined, transfer the disk to a muffle furnace and ignite at 550 C for 15 min. Remove the disk from the furnace, place it in a desiccator until cooled to room temperature, and then weigh.

b. Treatment of sample: Except for samples containing a very high concentration of suspended matter, or which filter very slowly, select a sample volume which equals 14 ml or more per sq cm of filter area.

Place the prepared filter disk in the membrane filter holder, Hirsch funnel or Buchner funnel, with the wrinkled surface upward. With the vacuum applied, wet the disk with distilled water to seat it against the holder or funnel. Measure out the selected volume of well-mixed sample with a wide-tip pipet, volumetric flask, or graduated cylinder. Filter the sample through the disk, using suction. Leaving the suction on, wash the apparatus three times with 10-ml portions of distilled water, allowing complete drainage between

* Whatman GF/C, or equivalent.

Discontinue suction, remove k, and dry it at 103 C for 1 :n (30 min in a mechanical oven). After drying, cool) room temperature in a efore weighing on an ana-ice.

ion with Gooch crucibles: y, use glass-fiber filter disks liameter (usually 2.1 or 2.4 ooch crucibles, making cer-: disk lies flat in the bottom ible and completely covers ions.

he disk and treat the sample 1 in ¶s 3a and b above, ex-e Gooch crucible is usually ed and weighed along with ther than removing the disk : handling.

4. Calculation

$$\text{mg/l total suspended matter} = \frac{A \times 1{,}000}{B}$$

where A = mg suspended solids and B = ml sample.

5. Precision and Accuracy

The precision of the determination varies directly with the concentration of suspended matter in the sample. The standard deviation was ±5.2 mg/l (coefficient of variation 33%) at 15 mg/l, ±24 mg/l (10%) at 242 mg/l, and ±13 mg/l (7.6%) at 1,707 mg/l ($n = 2$; 4×10). There is no satisfactory procedure for obtaining the accuracy of the method on wastewater samples, since the true concentration of suspended matter is unknown.

224 D. Volatile and Fixed Suspended Matter

Discussion

itilization of organic matter iter solids is subject to a errors. It should be done in rnace at 550 C.

us

e as that listed for Total Sus-tter (Method C above).

re

re the filter disk, filter the tion selected, and dry and olids as directed in Method l Suspended Matter, or pro-the filter disk upon comple-e step as outlined for the

b. Ignite the filter disk with its suspended matter for 15 min at 550 C, transfer the disk to a desiccator, allow to cool to room temperature, and weigh. Report the weight loss on ignition as mg/l volatile suspended matter and the weight of ash remaining as mg/l fixed suspended matter.

4. Precision and Accuracy

The standard deviation of the volatile matter determination was ±11 mg/l at 170 mg/l (coefficient of variation 6.5%) ($n = 3$; 4×10). As in the case of suspended matter, the accuracy of the determination cannot be evaluated. The principal sources of error are failure to obtain a representative sample and inadequate temperature control.

224 E. Dissolved M

Dissolved matter may be obtained b difference between the residue on evap oration (A) and total suspended matt

224 F. Se

Settleable matter may be determine and reported on either a volum (ml/l) or a weight (mg/l) basis, a given in the following procedure.

1. Procedure

a. By volume: Fill an Imhoff con to the liter mark with a thorough mixed sample. Settle for 45 min, gentl stir the sides of the cone with a ro or by spinning, settle 15 min longer, and record the volume of settleable matter in the cone as ml/l.

b. By weight: This technic defines settleable matter as that matter in sewage which will not stay in suspension during the settling period but either settles to the bottom or floats to the top.

1) Determine the suspended matter (in mg/l) in a sample of the sewage under investigation, as in Method C, preceding.

224 G. Method for Se

1. Discussion

These modifications are recommended for use with samples of materials such as river and lake sediments, sludges separated from wastewater

Reference 5

GROUND WATER MANUAL

A WATER RESOURCES TECHNICAL PUBLICATION

A guide for the investigation, development, and management of ground-water resources

FIRST EDITION
1977

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

WATER WELL DEVELOPMENT

17-1. Purpose of Well Development.—The primary purpose of well development or stimulation is to obtain maximum production efficiency from the well. Incidental benefits are stabilization of the structure, minimization of sand pumping, and the improvement of corrosion and encrustation conditions. Development also removes the mud cake from the face of the hole and breaks down the compacted annulus about the hole caused by drilling. Fines are removed from the pack and the aquifer, thus increasing the porosity and the permeability of the pack and aquifer. Water is made to surge back and forth through the screen, pack, and aquifer and to flow into the well at higher velocities than during pumping at design rates. Material which is brought to stability under high development velocities and surging will remain stable under velocities present during normal pumping operations.

Proper and careful development will improve the performance of most wells. Well development is not expensive in view of the benefits derived and only under unusual circumstances or improper methods will it cause harm.

Depending upon the circumstances, a number of methods and supplemental chemicals may be used in developing a well. Some of the common methods and the conditions for which they are used are described in the following sections.

17-2. Development of Wells in Unconsolidated Aquifers.—(a) *Overpumping.*—Pumping a well at a discharge rate considerably higher than design capacity is often the only well development procedure used. However, except in thin, relatively uniformed grained, permeable aquifers, this method alone is not recommended. The pump is normally set above the top of the screen; hence, development is primarily concentrated in the upper one-quarter of one-half the screen length. With the water moving in one direction only, stable bridging of the sand grains occurs so long as pumping continues. When pumping is stopped, the water in the column pipe drops back into the well causing a reverse flow which destroys the bridging. When the well is again pumped, sand will enter the well until stable bridging is reestablished. A well so developed may pump sand for several minutes each time the pump is started. This may continue for months or even years but may eventually clear up.

(b) *Rawhiding (Pumping and Surging)*.—The arrangement for rawhiding is similar to that for overpumping. However, the pump must not be equipped with either a rachet or other device that would prevent reverse rotation of the pump or a check valve. The well is pumped in steps, for example at ¼, ½, 1, 1½, and 2 times the design capacity. At the beginning of each step the well is pumped until the discharge is relatively sand free. The power is then shut off and the water in the column pipe is allowed to surge back into the well to break up bridging. The well may be surged one or more additional times by operating the pump until water is discharged at the surface and then stopping the pump. The pump is then operated again at the same rate repeating the surging cycle whenever the discharge clears. The rate of discharge is then increased and the same procedure followed at each of the higher rates, with the final rate being at the maximum capacity of the pump or well. Rawhiding is definitely superior to simple overpumping, but when used alone will usually result in development of only the upper portion of the screened aquifer. Rawhiding is recommended as a finishing procedure following initial development by any of the methods described in the following subsections (c), (d), and (e) of this section.

During final development by rawhiding, the amount of sand discharged by the well is measured when pumping is resumed after each cycle of surging. The initial discharge on resumption of pumping is usually almost sand free. Within a few seconds or minutes, depending upon the rate of discharge and the depth of the well, the sand will increase to a maximum. This condition will usually persist for a short period and then the amount of sand will begin to decrease until the discharge is practically sand free. At this time the well should be surged again.

The approximate concentration of sand being discharged can be estimated by looking through the discharge stream. The sand will be concentrated at the bottom of the stream where it issues from a discharge pipe with free discharge. It will look like a dark gray or brown layer. If an orifice is attached to the end of the pipe, the sand will appear as a dark vein in the center of the jet. The orifice should always be removed to avoid sand cutting its edge during rawhiding.

The time of maximum concentration of sand can be judged closely by observing discharge flow at the beginning of each rate of discharge. A sample is taken when the sand discharge is maximum.

Sand traps are available which will permit relatively accurate determination of sand content of the discharge, but they are expensive, heavy pieces of equipment. An Imhoff cone is commonly used to catch samples (see fig. 17-1). The cone should be held firmly with both hands, and the outside lip of the cone slipped into the bottom

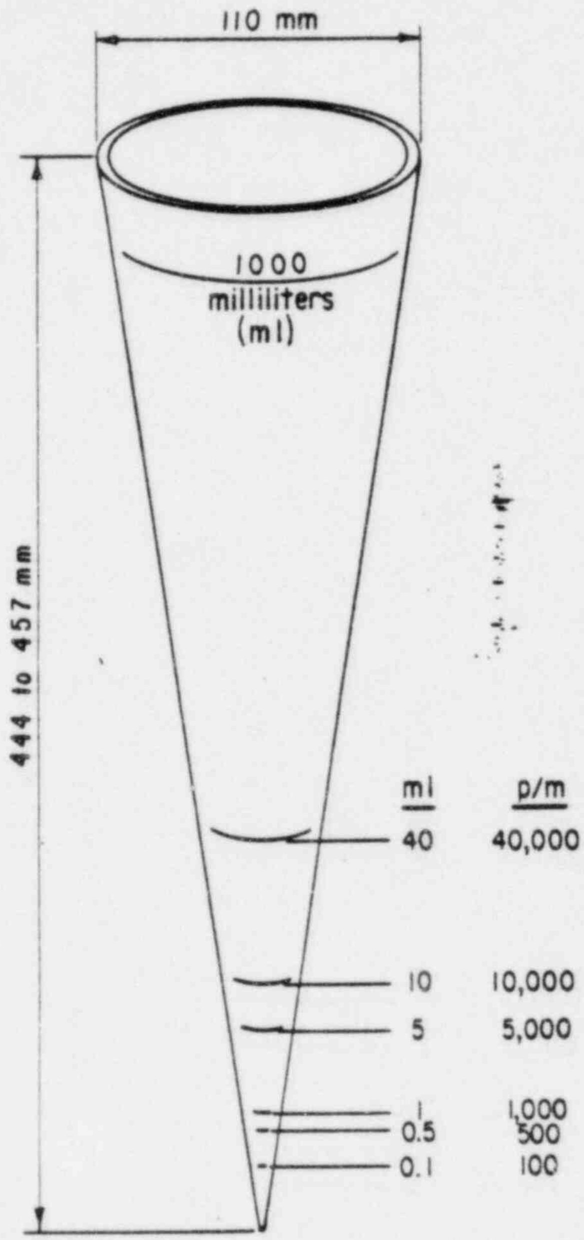


FIGURE 17-1.—Imhoff cone used in determination of sand content in pump discharge. 103-D-1523.

of the discharge stream to the center of the sand concentration. The cone fills in a fraction of a second and the entire procedure must be done rapidly.

The cone . then set in a holder to permit the contents to settle for a few minutes, and then the sand content by volume is estimated.

The smallest division on a cone is 0.1 ml (milliliters). About one-tenth of the smallest division on the scale is approximately 10 p/m by volume or 20 p/m by weight. For estimating purposes, multiply the volume by 2 to get weight. Acceptable sand content for various purposes is as follows:

(1) Municipal, domestic, and industrial supply—0.01 ml or 20 p/m by weight
(2) Sprinkler irrigation—0.025 ml or 50 p/m by weight
(3) Other irrigation (furrow, flooding, etc.)—0.075 ml or 150 p/m by weight

Since the sample is taken during the period of highest sand concentration in the discharge, the estimated sand content is probably somewhat high and on the safe side.

Rawhiding, pumping, and sampling should be continued at the maximum discharge rate until the desired sand content is reached.

Imhoff cones are made in two styles. One has a somewhat rounded bott m while the other has a more pointed bottom. The model with the pointed bottom is preferable for estimating small volumes of material. Most Imhoff cones are made of glass and the breakage frequency is sometimes high, particularly when sampling high capacity wells. Recently, a plastic model has been produced which is less likely to break, easier to clean, and less expensive, but unfortunately, it has the rounded rather than the pointed bottom [1,2,5].[1]

(c) *Surge Block Development.*—The surge block is one of the oldest and most effective methods of well development. Such blocks are particularly applicable for use with a cable tool rig, and often such a rig equipped with a surge block is used to develop a well drilled by other methods. Solid, vented, and spring-loaded surge blocks are used. The solid and vented blocks consist of a body block 1 to 2 inches smaller in diameter than the well screen, and fitted with as many as four ¼- to ½-inch-thick disks of belting, rubber, or other tough material having a diameter the same as the inside diameter of the screen in which they will be used. Most surge blocks are made by well drilling contractors.

The solid surge block has a solid body, whereas the vented one has a number of holes drilled through the body parallel to the axis. The

[1] Numbers in brackets refer to items in the bibliography, section 17–5.

Reference 6

Soil Mechanics

T. William Lambe • Robert V. Whitman

Massachusetts Institute of Technology

1969

John Wiley & Sons, Inc.

New York London Sydney Toronto

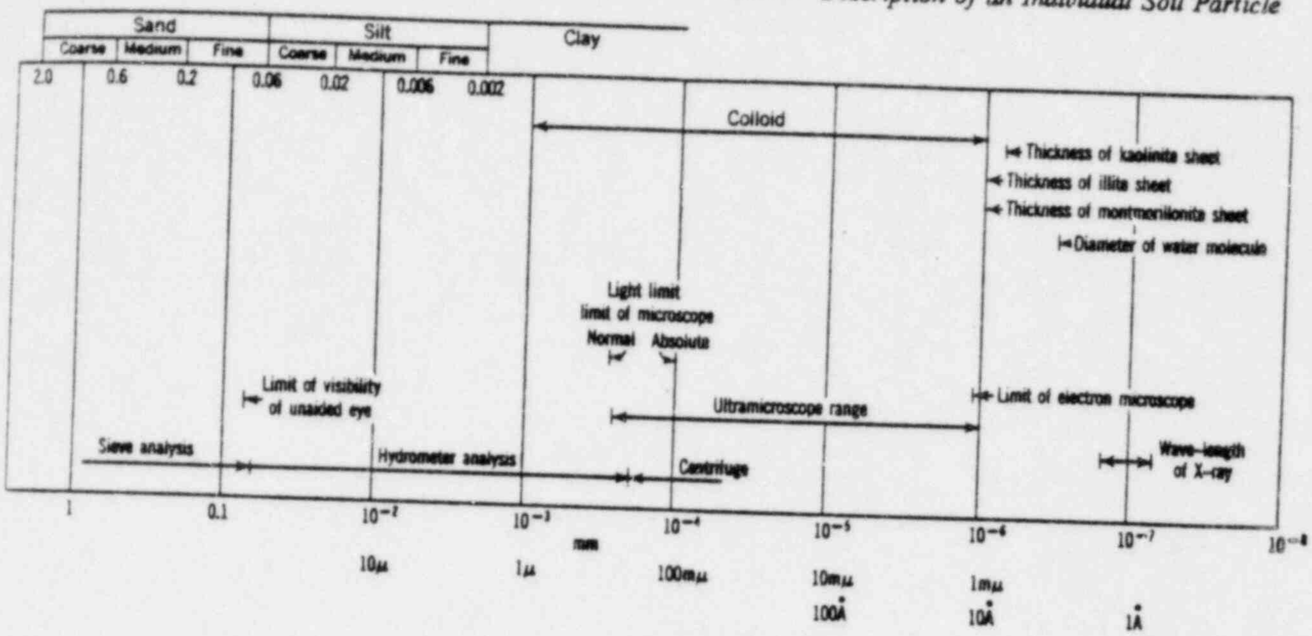

Sand
Silt
Clay
Coarse
Medium
Fine
Coarse
Medium
Fine
2.0
0.6
0.2
0.06
0.02
0.006
0.002
Colloid
Thickness of kaolinite sheet
Thickness of illite sheet
Thickness of montmorillonite sheet
Diameter of water molecule
Light limit
limit of microscope
Normal
Absolute
Limit of visibility
of unaided eye
Ultramicroscope range
Limit of electron microscope
Sieve analysis
Hydrometer analysis
Centrifuge
Wave-length
of X-ray
1
0.1
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
mm
10μ
1μ
100mμ
10mμ
1mμ
100Å
10Å
1Å

Fig. 4.1 Size.

for domestic needs at many places in the formation's subcrop area; however, it is not a dependable source for large supplies. The water is generally of good chemical quality except where beds, lenses, and stringers of evaporites such as anhydrite are present. In these areas, the groundwater is highly mineralized.[21]

The dominant sources of groundwater recharge, for bedrock aquifors, occur from either seepage from overlying unconsolidated aquifers or from surface lakes and streams, where the bedrock is near the ground surface.

2.4.13.1.1.3 Regional Groundwater Quality

Generally, the quality of water in the region varies with well depth and aquifer type. The glacial deposits usually produce higher yields and better quality water than the bedrock aquifers. In both the bedrock and the glacial deposits, however, the concentration of dissolved solids normally increases as the well depth increases. Usually, the unconsolidated aquifers contain high concentrations of sulfate, iron, and total hardness, while the bedrock aquifers generally contain high concentrations of sodium and chloride.[20] In most cases, the quality of groundwater in both the bedrock and unconsolidated aquifers decreases with depth.

44

2.4.13.1.2 Local Aquifers

In the vicinity of the site, fresh groundwater supplies are often difficult to obtain because of the scarcity of unconsolidated aquifers and widespread occurrence of mineralized water in the bedrock formations. A review of the water well records on file at the Michigan Geological Survey revealed that only small amounts of groundwater are obtained by wells from either the unconsolidated aquifers or the underlying sandstones of the Saginaw formation.

The unconsolidated deposits beneath the site have been subdivided into lithologic units as discussed in Subsection 2.5.1.2.2. The presence of the thick, impermeable clays (Units d and e) separate two groundwater occurrences: an unconfined aquifer which is discontinuous sand (Unit c) above the clays, and a deeper confined aquifer composed of Units f and g.

Within the power block area, the upper discontinuous sand (Unit c) ranges from 0 to 54 feet thick (Figure 2.4-39). The quantity of water in this sand is limited and is not a source of domestic or other supply in the area. On the other hand, the confined aquifer (Units f and g) is a source of domestic water in the site area. Two site investigation borings completely penetrated this aquifer, indicating that it is from 160 to 190 feet thick. Water rose to very near or slightly above the ground surface in the borings. A survey of domestic wells in the area (Table 2.4-8) indicates that similar confined conditions occur throughout the area.

In addition to wells in the confined drift aquifer zone, 11 nearby domestic wells extract groundwater from the underlying Saginaw formation. Although water in that formation is also confined, the potentiometric surface is lower than that present in the confined, unconsolidated aquifer. Table 2.4-8 includes both the unconsolidated and bedrock water wells on file with the State of Michigan Geological Survey for the site area.

Recharge of the unconfined aquifer is mainly by direct infiltration of precipitation. Beneath the plant site area recharge is primarily from the cooling pond. Recharge of the deeper confined unconsolidated aquifer is inhibited at the site area by a minimum of 135 feet of impermeable clay (Units d and e) overlying this zone. The most likely recharge areas are where this aquifer either outcrops or is connected with aquifers not in the immediate site vicinity.

Recharge of the Saginaw formation aquifer is believed to occur through interaction with the overlying, unconsolidated aquifers and at distant outcrop areas. The site investigation indicated that the shallowest bedrock aquifer zone beneath the site is greater than 350 feet below the surface and is confined within shale. Therefore, recharge of this aquifer does not occur at the site. Oil and gas well logs for the local area indicate that sandstone units north of the site are in contact with the glacial deposits. This area may be a recharge area for this aquifer. 44

2.4.13.1.3 Onsite Use of Groundwater

During operation of the Midland plant, no groundwater will be used by the plant facilities. All makeup and domestic water supplies will be obtained from surface water sources.

During plant operation, groundwater will be extracted from the upper unconfined aquifer as part of the permanent plant dewatering scheme (Subsection 2.4.13.5.1). All drawdown effects of the permanent dewatering system are restricted to the plant fill area contained by the cooling pond dike boundaries and slurry trenches (Subsection 2.4.13.5.1.2).

A water well survey completed during the site investigation located 57 water wells within the site boundaries. Table 2.4-9 lists these wells. All the water wells were successfully sealed during the early phases of construction. In addition to these 57 wells, 2 construction water wells have been installed at the site. These will also be sealed prior to plant operation.

2.4.13.5.1.1.2.1 Field Falling Head Tests

Field falling head permeability tests were performed in borings to evaluate the permeabilities of the Unit c lacustrine sand, Unit d lacustrine clay, Unit e till, sand backfill, and clay backfill. These tests were made in a cased boring by filling the casing to the top with water and monitoring the rate at which the water level declined. The results of these tests were analyzed using Hvorslev's variable head formula.[25] These tests were performed in the PD series borings discussed in Subsection 2.5.4.3 and shown in plan on Figure 2.5-17. The results of these permeability tests are presented in Table 2.4-11A. The average permeability for the lacustrine sand (Unit c) is 840 ft/yr. The average permeability of the lacustrine clay (Unit d) is 15 ft/yr. The glacial till (Unit e) also has an average permeability of 15 ft/yr. The sand backfill has an average permeability of 3,600 ft/yr and the clay backfill has an average permeability of 20 ft/yr.

The falling head permeability tests that were performed in clay are subject to some error due to leakage around the casing. Because the clays have such low permeability, if the casing is not seated properly in the clay, the water added to the casing will run up between the casing and the wall of the boring. However, this error is conservative because it results in higher permeability values.

44

2.4.13.5.1.1.2.2 Permeability Estimated From Grain Size

Grain size information was also used to estimate permeabilities of the lacustrine sand (Unit c) and sand backfill. Grain size information was taken from gradation analysis of numerous site borings. The permeability values are calculated using the D_{10} grain size and applying it to the the Hazen formula.[26] Gradation curves used in this analysis are presented in Appendixes 2M and 2N. The range of permeabilities determined for the Unit c and backfill sand are from less than 5,700 to 50,000 ft/yr and from less than 5,700 to 55,000 ft/yr, respectively.

The permeabilities determined from grain size analyses represent only relative permeability values. The Hazen formula is an empirical derivation relating permeability to grain size and may be subject to error when applying it to a different sand. The use of this method was intended only to provide a range of relative permeabilities that can be compared to field and laboratory permeability tests.

2.4.13.1.1.2.3 Pumping Tests

Eight constant rate pumping tests were performed during the site investigation to evaluate the permeability and degree of hydraulic connection in the lacustrine sand (Unit c) and sand backfill. The results obtained from these tests are presented in Table 2.4-11B and summarized as follows.

The TW series pumping tests were performed to measure the hydraulic characteristics of the backfill sands adjacent to the Units 1 and 2 containment structures. This program consisted of five constant rate tests (TW-1, TW-2, TW-3, TW-4, and TW-5) conducted between May 15, 1979, and June 27, 1979 (Figure 2.4-42). Information obtained from these tests was used for design of the construction dewatering system required to permit underpinning of the feedwater isolation valve pit structures and electrical penetration wings of the auxiliary building. Three of the tests (TW-1, TW-3, and TW-5) monitored deep backfill sands (elevation 579 to 596 feet). The pumping rates of these tests ranged from 6.5 to 11 gpm, and pumping periods ranged from 230 to 520 minutes.

The series of TW tests demonstrated that shallow backfill sands near the containment structures are in hydraulic contact with the deeper backfill sands. Significant drawdown measured in the shallow observation wells OW-2, OW-4, TW-2, TW-4, and AX-12 at the conclusion of the deep tests performed on TW-1 and TW-3 indicate that the shallow backfill sands will respond to pumping from the deeper backfill sands (Table 2.4-11B). The clay intervals encountered in the borings are not effective barriers to drainage. 44

Calculated transmissivities from the TW pumping tests range from 28 to 441 square ft/day (Table 2.4-11B) and the average permeabilities range from 1,460 to 11,315 ft/yr for the backfill sands near the containment structures.

The PD series pumping tests (PD-20, PD-5C, and PD-15A) were performed in backfill sand and lacustrine sand (Unit c) for the design of permanent dewatering system.

A constant rate pumping test was performed in test well PD-20 on October 30, 1979 (Figure 2.4-42). A 4-inch diameter test well was screened from elevation 600 to 605 feet in the backfill sands and pumped for 4,495 minutes at an average discharge of 7 gpm. Drawdowns were measured in three observation wells within 10 feet of the pumping well; PD-20A is screened in the underlying Unit c sand and PD-20B and PD-20C are screened in the backfill sand. Drawdowns were also measured in observation wells PD-3 and PD-5, which are open to the Unit c sands. They are located southeast of the pumping well at distances of 210 and 140 feet, respectively. Water level measurements were also taken in piezometers located inside the diesel generator building and adjacent to the circulating water intake structure, not more than 80 feet from the pumping well. After pumping stopped, recovery was measured for 9,705 minutes.

Test well PD-20 terminates in a narrow channel of backfill sand surrounding the circulating water discharge lines. This test was performed to determine if infiltration from the cooling pond occurs along these discharge lines. These backfill sands are in direct contact with the underlying lacustrine sand, and the pumping test demonstrated that the two sands are hydraulically connected. This is illustrated by the significant drawdown (1.31 feet), at the conclusion of the test, in observation well PD-3, 210 feet from the pumping well and monitoring only Unit c sands (Table 2.4-11B). Wells PD-5 and PD-20A also illustrate this.

The drawdown measured in piezometers PZ-2 (1.44 feet) and PZ-30 (0.67 feet), which are open to backfill sand beneath the diesel generator building, indicates that backfill sands beneath the building can be dewatered by pumping from the Unit c sands (Table 2.4-11B).

Transmissivities determined from the observation wells for the lacustrine and backfill sands range from 202 to 433 sq ft/day (Table 2.4-11B). Based on these values, the average permeability of the Unit c and backfill sands south of the diesel generator building is 4,015 ft/year.

On November 13, 1979, test well PD-5C was pumped at an average rate of 0.83 gpm for 4,959 minutes (Figure 2.4-42). The 4-inch diameter well is screened from elevation 593 to 603 feet in the Unit c sands. Drawdowns were measured in four observation wells (PD-3, PD-5, PD-5D, and PD-20A) open to the lacustrine sand and three wells (PD-5B, PD-6, and PD-20B) open to the backfill sands. Recovery was measured for 3,760 minutes after pumping stopped. 44

The interpretation of the data from the PD-5C test is complicated by fluctuations in the pumping rate. Because of the low yield, maintaining a constant discharge with the pumping equipment was difficult. Drawdown in the observation wells did not appear to stabilize and recovery following pumping was incomplete.

Calculated transmissivities range from 29 to 102 sq ft/day and the average permeability is 2,920 ft/year (Table 2.4-11B)

On December 4, 1979, a constant discharge test was begun in well PD-15A (Figure 2.4-42). The test was conducted for 8,610 minutes at a pumping rate of 12.5 gpm. The 4-inch well is screened from elevation 564 to 579 feet in the lacustrine sands. Recovery measurements were taken for 5,740 minutes following the pumping period.

Drawdown was measured in 12 observation wells during the test. A drawdown of 0.42 foot was measured in observation well OW-3, which is open to backfill sands in the main excavation and 615 feet from the pumping well (Table 2.4-11B). Other observation wells in backfill sands (PD-20B, SW-1, and SW-4) also responded with drawdowns of more than 0.40 foot, indicating a large area of influence and hydraulic connection throughout the combined Unit c and backfill sands.

Calculated transmissivities of the Unit c sand in the vicinity of PD-15A range from 173 to 1,103 square ft/day. The average permeability is 3,650 feet/year (Table 2.4-11B).

The pumping test method is accepted as one of the most accurate methods of determining aquifer permeability. Because observations of water levels are made some distance from the pumping well, permeability values can be obtained for a sizable portion of the aquifer. Additionally, the aquifer materials are not disturbed as they would be for a laboratory permeability test.[23]

2.4.13.5.1.1.3 Areas of Recharge

To effectively position the permanent dewatering wells for interception of seepage from the cooling pond, it was necessary to delineate areas where seepage could occur. Examination of Figure 2.4-39 indicates that permeable sands underlie the circulating water intake structure area. Other areas of the site, which are in contact with the cooling pond, are underlain by lacustrine clay (Unit d) or till (Unit e).

Examination of hydrographs (Appendix 2I) of observation wells near the diesel generator building area and near the circulating water intake structure area illustrates the response of groundwater levels to changes in cooling pond level. Observation wells in the area of the circulating water intake structure (CL-1, W-2, PD-38, and PD-9) responded relatively rapidly to changes in cooling pond level, whereas wells south of the diesel generator building (PD-3, PD-5, PD-6, PD-17, and PD-20A) responded slowly to cooling pond changes. Figure 2.4-39 indicates that in the circulating water intake structure area there is a minimum thickness of 10 feet of Unit c sand extending beneath the cooling pond, while south of the diesel generator building no Unit c sand is present at the cooling pond. Cross-section A-A' (Figure 2.4-53) shows the subsurface conditions south of the diesel generator building. 44

Evaluation of drawdown values for observation wells PD-3 and PD-5 at the conclusion of the PD-20 (Table 2.4-11B) pumping test, located south of the diesel generator building, shows that significant drawdown occurred in these wells. These observation wells are much closer to the cooling pond than to the pumping well, as shown in Figure 2.4-42. If recharge from the cooling pond had occurred, there would have been no drawdown or the drawdown would have stabilized rapidly. Further, the static water levels in these observation wells were below the cooling pond level before and after the pumping test. Review of the data from another pumping test, PD-5C, indicates that if recharge from the cooling pond had occurred south of the diesel generator

Reference 9

2.5.4.10.3 Settlements

This section deals with the evaluation of vertical ground movements (heave or settlement) under the plant facilities. Excavations up to 40 feet below the original ground surface were made to enable the construction of the containment and portions of the auxiliary building. A large area fill up to 35 feet high, measuring approximately 1,000 feet by 1,100 feet, has been placed as shown in Figure 2.5-46. Structural loads will be applied on this fill. The groundwater table at the plant area will be raised to a maximum possible elevation of 627 feet when the cooling water reservoir is filled. The power block area will then be permanently dewatered to elevations between about 590 and 595 feet. 44 44

The effects of the above construction operations on ground movements at the Midland site are as follows:

a. First, when the site was excavated to depths of 40 feet, the resulting removal of material caused the underlying soils to rebound upward.

b. Next, as the large area fill was placed and structures were constructed, the resulting loads recompressed the prior upward rebound and then caused additional settlement.

c. Next, raising the groundwater table will reduce the net foundation pressures. However, some settlement will continue until equilibrium is reached under the net increase in load. 44

d. Finally, dewatering to elevation 590 to 595 feet will cause additional settlement.

In general, the settlement analysis of Seismic Category I structures resting primarily on natural soil is based on an approach that incorporates Young's moduli, which are consistent with actual measurements. The settlement analyses of Seismic Category I structures resting primarily on fill are based on measured settlement versus time data for each structure. 44

These analyses are discussed separately in the following sections. Predicted settlements will be compared to measured settlements in each section. Differential settlement between all structures is also discussed.

Summaries of recorded settlements of Seismic Category I structures are in Table 2.5-14A and summaries of recorded settlements for nonseismic Category I structures are in Table 2.5-35.

2.5.4.10.3.1 Settlement of Seismic Category I Structures on Natural Soil 44

Ultimate heave or settlement values were estimated by calculating the stress changes from elastic half-space theory and then computing the settlement or heave using elastic theory.

Time-dependent settlements were based on observations when data
were available as described in Subsections 2.5.4.10.3.1.5.1, 44
2.5.4.10.3.1.5.2, and 2.5.4.10.3.2 and are given in Table 2.5-38.
When data were not available, time-dependent settlement was
estimated to be on the order of 30% of total calculated
settlement.

Parameters to establish the analytical model are discussed in the following subsections.

2.5.4.10.3.1.1 Plant Layout and Loads 44

As shown in Figure 2.5-47, the two units and the contiguous
structures occupy a total area measuring approximately 600 feet
by 600 feet. Preconstruction grade at the site is approximately
elevation 603 feet. Finished grade at the plant site is 31 feet 44
higher, at elevation 634 feet. Compacted fill was used to raise
the original ground surface to grade elevation.

Each containment was founded on a circular mat having a diameter
of 128 feet and located at a depth of 20 feet below original
ground surface. Portions of the auxiliary building were
established 40 feet below original ground surface on the layer of
very stiff to hard cohesive soils. The mat foundation grades for
the rest of the auxiliary building, the turbine building, and
associated facilities were placed at various elevations on
compacted fill. Portions of the auxiliary building will be
underpinned with a continuous wall supported on natural soil as 44
described in Subsection 2.5.4.10.3.1.5.1. The building loads
superimposed by the structures on undisturbed soil or compacted
fill are given in the soil pressure plan, Figure 2.5-47.

2.5.4.10.3.1.2 Subsurface Conditions 44

The plant site was essentially flat, and the ground surface was
at about elevation 603 feet. A detailed description of soil 44
conditions together with generalized soil profiles through the
plant site is given in Subsection 2.5.4.3.5. For the purpose of
analysis, the soil profile is divided into the layering system 44
shown in Figure 2.5-118.

2.5.4.10.3.1.3 Soil Parameters

The Young's Moduli used in the settlement calculation are
presented together with soil profile in Figure 2.5-118. Young's 44
Modulus in the natural soil ($E = 600\ S_U$)[74] is based on a
statistical relationship with the unconfined compressive strength
or undrained shear strength (S_U). The undrained shear strength
used is interpreted conservatively from the summation plot of
shear strength vs elevation given in Figure 2.5-33.

The Young's Moduli in the sand fill below the auxiliary building were determined using Figure 2.3 of Hall, Numark, and Hendron,[128] which shows shear modulus as a function of standard penetration test blowcount. The Young's Moduli were determined from the shear modulus which was determined from blowcounts under the structure. In areas where clay was present, the Young's modulus value was reduced to the low value indicated (Figure 2.5-118) which was consistent with plate load tests made in the tank farm area and Young's modulus back-calculated using loads and settlement measurements of the diesel generator building.

An analysis was performed to verify the Young's Moduli used to
calculate the settlements under the power block structures
resting on the hard natural clay. The soil parameters from 44
Figure 2.5-118 were used to estimate the settlement of the
reactor containment structures for the loads added between
May 17, 1977, and March 11, 1978. The stresses below the edges
of the reactor mats due to the change in the reactor building
loads were calculated using a formula for the stresses below an
embedded rigid circular plate taken from Figure 7.23a of Poulas
and Paris.[127] The settlement was calculated to be 0.4 inch from
elastic theory. The measured settlement at the edges of the
reactor mats between the above dates was 0.4 inch (Appendix 2E).
Relatively small loads added in the auxiliary building between
May 17, 1977, and March 11, 1978, were not included in the above
calculation. Hence, the calculated settlement should be greater.
This indicates that the actual Young's moduli of the natural soil
is higher than the values used in the analysis (Subsection
2.5.4.10.3.1.3) and, therefore, the Young's moduli used are
conservative.

The sampling of overconsolidated hard clays is usually difficult
due to the stiffness of the clays. Sample disturbance is
inevitable. This evidence is clearly shown from all the
laboratory consolidation test curves. Furthermore, experience
indicated that the estimated soil compressibilities from
consolidation tests are influenced and increased by the specimen 33
preparation of trimming and ring fitting. On the other hand, the
Young's Moduli of the in situ clays are derived from shear 44
strength test results, which are not affected by sample
disturbance to the same degree as laboratory consolidation test
results. 44

2.5.4.10.3.1.4 Groundwater Conditions

For settlement evaluation prior to dewatering, the static groundwater level is taken to be elevation 627 feet. This elevation will be the maximum operational level of the filled cooling pond. The final static groundwater level following permanent plant area dewatering is taken to be elevation 590 to 595 feet. 44

2.5.4.10.3.1.5 Analysis

The settlement evaluation for the plant structures was made from a consideration of the following cases:

a. Settlements due to fill and building net loads after reservoir is filled, water level at elevation 627 feet

b. Settlements due to dewatering to elevation 590 to 595 feet 44

Heave from pressure relief due to excavation of overburden soils above the foundations is not analyzed because: 1) pressure relief due to excavation would decrease quickly to zero by the subsequent placement of fill and building loads, 2) the heave associated with stress reduction is relatively small compared to the settlement due to large area fill and building loads, and is essentially elastic due to the highly overconsolidated nature of the in situ soils, and 3) the ultimate settlement analyzed for the above Case a loading condition was based on the application of appropriate building net loads. 44

For settlement computations, a total of 28 settlement points are established on a grid and at selected structure locations as shown in Figure 2.5-48.

Loading criteria and other pertinent parameters are presented in Figure 2.5-47. Based on the respective loading conditions, site soil conditions, and the selected Young's Moduli, ultimate settlements at each of the 28 points are calculated for load condition Case a. Settlement values resulting from this loading condition are calculated by evaluating the stresses from elastic half-space theory[75] and then computing the settlement using the theory of elasticity. 44

Dewatering settlements for the reactor containment and the auxiliary building sections on natural soil were calculated using the theory of elasticity and the average of the Young's Moduli and the constrained moduli back-calculated from settlement and load records of the reactor structures. The estimated settlement value for a drawdown from elevation 627 to 595 feet is 0.8 inch. Actual measured values were between 0.25 and 0.5 inch. Dewatering settlement of the turbine building and the auxiliary building sections on fill were estimated to be 1 inch for a drawdown from elevation 627 to 595 feet. Actual dewatering performed in the diesel generator building area has produced settlement of about 0.5 inch for a drawdown from elevation 620 to 595 feet. 44

The estimated total settlements at each of the 28 points were obtained respectively by adding the calculated settlement values of loading Case a to the calculated settlement values of loading Case b. These values are presented in Figure 2.5-48.

2.5.4.10.3.1.6 Discussion 44

Settlements at the 28 points calculated for Units 1 and 2 show the best estimates of settlement expected. Because of the possible variations in loads, soil conditions, and soil properties, deviations from the estimated values are possible.

It is known that if clays have previously been consolidated by pressures equal to or greater than those to be added by new construction, their settlement is relatively small and occurs so rapidly that it may be considered to be elastic. On the other hand, if the added pressures exceed the preconsolidation load, the settlements are larger and occur with appreciable time lag. With respect to the Midland site, the hard clay at the site is 44 heavily preconsolidated and the pressure added by new construction does not exceed the estimated preconsolidation pressures. Therefore, it is concluded that the settlement of the most heavily loaded portions of the plant will be essentially elastic. The differential settlements will be appreciably smaller than the maximum settlements.

Most critical piping connections between adjacent structures in the power block area were made after June 1979. Based on settlement measurements recorded since that date, the differential settlement is less than 0.5 inch at the structural interfaces where these connections were made and the trend indicates that this value will not be exceeded during the plant life. 44

The Seismic Category I emergency cooling water discharge structures in the cooling pond are founded in natural soil at elevation 582.5 feet and the settlement of these structures is expected to be negilible.

To ensure the integrity of the plant facilities and verify the settlement predicted by analysis, settlement measurements will be monitored at each instrument location to provide a history of time-movement. The measurements will reflect what the structures will actually experience. The monitoring program is discussed in Subsection 2.5.4.13.

2.4.13.2.8 Potential Seepage Effects from Onsite Cooling Pond

All surface sand deposits along the dike axes were removed and the areas backfilled with impervious clay fill or a bentonite slurry to minimize any seepage from the cooling pond into the Unit c sand outside the dike boundaries (Subsection 2.5.6.3.2). The underlying impermeable clays (Units d and e) minimize downward seepage from the cooling pond from reaching the confined unconsolidated or bedrock aquifers.

A groundwater monitoring program has been initiated to establish the relationship between the cooling pond and the various aquifer zones beneath the site. This program is discussed in Subsection 2.4.13.4.

2.4.13.3 Accident Effects

To be provided by amendment.

2.4.13.4 Monitoring or Safeguard Requirements

A groundwater quality monitoring program was established to ensure that seepage from the cooling pond is not entering the confined unconsolidated or bedrock aquifers at the site. The groundwater quality monitoring network consists of nests of wells that are screened in the lacustrine sand (Unit c), the glacial till (Unit e), and, where present, the confined unconsolidated aquifer (Units f and g). The monitoring system consists of eight nests of wells located around the perimeter of the dike as shown in Figure 2.4-35. The general design of these wells is presented in Figure 2.4-36. Boring logs and well construction summaries for each monitoring well are presented in Appendixes 2A and 2K, respectively. 44

Pre-startup baseline water quality data collection began in 1978. The results of the chemical analyses from this program are presented in Table 2.4-12A. During plant operation, water quality samples will be taken and analyzed annually. In addition to water quality monitoring, water levels will also be measured in these wells. The hydrographs of the baseline water levels taken since 1978 are presented in Appendix 2J.

The monitoring program for the permanent dewatering system is discussed in Subsection 2.4.13.5.1.6.

2.4.13.5 Design Bases for Subsurface Hydrostatic Loading

All plant structures, systems, and components are designed to withstand hydrostatic loading resulting from the site probable maximum flood as described in Subsection 2.4.3. The probable clay is blanketed by the uniform silty sand, but where the sand has been eroded, the clay extends to the ground surface.

The uniform silty sand covers either the glacial till or lacustrine clay over most of the pond area with varying thickness.

In addition to the above soils, the site is overlain by 4 to 18 inches of organic topsoil (more in a few marshy areas) and, in certain areas, by soft sandy and clayey silt, generally up to 3 or 4 feet thick.

2.5.6.3 <u>Foundation and Abutment Treatment</u>

2.5.6.3.1 General

The embankment is built directly on the ground surface after clearing all organic matter and loose sand.

The clay till, by virtue of its high strength and low permeability, is the most satisfactory foundation material at the 44
site. The clay till extends almost to the ground surface in the eastern part of the site, where the dike height is the greatest, so that the highest portions of the dike rest directly on an excellent foundation material. Shearing strengths of dike foundation soils are summarized in Tables 2.5-3, 2.5-3A, 2.5-3B, and 2.5-6 and are presented in detail in Appendix 2B. 44

The measured strength of the laucstrine clay was found to be adequate for support of the dikes.

2.5.6.3.2 Special Foundation Treatment 1

To control seepage through the dike foundations, a cutoff trench was excavated to a minimum depth of 8 feet through the natural 44
sand and 2 feet into an underlying soil of low permeability along the entire length of the dike. This trench, whose shape is shown in Figure 2.5-53, was backfilled with compacted impervious fill.

Where an appreciable depth of the sand and unfavorable groundwater conditions made a compacted fill cutoff impractical, a slurry trench cutoff was substituted. About 700 linear feet of slurry trench cutoff was constructed in three sections along the northeast dike. In the 700 linear feet there were about 11,400 square feet of slurry trench wall. Locations of the slurry trench sites are shown in Figure 2.5-46 and profiles through the trench sites are shown in Figures 2.5-51 and 2.5-52.

The slurry trench has a minimum 4 foot width and nearly vertical walls. The top of the slurry trench is 3 feet above the water 44
table. The trench extended from the surface of excavated foundation, through the sand, to penetrate a minimum of 2 feet

into impervious clay. The stability of the trench walls was maintained during excavation by filling the trench with bentonite slurry.

The slurry properties conformed to the API Recommended Practice 13B, dated November 1962, First Edition, Standard Procedure for Testing Drilling Fluids, including Supplement 1, dated March 1966.

2.5.6.4 <u>Embankment</u>

2.5.6.4.1 Design Features

The upstream (pond side) dike slopes are constructed on a 3-1/2 horizontal to 1 vertical slope while the downstream slopes are 3 horizontal to 1 vertical (see Subsection 2.5.6.5 for slope selection). The maximum dike height is about 35 feet in Sections G and I, Figures 2.5-53 and 2.5-59, and the minimum height is 7 feet in Sections D and E, Figure 2.5-58. The highest dike sections occurred along the northeast and east dikes while the lowest occurred in the southwest part of the cooling pond. Some sections of the south dike are actually in cut as in Section D, Figure 2.5-58.

The dike sections shown in Figures 2.5-53, 2.5-58, and 2.5-59 were selected based on 1) slope stability, 2) seepage control, and 3) the best use of materials which were excavated in the course of construction of the cooling pond. The embankment consists of up to six zones of different materials. These zones and materials are listed in Table 2.5-10 and described in the following paragraphs. | 18

The Zone 1 core material consists of clay till and lacustrine clay obtained from the area of the emergency cooling water reservoir and the southwest region of the cooling pond site. Figure 2.5-61 shows the Zone 1 borrow areas. Surficial sand and silty sand are excluded from Zone 1 as are any materials with less than 20% passing the number 200 sieve. | 44

Zone 2 materials were taken from the designated borrow and excavation areas and consist of random material not suitable for Zone 1, providing it is free of organic material or humus. Figure 2.5-61 shows the Zone 2 borrow areas.

Zone 1 and Zone 2 materials are compacted according to the requirements shown in Table 2.5-21.

Zone 3 is intended to be free draining and therefore is constructed with clean sands. Zone 3 is used as a chimney drain separating the low permeability Zone 1 material and the random Zone 2 material. Sands available at the site did not meet the specifications; therefore, all the Zone 3 material was imported from Mt. Pleasant, Michigan. Construction equipment was

2.4-42. Evaluation of the chemical data indicates that test wells screened in backfill sand (TW-2, TW-3, TW-4, TW-5, and PD-20) have concentrations of iron, total hardness, and sulfate in excess of EPA limits, while the test wells screened in Unit c sand have all parameters below EPA limits.

During operation of the construction dewatering system (Subsection 2.4.13.5.1.2.3), dewatering wells were sampled for chemical analyses. The results of these analyses are presented in Table 2.4-12C. The locations of the construction dewatering wells are shown in Figure 2.4-45. The quality of groundwater from these wells is generally good with only a few samples showing high iron, sulfate, and hardness values.

As part of the monitoring program for the permanent dewatering system, baseline water quality samples were taken from permanent dewatering wells. The results of these analyses are presented in Table 2.4-12D. The location of the permanent dewatering system is shown in Figure 2.4-46. Evaluation of the water quality data indicates all wells have iron concentrations in excess of EPA limits, with all other parameters below the limits.

2.4.13.2.5 Cation Exchange Capacities

The cation exchange capacities of four selected samples of natural soil from the site were determined. Two samples were obtained from the Unit c sand and two were taken from the underlying Unit d clay. The Unit c sand yielded values of 1.5 and 2.2 meq/100 gm and the underlying clay (Unit d) yielded 15.1 and 26.0 meq/100 gm. 44

Cation exchange capacities were also measured on 12 representative samples of silty clay backfill in the area of the diesel generator building and tank farm. Results ranged between 2.0 and 11.7 meq/100 gm (Subsection 2.5.4.2.5).

2.4.13.2.6 Groundwater Level Fluctuations and Recharge

Groundwater levels in the lacustrine (Unit c) sand around the site have been monitored since 1979. The results of this monitoring program are presented on hydrographs in Appendix 2.I. The hydrographs illustrate that the cooling pond level controls the groundwater level elevations under nonpumping conditions. Following startup of the permanent dewatering system (Subsection 2.4.13.5.1), the water levels in the lacustrine sand (Unit c) and sand backfill will be controlled primarily by the pumping operation of the system.

The primary recharge source for the lacustrine (Unit c) sand in the power block area is the cooling pond. Minor amounts of recharge are also occurring because of infiltration of precipitation and from normal nonsafety related pipe leakage during plant operation (Subsection 2.4.13.5.1.1.5).

As part of the groundwater quality monitoring program (Subsection 2.4.13.4), monitoring wells were installed on the cooling pond dike. These wells are screened in the lacustrine (unit c) sand and the lower confined unconsolidated aquifer (Units f and g). Water level measurements have been taken in these wells since 1978. Hydrographs for these wells are presented in Appendix 2.J. The screened intervals for these wells are presented on the observation well construction summaries in Appendix 2.K. The location of these wells are shown in Figure 2.4-35. Evaluation of the hydrographs of wells penetrating the lower confined unconsolidated aquifer, in comparison with changes in cooling pond level, indicate that the cooling pond level changes do not affect water levels in this lower aquifer.

Based on the evaluation of hydrographs and logs of deep borings in the power block area, it is apparent that the lower confined unconsolidated aquifer is isolated from the upper unconfined aquifer. Therefore, the recharge area for this aquifer is not in the immediate area of the plant site.

No long-term hydrographic data is available for bedrock aquifers in the site area. However, because of the limited usage of these aquifers in the site area, little variation in water level is expected to occur during the life of the plant.

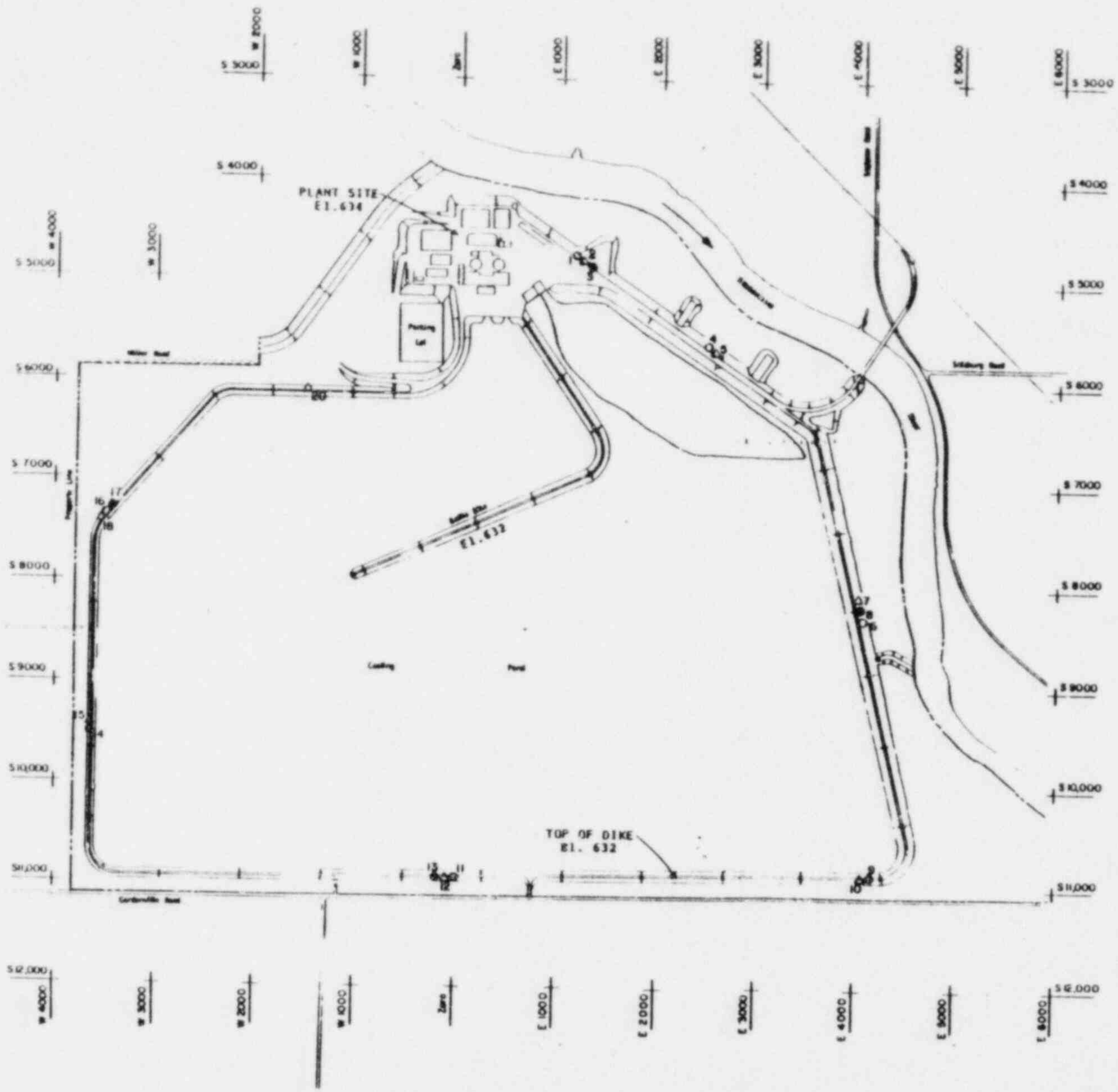
The recharge areas for the bedrock aquifers are thought to be either where the bedrock units are in hydraulic contact with unconsolidated aquifers, or where the bedrock units outcrop near the surface. 44

2.4.13.2.7 Reversibility of Groundwater Flow Patterns

The flow patterns in the Unit c sand, within the limits of the cooling pond dike, will be altered by operation of the permanent dewatering system (Subsection 2.4.13.5.1). Comparison of Figures 2.4-32, 2.4-40, and 2.4-41 shows that flow patterns north of the cooling pond will reverse. In general, the flow patterns within the dike boundaries will be toward the permanent dewatering wells.

Because the cooling pond dike was designed with an impervious cut-off, no alteration of the preconstruction flow pattern is expected to occur outside the dike boundaries (Subsection 2.4.13.2.8).

The impervious clay (Units d and e) that separates the Unit c sand from the confined aquifer (Units f and g) in the site area prevents any alteration of flow patterns in the lower aquifer during the permanent dewatering operation.



EXPLANATION

- ○ GROUNDWATER MONITORING WELL 50'± DEEP
- △ GROUNDWATER MONITORING WELL 150'± DEEP
- ● GROUNDWATER MONITORING WELL 200'± DEEP

NOTES:

1. SEE FIGURE 2.4-36 FOR WELL DESIGN.

CONSUMERS POWER COMPANY
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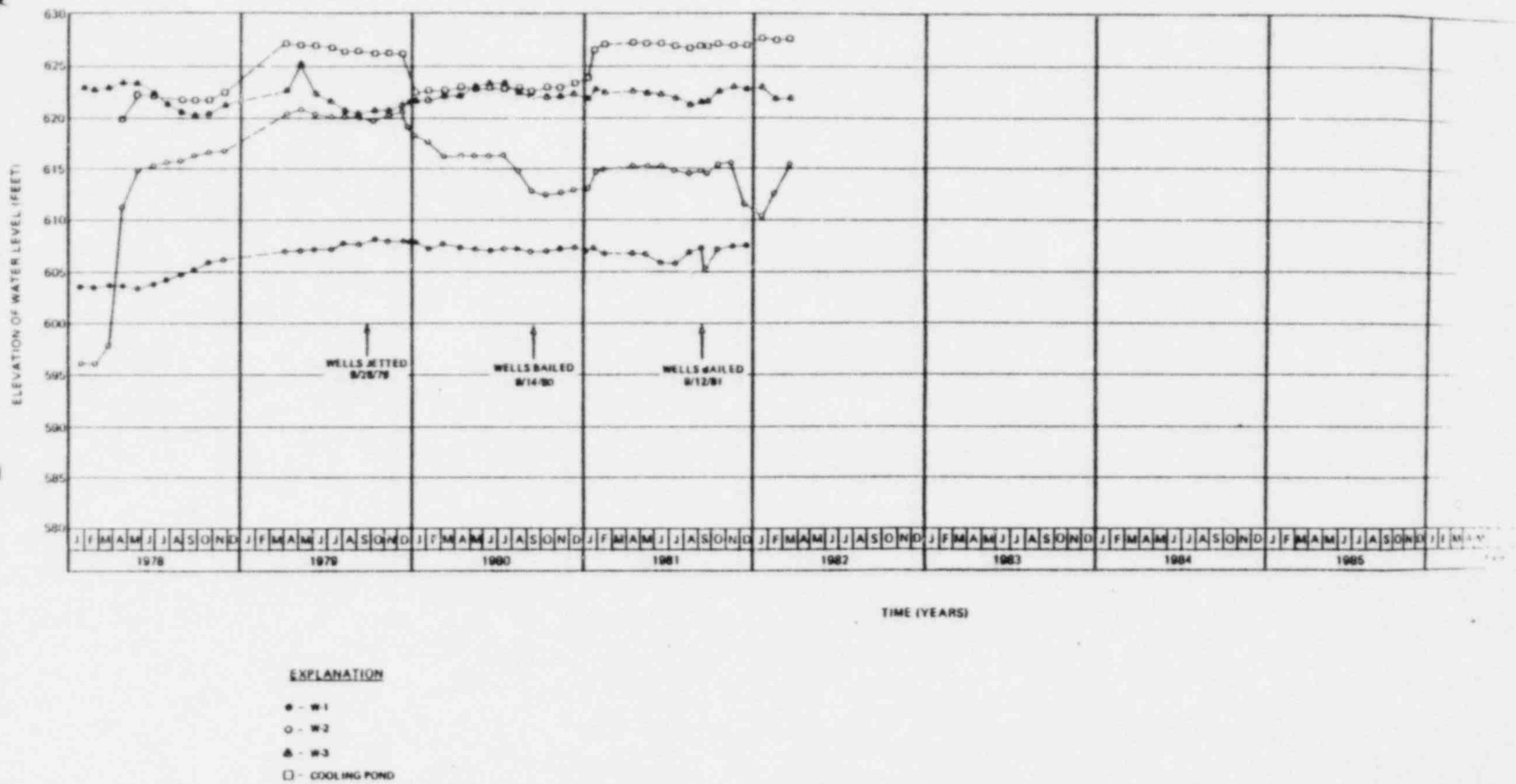
Groundwater Quality
Monitorung Well Locations
(SK-G-173, Rev 1)

FSAR Figure 2.4-35

5/79 Revision 21



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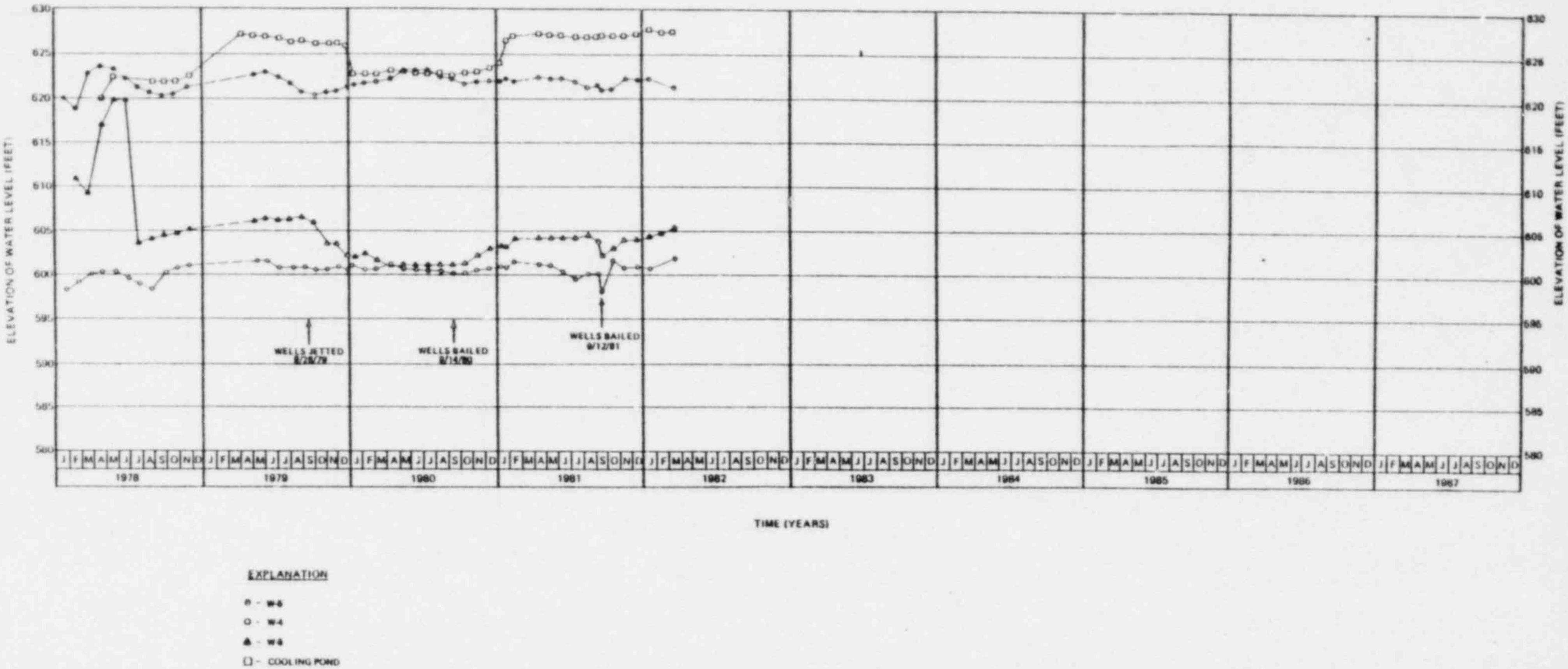

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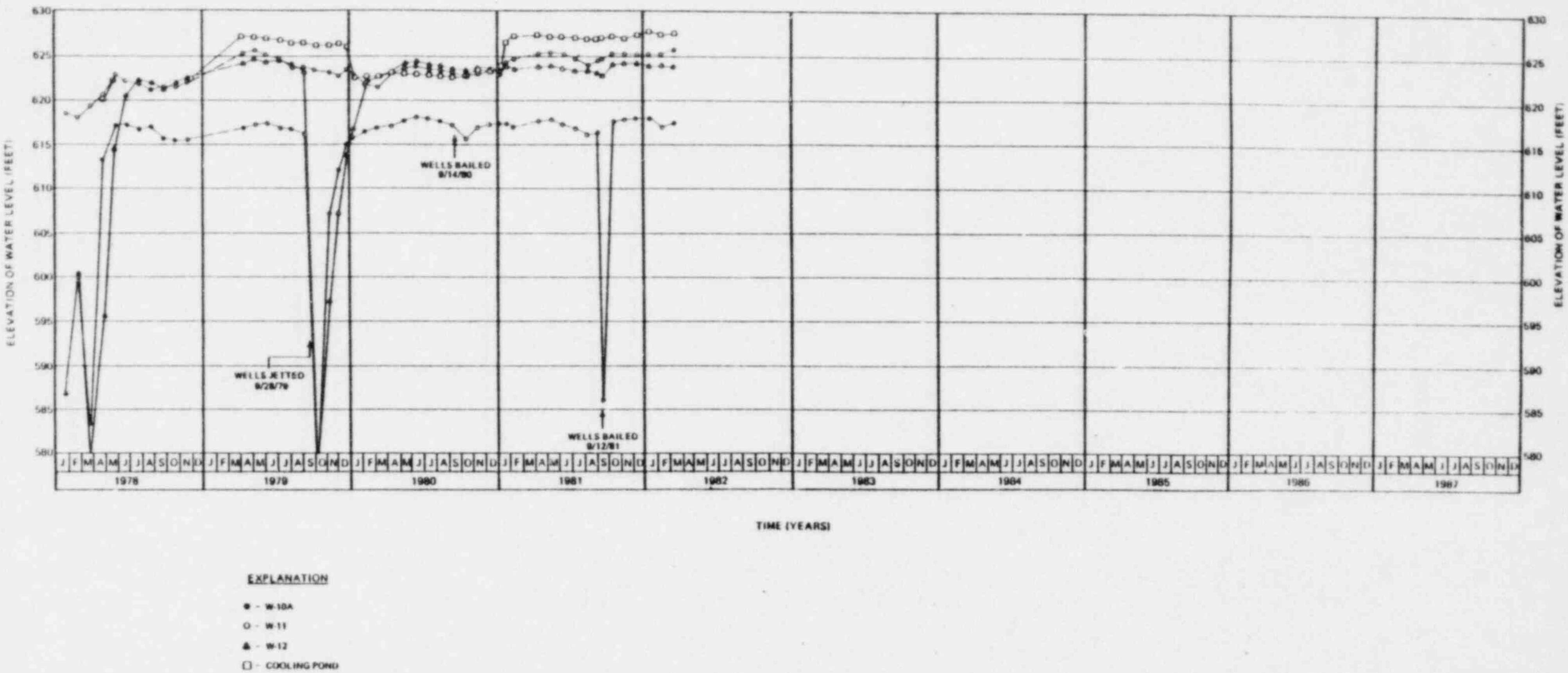
Hydrographs of Cooling Pond and Dike Ground Water Monitoring Wells W-4, W-5, and W-6 (SK-G-724, Rev 1)

FSAR Figure 2J-2

6/82 Revision 44



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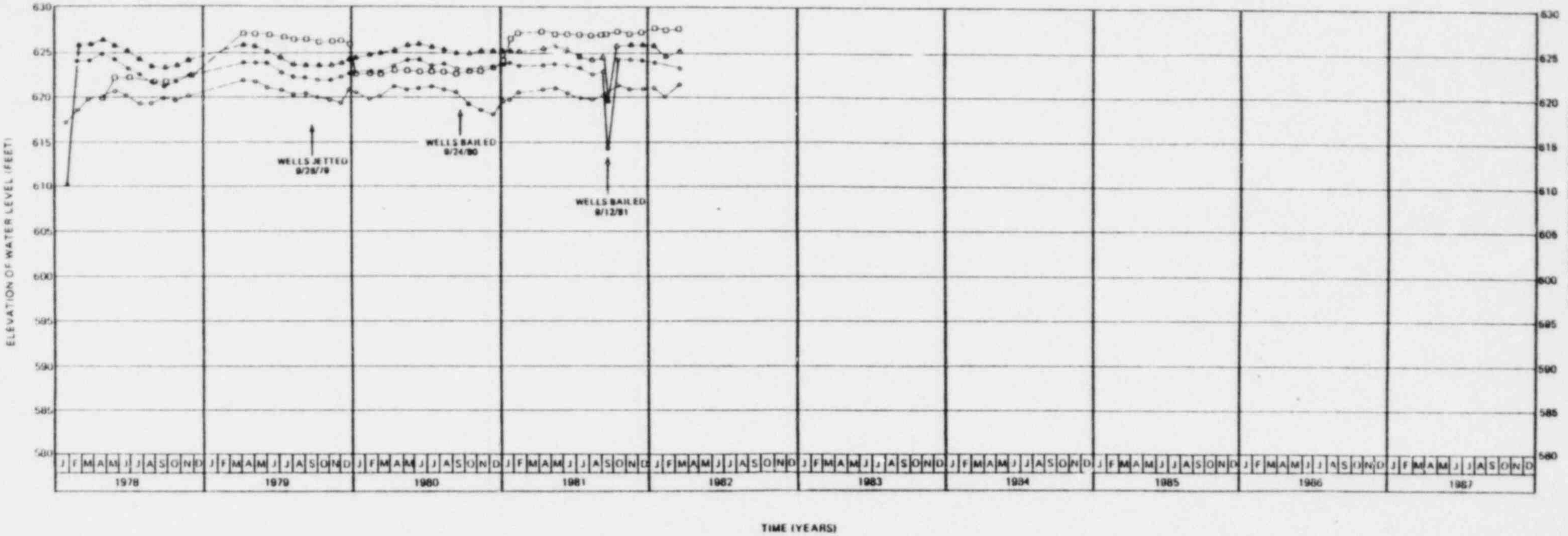
Hydrographs of Cooling Pond and Dike Ground Water Monitoring Wells W-10A, W-11, and W-12 (SK-C-725, Rev 0)

FSAR Figure 2J-3

6/82 Revision 44



EXPLANATION

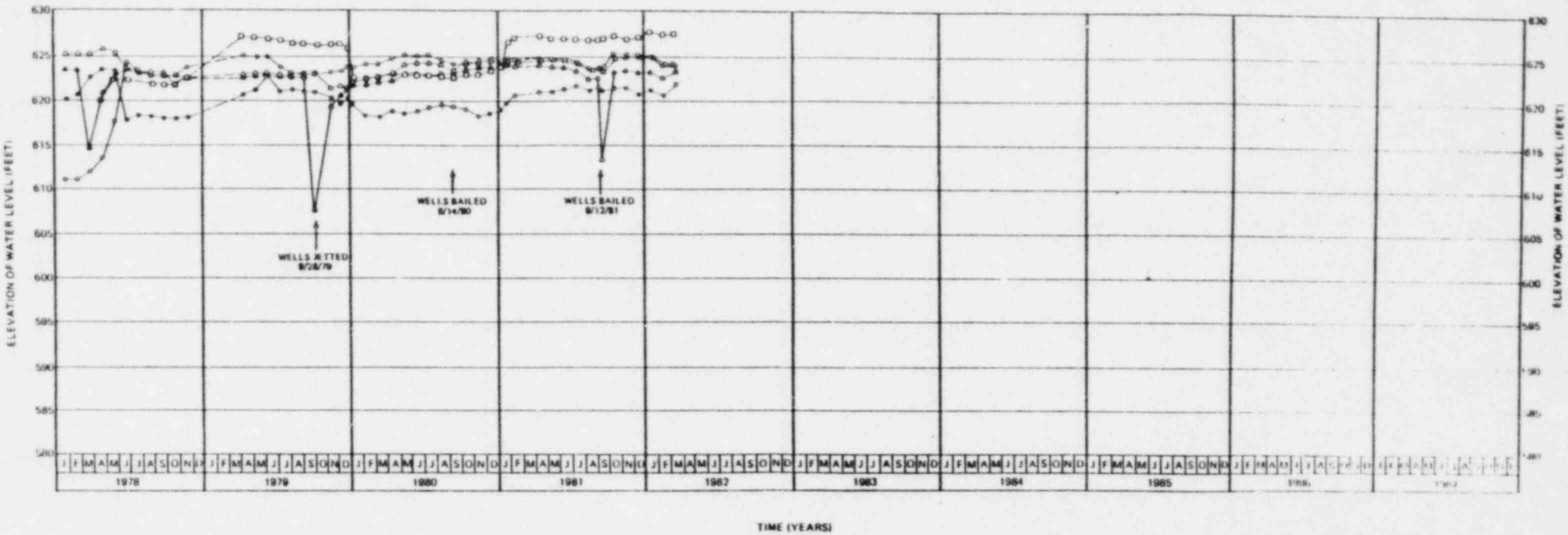
- ● - W-13
- ○ - W-14
- ▲ - W-15
- □ - COOLING POND

CONSUMERS POWER COMPANY
MIDLAND PLANT UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

Hydrographs of Cooling Pond and Dike Ground Water Monitoring Wells W-13, W-14, and W-15 (SK-G-726, Rev 0)

FSAR Figure 2J-4

6/82 Revision 44



EXPLANATION

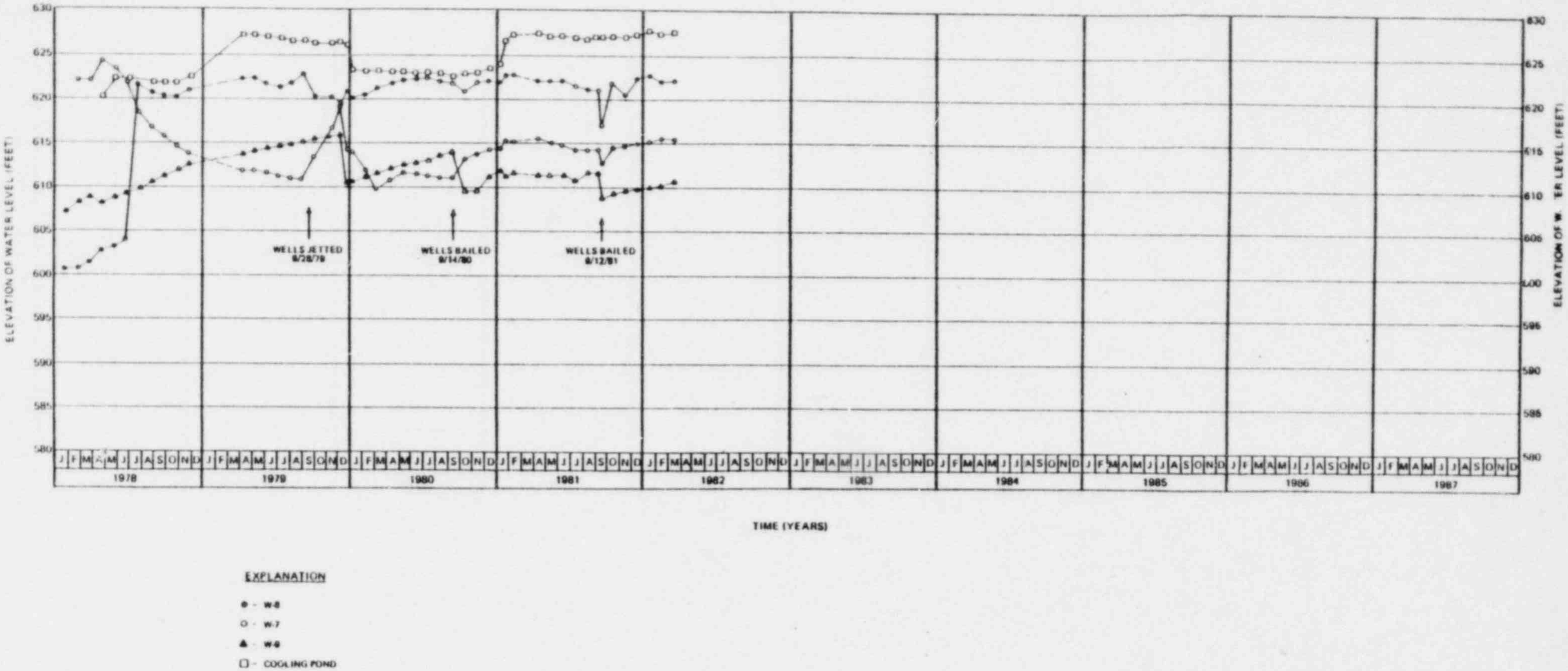
- ● - W-16
- ○ - W-17
- ▲ - W-20
- □ - COOLING POND
- △ - W-18

CONSUMERS POWER COMPANY
MIDLAND PLANT UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

Hydrographs of Cooling Pond and Dike Ground Water Monitoring Wells W-16, W-17, W-18, and W-20 (SK-C-727, Rev 0)

FSAR Figure 21-5

6/82 Revision 44



CONSUMERS POWER COMPANY
MIDLAND PLANT UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

Hydrographs of Cooling Pond and Dike Ground Water Monitoring Wells W-7, W-8, and W-9 (SK-G-728, Rev 0)

FSAR Figure 2J-6

6/82 Revision 44

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of
CONSUMERS POWER COMPANY
(Midland Plant, Units 1 and 2)

Docket No 50-329 OM
50-330 OM
Docket No 50-329 OL
50-330 OL

September 17, 1982

AFFIDAVIT OF GILBERT S KEELEY

My name is Gilbert S Keeley. I am the Project Manager. In this capacity, my responsiblities are as a member of the Project Office providing management direction in the area of Bechtel and B&W Contracts, Equipment Qualification, and Independent Design Verification.

I am primarily responsible for providing a response to Interrogatory IV, Questions 1 through 12 (except for 7) concerning Contention 4 and Interrogatory I, Question 19 (in part) concerning Barbara Stamiris Contention 1c. To the best of my knowledge and belief. the above information and the responses to the above interrogatories are true and correct.

Gilbert S. Keeley

Sworn and Subscribed Before Me This 17th Day of September 1982

Pamela J. Griffin
Notary Public
Jackson County, Michigan

My Commission Expires Sept 8, 1984

mi0982-0054q168

Barbara Stamiris

INTERROGATORY IV

RE INDEPENDENT DESIGN AUDIT: CONTENTION 4

Questions

1. How much time, money, and effort is involved in the Bechtel Audit of Bechtel construction and design announced at the 5/20/82 ACRS meeting? What is the purpose and justification for this self-audit? Who will pay for it?

2. What plans have been made toward an independent design and construction audit at Midland?

3. What contacts have been established thus far with various firms concerning the design and construction audit?

4. Provide names and addresses of all firms considered for performing the independent design and construction audit.

5. What criteria are being used to select the firm for the independent design and construction audit--what are the job requirements?

6. Explain in detail the job description, scope of the audit, and other descriptions of what exactly is to be done during this audit.

7. Provide all documents and correspondence exchanged thus far between CPC and prospective companies or individuals regarding the design and construction audit.

8. Explain to what extent the audit scope, depth, or methodology will be controlled by CPC.

9. Explain CPC's proposed plan of action for responding to audit findings.

10. When does CPC expect the selection of this audit firm to be decided?

11. When does CPC expect the audit to begin? To be concluded?

12. How is it possible for an outside auditor to independently assess the structural adequacy of the containment structures and other structures (due to the missing reinforcing bars) without relying upon CPC's statements and analysis of internal wall conditions?

Reponses

1. This question refers to a "Bechtel audit of Bechtel construction and design announced at the 5/20/82 ACRS meeting." During the 5/20/82 meeting there was discussion of an "independent design verification" conducted by Bechtel and CP Co. We assume that is what the question addresses.

The Midland Independent Design Review Program conducted by Bechtel & CP Co personnel (who were independent of the Bechtel Ann Arbor office and CP Co Midland Project) involved 3183 manhours of the personnel on the review team, at a cost of $204,100.

The purpose of the Program was to review Bechtel project engineering activities to determine if design criteria are being correctly implemented and if the design assumptions, design methods and the design processes are satisfactory. As discussed at the 5/20/82 ACRS meeting, CP Co decided that based on occurrences at Diablo Canyon and other plants, a design audit was prudent, even without a specific NRC request. CP Co decided that such an audit could be optimized by using people who were knowledgeable about the system but were not working on Midland design such as Bechtel personnel located in offices other than Ann Arbor or CP Co personnel that have not been involved in Midland. The Company also did not at that time, nor do we as yet, know what NRC staff requirements would apply to independent audits for plants that are in the construction and licensing stage similar to Midland. The Company believes that the Bechtel-CP Co audit will be extremely useful either in confirming the adequacy of design and construction, or, if problems are found, in providing timely identification so that corrective action may be taken consistent with overall project schedules.

2. To date the following plans have been made for an independent design and construction verification program on Midland.

CP Co Management decided that the Independent Design and Construction Verification Program should consist of two parts, and that both parts should be integrated into one report under the jurisdiction of one subcontractor.

The first part is to be an INPO-type evaluation. This type of evaluation has been under development since March of 1982 with INPO developing criteria to be used by the Utility Industry in performing their self evaluation. INPO evaluation teams made up of utility personnel and consultants have conducted evaluations of several pilot plants in 1982 and, in September 1982, issued the latest draft of the "Performance Objectives and Criteria for Construction Project Evaluations." In September 1982, workshops were held by INPO for utility and consultant personnel on how to implement the evaluation. INPO has discussed the program with the NRC Staff and NRC Staff has taken part in training sessions and INPO pilot plant programs. Although the INPO Evaluation Program was designed as a self evaluation program by the utility using its own employees in conjunction with assistance from other utilities or consultants, CP Co has decided to have the INPO evaluation performed by non-CP Co employees to obtain an extra degree of independence in the INPO-type evaluation.

The second part of the Independent Design and Construction Verification Program will be similar to what has been conducted on several plants which were or are to be licensed in 1982. This would be an in-depth review of a system which is important to safety and whose initial design required interfaces within the principal design organization and with another organization, such as the NSSS supplier. This type of program has been accepted by the NRC Staff on other plants. The contractor who will perform the independent, in-depth design and construction verification will be required to meet the independency criteria provided in Chairman Palladino's 2/1/82 letter to Representative John Dingell.

On September 2, 1982 a meeting was held with Region 3 and the staff to discuss the above plans.

3. Three firms have been contacted as potential suppliers of the services described in Item 2 above. All three firms have presented proposals and met with the Company.

4. The three firms considered were:

(a) Management Analysis Co
11095 Torreyana Rd
San Diego, CA 92121

A subcontractor for the second part of the independent design verification proposed by them was:

CYGNA Energy Services
141 Battery Street
Suite 400
San Francisco, CA 94111

(b) TERA Corporation
3131 Turtle Creek Boulevard
Dallas, TX 75219

(c) Torrey Pines Technology
PO Box 81608
San Diego, CA 92138

5. The basic criteria that are being used to select the firm for the Independent Design and Construction Verification Program include:

a. QA Knowledge and Experience

b. Technical Capability Including Experience of Personnel

c. Independency

d. Program Planning

e. Cost

The job requirements are explained in the answer to Question 6.

6. As discussed in the answer to Question 2, the independent design and construction verification program will consist of two parts.

Part 1 - INPO

The description of the work is found in the September 1982 INPO Performance Objectives and Criteria for Construction Project Evaluations. The contractor performing Part 1 will assemble a team of personnel who will use these criteria in implementing the evaluations. The preplanning phase will consist of selecting review areas based on complexity, status, interfaces, safety significance, and history of problems (Plant and Industry); and defining review material required (procedures, SAR, Spec's, drawings, develop tentative assignments and schedule). There will then be more detailed planning of the above, with a plant tour and identification of interfaces. The actual evaluation will consist of interviews, reviews of material provided, observation of activities, discussion of findings within the team, and drafting of performance evaluations.

Part 2

The INPO evaluation team will include one or more members who are employed by the Contractor doing the Part 2, in-depth review. They will assist in the INPO design review aspects, and use the information from the INPO activities to assist in determining the system to be verified in-depth.

The in-depth Part 2 design verification will confirm the design adequacy of an important safety system and will consist of the following activities:

a. Reviewing design inputs for conformance to system design criteria and committments;

b. Confirming that the design process conforms with design control requirements and that interface requirements were factored into design;

c. Reviewing drawings and specifications for conformance with design criteria, commitments, and incorporation of results of analysis and calculations;

d. For analyses and calculations, reviewing input assumptions, methodology, validation and usage of computer programs and checks of certain calculations outputs;

e. Performing confirmatory analyses and calculations of certain original design analyses and calculations;

f. Verifying as-built conditions by inspections and walkdowns of selected systems and components for conformance with design, inspection and test documentation.

The above would include all engineering disciplines involved in the system (electrical, mechanical, nuclear, civil, instrumentation and control, materials selection, and equipment qualification).

8. Consumers Power Company will not be controlling the Independent Design and Construction Verification Program. CP Co personnel will be answering questions during Parts 1 and 2, and will be providing information on the appropriate organization within CP Co or other Companies to obtain the answers to questions of reviewers. The methodology has been defined in the answer to Question 6. The scope and depth of the audit is pre-defined in accord with the audit methodology as described in the Response to Question 6. Once a contractor is retained, the Company will not interfere with the auditor's ability to carry out its function in accordance with the methodology. The auditors will be free to pursue areas to a depth which they believe necessary to support their conclusions.

9. Findings from the program will be evaluated to determine what corrective action, if any, should be taken. Depending on the nature of the finding, action could include re-analysis, rework, or replacement of hardware items or modifications of programs.

10. The selection of the firms to be involved in Parts 1 and 2 was made on September 16, 1982.

11. Consumers Power Company expects the Independent Design and Construction Verification Program to begin shortly after we make an additional presentation to the NRC. This presentation has not been scheduled. We hope that the Program can begin in October 1982. Some preliminary activities such as training of review team personnel is expected to start the last week in September 1982 and may commence before the additional presentation to the NRC. We expect that the Program would be concluded approximately four months after it commences.

12. For either of the structures mentioned, the independent design and construction verification reviewer would not have to rely upon CP Co statements and analysis of internal wall conditions other than to utilize the as-built drawings for the rebar. He could then use his own method of analysis to assess the adequacy. This is covered in the answer to Question 6, Part 2, Item (e). (Whether or not an independent audit would pursue the rebar matter on these structures depends on whether the audit encompasses them, and, if it does, whether the auditor judges Consumers Power Company's analysis to be adequate.)

CERTIFICATE OF SERVICE

I hereby certify that copies of the attached responses of Consumers Power Company to Discovery Questions of Intervenor Barbara Stamiris were sent by U S Mail, first class, postage prepaid, to the attached service list this 20th day of September, except for Barbara Stamiris, who was served by Federal Express.

James E Brunner

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