INTERVENOR PATRICIA LEE HOURIHAN'S

PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges

Robert M. Lazo, Esq., Chairman
Dr. Richard F. Cole
Dr. Dixon Callihan

In the Matter of	)	
	)	
ARIZONA PUBLIC SERVICE COMPANY, et al.	)	Docket Nos. STN 50-528
	)	STN 50-529
	)	STN 50-530
(Palo Verde Nuclear Generating Station, Units 1, 2, and 3)	)	August 13, 1982

Appearances

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Charles A. Bischoff, Esq.
for the Applicants

Lynne Bernabei, Esq.
for the Intervenor, Patricia Lee Hourihan

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for the Nuclear Regulatory Commission Staff

I. BACKGROUND

This decision on the application for licenses for three nuclear reactors at Palo Verde, Arizona, considers issues raised about the adequacy of the water supply for the operation and safe shutdown of the reactors.

The companies applying for the licenses (hereafter "Applicants") are the Arizona Public Service Company ("APS"), the Salt River Project Agricultural Improvement and Power District ("SRP"), El Paso Electric Company, Southern California Edison Company and the Public Service Company of New Mexico.

The application is for the operation of three pressurized water nuclear reactors, Units 1, 2, and 3, at the Applicants' Palo Verde Nuclear Generating Station site ("Palo Verde") in Maricopa County, Arizona, about 50 miles west of the city of Phoenix. Permits to construct the three units, each of which has a rated output of 1,270 megawatts of electrical power, were issued in May, 1976.[1]

The parties to this proceeding, in addition to the Applicants and NRC Staff ("Staff") are Intervenor Patricia Lee Hourihan and the Attorney General for the State of New Mexico.

The Atomic Safety and Licensing Board ("Licensing Board") originally approved the admission of five contentions, and permitted Ms. Hourihan to file additional contentions regarding emergency planning after the emergency plans had been prepared.[2]

1/ 41 Fed. Reg. 22897.

2 See Memorandum and Order, April 16, 1981.

Ms. Hourihan withdrew two of these contentions, and chose not to file a contention about emergency planning.

Applicants filed a motion for summary disposition on each of the remaining three contentions which the Staff supported. The Board granted applicants' motion for summary disposition on two contentions but denied the motion respecting Contention 5 on the adequacy of water available for cooling purposes at Palo Verde.[3]

The Board conducted two prehearing conferences. The public was permitted to make limited appearance statements on April 27, and April 28, 1982. The Board held hearings from April 27, to April 30, 1982; May 25 to May 28, 1982; and June 22 to June 25, 1982.

On April 28, 1982, Intervenor moved to substitute three new contentions for her original Contention 5, which read:

> "Applicants will not have an assured supply of usable treated municipal effluent for cooling purposes for Unit 3 of PVNGS during months of peak reactor need for the first five years of operation."

Without explicitly admitting the three contentions in the form proposed by Intervenor, we permitted litigation on the following three issues, which we now state as contentions:

1) Applicants have not demonstrated that they have an assured supply of water to operate three Palo Verde units.

2) Applicants have not demonstrated that their stated source of water for use as condenser cooling water--effluent--is of a quality adequate for that use up to 15 cycles of concentration or that their water reclamation plant and circulating water system can adequately treat effluent for use up to 15 cycles.

3) Applicants have not demonstrated that they have an assured and adequate water supply to shutdown the three units safely and maintain them in a safe shutdown condition.

3/ See Board Memorandum and Order, March 17, 1982.

The decisional record of this proceeding consists of:

1) The Commission's Notice of Hearing;[4]

2) Petitions and pleadings filed by the parties;

3) Transcripts of the hearing; and

4) All exhibits received into evidence.

This Board's jurisdiction is limited to a determination of findings of fact and conclusions of law on issues put into controversy by the parties to this proceeding or found by the Board to involve a serious safety, environmental or common defense and security question.[5] Because of the Board's decision to deny operating licenses to applicants on the basis of the issues in controversy it has made no such additional determinations in this case.

II. CONTENTIONS

A. Contention 1: An Assured Supply of Water for Condenser Cooling at Palo Verde.

Intervenor's position is that Applicants have not demonstrated an assured supply of water for the three Palo Verde units. Applicants argue that they will be able to obtain sufficient water for operation of the three units under two contracts, Agreement No. 13904 ("Agreement 13904") between APS and SRP and the municipalities of Phoenix, Glendale, Mesa, Scottsdale, Tempe and Youngtown; and a similar contract with the City of Tolleson. Applicants' position is that the two contracts are valid and there is

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4/ 47 Fed. Reg. 12888.

5/ 10 C.F.R. §2.760(a).

only a remote possibility that the cities will invoke section 21 of Agreement 13904 or section 10 of the Tolleson contract. These provisions allow the cities to refuse to deliver effluent to Palo Verde when there exists in the cities a critical need for water to be used for domestic purposes, there are no other reasonable sources of water available to meet that domestic need, reasonable steps have been taken to conserve the cities' water supplies, and reasonable notice has been given to APS and SRP.

By letter of February 10, 1982, Bill Stephens, executive director of the Arizona Municipal Water Users Association ("AMWUA")[6], representative of the cities who had contracted to sell applicants water for Palo Verde, informed the Board that Agreement 13904 was being renegotiated. He urged the Board to deny summary disposition on Contention 5 prior to such time as the contract had been fully renegotiated. He stated in that letter that among the critical issues being renegotiated were the amount of effluent available for Palo Verde, the cities' right pursuant to section 21 of the Agreement to refuse to deliver effluent in times of critical need, and the price of effluent to applicants.

On March 16, 1982, Mr. Stephens, to update the Board on the status of renegotiation, wrote that all talks between the

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6/ AMWUA is a voluntary, non-profit corporation established by the Maricopa County cities of Glendale, Mesa, Phoenix, Scottsdale and Tempe to promote the development of unified municipal water policies and provide for integrated water resource management among member cities. AMWUA member cities, and the Town of Youngtown, produce and treat the effluent Applicants wish to use for condenser cooling at Palo Verde.

parties had ceased. On April 26, 1982, he made a limited appearance statement in which he said he did not believe Applicants had an assured supply of water for operation of Palo Verde. Mr. J. Robert McCain, staff director for AMWUA, testified that he agreed that because of the uncertainties concerning the cities' future water supplies, the cities might in the future refuse to deliver water to Palo Verde if they developed a critical need for that water.

Intervenor argued that to determine a water supply for a major energy project such as Palo Verde one must not only analyze the physical water supply available to meet the estimated project needs, but, in addition, determine the institutional constraints on the availability of that water supply. The Board adopts Intervenor's approach to the issue, especially since a conservative approach is dictated by the location of these plants in the most arid part of the country. Not only is competition increased in an area such as the desert where water is a scarce resource, but the variation in physical water supplies is greater than in a more humid climate.

This Board, in conducting its cost-benefit analysis under the National Environmental Policy Act ("NEPA"), must consider all uncertainties about the applicants' water supply and the costs of that supply, in terms both of its price and the costs incurred by other water users in the area in losing that water resource. This Board must also consider the likelihood that applicants will be forced to obtain a water supply other

than effluent, and the environmental effects of obtaining it. NEPA imposes an affirmative obligation on this Board to seek information about the environmental consequences of applicants' proposed action, Alaska v. Andrus, 580 F. 2d 465, 473 (D.C. Cir. 1978), vacated in part sub nom Western Oil & Gas Assoc. v. Alaska, 439 U.S. 922 (1978), and consider alternatives to that action to the fullest extent possible. Calvert Cliffs' Coordinating Committee, Inc. v. AEC, 449 F. 2d 1109, 1128, (D.C. Cir. 1971). See also, Natural Resources Defense Council v. NRC, Nos. 77-1148, 79-2110 and 79-2131 (D.C. Cir. April 27, 1982), slip op. at 36.

In making the requisite NEPA balancing of costs and benefits in this case, we find that Applicants have not demonstrated an assured supply of water so as to convince us that the economic benefits from the plants' generation of electricity when water is available will outweigh the environmental costs incurred in construction and part-time operation of the plants.

The Board has determined that it will not take a "worst case" analysis to decide whether applicants have an assured supply of water. However, we believe applicants do need, at a minimum, a firm commitment for the required amount of water that is not dependent on the municipalities obtaining enough water to satisfy their domestic needs. We adopt the analysis set out by the Licensing Board in Philadelphia Electric Company (Limerick Generating Station, Units 1 & 2),

LBP-74-44, RAI-74-6 (1974), that applicants must demonstrate that their water supply is not dependent on the approval of a public or political body over which they have no control. In that case the Board directed the applicant for a construction permit to assume that a dam project yet to be approved by the Delaware River Basin Commission would not provide applicant with the necessary water storage and itself provide for that storage by the time of initial power operation. Id. at 1152. Here applicants are totally dependent on the municipalities' ability to develop adequate water supplies to avoid a critical need for water in the future. They, therefore, have abdicated in large part control over their entire cooling water supply to the cities.

Applicants cite the Black Fox decision as precedent for the position that a contract with an interruption clause similar to section 21 can serve as an assured, adequate source of water for a nuclear plant. See Public Service Company of Oklahoma (Black Fox Station, Units 1 & 2), LBP-78-26, 8 NRC 102,120 (1978), aff'd. ALAB-573, 10 NRC 775 (1979). However, the Licensing Board in Black Fox determined that the contract between applicants and Tulsa which contained an interruptability clause, provided a "reasonable assurance of adequate water supply" only after finding that Tulsa did not need the water being sold, the water being sold was of questionable quality for a pulbic water supply, and the city of Tulsa was proceeding in good faith to fulfill the contract. Ibid. In contrast,

the cities here who have contracted to provide effluent to Palo Verde have recently notified applicants that they may be forced to invoke section 21. Moreover, the contract is under renegotiation and the parties at this point are not hopeful of a quick, easy resolution of their differences. Mr. McCain testified definitively that under at least three possible future situations the cities could develop a critical need for water such that they would consider invoking section 21. Further, he testified, as did Intervenor's experts, that effluent is a valuable water resource that will be used increasingly in the future to augment the cities' domestic water supplies. Therefore, the Black Fox case supports Intervenor's position that under the circumstances of this case Agreement 13904 and the Tolleson Agreement, both containing interruptability clauses, do not assure applicants an adequate supply of water for Palo Verde.

1. ESTIMATED WATER REQUIREMENTS.

Applicants have estimated that they will need 64,000 acre-feet per year of effluent to satisfy condenser cooling water requirements. One assumption underlying this estimate is that all three plants will operate at 95 percent capacity for 11 months of the year, and will be shut down one month for maintenance and refueling.[7]

7/ Applicants' assumption is, therefore, that the three plants will operate at an 87 percent annual capacity factor.

Secondly Applicants assumed "average meteorological conditions in calculating the makeup consumption for Palo Verde. Thirdly, they assumed an evaporation or "reservoir loss" of 180 GPM.[8] The fourth, and most important assumption, is that effluent can be used up to 15 cycles of concentration prior to blowdown.

This Board believes applicants' estimate of their water needs is too low, and non-conservative, especially since the peak demand for electricity will be during the summer months, the same period in which relatively greater amounts of effluent will be required to produce electricity because of adverse meteorological conditions.

Applicants have calculated that the makeup needs for one unit operating at 95 percent capacity for an average June is 2114 acre-feet. An average June is one of averge meteorological conditions, including average air temperature, humidity and dew point.

We believe an assumption that all months during which the plant is operating will require about the same makeup as an average June is a conservative assumption. We also maintain applicants' assumption that the three plants will operate at 95 percent capacity for 11 months of the year. Therefore, we find the water needs of the three units to be 69,762 acre-

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8/ Upon close questioning from this Board applicants increased their estimated evaporation loss to .387 MGD or 269 GPM.

feet per year, exclusive of reservoir and water reclamation plant losses.[9]

The Board is also persuaded to assume adverse meteorological conditions in determining Palo Verde's makeup needs by applicants' use themselves of these assumptions. In November, 1977, APS vice-president E.E. Van Brunt admitted that applicants wished to contract for 93,600 acre-feet of water per year for three reactors in order to be able to deliver electricity during the peak month of demand, June, and to account for variation from average meteorological conditions.

This Board has used 500 GPM for the rate of evaporation from the reservoir, which is the figure used by the Staff in the FEIS, and 70 GPM for the water loss from the Water Reclamation Plant. Using these figures, we determine that for three reactors the total estimated water requirements at 70,671 acre-feet per year.

However, the most important assumption underlying the determination of applicants' water requirements is that applicants will be able to achieve 15 cycles of concentration using effluent as condenser cooling water. This assumption is examined closely in Section B in relation to the water quality contention.

9/ The Staff in the Final Environmental Impact Statement (FEIS) for Palo Verde determined that if Palo Verde plants were to operate at 60 percent capacity they will be cost-beneficial. The Staff calculated applicants' water requirements by consulting makeup rates set out in Table 3.4-6 of Applicants' Environmental Report-Operating License stage. These makeup rates assumed "average meteorological conditions." Because of the more serious institutional constraints this Board has determined restrict applicants' ability to rely on effluent as cooling water, we will not address the Staff's failure to use conservative assumptions in determining Palo Verde's water needs. (Staff Exh. 1 at 2-2, 6-

We must conclude that applicants' estimate of their water needs are much too low, in light of our analysis that is unlikely they can achieve 15 cycles of concentration using effluent as condenser cooling water. See Section B, infra.

2. EFFLUENT AVAILABLE FROM THE 91ST AVENUE AND TOLLESON WASTEWATER TREATMENT PLANTS.

Applicants intend to obtain the water necessary for condenser cooling at Palo Verde through purchasing effluent under two contracts: Agreement 13904, signed in 1973 with the cities of Phoenix, Glendale, Mesa, Scottsdale, and Tempe and the Town of Youngtown, and a contract signed in 1981 with the City of Tolleson.

Applicants have an option to purchase effluent from the 91st Avenue treatment plant ("91st Avenue Plant") after prior commitments are satisfied to the Arizona Department of Game and Fish of 6.5 MGD, or 7,300 acre-feet per year; to the Buckeye Irrigation Company of 26.8 MGD, or 30,000 acre-feet per year; and to the Water Conservation Laboratory of 1.1 MGD, or 1,200 acre-feet per year.10

Therefore, the commitments of effluent that are superior to applicants' commitment total 38,500 acre-feet per year, or 34.4 MGD.

Projections of the total amount of effluent available at the 91st Avenue Plant beginning in 1985 demonstrate that the 91st Avenue Plant will have a sufficient amount of effluent, after satisfaction of prior commitments, to sell

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10/ Although the Water Conservation Laboratory is not currently operating, a conservative approach requires us to assume that it may reconstruct its facilities and claim its prior commitment to 91st Avenue Plant effluent at some point within the presumed 40-year operating life of the Palo Verde plants.

applicants 70,761 acre-feet per year pursuant to Agreement 13904. However, as noted above, we do not believe these estimated needs are accurate since applicants have not demonstrated they can achieve 15 cycles of concentration using effluent as cooling water.

The projections adopted by the Maricopa Association of Governments ("MAG") in 1979 indicated that in 1985 the total amount of effluent available from the 91st Avenue plant and uncommitted[11] would be 76,748 acre-feet. The 1981 MAG Update projection for 1985 is 77,532 acre-feet. And the most recent MAG 1982 Update is 83,580 acre-feet.[12]

The City of Phoenix 1980 and 1981 projections for the amounts of effluent available in 1985 from the 91st Avenue Plant are considerably higher at 92,092 and 104,972 acre-feet respectively.

11/ These projections have subtracted the 38,500 acre-feet of water to which there are claims superior to applicants.

12/ In 1979 the Maricopa Association of Governments ("MAG") completed a three-year EPA-funded wastewater planning process and issued a 208 Water Quality Management Program that identified how wastewater would be handled through the year 2000. The plan was adopted by the cities and towns in Maricopa County and by the Regional Council. An update was prepared in 1982, in part due to changes in general water management in the State of Arizona brought about by passage of the Groundwater Management Act that emphasizes water conservation, and implementation of the Central Arizona Project ("CAP") that proposes effluent exchanges for CAP water.

We believe that MAG projections are generally reliable and have used conservative assumptions, including the assumption that cities will adopt conservation measures and that satellite wastewater treatment plants may be built. We note that the amount of effluent discharged in 1979 dropped six percent from the amount discharged in 1978 even though the City of Phoenix projections in both 1977 and 1978 projected an increase of about 11 percent. Therefore, while projections may be considered "generally reliable", they are not always accurate. Nevertheless, the Board accepts the 1982 MAG projections as a reasonable prediction of the amount of effluent to be discharged from the 91st Avenue Plant in 1985.[13]

However, we will note two uncertainties about the amount of effluent that will be available from the 91st Avenue Plant in 1985 and the years following. Intervenor has repeatedly argued, and Applicants have conceded, that the so-called MAG 208 Plan has been evolving from its original status in 1979. Among the changes made in a short three-year period is the option granted to some municipalities to build subregional or satellite wastewater treatment plants. If these subregional plants are built, municipalities will be able to send their sewage to these subregional plants which, in turn, will reduce the amount of sewage they send to the 91st Avenue Plant. Subregional plants

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13/ We adopt the lower MAG figures for the additional reason that we cannot assume that any wastewater treatment plant will operate beyond its capacity on a consistent basis, as does the City of Phoenix in its projections. It is true, of course, that the 91st Avenue Plant has operated beyond its capacity in the past.

are becoming increasingly attractive because municipalities wish to trade effluent for potable water to increase their domestic water supplies. In most cases these trades are economically feasible only if the effluent does not need to be transported great distances after treatment. Therefore, trades become feasible only if wastewater treatment plants are constructed near Indian reservations or other potential users. Mr. McCain testified that the cities are currently considering constructing a Northeast plant at or near the Salt River- Pima Indian Reservation and a Southeast plant near the Gila River Indian Reservation. Although it appears that construction of these two particular plants will not have a major impact on the amount of effluent discharged from the 91st Avenue Plant, as the cost of water rises and these trades become more feasible with the arrival of CAP water in the Salt River Valley, the cities may more aggressively build subregional plants to effect exchanges.

Applicants have failed to address, in addition, what this Board considers a second potential restriction on their physical supply of effluent--their failure as of the date the record was closed in this hearing to exercise their option to obtain effluent in accordance with section 7.1 of Agreement 13904. This provision of the contract requires applicants to notify the municipalities of their estimated schedule of delivery two years prior to delivery of any effluent. Therefore, according to Mr. McCain, under Agreement 13904, the municipalities are discussing whether or not they are required to deliver effluent

to Palo Verde prior to two years after the effective date applicants exercise their option in accordance with section 7.1 of the contract. Even if applicants promptly execute a schedule of delivery today, they could not expect to receive effluent in the required amount for Unit 1 until mid-1984, a full six to nine months after its scheduled startup date.

Since counsel for applicants apparently drafted Agreement 13904, in any dispute between the parties a court is likely to construe the contract in favor of the municipalities. This leads us to conclude that applicants' failure to exercise their option in accordance with contract requirements may restrict, at least until two years from exercise of that option, the amount of effluent available under Agreement 13904.

3. INSTITUTIONAL CONSTRAINTS ON THE AVAILABILITY OF EFFLUENT TO APPLICANTS.

Intervenor witnesses Mr. McCain and William Lorah presented convincing evidence that regardless of the fact that the amount of effluent projected to be available from the 91st Avenue Plant appears adequate to meet Palo Verde's estimated requirements, applicants had not demonstrated that the institutional constraints on that effluent will not prevent them from use of that effluent at Palo Verde.

Mr. McCain's testimony was especially credible since, as representative of the cities who have contracted to provide effluent to Palo Verde, he has a broad view of the future water needs of the cities and the ways in which the cities

hope to satisfy these needs. His opinion that under several possible set of future circumstances the cities would invoke section 21 demonstrates definitively, this Board believes, that applicants do not have an assured supply of water.

A. EFFLUENT EXCHANGES

Both Mr. Lorah and Mr. McCain testified that the possibility of mandatory exchanges of municipal effluent for Indian CAP potable water could drastically limit the cities' ability to deliver effluent under Agreement 13904. While the date of such effluent exchanges is not determined, applicants' witness Wesley Steiner, director of the Arizona Department of Water Resources ("DWR"), stated such exchanges would be essential in the later years of the CAP. Mr. Lorah said he believed they would be necessary prior to the 1990's if the Upper Basin states utilized their full portion of Colorado River water, and Mr. McCain testified he believed they would occur sometime after the year 2000.

The Secretary of the Interior has already reserved the right in all contracts with Indians contracting for CAP water to require them to trade up to 100,000 acre-feet of their CAP allocation each year for municipal effluent. These exchanges are necessary for CAP to satisfy the needs of all contractors for CAP water.[14]

14/ Mr. Steiner testified that the demand for CAP water was about five and one-half times as great as the supply.

B. OWNERSHIP OF MUNICIPAL EFFLUENT

Another institutional constraint on applicants' water supply noted by intervenor witnesses is the legal uncertainty about the ownership of municipal effluent. While this Board excluded testimony on the merits of the currently-pending Pima-Maricopa Indian Community lawsuit against the Secretary of the Interior and joint applicants, we do assign some weight to Mr. McCain's opinion that this lawsuit may adversely affect the cities' future water resources. If the Pima-Maricopa Indian Community were to prevail in its action, the Secretary of the Interior may be forced to exercise control over most if not all of the effluent currently committed to Palo Verde in order to meet unsatisfied Indian water rights.

C. SATISFACTION OF INDIAN WATER RIGHTS CLAIMS

A third, closely related, uncertainty about applicants' ability to obtain effluent under Agreement 13904 is the possibility that the Department of the Interior may attempt to exert dominion over municipal effluent to satisfy Indian water right claims. Mr. McCain testified that the Department has in the past mentioned that the doctrine of Secretarial control over return flow could lead to use of the effluent to satisfy the Indians' Winters rights claims.

D. RENEGOTIATION OF AGREEMENT 13904

The most critical institutional constraints on applicants' use of effluent derives, however, from Agreement 13904. For

one thing, the contract is currently being renegotiated. According to testimony both from applicants' witness Russell Hulse and representatives of AMWUA, negotiations have broken down. Although we have judiciously excluded testimony on the substance of these negotiating sessions, we believe that both applicants and AMWUA have stated that they are currently far from agreement and the negotiations are at a standstill. At this point the Board does not know if the renegotiations will lead to a contract that is substantially changed from Agreement 13904 or a reaffirmation of Agreement 13904.

Moreover, the cities in December, 1981, did put applicants on notice that they would be compelled to invoke section 21 of the contract if their water resources continued to be exhausted at the current rate. Although after rains in early 1982, the cities did not invoke section 21, their letter indicates their willingness to do so if they determine they have a critical water need. This willingness has spurred both sides to negotiate to change Agreement 13904 to give both parties greater security.

E. SECTION 21 OF AGREEMENT 13904

According to testimony from Mr. McCain, the cities may be faced with a period of critical need in the future during which they will consider invoking section 21. In order to determine how likely it is that the cities will develop such a critical need for water we must examine their future water needs and their future water resources to satisfy those needs. The future configuration of the cities' water resources will be different than those currently available due in large

part to the recent enactment of the Groundwater Management Act and the Central Arizona Project. Therefore, it is useful to outline first the current water resources of the cities in the Phoenix area, and then describe their future water resources.

The surface water available to the Salt River Valley comes from the Salt and Verde Rivers. The six reservoirs constructed on the two rivers have a total capacity of two million acre-feet. These reservoirs and their distribution systems were constructed as part of the federal reclamation project commonly called the Salt River Project. The land served by these reclamation waters includes land with the Salt River Reservoir District ("SRRD"). The owners of lands which receive the benefits of such reclamation waters are members of the Salt River Water Users Association ("SMWUA") the operating arm of which is called the Salt River Project Agricultural Improvement and Power District ("SRP"). SRP is one of the five joint applicants. SRP also operates about 249 pumps within SRRD to develop groundwater within SRRD boundaries.

All water developed by SRP can be used only within SRRD boundaries. Between 1948 and 1952, gates were installed on the Horseshoe Dam on the Verde River. All surface waters stored behind those gates accrue to the benefit of the City

of Phoenix and may be used either on-project or off-project. The storage capacity behind the gates is 73,000 acre-feet. However, before Phoenix accrues any of these "gate water credits", the lower portion of the dam in front of the gates must be filled to capacity.

Four of the cities which are signatories to Agreement 13904 are located both within SRP boundaries and partially without. The City of Tempe is located entirely within SRRD. All of the cities currently have municipal wells to serve a portion of their needs.

The most important of the area's future water resources is the Central Arizona Project ("CAP"). CAP, currently under construction, is a federal reclamation project that is intended to bring into central Arizona the state's remaining entitlement to waters of the Colorado River. All of the cities that are signatories to Agreement 13904 are expected to receive some CAP water. None of them has yet signed subcontracts with the Secretary of the Interior that will determine with certainty the amount and schedule of delivery of CAP water.

Mr. Juetten of SRP testified that the cities intend to drill new wells to increase their supply of groundwater in the future. He also mentioned that SRP was working with the cities to assist them in fulfilling their off-project water needs, through possible credit exchanges and exchange well programs.

Mr. McCain testified that other future water resources the cities may develop include withdrawing groundwater from

areas outside Maricopa County and transporting that water through the CAP aqueduct to the Salt River Valley; condemning existing water rights along the Colorado River; and reducing per-capita consumption of water through conservation programs mandated by the Groundwater Management Act.

However, this Board finds that none of these future sources of water can be expected to meet all of the cities' future water needs. Our central premise is that as the urban areas around Phoenix expand and the population continues to grow, the water needs of the cities will increase. The cities' most critical need will be to increase their supply of drinking water.

All witnesses acknowledged uncertainty about the ability of these future water resources to meet future needs. Mr. McCain, as representative of the cities, and Mr. Lorah, testified in detail about the uncertainties of these future water sources.

1. UNCERTAINTIES CONCERNING CAP

The CAP was originally scheduled to deliver water beginning in 1985. The construction of that portion of the project needed to serve the Phoenix area, including the Granite Reef Aqueduct, is not completed. Recently the federal government informed the State of Arizona that it must furnish $2 billion, or $200 million for each of the next 10 years, to complete CAP by 1992. Another potential problem is the defeat of the Peripheral Canal in California. There is a

small possibility that the California congressional delegation will not continue to support CAP.[15]

Regardless of the completion date of CAP, the amount of water to be delivered is not guaranteed. CAP, first of all, has the lowest priority claim on Colorado River water. The amount of water will, therefore, be dependent on the amount of water physically available on the Colorado River, which in turn is dependent on the amount of precipitation in the upper and lower basin states.

Secondly, the amount of available CAP water depends on the degree to which the Upper Basin states utilize their full allotment of 7.5 million acre-feet. Mr. Steiner testified that the Upper Basin states would use no more than 5.8 million acre-feet of their allotment. However, Intervenor witness William Lorah testified that the Upper Basin states intend to use their full allotment in development of their energy resources. His and Mr. McCain's testimony that the Upper Basin has a potential, if as yet unrealized, need for such water for energy projects and satisfaction of Indian claims, is highly credible. Therefore, we judge that the 1.6 million acre-feet of CAP water that Mr. Steiner predicts will be available in the early years of CAP is inflated.

Instead we accept as reasonable other DWR figures that show a dependable, or firm supply of about 630,000 acre-feet per year. Moreover, DWR currently estimates that 800,000

15/ The CAP was authorized as part of the Colorado River Basin Project, Public Law 96-537. The allocation of waters developed by CAP is the sole and legal responsibility of the Secretary of the Interior.

acre-feet will be available, on the average, only two out of every three years. In that event, all first priority users of CAP water, allocated 800,000 acre-feet per year, will experience a 20 percent shortage in supply almost 36 percent of the time.

Another uncertainty about the amount of CAP water available to the cities in the future is the recent Special Master's Decision. A Special Master appointed by the U.S. Supreme Court recommended to the Court that an additional 194,000 acre-feet of Colorado River water from Arizona's entitlement be granted to five Indian communities. If the Court adopts the Special Master's recommendation, the CAP supply will be reduced by about 120,000 acre-feet of water per year.

For all these reasons, the amount and date of delivery of CAP water to cities in the Phoenix area are uncertain. CAP, therefore, cannot be relied upon to solve the cities' expected future water needs.

2. UNCERTAINTIES CONCERNING GROUNDWATER

The cities anticipate that they will encounter a number of other problems in developing and utilizing the future water resources listed above. In respect to groundwater, the cities believe that they may not be granted permits to drill wells to deliver water to those areas where water needs are greatest, developing areas outside SRP boundaries. DWR currently interprets the Groundwater Management Act so as to

prohibit a city from drilling a well unless the well is within the city's current service area. A service area is defined as the area currently being served by the city's water system. If DWR adheres to this policy in the future, cities will not be able to drill wells to deliver water where it is most needed. This is an especially grave problem for cities such as Phoenix whose most severe needs are outside their service areas.

In addition, the growing contamination of groundwater is restricting the cities' ability to depend on groundwater for domestic supplies. Both Mr. Swanson and Mr. Lemmon of the Arizona Department of Health Services ("DHS") outlined the problems of groundwater contamination that DHS has discovered. Both predicted that the problem would worsen in the future. Mr. Swanson testified that DHS has already found eight wells in the Phoenix area with a level of trichloroethylene ("TCE") at a level DHS believes is a health concern, and at a level where the water should not be used for drinking water. All eight wells were ordered shut down. Mr. Swanson testified that these eight wells served about 200,000 persons.

He also testified that five percent of 93 wells sampled for dibromochloropropane ("DBCP") contained DBCP in excess of the state level of concern, and 28 percent were contaminated with a level of DBCP leading DHS to advise well owners to seek alternative water supplies for drinking and culinary uses.

Mr. Lemmon testified that in his work monitoring the contamination of groundwater by waste dumps and landfills, he concluded that an area of about 80 square miles in a band two miles wide on either side of the Salt River was contaminated by release of floodwaters in 1978 and 1979. These floodwaters infiltrated area landfills and caused leaching and leaking of gases. Over a 20-year period Mr. Lemmon estimates that between 700,000 to 800,000 acre-feet of groundwater along the River will be unsuitable for use as drinking water Moreover, Mr. Lemmon said he expected that even those landfills which had been closed would continue to leach and contaminate groundwater.

Both Mr. McCain and Mr. Lorah recognized that contamination of groundwater was a serious restriction on the cities' ability to depend on groundwater for municipal supplies, and on their ability to deliver potable water where it is most needed. Although contaminated groundwater may be used for other purposes, the cities will incur substantial, perhaps prohibitive costs, in transporting the water or treating it to obtain the necessary quality.

We believe, therefore, that even though the cities in the Phoenix area working actively to develop their future water resources, it is likely that they will at some time within the next 40 years, perhaps for a prolonged period, develop a critical need for water such that they will invoke section 21 of Agreement 13904 and thereby refuse to deliver effluent to Palo Verde.

The most convincing evidence on this point was presented by Mr. McCain who, as staff director for AMWUA, together with Mr. Stephens, represents the cities' water interests. He testified that he believed that under a number of circumstances he envisioned that the cities would develop a critical need for water and consider invoking section 21. These circumstances included the following:

1) If the CAP did not deliver water to the Salt River Valley on schedule and in the scheduled amounts; or

2) If there were a drought of three to four years on the Salt and Verde Rivers such that surface water supplies were decreased and Phoenix gate water credits were exhausted at a far greater rate than anticipated; or

3) If the cities were not able to drill new wells because of DWR regulations regarding service areas; the cities did not find water in drilling new wells; and the groundwater were contaminated in a portion of the wells that were drilled.

This Board finds that it is not only possible, but highly probable that at some point in the near future at least one of the above set of circumstances will occur. Therefore, this Board must conclude applicants have not demonstrated that they have an assured supply of water for condenser cooling purposes at Palo Verde.

B. CONTENTION 2: ADEQUACY OF EFFLUENT AS CONDENSER COOLING WATER UP TO 15 CYCLES OF CONCENTRATION.

The contention concerning water quality includes two issues:

(1) Whether applicants have demonstrated that they can use effluent as condenser cooling water up to 15 cycles of concentration on a consistent basis at Palo Verde; and

(2) Whether applicants have demonstrated the capability of the Water Reclamation Plant ("WRP") and Circulating Water System ("CWS") to treat effluent adequately for use as cooling water.

Intervenor argues that applicants have not demonstrated that the treatment processes of the WRP and CWS are adequate to treat the effluent to be used at Palo Verde so that they will be able to concentrate effluent of the quality discharged from the 91st Avenue Plant up to 15 cycles of concentration prior to blowdown. The amount of water required is inversely related to the number of cycles of concentration. Therefore, applicants' makeup requirements will be greatly increased, if they do not achieve 15 cycles.

Applicants argue that from their water reclamation studies ("WRS"), conducted in 1973 and 1974; their monitoring of effluent from the 91st Avenue Plant from 1976 to 1980; and the experience gained from other power plants, they are confident they can achieve 15 cycles of concentration with effluent of the quality that will be discharged from the 91st Avenue Plant.

Although it is unclear how applicants have defined a "cycle of concentration", it appears that 15 cycles of concentration is circulation of the effluent in the CWS up to the level in which the concentration of chlorine is increased by a factor of 15.

Effluent, before entering the circulating water system, is treated at the Water Reclamation Plant on-site, and after treatment stored in the "reservoir" until used as makeup. After reaching 15 cycles of concentration, the blowdown water is transported to an evaporation pond; consumption of the effluent is total in that blowdown water is not reused.

The WRP provides four treatment processes:

1) biological nitrification;
2) two-stage lime treatment;
3) filtration; and
4) chlorination.

Reliability studies conducted for the original design of the WRP indicated that, assuming a 12-month maintenance period, the possibility of the plant operating without a failure of at least one plant component was .0005 percent, or "almost zero." Assuming a three-month maintenance period, the possibility of the WRP operating without a failure of at least one component was 13.3 percent.

Because of these high unreliability figures, applicants modified the design of the WRP. Although applicants contend that the reliability of the facility has been greatly improved, they have offered no analysis whereby we can assess the plant's increased reliability. Therefore, we conclude that the WRP may still suffer from some of the same problems of unreliability, even with a new design.[16]

1. WATER RECLAMATION STUDIES

From August, 1973, to September, 1974, applicants analyzed effluent discharged from the 91st Avenue Plant; conducted tests using a circulating water test facility ("CWTF") which in part replicated the actual Palo Verde circulating water system ("CWS"); and operated a demonstration water reclamation plant ("demonstration plant") that included some of the features of the proposed WRP. The description of these tests and partial test results are included in the two-volume "Water Reclamation Studies." (JA Exh. BB.)

The studies' four objectives were:

(1) To determine if 91st Avenue Plant effluent could be effectively treated in a lime-soda softening plant to reach 15 cycles of concentration in the CWS;

(2) To identify potential problems in the circulating water system;

16/ This Board notes that applicants themselves are contradictory in their descriptions of the design changes. Mr. Bingham testified that the new design had incorporated a modular design, but with six independent modules. Later he testified that the design was modified from a modular design to a parallel arrangement of active components. Whatever the exact description of the current design, this Board does not understand applicants' failure to include this major new design in its Water Reclamation Studies, published in 1975, when there is testimony that the plant was redesigned in 1974.

(3) To determine the in-cycle treatment required for the CWS; and

(4) To determine relative corrosion rates for different possible condenser tube and tubesheet materials.

Applicants wished to determine whether or not they could reach 15 cycles of concentration using 91st Avenue Plant effluent, and to choose adequate condenser materials to avoid harmful degradation to the CWS, including excessive fouling, scaling, biofouling, and corrosion.

Applicants focused on five chemical constituents that they believed would cause the greatest problems in terms of scaling, fouling, corrosion or biofouling. These five are: calcium, magnesium, silica, phosphorus and ammonia. The level of total dissolved solids, or TDS, was also monitored since TDS is a general indicator of water quality. Applicants have not explained adequately why they focused on these five constituents since they acknowledge that other constituents and metals can cause similar degradation of the CWS.

The CWTF contained some components of a power plant circulating water system, such as a heat source, a heat exchanger, cooling tower, water pump and piping.[17] Admiralty-tubed and titanium-tubed heat exchangers were used in the

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17/ Mr. Bingham testified that the components they used in the CWTF included a swimming pool heater, pumps, an old wooden cooling tower and a heat exchanger.

tests. Coupon and galvanic tests were done to compile data on the relative corrosion of different metals.

Bench-scale laboratory tests were conducted at Bechtel facilities in California to verify the results of the CWTF tests.

The CWTF was scaled to about 1/40,000 of the size of the actual Palo Verde circulating water system. The flow rate in the CWTF was between 1/3800 and 1/5800 of the flow rate in the actual CWS.

2. ESTIMATED WATER NEEDS BASED ON WRS AND OPERATING EXPERIENCE OF OTHER POWER PLANTS.

Applicants designed their on-site WRP and determined their water requirements in reliance upon the Water Reclamation Studies, and the information they collected from other operating power plants in which cooling water achieved 15 or greater cycles of concentration. However, applicants have acknowledged that no other nuclear power plant uses effluent as its source of cooling water. No power plant that uses effluent or municipal wastewater as cooling water concentrates it past five cycles of concentration.[18] Moreover, although applicants could identify four power plants that use titanium condenser tubing and aluminium-bronze tubsheets,

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18/ It appears that one of the reasons for the WRS was to determine if in fact it was possible to concentrate effluent up to 15 cycles of concentration.

none of the four uses effluent as its source of cooling water.[19]

Intervenor challenged applicants' argument that the WRS demonstrated that effluent could be treated and used in the Palo Verde CWS up to 15 cycles of concentration on a consistent basis. Mr. Robinson analyzed applicants' water reclamation studies to determine if they provided substantial evidence to support use of 91st Avenue Plant effluent up to 15 cycles. Mr. Robinson concluded that these studies did not show that was feasible for the following reasons:

(1) The undersized scale, flow rates and volumetric flows are not reliable indicators of the conditions and conduct of the actual Palo Verde CWS;

(2) The geometry of the CWTF is different than the actual Palo Verde CWS;

(3) The two-week test periods were too short to compare to the 11-month expected operational period of the reactors;

(4) The coolant chemistry of the CWTF did not react as applicants had hypothesized that it would; nor did the constituents of special concern to applicants concentrate at identical rates, as applicants had predicted.

Mr. Robinson concluded from this analysis that applicants cannot rely on the WRS to demonstrate that they will be able

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19/ Applicants claim that the corrosion effects from use of effluent are similar to the effects from seawater. However, they have presented no data or analysis to permit this Board to evaluate their conclusion. Therefore, we will not assume any further information on the similarity between the two water sources than has been entered into the record.

to use effluent up to 15 cycles of concentration at Palo Verde without causing excessive degradation of the CWS.

We concur in Mr. Robinson's opinion that deficiencies in the WRS seriously weaken their usefulness in supporting applicants' claim that they can achieve 15 cycles of concentration.

The scale, flow values and flow rates of the CWTF were vastly undersized in comparison to the actual CWS at Palo Verde. Therefore, applicants may not have compiled sufficient information about corrosion caused by stress or cracking, or by irregularities in metal. We also believe that applicants did not adequately test for types of corrosion that may occur in conjunction with fouling. We believe the value of the WRS was further weakened by the fact that the geometry of the CWTF is much different than that of the CWS, and that all tests were only of two-week duration. Applicants have said they intend to run the three reactors for 11-month periods prior to shutdown for maintenance. Since corrosion, fouling and scaling are cumulative processes, the duration of the tests could be very important.

Our most serious criticism of applicants' WRS is, however, their apparent lack of understanding of the coolant chemistry in the circulating water system. Although applicants originally claimed that all five of the problem constituents concentrated

at the same rate, their own tests disproved that hypothesis. When they admitted that in fact in the CWS at Palo Verde the five constituents would not concentrate at the same rate, they offered no new definition of 15 cycles of concentration which would explain which constituent was the indicator of a cycle of concentration. Only upon cross-examination did Mr. Bingham admit that chlorine was the indicator constituent by which applicants determined they had achieved 15 cycles of concentration. If this is the case, the concentrations of the five constituents will vary greatly from the figures given in ER-OL, Table 3.6-1 after 15 cycles of concentration. Further, applicants have not indicated that they know with any precision the levels of concentration for the five constituents at 15 cycles of concentration.

It appears to us that applicants will not be able to treat the effluent to minimize the adverse effects of these five constituents if they do not first understand the likely concentration of these constituents in the circulating water system at Palo Verde.

Moreover, some of the CWTF test results showed unexpectedly high concentrations of metals that applicants believed might persist in the actual CWS. Some of these metals were in the list of constituents and metals which could cause degradation of the CWS.

Applicants' position is that regardless of the variations in levels of these five concentrations the addition of sulphuric acid, chlorine, foam control agent and scale inhibitors to the water in the CWS will compensate for any unexpectedly high concentration levels. Yet if applicants have not identified the design limits of the CWS in terms of these constituents, it will be impossible for them to determine what treatment is necessary or optimum. Applicants will encounter limitations on the concentrations of scale inhibitors or biofouling inhibitors that they can add to the effluent in the CWS. Moreover, Mr. Bingham admitted that although the CWS has great flexibility, there did exist a point beyond which the treatment processes cease to be effective.

Mr. Bingham appeared to believe that the quality of effluent coming into the WTP would affect the effluent discharged very little, or not at all up to a factor of twice the performance warranty limits for the equipment. However, Mr. Van Brunt believed there would be a direct correlation between the quality of influent to, and quality of effluent from the WRP. We too believe that although a skillful operator can treat differently for different constituent levels in influent to the WRP there are limitations on an operator's ability to treat water in the WRP or in the CWS.

3. FACTORS APPLICANTS FAILED TO CONSIDER

We also believe that although applicants have monitored the quality of effluent from the 91st Avenue Plant from 1973 to 1980, they have not examined the likely decrease in quality of effluent due to the addition of CAP water to the cities' raw water sources and the cities' increasing reliance on groundwater. Mr. Lorah testified that he expects the raw water sources to the cities will generally have a higher TDS level in the future since CAP water delivered to the Phoenix area has a TDS level that is higher than SRP water by about 232 ppm (parts per million).

In addition, he believes that the percentage of groundwater in the raw water supply is likely to increase. Since groundwater is generally of a poorer quality than surface water, it is likely the overall quality of water delivered to the cities will decrease. Generally, the quality of water, as measured by TDS level, is degraded about 200 to 300 ppm from the raw water to effluent stage.

Mr. Lemmon corroborated this testimony. He testified that from 1979 to the present he believes the percentage of groundwater in the municipalities' raw water sources has risen from about 40 percent of the total supply to 50 percent. He also believed, as Mr. Lorah, that the quality of the raw water sources of Valley cities will decrease with the addition of CAP water and the deteriorating quality of groundwater.

Applicants claim that through their monitoring of 91st Avenue Plant effluent from 1973 to 1980 they have good evidence that effluent quality, in terms of TDS and the five constituents of special concern, is fairly stable. We do not believe they have taken into consideration the likelihood that the quality will deteriorate by 200 to 300 ppm in TDS level over the next five years.

In addition, we do not believe that applicants have taken into account the volatile nature of effluent. For example, according to applicants' own measurements, phosphorus, often for one or two days a week, reaches peaks that are four to five times the average concentration of phosphorus in 91st Avenue Plant effluent. Applicants conclude this is because of the addition of detergents to the sewer system on wash days. However, the only analysis they have presented is a graph for a two-week period that shows peaks of phosphorus up to 21 mg/l (milligrams per liter) both on a Monday and also on a Monday and a Tuesday. A two-week period is simply not a sufficient period of time from which to draw any conclusions.

Mr. Lemmon testified that the 23rd Avenue Plant had been closed for many successive Friday afternoons because industries would dump their industrial wastes into the sewer system at the end of the business week and overload the plant. This confirms our belief that although applicants may have examined the overall, average quality of 91st Avenue

Plant effluent, they have not considered periodic, and perhaps prolonged, periods during which problem constituents will vary radically from the "average" concentrations.

Finally we find applicants' claim incredible that their WRP can operate at twice the performance warranty limits for each of the five problem constituents. Applicants represent that the design limits for their WRP are twice the "extreme case" level listed in JA Exhibit U, revised, at WGB-6. These "extreme case" levels are apparently performance warranty limits that the manufacturer has placed on the WRP equipment. First of all, it does not seem sensible to operate the WRP consistently beyond the limits for which its component parts are guaranteed by equipment manufacturers. More importantly, the average quality of water used in the CWTF during the water reclamation studies, measured in terms of the five problem constituents, was in all cases below the performance warranty limits. Therefore, applicants cannot determine, at least from their WRS, that they can increase these five constituents to almost twice the levels they reached during the tests and still treat the effluent adequately. We believe applicants' unreasonably high design limits for the WRP demonstrate uncertainty about their basic assumption that they can achieve 15 cycles of concentration using effluent from the 91st Avenue Plant as condenser cooling water.

We conclude, therefore, that applicants have not demonstrated, on the basis of their WRS or the accumulated operating experience of other power plants, that they can use effluent as condenser cooling water at Palo Verde up to 15 cycles of concentration. We therefore conclude that their estimated water requirements for the three plants will be greatly increased.

C. CONTENTION 3: ASSURED SUPPLY OF WATER FOR SAFE SHUTDOWN OF PALO VERDE

The third and final contention before this Board is the following:

> Applicants have not demonstrated they have an assured supply of water to shut down Palo Verde under normal or accident conditions, and therefore do not comply with 10 C.F.R. Appendix A, GDC 2 and 44, as implemented by Regulatory Guide 1.27, Rev. 2.[20]

Intervenor argues that applicants have not demonstrated an assured supply of water for safe shutdown of the reactors because:

1) they have not satisfied Regulatory Guide 1.27, Rev. 2; and

2) even if they meet, to the NRC Staff's satisfaction, the guidelines set out in Regulatory Guide 1.27, Rev. 2, they have not complied with GDC 2 and GDC 44, since if one takes a conservative approach applicants have not demonstrated an assured supply of water to bring and maintain the reactors in a safe shutdown condition.

20/ Testifying regarding this contention were William J. Bingham; Edwin E. Van Brunt; Raymond O. Gonzales; and Emanuel Licitra.

An extremely conservative approach is dictated in this case by the fact that applicants propose to operate three nuclear reactors in the most arid region of the country, far from any natural body of water.

Applicants argue that the ultimate heat sink ("UHS") provided for each reactor assures that they can be brought to safe shutdown under normal or accident conditions.

The ultimate heat sink is designed to provide the heat dissipation capability for each of the three reactors and their essential auxiliary systems during a shutdown normal or accident conditions. The UHS for each reactor consists of two independent and adjacent, concrete essential spray ponds, and two separate and redundant trains. Each train, together with the total water available from both spray ponds, is designed to dissipate 100 percent of the plant's heat under accident conditions.

The water supply available from the UHS for each reactor is a 26 to 28-day supply if one assumes adverse meteorological conditions as Regulatory Guide 1.27, Rev. 2, provides.

Applicants have proposed to the NRC that in order to assure continued capability of the UHS beyond this 26 to 28-day period, they will obtain water from the regional aquifer.

Mr. Van Brunt recently informed the NRC that the three wells currently supplying the domestic water system can

provide this continued capability. If the initiating event,[21] in this case a safe shutdown earthquake, renders the three wells inoperable, applicants propose to hire a well driller to drill a new well on the site. Applicants contend that a well or combination of wells capable of delivering 1200 GPM (gallons per minute) of water could be drilled within 15 days of a decision that the three wells are no longer operational.

Applicants argue, therefore, that the three operating wells, or alternatively the newly-drilled wells, will provide a continued capability to dissipate heat by the time water from the spray ponds is depleted.

The three wells currently providing water for the domestic water system are not safety-grade. Applicants have stated that any wells drilled to assure the capability of the UHS beyond 26 to 28 days will not be safety-grade.

On December 8, 1981, applicants met with NRC staff members to appeal the open item in the Staff's SER that found applicants have not satisfied Reg. Guide 1.27, Rev. 2 and GDC 44 because they had not shown an adequate supply of water for 30-day operation of the spray ponds. At the meeting, the NRC staff stated that they would accept a

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21/ Applicants postulate as the initiating event a safe shutdown earthquake ("SSE"). They do not analyze the water sources available to provide continued capability to the UHS beyond the 26 to 28 day period in the event of the occurence of any of the other initiating events described in Regulatory Guide 1.27, Rev. 2.

26 to 28-day water supply in the spray ponds if applicants (1) established procedures to ensure the continued capability of the UHS beyond this period; and (2) demonstrated that these procedures would be available even after certain design basis occurences that could trigger the accident.

The NRC Staff has also stated that they may require a second "back-up source" to ensure continued capability of the spray ponds beyond the 26 to 28-day period.

On February 5, 1982, applicants sent to the NRC an amendment to the FSAR, Section 9.2.5. This amendment recalculated the amount of water available from the UHS to be only 26 to 28 days under adverse meteorological conditions and not 30 days as stated originally. In addition, applicants claimed that at least 60 days prior to fuel load they would have procedures available to ensure continued capability of the UHS beyond 26 to 28 days. The two sources of water applicants described as available for that purpose were the domestic water system and the station makeup water reservoir.

On June 17, 1982, applicants informed the NRC staff that the source of water that would provide continued capability to the UHS beyond the 26 to 28-day period was the regional aquifer. Applicants proposed use of the three wells currently serving the domestic water system, or if these wells were damaged, the drilling of new wells on the site within the 26 to 28 day period.

The NRC Staff has not determined if applicants' recent proposal meets standards set out in Reg. Guide 1.27, Rev. 2.

Intervenor presented evidence that applicants have not yet obtained certification from the Department of Water Resources of groundwater rights to pump water for use in the safe shutdown of the reactors. Applicants have applied for both Type I Non-Irrigation Grandfathered Rights and Type II Non-Irrigation Grandfathered Rights from DWR. The Groundwater Management Code, of which this Board takes judicial notice, does not permit drilling of wells or use of existing wells beyond certain production levels without certification that the landowner has groundwater rights certified by DWR. Therefore, we find that at the present time applicants do not have groundwater rights to pump water in the amounts required for shutdown of Palo Verde.

Intervenor presented evidence that applicants have encountered problems in drilling test wells on the Palo Verde site due to plugging of case perforations by silts or clay. Applicants encountered these problems even though the wells were cased. NRC Staff Witness, hydraulic engineer Raymond Gonzales testified that these problems might indicate that the person drilling the well did not have sufficient information to design the well to avoid clay problems. Mr. Van Brunt testified that some dewatering wells on the site have not produced the water applicants had expected.

Mr. Van Brunt, when questioned by Intervenor on the basis for his assertion that a well could be drilled on the Palo Verde site within 15 days, stated he did not know whether applicants had considered the effects of a seismic event such as a SSE on the regional aquifer, or whether well drillers might be reluctant to come to the Palo Verde site after an accident initiated by a SSE. Mr. Gonzales testified that an earthquake might affect the hydrogeology of an area and that knowledge of the hydrogeology of the area is important in determining the location of the regional aquifer. He also testified that no one knows with 100-percent accuracy the hydrogeology underlying a site, and that there is always some possibility of drilling a well that will not produce water.

Applicants presented no technical studies to support Mr. Van Brunt's statements about the possibility of drilling a well in 15 days after a SSE. Further, Mr. Van Brunt testified that he had done no analysis other than a time against drawdown analysis to support his statement that a well drilled at the Palo Verde site could provide 225 GPM of water to the UHS continuously for a 15 to 30-day period.

This Board concludes that since the spray ponds can only provide water sufficient for 26 to 28 days, and given the extreme scarcity of water in the Arizona area, applicants'

proposed procedures to assure continued capability of the UHS beyond 26 to 28 days are not adequate to meet the guidelines of Regulatory Guide 1.27, Rev. 2, or to satisfy GDC 2 and 44.

It appears Mr. Van Brunt's letter of June 17, 1982, unsupported by any technical analysis or documentation, was hastily drawn up for presentation to this Board in the last week of these hearings. The applicants have failed to address to the satisfaction of this Board the following issues:

(1) What groundwater rights do the applicants currently hold under Arizona law to draw water in the amounts needed to shut down the three reactors?

(2) Would a SSE affect the hydrogeology of the site?

(3) What problems have applicants, and the prior owners of the Palo Verde site, encountered in drilling wells on the site?

(4) What information have applicants collected on the availability of well drillers to drill a well at the Palo Verde site during accident conditions caused by a SSE?

(5) What water sources do applicants have available to assure the continued capability of the UHS after 26 to 28 days if the wells drilled on site do not produce water?

Although we find that applicants have not satisfied Regulatory Guide 1.27, Rev. 2, we find further that even if they were to meet its minimum guidelines, we do not believe

they have complied with GDC 2 and 44. In an arid area such as Arizona, competition for water resources is great, and the cost and difficulties of obtaining alternative water supplies are very high. We believe, contrary to the NRC staff, that bare compliance with the Regulatory Guide is not sufficient to ensure that the Palo Verde reactors can be safely shutdown.

We find, instead, that applicants must meet and exceed the basic recommendations contained in Regulatory Guide 1.27, Rev. 2. Therefore, we recommend that the applicants provide, at a minimum, at least two sources of water to ensure continued capability of the UHS beyond the 26 to 28-day period, and that any equipment used to pump or transport this water be safety-grade.

FINDINGS OF FACT

1. Contention No. 5, as modified by the Board on April 28, 1982, upon motion of Intervenor, is as follows:

> Applicants have not demonstrated that they have an assured supply of water for cooling purposes for three nuclear reactors at the Palo Verde site.[1]

2. Applicants intend to obtain sewage effluent to use as condenser cooling water at Palo Verde from the 91st Avenue Sewage Treatment Plant ("91st Avenue Plant") and the City of Tolleson Wastewater Treatment Plant ("Tolleson Plant"). Applicants Arizona Public Service Company ("APS") and Salt River Project Agricultural Improvement and Power District ("SRP") entered into a contract with the cities of Phoenix, Glendale, Mesa, Scottsdale and Tempe and the Town of Youngtown ("Cities") to purchase effluent to use for construction and

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1/ Testifying respecting this contention were: Russell D. Hulse, Vice President, Arizona Public Service Company; Richard Juetten, Salt River Project; Wesley E. Steiner, Director of the Arizona Department of Water Resources; John Schaper, attorney for the Buckeye Irrigation Company and Buckeye Water Conservation and Drainage District; Robert B. Steytler, Assistant Director of the Water Sewage Department for the City of Phoenix; William G. Bingham, Project Engineering Manager for the Bechtel Power Corporation; and Jack Muir, Director of Wastewater Utilities for the City of Tolleson, as Joint Applicants' witnesses; William L. Lorah, Vice President of Wright Water Engineers; Edwin K. Swanson, Manager of the Ambient Water Quality Unit of the Bureau of Water Quality Control for the Arizona Department of Health Services; James L. Lemmon, Hydrologist with the Bureau of Waste Control of the Arizona Department of health Services; Edwin E. Van Brunt, Vice President of the Arizona Public Service Company as an adverse witness; and John Robert McCain, Staff Director of the Arizona Municipal Water Users Association as Intervenor witnesses; and Raymond O. Gonzales, Hydraulic Engineer, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, as a NRC Staff witness.

operation of Palo Verde ("Agreement 13904"). Agreement 13904 provides applicants with the option of purchasing up to 140,000 acre-feet of effluent per year from the six cities after the cities have satisfied prior, superior commitments. Applicants are only entitled to the amount of effluent available from the 91st Avenue Plant, or the 23rd Avenue Plant in the event the 91st Avenue Plant is unable to meet the full requirements of applicants.

Agreement 13904 does not guarantee applicants any set amount of effluent. (JA Exh. H).

The price for effluent obtained pursuant to Agreement 13904 and delivered for operation is 40 percent of the price established for Central Arizona Project ("CAP") water sold for municipal and industrial uses ("M & I Water"), but in no event less than $20 per acre-foot nor more than $30 per acre-foot.

If effluent is delivered prior to the establishment of the price for CAP M & I Water, the price for effluent is $20 per acre-foot. Ibid.

3. Section 7.1 of Agreement 13904 provides that applicants must give the cities an estimated schedule of delivery two years prior to delivery of any effluent to them under the contract. Section 7.1 requires applicants to exercise their option for delivery of effluent in accordance with Exhibit D. (JA Exh. H). Applicants have not exercised their option in accordance with section 7.1 and therefore may not be able to

obtain effluent deliveries under Agreement 13904 until two years after they properly exercise their option. (McCain, Tr. at 2240-42, 2247, 2251, 2254-2256.)

4. The existing commitments for effluent discharged from the 91st Avenue Plant are 30,000 acre-feet per year, or 26.8 MGD (million gallons per day) for the Buckeye Irrigation Company ("BIC"); 7,300 acre-feet per year or 6.5 MGD for the Arizona Department of Game and Fish ("ADGF"); and 1,200 acre-feet per year or 1.1 MGD for the Water Conservation Laboratory. The commitments for effluent discharged from the 91st Avenue Plant that are superior to the commitment to applicants under Agreement 13904 total 38,500 acre-feet per year or 34.4 MGD. (Hulse, ff. 404 at 4; JA Exh. H; JA Ex. LL, Table IV-1 at IV-4).

5. On June 12, 1981, APS and SRP entered into an agreement to purchase effluent from the City of Tolleson ("Tolleson Agreement") in excess of the sum of 2.0 MGD committed for the production of sod ("Committed Effluent") and 10 percent of the amount of effluent in excess of the 2.0 MGD reserved by Tolleson ("Reserved Effluent") and (b) any amounts of Committed Effluent not actually sold, and of the Reserved Effluent not actually used or disposed by Tolleson, not to exceed 8.3 MGD. The Tolleson Agreement was amended on November 12, 1981. (JA Exhs. J and K). This agreement does not guarantee applicants any specific amount of effluent in any year. (Muir, Tr. at 1083)

6. The price for effluent under the Tolleson Agreement is the greater of (1) $35 per acre-foot plus an adjustment for inflation; (2) 45 percent of the price per acre-foot for CAP M&I Water; or (3) 100 percent of the price per acre-foot paid under Agreement 13904. (JA Exh. J). There is no ceiling on the price applicants may be obligated to pay under the Tolleson Agreement.

7. Effluent is to be delivered from both the 91st Avenue Plant and the Tolleson Plant by means of a 36.5 mile-long pipeline originating at the 91st Avenue Plant (Bingham, Tr. at 1296-97).

8. The capacity of the 91st Avenue Plant is now 90 MGD. (Steytler, Tr. at 846; JA Exh. L at III-13). The capacity of the 91st Avenue Plant is being expanded to 120 MGD to be completed in 1982. *(Steytler, Tr. at 847; McCain, Tr. at 2275) It is planned that the 91st Avenue Plant will be further expanded to 150 MGD; this expansion is scheduled to be completed by 1986. (Steytler, Tr. at 847; JA Ex. LL at III-20).

9. The capacity of the Tolleson Plant is 8.3 MGD or 9,300 acre-feet per year. The Tolleson Plant is currently treating 6 MGD or 6,400 acre-feet of effluent per year. (Muir, Tr. at 1034-35).

10. In 1979, the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency made projections about the amount of effluent to be discharged from the 91st Avenue Plant and the 23rd Avenue Plant. These projections were adopted by the Maricopa Association of Governments for use in the MAG 208 Wastewater Management Plan ("1979 MAG Plan") (JA Exh. B).

The 1979 MAG Plan projected therefore that the amount of effluent available from the 91st Avenue Plant and uncommitted[2] in 1985 will be 76,748 acre-feet. (JA Exh. G).

11. The City of Phoenix projected in 1980 that 92,092 acre-feet of uncommitted effluent will be discharged from the 91st Avenue Plant in 1985. The City of Phoenix projected in 1981 that 104,972 acre-feet of uncommitted effluent will be discharged by the 91st Avenue Plant in 1985. These projections are considerably higher than the MAG projections. (JA Exh. G). The City of Phoenix projections are considerably less reliable than the MAG projections because they assume that the 91st Avenue Plant can operate consistently above capacity. (McCain, Tr. at 2327)

2/ Prior commitments to BIC, ADGF and the Water Conservation Laboratory were subtracted from the total amount of effluent that is projected to be available from the 91st Avenue Plant in order to calculate the "uncommitted" effluent available from the 91st Avenue Plant.

12. In 1981 MAG published a Draft Update Plan that included a projection that the amount of available, uncommitted effluent from the 91st Avenue Plant in 1985 will be 77,532 acre-feet. The most recent MAG Update, issued in May, 1982, projected that 83,580 acre-feet will be available in 1985. (JA Exh. G).

The MAG projections were updated in 1982 for the following reasons:

(1) Increased population projections by the MAG Transportation Planning Office;

(2) Passage of the Arizona Groundwater Management Act which emphasizes the necessity of water conservation efforts; and

(3) Proposed Central Arizona Project ("CAP") allocations that encourage the trading of effluent for CAP water. (JA Exh. LL at I-1).

13. From 1978 to 1979, the amount of effluent discharged from the 91st Avenue Plant descreased from 64,320 acre-feet to 60,573 acre-feet in 1979. This is a decrease of about six percent. (JA Exh. G). The City of Phoenix projected both in 1977 and 1978 an increase of about 11 percent from 1978 to 1979. (Ibid.)

14. The City of Phoenix projections are determined by regression analysis using past historic flows. (Steytler, Tr. at 854-55). Mr. Steytler, in making these projections for the City of Phoenix, did not consider increasing population projections, probable future conservation measures, or worsening economic conditions such as increased unemployment,

inflation or decreasing economic growth. (Steytler, Tr. at 899-901). Mr. Steytler acknowledged that consideration of these factors might change future projections of the amount of effluent available from the 91st Avenue Plant. (Ibid)

15. Cities in the Phoenix area are increasingly interested in constructing subregional wastewater treatment plants in order to effect trades of effluent for potable water. To be economically feasible, these trades need to be made near the location where the effluent will be used. Mr. McCain testified that the cities are currently considering building a Northeast plant at or near the Salt River Pima Indian Reservation and a Southeast plant near the Gila River Indian Reservation in order to make effluent exchanges with these Indian communities. Mr. Steytler also testified that the cities are very interested in making these trades in order to augment their drinking water supplies. (McCain, Tr. at 2192-93; Steytler, Tr. at 894-95).

16. The 1979 MAG Plan provided that the 91st Avenue Plant would be substantially increased in capacity and two interconnectors would be constructed, the 99th Avenue Interceptor and the Southern Avenue Interceptor, in order to create additional capacity for flows of sewage effluent from cities within the Phoenix area to the 91st Avenue Plant. The 1979 MAG Plan rejected the alternative of constructing subregional plants for those municipalities that required extra capacity for treatment of their sewage, in favor of the proposed major expansion of 91st Avenue Plant (Steytler, Tr. at 877-79).

The 1982 MAG Update, in contradiction in the 1979 MAG Plan, permits the construction of subregional plants in Mesa and in the area of Northeast Phoenix, Paradise Valley and North Scottsdale. (Steytler, Tr. at 887-88; McCain, Tr. at 2416-19)

18. Subregional and satellite wastewater treatment plants will treat sewage that would otherwise flow to the 91st Avenue Plant. Their planned construction creates uncertainty about the projections made by the City of Phoenix and MAG for flows from the 91st Avenue Plant. Although the two plants that are currently being considered, the Northeast and Southeast plants, would not have a large impact on the effluent available from the 91st Avenue Plant a significant trend may develop to build subregional plants. This will become increasingly attractive, as cities find they wish to exchange effluent to increase their domestic water supplies. (McCain, Tr. at 2420)

19. Applicants have estimated that the condenser cooling water requirements for each unit at Palo Verde is 21,350 acre-feet per year, or 64,050 acre-feet per year for all three reactors.

20. Applicants' assumptions underlying this estimate are the following:

(a) Average meteorological conditions calculated on an average monthly basis;

(b) Each reactor will operate at a capacity factor of 95 percent for 11 months each year;

(c) Cooling water losses include evaporation losses calculated at 180 GPM and Water Reclamation Plant losses calculated at 70 GPM for all three reactors;

(d) Applicants will be able to treat and circulate effluent up to 15 cycles of concentration prior to its blowdown from the circulating water system. (JA Exh. X, Figure 3.3-1, sheet 2 of 4; JA Exh. T at WGB-3; and Bingham, ff. 920, at 2).

21. Effluent requirements for Palo Verde are greatest during the summer months when the evaporation rates are the highest. In addition, the summer months are the time of peak demand for electricity. (Gonzales, ff. 2522, at 2; JA Exh. X., sec. 3.4.1; JA Exh. T at WGB-3)

22. Applicants used average monthly meteorological conditions to calculate their effluent requirements for Palo Verde. (Bingham, ff. 920, at 2; JA Exh. T at WGB-3) We believe that this is a non-conservative approach and that it is more reasonable to use the water requirements for the average June as the base month. Using applicants' calculation that the makeup requirement for an average June is 2114 acre-feet (JA Exh. T at WGB-4), we calculate that the annual water requirements for three reactors, exclusive of evaporation and water treatment plant losses to be 69,761 acre-feet per year.

Applicants themselves have used an assumption of adverse meteorological conditions in determining the required amount of makeup for the three reactors. In 1977, Mr. E.E. Van Brunt, APS Vice-President, said applicants estimated they would need 93,600 acre-feet per year in contractual commitments of effluent for three reactors. He stated that applicants used these conservative requirement figures because they needed to deliver electricity during the peak month of demand, June, and to account for variations from average meteorological conditions. (Int. Exh. XVII).

23. We adopt 500 GPM as evaporation loss, relying on the evaporation rate the Staff used in the Palo Verde FEIS.[3]

We adopt the applicants' use of 70 GPM as the loss from the water reclamation plant.

24. If we accept applicants' assumption that they can achieve 15 cycles of concentration using effluent as condenser cooling water, we find that the makeup required for three reactors in any year is equal to 70,671 acre-feet.

3/ Applicants have used an evaporation or reservoir loss rate of 180 GPM. (JA Exh. X, Figure 3.3-1, sheet 2 of 4). Upon close questioning by this Board, applicants changed the evaporation loss for the reservoir to .387 MGD or 269 GPM. We believe that this evaporation figure is still too low, and so adopt the NRC Staff evaporation loss figure of 500 GPM.

25. Nonetheless, as will be explained below, we find that this is not an accurate estimate of applicants' water requirements since we do not believe they can achieve 15 cycles of concentration using effluent as condenser cooling water.

26. The Arizona Municipal Water Users Association ("AMWUA") is a voluntary, non-profit corporation comprised of the cities of Glendale, Mesa, Phoenix, Scottsdale and Tempe. Its purpose is to develop unified water policies for the urban areas of Maricopa County and institute wise water resource management for the cities. (McCain, Tr. 2161-62).

Mr. Bill Stephens, executive director and counsel, and Mr. John Robert McCain, staff director, for AMWUA represent these cities regarding water issues.

27. Mr. Stephens, by letter of February 10, 1982, informed us that Agreement 13904 was being renegotiated and therefore he believed we should not grant applicants' motion for summary disposition on the contention concerning the adequacy of water for Palo Verde.

Among the items being renegotiated were the following:

(1) The extent of the right of the cities pursuant to section 21 to refuse to deliver effluent when there exists in the cities a critical need for water for domestic purposes;

(2) The amount of effluent available for cooling purposes at Palo Verde;

(3) Cost of effluent for Palo Verde;

(4) Source of effluent for use at Palo Verde.

28. The renegotiations began when Mr. Stephens sent a letter on December 9, 1981, to APS to notify it that the cities would probably find it necessary sometime in 1984 to refuse to deliver water to Palo Verde because of an expected critical need for water. (JA Exh. I).

29. Both Agreement 13904 and the Tolleson Agreement provide that the cities may refuse to deliver effluent to applicants under the following circumstances:

(1) There exists in the cities a critical need for water to be used for domestic purposes;

(2) All other reasonable sources of water have been exhausted;

(3) Reasonable steps have been taken to conserve the water supply in the cities; and

(4) Reasonable notice of the critical need has been given to APS and SRP.

(JA Exh. H, Section 21; JA Exh. J, section 10).

30. The Tolleson Agreement also permits the City of Tolleson to terminate the contract if in the future it is prohibited by federal law or regulation from selling effluent. (JA Exh. J, section 14.3; Muir, Tr. at 1041)

31. Intervenor witnesses William Lorah and J. Robert McCain testified that to analyze the water resources available to an industry or to a municipality, one must analyze

both the physical supply of water available and the institutional constraints on the availability of that water supply. (Lorah, Tr. at 1349-51, 1354-55; McCain, Tr. at 2176-79) This Board adopts this method of analysis in determining the water resources available for use as cooling water at Palo Verde and whether applicants have an assured supply of water for Palo Verde.

31. According to applicants and to representatives of the cities, Agreement 13904 is currently being renegotiated. (Hulse, Tr. at 484-87 557-66; McCain, Tr. at 2237; JA. Exh. I) We also understand that at the current time all negotiations have come to a standstill. We believe that this renegotiation, which includes most major aspects of the contract, indicates that the contract which results from the renegotiations may be substantially changed or that the contract may be eventually dissolved. Therefore, we consider the renegotiation of Agreement 13904 a significant institutional constraint on applicants' ability to purchase effluent under that contract.

32. A second institutional constraint that may threaten applicants' ability to obtain effluent under Agreement 13904 is the possibility that the Secretary of the Interior will assert control over municipal effluent to satisfy Indian water right claims. Mr. McCain testified that the Department has stated in the past that it may attempt to use municipal effluent to satisfy a portion of the Indians' Winters rights claims. (McCain, Tr. at 2229)

33. A third institutional constraint on applicants' water supply is the legal uncertainty about the ownership of municipal effluent. This Board has excluded testimony on the merits of the lawsuit brought by the Pima-Maricopa Indian Community against the Secretary of the Interior and Joint Applicants which alleges that the Secretary has responsibility over all return flow of reclamation waters, including effluent, and must use it, if necessary, to satisfy the Indians' water right claims.

Intervenor witnesses, including Mr. Lorah and Mr. McCain testified that in their expert opinions this uncertainty must be considered in determining the future water supplies available to applicants. (Int. Exh. XIX and XX; McCain, Tr. at 2216-17)

Mr. John Schaper, attorney for the Buckeye Irrigation District, testified that it was his legal opinion that ownership of municipal effluent is uncertain. (Schaper, Tr. at 835-37; Int. Exh. VIII).

34. The fourth, and most critical institutional constraint on applicants' water supply is section 21 of Agreement 13904 and section 10 of the Tolleson Agreement which allow the cities to refuse to deliver effluent to Palo Verde if they have a critical need for water for domestic purposes and have exhausted all other alternative sources of water available to them.

35. The cities' current sources of water include surface water obtained from the Salt River Project and from groundwater. Surface water is diverted from the Salt and Verde Rivers. The six reservoirs constructed on the two rivers have a total capacity of two million acre-feet. These reservoirs and distribution systems were constructed as part of the Salt River Project, a federal reclamation project established in 1902. (Lorah, Tr. at 1364; Int. Exh. XVII) The waters are diverted at the Granite Reef Dam into the Arizona Canal and the South Canal for distribution within the Salt River Reservoir District ("SRRD"). (Juetten, Tr. at 633-34; JA Exh. M)

36. The owners of land within the SRRD whose lands benefit from the reclamation water brought into the Salt River Valley by the reclamation project are shareholders in the Salt River Valley Water Users Association, which was incorporated in 1903. This Association contracts with the federal government for the repayment of costs incurred in building reclamation facilities that benefit the owners' lands. The operating arm of the reclamation project is the Salt River Project Agricultural Improvement and Power District ("SRP"). (Ibid.)

Surface waters collected and distributed by SRP cannot be transported to off-project lands except if an equal amount of water is credited to member lands within the SRRD.

37. The Salt River Project maintains about 249 deep-well pumps. (Juetten, Tr. at 636-37).

38. In 1979 about 60 percent of all municipal raw water sources was surface water and 40 percent was groundwater. Today about 50 percent of the water used by municipalities within the Salt River Valley is surface water and 50 percent is pumped groundwater. (Int. Exh. XXXIII at 3)

39. Of the five AMWUA members that are parties to Agreement 13904, only Tempe lies entirely within the SRRD. (Juetten, Tr. at 645). Phoenix, Mesa, Scottsdale and Glendale all lie partially within the SRRD and partially outside SRRD. (Juetten, Tr. at 640, 644, 654-55).

40. Between 1948 and 1952 gates were installed on the Horseshoe Dam. Phoenix has rights to all water that accumulates behind these gates, up to a storage capacity of 73,032 acre-feet. The amount of water stored behind the gates is recorded as "gate water credits." (Juetten, Tr. at 659-61; 683, 687, 691). Phoenix can utilize these gate water credits either for its on-project lands or off-project lands. Subtracted from these credits are transportation losses of about nine percent and evaporation losses of about six-and-one-half percent. (Juetten, Tr. at 688, 691) Phoenix begins to accumulate gate water credits only after the lower portion of the Horsehoe Dam, in front of the gates, is filled up its capacity of about 60,000 acre-feet. (Juetten, Tr. at 687)

Phoenix can lose the benefit of a portion of its gate water credits if the capacity of 73,032 acre-feet is exceeded in times of flooding or heavy rains. If the portion of the dam behind the gates can no longer hold additional water, water is released into the Salt River and Phoenix loses the benefit of these credits. (Juetten, Tr. at 688)

41. Applicants have argued that in 1981 none of the cities of Phoenix, Tempe, Mesa, Glendale and Scottsdale were able to use its full SRP entitlement for those portions of the cities within the SRRD. Although this may be true, it appears that in very dry or drought years, these cities would not be allocated enough water per acre (water duty)

for their account acreage to meet all their on-project needs. For example, in 1977 the SRP Board of Governors voted to allocate as water duty only two acre-feet of water per acre instead of three acre-feet, as in recent times. In that event, according to applicants' estimate of Phoenix's water needs, Phoenix's on-project needs would not be met. Therefore, we find that the Board of Governors during a dry year could in fact reduce the water duty per acre to the point that the on-project lands would require more than their SRP entitlement. (Juetten, Tr. at 706-10; JA Exh. P)

42. The Central Arizona Project ("CAP") is a federal reclamation project whose purpose is to bring into central Arizona the State of Arizona's remaining entitlement to water from the Colorado River. (Steiner, Tr. at 741; Lorah, Tr. at 1402-03; McCain, Tr. at 2209; JA Exh. Q)

CAP is the lowest priority of all waters diverted from the Colorado River, including other waters allocated to Arizona. (Ibid.)

43. It was originally anticipated that CAP would begin delivering water to the Phoenix area around 1985. (Steiner, Tr. at 744-45; McCain, Tr. at 2179, 2199-20).

44. At the present time the distribution system to bring CAP water into the Phoenix area including the Granite Reef Aqueduct is not completed.

45. The federal government has recently informed the State of Arizona that the state must furnish $2 billion, or $200 million in each of the next 10 years, in order to complete CAP by 1992. (McCain, Tr. at 2204).

46. The defeat of the Peripheral Canal in California creates some possibility, albeit small, that the California congressional delegation will not continue to support CAP. (McCain, Tr. at 2205)

47. The CAP anticipates that effluent exchanges between the municipalities and the Indians will occur sometime before the year 2034. (Exh. Q at 3, 71-72).

The Secretary of the Interior has reserved the right in all CAP contracts signed with Indian tribes to require them to exchange a portion of their CAP allocation for effluent. (Lorah, Tr. at 1405)

Mr. Steiner testified that these effluent exchanges are essential to allow the CAP to fulfill its allocation goals. (Steiner, Tr. at 758).

Mr. Lorah testified that these exchanges may be necessary as early as 1990, (Lorah, Tr. at 1405), if the Upper Basin states use their full allotment of Colorado River water sooner than anticipated. Mr. McCain testified that he believes these trades will begin around the year 2005. (McCain, Tr. at 2189-90). Mr. McCain also testified that despite the problems that may be

encountered in the exchanges, they will by necessary as the cities in the future develop the need for more potable water sources. (McCain, Tr. at 2369)

The proposed CAP schedule of allocations anticipates that these effluent exchanges will be on the basis of one acre-foot of effluent for one acre-foot of CAP water after the year 2005. (Exh. Q at 71-72)

48. We conclude that if these exchanges were mandated by the Secretary, they would significantly restrict the availability of effluent to applicants under Agreement 13904.

Therefore, we conclude that these exchanges, which all witnesses have testified will occur at some point in the future, are a significant institutional constraint on the availability of effluent to applicants for use at Palo Verde.

Moreover, we find that exchange of effluent for potable water is one of the most promising ways in which cities hope to increase their domestic water supplies in a time of critical need. (McCain, Tr. at 2181-84)

Effluent increasingly is considered by the cities to be a valuable water resource. (Id. at 2181)

49. The amount and schedule for delivery of CAP water to municipalities in the Phoenix area is not definite since the Secretary of the Interior has not signed CAP contracts with any users except the Indian tribes. (Ibid.)

The total amount of water available through CAP to the Phoenix area is therefore uncertain.

50. The amount of water that will eventually be available is dependent on the extent to which the Upper Basin states utilize their full allotment of 7.5 million acre-feet of water from the Colorado River. Although Mr. Steiner has testified that he does not believe the Upper Basin states will utilize more than 5.8 million acre-feet, both Mr. Lorah and Mr. McCain testified that they expect the Upper Basin States to use their full allocation in development of energy resources. (McCain, Tr. at 2210; Lorah, Tr. at 1404) We accept their testimony and find that it is likely the Upper Basin states will utilize close to their full allotment of 715 million acre-feet of water from the Colorado River.

51. The Department of Water Resources ("DWR") has calculated that a dependable or "firm supply" of 630,000 acre-feet of water will be available from CAP. This means that all first priority users of CAP water, allocated 800,000 acre-feet per year, will experience a 20 percent shortage in supply about 36 percent of the time. (Steiner, Tr. at 751-52; JA Exh. Q)

52. Another uncertainty about the amount of CAP water to be delivered to the Phoenix area in the future is the recent decision of the Special Master appointed by the United States Court, granting five Indian communities

additional water from Arizona's entitlement under the decree in Arizona v. California. The Special Master recommended to the Court that an additional 194,000 acre-feet of Colorado River water be granted to the tribes. (McCain, Tr. at 2209, Lorah, Tr. at 1403)

If the Supreme Court adopts the Special Master's recommendation, the CAP supply will be reduced by about 120,000 acre-feet of water per year. (Ibid.)

53. We find, therefore, that the amount of water which will be delivered to the municipalities in the future by CAP is uncertain, and is likely to be less than originally anticipated due to satisfaction of Indian claims, financial problems in completing construction of the project, and development of the Upper Basin states that will lead them to use their full entitlement of 7.5 million acre-feet of water.

54. One way in which cities hope to increase their water supplies in the future is by drilling new wells. (Juetten, Tr. at 662; McCain, Tr. at 2179). However, the Department of Water Resources ("DWR") currently interprets the Groundwater Management Act to prohibit a city from drilling a well unless the well is within the city's service area. "Service area" is defined as the area currently being delivered water by that city. (Steiner, Tr. at 787) If DWR

adheres to this policy cities will be unable to drill wells to deliver water to developing urban areas that the city does not serve. (Int. Exh. XX at 4; McCain, Tr. at 2211) Cities such as Phoenix may then have difficulty serving the water needs of those urban areas outside the SRRD.

55. Another restriction on the cities' ability to increase their future water supplies by drilling more wells is that increasing amounts of groundwater in the Phoenix area have been found to be contaminated and unsuitable for use as drinking water.

Mr. Swanson testified that the Arizona Department of Health Services ("DHS") has found eight drinking water wells in the Phoenix area contaminated with trichloroethylene, ("TCE") and five wells contaminated with dibromochloropropane ("DBCP"). In addition, he found that a full 28 percent of 93 wells sampled for DBCP had levels greater than .01 ppb, a level of concern to DHS.

The Department recommended that the eight wells with TCE be shut down and advised the owners of the five wells contaminated with DBCP not to use water from those wells for drinking or culinary purposes. (Int. Exh. XXX; Swanson, Tr. at 1845, 1886-87)

Mr. Swanson also testified that he expects DHS to find greater groundwater contamination in the future as the Department's detection capabilities improve and contamination

diffuses throughout the aquifer.

He testified further that it is very costly to treat contaminated water or to transport it to use as irrigation water. He estimated that to treat contaminated groundwater to levels of safety for potable water would cost from 10 to 50 cents per thousand gallons. (Swanson, Tr. at 1888-89)

56. Mr. Lemmon testified that the release of floodwaters in the 1978 to 1980 period caused groundwater levels to rise and infiltrate landfills which lead to leaching and leaking of gases into the groundwater. Over a 20-year peiod Mr. Lemmon estimated that between 700,000 to 800,000 acre-feet of groundwater would be contaminated and thereby made unsuitable as drinking water. (Int. Exh. XXXIII at 7)

He further testified that even those landfills that are now closed will continue to contaminate groundwater, and new federal legislation regulating landfills are only preventative. (Lemmon, Tr. at 1916, 1971-72)

Mr. Lemmon estimated that it would cost between $7 to $8 million to take all corrective actions necessary to stop such leaching from the 40th Street Landfill alone. (Id. at 1964)

Mr. Lemmon estimated that the cost of treating 700,000 to 800,000 acre-feet of contaminated water to make it safe for drinking water would be between $57 to $346 million, or from $.25 to $1.50 per thousand gallons. (Id. at 1991)

57. We conclude that groundwater contamination is a serious restraint on the cities' development of groundwater as a water resource in the future. Not only does contamination reduce the total amount of water available to cities as drinking water, but it also reduces cities' flexibility in delivering water where it is most needed.

58. Mr. McCain testified that the cities may develop a critical need for water and would consider invoking section 21 of Agreement 13904 under any of the following sets of circumstances:

1) The CAP did not deliver water to the Salt River Valley on schedule and in the scheduled amounts;

2) There were a drought of three to four years on the Salt and Verde Rivers such that surface water supplies were decreased and Phoenix gate water credits were exhausted at a greater rate than anticipated; or

3) The cities were unable to drill new wells because of DWR regulations, the cities did not find water in drilling some wells, and the groundwater was contaminated in a portion of the wells they did drill. (McCain, Tr. at 2232-37)

59. This Board concludes, therefore, that it is likely if not probable that the cities will find it necessary to invoke section 21 of Agreement 13904 in the future because of insufficient water supplies for domestic purposes.

Although we cannot predict that that will happen in any particular year we believe it is likely to occur in the early years of anticipated operation of the three Palo Verde plants if CAP delivery of water is delayed past 1985. In addition,

the cities may well develop a critical need for water in the later years of CAP when the available amounts are expected to decrease and effluent exchanges become necessary.

We also conclude that despite the increasing amounts of effluent available from the 91st Avenue Plant in the future, the institutional constraints on applicants' use of that water at Palo Verde mean applicants can not depend on it as an assured supply of water for operation of three reactors.

B. ADEQUACY OF EFFLUENT AS CONDENSER COOLING WATER UP TO 15 CYCLES OF CONCENTRATION.

60. The contention concerning the adequacy of effluent for use as cooling water at Palo Verde is, in two parts, as follows:

> 1) Applicants have not demonstrated that the on-site Water Reclamation Plant ("WRP") and circulating water system will be able to treat the effluent adequately for use as cooling water at Palo Verde;
>
> 2) Applicants have not demonstrated that they can, on a consistent basis, use as cooling water at Palo Verde, effluent concentrated up to 15 cycles of concentration without excessive degradation of the cooling system.

61. Applicants argue that they can achieve 15 cycles of concentration with the effluent that will be available from the 91st Avenue Plant. They rely on the results of their water reclamation studies ("WRS") conducted in 1973 and 1974, on their monitoring of the effluent from the 91st Avenue Plant from 1976 to 1980; and on the operational experience of other power plants. (Bingham, ff. Tr. 2585 at 2586-89).

62. Effluent from the 91st Avenue Plant and the Tolleson Plant that will be used as makeup to the circulating water system ("CWS") will be treated at the on-site Water Reclamation Plant ("WRP") and stored in the on-site reservoir. (Bingham, ff. Tr. 920 at 2; JA Exh. X at 3.6-5).

4/ Testifying concerning this contention were Wesley E. Steiner, Director of the State of Arizona Department of Water Resources; and William G. Bingham, Project Engineering Manager for Bechtel Power Corporation as witnesses for Joint Applicants; William L. Lorah, Vice President of Wright Water Engineers; William Paul Robinson, Executive Director and Environmental Analyst for the Southwest Research and Information Center; James L. Lemmon, Hydrologist with the Bureau of Waste Control of the Arizona Department of Health Services; Edwin E. Van Brunt, Vice President, APS, as an adverse witness; and John Robert McCain, Staff Director of the Arizona Municipal Water Users Association, for Intervenor.

63. The effluent will be further treated in the circulating water system as needed. Blowdown from the CWS will be pumped to on-site evaporation ponds. Effluent used as cooling water at Palo Verde is totally consumed and will not be reused. (JA Exh. X at 3.4-4).

64. The CWS removes thermal energy that is not used to generate electricity. The CWS consists of the condenser, the cooling towers, circulating water pumps, a chemical injection system, and the systems which bring makeup into the CWS and transport blowdown out of the CWS. (JA Exh. X at 3.4-1).

The condenser tubing is titanium and the tubesheets and pump impellers are aluminum-bronze. (Bingham ff. 2585, at 9-10).

65. Water can be treated within the circulating water system by the addition of sulphuric acid, scale inhibitors, chlorine and a foam control agent. (Id. at 19).

66. The Water Reclamation Plant treats the effluent in four stages:

1. biological nitrification;
2. two-part lime treatment;
3. filtration; and
4. chlorination.

(Bingham, ff. 920, at 3-4; Robinson, Tr. at 1597).

67. The WRP was originally designed in a modular form. Reliability studies conducted for this design indicated the following:

1) if one assumed a 12-month maintenance period, the probability of the plant operating without a failure of at least

one plant component was .0005 percent, or "almost zero"; and

2) if one assumed a three-month maintenance period, the probability that the WRP would operate without a failure of a least one component was 13.3 percent. (Int. Exh. XXV; Bingham, Tr. at 1125-33; Robinson Tr. at 1617-18).

Because of the high unreliability of the WRP, applicants completed a major new design of the facility in 1974. (JA Exh. FF).

68. Applicants claim that the new design is a parallel arrangement of active components and greatly improves the reliability of the WRP. No new reliability analysis of this new design has been presented. (Bingham, ff. 2585, at 19-20; JA Exh. FF.).

69. This Board finds, therefore, that it cannot determine if the new design improves the reliability of the WRP. We also find that the reliability analysis included in the WRS compels the conclusion that at least some component of the WRP will not operate properly for a large portion of the time.

70. From August, 1973 to September, 1974, applicants conducted the Water Reclamation Studies ("WRS") which included an analysis of the constituents in the effluent discharged from the 91st Avenue Plant that might cause degradation of the reactor circulating water system by scaling, fouling, bio-fouling or corrosion. Applicants determined that the five constituents that were most harmful in terms of causing these types of degradation were calcium, magnesium, silica, phosphorous and ammonia. (Bingham, ff. 920 at 3; Robinson, Tr. at 1596; JA Exh. BB).

71. Applicants have stated that a large number of other constituents and some metals can degrade the CWS. (JA Exh. Y). Applicants have not explained the basis on which they chose to focus on the five constituents of calcium, magnesium, silica, phosphorous and ammonia.

72. The Water Reclamation Studies also included tests using the circulation water test facility ("CWTF") which replicated in part the CWS at Palo Verde.

Applicants also operated a demonstration water reclamation plant ("demonstration plant") that included some features of the proposed WRP.

Finally, bench scale laboratory tests were conducted at Bechtel Laboratories in California to confirm the results of the CWTF tests. (Ibid.)

73. The objectives of the water reclamation studies were:

1) To determine if 91st Avenue Plant effluent could be treated in a lime-soda softening plant to achieve 15 cycles of concentration in the CWS;

2) To identify potential problems in the CWS;

3) To determine required in-cycle treatment for the circulating water system; and

4) To determine relative corrosion rates for different possible condenser tube and tubesheet materials. (JA Exh. BB, Part 5, at 5-1).

74. Applicants concluded from these tests that they could use effluent of the quality obtained in 1973 and 1974 from the 91st Avenue Plant up to 15 cycles of concentration for condenser

cooling purposes.

Also as a result of these tests, they chose to employ titanium for condenser tubing and aluminum-bronze for tubesheets and impeller pumps. Applicants chose these materials although only two of the tests they had done used titanium tubing. (Bingham, Tr. at 2682-83).

75. Applicants believe that they can use effluent obtained from the 91st Avenue Plant up to 15 cycles of concentration without excessive scaling, fouling, or corrosion of the CWS. (Bingham, ff. 920 at 2-4).

Fouling was defined as acceptable or "non-excessive" if there was "practically no deposition in tubes after two weeeks of tests." Corrosion was defined as acceptable if there was less then 1 mil/year. Fouling was defined as both scaling due to inorganic salts or organic fouling. (JA Exh. Z).

76. The demonstration plant, located at the site of the 91st Avenue Plant carried out the principal treatment processes of the proposed WRP.

77. The CWTF consisted of a heat source (a swimming pool heater), a heat exchanger, an old wooden cooling tower, circulating water pumps, and piping. (Bingham, Tr. at 1195; ff. 2585, at 4-5; JA Exh. B, Part 5, at 5-14).

78. Wastewater effluent discharged from the 91st Avenue Plant was treated at the demonstration plant and then fed into the CWTF. The CWTF concentrated the treated wastewater and circulated it through the heat exchangers and cooling tower.

Two-week tests were conducted using varying concentrations of scale inhibitors, corrosion inhibitors, chlorine, and ammonia. Both titanium and admiralty tubing were connected to the heat exchanger. (Bingham, ff. 2585, at 5; Robinson, Tr. at 1623).

Coupon and galvanic tests were conducted to provide data on relative corrosion rates for different possible condenser tubing and tubesheet materials. (Robinson, Tr. at 1623).

79. The CWTF was scaled to 1/40,000 of the size of the Palo Verde CWS. The flow rate in the CWTF was between 1/3800 and 1/5800 of the flow rate in the actual CWS. (Robinson, Tr. at 1610-11).

80. No other nuclear plant in the United States utilizes effluent for condenser cooling water. (Bingham, Tr. at 1196).

81. No fossil fuel power plant that uses treated wastewater as condenser cooling water concentrates it over five cycles of concentration. (Staff Exh. 8; Bingham, ff. 2585 at 3).

82. No power plant that uses the exact combination of condenser tubing of titanium and tubesheets of aluminium-bronze uses effluent for cooling water. (Bingham, Tr. at 2635-36).

83. Applicants claim that corrosion test data obtained during the CWTF tests demonstrate that seawater is similar to effluent in terms of its corrosive effects. No evidence was introduced to corroborate that conclusion. (Bingham, ff. Tr. 2585, at 9).

84. From 1973 to 1974, about 1000 grab samples from the 91st Avenue Plant effluent were analyzed for the five constituents

which applicants believed were of most concern in terms of degradation of the CWS. (Bingham, Tr. at 1078; JA Exh. V, revised, at WGB-5).

85. The average concentrations of these five constituents for these samples were:

calcium	52.9 mg/l (milligrams per liter)
magnesium	22.9 mg/l
silica	28.8 mg/l
phosphate	22.1 mg/l
ammonia	30.9 mg/l

(JA Exh. U, revised, at WGB-5).

86. From 1976 to 1980, a consultant to applicants analyzed the concentrations of these five constituents in effluent discharges from the 91st Avenue Plant. The range of concentrations for this four-year period were:

calcium	40-50 mg/l
magnesium	20-30 mg/l
silica	33 mg/l
phosphate	7.0-7.5 mg/l
ammonia	20-30 mg/l

(JA Exh. U, revised, at WGB-12; WGB-14; WGB-16; and WGB-18).

87. The average concentrations for the five constituents in the effluent discharges from the 91st Avenue Plant during this four-year period were:

calcium	46 mg/l
magnesium	24 mg/l

silica	28 mg/l
phosphate	22 mg/l
ammonia	18 mg/l

(Id. at WGB-6).

88. The average concentration for the five constituents in the demonstration plant output and influent to the CWTF were:

calcium	66.0 ppm (parts per million)
magnesium	6.0 ppm
silica	8.0 ppm
phosphate	0.1 ppm
ammonia	5.0 ppm

(JA Exh. BB, Part 5, at 5-6; Int. Exh. XXIV).

89. The average concentrations for these five constituents in the blowdown water from the CWTF, after 15 cycles of concentration were:

calcium	800 ppm
magnesium	100 ppm
silica	80 ppm
phosphate	1.8 ppm
ammonia	15-20 ppm

(Int. Exh. XXIV).

90. Applicants presented testimony that the "performance warranty limits" for influent to the WRP are:

calcium	64 mg/l
magnesium	28 mg/l
silica	40 mg/l
phosphate	56 mg/l

ammonia	35 mg/l

(Bingham, Tr. at 941, 1099; JA Exh. U, revised, at WGB-6).

91. Applicants have presented testimony that the design limits of WRP are twice the performance warranty limits for the five constituents, or the following:

calcium	128 mg/l
magnesium	56 mg/l
silica	80 mg/l
phosphate	112 mg/l
ammonia	70 mg/l

92. Intervenor witnesses testified that the quality of effluent discharged from the 91st Avenue Plant could be expected to decline with delivery of CAP water to the Salt River Valley and the increasing dependence of the municipalities on groundwater as a raw water source. (Lorah, Tr. at 1417-23; Int. Exh. XX; Lemmon, Tr. at 1965-66).

93. Both Mr. Lorah and Mr. Steiner estimated that the TDS level in CAP water is about 200 to 300 ppm higher than the TDS level of SRP water. (Ibid.; Steiner, Tr. at 785).

94. Mr. Lemmon testified that from 1979 to the present groundwater has grown from 40 percent to 50 percent of the total raw water sources to the cities. He further testified that he believes the quality of raw water sources to the cities will decline due to the declining quality of groundwater pumped in the Phoenix area caused in part by pumping patterns. (Lemmon, Tr. at 1965-66).

95. Applicants did not consider in determining that they could achieve 15 cycles of concentration that the quality of the effluent discharged from the 91st Avenue Plant is likely to decline. Instead they assumed it will remain within the quality range observed from 1973 to 1980.

96. Applicants' data for the concentration of phosphorous in 91st Avenue Plant effluent for the 1976 to 1980 period show a wide variation in the concentration of phosphorous. For example, concentrations of phosphates have risen to 21 mg/l or four to five times the average concentration of phosphates in the 91st Avenue Plant effluent. (JA Exh. V, revised, at WGB-17).

97. Applicants believe that these high peaks result from detergents being disposed of in the sewer system on wash day. The only evidence they have presented to substantiate this hypothesis is data from a two-week period. This data shows that unusually high peaks of phosphate occurred on Monday and then on both Monday and Tuesday. (Bingham, Tr. at 1114-15, and 1293; JA Exh. AA).

98. We conclude that this analysis does not sufficiently explain the wide variations and peaks in phosphate. Nor does it allow applicants with any certainty to predict when such peaks are likely to occur.

99. Intervenor has also presented evidence that the quality of sewage sent to the 23rd Avenue Plant can vary greatly. Mr. Lemmon testified that for a series of successive Friday afternoons from 1978 to 1981 the 23rd Avenue Plant was closed down because industries had all disposed of their industrial wastes at the end of the business week. (Int. Exh. XXXIII).

100. We find Mr. Lemmon's testimony and the applicant's own data on the widely-varying phosphate levels to be evidence of the volatile and rapidly-changing nature of effluent.

101. We conclude that applicants have not adequately examined the possibility that the quality of effluent discharged from the 91st Avenue Plant may vary greatly due to poor waste disposal practices or unanticipated personal use habits of Phoenix residents.

102. The average concentrations of the five problem constituents from 1973 to 1974 were lower than the "performance warranty limits" for influent to WRP. These average concentrations were also considerably lower than applicants' professed design limits for the WRP.

103. We do not believe that applicants have sufficient information from their water reclamation studies to claim that the WRP will function adequately at greater than twice the average concentrations of these five constituents in tests in the Water Reclamation Studies.

104. We also find it is not likely applicants will be able to operate the WRP on a consistent basis beyond the range of concentrations of the five problem constituents for which equipment manufacturers will warrant the components of the WRP.

105. Intervenor witness Robinson testified that in his opinion applicants' water reclamation studies did not demonstrate that 15 cycles of concentrations could be achieved using effluent as cooling water without causing excessive degradation of the Palo Verde CWS. (Robinson, Tr. at 1688).

106. Mr. Robinson stated the basis of his opinion was the following:

1) The undersized scale, flow rates and volumetric flows of the WRS are not reliable indicators of the conditions and operation of the actual CWS at Palo Verde;

2) The geometry of the CWTF was different than the actual Palo Verde CWS;

3) The two-week test periods were too short to compare to the 11-month expected operational period of the reactors;

4) The coolant chemistry of the CWTF did not react as applicants had hypothesized that it would; nor did the constituents of special concern to applicants concentrate at identical rates, as applicants had predicted. (Robinson, Tr. at 1689).

107. Mr. Robinson testified that the undersized scale, flow volumes and flow rates of the CWTF led him to conclude that the applicants had not compiled sufficient information about certain types of corrosion, including corrosion caused by stress or cracking; by irregularities in metal; or corrosion occuring in conjunction with fouling. (Robinson, Tr. at 1623-26; Int. Exh. XXVI).

108. Mr. Robinson further testified that the fact that the geometry of the CWTF was much different than the CWS and that the tests were only of two-week duration limited their value in terms of predicting the operation of the CWS at Palo Verde. The extremely short time period for the tests is especially significant in light of the fact that corrosion, fouling, and

scaling are cumulative processes. (Robinson, Tr. at 1629-30).

109. Mr. Robinson testified that applicants' data did not demonstrate that the five problem constituents concentrated at the same rate as applicants had predicted. (Robinson, Tr. at 1631-1665).

Mr. Robinson, therefore, concluded that applicants did not understand the chemistry of the CWS since they could not predict how the levels of the problem constituents would increase with an increase to 15 levels of concentration of chlorine. Apparently the applicants have now adopted as the definition of 15 cycles of concentration the concentration of makeup to the CWS to the point the concentration of chlorine increases by a factor of 15 from the feed to the CWS. (Bingham, Tr. at 2654).

110. Mr. Robinson testified that it was important to understand how these five constituents would react in the CWS in order to determine the proper treatment to prevent degradation of the CWS.

111. Mr. Robinson also testified that some of the CWTF test results showed unexpectedly high concentrations of metals in the blowdown water. (Robinson, Tr. at 1661-65). Applicants believed these unexpectedly high concentrations might persist in the CWS. (Int. Exh. XI). Applicants did not explain whether they have now determined the cause for these unexpectedly high levels of certain metals or whether they know if these levels will continue to exist in the CWS.

112. Mr. Bingham testified that applicants can treat unexpected variations in levels of the five constituents by adding

in the CWS sulphuric acid, chlorine, foam control agent and scale inhibitors. (Bingham, ff. 2585, at 19). Under cross-examination however, Mr. Bingham admitted that there were limits on the effectiveness of scale inhibitors, acid, anti-foam agents and chlorine, so that beyond a certain point they were no longer effective. (Bingham, Tr. at 2658-59). Mr. Robinson also stated that there were limits on the concentrations of scale inhibitors (Robinson, Tr. at 1681) and bio-fouling inhibitors such as chlorine that could be added to the CWS. (Id. at 1682).

113. Mr. Bingham testified that the quality of influent to the WRP could decrease by factor of two in terms of the five problem constituents prior to deterioration in the quality of effluent discharged by the WRP into the circulating water system. Mr. Van Brunt's testimony contradicts that statement. He said in 1977 (Int. Exh. XVIII), and again during this hearing (Van Brunt, Tr. at 2094), that there is a direct correlation between the quality of effluent that is delivered to the WRP and the quality of water that leaves the WRP after treatment. Mr. Van Brunt's statements in 1977 that Buckeye groundwater could not be treated at the WRP without increasing applicants' water requirements by a factor of two or three is in direct contradiction to Mr. Bingham's testimony that the quality of influent to the WRP can deteriorate by a factor of two prior to any deterioration in the water discharged for use in the CWS.

114. The amount of water applicants require for condenser cooling purposes at Palo Verde is inversely related to the number of cycles of concentration they can achieve in circulating the

effluent through the CWS. (Bingham, Tr. at 936; JA Exh. U, revised, at WGB-6).

115. Under steady state conditions the relationship is described as follows:

$$\text{Cycle of Concentration (c)} = \frac{\text{Blowdown Concentration}}{\text{Makeup Concentration}}$$

Rewriting using two simultaneous equations yields:

<u>Chemical Balance</u> $\quad \dfrac{\text{Makeup Flow}}{C} = \text{Blowdown Flow}$

<u>Flow Balance</u> $\quad$ Makeup Flow = Blowdown Flow + (evaporation + drift)

Combining two simultaneous equations yields:

(Cycles - 1) (Makeup Flow) = Cycles (evaporation + drift)

or

$$\text{(Makeup Flow)} = \frac{\text{Cycles}}{\text{Cycles} - 1}\,\text{(evaporation + drift)}$$

(Int. Exh. IX).

116. Applicants presented evidence that the relationship between cycles of concentration and makeup requirements could be graphically depicted. (JA Exh. U, revised, at WGB-6).

However, applicants argued that this graphic description of the relationship was the same for all five constituents. (Bingham, Tr. at 1091-92).

117. We conclude, based on Mr. Robinson's testimony and data from the applicants' water reclamation studies that all five constituents do not concentrate at the same rate under steady state or non-steady state conditions. (Robinson, Tr. at 1658-65; Int. Exh. X and XI).

118. We therefore do not accept applicants' representation that the graph in JA Exh. U, revised, at WGB-6, is a depiction of the relationship between makeup water requirements and cycles of concentration.

119. Based on Mr. Robinson's analysis of the Water Reclamation Studies and our own findings that applicants have not examined adequately the likely reduction in quality of effluent discharged from the 91st Avenue Plant, or the volatile nature of effluent, we conclude that applicants have not demonstrated that they can in fact achieve 15 cycles of concentration using effluent as condenser cooling water at Palo Verde.

120. We also conclude, based on the above analysis, on the poor reliability expected of the WRP, and on the questions raised by Intervenor, that applicants have not demonstrated that the WRP and CWS can treat effluent from the 91st Avenue Plant to a level whereby it can be used at Palo Verde without causing excessive degradation to the circulating water system.

121. Finally, we conclude that applicants have underestimated the makeup requirements for Palo Verde since it is unlikely that they will be able to achieve 15 cycles of concentration using effluent as condenser cooling water.

C. ASSURED SUPPLY OF WATER FOR SAFE SHUTDOWN OF PALO VERDE

122. The contention concerning the adequacy of applicants' water supply to shutdown Palo Verde is the following:

> Applicants have not demonstrated an assured supply of water to shut down Palo Verde under normal or accident conditions, and therefore have not complied with 10 C.F.R. Appendix A, GDC 2 and GDC 44, as implemented by Regulatory Guide 1.27, Rev. 2.

123. The ultimate heat sink ("UHS") is designed to provide heat dissipation capability for the reactors and their essential auxiliary systems during a safe shutdown under normal or accident conditions. (JA Exh. W at 9.2-63 and Section 9.2.5.2 as cited in Int. Exh. XIII).

124. The UHS for each reactor consists of two independent and adjacent concrete essential spray ponds and two separate and redundant trains running from those spray ponds. Either of the independent trains together with the total amount of water available from both spray ponds is designed to dissipate 100 percent of the plant's heat under accident conditions. (Ibid.)

125. The water supply available from the UHS in the event of a design basis loss of coolant accident is a 26 to 28-day supply if one assumes adverse meteorological conditions as recommended in Regulatory Guide 1.27, Rev. 2. (Int. Exh. XII; Int. Exh. XIII)

Applicants originally calculated that the two essential spray ponds for each reactor contained a 30-day supply.

Upon recalculation using the assumption of adverse meteorological conditions described in Reg. Guide 1.27, Rev. 2, applicants calculated the supply to be only a 26 to 28-day supply. (Int. Exh. XIII)

126. In a meeting between applicants and NRC Staff on December 8, 1981, applicants appealed an open item in the SER, section 2.4.4.2, that found applicants had not satisfied Reg. Guide 1.27 and had not met GDC 44 because the spray ponds did not contain a 30-day supply of water. (Int. Exh. XXXV)

127. The staff agreed at that meeting that a 26 to 28-day supply of water in the spray ponds was acceptable if applicants established procedures to assure sources of water were available after an initiating event, to ensure continued capability of the spray ponds after the 26 to 28-day supply of water was exhausted. (Int. Exh. XV)

128. On February 5, 1982, applicants sent to the NRC Staff an amendment to the FSAR, section 9.2.5, which stated that the amount of water available from the UHS under adverse meteorological conditions was only 26 to 28 days. Applicants also informed the NRC Staff that at least 60 days prior to fuel load they would make available procedures to ensure continued capability of the UHS beyond 26 to 28 days. The two water sources they specified were the domestic water system and the station reservoir. (Int. Exh. XIV; JA Exh. W, at 9.294B)

129. On June 17, 1982, applicants informed the NRC Staff that they would rely on the regional aquifer to provide continued capability to the UHS beyond the 26 to 28-day period of supply from the spray ponds. They proposed that three onsite wells currently serving the domestic water system would provide this continued capability. If these wells were rendered inoperable by the initiating event, applicants proposed to drill a well or wells on the site capable of delivering 1200 GPM (gallons per minute) of water. They claim that within 15 days of a decision that the three wells are no longer operational they can have drilled a new well on the site. (Int. Exh. XXXV)

130. The only "initiating event" applicants have considered is a safe shutdown earthquake ("SSE"). They did not consider any other design basis occurrence or initiating event described in Regulatory Guide 1.27, Rev. 2. (Van Brunt, Tr. at 2127)

131. The NRC Staff has not determined whether or not applicants, through this proposal of June 17, 1982, have satisfied Reg. Guide 1.27, Rev. 2, or the requirements of GDC 2 and 44.

132. Applicants have applied for Type I Non-Irrigation Grandfathered Rights and Type II Non-Irrigation Grandfathered Rights from the Arizona Department of Water Resources.

DWR has not certified that applicants have such groundwater rights, although they verified applicants have properly filed their applications for such rights. (Int. Exh. XXXVI and XXXVII). Applicants have presented no evidence to indicate that they presently have groundwater rights to pump groundwater for use to ensure continued capability of UHS beyond 26 to 28 days.

133. This Board takes judicial notice of the Arizona Groundwater Management Code which provides that all landowners who pump groundwater must have groundwater rights certified by DWR if they pump groundwater at the rate of 225 GPM as is required for the safe shutdown of Palo Verde.

134. This Board concludes that applicants do not at the present time hold groundwater rights to pump water in the amounts required to ensure continued capability of the UHS beyond the 26 to 28 days.

135. Applicants have encountered problems in drilling test wells on the Palo Verde site, due to plugging of well casing perforations by silts or clay. (Int. Exh. XLI). These wells were cased. (Ibid.); Gonzales, Tr. at 2514)

Mr. Van Brunt testified that dewatering wells at Palo Verde have not produced water as applicants had expected. (Van Brunt, Tr. at 2131)

136. Mr. Gonzales testified that the hydrogeology of an area might change after an earthquake. He also testified that knowledge of the hydrogeology of an area is important in determining the location of the regional aquifer. (Gonazles, Tr. at 2497) Mr. Gonzales also stated that one cannot know with exact certainty the hydrogeology of an area, and that it was possible to drill a well and not find water. (Gonzales, Tr. at 2497-98).

137. Applicants have stated that the three wells currently providing water for the domestic water system are not safety-grade. (Van Brunt, Tr. at 2136) They have also stated that any wells drilled to assure the capability of the UHS beyond 26 to 28 days will not be safety-grade. (Van Brunt, Tr. at 2137)

138. The NRC Staff has not yet accepted applicants' proposal to use three domestic system wells or to drill a new well to provide continued capability to the UHS beyond 26 to 28 days.

The NRC Staff may still require a second, backup source of water to assure continued capability. (Van Brunt, Tr. at 2109)

139. Mr. Van Brunt stated that he did not know whether or not applicants or their consultants had considered the possibility that an earthquake may cause the hydrogeology of an area to change. (Van Brunt, Tr. at 2133) He also stated that he did know whether applicants had considered

that a well driller might be reluctant to come to the Palo Verde site under accident conditions initiated by a SSE. (Van Brunt, Tr. at 2128)

140. Applicants presented no technical studies to support Mr. Van Brunt's conclusion that applicants could drill a well at the Palo Verde site after a SSE in 15 days, and that the well or wells drilled could produce 225 GPM of water continuously.

141. The Board concludes that applicants have not demonstrated that they can assure continued capability of the UHS beyond 26 to 28 days by use of the three wells currently providing water to the domestic water system or by drilling a new well or wells on the site. We do not believe applicants have presented sufficient evidence for us to determine that it is possible to drill a well at the Palo Verde site within 15 days.

142. Finally, the Board finds that given that the spray ponds can only ensure a water supply of 26 to 28 days under adverse meteorological conditions, and given that the Palo Verde plants are located in an arid region and are not near any large natural body of water, applicants must provide a backup source in addition to the wells tapping into the regional aquifer to ensure continued capability of the UHS beyond 26 to 28 days.

143. The Board concludes that applicants have not satisfied Regulatory Guide 1.27, Rev. 2, and have not met the requirement of GDC 2 and 44.

CONCLUSIONS OF LAW

The Board has considered all of the evidence submitted by the parties and the entire record of this proceeding. Based on the findings of fact set forth herein, which are supported by reliable, probative and substantial evidence in the record, this Board, having decided all matters in controversy, concludes that, pursuant to 10 C.F.R. §2.760a all three applications for licenses to authorize operation of Palo Verde Nuclear Generating Station, Units 1, 2, and 3, should be denied.

ORDERED

Wherefore, it is ordered that the Director of Nuclear Reactor Regulation is authorized, upon making requisite findings with respect to matters not embraced in this Initial Decision, in accordance with the Commission's regulations, to deny Joint Applicants' licenses to operate Palo Verde Nuclear Generating Station, Units 1, 2, and 3. Applicants shall be free to renew their applications at such time as they can demonstrate that they have an assured supply of water both for the operation and for the safe shutdown of all three nuclear reactors.

It is further ordered that this Initial Decision shall constitute the final action of the Commission fortyfive (45) days after the issuance thereof, subject to any review pursuant to 10 C.F.R. §§2.760, 2.762, 2.764, 2.785, and 2.786.

Exceptions to this Initial Decision may be filed within ten (10) days after its service. A brief in support of the exceptions shall be filed within thirty (30) days thereafter and forty (40) days in the case of the Staff. Within thirty (30) days of the filing and service of the brief of any appellant, and forty (40) days in the case of the Staff, any other party may file a brief in support of, or in opposition to, the exceptions.

FOR THE ATOMIC SAFETY AND LICENSING BOARD

_____
Dixon Callihan
ADMINISTRATIVE JUDGE

_____
Richard F. Cole
ADMINISTRATIVE JUDGE

_____
Robert M. Lazo, Chairman
ADMINISTRATIVE JUDGE

Dated at Bethesda, Maryland
this ____ day of _____, 1982.

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ARIZONA PUBLIC SERVICE	)	
COMPANY, et al.	)	Docket Nos. STN 50-528
	)	50-529
(Palo Verde Nuclear	)	50-530
Generating Station,	)	
Units 1, 2, and 3)	)	
	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "Intervenor's Proposed Findings of Fact and Conclusions of Law" was mailed first class, postage prepaid, or deliverd by other means as specified below, this 13th day of August, 1982, to:

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