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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

AUG 3 1984

Note: This input was revised on 11/29/84. (See insert following p. 13). Revised pages were hand carried to the [illegible] B.K. Singh on 11/29/84. This revision did not affect the PMP writeup.

Docket Nos. 50-412

MEMORANDUM FOR: Thomas M. Novak, Assistant Director for Licensing
Division of Licensing

FROM: William V. Johnston, Assistant Director
Materials, Chemical & Environmental Technology
Division of Engineering

SUBJECT: HYDROLOGIC ENGINEERING INPUT TO THE BEAVER VALLEY-2 SER

Plant Name: Beaver Valley Power Station, Unit 2
Licensing Stage: OL
Responsible Branch: Licensing Branch No. 3; M. Ley, PM
Requested Completion Date: July 27, 1984

Enclosed is our Hydrologic Engineering input to the BVPS-2 SER. This input was prepared by R. Gonzales who can be reached on extension 28117.

We have not received responses to many of the questions which we submitted to you on August 25, 1983; consequently, this input contains the following open items:

1) Potential for flooding from local intense precipitation (Section 2.4.2.3).

2) Flooding from Peggs Run (Section 2.4.2.3).

3) Adequacy of river water temperature determination interval (Section 2.4.11.2).

The figures used in this input were provided to M. Ley of Licensing Branch No. 3 as input to the BVPS-2 DES. Those DES figures can be used here with appropriate changes to the figure numbers.

William V. Johnston

William V. Johnston, Assistant Director
Materials, Chemical & Environmental Technology
Division of Engineering

Enclosure: As stated

cc: See next page

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HYDROLOGIC ENGINEERING INPUT
TO THE BEAVER VALLEY POWER STATION UNIT 2 SER

DOCKET NUMBER 50-508

2.4 Hydrologic Engineering

The staff has reviewed the hydrologic engineering aspects of the applicant's design, design criteria, and design bases for safety-related facilities at Beaver Valley. The acceptance criteria used as a basis for staff evaluations are set forth in SRP 2.4-1 through 2.4-14 (NUREG-0800). These acceptance criteria include the applicable GDC reactor site criteria (10 CFR 100), and standards for protection against radiation (10 CFR 20, Appendix B, Table II). Guidelines for implementation of the requirements of the acceptance criteria are provided in RGs, ANSI standards, and Branch Technical Positions (BTPs) identified in SRP 2.4-1 through 2.4-14. Conformance to the acceptance criteria provides the bases for concluding that the site and facilities meet the requirements of 10 CFR 20, 50, and 100 with respect to hydrologic engineering.

2.4.1 Hydrologic Description

As shown in Figure 2.1, the Beaver Valley Power Station (BVPS) is located in southwest Pennsylvania about 5 miles east of East Liverpool, Ohio, and about 25 miles northwest of Pittsburgh, Pennsylvania. The station is on the south side of the Ohio River adjacent to the New Cumberland Pool about 3.0 river miles downstream of the Montgomery Lock and Dam and 19.7 miles upstream of the New Cumberland Locks and Dam. The normal water level in the New Cumberland pool is maintained by the U.S. Army Corps of Engineers at elevation 664.5 feet above mean sea level (msl). By comparison, the station finished grade elevation varies from 730 ft-4 in msl to 735 ft msl except along the river where the station grade elevation slopes down to about 675 ft msl.

The head of the Ohio River is at Pittsburgh where the Allegheny and Monongahela Rivers merge. From Pittsburgh, the Ohio River flows in a northwesterly direction for about 25 miles, thence westerly for another 25 miles and finally southwesterly for about 905 miles to Cairo, Illinois where it joins the Mississippi River. The Ohio River is highly regulated by many reservoirs on its tributaries

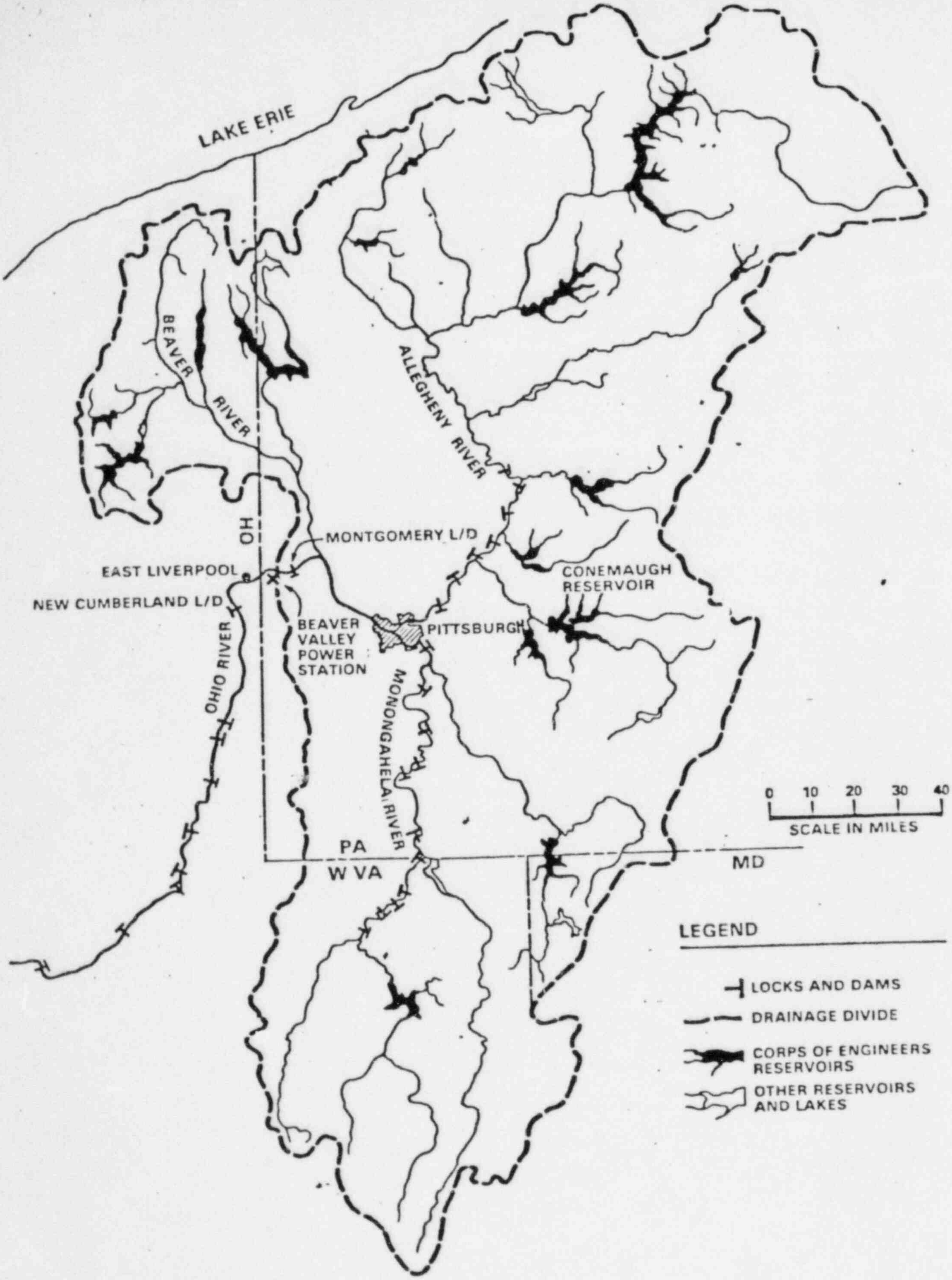


FIGURE ~~4.3.2~~ 2.1 OHIO RIVER DRAINAGE AREA and by numerous locks and dams. The drainage area of the river upstream of the BVPS is about 23,000 mi^2 yielding a mean discharge of about 36,700 cfs.

Significant hydrologic safety-related plant features include the intake structure, the alternate intake structure and the emergency outfall structure. The locations of these structures relative to other plant features are shown on Figure 2.2.

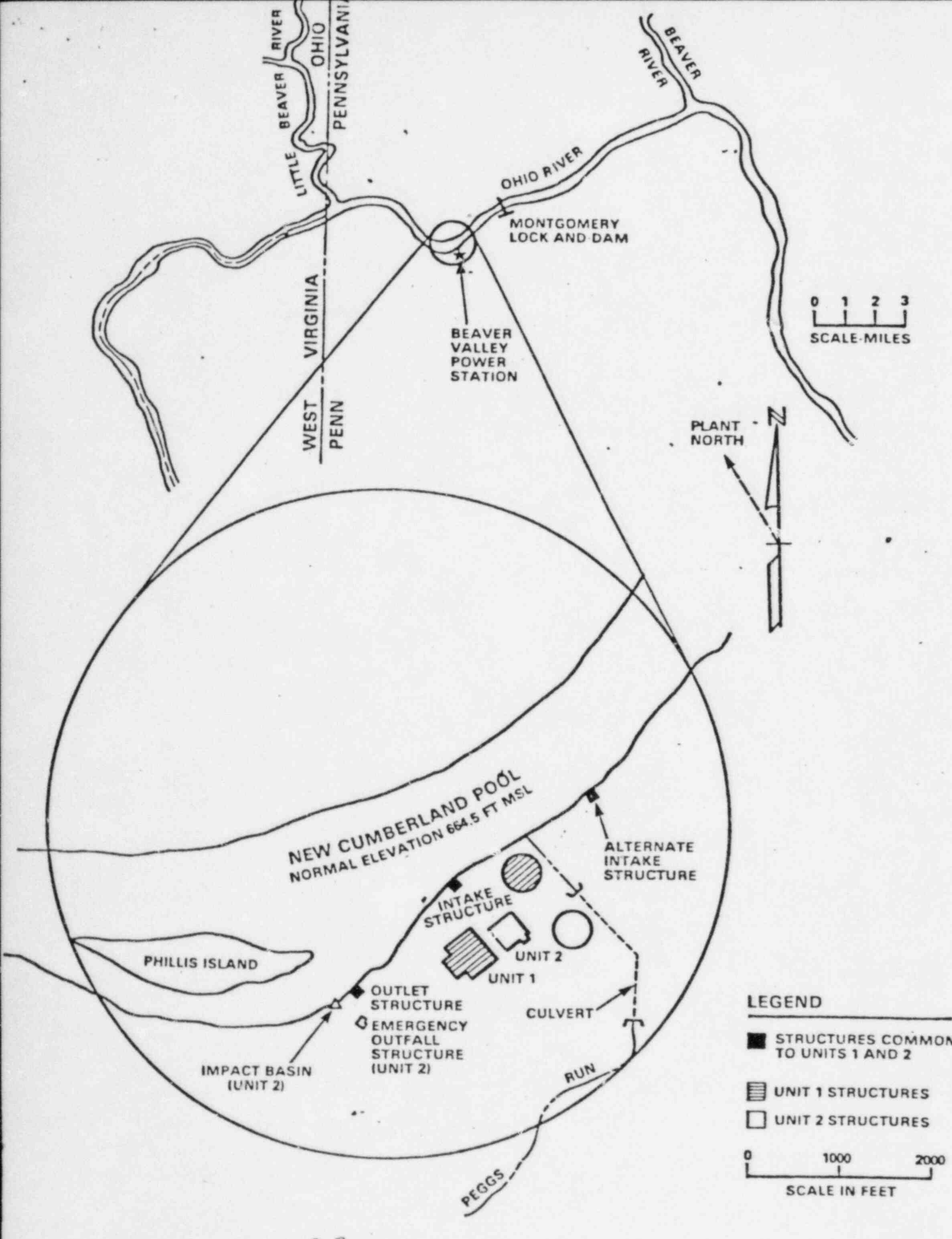
Cooling water for both normal and accident conditions will be supplied by the service water pumps in the intake structure located on the bank of the Ohio River. Should a navigation accident such as a barge impact or gasoline barge explosion affect the ability of the intake structure to obtain water from the river, the alternate intake structure would automatically be switched into service to supply the necessary cooling water. The capability of the Ohio River to provide an adequate supply of water is discussed in Sections 2.4.11.1 and 2.4.11.2 of this report.

The applicant has provided hydrologic descriptions of the plant site and vicinity. The staff has reviewed the applicant's information in accordance with procedures in SRP 2.4.1 and 2.4.2. The staff concludes that the requirements of GDC-2 and of 10 CFR Part 100, with respect to general hydrologic descriptions, have been met.

2.4.2 Floods

2.4.2.1 Flood History

The largest recorded flood on the Ohio River in the vicinity of the site occurred on March 15, 1936. During this flood, the stream gaging station located about 23 miles upstream of the station at Swickly, Pennsylvania, recorded a peak discharge of 574,000 cfs. The Corps of Engineers estimates that this 1936 flood had a peak discharge of about 510,000 cfs and a maximum elevation of 703.1 ft msl at the BVPS site. This elevation is almost 27 ft lower than the station grade elevation of 730.0 ft msl.



2.2

FIGURE 4.3-1 PRINCIPAL HYDROLOGIC FEATURES

2.4.2.2 Flood Design Considerations

Six potential sources of site flooding were considered by the applicant:

(1) intense local precipitation over the project site
(2) floods on Peggs Run
(3) floods on the Ohio River
(4) dam failures
(5) surges and seiches
(6) tsunamis

The staff has reviewed the material presented by the applicant in accordance with procedures in SRP 2.4.2. Based on this review, the staff concludes that there are no other credible sources of potential flooding of the plant site.

2.4.2.3 Effects of Intense Local Precipitation

Site drainage at the BVPS includes hillside drainage to the south of the plant and Peggs Run which parallels the highway road fill just east of the plant between the highway and the cooling tower area. To prevent flooding from hillside drainage, the plant has a storm drainage system which is designed for a rainfall intensity of 4 inches per hour. This is less than the probable maximum precipitation (PMP) so during a PMP event, some water could pond on the site.

PMP is the estimated depth of precipitation (rainfall) for which there is virtually no risk of exceeding. The PMP values used by the applicant to estimate the depth of local flooding, were determined from Hydrometeorological Report 33 (U.S. Weather Bureau 1956) and Engineering Manual, EM-1110-2-1411 (U.S. Army Corps of Engineers 1952). These rainfall values were as follows:

Duration (hours)	PMP (inches)
0.25	4.3
1	9.3
2	13.0
3	16.5
6	24.6
24	31.3

Using these PMP values, the applicant determined that maximum flood levels would remain 0.13 ft, 0.10 ft and 35.6 ft below the lowest access openings to the Control Building, the Radwaste Building, and the Reactor Building, respectively. It is not clear to the staff if these are the only safety-related buildings that could potentially be affected by flooding; therefore, a question has been submitted to the applicant and the staff is awaiting a response.

The staff has reviewed the information provided by the applicant in accordance with procedures described in SRP Sections 2.4.2 and 2.4.3. The staff used Hydrometeorological Reports 51 and 52 (U.S. National Weather Service, 1978 and 1982) in its PMP determinations. These reports update and supercede Hydrometeorological Report 33 and EM 1110-2-1411 which were used by the applicant. The staff concludes that the PMP amounts determined by the applicant are not conservative. In addition, the applicant has not provided sufficient information to support its conclusion that local floods will not enter safety-related buildings. The staff has submitted questions to the applicant and will complete its review pending responses by the applicant. The staff cannot conclude at this time that the plant meets the requirements of GDC-2 with respect to flooding from local intense precipitation.

Peggs Run is constricted in a deeply incised channel between the highway embankment and the cooling tower area at elevations as low as about 670 feet above msl. Construction of the plant required that a portion of Peggs Run be enclosed in a 15 ft diameter culvert so that the plant fill area could be extended across the Run. Location of the culvert is shown on Figure 2.2. The culvert empties into an open channel before entering the Ohio River. In analyzing the flood effects of a PMP event occurring over the Peggs Run drainage area, the applicant assumed that the 15 ft culvert was blocked. The applicant concluded that water levels in the vicinity of safety-related structures, due to flooding from Peggs Run, would be below the minimum station grade elevation of 730 ft-4 in msl.

The staff has reviewed the material presented in the FSAR and concludes that the applicant has not provided sufficient information to support its conclusion that flooding from Peggs Run will not affect safety-related buildings. The staff will complete its review following receipt, from the applicant, of responses to staff questions concerning flooding on Peggs Run.

The effects of local intense precipitation on roofs of safety-related buildings, has not been addressed in the material provided by the applicant. The staff will thus require that the applicant demonstrate and provide the basis for the ability of safety-related structures to withstand the accumulation of the PMP in the event that roof drains are blocked. All safety-related structures having roofs with parapets should be identified and the heights of parapets should be given. In addition, the criteria for the size, number and location of scuppers in those parapets should be provided. HMR 51 and HMR 52 should be used in this determination.

2.4.3 Probable Maximum Flood on Streams and Rivers

The Probable Maximum Flood (PMF) is defined as the hypothetical precipitation-induced flood that is considered to be the most severe reasonably possible.

A PMF estimate for the Ohio River was developed by the U.S. Army Corps of Engineers, Pittsburg District (1970). This PMF was reviewed by the staff during the CP stage and again during the Unit 1 OL review. The staff concluded that the PMF as developed by the Corps of Engineers was acceptable. The PMF was estimated to produce a peak discharge of 1,500,000 cfs and a maximum still water level of 730 ft msl. The finished station grade elevation varies from 730 ft-4 in msl to 735 ft msl except along the river where the intake structure is located. In this area, the grade elevation is about 675 ft msl. The applicant states that entrances to the reactor building, the control building and the radwaste building are located above minimum local plant grade (730 ft-4 in msl); the lowest being at an elevation of 730 ft-8 in. The intake structure which is located at elevation 675 ft msl is equipped with flood doors. As discussed in Section 2.4.2.3, it is not clear to the staff if these are the only safety-related structures that potentially could be affected by flooding. Resolution of this item will be discussed in a supplement to this SER.

Although the PMF level at elevation 730 ft msl is below entrances to safety-related structures identified by the applicant, winds blowing across the water may generate waves which could runup against the intake structure which is located close to the river. The applicant determined that coincident wind-wave activity could result in 5 ft high waves that would runup about 6.7 ft above the still water level of 730 ft msl at the intake structure. In the analysis of the required flood protection for the additional wind-wave increment, the applicant determined that the wave action would not exceed the structural design basis for the intake structure. However, to prevent water from entering the intake structure, flood doors are provided and the ventilation air intakes are extended to elevation 737 ft msl. Wind waves would not affect other safety-related structures because they are located away from the river bank.

In response to the staff's position, the applicant has proposed a technical specification that requires a plant flood alert be issued for an Ohio River water level of 690 ft msl. The plant will be shut down immediately if the river water level reaches an elevation of 695 ft msl and water is rising upstream.

The staff reviewed the Ohio River flood analysis at the CP stage and concluded then that there was no potential danger to safety-related structures from a PMF with coincident wind generated waves. The staff has reviewed the FSAR material presented by the applicant in accordance with procedures described in SRP 2.4.2 and 2.4.3. Based on this review, the staff has now determined that there is no new information that would change the earlier conclusion. Thus, the plant meets the guidelines of RG 1.59, "Design Basis Floods for Nuclear Power Plants", and the requirements of GDC-2 with respect to flooding from the Ohio River.

2.4.4 Potential Dam Failures

All of the Corps of Engineers' dams on the tributaries of the Ohio River are designed to pass localized PMP's, thus failures by overtopping are not considered credible events. Although the dams are also designed for earthquake loads, both the applicant and the staff, during the CP review, analyzed floods which could be caused by seismically induced dam failures. The applicant concluded that the worst case of such an arbitrarily assumed event would be a failure of Conemaugh Dam. This failure, even when postulated coincident with a standard project flood, which is a flood about half as severe as a PMF, would produce a water level of 725.2 ft msl. This is less critical than the flood level that would result from the PMF (730 ft msl) as discussed in Section 2.4.3. At the CP stage, the staff considered flood waves which could result from arbitrarily assumed seismically-induced dam failures coincident with both a flood producing about half the PMF runoff rate, and the simultaneous failure of more than one dam coincident with a 25 year flood, using the criteria suggested in RG 1.59, "Design Basis Floods for Nuclear Power Plants." The staff concluded that for both single and multiple dam failures, the flood level at the site would be less than that from a PMF.

The FSAR does not contain any new information that would cause the staff to change its conclusion that a flood caused by potential dam failures will not affect the safety of BVPS-2. Thus, the staff concludes that the station meets the requirements of GDC-2 and 10 CFR 100, Appendix A, with respect to flooding by dam failures.

2.4.5 Probable Maximum Surge and Seiche Flooding

BVPS-2 is not located near any large bodies of water where surge and seiche flooding would be a significant consideration.

2.4.6 Probable Maximum Tsunami Flooding

A tsunami is a gravity wave system that is created by a disturbance in the crust of the earth underlying large bodies of water and the resulting uplift of the water surface over a large area. Since BVPS-2 is not located near a large body of water, tsunami are not a credible source of flooding.

2.4.7 Ice Effects

2.4.7.1 Potential Ice Jamming

The U.S. Army Corps of Engineers has been maintaining records of icing in the New Cumberland pool of the Ohio River since 1963. During this time, there haven't been any occurrences of ice jamming or gouging or any reports of rising water levels due to ice buildup. Normally ice jams form at obstructions and irregularities, none of which exist in the vicinity of the intake structure. The Shippingport bridge crosses the Ohio River about 1000 feet upstream of the intake. However, the three support piers do not form a significant channel obstruction.

The only significant occurrence of ice jamming in the vicinity of the BVPS was in 1936. At that time, the unadjustable wicket-type gates of an old navigation dam had to be dropped to avoid damage from a large ice floe. The resulting low pool caused an ice jam with about a 5 ft rise in the water level behind it. All of the old dams in this reach of the Ohio River have been removed. The New Cumberland dam is equipped with adjustable gates, some of which can be lowered to pass ice and then raised to maintain the pool at a normal elevation of 664.5 ft msl. In addition, ice can be passed through the locks. Thus an ice jam similar to that of 1936 is unlikely to reoccur because the obstacles that caused the ice jam have been eliminated. However, if it did occur and the river rose 5 ft, the water level would remain 60.5 ft lower than the minimum local plant grade elevation of 730 ft-4 in msl.

One of the most severe ice jams experienced on the Ohio River occurred at the Markland locks and dam in early 1978. Although the Markland locks and dam are located about 500 miles downstream of BVPS, the applicant addressed the possibility of a Markland type ice jam forming in the New Cumberland pool. The applicant concluded that the possibility of a similar ice jam occurring at the New Cumberland pool is very low because the New Cumberland dam has submergible gates which permit ice to pass over them. In contrast, the Markland dam gates are not submergible. This is one reason ice piled up against the dam in 1978. In addition, the combination of meteorological events which led to the Markland ice jam, extreme cold and low flow followed by severe flooding, are of low probability. Following the Markland ice jam, the Ohio River Industry Ice Committee was formed to better ensure communication, operating procedures and other measures to prevent a recurrence of the problems experienced at Markland.

In order for the BVPS to be flooded by an ice jam downstream at the New Cumberland Dam, the water level in the New Cumberland pool would have to rise over 65 feet for a 20 mile distance upstream of the dam. It is extremely unlikely that this could occur. Therefore, the staff concludes that there is no credible ice jam that could affect the safe operation of the plant.

Formation of an ice jam upstream of the station would not affect the safe operation of the station because as discussed in Section 2.4.11.2, a technical specification requires shutdown of the plant during extreme low river flows.

2.4.7.2 Potential Blockage of Intake by Ice

The applicant addressed the potential for blockage of the intake by ice. Because of the relatively straight shoreline and the fact that the intake can withdraw water from elevation 646.0 to 659.5 ft msl, the applicant concluded that it is unlikely that ice floes could pile up in such a way as to block a significant portion of the intake. . In addition, the cleaning mechanism for the bar racks will remove ice just as it removes other debris.

The potential for frazil or anchor ice adversely affecting the intake structure was also examined by the applicant. There are no historical data on frazil ice formation in the Ohio River. However, a check of a number of facilities having intakes equipped with trash racks and traveling screens similar to BVPS showed no problems with frazil ice formation or blockage by ice floes. BVPS-1 which has been operating since 1976 and the adjacent Bruce Mansfield Plant which has been operating since 1975 have not experienced any problems with icing even during the severe winter of 1977-1978.

The staff has reviewed the information provided by the applicant concerning ice effects, in accordance with procedures in SRP 2.4.7. The staff concludes that Position 2 of Regulatory Guide 1.27 and the requirements of GDC-2 are met with respect to ice blockage of the safety related water intake structure.

2.4.8 Cooling Water Canals and Reservoirs

There are no safety-related or other cooling water canals or reservoirs associated with BVPS-2.

2.4.9 Channel Diversions

The Ohio River is a source of both normal and emergency cooling water supply. See Sections 2.4.11.1 and 2.4.11.2. There is no potential for upstream diversion of the river because the Ohio River valley is deeply entrenched in bedrock of sandstones and shales.

2.4.10 Flooding Protection Requirements

As described in Section 2.4.3, a PMF on the Ohio River would result in a maximum stillwater level of 730 ft msl. All seismic Category I structures except the intake structure are located above this elevation. The intake structure which is located at elevation 675 ft msl and could be subjected to the effects of coincident wind waves and associated runup, is flood protected to an elevation of 737 ft msl by extending the ventilation air intakes to this elevation. In addition, the structure has flood doors and the cubicles containing the service water pump motors are completely sealed so that the entire intake structure could be under water without affecting pump operability.

Although the staff agrees that locating safety-related structures at elevation 730 ft msl is adequate to prevent flooding from the Ohio River, it is unable to determine whether this is adequate to prevent flooding from local intense precipitation or from Peggs Run. As stated in Section 2.4.3, the staff has submitted questions to the applicant concerning the effects of local flooding and will complete its review and determine the need for additional flood protection pending responses by the applicant.

2.4.11 Cooling Water Supply

The cooling water systems consist of the main circulating water system (CWS) and the service water system (SWS). The CWS is a closed loop utilizing a natural draft cooling tower to dissipate heat to the atmosphere. The SWS takes water from the Ohio River through the intake structure. A portion of the service water is discharged to the circulating water lines and travels from there to the cooling tower. By this means, the SWS provides the makeup water necessary to replace water losses due to evaporation and drift and to maintain acceptable water quality in the CWS.

2.4.11.1 Normal Water Supply

Under normal operating conditions, the SWS withdraws about 27,570 gallons per minute (gpm) from the New Cumberland pool on the Ohio River. This water is pumped by two of three 50-percent capacity service water pumps located in the intake structure to cooling equipment in various unit buildings. A portion of the water (19,170 gpm) is then discharged to the main circulating water lines to be used as makeup water to the cooling tower. The rest (8,400 gpm) is discharged to the emergency outfall structure to prevent silt buildup in the 30 inch service water discharge lines.

The applicant considered the effect of low flows in the Ohio River on station operation. The average discharge in the Ohio River based on 43 years of record is about 36,675 cfs. The lowest flow of record occurred during the extreme drought of 1930 when a minimum flow of 1,250 cfs flowed past the site. Since that time, eight reservoirs with low flow augmentation capabilities have been constructed. Had these reservoirs been operating in 1930, the minimum flow would have been 4,000 cfs instead of 1,250 cfs. This is somewhat lower than the 7-day 10-year low flow which has been estimated to be about 5,200 cfs. Since only 61.4 cfs (27,570 gpm) will be withdrawn for normal operation of BVPS-1 and ~~1,283~~ 128.3 cfs (57,570 gpm) when both BVPS-1 and BVPS-2 are operational, the staff concludes that the Ohio River provides a highly reliable source of cooling water. Thus the requirements of GDC-44 with respect to having an adequate source of cooling water to dissipate heat under normal operating conditions, have been met.

2.4.11.2 Emergency Water Supply

Emergency safe shutdown and cooldown of BVPS-2 can be accomplished using the ultimate heat sink (UHS) which is the Ohio River. During an emergency requiring plant shutdown, the service water pumps will continue to withdraw water from the Ohio River just as they do during normal operation. However, water that is normally used for condenser cooling will be automatically diverted to those cooling systems required for emergency plant shutdown.

At the CP stage, the applicant proposed a minimum design river level of 648.6 ft msl based on a postulated failure of the New Cumberland Dam which, as shown on Figure 2.4.1, is located downstream of BVPS. In reviewing the applicant's analysis of potential low river flows, the staff determined that the minimum river flow of 4,000 cfs, assumed by the applicant, was dependent on the ability of upstream reservoirs to augment low flows. Since the dependability of such augmentation is based on others providing reservoir storage, the staff independently estimated that the minimum river flow could be as low as 800 cfs. The staff thus requested that the applicant provide assurance that with a low flow of 800 cfs, the depth of water in the intake structure would be adequate to provide the required pump submergence so the pumps would be capable of supplying safety-related cooling water. If this could not be assured, the staff required that the applicant develop a technical specification to define the minimum water level in the river under which the station would be operated. This requirement was necessary so that during declining river flows, the station would be shut down while there was still an adequate flow in the river. In response to the staff's request, the applicant proposed a technical specification that limits the operation of BVPS to periods when the water level in the river is at or above elevation 654 ft msl. The service water pumps are designed to supply water at river levels as low as 648.6 ft msl. Therefore, the staff concludes that a river level limit of 654 ft msl is adequate to assure that the plant can be safely shut-down during low flow conditions in the Ohio River.

The ultimate heat sink is designed to handle heat loads at a maximum river water temperature of 86°F. Therefore, in addition to specifying the minimum river level at which the station can operate, the technical specification will allow station operation only when the river temperature is less than or equal to 86°F. Average river water temperatures will be determined once every 24 hours. ~~The applicant has not provided sufficient information to assure that a 24-hour inspection interval is frequent enough so that rapid river water temperature changes do not result in a water temperature greater than 86°F between~~ Ins. A

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BVPS INSERT

The 24 hour surveillance interval is the same as was established for BVPS-1. Since BVPS-1 began operating in 1976, the river temperture has never exceeded 86°F. Because the Ohio River drains such a large area, 23,000 mi² at the site, the temperature of the river water remains fairly constant and temperature changes are small and gradual. In order for the river temperature to exceed 86°F, a lengthy period of extreme warm weather would have to be experienced over the Ohio River drainage area. Even in this case, temperatures would increase very slowly. Since river water temperatures will be monitored frequently (every 24 hours) the staff concludes that even during an unusual warming trend, river temperatures will not increase too rapidly to allow safe shutdown of the plant should temperatures exceed 86°F.

~~inspection intervals. Therefore, the staff will require that the applicant provide information on how rapidly river water temperatures can rise in critical situations and how this is related to the 24 hour inspection interval. The applicant should provide assurance that the proposed inspection interval is frequent enough so that rapid water temperature changes do not result in water temperature being too high for safe operation of the ultimate heat sink.~~

Because the intake structure is located on the bank of the Ohio River, it is expected that suspended sediment in the river will accumulate in the lower part of the structure. The applicant states that silt accumulation in the intake structure will be monitored semi-annually in the spring and fall, and that silt exceeding a 15 inch allowable limit will be removed by a pumping operation. The 15 inch limit is based on experience gained from operation of BVPS-1. During periods of high river flows, which generally occur in the spring, silt could accumulate to levels exceeding 15 inches. However, the spring inspection will assure that silt does not accumulate to a level that will adversely affect SWS pump operability. Fall inspections at BVPS-2 have shown no appreciable silt buildup when silt was removed during spring inspections. The staff thus concludes that an allowable silt accumulation level of 15 inches and a semi-annual inspection interval are adequate to preclude sediment from accumulating to a level that could affect the capability of the service water pumps in the intake structure to obtain an adequate amount of cooling water for safety-related purposes.

The cooling water requirement for emergency shutdown is less than that required for normal operation. Therefore, since the staff concluded in Section 2.4.11.1 that the flow in the Ohio River is adequate for normal operation even under extreme drought conditions, the flow is also adequate for emergency operation. The staff thus concludes that the Ohio River meets the recommendations for an ultimate heat sink as set forth in Regulatory Guide 1.27 and the requirements of GDC-44 with respect to thermal aspects of the heat transfer system.

2.4.12 Groundwater

2.4.12.1 Groundwater Description

The BVPS is located on a terrace of alluvial deposits which were deposited by the higher stages of the ancestral Ohio River drainage system during the Pleistocene period. The terrace is about 4,000 ft long and 1,800 ft wide at its widest point. It is over 100 ft thick and consists predominantly of sands and gravels. The permeability of these alluvial deposits has been determined to range from 5.7×10^{-5} to 2.0×10^{-4} ft/sec.

Underlying the terrace deposits is bedrock of the Pennsylvanian age. This bedrock is a carbonaceous shale which dips southeastward at about 15 to 20 ft/mi and has a surface elevation of about 620 ft at the site.

The sands and gravels in the terrace deposit on which the station is located forms the only significant aquifer in the site area. Both upstream and downstream of the station, the terrace pinches out against the steep bedrock valley wall.

Recharge to the terrace aquifer is primarily from precipitation in the immediate area. Groundwater occurs under hydrostatic conditions with the phreatic surface having a contour in subdued relief approximating the ground surface. Beneath the station, the groundwater elevation is normally at about 665 ft msl and movement is directed in a northwest direction towards the Ohio River. Since plant grade is 730 ft msl, groundwater is encountered about 65 ft below the land surface;

2.4.12.2 Groundwater Use

Groundwater wells within the site boundary consist of two construction wells, two wells which supply water to the Shippingport Atomic Station located adjacent to and southwest of BVPS and two wells which will supply domestic water to BVPS-2. None of these wells are located downgradient from BVPS-2.

2.4.12.3 Design Basis for Subsurface Hydrostatic Loading

The applicant's design basis groundwater level for hydrostatic and combined loading is elevation 730 ft msl, which is the elevation of the PMP. The staff concurs that this level meets the criteria of SRP 2.4.12 and thus concludes that it meets the requirement of GDC-2.

2.4.13 Accidental Release of Liquid Effluents

SRP Section 2.4.13 sets forth criteria and procedures for the analysis of accidental releases of liquid effluents in ground and surface waters. Using these, the staff analyzed a postulated failure of the Refueling Water Storage Tank (RWST) and the Evaporator Bottoms Storage Tank (EBST). These tanks were selected because they have the highest potential concentrations.

The RWST is an outside tank located at grade level just east of the reactor containment building. The staff postulated that this tank would fail and its entire contents would be introduced instantaneously into the New Cumberland Pool of the Ohio River (see Figure 2.2). This is a conservative assumption because in reality the spill would not enter the Ohio River instantaneously; instead it would probably flow into Peggs Run just east of the BVPS-1 cooling tower before it entered the New Cumberland Pool.

There are three municipal water intakes between BVPS-2 and the New Cumberland Locks and Dam. Two of these are located on the opposite side of the river at Midland, Pennsylania, and East Liverpool, Ohio, about 1.3 and 5.2 miles downstream of BVPS-2, respectively. The third intake is on the same side of the river at Chester, West Virginia, about 7.1 miles downstream of BVPS-2.

An accidental spill from the RWST would not disperse to the far shore where the Midland and East Liverpool intakes are located. Therefore, these intakes would not be affected. The Chester intake could be affected. However, the staff in its evaluation determined that by the time the RWST spill flowed past the Chester intake, it would be diluted by the water in the New Cumberland Pool so that the concentrations of all the nuclides would be reduced to less than the limits shown in Table II of Appendix B in 10 CFR Part 20.

The EBST which is located in the auxiliary building was postulated to fail, spilling its contents on the floor. The spill was then assumed to instantaneously and non-mechanistically leak through the building floor into the groundwater where it would be dispersed and transported down-gradient to the Ohio River (see Section 2.4.12 for a discussion of the groundwater regime). There are no water supply wells along this route which is entirely within the site boundaries. A conservative analysis by the staff indicated that as a result of dilution alone, all nuclides would be smaller than the 10 CFR Part 20 requirements at the point where the contaminated groundwater would be intercepted by the Ohio River.

Based on these analyses the staff concludes that postulated accidental spills of radioactive effluents will not result in contamination of any surface or groundwater supplies. Thus the requirements of 10 CFR Part 100 with respect to potential groundwater contamination have been met by the BVPS-2.

2.4.14 Technical Specifications and Emergency Operating Requirements

The PMF level of 730 ft msl as described in Section 2.4.3 is the design basis flood level for all safety-related structures. A technical specification will be adopted to define the actions to be taken in the event of rising flood levels approaching the design basis elevation.

As discussed in 2.4.11.2, a technical specification will be established to define the minimum river water level and maximum river water temperature at which plant shutdown must be initiated. This technical specification is required to assure that during periods of declining water levels in the river, the plant is safely shutdown while there is still an adequate supply of water available. The temperature restriction is needed to assure that river water has sufficient heat dissipating capacity to cool the plant adequately during an emergency condition.

2.4.15 Conclusions

The staff has reviewed the design of BVPS-2 with regard to hydrologically and hydraulically-related plant safety features according to procedures outlined in the SRP. On the basis of this review, the staff concludes that large-scale river flooding does not pose a threat to the safe operation of the plant or the integrity of the site. The staff, however, is unable to conclude that local flooding and flooding from Peggs Run will not threaten the plant. The staff concludes that BVPS-2 meets the requirements of GDC-2 with respect to potential flood hazards except for the outstanding item concerning local flooding and Peggs Run flooding.

The staff has reviewed the availability of water for normal and emergency cooling purposes during diminished flow periods in the Ohio River. The staff concludes that there is sufficient water available to maintain safe plant operation over any reasonable drought period as required by GDC-44.

As discussed in Sections 2.4.3 and 2.4.11.2, operating procedures employing the use of technical specifications are required for both severe floods and droughts to ensure the operability of safety-related equipment. The technical specification proposed for severe floods (described briefly in Section 2.4.3) assures that the station can be safely shutdown during high flows in the Ohio River. Thus the staff finds the hydrologic aspects of that technical specification is acceptable. Section 2.4.12.2 also states that BVPS-2 will be operated only when the water level in the river is at or above elevation 654 ft msl and when the river water temperature is at or below 86°F. The staff has concluded that elevation 654 ft msl is adequate to allow the plant to be safely shut down during low flow conditions. However, as stated in Section 2.4.11.2, the staff cannot conclude that a proposed 24 hour temperature determination interval is frequent enough to assure that rapid river water temperature changes do not result in water temperatures being too high for safe operation of the ultimate heat sink.

Draft
Never signed!

July

MEMORANDUM FOR: Thomas M. Novak, Assistant Director for Licensing
Division of Licensing

FROM: R. Wayne Houston, Assistant Director for Reactor Safety
Division of Systems Integration

SUBJECT: BASIS FOR BEAVER VALLEY 2 POWER LOCKOUT DESIGN MODIFICATION REQUIREMENTS

In Section 7.3.3.15 of the Beaver Valley 2 draft SER, ICSB expressed a concern that the power lockout scheme used for certain motor-operated valves was designed such that the single-failure criterion could not be met due to a non-detectable failure within the circuitry. The applicant's response to that concern, dated March 28, 1984, provided a circuit modification intended to resolve this issue.

In response, ICSB stated, in our Licensing Position #2 for Beaver Valley 2 dated April 30, 1984, that the proposed design modification did not satisfy our concern and that further design modification would be required in order for the power lockout circuitry to satisfy the single-failure criterion of IEEE-STD-279. In a June 8, 1984 letter, the applicant claims that the requirements of paragraph 4.2, "Single Failure Criterion", of IEEE-STD-279 are met by the existing design in that the valves are open (with power locked out), that an actuation signal is not required, and that therefore no single failure can prevent them from performing their safety function (being open). Additionally, in a June 15, 1984 letter the applicant claims the ICSB's position on this issue constitutes a new interpretation of IEEE-STD-279 and should be processed in accordance with NRR procedures for plant specific backfitting.

ICSB has reviewed the applicant's claims and believes that the characterization of this issue as a backfit is inappropriate. As stated by the applicant on page 8.3-58 of the FSAR under "Compliance with Branch Technical Position ICSB 18":

> "Manually-controlled, electrically-operated safety class valves, for which power is removed, are listed in Table 8.3-5. These valves are controlled from the main control room. Power is removed from these valves to meet single failure criterion."

It is clear that the applicant has developed a power lockout scheme in order to meet the single failure criterion and his letter of June 8, 1984 claims that the circuit design meets the requirements of paragraph

Contact:
F. Burrows, ICSB
X29455

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4.2 of IEEE-STD-279. ICSB's position on this issue is based on our review following the guidance of Chapter 7 of NUREG-0800 (SRP) to confirm that the circuitry functions to meet those requirements. Following the SRP and the subsequent guidance of R.G. 1.53, "Application of the Single-Failure Criterion to Nuclear Power Plant Protection Systems," we end up with additional guidance provided by IEEE-STD-379, "IEEE Standard Application of the Single Failure Criterion to Nuclear Power Generating Station Class 1E Systems." From Section 4 of that standard we quote:

> "The following is a generic statement of the single failure criterion:
>
> The system shall be capable of performing the protective actions required to accomplish a protective function in the presence of any single detectable failure within the system concurrent with all identifiable, but nondetectable failures,..."

Restating our concern, ICSB has identified a nondetectable failure within the power lockout scheme which in the presence of a detectable failure would prevent valves from accomplishing their protective functions. We therefore conclude, based on the above guidance, that this is not a new interpretation of IEEE-STD-279 or a new requirement (backfit). We once again request that the applicant respond to ICSB Licensing Position #2 on this issue and modify the circuitry used for power lockout to meet the single failure criterion.

R. Wayne Houston, Assistant Director
for Reactor Safety
Division of Systems Integration

cc: D. Muller
G. Knighton
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NRC STAFF POSITION REGARDING USE OF PROBABLE MAXIMUM PRECIPITATION AND U.S. NATIONAL WEATHER SERVICE'S HYDROMETEOROLOGICAL REPORTS 51 AND 52

The staff has always recognized the importance of utilizing the most recent engineering technology in evaluating the potential impacts of flooding on site safety. For the last 15 years, the staff has utilized the probable maximum (PM) hydrologic event concept as the design basis for safety evaluation of nuclear power stations. SRP Section 2.4.2 specifically points out the use of the probable maximum concept and that new information may become available at the OL stage. If new information becomes available, a brief review should be carried out to evaluate its significance. Where the OL review reveals that the controlling flood level differs more than 5% less conservatively from the CP evaluation, any supplemental provisions needed in the flood protection design basis should be directed toward early warning measures and procedures for assuring safe shutdown of the plant or toward minor structural modification to accommodate the design flood level.

When the staff became aware that the National Weather Service (NWS), an arm of the National Oceanic and Atmospheric Administration (NOAA) had published two new reports which relate to probable maximum precipitation (PMP), applicants for OL's including Duquesne Light Company were requested to assess the effects of the use of the new reports on plant safety.

The two new NWS reports provide the results of recent extensive technical studies that NWS conducted jointly with the Corps of Engineers. The reports were published in June 1978 and August 1982. The first of those reports, Hydrometeorological Report No. 51 (HMR-51), essentially expanded the information previously presented in HMR-33 which is cited in the SRP Sections 2.4.2 and 2.4.3 and which the applicant had used in its analysis. The expansion consisted of extending the precipitation duration from 48 hours to 72 hours and increasing the drainage areas from 1,000 square miles to 20,000 square miles. The second report, HMR-52, provides, among other things, techniques to analyze PMP for drainage areas of 1 square mile and durations of 1 hour and less. These techniques have the effect of increasing the calculated PMP at specific sites.

In order to better understand the situation at the Beaver Valley site, it is necessary to briefly review the development of NRC flood criteria in general and localized PMP in particular.

General Design Criterion 2, "design basis for protection against natural phenomena", addresses appropriate design basis for floods but only in general terms. It requires that design bases reflect consideration of the most severe historical data with sufficient margin for the limited accuracy, quantity, and period of time in which data have been accumulated.

Guidance on what constitutes sufficient margin is contained in Regulatory Guides 1.59, "Design Basis Floods for Nuclear Power Plants", and 1.102, "Flood Protection for Nuclear Power Plants". These documents state that the appropriate design basis for precipitation induced flooding is the Probable Maximum Flood (PMF) as developed by Corps of Engineers. This PM criterion has been used by the staff since at least 1970 and we are not aware of any previous guidance defining "sufficient margin" to be less severe than the PM hydrologic event. Thus it is well established that the PM criterion best meets GDC 2 with respect to hydrologic events.

Procedures for estimating PMF's (including probable maximum hurricane, PMH's) are given in Regulatory Guide 1.59 in Appendix A, which was replaced by ANSI Standard N170-1976 "Standards for Determining Design Basis Flooding at Power Reactor Sites", and Appendix B, "Alternative Methods of Estimating Probable Maximum Floods". It is clear, however, from reading the Regulatory Guides that the PMF and not the methodology of its estimation, is the criteria.

An integral component in the PMF determination is the Probable Maximum Precipitation (PMP). The definition of PMF given in the ANSI standard is "...the hypothetical flood...that is considered to be the most severe reasonably possible, based on comprehensive hydrometeorological application of probable maximum precipitation and other hydrologic factors favorable for maximum flood runoff..." The discussion of Probable Maximum Precipitation in the ANSI standard references a number of individual reports, most of which are National Weather Service (or U.S. Weather Bureau) publications. It is clear from the context, however, that it is the procedures established by the National Weather Service, and not a particular report available at one point in time, that form the basis for determining the PMP. Thus ANSI N170-1976 states in Section 5.2, which is titled, "Probable Maximum Precipitation:"

> "Probable maximum precipitation estimates for the United States are ava.lable in generalized studies prepared by the National Weather Service. They are presented in varying degrees of completeness. Specific probable maximum precipitation estimates for areas not adequately covered by these studies may be made using techniques similar to those employed by the National Weather Service."

The more recent version of the standard, ANSI/ANS 2.8-1981, which has not yet been formally incorporated in Regulatory Guide 1.59, states:

> "Probable maximum precipitation estimates for the United States are available in generalized studies prepared by the National Weather Service. They are presented in 12.1 [the reference section of the standard]. These should be used whenever applicable."

It should be noted that these ANSI standards were written by working groups composed primarily of individuals from utilities anc ieir consultants. The clear implication of both of these statements is to rely upon the expertise of the National Weather Service and to accept newer National Weather Service PMP studies as they become available. We note that the 1981 ANSI standard lists Hydrometeorological Report 51 as a reference.

The Standard Review Plan recognizes that improved methodologies may be developed and allows for their use in the period before they are actually incorporated in the SRP. For example, the Review Procedures section of SRP 2.4.2 states that "Improvements in calculational methods may occur..." and discusses their use.

Local flooding or plant site drainage, as it is called in the ANSI standards, is a subcategory of probable maximum floods resulting from local precipitation. Both ANSI standards state "The effects of local probable maximum precipitation on the plant site shall be determined and summarized." and direct the reader to the section on PMP for its determination.

There are two characteristics of local PMP that differentiate it from PMP in general; the small areas and short durations involved. HMR-51 and its predecessor, HMR-33, define PMP for various combinations of duration and drainage area in the central and eastern parts of the U.S. The shortest duration and drainage area addressed are 6 hours and 10 square miles, respectively. Local flooding determinations usually require consideration of PMP's with durations of 1 hour or less and areas corresponding to the drainage area contributing to potential flooding at the site; typically less than 1 square mile. Until recently, procedures for evaluating PMP for smaller drainage areas and shorter time intervals were not documented. Thus it was the staff practice to use the 10-square mile PMP value for all areas less than or equal to 10 square miles.

There were several schemes available to distribute the 6 hour PMP value into shorter time intervals. Clearly, assuming that one-sixth of the 6 hour depth occurs in each hour would not only be non-conservative, it would also be unreasonable. In actual storms, the rainfall intensity continually changes such that the most severe hour contains considerably more rainfall than one-sixth of the six hour amount. The staff had been using a time distribution taken from U.S. Army Corps of Engineers Engineering Manual 1110-2-1411, "Standard Project Flood Determinations", revised March 1965, originally published as Civil Engineer Bulletin No. 52-8 (March 1952). That distribution put 38 percent of the six hour standard project storm rainfall in the most severe one hour. This is the distribution that is referenced in SRP 2.4.2 and 2.4.3 and is one of several referenced in the ANSI standard. The time distribution taken from the original version, i.e., Engineer Bulletin No. 52-8 put 55 percent of the six hour rainfall in the most severe hour.

HMR-52, "Application of Probable Maximum Precipitation Estimates - United States East of the 105th Meridian", was published in August 1982. In addition to providing a stepwise approach to evaluating the temporal and spatial distribution of PMP estimates derived from HMR-51, this report presents procedures for determining PMP values for durations less than 6 hours. HMR-52 presents a map of the eastern United States with values of the 1 hour-10 square mile PMP contoured. Comparison with a similar map in HMR-51 for the 6 hour-10 square mile PMP indicates that the percentage of the 6 hour PMP in the most severe hour ranges from less than 50 percent near the Gulf of Mexico to about 65 percent in Maine, with most values being between 50 and 60 percent. Thus, while the time distribution of HMR-52 is more severe than that of EM 1110-2-1411, it is similar to that of the older Civil Engineer Bulletin No. 52-8.

HMR-52 also gives values for PMP's with areas as small as 1 square mile. Since the appropriate drainage area for most local site flooding situations is less than 1 square mile, this apect of HMR-52 is also appropriate for local flooding analysis. HMR-52 shows that the 1-hour 1 square mile PMP, is 22 percent more intense than the 1-hour 10 square mile PMP. While the staff had not considered this increase in PMP intensity for drainage areas less than 10 square miles before the issuance of HMR-52, it is appropriate for small drainage areas.

Thus, the use of HMR-52 results in two improvements in calculating local PMP. It presents the most current estimation of the time distribution of PMP and it allows calculation of PMP for areas as small as 1 square mile. Based upon our conclusion that the Regulatory Guides and ANSI standards define the flood criteria in terms of the PMP rather than specific evaluation techniques and the SRP guidance concerning use of improved calculational methods and the OL-stage, we conclude that the staff's use of HMR-51 and HMR-52 is neither a "rachet" nor a "backfit".

The staff's concern is that there are many safety-related components that are not designed to withstand moisture or become inundated by water. This is the reason that safety-related structures are designed to prevent water from entering and affecting vulnerable safety-related equipment. Failure of a structure such as collapse of a roof due to excessive ponding or water entering through an inadequately designed door could inundate safety-related equipment and potentially prevent a plant from being safely shut down.

Since GDC-2 requires that flood design bases reflect consideration of the most severe historical data with sufficient margin for limited accuracy, quantity and period of time in which data have been accumulated, and since the staff is not aware of any previous guidance defining "sufficient margin" to be less severe than the PMF, the staff concludes the BVPS-2 must be shown to be safe from design basis floods as determined by the most up-to-date PMP data; which are contained in HMR-51 and HMR-52. To do otherwise would bring into question the assurance that the plant design meets GDC-2 with respect to hydrologic events.

At the CP stage, the applicant proposed a minimum design river level of 648.6 ft msl based on a postulated failure of the New Cumberland Dam which, as shown on Figure 2.4.1, is located downstream of BVPS. In reviewing the applicant's analysis of potential low river flows, the staff determined that the minimum river flow of 4,000 cfs, assumed by the applicant, was dependent on the ability of upstream reservoirs to augment low flows. Since the dependability of such augmentation is based on others providing reservoir storage, the staff independently estimated that the minimum river flow could be as low as 800 cfs. The staff thus requested that the applicant provide assurance that with a low flow of 800 cfs, the depth of water in the intake structure would be adequate to provide the required pump submergence so the pumps would be capable of supplying safety-related cooling water. If this could not be assured, the staff required that the applicant develop a technical specification to define the minimum water level in the river under which the station would be operated. This requirement was necessary so that during declining river flows, the station would be shut down while there was still an adequate flow in the river. In response to the staff's request, the applicant proposed a technical specification that limits the operation of BVPS to periods when the water level in the river is at or above elevation 654 ft msl. The service water pumps are designed to supply water at river levels as low as 648.6 ft msl. Therefore, the staff concludes that a river level limit of 654 ft msl is adequate to assure that the plant can be safely shut-down during low flow conditions in the Ohio River.

The ultimate heat sink is designed to handle heat loads at a maximum river water temperature of 86°F. Therefore, in addition to specifying the minimum river level at which the station can operate, the technical specification will allow station operation only when the river temperature is less than or equal to 86°F. Average river water temperatures will be determined once every 24 hours. ~~The applicant has not provided sufficient information to assure that a 24-hour inspection interval is frequent enough so that rapid river water temperature changes do not result in a water temperature greater than 86°F between~~

inspection intervals. Therefore, the staff will require that the applicant provide information on how rapidly river water temperatures can rise in critical situations and how this is related to the 24 hour inspection interval. The applicant should provide assurance that the proposed inspection interval is frequent enough so that rapid water temperature changes do not result in water temperature being too high for safe operation of the ultimate heat sink.

Because the intake structure is located on the bank of the Ohio River, it is expected that suspended sediment in the river will accumulate in the lower part of the structure. The applicant states that silt accumulation in the intake structure will be monitored semi-annually in the spring and fall, and that silt exceeding a 15 inch allowable limit will be removed by a pumping operation. The 15 inch limit is based on experience gained from operation of BVPS-1. During periods of high river flows, which generally occur in the spring, silt could accumulate to levels exceeding 15 inches. However, the spring inspection will assure that silt does not accumulate to a level that will adversely affect SWS pump operability. Fall inspections at BVPS-2 have shown no appreciable silt buildup when silt was removed during spring inspections. The staff thus concludes that an allowable silt accumulation level of 15 inches and a semi-annual inspection interval are adequate to preclude sediment from accumulating to a level that could affect the capability of the service water pumps in the intake structure to obtain an adequate amount of cooling water for safety-related purposes.

The cooling water requirement for emergency shutdown is less than that required for normal operation. Therefore, since the staff concluded in Section 2.4.11.1 that the flow in the Ohio River is adequate for normal operation even under extreme drought conditions, the flow is also adequate for emergency operation. The staff thus concludes that the Ohio River meets the recommendations for an ultimate heat sink as set forth in Regulatory Guide 1.27 and the requirements of GDC-44 with respect to thermal aspects of the heat transfer system.

DRAFT:RGonzales:ws
11/29/84 (RGonzales-17)

BVPS INSERT

The 24 hour surveillance interval is the same as was established for BVPS-1. Since BVPS-1 began operating in 1976, the river temperture has never exceeded 86°F. Because the Ohio River drains such a large area, 23,000 mi² at the site, the temperature of the river water remains fairly constant and temperature changes are small and gradual. In order for the river temperature to exceed 86°F, a lengthy period of extreme warm weather would have to be experienced over the Ohio River drainage area. Even in this case, temperatures would increase very slowly. Since river water temperatures will be monitored frequently (every 24 hours) the staff concludes that even during an unusual warming trend, river temperatures will not increase too rapidly to allow safe shutdown of the plant should temperatures exceed 86°F.

AUG 06 1984

MEMORANDUM FOR: Thomas M. Novak, Assistant Director for Licensing
Division of Licensing

FROM: William T. Russell, Deputy Director
Division of Human Factors Safety

SUBJECT: BEAVER VALLEY, UNIT 2 - SER INPUT

As noted in my memorandum of July 5, 1984, we had arranged, as part of the LQB review of FSAR Chapters 13.1, 13.4 and 13.5.1, for a management audit meeting on July 10, 11 and 12, 1984. However, this meeting was cancelled as a result of a telephone conversation with the applicant in which the applicant told us that the Duquesne nuclear organization was in the process of major reorganization from the top down. It was apparent that the planned audit, which would have been based upon the existing FSAR description of the applicant's organization, should be postponed until the new organization is in place and is described in FSAR-type written material for our review. The applicant indicated that revised information will probably be available early in September, such that an audit meeting might be scheduled prior to an expected outage of Unit 1 around October 1. (The outage would effectively preclude the applicant's management personnel from participating in an audit meeting in October.)

Based upon a late September audit meeting, we estimate that our SER input covering SRP Sections 13.1, 13.4 and 13.5.1 will be provided by October 19, 1984.

/s/ William T. Russell
William T. Russell, Deputy Director
Division of Human Factors Safety

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