Date: 3/1/83

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In The Matter of	)	
	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket Nos. 50-454 OL
	)	50-455 OL
	)	
(Byron Nuclear Power Station, Units 1 & 2)	)	

SUMMARY OF TESTIMONY OF
LAWRENCE HOLISH REGARDING
CONSOLIDATED CONTENTIONS 39 AND 109

Mr. Holish is an engineer, employed by Sargent & Lundy, the Byron Station Architect-Engineer. He is Head of the Geotechnical Division at Sargent & Lundy, and was involved in the geologic and geotechnical work performed with respect to establishing the Byron foundation design criteria and for the Byron project design assessment. Mr. Holish's testimony addresses the assumptions used in determining the time it would take radioactive contaminants released to the groundwater to travel to the nearest well.

Mr. Holish first describes the hydrogeological and geological characteristics of the Byron site. He then discusses data, and his analysis of that data, which were derived from field pumping tests on wells located near the Byron site. Mr. Holish concludes that, based upon these data, the transmissivity of the rock is approximately 700

D503

gallons per day per foot of aquifer. Mr. Holish then concludes that because the transmissivity value utilized in performing the design basis event analysis for Byron was 2000 gallons per day per foot of aquifer, the 18 year travel time calculated for the design basis event is most likely conservative. Finally, Mr. Holish presents a general discussion of travel times which would be associated with a core melt scenario at Byron. He concludes that the travel time associated with such an event would be approximately 24 years, which would allow ample time to take action to interdict the flow of contaminated water thereby mitigating the consequences of the release of contaminants to the groundwater.

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TESTIMONY OF LAWRENCE L. HOLISH

Q1: Please state your name.

A1: Lawrence L. Holish.

Q2: By whom are you employed?

A2: Sargent & Lundy Engineers.

Q3: In what capacity?

A3: I am Head of the Geotechnical Division.

Q4: Please describe your educational and professional background.

A4: In 1963 I received a B.S. in civil engineering from Michigan Technological University. Since graduation I have been employed by the West Virginia Road Commission, Charleston, West Virginia, Stone and Webster Engineering Corporation, Boston, Massachusetts, and Sargent & Lundy Engineers for 2, 5, and 10 years, respectively. During these 17 years I have participated, and in most cases, provided administrative control of the investigation, evaluation, and design of foundations for 15 nuclear gener-

ating stations and 25 fossil fuel stations.

Prior to becoming Head of the Geotechnical Division at Sargent & Lundy, I was a Senior Soil Engineer. In that capacity I was responsible for the establishment and preparation of the technical criteria and procedures developed for the Byron Station foundation grouting program, and subsequent earth work. During the initial design and construction of the Byron Station, I provided the interpretation of geologic and geotechnical subsurface exploration data required for foundation design criteria and for subsequent project design assessment.

Q5: What is the scope of your testimony?

A5: My testimony addresses those aspects of consolidated Contentions 39 and 109 which bear upon the hydrological characteristics of the Byron site and the analyses which were performed regarding movement of groundwater.

Q6: Please describe the hydrogeological characteristics of the Byron Site.

A6: As a preface, it should be noted that a complete detailed description of the geologic characteristics of the Byron site is contained in Chapter 2.5 of the Byron FSAR. To aid in the understanding of the following description I have attached as Exhibit 1 to this testimony a stratographic column of the Byron site geologic formations.

The four most significant hydrogeologic units at the site are the glacial drift, the Galena-Platteville dolomites, the sandstone units of the Cambrian-Ordovician Aquifer (the St. Peter, Ironton and Galesville Sandstones), and the Mt. Simon Sandstone.

The site area is covered with a mantle of glacial drift consisting mainly of glacial till covered by a few feet of loess (windblown silt). A study of borehole logs at the site indicates that the thickness of the drift averages 16 feet. Due to the generally low permeability and thinness of the till, it is not possible to develop groundwater wells by drilling into the drift. The drift is recharged by precipitation.

Beneath the thin mantle of drift are dolomites and limestones of the Ordovician-age Galena and Platteville Groups. Borehole logs indicate that the thickness of the Galena-Platteville dolomites at the site range from 100 to 225 feet. The depth to the top of the dolomite equals the thickness of drift. The dolomites are extensively fractured near the top, with solutionally enlarged openings in places. These characteristics are not found at depth where the dolomites become dense.

In the site area, the Galena-Platteville dolomites are recharged by precipitation through the overlying glacial drift and discharge into the Rock River and its associated tributaries and into shallow domestic wells.

Regionally, the Galena-Platteville dolomites are hydraulically continuous with the lower sandstone units of the Cambrian-Ordovician Aquifer. However, in the vicinity of the Byron site, groundwater in the Galena-Platteville dolomites is perched on the Harmony Hill Shale Member of the Glenwood Formation which has low permeability. The low permeability of the Harmony Hill Shale Member was demonstrated by comparing the head relationships measured in observation wells. Specifically, piezometric levels in piezometers installed below the Harmony Hill Shale Member are at least 686 feet MSL, whereas piezometric levels in piezometers installed above the Harmony Hill Shale Member are at least 745 feet MSL.

The Glenwood Formation grades down into the thick sandstones of the St. Peter Sandstone. The Ordovician-age St. Peter Sandstone is permeable and has a relatively uniform lithology throughout the area. In the regional area, the St. Peter Sandstone is discharged primarily through wells for small municipalities, subdivisions, parks, and small industrial concerns.

Lower in the stratigraphic column are the Ironton and Galesville Sandstones comprising a portion of the aquifer which is about 150 feet thick in the regional area. In the site area, the Ironton and Galesville Sandstones are about 105 to 115 feet thick. The sandstones are discharged primarily through wells serving various industries and municipalities. The Ironton and Galesville Sandstones are considered the

best bedrock aquifer in northern Illinois because of their consistent permeability and thickness. Yields on the order of hundreds of gallons per minute may be obtained from the Ironton and Galesville Sandstones in wells less than 1,000 feet deep.

Below the Ironton and Galesville Sandstones is the Eau Claire Formation, about 405 feet thick. The basal part of the Eau Claire Formation and the underlying Mr. Simon Sandstone (which is about 1,430 feet thick) form the basal Cambrian-age Mt. Simon Aquifer. Wells which terminate in the Mt. Simon Sandstone have yielded many hundreds of gallons per minute.

Q7: Please describe the geologic characteristics of the Byron plant site.

A7: Within the Galena-Platteville dolomites is the Dunleith Formation which is the upper bedrock unit at the site and provides topographic control and forms the foundation of the power block safety related structures. This unit is slightly to moderately weathered as it is the upper bedrock unit. Solution activity has occurred along many of the joints, fractures, and bedding planes, and reddish-brown clays or yellow silty sands may be found along these planes.

The Dunleith Formation contains zones of thin green shale partings which are predominant in its lower portions. At the plant location, these shale partings grade in at approximate elevation 804.

During foundation preparation activities for the Byron Plant, 154 borings, ranging in depth from 5 to 317 feet, were drilled. Rock samples were cored from the bedrock using 2-3/4 inch diameter double tube core barrels. Results of the drilling indicate that the Dunleith formation is fractured, jointed, and thin bedded, but there are no large openings along joints and bedding planes. The variation in the quality of bedrock at the plant location results from vertical variations in lithology and the proximity of the boring to principal joints which traverse the site.

Four joint patterns are present in the site area: (1) a northwest trending pattern paralleling the regional structural trend; (2) a northeast pattern essentially perpendicular to the regional structure; (3) a north-south pathway transverse to the structure; and (4) an east-west pattern which is also transverse to the structure.

Based on analysis of areal photography data the joint patterns have a normal spacing of approximately 200 to 500 feet. Examination of bedrock exposures indicates that these four patterns are detectable below the surface, and that the spacing decreases with depth. Near surface joint patterns mapped in the plant area are reported in Chapter 2.5 of FSAR. Some joints are clean with openings ranging from 1/16 to 1/8 inches. Some joints are clay filled. Examination of outcrops and cores indicate that fracturing and weathering appears to decrease below the Dunleith-

Guttenburg Formational contact. Specifically, rock quality measurement values of rock in the Dunleith are always low whereas in the formations below the Dunleith rock quality measurement values are higher except near areas of joints. Zones of solution activity, low rock core recovery, and low rock quality measurements have served as channelways for the movement of groundwater, and examination of the rock cores suggest that solution activity has occurred along these channelways.

Because of these bedrock characteristics, it was decided to fill and seal all major solution enlarged joints, bedding plane, and other planar features of the bedrock by pressure rock cement grouting. The geologic descriptions indicated that grouting of the main plant area down to the Platteville-Ancell contact would significantly retard the downward and horizontal percolation of groundwater, and hence also limit the rate of solution activity. The grouting program is described in FSAR Attachments 2.5A and 2.5B.

Insitu testing of the grouted foundation rock mass verified that the grouting program resulted in making the rock mass significantly more impermeable than it had been prior to grouting. This would greatly restrict the seepage of any accidentally released effluents into the surrounding groundwater environment.

Q8: Have you performed any field tests designed to determine the water movement characteristics of the aquifer underlying the Byron site?

A8: Field pumping tests on wells located on the western edge of the site were conducted in June and July, 1974. These pumping tests were not conducted for the specific purpose of determining the water movement characteristics of the aquifer. Instead, they were conducted to determine whether there were significant levels of cyanide in the water drawn from these wells. At the time, we were concerned that well water may have been contaminated due to the existence of a land burial waste dump in the area. However, the data derived from these pumping tests is helpful in evaluating the water movement characteristics of the site area.

Q9: What conclusions do you derive from these pumping test data?

A9: Based on the pumping test results, we are able to determine the approximate rate at which the wells are recharged. Assuming a saturated thickness of 111 feet and 90 feet of the two wells, we calculated that the hydraulic conductivity of this portion of the aquifer to be 6.3 gpd/ft^2 for one well and 22.2 gpd/ft^2 for the other well. Hydraulic conductivity represents the volume of water which will flow through a unit area during a given period of time assuming a given hydraulic gradient. Based on the geophysical measurements made in site borings and from literature, we determined the effective porosity of this portion of the aquifer to range from 0.05% to 0.10%. The transmissivity characteristic associated with the aquifer,

based upon these data, would be approximately 700 gallons per day per foot of aquifer.

Q10: What was the transmissivity value utilized in performing the design basis event analysis?

A10: The design basis event regarding ground water contamination considers the postulated rupture of a boron recycle holdup tank and subsequent release of radioactivity into the ground water. For the analysis of the ungrouted bedrock we assumed a transmissivity value of 2000.

Q11: How does that value compare to the value derived from the pumping tests described above?

A11: The value utilized in performing the accident analysis assumes a higher transmissivity level; that is groundwater would travel faster under the assumed transmissivity level than it would under the level calculated from the pump testing data.

Q12: Are you able to draw any conclusions from the fact that a higher transmissivity value was used for the accident analysis than the value which was derived from the pumping tests?

A12: Yes, the groundwater travel times associated with the design basis event (i.e., approximately 18 years to reach the nearest well) are most likely conservative for the Byron site.

Q13: Are you aware of any other information which supports this conclusion?

A13: Yes. Subsequent to the interpretation of field collected effective porosity data, a comparison was

made to other sites where similar bedrock conditions have been encountered. The literature reviewed indicates the values of effective porosity measured at the Byron site are similar to those described by E. R. Ekren in his 1974 U.S. Geologic Survey Open File Report 74-158 entitled, "Geologic and Hydrologic Considerations for Various Concepts of High-Level Radioactive Waste Disposal in Conterminous U.S."

Q14: Have you considered the hydrogeologic aspects of a postulated core melt event at Byron?

A14: For the purpose of addressing concerns raised by the intervenors, we have performed two alternative qualitative evaluations of fluid flow, based upon the previously collected hydrogeologic properties, to interpret the groundwater flow in conjunction with the radionuclide release postulated from a reactor core meltdown scenario.

The first evaluation assumed the existence of most of the hydrogeologic parameters used in performing the boron tank analysis. Conservatively, only the hydraulic gradient was varied by assuming that the molten core would reach a depth of 20 feet below the reactor base-mat foundation. No credit for additional impermeability of the rock mass was taken despite the likely creation of ceramic surface due to melting of the shales in the Dunleith foundation bedrock or the initial hydraulic gradient reversal as the molten mass moves below the phreatic surface and flashes the groundwater to steam to be vented to the containment. The lower effluent egress elevation for the core melt mixing zone amounts to an 81% reduction in the hydraulic gradient.

The determination of travel time along the postulated pathway of the effluents from the unit one reactor core location to the nearest well is estimated to be approximately 24 years.

The second evaluation considers the approach of D. T. Snow as reported in the American Society of Civil Engineers Journal of Soil Mechanics, Foundation Division Volume 94, 1973. Snow's work indicates that, for a rock of given conductivity, the fracture porosity depends on the joint (fracture) spacing and to some extent on apperature widths and joint (fracture) orientations. He also reported that joint porosity decreases with depth approximately logarithmically although certain weathered zones were excluded from the study. For the Byron site, the principal joint systems spacing and patterns have been identified through air photo interpretation and examination of rock outcrops. In addition, 43 comprehensive detailed geologic maps were constructed of the main plant excavations and are reported in the FSAR. Detailed descriptions were provided of the foundation material type; the location, arrangement, attitude and apperature size of all joints and location of fault data. Based upon the (1) measured hydraulic conductivity of the foundation bedrock for both the grouted and ungrouted rock; (2) the closest continuous joint spacing noted during the geologic mapping program and; (3) a corresponding aperture opening, effective porosity was calculated. The effective porosity is 1/2 to as much as 10 times less than porosities determined from insitu water

pressure test and geophysical data collected at and adjoining the station site. The calculated reduction in porosity would reduce the effluent flow rate thereby increasing the radionuclide release travel time.

Q15: Are you aware of any steps which could be taken to reduce the flow of groundwater in the event of a radioactive release?

A15: Yes. Two possible methods exist. The first method consists of pumping and retrieving contaminated groundwater and storing it for treatment. This can be done by installing multiple groundwater wells at the perimeter of the Station's property that extend down to the Galina-Platteville formation. These wells would be close enough together so that the area the wells influence overlap to create an extensive drawdown of the groundwater and reverse the hydraulic gradient. Groundwater monitoring wells also would be installed down gradient from the spill at varying elevations.

The second method of retarding the flow of contaminated groundwater would involve constructing an impermeable barrier in rock. This could be accomplished through pressure rock cement grouting the entire Galena-Platteville rock formation down gradient from the spill.

AGE (MILLIONS OF YEARS BEFORE PRESENT)	SYSTEM	SERIES	FORMATION	GRAPHIC COLUMN	THICKNESS (FEET)	LITHOLOGY
	QUATERNARY	PLEISTOCENE[1]			0-113	ALLUVIUM, LOESS, TILL
430	ORDOVICIAN	CHAMPLAINIAN[1]	DUNLEITH		29.5-101.0	DOLOMITE, BUFF, MEDIUM GRAINED
			GUTTENBERG		3.5 - 6.0	DOLOMITE, BUFF, RED SPECKLED
			QUIMBYS MILL		7.0 - 13.0	DOLOMITE, BUFF AND GRAY
			NACHUSA		12.5 - 24.0	DOLOMITE AND LIMESTONE, BUFF
			GRAND DETOUR		30.0 - 46.0	DOLOMITE AND LIMESTONE, GRAY MOTTLING
			MIFFLIN		13.0 - 26.0	DOLOMITE AND LIMESTONE, ORANGE SPECKLED
			PECATONICA		14.5 - 31.0	DOLOMITE, BROWN, FINE GRAINED
			GLENWOOD		18.5 - 37.0	SANDSTONE AND DOLOMITE
			ST. PETER		100 - 600	SANDSTONE, FINE; RUBBLE AT BASE
		CANADIAN	SHAKOPEE[2]		0 - 67	DOLOMITE, SANDY
			NEW RICHMOND[2]		0 - 35	SANDSTONE, DOLOMITIC
			ONEOTA[2]		190 - 250	DOLOMITE, SLIGHTLY SANDY; OOLITIC CHERT
			GUNTER[1]		0 - 15	SANDSTONE, DOLOMITIC
500	CAMBRIAN	CROIXAN	EMINENCE[2]		50 - 150	DOLOMITE, SANDY; OOLITIC CHERT
			POTOSI[2]		90 - 220	DOLOMITE, SLIGHTLY SANDY AT TOP AND BASE, LIGHT GRAY TO LIGHT BROWN; GEODIC QUARTZ
			FRANCONIA		(100)	SANDSTONE, DOLOMITE AND SHALE, GLAUCONITIC
			IRONTON-GALESVILLE		(150)	SANDSTONE, MEDIUM TO FINE GRAINED, DOLOMITIC IN PART
			EAU CLAIRE		(400)	SILTSTONE, SHALE, DOLOMITE, SANDSTONE, GLAUCONITE
			MT. SIMON		(1500)	SANDSTONE, FINE TO COARSE GRAINED
600	PRE-CAMBRIAN					GRANITE AND GRANODIORITE, PINK AND GRAY

NOTES:

1. INDICATES UNITS ENCOUNTERED DURING SITE EXPLORATION.
2. INDICATES PRESENCE OF UNIT NOT VERIFIED AT SITE LOCATION.
3. THICKNESSES IN PARENTHESES ARE INFERRED FROM ISOPACH MAPS AT THE ILLINOIS GEOLOGICAL SURVEY.
4. THE SYMBOL ~~~ INDICATES THE PRESENCE OF AN UNCONFORMITY.

REFERENCE:

MODIFIED FROM: BUSCHBACH T.C., 1964, CAMBRIAN AND ORDOVICIAN STRATA OF NORTHEASTERN ILLINOIS: ILLINOIS GEOLOGICAL SURVEY, REPORT OF INVESTIGATIONS 218, p.16.

BYRON STATION

FINAL SAFETY ANALYSIS REPORT

FIGURE 2.5-8

REGIONAL STRATIGRAPHIC COLUMN

Exhibit 1