



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

AUG 28 1978

MEMORANDUM FOR: Robert E. Jackson, Chief
Geosciences Branch, DSS

THRU: Leon Reiter, Leader
Geology and Seismology Section
Geosciences Branch, DSS

FROM: Phyllis Sobel, Geophysicist
Geology and Seismology Section
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SUBJECT: DR. DAVID SIMPSON'S REVIEW OF LAKE JOCASSEE SEISMICITY

The three unit Oconee Nuclear Power Plant is located approximately 11 miles downstream from the Lake Jocassee Dam in northwestern South Carolina. Beginning in 1976 the NRC staff reviewed the potential impact of reservoir induced earthquake activity at Lake Jocassee on Jocassee Dam and the Oconee plant. Dr. David Simpson was asked to provide technical assistance to the NRC staff in their review. Dr. Simpson's contract (Order No. DR-77-1203) expired February 28, 1978. The contract specified that he would write an original comprehensive final report. However, the report was not written and the NRC staff has therefore not finished their review. I recommend that Dr. Simpson's contract be extended until February 28, 1980 so that he can provide the final report.

Background

The Jocassee hydro station in Oconee County, South Carolina was built by the Duke Power Company in the early 1970's. The lake was filled in January 1975 and maximum head was first achieved on March 15, 1975. The region had been one of low seismic activity. The first reported earthquake in the area occurred on August 12, 1973.

On October 18 and November 6 and 25, 1975, after the reservoir filling, three earthquakes were felt in the vicinity of the dam. The largest event was a magnitude (ML) 3.2 earthquake on November 25, 1975. The maximum estimated intensity of this event was III-IV (MM). In December, 1975 the Jocassee Hydro Consulting Board concluded that the largest earthquake would have no detrimental effect on the dam. However, the Board recommended that Duke Power coordinate the investigations of the University of South Carolina, Georgia Tech, and Law Engineering in evaluation the significance of these events and establishing a seismic monitoring program.

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Beginning after the October 18, 1975 earthquake, a network of portable seismographs were deployed in the vicinity of Jocassee reservoir. In an August 1976 report entitled "The Jocassee Earthquakes," Pradeep Talwani and other investigators at the University of South Carolina reported on the first six months of seismic monitoring (November 1975 to May 1976). Over one thousand events were recorded between November 8, 1975 and May 31, 1976. Fifteen felt events occurred between December 8, 1975 and June 2, 1976. The number of recorded events rarely exceeded 10 events per day.

The seismic activity at Lake Jocassee was associated with the impoundment of over 100 m of water behind Jocassee dam. The initial activity was centered near the dam and the epicentral volume increased with time while centering on the lake. Several possible precursors to the larger earthquakes were noticed, including (1) ts/tp ratio anomalies, (2) changes in b-values and (3) a lull in a period of increased seismicity before the larger earthquake.

During their May 20, 1976 meeting, the Jocassee Hydro Consulting Board concluded that the data did not suggest a hazard to the dam. The Board concurred with the Duke decision to terminate the seismic network on June 30 and replace it with a permanent high sensitivity seismograph that is integrated into the South Carolina network.

Initiation of NRC Review

Beginning in 1976 the NRC staff reviewed the potential impact of reservoir induced earthquake activity at Lake Jocassee on Jocassee dam and the Onocee Nuclear Power Plant located about 11 miles downstream. From March 1, 1977 through February 28, 1978, Dr. David Simpson was under contract to the NRC to provide technical assistance to the NRC staff. Dr. Simpson is a recognized authority and qualified expert in the very specialized field of research relating to reservoir-induced seismicity. He has worldwide experience in this area and his expertise would insure that the staff would review this situation in the best manner.

From June 1976 to December 1978 seismic monitoring continued and the level of seismic activity remained low. The average number of events per day was about one or two and the maximum earthquake was magnitude (M_L) 2.6. Before June 1976 the events occurred at depths of less than 2km; since June 1976 the seismicity deepened but there was no further growth in epicentral area. Pradeep Talwani has suggested that the large events ($M_L > 2.0$) occur after a sustained period of lake level increase.

Lake Keowee Seismicity

While monitoring seismic activity near Lake Jocassee, a series of earthquakes was observed from December 29, 1977 to February 27, 1978 near Lake Keowee (15 or 20 km south of Lake Jocassee and 2 to 4 km west of the Oconee plant). A portable seismic network was installed in the area. The seismic activity was in the form of an earthquake swarm, with nearly 100 or more events per day between January 4 and 7, 1978. The level of seismic activity was low ($M \leq 2.2$). Before the swarm began fourteen possible Keowee events had been recorded by the Lake Jocassee network. Also it appeared that the July 13, 1971 Seneca earthquake (maximum intensity IV and 3.8 M_L) was located near the Keowee activity. The Seneca earthquake occurred after the last period of rapid filling of Lake Keowee in April 1971. This suggests that the area of the Keowee earthquake swarm has had a history of seismic activity which was possibly associated with Lake Keowee. The seismicity was probably undetected due to lack of instrumentation in the epicentral area. On January 19, 1979 a magnitude (M_L) 2.8 earthquake occurred in the same area a few weeks after the raising of the lake level by about 10 feet.

Recent Seismicity at Lake Jocassee

Pradeep Talwani has continued the seismic monitoring at Lake Jocassee with a three-station network funded by the U. S. Geological Survey. On August 25, 1979 a magnitude 3.6 earthquake occurred within the seismic network. The preliminary location is shown on the enclosed map. This event was felt in South Carolina, North Carolina and Georgia. There are no confirmed reports of damage. The generators at the Jocassee hydro station were tripped. The accelerometers at the Oconee plant were not triggered; I am currently investigating what their trigger level is. The morning after the event, portable seismometers were deployed to monitor for aftershock activity. I will inform you of any additional earthquake activity in the area.

Extension of Dr. David Simpson's Contract

The NRC contract with Dr. Simpson (enclosed) specified that upon completion of the inquiry and evaluation of the data, Dr. Simpson would submit a final report to the NRC which would provide his findings, conclusions and recommendations concerning the potential hazard presented by the Jocassee Dam to the Oconee Plant site. The final report was not written and the NRC staff will not be able to complete their review without the report. Since Dr. Simpson's Contract (Order No. DR-77-1203) expired February 28, 1978, we request that Dr. Simpson's contract be extended until February 28, 1980 so that he can provide the final report. Dr. Simpson's report would help us close out this review and also be helpful in analyzing reservoir induced seismicity at other sites in the southeastern U. S.

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