NATHAN M. NEWMARK
CONSULTING ENGINEERING SERVICES
111 TALBOT LABORATORY, URBANA, ILLINOIS

DOCKET NO. 50-249

25 May 1966

RECEIVED
'66 MAY 27 PM 4 48
U.S. ATOMIC ENERGY COMM
REGULATORY
MAIL SECTION

Mr. Edson G. Case, Assistant Director
Division of Reactor Licensing
U. S. Atomic Energy Commission
Washington, D.C. 20545

Re: Contract No. AT(49-5)2667
Dresden Nuclear Power Station Unit 3

Dear Mr. Case:

In accordance with your request, Dr. W. J. Hall and I have reviewed the design and analysis report for the above-mentioned nuclear reactor, and we send you herewith three copies of our comments. This is a preliminary draft which we shall be glad to review and revise after you have had an opportunity to consider our questions and comments.

Thank you for your cooperation.

Sincerely yours,

N M Newmark

N. M. Newmark

bjw
cc: W. J. Hall
Enclosures (3)

ACKNOWLEDGED

1548

NATHAN M. NEWMARK
CONSULTING ENGINEERING SERVICES
111 TALBOT LABORATORY, URBANA, ILLINOIS

DRAFT

Report to AEC Regulatory Staff

ADEQUACY OF THE STRUCTURAL CRITERIA FOR THE DRESDEN NUCLEAR POWER STATION UNIT 3

(AEC Docket No. 50-249)

by

N. M. Newmark and W. J. Hall

May 1966

ADEQUACY OF THE STRUCTURAL CRITERIA FOR THE DRESDEN NUCLEAR POWER STATION UNIT 3

by

N. M. Newmark and W. J. Hall

INTRODUCTION

This report is concerned with the adequacy of the containment structures and components for the 715 MWe (net) Dresden Nuclear Power Station Unit 3, hereafter referred to as Dresden Unit 3, for which application for a construction permit and operating license has been made to the United States Atomic Energy Commission by the Commonwealth Edison Company. The facility is located along the Illinois, Des Plaines, and Kankakee Rivers, in Grundy County, Illinois, about 50 miles southwest of Chicago, Illinois. Dresden Unit 3 will be constructed immediately adjacent to, and to the west of, Dresden Unit 2, which in turn is west of the original Dresden Unit 1. Dresden Unit 2 is now under construction.

Specifically, this report is concerned with the evaluation of the design criteria that determine the ability of the primary and secondary containment systems to withstand a design earthquake of 0.1g maximum transient ground acceleration simultaneously with the other loads forming the basis of the containment design. The facility also is to be designed to withstand a maximum earthquake loading of 0.2g to the extent of preserving the ability to maintain the plant in a safe shutdown condition.

This report is based on information and criteria set forth in the Plant Design and Analysis Reports (PDAR), and supplements thereto, as listed at the end of this report, and on information contained in our earlier report on Dresden Unit 2 (Ref. 4). Also, we have participated in discussions with the AEC Regulatory Staff concerning the design of this unit.

DESCRIPTION OF THE FACILITY

Dresden Unit 3 is described in the PDAR as a 2,255 MWt (715 MWe net)single-cycle forced circulation boiling water reactor that produces steam for direct use in the steam turbine. In most respects the design is essentially identical to that of Dresden Unit 2.

The primary containment system, which houses the reactor vessel and the recirculation system, consists of the drywell, vent pipes, and a structure shaped like a torus, which contains a pool of water, for pressure suppression purposes; the center of the torus lies slightly below the bottom of the drywell. The drywell and all other aspects of the primary containment system appear to be identical to those of Dresden Unit 2, as described in Ref. 4.

The reactor building provides secondary containment when the primary containment is in service, and also serves as a primary containment structure during periods when the primary containment is open for servicing purposes. Thus, this building, together with the standby gas treatment system and a 310 ft. stack, provide the secondary containment barrier. The reactor building serves as a common secondary containment for both Units 2 and 3. A new 310 ft. stack is to be provided with this dual Unit 2 and 3 design. A new stack was not noted as part of the original Dresden Unit 2 design, which was intended to use the same stack as Unit 1, originally. The common reactor building, which is a controlled leakage structure, appears to be similar in design in terms of the foundation and superstructure to that previously described for Dresden Unit 2 (Ref. 4).

SOURCES OF STRESSES IN CONTAINMENT STRUCTURES AND TYPE 1 COMPONENTS

The primary containment system, which includes the drywell, vents, torus, and penetrations, is to be designed for the following conditions, as noted on page V-3-1 of Ref. 1: pressure suppression chamber internal design pressure, + 62 psig, and - 1 psig; drywell internal design pressure, + 62 psig, and - 2 psig; initial suppression chamber temperature rise, 50^{o} F; and initial suppression chamber pressure rise, 21 psi max. As noted on page V-6-1 and following of PDAR Vol. 1, the aseismic design of the primary containment system, which is classified as a Class I -- Critical Structure, will be based on dynamic analyses using response spectrum curves corresponding to a 0.1g design earthquake. It is further noted that the design will be such that a safe shutdown can be made during a ground motion of 0.2g, or in other words, for a maximum earthquake with twice the intensity of the basic design earthquake. All structures will be designed to withstand a wind velocity of 110 mph, and where failure possibly could affect the operations and functions of the primary containment and reactor primary system, the design is to be made to assure that safe shutdown can be achieved, considering the effects of possible damage arising from a short term tornado loading.

The reactor building, which comprises the secondary containment system, is listed as a Class I -- Critical Structure. The reactor building is to be designed to withstand an internal pressure of 7 in. of water (about 1/4 psi) without structural failure and without pressure release. The aseismic design of the structure is to be made for forces (supposedly coincident with dead load, snow load, and other applicable operating loads) for design and maximum earthquakes as noted for the primary containment. The structure is to be designed to withstand a wind velocity of 110 mph, and again, for short-term tornadic loadings, safe shutdown of the plant is assured.

The Class I -- Critical Equipment, which includes the nuclear steam supply systems and the reactor cooling and standby systems among other items, and falling within the classification of Class I -- Critical Structure or Class I -- Critical Equipment, as listed in Section V-6 of PDAR Vol. 1, are to be designed to withstand the same aseismic forces as noted earlier for the primary and secondary containment systems, in conjunction with other applicable loads.

COMMENTS ON ADEQUACY OF DESIGN

Seismic Design Criteria -- We agree with the approach adopted, which is identical to that adopted for Dresden Unit 2, namely that of basic design for a design earthquake of 0.1g, with the provision that a safe shutdown can be made for a maximum earthquake of twice this intensity.

The design spectra presented as Figs. 54 and 54a of PDAR Vol. II are identical to Fig. 54 and Fig. II-15-1 of the Dresden Unit 2 application, and we concur in the use of these spectra for the dynamic analyses.

On page V-6-5 of PDAR Vol. I, it is noted that the vertical acceleration will be taken to be equal to two-thirds the horizontal ground acceleration. It is also noted that for the design of Class I structures and equipment, the maximum horizontal acceleration and the maximum vertical acceleration will be considered to occur simultaneously, and we concur with this approach. It is further noted that where applicable, the resulting seismic stresses for the two motions will be combined linearly. As noted in our report for Dresden Unit 2, (Ref. 4) we gather that the interpretation of this latter statement is to the effect that the maximum stresses which occur simultaneously at a particular location will be added directly to the stresses arising from other loadings, for example dead load, pressure, wind, thermal effects, etc., in arriving at or checking the design. On the assumption that this interpretation is correct, we concur in the approach.

For the 0.2g maximum earthquake, and safe shutdown, it is noted that functional load stresses probably will not exceed yield stress, but in case they do, analysis will be made to assure that the resulting deflections or distortions will not prevent proper functioning of the structure or pieces of equipment and will not endanger adjacent structures or components. This criterion appears reasonable to us.

The table of damping coefficients given on page V-6-2 is identical to that given on the same page for the Dresden Unit 2 design, and accordingly we must concur in the values given therein. However, by way of comment, and suggestion for consideration, we should note that as a result of more recent considerations in the case of the damping for reinforced concrete structures, which constitute an integral part of the primary containment, or which could play a significant role in the ability of the containment to function properly in terms of leakage and otherwise, we have suggested that about 5% damping is appropriate for structures and components relatively unimportant for safety; not more than 2% appears appropriate for those of great importance to safety. Thus in terms of the primary containment, one should consider a lower value of damping, of about 2%, in connection with certain portions of the primary concrete containment and suppression system.

The design of the new stack is treated generally in Section V-6 of PDAR Vol. I, and further comment is given in Amendment No. 1 to the PDAR (Ref. 3) on page B-1-1. The latter description indicates that a formal dynamic analysis will be made involving both earthquake forces and wind forces, for forces corresponding to a 0.2g maximum earthquake and a tornado wind velocity of 300 mph respectively. It is noted that consideration has been given to the possibility of a stack toppling, and the possible sources of difficulty which this could provide. It appears that the falling stack probably would not jeopardize the ability to shut down the reactor safely, but this is a factor which should be given careful consideration. Attention should be paid to the possibility of the stack failing at a low elevation unless it is specifically designed not to do so.

No details were noted concerning specific attention to the strengthening of areas around penetrations of the containment, particularly in the primary containment area. In the case of large penetrations especially, care should be taken to ensure that these items will maintain the required strength and ductility under earthquake and service loadings; this matter should receive special attention.

No special mention of cranes is made in the report. The possibilities of the effects of earthquake-type loadings on the stability of cranes should be studied carefully to be sure that these will not fail or topple and cause serious damage or in other ways hinder the proper operation of the facility.

<u>Primary and Secondary Containment Structures</u> -- Tables of allowable stresses for the primary and secondary containment design are presented on pages V-6-3 and V-6-4 of PDAR Vol. I. These tables appear to be essentially similar to tables presented in Amendment No. 4 for Dresden Unit 2; the tables

appear to be in agreement with applicable codes, or in other cases appear reasonable to us.

As we noted in the report for Dresden Unit 2, the selection of a wind velocity of 300 mph as being applicable in a tornado may be open to question. Some studies indicate that a value as much as 500 mph may be more reasonable. Probably this higher velocity would not affect the design of the primary containment structure or the ability to achieve a safe shutdown. On the other hand, the higher wind velocity may have an effect on the stack and the reactor building, and it is suggested that this factor be considered in assessing the over-all safety of the design.

A study of the PDAR documents indicates that the piping appeared to meet the applicable ASME and ASA code provisions as in the case of Dresden Unit 2, and no further comment is made herein on this matter. The pipe penetrations appear to be similar to the previous design also. It is noted also on page V-2-1 and in several other places in PDAR Vol. 1 that provisions will be made to accommodate the jet forces resulting from postulated rupture of any pipe connecting to the reactor vessel, and that the design will be made to prevent containment failure as a result of such an accident. We were also pleased to note, as for example on page V-3-5, the more definitive criteria concerning the NDT properties for the steel drywell shell. Such an approach lends confidence to the ability of the shell to withstand rupture or fracture not only from an accident, but from external loadings that might affect the integrity, as for example, earthquake loading.

CONCLUSIONS

In keeping with the design goal of providing serviceable structures and components with a reserve of strength and ductility, and on the basis of the information presented, we believe the design criteria outlined for the primary containment, secondary containment, and Type 1 piping, can provide an adequate margin of safety for aseismic resistance.

In the body of our report we have noted several items which deserve further consideration on the part of the applicant.

REFERENCES

1. "Plant Design and Analysis Report--Volume I," Dresden Nuclear Power Station Unit 3, Commonwealth Edison Company, 1966.

2. "Plant Design and Analysis Report--Volume II," Dresden Nuclear Power Station Unit 3, Commonwealth Edison Company, 1966.

3. "Plant Design and Analysis Report--Amendment No. 1 -- Answers to AEC Questions," Dresden Nuclear Power Station Unit No. 3, Commonwealth Edison Company, 1966.

4. "Adequacy of the Structural Criteria for the Dresden Nuclear Power Station Unit 2," Report to the AEC Division of Reactor Licensing, by N. M. Newmark and W. J. Hall, September 1965.