SAFETY EVALUATION REPORT

STRUCTURAL UPGRADE PROGRAM

R. E. GINNA NUCLEAR POWER PLANT

I. INTRODUCTION

In response to staff safety evaluations prepared under the Systematic Evaluation Program (SEP) Topics II-2.A, Severe Weather Phenomena (Ref. 1); III-2 Wind and Tornado Loadings (Ref. 2); III-4.A, Tornado Missiles (Ref. 3); III-6, Seismic Design Considerations (Ref. 4); and III-7.B, Design Codes, Design Criteria and Load Combinations (Ref. 5), Rochester Gas and Electric Corporation (RG&E) proposed to review the concerns given in each safety evaluation report (SER) and submit a plan that would address those concerns collectively in a Structural Upgrade Program (SUP).

By letter dated April 22, 1983 (Ref. 6), RG&E submitted the results of their review and their proposed course of action which the staff subsequently approved in the Integrated Plant Safety Assessment Report NUREG-0821 Supplement No. 1 dated August 1983 (Ref. 7). Modifications to the details of the original design criteria were discussed in meetings with the staff. By letter dated July 13, 1984 (Ref. 8), RG&E summarized changes to the original design criteria and presented the results of a structural stability assessment as well as responses to all open items in the staff SER.

During the course of performing analyses, the licensee proposed modifications or refinements to the details of the design criteria while keeping the overall criteria and intent of the SUP intact. The overall intent is to assure the ability to safely shutdown and to preserve structural stability such that no gross collapse of a critical structure occurs for extreme environmental events.

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Items such as siding failure or local member failure are permissable provided that the ability to safely shutdown is not jeopardized. In addition to safe shutdown, the licensee will maintain the integrity of reactor coolant pressure boundary and assure the capability to prevent accidents which could result in offsite exposures greater than the guidelines given in 10 CFR Part 100.

The loadings used for the analysis are a 132 mph tornado, a 75 mph normal wind plus a 40 psf normal ground snow, and a 100 psf extreme snow. Modifications to the original criteria proposed as the effort progressed are as follows:

1. The screenhouse was eliminated from the scope of structures considered for upgrade because the structure is not required to achieve plant shutdown.

2. Computer results were reviewed against the actual structural configurations because the computer models idealized the actual structures.

3. The Turbine Building operating floor live load was reduced from 1000 psf to 100 psf because the larger load is only present during turbine generator maintenance when the plant is shutdown.

4. Members with excessive kl/r ratios were evaluated to determine actual load carrying capacity.

5. Modifications for members whose failure would not damage required safety equipment were deleted.

6. Individual or groups of anchorages and/or actual connections were evaluated instead of using a statistical projection.

Any members found overstressed, considering the above, were then reevaluated considering:

1. The live loads were reduced to 25% of the loads shown on the construction drawings for all floors other than the turbine building operating floor.

2. Steel yield stress was increased from fy to 1.2 fy to account for higher yield stresses in steel than the minimum specified.

3. The original criteria specified a 0.4 psi differential pressure without accounting for existing openings (e.g., doors, windows, HVAC openings, etc.) that would provide venting. This revision to the criteria will account for existing openings and, if necessary, additional vent area will be provided to eliminate or reduce the differential pressure loads.

The results of the wind speed hazard studies were discussed with the Advisory Committee for Reactor Safeguards (ACRS). The ACRS requested an estimate of the capability of the structures to maintain overall integrity with no stability failure for windspeeds greater than the proposed design windspeed of 132 mph. To comply with the ACRS request, the licensee undertook an evaluation to determine, using realistic rather than conservative assumptions, the collapse capacity of their structures. These assumptions are described in Ref. 8. The licensee concluded that structural stability will be maintained to windspeeds approaching 200 mph. Details of the analysis and conclusions were presented to the ACRS on April 4-5, 1984. The ACRS concurred with these results by letter dated April 9, 1984 (Ref. 9), but recommended that the staff consider the operability of the diesel generator during the reduced pressure transient accompanying a tornado.

The licensee has described detailed implementation plans for the SUP that generally provide for plant-specific design features and more realistic load combinations for postulated extreme environmental events. These provisions satisfy the original intent of the SUP, to ensure the capability for safe shutdown in such events, and are consistent with sound engineering practices.

The reduction of live load in the turbine building is reasonable because the live load used in design of the turbine building would only occur during maintenance periods and would not be continuously present. Reduction of live load for other floors to 25% of design live loads is also reasonable, because those loads are similarly conservative conditions that would usually only occur during maintenance or rare transient conditions. Full design live load most likely will never occur as loads are often overestimated for conservatism. Additionally, it is unrealistic from a probabilistic viewpoint to assume full live load is present during the same time period when a rare event, such as a tornado, occurs.

Accounting for higher yield stress than minimum specified, although reducing the conservatism, is realistic because the actual material yield is higher than the minimum specified in almost all instances. For example, Gaylord (Ref. 10) reports that 3,974 mill test specimens from 33,000 tons of A7 steel resulted in a yield stress below 35 ksi in about 5% of the specimens with perhaps 2% below 33ksi and more than 33% had yield stresses greater than 40 ksi. The minimum specified yield stress for A7 steel is 33 ksi. The licensee has chosen to increase the yield stress by 20%. Yield stress level is affected by such things as material thickness, strain rate of testing and specimen position. Steel tested at low strain rates as performed in a laboratory exhibit lower yield stress than tests performed at higher strain rates, as in the case of ASTM tests. Beedle (Ref. 11) reports that this difference can range from 15-20% and Gaylord (Ref.10) states that yield stress performed at a slow strain rate (zero strain rate) may be 10-15% lower than the yield stress reported in rolling mill acceptance tests.

Tests on 165 samples of A36 steel at Lehigh University using a slow strain rate resulted in an average yield stress of 39.4 ksi. The above information by Beedle and Gaylord indicates that testing the samples at higher strain rates would have resulted in an average yield that the licensee has proposed to use. Considering this and the margin shown to collapse in conjunction with the intent of the SUP at Ginna, namely to assure structural stability, the staff concludes that the increase in yield stress used in the analyses is acceptable.

The licensee's intent to account for existing openings or provide additional venting area to reduce differential pressure loads is a refinement of the original overall analysis and is acceptable to the staff. In Section D of the licensee's July 13, 1984 submittal, the licensee described the criteria that will be used when designing modifications and analyzing plant structures. The staff has reviewed these criteria and concludes that they will provide reasonable assurance of structural integrity, based on comparisons to contemporary design practices, with the following comments and clarifications.

1. Live loads to be used in conjunction with the extreme loadings will be 25% of loads shown on the plant construction drawings. This proposal is reasonable for reasons discussed earlier.

2. The licensee has proposed to use an operating thermal load of 2.5% of the dead load and include it as part of the dead load. In general, this is acceptable; however, the licensee should assess actual thermal loads for any regions known to have high operating temperatures (e.g., concrete surrounding the reactor vessel) or where additional dead load may increase structural resistance.

3. The licensee has proposed to include actual pipe loads where the reactions will be large, such as from main steam and feedwater systems, and to include lesser pipe reactions as 2.5% of dead loads. By considering major reactions independently from smaller loads, the approach proposed is reasonable.

4. The licensee has proposed to use a 75 mph wind load based on ANSI A58.1-1982, except that the wind profile will not vary with height and pressure will be uniformly applied to the windward face. Use of ANSI A58.1-1982 is acceptable and uniformly applying the wind pressure should not create too large a difference from ANSI requirements since ANSI applies a uniform wind pressure between 0-30 feet above grade before gradually increasing the pressure with height. However, ANSI requirements regarding sidewall pressures and leeward pressures should be adhered to.

5. The licensee has proposed not to upgrade siding and decking for extreme loads. This is acceptable since siding and decking failure will not cause structural collapse; however, any loads imparted by the decking or siding to the main structural frame should be included in the analysis. Additionally, it must be assured that any roof decking failure from snow loads will be local.

In Section E of the liensee's submittal, each of the open items identified by the staff is addressed as follows:

1. The staff does not consider the use of a pressure drop of .4 psi by the licensee versus the .46 psi calculated by the staff to be significant. This is especially true in light of the licensee's proposal to utilize openings to eliminate differential pressure loads.

2. Considering missiles, the licensee previously committed to re-examine the effects of tornado-induced missile impacts on primary structural members. Using methods previously approved by the staff, the licensee concluded that a 132 mph windspeed does not provide enough aerodynamic lift to permit the utility pole

(i.e., the limiting missile) to become airborne. At speeds approaching 200 mph, the utility pole can become airborne for short distances; however, the probability of the missile striking a steel member and causing failure is low given that the probability of exceeding a 188 mph tornado is approximately 10^{-6}/yr. Considering that the probability of exceeding a 132 mph tornado is approximately 10^{-5}/yr, the staff concludes that the probability of generating missiles and causing damage to the structural framing is sufficiently low.

3. The licensee has made a previous commitment to examine the local effects of peak pressures on primary members. By demonstrating structural stability to 200 mph using average pressure, the licensee has provided assurance that the primary structure will be stable for a 132 mph tornado peak pressure.

4. The licensee committed to reexamine roof decks for potential buckling. In the July 13, 1984 submittal, the licensee states that the buckling load is greater than the yield stress of the roof decking and that calculated stress in the roof deck is less than 1.6 times allowable and less than yield and, therefore, buckling will not occur. While this explanation is acceptable to the staff, the licensee should confirm this conclusion considering lengths and shape of the decking and noting that elastic buckling can occur for long, unsupported lengths.

5. The licensee has committed to reexamine the control building east wall and the reinforced concrete structures of the diesel generator building.

The licensee has relied on the seismic analyses performed by Lawrence Livermore Laboratory (NUREG/CR-1821) as part of

SEP Topic III-6 (Seismic Design Considerations), to conclude that the main structural elements are stable for earthquakes. However, the licensee will review steel code changes concerning coped beams, moment connections and steel embedments relative to seismic loads and load combinations as part of the Structural Upgrade Program. Although conclusions regarding overall integrity were developed under Topic III-6, the licensee should assure that those conclusions remain valid when considering seismic loads in combination with other loads (e.g., pipe reaction, thermal, pipe break, etc.) Subject to this confirmation, the staff concludes that the licensee's approach to resolve seismic loads is acceptable.

In Section G of the licensee's submittal, tornado missile protection is addressed. As stated in previous submittals, the licensee is evaluating (1) structures, systems and components necessary to achieve and maintain save shutdown (2) the surface of the spent fuel pool; (3) the reactor coolant pressure boundary and main steam and feedwater lines; and (4) items whose failure could cause inadvertent operation or failure of safety-related equipment. The licensee has previously proposed to consider systems necessary to prevent offsite doses from exceeding 10 CFR Part 100. The conclusions and approaches presented in Section G are acceptable to the staff with the following comments:

1. The licensee has committed to evaluate the effects of failure of masonry block walls on steam and feedwater lines and related items such as main steam isolation solenoid valves and auxiliary feedwater system connections..

2. The licensee has analyzed the effect of a utility pole entering the pool as part of proposed Technical Specification changes. This analysis is conservative because, as

previously described, the licensee has demonstrated that the design windspeed will not cause the utility pole to become airborne.

3. The licensee has committed to prevent blockwalls from entering the spent fuel pool.

4. The licensee has committed to provide additional missile protection to the diesel generator building, the east wall of the control building, and the power supply and piping associated with one auxiliary feedwater pump.

5. The licensee will assure sufficient instrumentation to monitor safe shutdown conditions and perform an evaluation of the effects of depressurization on diesel generator operability, as requested by the ACRS.

III. CONCLUSIONS

As a result of the evaluation described above, and in conjunction with previous staff conclusions presented in NUREG-0821 and its Supplement, the staff concludes that the analysis methods, assumptions and acceptance criteria specified for the Ginna Structural Upgrade Program are acceptable. The staff further concludes that, when all of the resulting plant modifications are complete, the implementation of the Structural Upgrade Program will provide reasonable assurance that the Ginna plant can safely shutdown following specified extreme environmental events. This conclusion is subject to the following conditions and recommendations:

1. The licensee should assess actual thermal loads for use in load combinations for any areas of the plant known to have high operating temperatures (e.g., concrete surrounding the reactor vessel).

2. Straight wind loads should be applied to windward, leeward and side walls as prescribed by ANSI A58.1-1982.

3. Although portions of siding and decking are permitted to fail, any loads imparted by the siding or decking to the steel frame should be considered in the analysis. It is not acceptable to assume all siding blows off and reduces load applied to the steel frame.

4. If portions of the roof decking are permitted to fail from snow loading, the licensee should assure that the failure is local and consequences are acceptable.

5. In demonstrating the adequacy of roof decks, the licensee should account for buckling, taking into account such factors as unsupported lengths, deck shape, and noting that elastic buckling can occur for long, unsupported lengths.

6. The licensee has committed to examine the east wall of the control building and portions of the diesel generator for tornado winds and missiles.

7. The licensee should assure that previous conclusions reached regarding seismic capability developed in SEP Topic III-6 remain valid considering seismic loads in combination with other loads.

8. The licensee has committed to evaluate the effects of masonry blockwall failure on main steam and feedwater lines and associated valves, and to prevent the walls from entering the spent fuel pool.

9. The licensee has committed to assure operability of the power supply and piping associated with one auxiliary feedwater pump, assure sufficient instrumentation to monitor safe shutdown conditions, and to perform an evaluation of the effect of depressurization on diesel generator operability.

IV. REFERENCES

1. Letter, November 3, 1981 from Crutchfield (NRC) to Maier (RG&E), Subject: SEP Topic II-2.A, Severe Weather Phenomena.

2. Letter, April 21, 1982 from Crutchfield (NRC) to Maier (RG&E), Subject: SEP Topic III-2, Wind and Tornado Loadings, R. E. Ginna Nuclear Power Plant.

3. Letter, April 16, 1982 from Crutchfield (NRC) to Maier (RG&E), Subject: SEP Topic III-4.A, Tornado Missiles - R. E. Ginna Nuclear Power Plant.

4. Letter, January 29, 1982 from Crutchfield (NRC) to Maier (RG&E), Subject: SEP Safety Topics III-6, Seismic Design Consideration and III-11, Component Integrity - Ginna Nuclear Power Plant.

5. Letter, April 21, 1982 from Crutchfield (NRC) to Maier (RG&E), Subject: SEP Topic III-7.B, Design Codes, Design Criteria and Load Combinations - R. E. Ginna Nuclear Power Plant.

6. Letter, April 22, 1983 from Maier (RG&E) to Crutchfield (NRC), Subject: Structural Reanalysis Program, SEP Topics II-2.A, III-2, III-4.A and III-7.B, R. E. Ginna Nuclear Power Plant Docket No. 50-244.

7. Integrated Plant Safety Assessment Report, Supplement No. 1 (IPSAR), Systematic Evaluation Program, R. E. Ginna Nuclear Power Plant NUREG-0821, Supplement No. 1.

8. Letter, July 13, 1984 from Kober (RG&E) to Crutchfield (NRC), Subject: Structural Upgrade Program, SEP Topics II-2.A, III-2, III-4.A, and III-7.B, R. E. Ginna Nuclear Power Plant, Docket No. 50-244.

9. Letter, April 9, 1984 from Ebersole (NRC-ACRS) to Palladino (NRC), Subject: ACRS Report on Full Term Operating License for the R. E. Ginna Nuclear Power Plant.

10. Gaylord, E.H. and Gaylord, C.N., "Design of Steel Structures," McGraw-Hill Book Company, 1972.

11. Beedle, L.S., "Plastic Design of Steel Frames," November 1966.

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