Design Analysis

Reactor Trip System Reliability

Rochester Gas and Electric Corporation

89 East Avenue

Rochester, New York 14649

EWR 3698

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1.0 Purpose

1.1 The primary objective of this analysis is to establish an estimated failure rate for the Reactor Trip (RT) breakers. The analysis will be based on historical data taken at Ginna Station over a 16 year period. An assessment will also be made of the impact of 12 additional RT breaker tests on the derived maximum failure rate. The validity of the analysis is based on specific maintenance activities being performed and the testing program being sufficiently comprehensive. Therefore, the maintenance and test activities are described along with the analysis.

1.2 The primary purpose of Generic Letter 83-28 was to achieve a high reactor trip system reliability by requiring the addition of a diverse tripping feature (STA) on each breaker, the inclusion of independent testing of each feature, response time testing, and trending of both mechanical and electrical parameters. The trending activities resulted in additional electrical and mechanical trip tests. The parameters selected for trending are considered to be good indicators of an impending failure. If unchanged, these trends will give further assurance that the RT breakers will be available, when required. Trending, discussed in Section 5, provides a means of detecting incipient failures. It also monitors the effectiveness of the test and maintenance programs.

Generic Letter 83-28 proposes that additional monthly on-line testing be performed. This testing will add 12 more electrical tests per year per breaker. Section 4 of this analysis establishes a basis for the probability of a single breaker failure. The results will show that additional testing will produce no significant change in the confidence levels associated with the historical data failure probability.

2.0 RT Testing Program

2.1 The RT breaker trip data, taken over a sixteen year period, consists of the verification of a trip on demand by each of the two reactor trip breakers and the verification of each RPS logic function during channel testing. The RT breaker tests are performed each refueling outage and use the output of the RPS system logic (RT relays) to trip the breakers. The logic or channel tests are performed monthly and consist of both setpoint and logic verification up to but not including the RT relays. The test interval associated with each type test has been in existance

during the 16 year period. The "as found" functional test data taken during the 1985 outage was found to be repeatable with the test results of the prior year which indicates no significant changes in breaker operability. Specifically, the RT breaker "as found" response times were found to be repeatable with the post maintenance response times recorded the prior year in the maintenance and tests of the RT breakers prior to the issuance of generic letter 83-28. A failure rate for the RT breakers can be determined using historical data.

2.2 The two reactor trip breakers and the bypass breaker have been trip tested each refueling outage since 1969. Prior to the issuance of Generic Letter 83-28, each of the reactor trip breakers were tripped a minimum of 23 times each year. Twelve of these trips were electrical trips. The 24 trip tests on the two RT breakers over a 16 year period plus the additional 46 tests performed during the 1985 refueling outage totals 430 tests. No failures, were found over the 16 year period. This data will be used in Section 4.

2.3 While on-line, the reactor trip logic system is tested monthly. Specifically, the individual relays associated with an analog signal on each protection channel are tested to verify their setpoints. The tests are performed on each of the four channels and consist of inputting test signals and verifying the setpoints and output relay logic. This test verifies the RP System up to the reactor trip relays. The RT relays and breakers are tested concurrently each refueling outage.

3.0 <u>Maintenance</u>

3.1 A comprehensive RT breaker maintenance program has been followed since 1969. As a result, the two DB50 breakers perform as though they were new at the end of each refueling outage.

3.2 The maintenance program associated with the two RT breakers and the bypass breaker has been enhanced following the issuance of Generic letter 83-28. Mechanical and electrical parameters are now being measured and trended to forecast any degradation in operability. Four parameters have been selected, consistent with 4.2.2 of Generic Letter 83-28, for trending. They are; (1) undervoltage trip attachment

dropout voltage, (2) tripper bar trip force, (3) breaker response time for both the UVTA and the STA and (4) breaker insulation resistance. The parameters are determined with the RT breakers in the as found condition prior to maintenance. Following the maintenance the breakers are again tested prior to going into service.

4.0 Failure Rate Estimate

4.1 A total of 430 electrically actuated automatic RT breaker trips have been recorded without a single failure. An estimate of the maximum failure rate at a confidence level of 99.5% serves as a benchmark to assess the impact of the 12 additional yearly tests requested by the NRC Staff.

4.2 From actual test data, the maximum failure rate is 0.0122 at 99.5% confidence. Each RT breaker has been tested using only one of the trip attachments which are now redundant on each breaker. Series trip breakers require that four independent failures occur before the RT breaker function will not be successfully completed upon demand. If 12 additional tests had been performed each year (without a failure) the failure rate would have been 0.0069. This small decrease in failure rate does not signicantly change the probability of the series breakers to successfully perform the trip function and does not justify the potentially increased risk associated with on line testing of the RT breakers.

5.0 Trending Limits and Results

5.1 The RT breakers response times have been measured over several years, however, the data has only been recorded since the 1985 refueling outage. The data for each breaker has been consistent and shows that the elapsed time from the STA being energized until the RT breaker is physically open ranges from 57-60 milliseconds. This corresponds to approximately 3.5 cycles. The data for the UVTA under similar condition ranges from 79-85 miliseconds. This corresponds to approximately 5 cycles. The DB50 breaker is normally a 4 cycle breaker when tripped by its shunt coil. The response times indicate that the as found condition of the RT breakers are similar to what would be expected of new breakers. The as found response times may be used to demonstrate that the breakers have been operational between refueling outages. This condition could only be repeated provided that the maintenance is sufficiently comprehensive and that the test frequency is not excessive.

5.2 The response time assumed in the Ginna Station accident analyses is 10 cycles. A significant margin exists between the measured and the required values. Therefore, based on the test data (over a two year period) the test and maintenance intervals have been adequate. However, should the "as-found" response time of either the UVTA or the STA exceed 8 cycles, on-line testing and maintenance will be performed consistent with the Westinghouse Owner's Group recommendations.

6.0 Results and Conclusion

6.1 A 16 year accumulation of historical test data has indicated that the RT breakers and the bypass breaker have performed as a highly reliable component in the reactor protection system. In addition, the performance of additional on-line testing will not significantly decrease the probability of RT breaker failure upon demand and may contribute to failure modes caused by excessive breaker operating cycles.

6.2 The maintenance and testing program associated with the RT and bypass breakers, which includes measuring and trending mechanical and electrical parameters and independent testing of the UVTA and STA components, will provide better assurance that the probability of failure upon demand will be minimized. Should drifting in the trended parameters be noted that indicates any form of degradation then increased monitoring by monthly on-line testing, will be performed.

6.3 In lieu of changing the RT breaker test intervals to those suggested by Generic letter 85-09, this analysis supports continued on-line channel tests on a monthly basis and breaker testing on a refueling outage basis.