VIRGINIA ELECTRIC AND POWER COMPANY

NORTH ANNA UNIT NOS. 1 AND 2

GENERAL DESIGN CRITERIA 17 ANALYSIS

UNIT 2 GENERATOR BREAKER INSTALLATION

ATTACHMENT I

INDEX

I. TWO UNIT LOAD SHED BACKGROUND

On April 27, 1979, a report was made under the provision of 10CFR50.55(e) concerning potential overloads of the reserve station service system. The potential overloads occurred during two unit station service bus loading of the reserve station service transformers (RSSTs). Subsequent reports dated May 23, 1979 (Serial No. 403) and August 7, 1979 (Serial No. 403A) identified 5KV cable and overhead bus modifications, load shedding, and operating restrictions as the modifications required to ensure adequacy (in the areas of equipment loading, voltage profiles, and switchgear duty) of the offsite power supply. It was noted that we were continuing additional analysis to identify modifications to eliminate the need for load shedding and operating restrictions.

The modifications specifically identified in the previous paragraph were installed. The load shedding, which is still in effect, is initiated when a Unit 1 and a Unit 2 station service bus are simultaneously fed from the same RSST. Loads are shed from both units' station service buses. The specific loads shed are determined by which buses load the RSSTs and which feedwater pumps are running.

Serial No. 725A, dated September 24, 1980, identified the installation of generator breakers on Units 1 and 2 as the modifications we would install to allow removal of the two unit load shedding and associated operating restrictions. Subsequent internal decisions allowed only the installation of the Unit 1 generator breaker, which was completed in 1981.

Our complete GDC-17 submittal was made in Serial No. 076, dated February 26, 1982, with additional NRC requested information provided in Serial No. 233, dated May 20, 1982, Serial No. 316, dated June 4, 1982, Serial No. 374, dated July 1, 1982, and Serial No. 608, dated October 26, 1982. The worst case basis for the majority of this analysis was the transfer of Unit 2 station service loads to the RSSTs. Due to the generator breaker, Unit 1 station service loads were assumed to remain backfed from the station service transformers (SSTs) rather than transferred to the RSSTs. Analysis of two unit loading to the RSSTs was completed at NRC request and utilized the two unit load shed to obtain acceptable results. The acceptability of our analysis was documented in NRC Safety Evaluations dated January 11, 1983 and November 13, 1984.

The two unit load shed scheme is currently enabled whenever 1) one unit is on-line and the other unit is in start-up, 2) both units are on-line, or 3) both units are in start-up.

II. UNIT 2 GENERATOR BREAKER INSTALLATION

We have identified numerous advantages of a generator breaker installation in general, all of which apply to installation of a generator breaker on Unit 2. Because a generator breaker is presently installed on Unit 1, an additional advantage is that Unit 2 will become symmetrical with Unit 1, which will reduce training requirements, procedural differences, and potential operator errors. The general advantages of generator breakers that we have identified are the following:

a. Increased operating flexibility

i. Station service loads may be supplied from either station service or reserve station service transformers. Loss of an RSST should not affect unit operation or start-up with respect to station service bus operation. Obviously, the loss of an RSST must be evaluated for its effect on emergency bus power sources.

ii. Unit start-up would normally be accomplished with the station service transformers, backfed from the generator step-up transformers, supplying the station service buses.

iii. Circumvents the need to pull the generator links to obtain backfeed capability. Backfeed capability is supplied immediately when a generator breaker opens.

iv. Provides additional sources of offsite power which are independent of unit operation.

v. Simultaneous two unit start-ups would be possible, even though North Anna has shared RSSTs.

b. Increased Equipment Protection

i. Reduces stresses on the generator caused by fault current flowing in the generator for faults on the load side of the generator breaker.

ii. Reduces damage occurring at the fault location due to the generator contribution for faults on the load side of the generator breaker. (A Westinghouse study indicates a marked increase in the chances of transformer fire if a faulted transformer is supplied for more than 0.2 seconds. A generator breaker operates in .12 seconds versus generator coastdown of 5 seconds.)

iii. Reduces the potential for automatic transfer of station service buses when a unit trips. This 5-10 cycle transfer electrically and mechanically stresses motors, which potentially shortens motor life. The automatic transfer would occur only in the event of an electrical fault in the generator step-up transformers (GSUs), isolated phase bus, station service transformer, 500KV generator leads to the switchyard, feeder cable to the station service buses, a failure of the generator breaker or of the 500KV breakers connecting the GSUs to the 500KV system, or a protective relaying circuit failure.

iv. Reduces the need for manual transfer of station service buses between the station service transformers and the reserve station service transformers. In this operation, the transformers are paralleled for a short period of time, which creates a potential overduty condition of the 5KV switchgear.

As applied to GDC-17, the major contribution of a generator breaker is to establish a source of offsite power which is independent of both normal unit operation and other sources of offsite power. With the unit on-line, the generator breaker is closed and the station service buses are supplied from the SSTs. For normal reactor, turbine, and generator trips, the generator breaker opens and the station service buses remain aligned to the SSTs, which are backfed through the generator step-up transformers. Unit start-ups are normally accomplished with the same equipment line-up. This means of operation drastically reduces the requirement that the RSSTs supply a unit's station service buses, which would occur only in abnormal conditions. This reduction in the frequency of transfer of load to the RSSTs provides for a more reliable offsite power supply to the emergency buses. As mentioned in b.iii. above, the specific abnormal conditions which would cause transfer of the station service buses to the RSSTs include GSU and SST failure, breaker failure of either the generator breaker or the 500KV generator transmission leads breaker(s), isolated phase bus failure, station service bus feeder cable failure, generator transmission leads (from the GSUs to the 500KV switchyard) failure, or protective relaying circuit failure. In the event of one of these failures, the transfer of station service buses from the SSTs to the RSSTs would be immediate.

Failure of equipment used in the output path of the generator (i.e. GSUs, generator breaker, 500 KV generator leads or associated breakers, and isolated phase bus) is expected to cause an outage, during which time the affected unit's station service buses would be fed from the RSSTs. The load during this time would be lower than the worst case loading experienced at 100% power. If the outage was sufficiently long, the loading would be appreciably lower (i.e. approaching a refueling load). Once the failure was repaired and tested, the station service buses would be transferred back to the SSTs for operation of the unit.

Failure of equipment used to supply station service loads (i.e. SSTs and the 5KV station service bus feeder cable) would cause an outage expected to be of shorter duration than that discussed above. To minimize outage time, the affected equipment could be separated from the 22KV generating system and the unit could be reconnected to the 500KV system. In this case, two of the three station service buses would be fed from the SSTs. The remaining bus could be fed from an RSST. The affected unit could operate at 100% power with this arrangement. This condition would last until an outage of sufficient duration occurred to allow replacement of the failed equipment. Alternatively, the failed equipment could be replaced prior to unit reconnection and transfer of all station service buses back to the SSTs would occur.

The abnormal conditions that cause station service bus loading of the RSSTs are low frequency events which are typically either of relatively short duration or have relatively light electrical loading as discussed above. After the Unit 2 generator breaker installation, the probability of one of these conditions occurring on each unit at North Anna within the same time frame (i.e. prior to correcting the first failure) is remote. An even more unlikely event is the occurrence of both of these conditions at the same time an accident (SI or CDA) occurs.

Removal of the two unit load shed will increase the reliability and safety of both units. The two unit load shed would be needed only in the event of failures of the type described above on both units during the same time period. The unlikely occurrence of this low probability condition justifies that it not be used as a design criterion and, therefore, justifies removal of the two unit load shed modification. Leaving the two unit load shed installed and operational inherently increases the likelihood of nonintended operation and reduces operational flexibility.

III. UNIT 2 GENERATOR BREAKER EFFECT ON PREVIOUS GDC-17 SUBMITTALS

This section discusses the effect that installation of a Unit 2 generator breaker and removal of the two unit load shed will have on the previous GDC-17 submittals.

The need to consider two unit loading on the RSSTs as a GDC-17 analysis condition is eliminated by the addition of the Unit 2 generator breaker. The worst case loading of the RSSTs will include loads normally supplied by the RSSTs (i.e., the emergency buses and the circulating water buses) and the transfer of one unit's station service buses (at maximum loading) to the RSSTs. This scenario considers a single, abnormal, low frequency event occurring during the accident condition.

The following is an evaluation of the effect of the Unit 2 generator breaker addition on the indicated sections of our Serial No. 076, February 26, 1982 GDC-17 submittal:

A. ATTACHMENT I, SECTION I: ELECTRICAL SYSTEM

This section is revised to include the Unit 2 generator breaker, which is shown on the one-line diagram in the attached Appendix A. The Unit 2 operation is revised as discussed in Section II: Generator Breaker Installation of this report.

The installation of station service bus ties to Unit 2 emergency buses is still under consideration. At present the original design is being re-evaluated. If a new design is installed, we will submit results of our GDC-17 analysis of the new design to you.

B. ATTACHMENT I, SECTION II: ELECTRICAL EQUIPMENT RATINGS

The Unit 2 generator breaker does not change this section. The design of the Unit 2 breaker is the same as the Unit 1 breaker and the installation will be equivalent.

C. ATTACHMENT I, SECTION III: ANALYSIS ASSUMPTIONS

1. Assumption A

We are in the process of installing approximately 1500 MVARs of capacitors on our 230KV transmission system. These capacitors will change our worst case switchyard voltage drop experienced on a two unit trip to 10KV. The previous analysis used a 15KV drop. The lowest switchyard voltage will remain 505KV. The worst case voltage drop assumed to occur instantaneously with the CDA or other anticipated transient being analyzed is from 515KV to 505KV. Potentially, voltages below 515KV may occur due to abnormal system/generating conditions. However, due to these same system/generating conditions, the voltage drop experienced on unit trip(s) will be less than 10KV and the resulting voltage will be 505KV or higher.

The expected steady-state high system voltage is 535KV and the operating procedures provided in our July 1, 1982 submittal, Serial No. 374, will continue in effect. During some infrequent system conditions, the transmission voltage may rise to 540KV for up to several hours prior to reduction to 535KV.

2. Assumption B

With a system voltage drop from 515KV to 505KV, the RSST LTC position will be, relatively, in more of a boost position at the postulated accident occurrence than the RSST LTC position determined by 520KV (which was used in modeling a 15KV transmission voltage drop). Therefore, the voltage profiles presented in our previous analysis will be improved by this added boost.

3. Assumption C

With the Unit 2 generator breaker addition, transfers of station service buses to the RSSTs occur only in abnormal conditions. The voltage profile cases submitted in the February 26, 1982 report consider transfer of a single unit's station service buses to the RSSTs both immediately upon the occurrence of the condition being analyzed and at times 60 seconds and later after the occurrence of an accident. This remains a valid assumption for analysis of North Anna with generator breakers installed on both units.

4. Assumption D

Single unit station service bus loading of the RSSTs plus loads normally fed from the RSSTs will be the design basis.

5. Remaining Assumptions

The other assumptions are unaffected by the Unit 2 generator breaker addition.

D. ATTACHMENT I, SECTION IV: EQUIPMENT LOADING ANALYSIS

The likelihood of the RSST overloads is reduced. The worst case maximum loads are unaffected.

E. ATTACHMENT I, SECTION V: VOLTAGE ANALYSIS

1. A. Guidelines and Assumptions

Adding the Unit 2 generator breaker does not change the fact that a failure causing transfer of a unit's station service buses to the RSSTs may occur at any time with respect to a postulated accident. Therefore, the cases to be analyzed are the same as those presented in this section. The potential for station service bus loading to the RSSTs is much lower.

2. B. Voltage Profile Summary Sheets

The voltage profile results provided on these sheets are approximately 0.5% - 2% below those expected with the new 10KV worst case transmission voltage drop for buses fed from transformers connected to the system rather than to a generator. This change also applies to sections F, G, H, I, and J.

3. K. Overvoltage Analysis

With 540KV at the switchyard, the RSSTs will correct their secondary voltages to within 109% of the nominal motor rating of 4000V, which is the voltage level analyzed in the 1982 submittal.

4. Remaining Sections

The remaining sections are unaffected by the generator breaker addition.

F. ATTACHMENT I, SECTION VI: MOTOR OPERATED VALVE ANALYSIS

This section is not affected by the Unit 2 generator breaker addition.

G. ATTACHMENT I, SECTION VII: COMPUTER MODEL VERIFICATION

This section is not affected by the Unit 2 generator breaker addition.

H. ATTACHMENT I, SECTION VIII: REVIEW FOR SIMULTANEOUS OR CONSEQUENTIAL LOSS OF OFFSITE POWER SOURCES

The generator breaker installation increases offsite power availability by creating an additional independent source of offsite power which is not dependent on the mode of operation of Unit 2.

I. ATTACHMENT I, SECTION IX: TECHNICAL SPECIFICATIONS

This section is not affected by the Unit 2 generator breaker addition.

J. ATTACHMENT I, SECTION X: SUMMARY OF MODIFICATIONS

1. Operating restrictions (also refer to Attachment I, Appendix J and Attachment II, Appendix B, both of the 1982 submittal).

   a. If the Unit 2 station service to emergency bus ties are installed (as originally designed), then transfer of bus 2H to bus 2C will not require a transfer of bus 2J unless bus 2J is being fed from the same source as bus 2C (i.e. RSST C).

   b. The existing two unit load shed scheme will be removed.

2. The modifications discussed in sections B, C, D, E, F, G, and H have been completed and will remain in-service.

3. The status of the operating restrictions and modifications has been discussed in Serial Nos. 235A through J, the latter dated November 28, 1984.

K. ATTACHMENT II: TWO UNIT SIMULTANEOUS LOADING OF THE RSSTs

Due to the low occurrence possibility, the analysis in this section is not required. The overload alarms on the RSSTs will remain in service.

Serial No. 233, dated May 20, 1982, Serial No. 316, dated June 4, 1982, Serial No. 374, dated July 1, 1982, and Serial No. 608, dated October 26, 1982 are unaffected by the addition of the Unit 2 generator breaker. Serial No. 608, which provides an overvoltage analysis, is unaffected by a several hour transient to 540KV because this voltage is not high enough to exceed the RSST load tap changer corrective capability. Therefore, the results presented in Serial No. 608 would not change.

IV. SUMMARY

The intent of this report is to delineate several major points concerning the generator breaker application at North Anna, the specific installation of a breaker on Unit 2, and the removal of two unit load shedding. These points have been discussed in Sections II. and III. and are briefly summarized as follows:

1. Generator breakers:

   a) improve unit operation, flexibility, and equipment life.

   b) minimize station service loading of the RSSTs and, thereby, provide better regulated source(s) of offsite power for the emergency buses.

   c) when installed on units which share a common reserve power system (e.g. North Anna Unit Nos. 1 and 2), eliminate the need to consider multiple unit loading of the reserve system as a design criterion.

2. After a generator breaker is installed on Unit 2, the occurrence of two unit loading on the RSSTs is minimized. The reliability of the units is increased by removal of the complexity of controls created by the two unit load shed scheme.

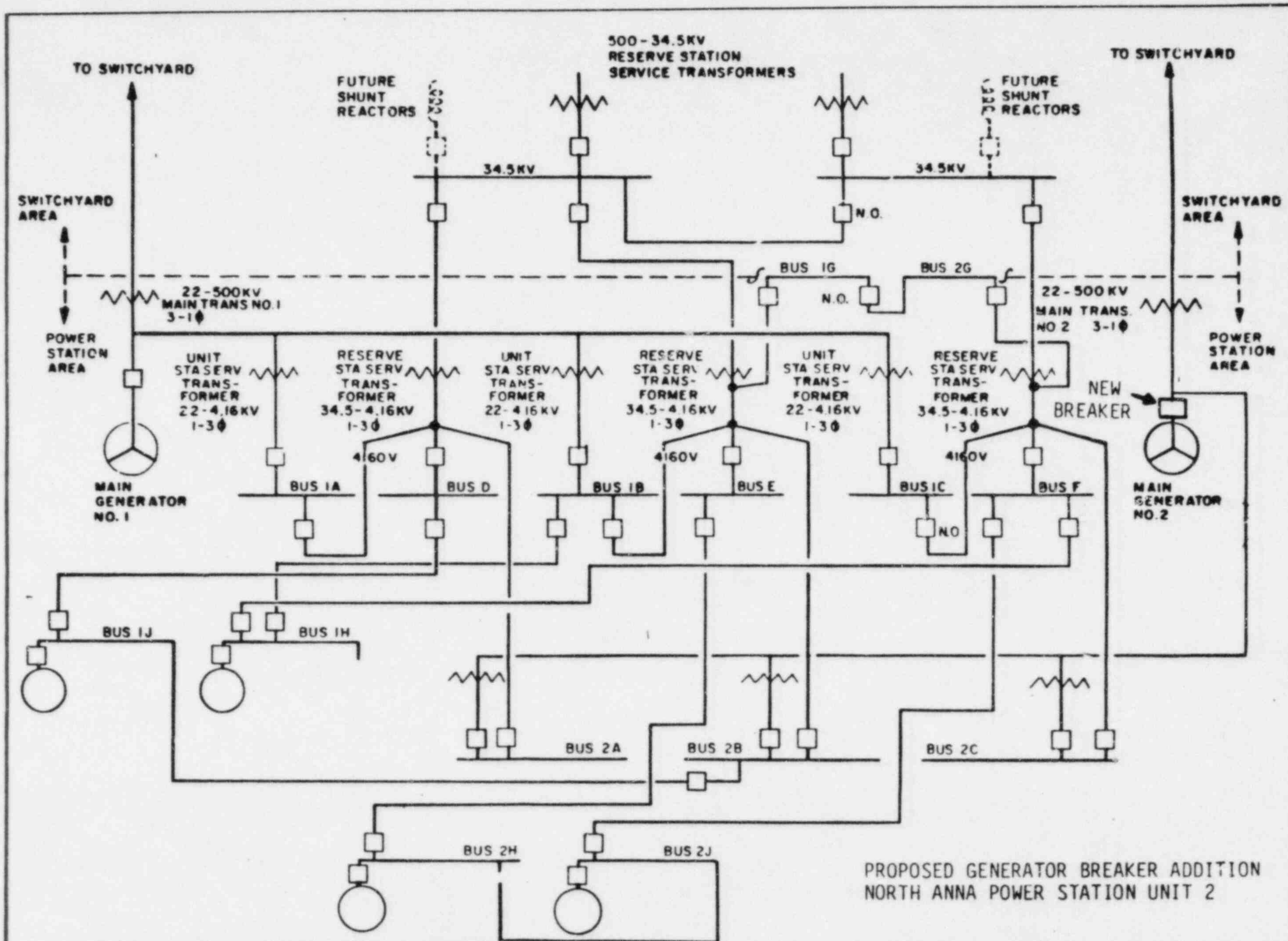
3. The addition of a Unit 2 generator breaker and removal of the two unit load shed scheme is bounded by the GDC-17 analysis previously submitted to the NRC. The addition of the breaker and the 230KV capacitor banks will improve actual GDC-17 performance over that for which the analysis has been submitted.

To achieve the maximum benefit from the Unit 2 generator breaker installation, the subsequent removal of the two unit load shed scheme should be allowed for North Anna Power Station.

APPENDIX A

NORTH ANNA ONE LINE DIAGRAM

UNIT 2 GENERATOR BREAKER ADDITION



PROPOSED GENERATOR BREAKER ADDITION
NORTH ANNA POWER STATION UNIT 2

FIGURE 1
DC 85-04-2