Design Intent

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Degraded Grid Voltage Protection Workshop

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Degraded Voltage Relay Design Intent

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NRC Guidance Documents

- D.K. Davis letter, Safety Evaluation and Statement of Staff Positions Relative to the Emergency Power Systems for Operating Reactors, 6/3/1977
- Generic Letter 79-036, RE: Adequacy of Station Electric Distribution Systems Voltages, 8/8/1979. Applies to all commercial facilities licensed before August of 1979.
- Appendix 8A (Branch Technical Positions) of NUREG 0800 (Standard Review Plan), Branch Technical Position PSB-1, Adequacy of Station Electric Distribution Systems Voltages. Applies to all commercial facilities licensed after August of 1979.

Events Leading to Degraded Voltage Protection

- Millstone
  - July 5, 1976: Sustained low bus voltage resulted in failure of control circuit contactor pickup and fuse clearing on multiple MCC control circuits
  - July 21, 1976: In response to the July 5 event, the undervoltage relay setpoint for Millstone was increased to provide degraded voltage protection. The relays tripped while starting a circulating water pump, indicating the need for a time delay.
  - NRC issued an unnamed generic letter (D.K. Davis 6/3/77 letter) requiring a separate relay for degraded voltage protection ("Second Level Undervoltage")

Subsequent Events

- ANO
  - September 16, 1978 event: Protective relay setting error caused transfer of both units auxiliary power to a transformer sized for one unit
  - Excessive voltage drop tripped degraded voltage relays on Unit 2 (not yet installed on Unit 1)
  - NRC Issued IN 79-04, Degradation of Engineered Safety Features, and GL 79-036, Adequacy of Station Electric Distribution Voltage following the ANO event.

NRC DVR Requirements

- Protect safety related loads from the effects of a sustained degraded voltage condition
  - The selection of voltage and time set points shall be determined from an analysis of the voltage requirements of the safety related loads at all onsite system distribution levels
  - Coincident logic to preclude spurious trips
  - The time delay shall not exceed the accident analysis
  - The time delay shall minimize the effect of short duration disturbances (such as motor starting)
  - The allowable time duration of a degraded voltage condition shall not result in failure of safety systems or components

D.K . Davis 6/3/1977 letter

Subsequent NRC DVR Requirements

- The selection of undervoltage and time delay setpoints shall be determined from an analysis of the voltage requirements of the Class 1E loads at all onsite system distribution levels
- Two delays, one for “safety actuation signal” and a second delay “of a limited duration” bypassed by SI. Implies that the second delay is intended to allow operator actions for restoration of adequate voltage.
- “The second time delay should be of a limited duration such that the permanently connected Class 1E loads will not be damaged.”
- All sources must be analyzed

Appendix 8A (Branch Technical Positions) of NUREG 0800 (Standard Review Plan), Branch Technical Position PSB-1, Adequacy of Station Electric Distribution Systems Voltages

Original Design Intent

- PSB-1 modified the requirements of the original generic letter to avoid excessive reduction in offsite power reliability
- AC Power distribution systems may be vulnerable to a common mode failure
  - Specifically, a sustained voltage lower than equipment ratings could result in a loss of capability of safety related equipment
- The “Second Level Undervoltage Relay” was intended to detect a sustained low voltage equipment and transfer safety loads to onsite sources (diesel generators)

What can we Conclude?

- PSB-1 design may have an unintentional impact on the reliability of off-site power (setpoint & timers)
- NRC guidance documents not in agreement (ex. 1977 Letter & PSB-1)
- Plants regulatory commitments vary in accordance with each reactor's licensing basis
- "Interpretation" by inspectors is not a preferred solution
- Key technical points not adequately explained
  - **Consideration of starting versus running voltage**
  - Time delay setting requirements