SNC Degraded Grid Design Criteria

SOUTHERN COMPANY

April 23, 2014

Agenda

- Purpose
- Background
- New SNC Degraded Grid Relaying Design Criteria
- Methodology
- Comments and Questions

Purpose

Review the design criteria being used by Southern Nuclear for the new degraded grid voltage protective relaying at Hatch Nuclear Plant and Farley Nuclear plant.

These criteria draw from previous industry guidance and our own experience, but are not intended as a commitment to any particular existing guidance document.

Obtain NRC feedback on the criteria to help ensure that the implemented solutions meet NRC expectations for automatic protection for potential degraded grid events and resolve NRC findings from the related CDBIs.

Background

For a potential degraded grid event, previous designs:

- Relied on manual actions by the transmission system and plant operators to prevent an occurrence.
- Some required Class 1E loads were not automatically protected from a sustained voltage inadequacy.

There are currently two submittals on the docket, one for Plant Farley and one for Plant Hatch, that include a schedule for the degraded grid modification projects. The LAR submittals revise each plants operating license to include completion dates, by unit, for the modifications.

Background – Scope of Modifications

- FNP:
  - Replacement of the existing degraded voltage relays
  - Raising the existing voltage setpoints.
- HNP:
  - Replacement of the existing degraded voltage relays including change from 2 relays to 3 relays (2 of 3 logic).
  - Raising the existing voltage setpoints.
  - Replacement of 4 existing startup auxiliary transformers
  - Addition of 2 new startup auxiliary transformers and 230KV breakers including associated relaying, fire protection, etc.
  - Upgrade of 4.16KV bus short circuit capability for 10 buses (breakers and bus bracing).

Background – Farley Schedule

- January 2015 – Submit Farley License Amendment Request (LAR)
- January 2016 – NRC approval of Farley LAR
- Spring Outage 2016 (U2R24) – Design implementation begins on U2
- Fall Outage 2016 (U1R27) – Design implementation begins on U1
- Fall Outage 2017 (U2R25) – Design implementation completed on U2
- Spring Outage 2018 (U1R28) – Design implementation completed on U1

Background – Hatch Schedule

- December 2015 – Submit Hatch License Amendment Request (LAR)
- December 2016 – NRC approval of Hatch LAR
- Spring Outage 2017 (U2R24) – Design implementation begins on U2
- Spring Outage 2018 (U1R28) – Design implementation begins on U1
- Spring Outage 2019 (U2R25) – Design implementation completed on U2
- Spring Outage 2020 (U1R29) – Design implementation completed on U1

Definitions & Acronyms

- DVR – Degraded Voltage Relaying
- MEV – Minimum Expected Voltage – The steady state voltage level at the 4.16kV buses that is expected when the 230kV switchyard is at the minimum voltage based on contingency studies defined by the FSAR.
- MRV – Minimum Required Voltage – The steady state voltage level at a Class 1E 4.16kV bus that is required for its safety-related loads to accomplish their safety functions. The safety-related motors shall be able to start successfully with the pre-start steady-state bus voltage at the MRV.

Design Criteria - Voltage

- The DVR shall be set such that offsite power will be automatically disconnected and transferred to onsite power during an extended degraded grid condition (any voltage dip having a longer duration than expected for normal or accident operations).
- The DVR on the Class 1E 4.16KV bus will be set so that, including tolerances, voltage dropout value will be above the MRV value.
- The DVR voltage reset value, including tolerances, will be set below the MEV.

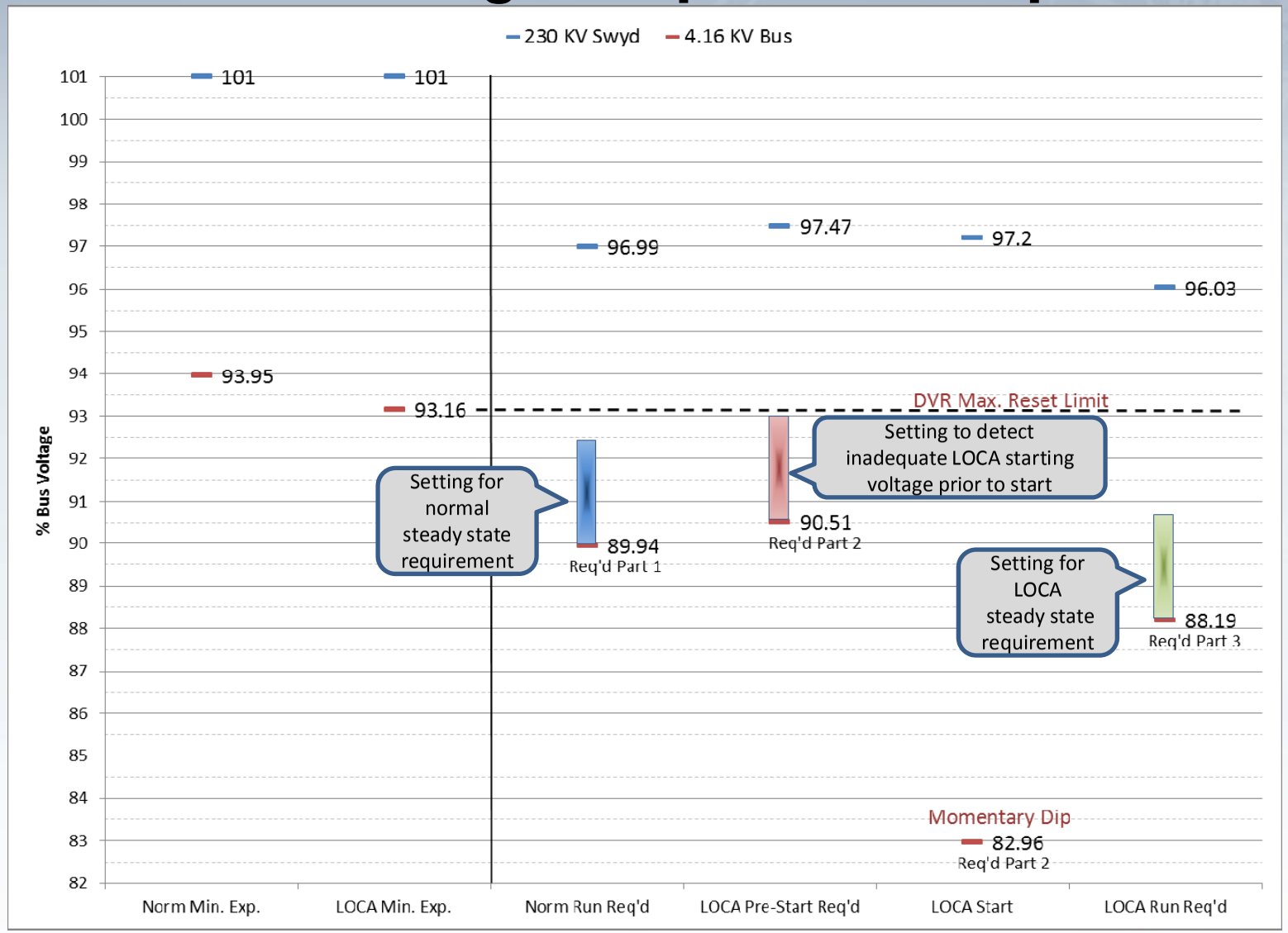
Design Criteria - Time Delay

- The DVR minimum time delay will be set such that, with tolerances, it will delay actuation to prevent a spurious trip due to motor starting or other momentary transient events.
- The DVR maximum time delay will be set such that, with tolerances, it will:
  - be less than the maximum time allowed for the diesel generator to start and obtain rated speed and voltage.
  - prevent loss of Class 1E functions when the voltage is inadequate by actuation prior to a trip of loads on overload.

Voltage Setpoint Methodology

- Part 1 – Using maximum expected non-accident bus loading, determine minimum acceptable steady-state voltage for normal operation.
- Part 2 – Using maximum expected accident loading, determine the minimum pre-start voltage that provides acceptable Class 1E motor starting (e.g. during LOCA block motor starting)
- Part 3 – Using maximum expected accident loading, determine the minimum steady-state voltage that provides acceptable Class 1E motor operation and starting for individual motors.
- The maximum voltage of Parts 1-3 determines the MRV (i.e. analytical limit).

DVR Voltage Setpoint Example



Colored bar represents the DVR voltage setting uncertainty & reset requirement

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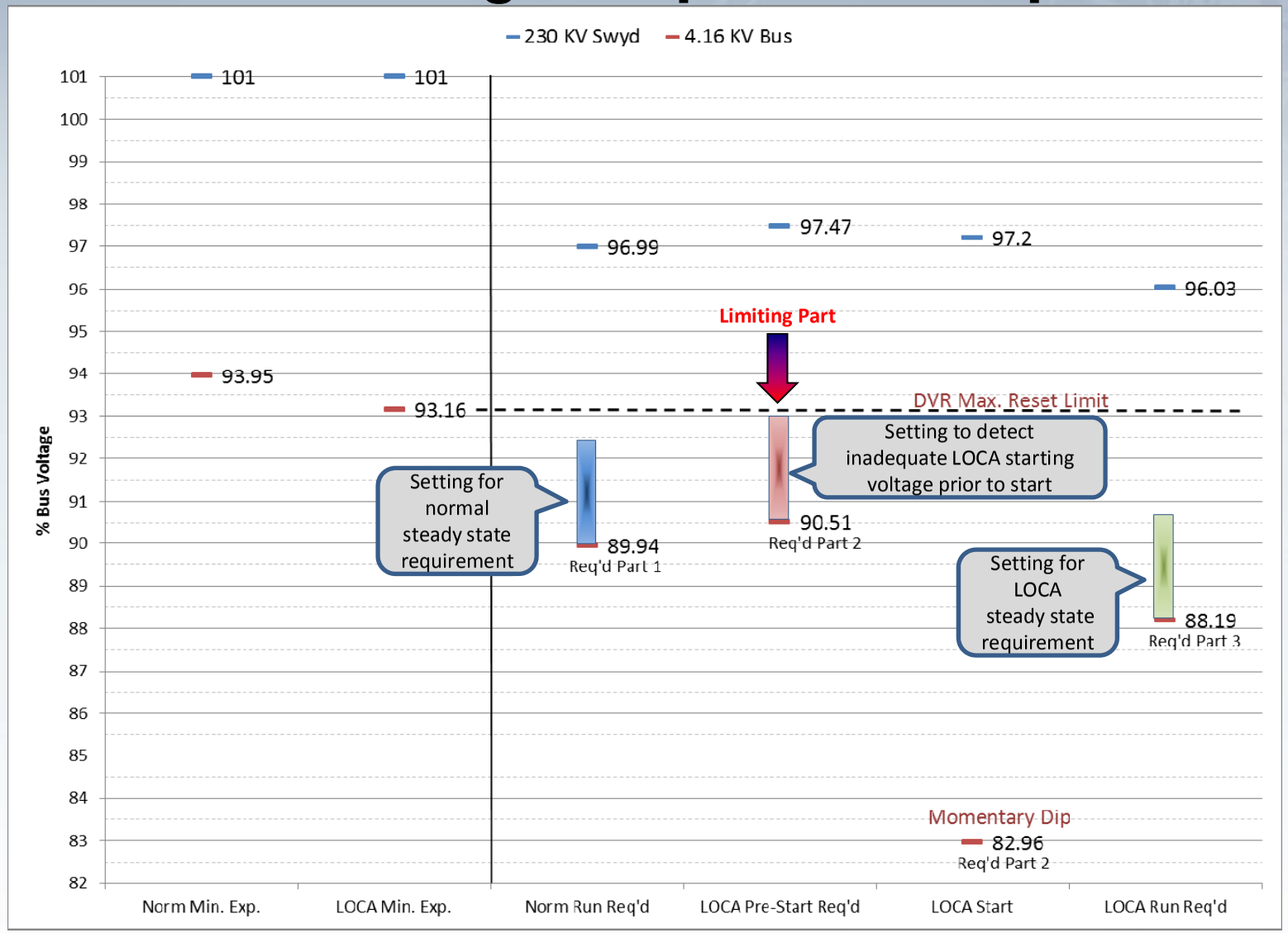
DVR Voltage Setpoint Example



Colored bar represents the DVR voltage setting uncertainty & reset requirement

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DVR Time Delay Setpoint Example

- Minimum Delay:
  - At MEV, LOCA block motor starting voltage transient lasts for 7 seconds (i.e. recovers above the DVR voltage reset value).
  - The duration of all other motor starting or fault transient events is less than 7 seconds.
- Maximum Delay:
  - Upon a LOCA, the diesel must start and be at normal voltage and frequency (i.e. ready for loading) at 15 seconds.
  - With inadequate voltage, motors cannot stall for greater than 12 seconds without tripping on overload.
- Considering DVR time delay uncertainty, the setting must be between 7 and 12 seconds.

LAR Submittal Content

- Calculations (portions) demonstrating the use of the methodology and the setpoint results.
  - Criteria, methodology and assumptions
  - Steady-state and starting cases for the MEV and the DVR setting part of the analysis showing voltages for each Class 1E bus and its required loads.
  - Setpoint uncertainty calculations
  - Basis for setpoints
- List of the most limiting components for each study case.

Comments or Questions?