NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Lesson Learned

Lack of Separation for Critical Control Power Supply Leads to Loss of Multiple Units at a Power Station

Primary Interest Groups
Generator Owners (GO)
Generator Operators (GOP)

Problem Statement
A short circuit in a critical ac control power panel resulted in the trip of a one generator at a large power plant. Inadequate separation of the critical ac power supply to key control systems and the plant instrument air system contributed to the loss of two additional generators at the same plant, creating a large system frequency disturbance.

Details
The power plant consisted of three large steam-generating units owned and operated by the same entity. The units were similar in design, operation, and fuel source. All three units were operating at or near maximum output at the time of the outage.

The power plant had seven Soot-Blowing Air Compressors (SBAC). Unit A supplied the motor and control power for SBACs A, B, and C. Unit B supplied the motor and control power for SBACs D and E. Unit C supplied the motor and control power for SBACs G and H. At the time of this event, SBACs E and H were offline due to maintenance. All SBACs fed into a common header that supplied all compressed air and instrument air at the plant. One of the systems that the SBAC header fed was a common boiler/turbine area instrument air header. (Instrument air is dried and used for critical control devices such as valves, dampers, gates, etc.) The plant air systems were solely dependent on the SBACs, which supply air through common headers for the soot-blowing air (at approximately 280 psi), service air (at approximately 120 psi), and instrument air (at approximately 120 psi).

A short circuit occurred in a critical ac control panel for Unit A, which caused a control voltage drop on several components, including the Furnace Supervisory Safeguard System (FSSS) Programmable Logic Controllers (PLC) and SBACs A, B, and C. The voltage drop caused the loss of both the primary and backup FSSS PLCs and led to the trip of Unit A on normal reverse power operation. Investigation indicated that the short circuit originated from the FSSS racks 2 and 3 electrical circuits. The voltage drop caused the PLCs' power supplies to sense low-control power voltage of less than 97 volts for at least 13.6 milliseconds, at which point the PLCs went to a "safe" condition and shut down the systems they controlled.

The voltage drop also tripped SBACs A, B, and C and led to the rapid degradation of plant service air supply and plant instrument air pressure on Units B and C. When SBACs A, B, and C tripped, it caused the loss of approximately 60 percent of plant air supply capacity. All air pressures dropped sharply,

demonstrating that the air usage at the time was too great to be supported by only two SBACs. Plant personnel began identifying and manually isolating air to as many non-essential areas in the plant as possible, but air pressure continued to decay. To further exacerbate the condition, SBAC G tripped (due to high air temperature) approximately nine minutes after SBACs A, B, and C tripped, leaving only SBAC D running. Units B and C tripped when the instrument air pressure dropped too low to keep the discharge dampers open on the Primary Air (PA) fans. Low PA pressure caused the FSSS to trip all the pulverizers, resulting in unit trips due to loss of all boiler fuel.

Corrective Actions

Investigation of the event resulted in the following corrective actions:

1) Critical ac control panel:
    a) Control power for both the primary and backup FSSS PLCs for Unit A was supplied from the same critical ac control panel. Corrective action was to supply control power to the primary and backup FSSS from two separate critical ac power panels.
    b) Fusing in critical ac power panel was not appropriately sized. An engineering analysis was completed and correct fuses were installed in the critical ac panels.
    c) Out-of-service circuits and non-critical circuits were connected to the critical ac power panel. An engineering review was completed, and out-of-service and non-critical circuits were removed from the critical ac power panel.
    d) Data loggers were installed to help identify the area of the short circuit.
2) Plant air supply system: Control power for the three SBACs was supplied from a common critical ac control panel. The power supply was re-configured to supply control power to no more than two SBACs from the same critical ac control panel.
3) Non-critical plant air usage could not be quickly shut off as air pressure began to degrade: After evaluating the usage on all the monitored branches, if the non-essential air had been shut off promptly, Units B and C could have maintained sufficient instrument air pressure to continue operating. Appropriate methods and isolation points were identified to isolate and remove non-critical air usage during an emergency.

Lessons Learned

1) Control power for critical primary and backup systems, such as the FSSS and plant air supply, should be supplied from separate critical ac power panels where appropriate.
2) Critical ac power panels should be maintained with proper fusing and, to reduce the probability and impact of an equipment failure such as a short circuit, should only be connected to necessary circuits.
3) Technical and procedural controls should be applied to air supply systems to reduce the non-critical air usage when air supply is insufficient to meet critical functions.

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