Substation Commissioning and Testing

PRINTS

Following is a checklist of general procedures to be followed during commissioning and testing work. The sequence in which various testing, commissioning, and documentation activities take place, is largely determined by test personnel based on their experience with the particular equipment at hand. Subsequent sections will describe testing sequences as appropriate, to be used as reminders for personnel during installation.

PROJECT OVERVIEW

- Review the work plan. Start with the project requirement diagrams, one-lines and schematics to determine the scope of the project and what equipment and wiring will be modified during the project.
- Check to see if equipment, line, bus, or other outages will be required and how these outages may affect work sequence.
- Coordinate with construction personnel and the local owners and set up outages as soon as possible.
- Review print package for completeness – outdoor, indoor, alarms, etc.

REVIEW PRINT PACKAGE (IN THE FIELD)

- Verify that the schematics are consistent with design objectives, have full functionality and comply with company standards.
- Compare the control and relay schematics to the one-line drawings and verify that they agree.
- Check the wiring prints to verify that each cable is shown on the cable list for both ends, that the same number of conductors are used at both ends, and that each conductor has the same designation on both ends.
- Compare the wiring to the schematics.

VERIFY PARTS INVENTORY

Verify that the necessary parts are on hand to complete the project. When checking the parts inventory, validate the following:

- The correct number of each part.
- Part numbers match what is specified on the drawings (and vice-versa).
- The contact arrangement on relays matches what is shown on the drawings.
- FT-1 switches have the proper number and orientation of current and voltage switches.

- Voltage and current ratings on all devices match application and drawings.

ORGANISE RECORD REVISIONS

- Before starting a project, identify and obtain the latest information about existing conditions.
- Check the design prints against any as-built prints to be sure all changes are reflected on the prints.

CLEAR OLD EQUIPMENT

- Verify any equipment to be removed is physically isolated from the power system by opening switches, disconnects, removing jumpers, etc.
- Use Lockout/Tagout procedures or insulated tools on all energy sources.
- Cut out all alarms associated with the equipment.
- Identify and isolate all AC (heater/compressor bus, etc.) and DC current and potential sources.
- Be sure that all trip, MWTT, lockout, and interlock circuits are isolated so they do not affect operation of any other equipment still in service.
- Record nameplate information for all removed equipment incase it needs to be accounted for.

SUPPLY ELECTRICIANS WITH UPDATED WIRING PRINTS

- Mark clearly the changes made.
- Specify if there is an order in which the work needs to be completed.
- Identify “hot panel work” and supervise.

PRE-TEST CIRCUITS

- Buzz all new panels and equipment.
- Megger and buzz indoor and outdoor cables.
- Count and verify wire colors on terminal blocks.

SUMMARY OF CIRCUIT-CHECKING PROCEDURES

Circuit checking requires verifying that all schematics are correct, wiring prints agree with schematics, and one check print is kept up at all times showing what has been changed and checked. The general approach to working through the prints should correspond to the following:

- Make certain all schematics are correct, functional, and meet design objectives.
- Make certain all wiring prints agree with the schematics.

- Check to see all wiring is functional and agrees with the physical panel, equipment, any established standards, project outlines, and other directives.
- Check the wiring against the schematic and mark or highlight a copy of the prints as they are verified. Also mark cables as they are meggered.
- Verify all labeling, color codes, terminal blocks, etc.
- Check for proper layouts of panels, orientation and location of equipment on the prints along with switch makeups.

CHECK PRINTS

Accurate and up-to-date prints are the test engineer's most important tool. Failure to vigilantly record any print changes not only creates work for the next person working at the substation, but can also lead to trip outs or personal injury. Note the following process for handling prints:

- "Check print" refers to a "master copy" of a design print.
- The check print shows work checked off as it is completed, the status of the job, corrections that were necessary, and any notes or information pertinent to job completion.
- If copies of a print are given to the electricians for wiring, the check print must always be updated with any changes made.
- It may also be important to update the outdoor prints with any nonelectrical (civil/structural) changes made.
- Corrections are typically more accurate when done at the time of the changes, rather than at a later date (i.e., when the job is completed). Make corrections in a timely fashion.
- The check print will be the only print placed in the file that shows all the work done on that work order.
- When used in an organized manner, notes written off to the side of the print or, if extensive, on an attached sheet may be the best means of tracking progress in checking panels, schematics and equipment. Although all work should be done at the time, cases do arise when changes can't be fully indicated while work is progressing. Note that on the print, but don't use it as a means of leaving sticky problems for someone else.
- Occasionally, temporary circuits are required as an interim step before completion of permanent wiring. Show temporary wiring that may be an intermediate step or the condition in which the circuit will be left when the test crew leaves. Indicate the date of the temporary wiring check, who checked it, and a brief description of temporary wiring.
- An up-to-date check print is crucial. For example, unforeseen circumstances may not allow immediate completion of a job. If the job has been unexpectedly put aside for a time, the prints must be in a condition of readiness such that any qualified personnel could come in and continue on. If the prints do not reflect the state of the job, the

follow-up test engineer would be better off if work had never been started!

- Print changes must be as neat and legible as possible. If the copied print is not readable, mark it up so that any changes made are obvious. If an explanation is necessary for the change, write “Design Note:” preceding the explanation.