IEEE 1248
Guide for the Commissioning of Electrical Systems in Hydroelectric Power Plants*

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*137 pages of joyful reading!
Scope

- This guide is directed to the plant owners, designers, and contractors involved in the commissioning of electrical systems of hydroelectric plants.
- This guide suggests inspection and tests to be used following the completion of the installation of components and systems through to commercial operation.
Huh?

• Commissioning: *A process that assures that a component, subsystem, or system will meet the intent of the designer and the user.*

• Commissioning Test: *A test conducted when the equipment is installed to verify correct operation.*

• Commissioning Tests: *Tests of correct function of the complete system with all equipment connected and live.*
Useful For

• A new hydroelectric plant installation;
• Rehabilitation of an existing hydroelectric plant; or
• Replacement and upgrade of existing electrical equipment.
Types of Testing

- **construction testing:** Performing required inspections and tests to ensure that completed installations are in accordance with contract requirements and the latest engineering and design information.

- **operational testing:** All testing required to verify system operation in accordance with design requirements after the major component is energized or operated.

- **performance testing:** Testing conducted to evaluate the compliance of a system or component with specified performance.

- **preoperational testing:** All testing required for system components prior to energizing or operating the major system component.

- **prestartup testing:** All testing required prior to rotating the generating unit under power (hydraulic or electrical) which is unique to the unit and not associated with system testing.

- **startup testing/wet testing:** Operation testing of the generating unit from initial-powered rotation to verify suitability for operation.
Organization

• Who does what? Contractors, Owner, Engineer, Manufacturers, Operations, Maintenance, Innocent Bystanders

• Jurisdiction:
  – Boundaries of control
  – Tagging
  – Turn-over process

• Acceptance Process
Procedures

Yes – YOU NEED THEM!

• Administrative
• Mechanical
• Electrical
• Instrument
• Preoperational
• Operational
Construction Test Phase

• The construction contractor usually performs required inspections and tests to ensure that completed installations are in accordance with contract requirements and the latest engineering and design information.

• The results of construction testing should be documented by the construction contractor and turned over with release of equipment to the preoperational testing group.
Electrical

• Insulation resistance testing of electrical equipment and cables;
• Continuity tests to verify cable routing;
• Initial operation of motors uncoupled (phase rotation check);
• Inspection and testing of motor control centers and switchgear; and
• Verification of cable terminations in accordance with design documents.
Mechanical

• Hydrostatic testing of piping systems;
• Mechanical equipment alignment;
• Initial lubrication of mechanical equipment;
• Tank cleaning and piping cleaning (flushing);
• Inspection of mechanical equipment and piping systems; and
• Mechanical test procedures implementation.
Instrumentation

- Testing of pneumatic instrument lines for leaks;
- Verification of proper grounding of shielded cables;
- Installation of instrumentation in accordance with design documents;
- Continuity tests to verify cable routing;
- Verification of cable terminations in accordance with design documents; and
- Instrument test procedures implementation.
Preoperational Tests

• Insulation resistance testing of electrical equipment, to be done prior to terminations (power cables);
• Checkout of electric motors;
• Checkout of motor operated valves, dampers and gates;
• Checkout and verification of electrical control circuitry through functional testing;
• Calibration of electrical relays and meters;
• Checkout and trip check tests of switchgear, motor control centers, and molded case breakers;
• Flushing of mechanical systems/subsystems;
• Blowdown of station/instrument air lines;
• Verification of instrument calibration;
• Loop calibration of all instrument loops;
• Functional loop checkout of all instrument loops;
• Preoperational testing in accordance with approved preoperational test procedures;
• Vendor testing of supplied equipment and systems;
• Vibration testing of driven equipment;
• Visual inspection of all systems and equipment; and
• Verification of polarity and integrity of instrument transformer circuits.
Operational Tests

- Hydraulic operation of spiral case shut-off valves and proper setting of closing and opening times;
- Wicket gate or nozzle alignment and verification of proper opening and closing times;
- Governor control setting verification;
- Verification of proper lubrication of generator and turbine bearings;
- Final check of unit braking system;
- Initial operation of the turbine-generator and bearing run in;
- Electrical and mechanical overspeed trip tests;
- Final setting of vibration shutdown sensors;
- Voltage regulator and excitation system tests;
- Verification of proper generator to system synchronization;
- Testing and verification of electrical protection systems with load;
- Load rejection tests;
- Performance runs at prescribed loads;
- Operation and monitoring via plant control systems (local and remote); and
- Coordinated testing with all plant units.
Using the Guide

OK, once you know what you are going to test...

- Provides matrices of recommended tests by equipment
For Lots of Stuff

- ELEVATORS
- EMERGENCY POWER—Uninterruptible power supply (UPS)
- EMERGENCY POWER—UPS distribution panel
- EMERGENCY POWER—Diesel generators
- ENVIRONMENTAL
- EXCITATION SYSTEMS
- FIRE DETECTION
- FIRE PROTECTION—CO₂/Halon
- FIRE PROTECTION—Water
- FLOW MONITORING
- GENERATOR
- GENERATOR SWITCHGEAR/Terminal equipment
- GOVERNOR
- GREASING
- GROUNDING
- HIGH-VOLTAGE SWITCHGEAR
- HEATING, VENTILATION, AND AIR CONDITIONING
- HYDRAULIC SYSTEMS
- HYDRAULIC TURBINE
- INSTRUMENTATION AND CONTROL
- LOAD COMMUTATING INVERTER/CYCLOCONVERTER
- LEVEL DETECTORS
- LIGHTING
- LUBE OIL
- PENSTOCK RUPTURE MONITORING
- POTABLE WATER

And a whole lot more!
Tests*

• Description of the Test
• Equipment Required
• Supporting Documents (standards)
• Duration/Work Required

* The Procedures are on YOU!
Bibliography

• Applicable standards by equipment type
Shameless Plug: A working group is actively working on revision of the Guide. All great and energetic minds are welcome to help!