

IEEE 1248

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

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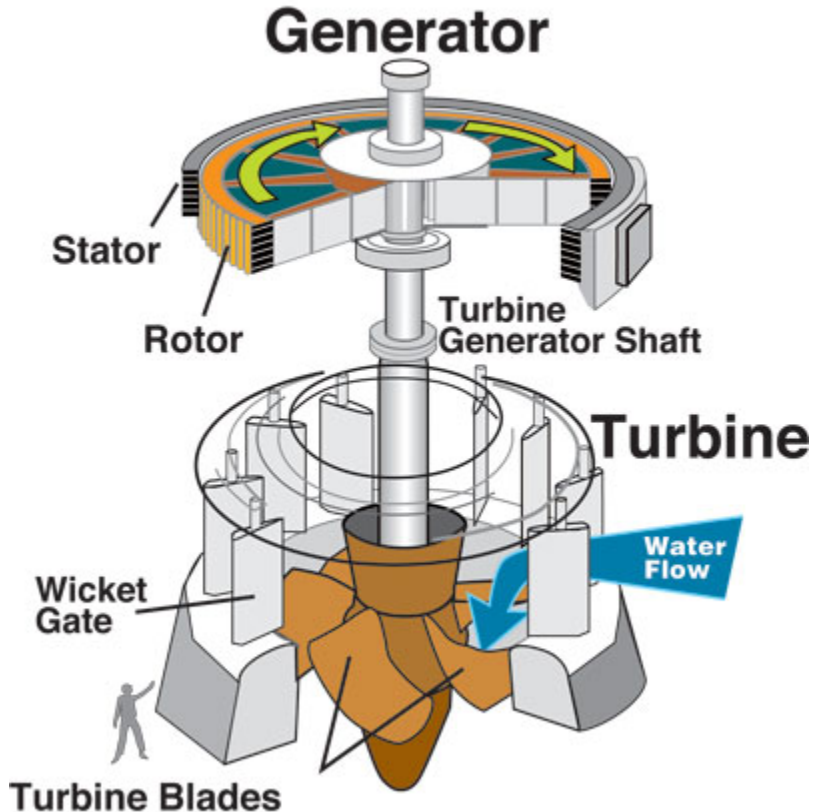
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*137 pages of joyful reading!

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.



CHELAN COUNTY
POWER

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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

EQUIPMENT/SYSTEM	Test									
	Visual Inspection	High potential	Circuitry checkout	Leak testing	Temperature rise	Harmonic distortion	DC winding resistance	Insulation resistance	Functional checks	Initial operation
8.1.17 EXCITATION SYSTEMS										
Rotating excitation system										X
Three-phase ac/dc exciter	X				X		X	X	X	
Rectifier bridge	X				X				X	
Air cooling system	X		X	X	X				X	
Water cooling circuits	X		X	X	X				X	
Field breaker/leads	X	X	X						X	
Controls	X		X						X	
Static excitation system										
Rectifier bridge	X				X				X	
Air cooling system	X		X	X	X				X	
Water cooling system	X		X	X	X				X	
Field breaker/leads	X	X	X						X	
Controls	X		X						X	
Excitation transformer	X				X		X	X		

Recommended tests
Static excitation
Systems controls

Equipment components, static excitation system
"X" means recommended test for component

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!

