

MANUFACTURING INSPECTION

PHOENIX ELECTRIC CORP. PLANT IN NORWOOD, MA USA

MAY 29, 2018

Prepared for: Natural Resources Canada and Nalcor Energy

Project Lead: Nik Argirov

Date: June 12, 2018

Quality Assurance Statement

Office Address	803-633 Kinghorne Mews, Vancouver BC, V6Z 3H3
Prepared by	Vlad Kahle and Nik Argirov
Approved for Issue by	Nik Argirov

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1. GENERAL

On May 29, the Independent Engineer (IE), Argirov Engineering Inc (AEI), together with Nalcor representative, participated in a factory visit at Phoenix Electric Corporation (PEC) plant in Norwood, MA USA.

Four ABB manufactured HECS-100L generator circuit breakers (GCBs) will be installed in the LCP Muskrat Falls hydroelectric plant. Local control cabinets (LCC) for the GCBs were made by Phoenix Electric Corporation (PEC) as subcontracted by ABB.

The GCBs were factory acceptance tested (FAT) in Switzerland and one of them shipped to PEC in Norwood, MA for testing of the LCCs. PEC control cabinets were connected to the GCB and were subsequently tested by ABB, PEC and NALCOR technical staff. IE visited the PEC plant to witness the FAT of the first GCB's LCC.

Reference Documents:

[1] LCP ITP #: MFA-AB-SD-3438-QM-K07-0003-01 REV A1

[2] LCP ITP #: MFA-AB-SD-3438-QM-Q04-0002-01

Attendees:

IE: Nik Argirov and Vlad Kahle

LCP: Russell Hobbs

ABB: Lou Serio (test leader) and Ronald Pinero

PEC: Stephen Simo (VP), Sandro Silva, Eric Frost

2. AGENDA

Meeting:

- Safety briefing key points were to exercise caution when walking around the plant, not to touch any electrical equipment and be cognisant of the noise generated by the GCB operations and workshop machinery.
- Review of the integrated test procedure and quality plan.
- Review of the LCC drawings.

FAT's Completed to Date:

IE were advised that full range of FAT's were conducted in the ABB factory in Switzerland (ref. [2]). Test results were not available for review to the IE at this time; the test certificates were issued to NALCOR already. ABB specialists indicated these tests were completed and documented:

- Insulation Resistance (phases to ground, phase to phase, line to load side in open position)
- Overpotential tests and verification of the BIL at 125kV.

- Millivolt drop test for GCB main contacts
- Maximum available fault current and asymmetrical fault interruption test (type test only)
- Mechanical operation (spring charge mechanism, motion analyzer trip & close using timing rods to produce timing charts, auxiliary contact timing)
- Timing test at minimum operating voltage
- Motor current and Overload trip test
- Alarms test
- SF6 heaters function, gas density and dielectric strength test
- SF6 leakage by using gas leak detectors (sniffers)
- Minimum SF6 pressure for trip and close
- SF6 low pressure trip/ close block
- Tripping and closing control voltages and currents, minimum control operating voltage
- Trip coil 1 and 2 function verification,
- HECS-100L GCB's are not designed for trip free but will withstand close on a fault.
- CT's and VT's tests
- Disconnect and grounding switches checks
- Surge arrestors and capacitor tests.

LCC Operational Tests:

IE witnessed LCC operational tests prescribed by the document [1]. Tests consisted of the GCB operations, verification of the LCC circuitry, GCB/ disconnect/ grounding switches control functions and indications.

Shipping and After Arrival Tests:

The equipment will be transported from the PEC facility to the site by air cushioned transporters. Impact monitors will not be installed on the GCB's as this method of conveyance is expected to protect the GCB's from mechanical damage. Following the GCB installations at MFA, full range of the control and functional tests will be repeated.

3. COMMENTS AND CONCLUSIONS

ABB and PEC specialists satisfactorily answered all IE questions. The LCC tests are well prepared and documented and the tests were conducted in professional manner. It is the IE opinion that the ABB and PEC staffs are suitably qualified for acceptance testing of the MFA GCB LCC's.

APPENDIX

Photographs



Photo 1: MFA GCB Local Control Cabinet (LCC)



Photo 2: LCC auxiliary relays and fusing



Photo 3: Detail- Mimic board with local controls and display

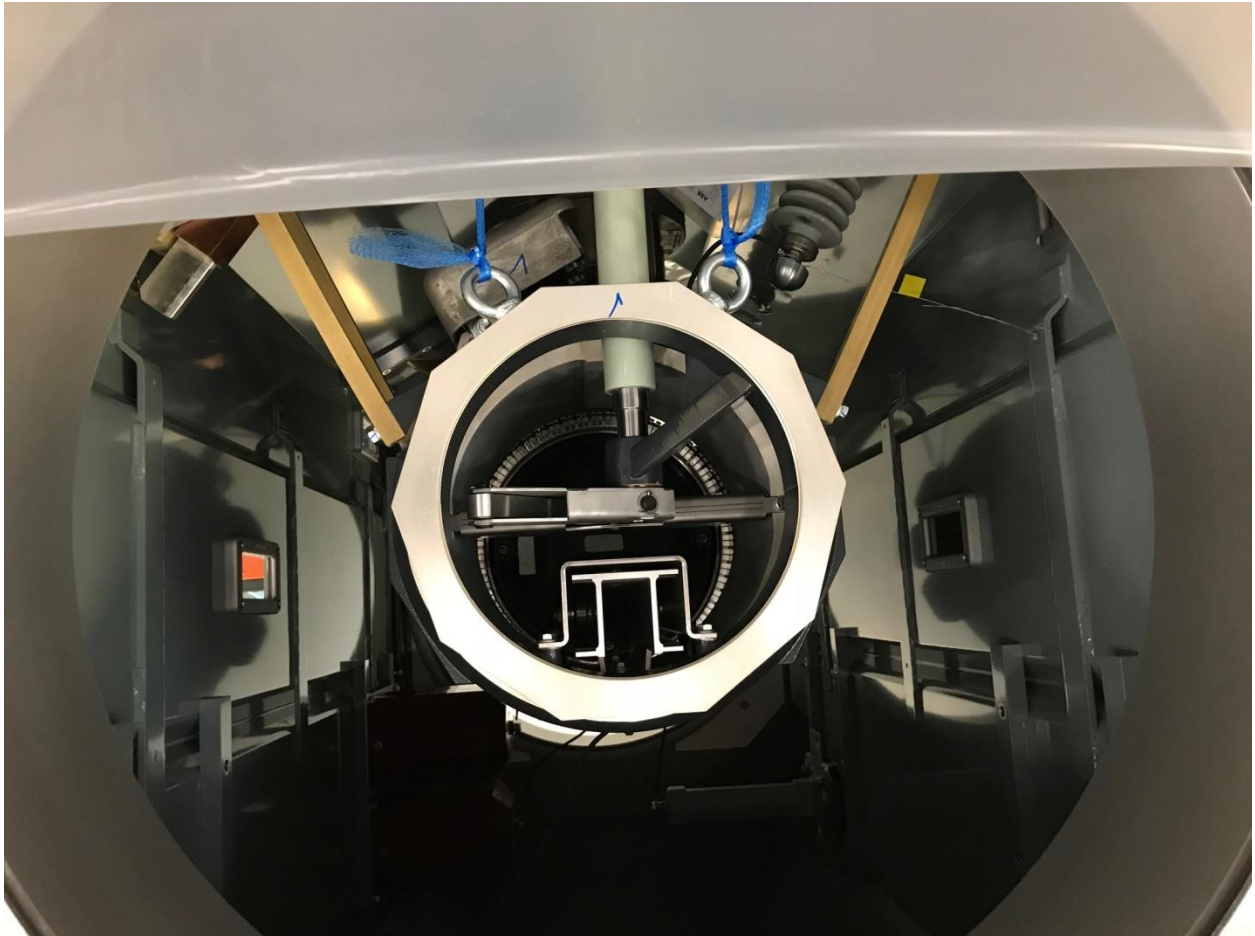


Photo 4: Detail - GCB Disconnect switch linkage and contact.

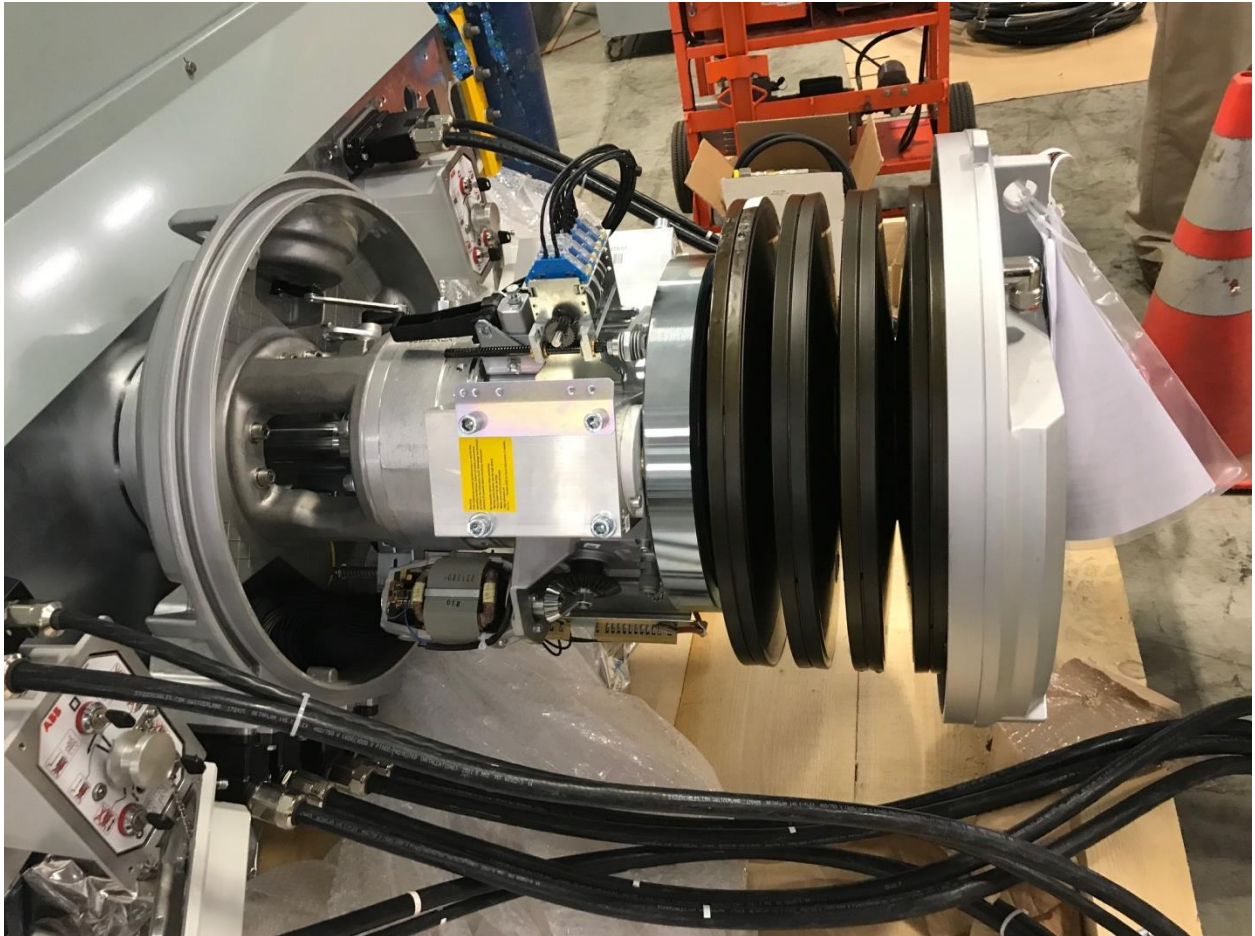


Photo 5: Detail - GCB main spring