

OVERVIEW OF LIBBY TRANSFORMER T1 REHAB

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HOW DID WE GET HERE

HISTORY

- Libby T1 transformer has been in service 45 years and has experienced forced and extended planned outages due to failures of auxiliary protective devices and bushing components, oil leaks, and is exhibiting signs of degradation of the insulating oil.
- A limited rehabilitation of the T1 transformer was performed in 2001, and the T2 and T3 transformers were rehabilitated in 2010 and 2020 respectively.
- A condition assessment of the transformer was completed by the Hydroelectric Design Center in October 2020. The assessment developed several alternatives for the refurbishment of the transformer.



TODAY

- Approved scope for this project is to improve and extend the reliability of Libby T1 Generator Step-up Transformer through a comprehensive refurbishment. The transformer will be refurbished to replace those failed or failing components that threaten the near-term reliability of the transformer.

APPROVED SCOPE

- Replace the following equipment:
 - High-voltage, low-voltage, and neutral bushings
 - Pressure relief device
 - Bushing potential devices
 - Lightning arresters
 - Dehydrating breathers
 - Analog gauges
 - Vacuum valve
 - Conservator tank bladder
 - Pressure vacuum bleeder valve
 - Specified gaskets
 - Low-voltage connectors
- Add rapid pressure rise seal-in relay
- Perform weld repairs
- Inspect deenergized tap changer
- Degas and process transformer oil
- Inspect deenergized tap changer



OVERVIEW: OUTAGE CONSTRAINTS



This project seeks to have Contractor complete the rehabilitation work on the transformer during a six-week outage window or less. Work should be planned to minimize outage durations.

Outage Plans

- Outage periods typically planned between August and September.
 - Long lead-times for manufacturing and supply of transformer bushings and bushing potential devices.
- Outages must be requested from BPA 90 days in advance to guarantee a line outage
- Contractor will need to coordinate the logistics of on-site equipment movement outside of the powerhouse

Constraints and Considerations

- Outage considerations include extreme weather conditions and fish passage. Work is scheduled in late summer due to the following constraints.
 - Springtime is difficult due to fish passage,
 - Fall and winter months are difficult due to inclement weather conditions.
- On-site transformer refurbishment work is dependent on NTP date, annual outage, and long lead items.



OVERVIEW: PROJECT PHYSICAL CONSTRAINTS



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Contractor will need to coordinate with the Project to determine location for oil processing equipment and, containment berm and oil storage container.

- Drain oil from T1 (14,030 gallons) into **oil storage container** located in the parking area adjacent to the end of the powerhouse and entrance to the transformer service deck
- Process oil with an **oil processing trailer** located on the deck and add oxidation inhibitor. Contractor must determine amount of inhibitor to add
- Provide 300 gallons of make-up oil for re-filling
- Remove radiators that show signs of leaking and place radiators and any other leaky equipment in **containment berm**
- Equipment that must fit on the deck includes, crane and oil processing trailer.





OVERVIEW: OIL DRAINING, STORAGE, REFILLING AND VACUUM PROCESSING



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OVERVIEW: BUSHING REPLACEMENT



High-voltage bushing

ABB Type O-Plus-Dry, Style 230N1200AA

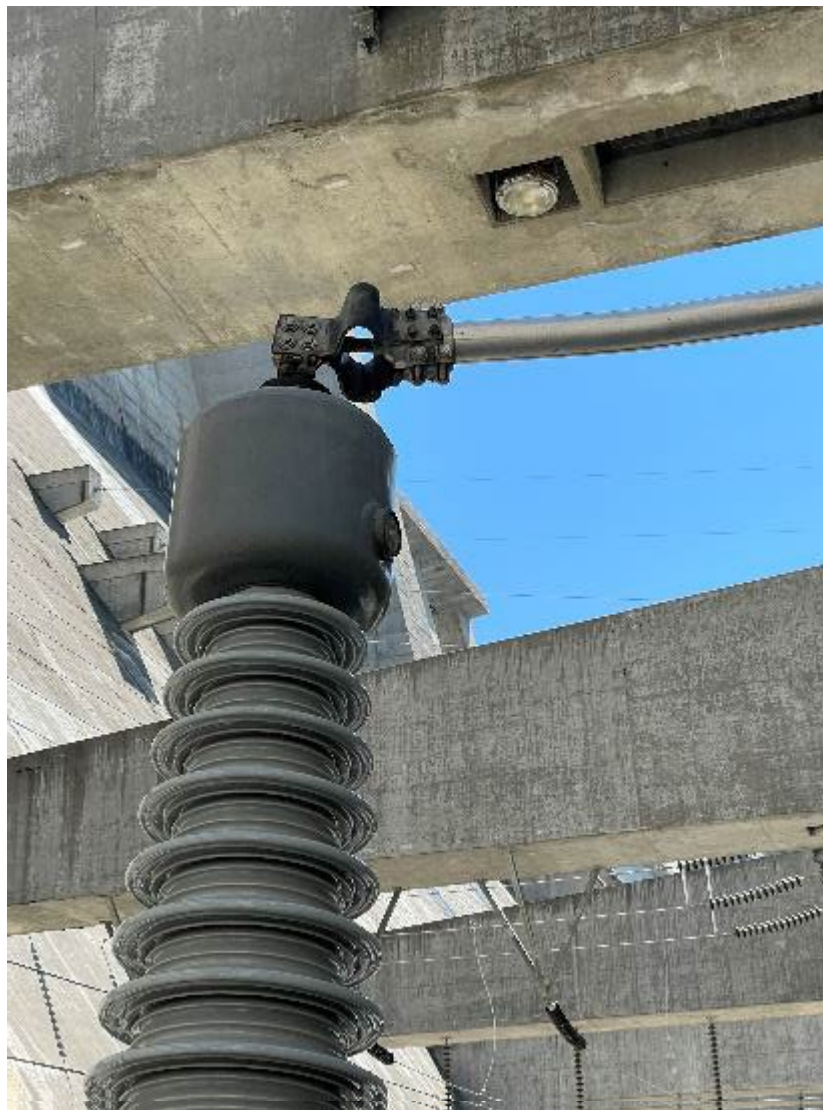
- 230kV type 1,200A current rating, and are referred to as 'O Plus Dry'.
- This type of bushing is the same as that on T3 transformer and the project spare bushing.

Modifications

- Replacement bushing is 8-inches shorter than the existing bushing.
- Modify high voltage tubular bus connecting to the bushing terminal Cut section and weld longer section of bus to reach the replacement bushing terminal.
- Recommended reusing bottom connector and the bolting hardware from old bushing be reused for the replacement HV bushing.



OVERVIEW: BUSHING REPLACEMENT



OVERVIEW: BUSHING REPLACEMENT

Low-voltage bushings

ABB Type LCRJ

- Direct replacement, no modifications necessary
- Rated for high-temperature applications, of a low-corona design and is considered a direct replacement of the existing bushing
- Gaskets must be fluoroelastomeric rubber (also known by the industry name of Viton) gaskets which are designed for high temperatures



OVERVIEW: BUSHING REPLACEMENT

Neutral bushing

ABB Type O-Plus-Dry, Style 025N0412AA

- Direct replacement, no modifications necessary
- Original neutral bushing was replaced in 2015 with an ABB O+C type bushing
- Existing spare bushing is ABB 025N0412AA
- Gaskets must be fluoroelastomeric rubber (also known by the industry name of Viton) gaskets which are designed for high temperatures



Surge Arrester

- Replacement arresters researched have mounting bolt patterns with a smaller dimension than the original arresters. Contractor must either drill new mounting holes, or provide a mounting adapter.
- If length of conductor from the arrester terminal to the HV bus is different, may require replacement.



OVERVIEW: REFURBISHMET EQUIPMENT

- Inspect de-energized tap changer.
- Service de-energized tap changer handwheels mechanism.



DE-ENERGIZED TAP
CHANGER



OVERVIEW: REFURBISHMET EQUIPMENT



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- Replace low-voltage connectors.



LOW VOLTAGE BUSHING
DOG HOUSE



LOW VOLTAGE
CONNECTORS
(TYPICAL
EXAMPLE)

OVERVIEW: REFURBISHMET EQUIPMENT

- Replace dehydrating breathers
- New conduit will need to be routed to the control cabinet for each dehydrating breather's power and annunciation wiring.
- The conduit can be routed along the transformer tank seam flange using parallel beam clamps which are secured to the flange



DEHYDRATING
BREATHER





OVERVIEW: REFURBISHMENT EQUIPMENT REPLACEMENT



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BUSHING POTENTIAL
DEVICES (BPD)



ANALOG
GAUGES



THERMOWELLS

- Replace BPDs.
- Replace analog gauges including winding temperature gauges, oil temperature gauge, and liquid level gauge.



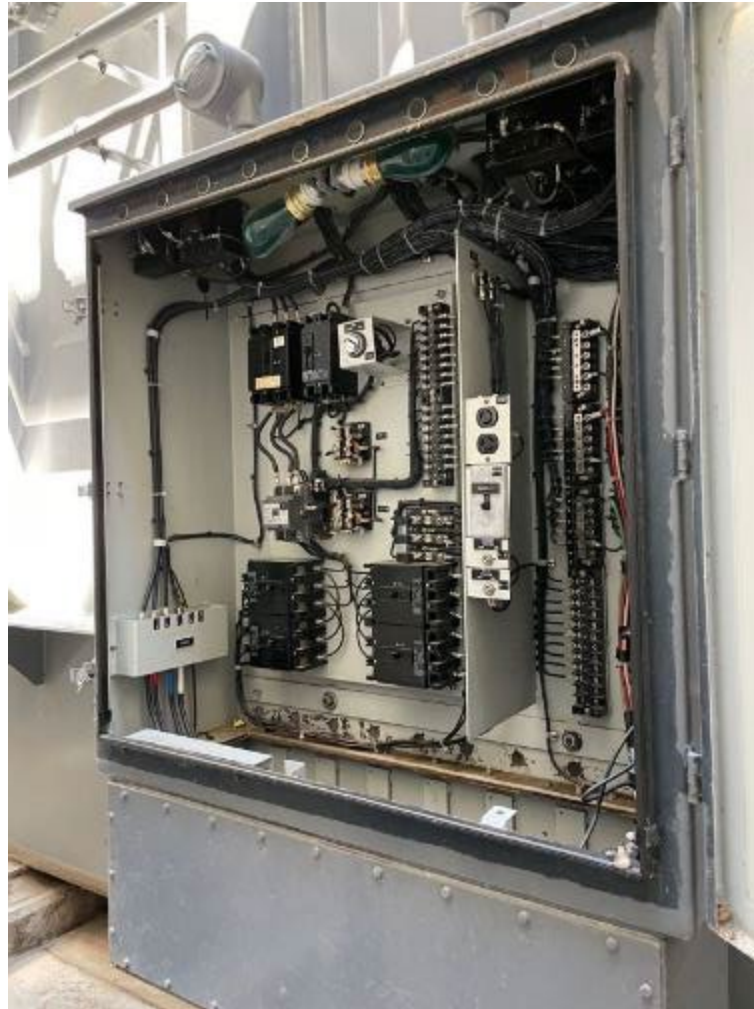


OVERVIEW: REFURBISHMENT EQUIPMENT REPLACEMENT



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- Install new rapid pressure rise seal-in relay in control cabinet.



CONTROL CABINET



CONDUIT BELOW
CONTROL CABINET

OVERVIEW: REFURBISHMET EQUIPMENT



CONSERVATOR TANK

PRESSURE VACUUM
BLEEDER VALVE

- Replace conservator tank bladders and pressure vacuum bleeder valves.



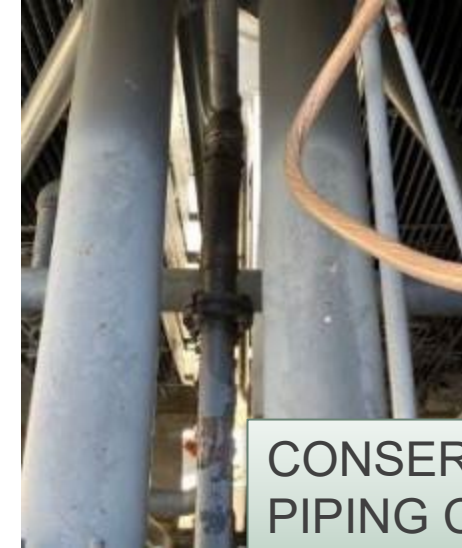
OVERVIEW: GASKETED AND THREADED CONNECTION LEAKS



MANHOLE GASKET AND
BUSHING POTENTIAL TAP



VACUUM VALVE



CONSERVATOR TANK OIL
PIPING CONNECTION



MAIN DRAIN VALVE AND
LOWER FILTER VALVE



LEAK FROM VACUUM VALVE
GOING DOWN TANK WALL



OVERVIEW: WELD LEAKS

- Repair weld leaks using Belzona 1161
- Two tank weld leak locations were identified on Segment 2
- Two radiator fin weld leak locations were identified on Segment 4





OVERVIEW: COMMISSIONING



Commissioning will be led by the **Contractor**

Government Role

- Provide OEM transformer commissioning documentation to Contractor
- Provide any available additional requested drawing information
- Provide qualified Operators for lockout tagouts
- Government will work with Contractor to verify proper annunciation and control actions in the control room
- Government will work with Contractor to energize the transformer and provide loading

Contractor Role

- Lead the overall commissioning process
- Provide an overall lead Commissioning Engineer
 - Develop plans
 - Single point of contact
 - Coordinates with Government Commissioning Lead
- Provide testing and commissioning plans for each subsystem
 - Schedules / durations, step-by-step inspections procedures, pre-work test plan and post-work test plan
- Perform operational testing, including monitoring of the transformer under vacuum
- Provide qualified craftsman during commissioning