ABB Ability™ inspection for transformers – TXplore™
Oil-filled transformer internal inspection service
Use ABB's inspection service to examine the internal structure of your power transformer without having to remove the oil or sending an inspector into confined spaces.
TXplore – World’s first submersible inspection robot

**TXplore inspection benefits**
Ability to perform an internal inspection of an oil filled transformer without needing to drain the oil.

**Safety**
- Eliminates the need for a human to enter harsh and confined-space environments
- Can reach zones inaccessible to humans
- Inspection team works from outside the transformer

**Speed**
- Immediate deployment
- Significantly reduces outage time (from weeks to days)

**Simplicity**
- Minimal oil is handled as the TXplore can enter through a top manhole cover
- No need for a confined-space on-site rescue team

**Expert support**
- Near real-time images are available to ABB experts
- Experts from around the world are able to support inspection as it happens
- ABB Ability platform provides remote access to images

- Option for customers to receive a comprehensive report with solutions to resolve issues identified by the TXplore

**Informed decisions**
- The challenge of oil handling and entering the transformer can be a barrier to performing an inspection
- Guesswork is eliminated with the support of high-quality images

**Inspections can become more routine**
The TXplore can assist in emergency inspections of critical transformers when operational issues are detected. TXplore can be deployed as soon as the transformer is de-energized. This additional data supports a more accurate evaluation of the transformer’s ability to continue to operate reliably. TXplore can become part of a routine periodic inspection, combined with typical oil samples analyzed for chemistry, dissolved gases and electrical tests such as ratio, power factor, SFRA and others.

This evaluation allows the transformer operator to confirm asset readiness/reliability and to use baseline data for future condition comparisons.
The need for understanding your asset condition

Power transformers are critical to moving electrical energy over long distances. They have very long service lives, typically providing reliable energy transfer for several decades. To ensure a long service life, maintenance must be carried out as the transformer ages and issues arise. The largest transformers are typically filled with mineral oil, which acts as a coolant and provides electrical insulation for the high voltages the transformer must withstand. Both the mineral oil and cellulose insulation break down from the stresses of use and aging.

The challenges of traditional inspections

In the past, to evaluate if a specific internal component or system required repairs, it was necessary for someone to perform an internal inspection of the transformer. This required bringing oil processing and storage equipment to the site and removing the oil from the transformer. An internal inspection expert would then enter the transformer and perform the inspection. All of this causes a significant outage and considerable expenses for the customer.

The internal inspection is quite challenging because spaces are tight and the environment is not human-friendly. It is also dangerous, as the confined space requires effort to ensure the air inside is breathable. The process can result in the need for extensive processing to remove gas, moisture and re-establish oil impregnation of the insulation system.

The ability to perform an internal inspection while the transformer is filled with oil

ABB has developed the TXplore to function as a remotely controlled inspection submarine. This allows an inspection of the transformer with minimal to no oil being removed by inserting the device through a top manhole cover. This completely eliminates the need to place a human inspector at risk and expose the transformer’s internal structure to external contaminants and potential damages from the weight of a human performing an inspection.

An on-site operator directs the TXplore using a wireless controller. The TXplore has multiple lights and high-definition cameras that are able to provide photographs and video during the internal inspection. With local communication and support through the ABB Ability platform, transformer experts and customers can watch inspections in near real-time from remote locations. This feature allows ABB to bring the experts in to help with the evaluation and remotely direct operators to look at specific areas in more detail, improving the ability to accurately identify the root cause of a problem.

Get connected and make better decisions

TXplore inspection can be viewed by our experts via an internet connection. Experts can review information collected during the inspection and develop action plans to improve the reliability of the critical transformer asset.

TXplore service can be scheduled to take advantage of a planned outage with little or no increase in the outage duration. ABB can also deploy a team to perform an inspection when unforeseen issues are encountered with same- or next-day response.
Traditional and advanced internal inspection comparison

**Traditional**

- Disconnect
- Drain and store oil
- Connect breathable dry air system and purge transformer
- Assemble confined-space rescue team
- Perform human inspection
- Remove breathable air system, seal transformer and place under vacuum
- Reprocess oil and vacuum-fill transformer
- Set time and basic testing
- Reconnect and return to service

4-10 days

**Advanced**

- Disconnect
- Perform TXplore inspection
- Reconnect and return to service

1-2 days

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Let’s not forget Health, Safety and Environment!

- No longer necessary for personnel to physically enter transformer
- Minimized environmental hazards (i.e., oil spillage and soil contamination)
Frequently asked questions

1. **What is the advantage of the TXplore compared to a periscope camera, borescope or other methods used today?**
   Previous devices are very useful for inspecting areas close to the opening on the cover. However, the TXplore system is not limited by distance from the point of entry or the need to maneuver through or around structures inside the transformer. Wireless communications allow it to reach areas far from the opening used for the inspection.

2. **We are not expecting the oil to be clear. Is the TXplore proven for different types of oil and different oil conditions?**
   Testing has taken place with both new and service aged oils that is significantly darkened. The images in aged oil are very good, but limited in distance. The unique LED arrangement and illumination help collect good close-up images in dark oil.

3. **Is there a chance the TXplore can introduce contamination or cause damage to the transformer being inspected?**
   In our development efforts, we have done extensive testing to make sure that contamination or bubbles are mitigated during the course of an inspection. This has been confirmed through multiple oil samples analyzed after the completion of pilot inspections. The momentum of the robot and control of the speed ensure the device cannot damage transformer structures.

4. **Is there a maximum oil viscosity for the TXplore system?**
   The TXplore service can be offered for mineral oil, ester fluids and silicone. It is configured as standard based on the density of mineral oil. Adjustments in the buoyancy control system are required for other density liquids.

5. **Can the TXplore inspect a transformer that contains PCB contaminated oil?**
   Yes. For every inspection, an oil analysis must be performed before we enter the transformer. If PCBs are present, there will be an extra cost once the inspection is complete. The extra cost will cover the additional cleaning process of the TXplore.

6. **How quickly can ABB respond to a request for an inspection?**
   We can essentially respond as quickly as we can drive or fly to the inspection site pending availability of the TXplore. The entire TXplore system is transportable in two packages, which can be checked as baggage by airlines since each case weighs less than 20 kg (44 lbs).

7. **What is the smallest size transformer that the robot will fit?**
   The system is able to fit into any space where a human can fit. Since the TXplore is much smaller (18 cm x 20 cm x 24 cm (7” x 7.9” x 9.3”)] than a human inspector, it can get into much tighter spaces. The final determination will be the specific design of the transformer being inspected. An opening on the top of the transformer must be available for inserting the robot.

8. **Can the TXplore inspection be used to accomplish requirements set by NERC/FERC for safe non-destructive inspection methods for substations that are documented with recordable data?**
   Yes. This requirement must be identified during the proposal development. If video documentation is required, an extra charge will be applied to cover the cost of providing a video documenting the internal inspection that can be preserved by the customer or by ABB (for an additional fee).
Frequently asked questions

9. How many transformer inspections has the TXplore performed?
Orders are being executed on a regular basis in the US. A listing of customers is being developed, as we’re just out of the pilot phase and able to quote and book orders. We are now focused on our global rollout strategy to ensure system availability and fast deployments across the Transformer Service network.

10. Can ABB offer the service to other OEMs when they have issues on their test floor?
Yes. TRES is able to offer this service for any customer. Our trained operators will always operate the system. In the case of working for other OEMs or equipment manufacturers, they would be expected to provide technical assistance and transformer preparations for the inspection when working with the TRES operator.

11. Will future designs enable inspection when the transformer is energized?
Inspecting an energized transformer would put the transformer in great risk as the robot would have a dramatic impact on the electromagnetic fields inside. At this point in time it is not possible to introduce such a device and disturb the fields with an acceptable margin of safety.

12. Can ABB offer demos for interested customers?
We are in the process of rolling out the TXplore across our global service network. Transformer Service locations with the TXplore capabilities might be able to offer pilot inspections based on scheduling and availability.
Additional information

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