SECTION 26 01 60.15
TRANSFORMER MONITORING SERVICES - SCHNEIDER ELECTRIC ECOSTRUXURE TRANSFORMER EXPERT

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 26 01 60.13 - Maintenance Services for Electrical Distribution Equipment - Schneider Electric EcoCare.

1.02 ABBREVIATIONS AND ACRONYMS

A. DGA: Dissolved gas analysis.

B. DP: Degree of polymerization.

C. IoT: Internet of things.

D. PD: Partial discharge.

E. RH: Relative humidity.

1.03 REFERENCE STANDARDS

A. ASTM D3612 - Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography; 2002 (Reapproved 2017).

B. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).

C. IEC 60567 - Oil-Filled Electrical Equipment - Sampling of Free Gases and Analysis of Free and Dissolved Gases in Mineral Oils and Other Insulating Liquids - Guidance; 2023.

D. IEC 60599 - Mineral Oil-Filled Electrical Equipment in Service - Guidance on the Interpretation of Dissolved and Free Gases Analysis; 2022.

E. IEEE C57.12.10 - IEEE Standard Requirements for Liquid-Immersed Power Transformers; 2017.

F. IEEE C57.104 - IEEE Guide for the Interpretation of Gases Generated in Mineral Oil-Immersed Transformers; 2019, with Errata.

G. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate work to provide service-plan-compatible equipment and systems with sensors, interfaces, and other appurtenances required for specified functionality.
   2. Coordinate with Owner for access to utilities and existing infrastructure.

B. Schedule installation to minimize disruption to ongoing operations.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

1.06 QUALITY ASSURANCE

A. Manufacturer/Services Supplier Qualifications:
   1. Certified in accordance with ISO 9001 with applicable quality assurance system regularly reviewed and audited by third-party registrar. Develop and control manufacturing, inspection, and testing procedures under guidelines of quality assurance system.
   2. Service and technical support services available 24 hours per day, 7 days per week from manufacturer or their representative.

B. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver monitoring system components in manufacturer's original, unopened packaging with labels clearly identifying product name and manufacture or installed on new transformer at factory.

B. Store components in clean, dry, and temperature-controlled environment until ready for installation.

C. Handle components with care to prevent damage during transportation and installation.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Provide manufacturer warranty for defects in material under normal use and service for period equal to service subscription duration.

PART 2 PRODUCTS

2.01 MANUFACTURERS/SERVICE SUPPLIERS

A. Schneider Electric; EcoStruxure Transformer Expert; www.se.com/#sle.

2.02 TRANSFORMER MONITORING SYSTEM - GENERAL REQUIREMENTS

A. Basis of Design: Schneider Electric; EcoStruxure Transformer Expert; www.se.com/#sle.

B. Description:
   1. Provide comprehensive transformer monitoring system for liquid-filled transformers.
   2. Provide array of sensors integrated into single probe to monitor critical parameters:
      a. Oil temperature.
      b. Water activity (relative humidity).
      c. Vibration and acoustic signals.
   3. Provide real-time data acquisition, automated analysis, and predictive maintenance capabilities.
   4. Provide data processing unit for initial data validation, encryption, and preprocessing before transmitting to central analytics platform.
   5. Central Analytics Platform: Hosted on secure cloud infrastructure; perform advanced analytics, providing actionable insights and advance recommendations.

C. Comply with:
   1. ASTM D3612.
   2. IEC 60567.
   3. IEEE C57.104.
   4. IEC 60599.
   5. IEEE C57.12.10.

D. Measurement Capabilities:
   1. Oil Temperature:
      a. Measurement Range: From minus 4 degrees F to 257 degrees F.
      b. Accuracy: Plus/minus 0.9 degrees F from 32 degrees F to 230 degrees F; plus/minus 3.6 degrees F otherwise.
   2. Surface Contact Temperature:
      a. Measurement Range: From minus 4 degrees F to 212 degrees F.
      b. Accuracy: Plus/minus 0.5 degrees F.
   3. Water Activity (Relative Humidity):
      a. Measurement Range: From 0 to 100 percent relative humidity.

b. Accuracy: Less than 2 percent (20 to 95 percent RH) from 32 degrees F to 212 degrees F.

4. Hydrogen Levels (External Sensor Add-On on Main Probe):
   a. Measurement Range: From 0 to 2,000 ppm.
   b. Accuracy: Plus/minus 5 percent of reading.
5. Partial Discharge Activity:
   a. Detection: Correlated multi-band ultra-high frequency (UHF).
   b. Frequency Range: From 315 to 433 and 915 MHz.
6. Vibration/Acoustic Measurement Range: From 50 to 2,400 kHz.

E. Components:
1. Sensors:
   a. Integrated into single probe for comprehensive monitoring capabilities.
   b. Accommodate FM global certified H2 probe add-on.
2. Data Processing Unit:
   a. Perform initial data validation, encryption, and preprocessing.
   b. Support secure and accurate data transmission to central analytics platform.
3. Central Analytics Platform:
   a. Hosted on secure cloud infrastructure.
   b. Provide advanced analytics, actionable insights, and advance recommendations.
4. Communications Interface:
   a. Support multiple communication protocols, including 3G/4G.
   b. Support seamless data transfer from sensors to central analytics platform.
5. User Interface:
   a. Provide user dashboard accessible via web and mobile applications.
   b. Provide fleetwide view of transformer health, historical data analysis, and real-time alerts.
6. Power Supply:
   a. Control Cabinet: Include provisions for DIN-rail-mounted 100-240 VAC/24 VDC converter power supply.
   b. Control Power Rating: Capable of wiring 15 W of 100-240 VAC control power from existing control power supply in control cabinet to DIN-rail-mounted probe power supply.
7. Control Wiring: Include provisions for addition of control power wiring for power connection cable and external temperature sensor to be run from control cabinet to probe port and temperature monitoring location on opposite side of transformer, respectively.

F. Environmental and Operating Conditions:
1. Operating Temperature Range: From minus 4 degrees F to 140 degrees F; sensors and related equipment to maintain accuracy and reliability throughout range.
2. Humidity Range:
   a. Relative Humidity Range: From 0 to 100 percent, noncondensing.
   b. Prevent moisture ingress and damage due to high humidity levels.
3. Ingress Protection: Provide system components, including sensors and data processing units, with ingress protection rating of IEC 60529, IP65.
4. Altitude: Up to 9,843 feet.
5. Shock and Vibration Resistance: Prevent damage or performance degradation due to mechanical shocks or vibrations.
6. Corrosion Resistance: Protection against corrosion; external surfaces and connectors treated or coated to prevent corrosion and extend operational life of system.
7. Ultra Violet (UV) Resistance: External components exposed to sunlight to be UV-resistant to prevent degradation due to ultraviolet radiation; use materials and coatings that provide long-term protection against UV exposure in outdoor installations.

2.03 CYBERSECURITY

A. Principles:
   1. Secure System Design: Restrict unauthorized access with physical and digital methods.
   2. User Identification: Enforce strong user identification and authentication procedures; use unique identifiers and secure login credentials for all users.
   3. Data Integrity and Confidentiality:
      a. Protect data transmitted and stored by system using strong encryption methods such as AES-256.
      b. Use HTTPS with TLS encryption for data transmission between probe and cloud-based analytics platform.
   4. Security Procedures and Best Practices:
      a. Implement comprehensive security procedures and adhere to industry best practices to mitigate risks.
      b. Update security protocols and practices to address new and emerging threats.

B. Monitoring:
   1. Continuous Monitoring:
      a. Implement continuous monitoring of system for potential cybersecurity threats.
      b. Use automated tools to detect and alert on suspicious activities or anomalies.
   2. Periodic Penetration Testing: Conduct regular simulated cyberattacks to evaluate system security; performed by certified cybersecurity specialists to identify and address vulnerabilities.
   3. Dynamic and Static Vulnerability Scanning: Continuously scan for vulnerabilities using third-party security tools; integrate into development pipeline for ongoing security assessment.
   4. Role-Based Access Control (RBAC): Implement to control user access based on their roles and responsibilities, only giving users access to relevant data.
   5. Multi-Factor Authentication (MFA): Enforce for all logins; mandatory for customers, partners, and employees accessing system.
   6. Incident Response: Establish and maintain incident response plan to address and mitigate impact of cybersecurity incidents; include procedures for detecting, reporting, and responding to security breaches.
   7. Audit Trails:
      a. Maintain comprehensive logs of user activities, system access, and security events.
      b. Use audit trails to monitor and review user activities for accountability and security.
   8. Data Encryption:
      a. Encrypt data stored on cloud-based platform using AES-256 encryption to protect sensitive information.
      b. Manage encryption keys securely and rotate periodically to maintain security integrity.

2.04 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Assemble and test monitoring system at manufacturer's facility before shipment.

C. Perform calibrations as required in factory on sensors for accurate measurements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install components in accordance with manufacturer’s written instructions.

B. Use proper tools and techniques for secure and accurate installation.

C. Prepare mounting surfaces for proper alignment and positioning of sensors and components.

D. Provide access to required utilities and infrastructure for system installation.

E. Valve Compatibility and Mounting Location:

1. Install probe insertion port utilizing 1-inch ball valve with threaded fittings (3/4 inch NPT) on front of tank, same wall as other transformer monitoring gauges; ball valve to allow probe to pass through when fully opened.
2. Port Vertical Position: Height of 4 to 22 inches below minimum oil level.
3. Port Horizontal Position: Determined by supplier; identified on outline drawing as "future provision for transformer monitoring".
4. Protrude probe into tank 1 inch with probe length of 12.4 inches. Provide valve and flange length to accommodate 11.4 inches insertion.
5. Provide mounting clearance for external installation; probe extends externally from ball valve approximately 10 inches with 2.9-inch diameter.
6. Account for power and thermal sensor connection cable protrusions extending out approximately 6 inches.
7. Front Port Clearance: Minimum of 24 inches.

3.02 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Inspection:
   1. Conduct thorough inspection of installed system for compliance with specifications.
   2. Verify connections, mounts, and components are secure and correctly installed.
   3. Correct identified deficiencies.

C. Testing and Verification:
   1. Perform on-site testing to verify proper functionality and performance of installed monitoring system.
   2. Verify sensors provide accurate and reliable data as specified.
   3. Document test results and report issues or deviations.

3.03 PROTECTION

A. Protect installed system from subsequent construction operations including environmental and physical hazards.

B. Verify cybersecurity measures are in place to protect data integrity and system security.

C. Verify system’s access controls, encryption, and monitoring features are functional.

3.04 MAINTENANCE

A. See Section 26 01 60.13 for additional information.

B. Provide to Owner, as alternate to base bid, separate contract for switchgear service plan for two years from date of Substantial Completion including, but not limited to, dedicated customer success management team, priority remote and on-site (within 100 miles of service location) expert support, discounted service rates, continuous monitoring and alarming, online training.

END OF SECTION 26 01 60.15