DOBLE CONSULTING & TESTING SERVICES

TRANSFORMER RELIABILITY

CONDITION ASSESSMENT SERVICES

IMPROVING ASSET RELIABILITY THROUGH UNDERSTANDING TRANSFORMER HEALTH

Transformer reliability assessment services from Doble Power Services provide a solid foundation for an effective transformer life-cycle management program. No one can precisely answer when equipment will fail, but it's essential to manage the risk. Whether evaluating an individual transformer or a fleet, reliability assessments are complex and require a proven methodology and an experienced team of design engineers, chemists and technicians using numerous evaluation criteria.

WHO SHOULD USE DOBLE'S TRANSFORMER RELIABILITY ASSESSMENT SERVICES?

Doble works with asset managers, corporate lead engineers and plant/system engineers who typically have a large fleet of critical transformers and are looking for a trusted energy infrastructure partner to help identify units at risk of failure so that limited maintenance resources can be focused where needed most. They may also have an at-risk transformer and be looking for mitigating steps they can take to improve reliability and extend asset life.

Doble has assembled a transformer condition assessment team with unmatched expertise:

- Extensive global experience
- Proven transformer reliability assessment methodology
- Global, industry-leading laboratory diagnostics research
- Independent, unbiased expert opinion not affiliated with manufacturers
- Doble KnowledeBase containing decades of statistically significant data including 25 million test results on over 350,000 types of electrical apparatus

CONDITION ASSESSMENT METHODOLOGY

Doble has adopted a two-stage approach with the intent of consolidating all sources of transformer asset health information into an integrated view.

Asset Health Review Survey (Level 1)

- Initial review of existing test data
- Asses technical condition and develop a general condition overview to identify units that are at greatest risk of failure (red, yellow or green)
- Prioritize where to undertake a more detailed investigation

Comprehensive Assessment (Level 2)

- Detailed review of transformer condition including a design family evaluation
- May include a full-suite of on-line and off-line diagnostic testing
- Benchmark oil analysis and electrical test data against Doble KnowledgeBase
- Second refinement of technical condition and risk assessment to highlight areas of concern

ASSET HEALTH REVIEW SURVEY (LEVEL 1)

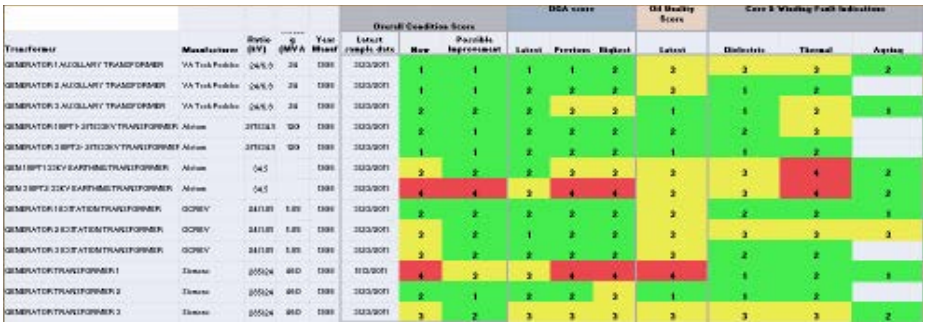
Using available test data, Doble will perform an initial survey rating important criteria (Table 1) on a 5-point scale (Table 2) to develop a general condition overview (rating of green, yellow or red) of the transformer population & prioritize resources.

- Prepare an asset health register
- Systematically collect and review all available test data
  - Nameplate
  - Design and factory test data
  - DGA and oil analysis data
  - Electrical field test data
  - Operations and loading history
  - Fault and short circuit history
  - Maintenance and repair history
  - Existing infrared and RFI survey data
- Identify critical information gaps and develop process for periodic updating
- Using Doble's proven asset health review methodology, score transformer on up to nine (9) criteria and overall health

Table 1. Key Survey Criteria

- Overall condition
- Dissolved gas analysis (DGA)
- Oil quality
- Water content
- Furans
- Dielectric, Thermal & Mechanical
- Bushings
- Load tap changer DGA & condition

Asset Health Review Survey



Units that are strategic or at risk of failure are identified and scheduled for additional investigation and off-line testing.

Table 2. Rating Scale

CONDITION	DEFINITION
As New	No damage or deterioration
Normal/Aging Performance	Reasonable for age, no action required
Aged/Some Performance Issues	Some aging; in need of monitoring but not urgent
Suspect/Major Performance Issues	Clearly identified aging and at significant risk of failure. Remedial action plan required.
Unacceptable	Unacceptable aging deficiencies; implement remedial action plan immediately

COMPREHENSIVE ASSESSMENT (LEVEL 2)

Detailed review of transformer condition focusing on units from the asset health review that indicate significant risk in order to determine suitability for continued service. Assessment will highlight areas of concern and provide remedial action recommendations to improve reliability.

- For units scored yellow or red, perform detailed review to identify faults or accelerated aging & possible root causes
- Perform thorough design family review
- Benchmark oil analysis and electrical test data against Doble KnowledgeBase
- Provide specific remedial action recommendations to improve transformer reliability and overall condition
- May include full-suite of on-line and off-line diagnostic testing

Additional On-line and Off-line Diagnostic Tests May Include:

- Laboratory analytical tests
- Thermal ageing and hot spots
- Dielectric condition (electrical test)
- Mechanical condition (electrical tests, visual inspection)
- Tank and external metalwork (visual inspection)
- Bushings (electrical tests, inspections)
- Tap changers (oil condition)
- Arresters (leakage current test, visual inspection)

ADDITIONAL SERVICES

Doble provides a comprehensive suite of transformer life-cycle management solutions specifically designed to meet your needs.

- Transformer maintenance program development consulting
- Transformer or component (LTC, bushings, etc.) failure analysis
- Routine & advanced testing
- Partial discharge testing
- Consulting services for new transformer procurement
  - > Specification writing and review
  - > Factory audits
  - > Proposal evaluation
  - > Design review
  - > Factory test witnessing

For more information about how these services can provide you a competitive advantage, contact Doble at services@doble.com.

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