Turbine Generator Health Assessment

TG Advisers, Inc.

Health Assessment Goals

- Establish unit condition
- Evaluate problem areas and risk
- Define actions to address risks
- Produce a living document for future use
- Provide financial return with improved availability and reduced future costs

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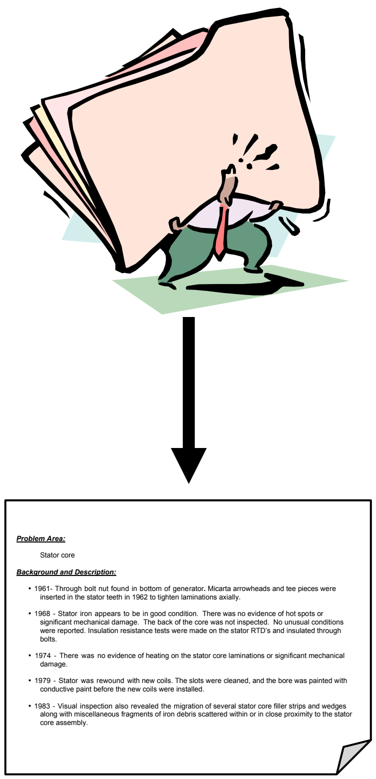
Establishing Unit Condition

- Onsite operations and maintenance interviews
- Inspection report review, evaluation, and interpretation
- Operating data survey
- OEM generic issues review
- Organization using a Problem Area approach



Problem Area:

Stator core

Background and Description:

- 1961- Through bolt nut found in bottom of generator. Micarta arrowheads and tee pieces were inserted in the stator teeth in 1962 to tighten laminations axially.
- 1968 - Stator iron appears to be in good condition. There was no evidence of hot spots or significant mechanical damage. The back of the core was not inspected. No unusual conditions were reported. Insulation resistance tests were made on the stator RTD's and insulated through bolts.
- 1974 - There was no evidence of heating on the stator core laminations or significant mechanical damage.
- 1979 - Stator was rewound with new coils. The slots were cleaned, and the bore was painted with conductive paint before the new coils were installed.
- 1983 - Visual inspection also revealed the migration of several stator core filler strips and wedges along with miscellaneous fragments of iron debris scattered within or in close proximity to the stator core assembly.

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Problem Areas

- Problem areas are failure modes and chronic conditions judged to be of concern
- A minimum of 45 areas segmented by turbines elements, valves, generator and systems
- Each problem area reviewed for:
  - Long-term trends
  - Parts replacement history
  - Effectiveness of past repairs and alterations
  - Inspection findings

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Problem Area History

- LP Blade Erosion
  - 1970: X recommends L-0 replacement. Stellites eroded 1" above outer lashing wire on inlet side. Last 3 rows "metal sprayed."
  - 1974: L-0 erosion 1/4" into blade. Last 3 rows metal sprayed.
  - 1979: L-0 erosion with saw-toothed, jagged appearance. Blades blended and last 3 rows metal sprayed. X recommends replacement.

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Problem Area History (continued)

- LP Blade Erosion
  - 1983: L-0 rows replaced. L-1 and L-2 stellite repairs required.
  - 1989: L-0 blades exhibited erosion with stellite separation. L-1 had moderate rivet erosion while L-2 exhibited stellite pitting. X recommends stellite replacement on all six rows by next outage.
  - 1992: Visual exam shows L-0 patterned erosion and stellite wear. Blades deemed repairable at a later outage.
  - 1996: L-0 blades replaced. X completes repairs to remove loose stellite tips, install L-1 weld dams and plug weld one L-2 eroded tenon. Foil erosion noted on rows 1–3.
  - 1998: Flow tested L-0, L-1, & L-2 water catchers drained freely.

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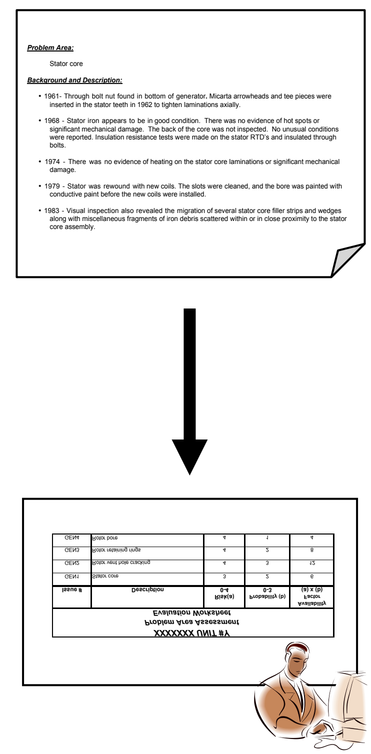
Problem Area Risk Analysis

- Each problem area is assessed an availability factor, A_f
- Af is a function of failure impact & probability
- Impact relates to outage duration and costs if problem area results in failure
- Probability is potential for failure over a defined time period (usually inspection interval)
- A_f is used to risk rank problem areas for action at upcoming outages



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Problem Area Ranking

- Example generator problem area ranking (partial table shown)

Issue #	Description	Risk 0-4	Probability 0-3	Availability Factor
GEN2	Rotor vent hole cracking	4	3	12
GEN5	Rotor field winding	4	3	12
GEN3	Rotor retaining rings	4	2	8
GEN1	Stator core	3	2	6

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Problem Area Actions

- Detailed unit actions and recommendations developed for critical problem areas
- Example - generator rotor vent hole cracking:
  - Limit overspeed severity by reducing trip setting to < X %. Investigate rotor pre-warming capability.
  - Monitor crack growth by eddy current inspections
  - Re-inspect rotors at intervals < X years or Y overspeed cycles. Schedule rewinds and repairs when crack length exceeds X".
  - Field winding insulation is > 45 years. Plan to rewind rotor and inspect axial vent holes at the next outage.

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Documentation

- Final report contains:
  - Executive summary
  - Description of health assessment process
  - Outage planning recommendations
  - Problem area risk assessment
  - Problem area description and analysis
  - Unit history summary

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Financial Benefits

- Savings result from:
  - Increased availability and reduced forced outage costs
  - Improved planning and greater flexibility to solicit bids
- Savings vary with:
  - Unit size, age, and condition
  - Desired operating period after the next inspection outage
  - Labor and fuel costs
- Estimated savings for a 6 year inspection interval:
  - 800 MW 1970s vintage unit: $400,000
  - 150 MW 1950s vintage unit: $200,000
  - Savings in current $
  - Planning and bidding benefits not included

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Conclusions

- The Health Assessment offers significant savings and also…
  - Serves as the foundation to optimize outage cycles
  - Provides a single, organized reference that supports technical decision making
  - Allows easy updating as additional information becomes available
- TG Advisers stands ready to provide the expert knowledge to help you meet your operational and financial goals

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