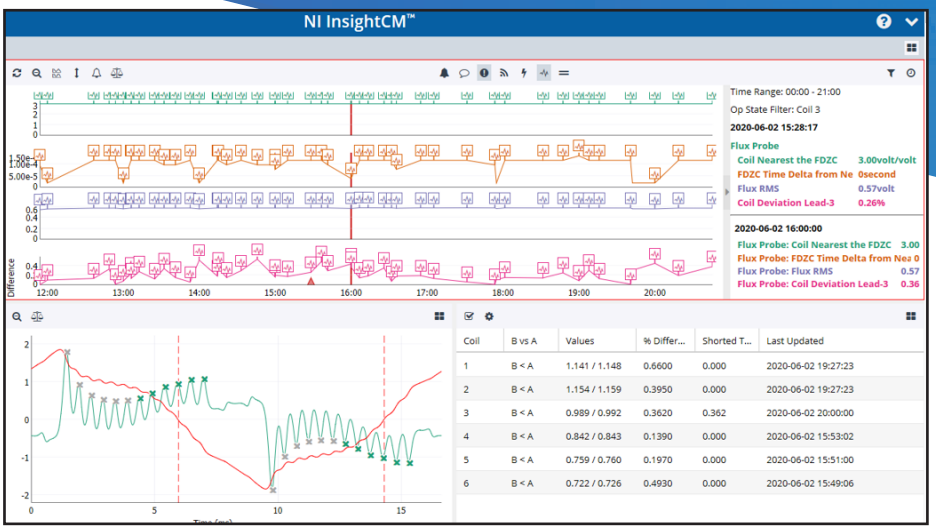
CUTSFORTH
ROTOR FLUX MONITORING



This paper may be used in conjunction with Cutsforth™ Rotor Flux Monitoring Professional Development Webinar from June 25th, 2020. You can find a recording at Cutsforth.com/RFM

Do you know whether degradation of the rotor windings within your generators are placing your operation at risk? How often do you measure the flux signals for shorts? Do you measure during transitional states, different load conditions? Read on to learn why online condition monitoring of the rotor field is crucial to your generator's health.

WHAT IS ROTOR FLUX MONITORING?

Rotor Flux Monitoring (RFM) is the process of acquiring signals from the generator's existing rotor flux sensor to measure deterioration in the insulation of the windings that can result in shorted turns. This degradation can be caused by thermal wear, contamination, load cycling or vibration.

What Does RFM Analyze?
RFM analyzes the percent deviation between leading and lagging values of each coil representing the number of shorted turns that exist in the windings of that coil.

Why is Monitoring Rotor Flux Important?
Damaged insulation can lead to imbalances in the rotor field leading to increased vibration, in turn leading to additional damage, and further degradation. As the condition of the insulation continues to degrade, the probability of shorted turns and unplanned outages increases.

Advance knowledge of insulation failure and real-time feedback of the extent of the damage helps the plants determine the best course of action for continued operations. Plants are then able to better plan maintenance activities rather than facing surprise forced outages.

The monitoring system alerts plants to a change in the percent variance in the rotor flux field indicating the level of deterioration in the insulation of the windings resulting in shorted turns. This damage can lead to:

- Increased demand on excitation systems
- Imbalances in the rotor field
- Increased vibration
- Degradation of flux field integrity
- Reduced generator capacity
- Increased risk of rotor ground fault
- Potential unexpected generator failure or forced outage

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HOW HAS CUTSFORTH™ INNOVATED ROTOR FLUX MONITOR-

Cutsforth™ addresses a number of concerns including energy security, environmental and operational protection, system efficiency, data distribution, and system reliability and control. Plants are now able to own and control their data: who sees it, what happens to it, and who can do what with the system.

What are the System Features?

- Flexible system
  - » Plants are able to customize their systems to capture meaningful data
- Data driven decisions
  - » Advanced alerts allow for condition based maintenance decisions
  - » Fewer surprise outages due to rotor shorts
  - » Trends are measured through archived data for early indications of defects
- Ability to track flux density zero cross (FDZC)
  - » The system collects data when the FDZC coincides with the coil
- Real-Time Data
  - » Plants can now rely on continuous data rather than having to rely on a single snapshot
  - » The system shows flux waveforms
  - » Tables are a quick, easy way to view the data
  - » The system calculates flux deviations associated with FDZC
- Custom Notifications
  - » Plants can set and control multi level alarms allowing notification when deviations and shorted turns move beyond a specific level
  - » Control who receives the alerts (i.e. email distribution list)

WHAT ARE THE FINANCIAL IMPACTS?

Estimated Financial Assumptions

Risk Scenario: Rotor ground fault due to poor insulation

FACTOR	ASSUMPTION*
Approximate Repair Cost	$1.5-$2.5 Million
Lost Revenue Assumptions Assumption based on: • 150 MW Base Load Generator • 25-40 Days in unplanned outage • $25 MW per hour • 12 Production hours per day	$1.1 – $2 Million
Total Revenue Impact • Repair Costs + Lost Revenue • **Does not account for power buy back cost to fulfill production quota	$2.6– $4.5 Million

Estimated Return on Investment:

With Cutsforth™ Rotor Flux Monitoring system

COST DEFERRAL/ELIMINATION	O&M BUDGET SAVINGS* NET PRESENT VALUE OVER 72 MONTHS
Deferred Maintenance Scenario • Eliminates rotor out maintenance events • Replaces with Moderate Inspections	$537,000
Eliminate Annual Outsourced Rotor Flux Measurements	$46,228
Risk Avoidance • Avoid risk of partial rewind or replacement of rotor assembly	$56,378
Total O&M Budget Savings Over 72 Months (NPV)	**$639,606**

FACTOR	VALUE*
Total O&M Budget Savings Over 72 Months (NPV)	$639,606
Total Cost of Cutsforth's Rotor Flux Monitoring • Cutsforth hardware & InsightCM™ License: $35,000 • Assumes $15,000 in potentially necessary electrical contractor work	$50,000
Total Return on Investment	**53%**

CONCLUSION

Rotor Flux Monitoring eases financial burdens on plants while providing real-time information leading to advance knowledge of maximum flux deviation. This early detection allows plants to determine outages based on condition of the rotor rather than having to rely on a calendar.

For more information on Rotor Flux Monitoring or any of our other monitoring systems visit **www.cutsforth.com**.

Note: All numbers are estimates. The results are illustrative only. Specific risks, costs, and prices will vary. This is not a guarantee of savings nor a guarantee of eliminating risk. Proper maintenance must be performed