

CUTSFORTH

GENERATOR FIELD MONITORING

This paper can be used in conjunction with Cutsforth™ Generator Field Monitoring Professional Development Webinar from August 19th, 2021. You can watch the recording at [Cutsforth.com/GFM](https://cutsforth.com/GFM)

⚡ Introduction:

Generator Field Monitoring combines Premium Shaft Ground Monitoring (SGM) and Rotor Flux Monitoring (RFM) systems into one powerful controller. Plant personnel can achieve the benefits of both systems for better trend analysis and easier system management.

⚡ Shaft Ground Monitoring:

Monitoring the shaft grounding allows plants to reduce operation expenses, while optimizing capital. The system detects failures such as poor shaft contact, bearing faults, and stator issues.



Figure 1: Shaft Ground Monitoring Screenshot

Shaft Ground Monitoring Case Study

SGM measures 0 to peak, DC, and RMS levels at the ground current, shaft voltage, turbine and exciter shaft voltage to give a better and more complete picture.

The generator in Figure 2 is challenging, and has high peaks that aren't picked up by handheld meters. The operator was alerted to the high peaks based on pre-determined alarms, and replaced the ropes.

Shortly thereafter, the voltage began to increase again in a steady fashion again alerting the team to a potential failure. The plant was able to fix the concern during an upcoming outage rather than the failure causing a costly forced outage in the future.



Figure 2: RMS Data Screenshot



⚡ Rotor Flux Monitoring:

Advanced knowledge of insulation failure can prevent shorted winding turns, damaged insulation, and forced outages. Measuring the magnetic flux signal within the rotor alerts plants to early detection of potential failures.

Trending and Analyzing RFM Data

Figure 3 shows a breakdown of a RFM analysis:

- Image A is the asset tree showing all the items the system is measuring and calculating on one flux probe.
- Graph B indicates how the waveform is collected and analyzed. The dotted lines show which coil is at zero cross when the scan is taken.
- Table C calculates the percent difference between the lead and lag on each coil representing any potential shorted turns.
- Graph D conveys RMS calculations of the flux density waveform.

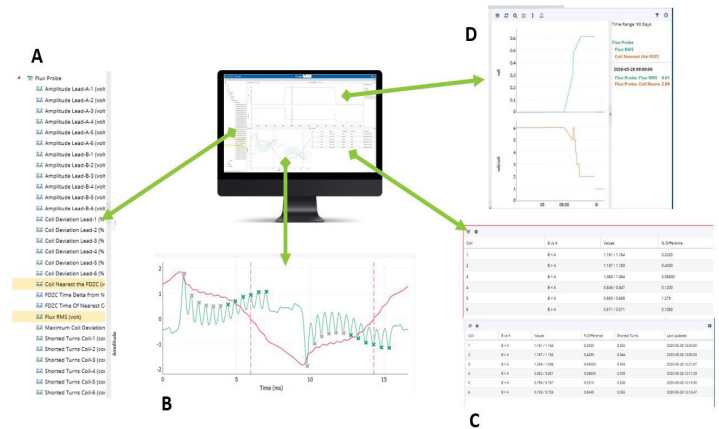


Figure 3: Rotor Flux Monitoring Components

⚡ Generator Field Monitoring Return on Investment:

Shaft Ground Monitoring ROI

Assumptions for 6-year Outlook Period	
Premium Shaft Voltage & Current Monitoring System	\$80,000
Bearing Failure Cost	\$375,000
Failure Risk without Monitoring	2%
Discounted 6-year risk	\$28,357
Average Outage Duration	10 Days
MW for Sample Generator (Avg.)	150 MW
Runtime Per Day (Avg.)	14 hours
Average revenue per MWh	\$24
Lost Revenue	\$504,000
Replacement Cost (25% Premium)	\$630,000
Manpower Savings	\$36,000
Robotic Inspection vs Rotor Out	\$536,027
Financial Impact Over 6-Years	
Present Value <i>Assumes 8% cost of capital</i>	\$1,075,087
Return Multiple	13.4 x
Rate of Return	54%

Rotor Flux Monitoring ROI

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

⚡ Future of Predictive Maintenance: Monitoring Initiatives

Companies with multiple monitoring systems are able to validate potential failures by measuring different electrical signals within various equipment throughout the plant. Abnormal waveforms found in one monitoring system are usually replicated in others, allowing personnel the confidence and knowledge that their equipment is either healthy or will need maintenance in an upcoming outage. Fewer surprise outages ultimately save plants money, and free up resources to be reallocated to other projects.

* Note: The results are estimates and 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.