

Industry

NAVIGATOR

SUSTAINABLE DEVELOPMENT
STRATEGIES FOR T&D

CONFERENCE 2025

Advanced Online Electrical Testing in Real-Time Aided by Electromagnetic Signature Analysis, AI Technology, and Acoustic Spectral Analysis

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Industry Navigator 2025 Conference Sustainable Future

- Global Electricity Demand Increase
Demand Growth Stimulated By:
Data Transfer & Storage – USA 5 %
Growth of China (8T KWH), USA (4T KWH), India (1.5T KWH)
- Supply Chain Issues and Long Lead Times
- Shortage of Availability of Used Electrical Apparatus
- Dynamically Changing Grid Architecture
- Dynamically Changing Grid Ownership and Long-Term Strategic Planning
- Shortage of Qualified Skilled Labor
- Outdated Testing and Monitoring Methods
- Introduce the Future



The First 100 Years



Power Factor (Tan Delta)
DC Winding Resistance
Transformer Turns Ratio
Megger Test
Polarization Index
Leakage Reactance
Sweep Frequency Response Analysis
AC/DC Hi-Pot
Surge Test



EMI and EMSA

EMI stands for Electromagnetic Interference. EMI (also called radio frequency interference or RFI) is an unwanted disturbance that affects an electrical circuit due to either electromagnetic conduction or electromagnetic radiation emitted from a defect within the electrical circuit or from an external source. EMSA is the acronym for Electromagnetic Signature Analysis.

A defect yields high voltage discharges (partial discharges) and low voltage arcing, they can generate:

- 1) Light
- 2) Chemical changes (ozone in air, hydrogen in oil)
- 3) Audible noise (sound)
- 4) Heat
- 5) Radio noise (EMI)

We are interested in the Radio Frequency and Audible Sound generation.

The RF energy dissipated is analyzed in detail to assess apparatus condition.



EMSA Diagnostics – Online Test

EMSA data is collected from the temporary/permanent installation of a split core radio frequency current transformer (RFCT) around a power conduit, on a safety ground or around a neutral lead and brought to a spectrum analyzer for analysis.

There are no hot connections required to any energized conductor – passive test.

There is no interference with operations.

There is no arc flash hazard. The EMI signature and pattern generated by a defect are unique to each location and type of defect involved.

Maintenance recommendations and condition verification can be made with the first test.

Knowing which equipment is healthy is just as important as knowing where attention is needed.



EMSA Testing & Diagnostics



EMSA Diagnostics & Maintenance

Time-Based Maintenance (TBM), Condition-Based Maintenance (CBM), and Predictive-Based Maintenance (PBM) are all superseded with the application of EMSA (Electromagnetic Signature Analysis) and the concept of Knowledge-Based Maintenance (KBM) and “Actionable Intelligence”

This technique was initially developed by a major electric utility and has been applied at hundreds of industrial sites since 1980.

Over 11,000 tests have been performed since 1980.

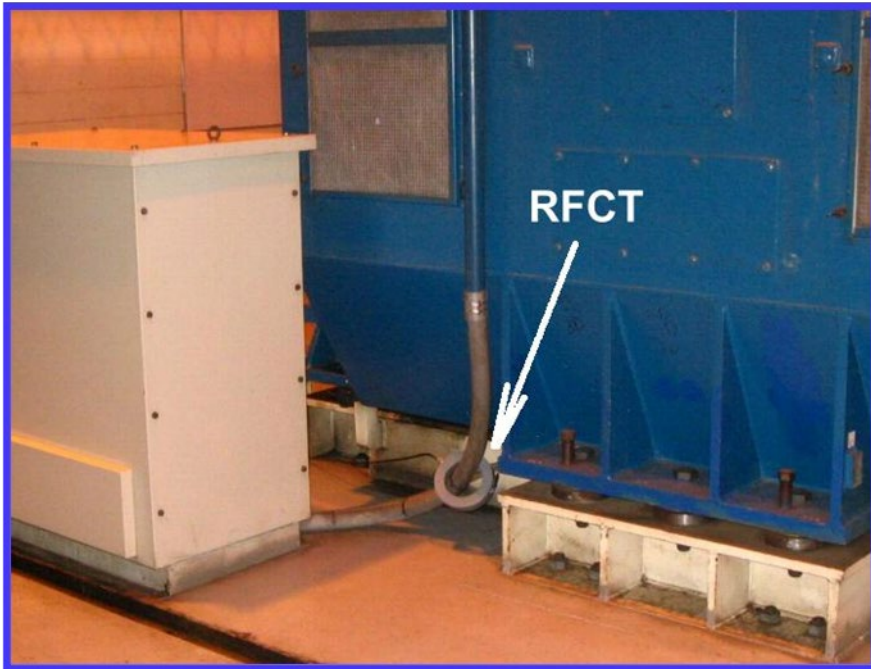
Over 70 types of mechanical and electrical defects have been identified.

Condition of motors, generators, transformers, cables, bus and switchgear can be determined from the first test.

The costs associated with a “Run to Failure” operational philosophy or traditional offline testing protocol dwarf the costs associated with a proactive strategic approach.



RFCT Location Examples: Generators



RFCT Location Examples: Motors



RFCT Location Examples: Bus Systems

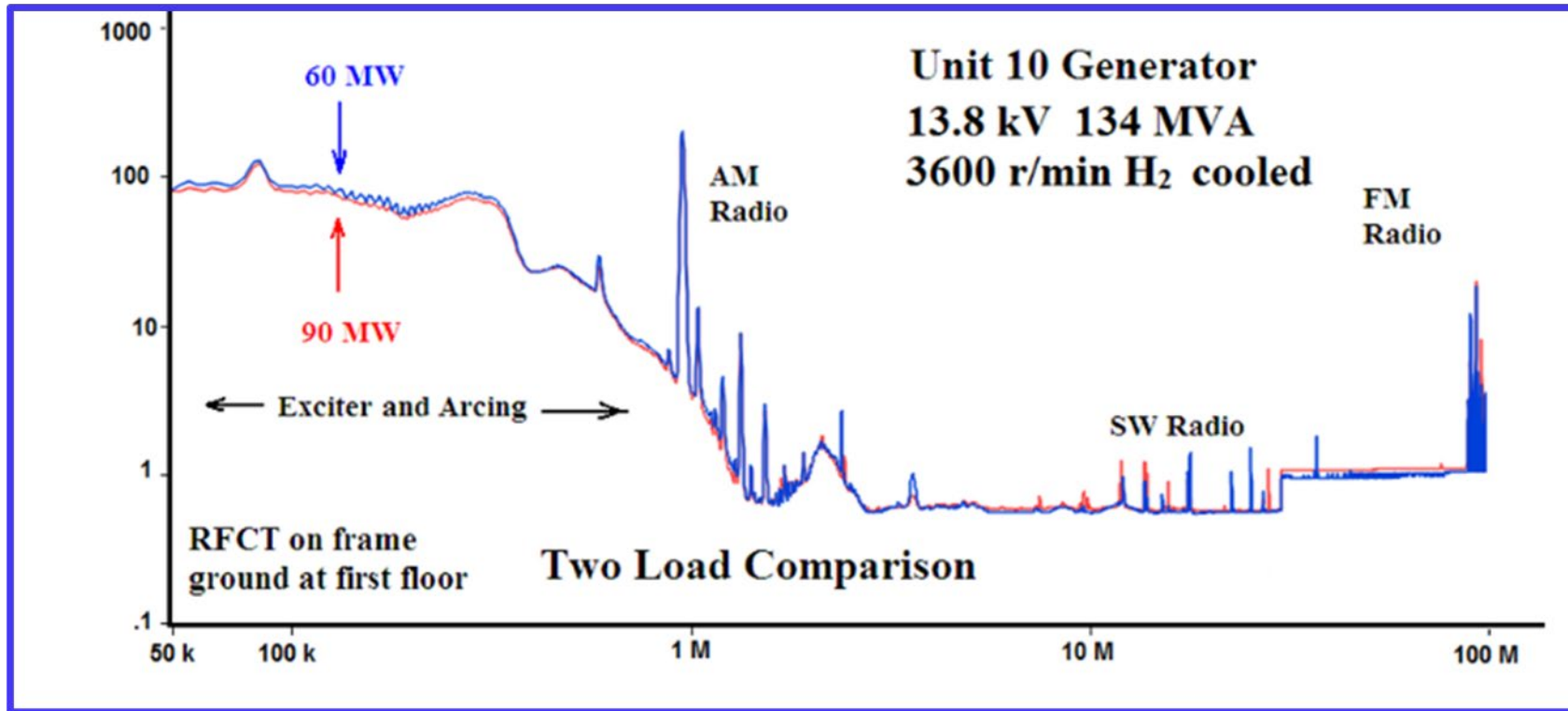


RFCT Location Examples: Transformers



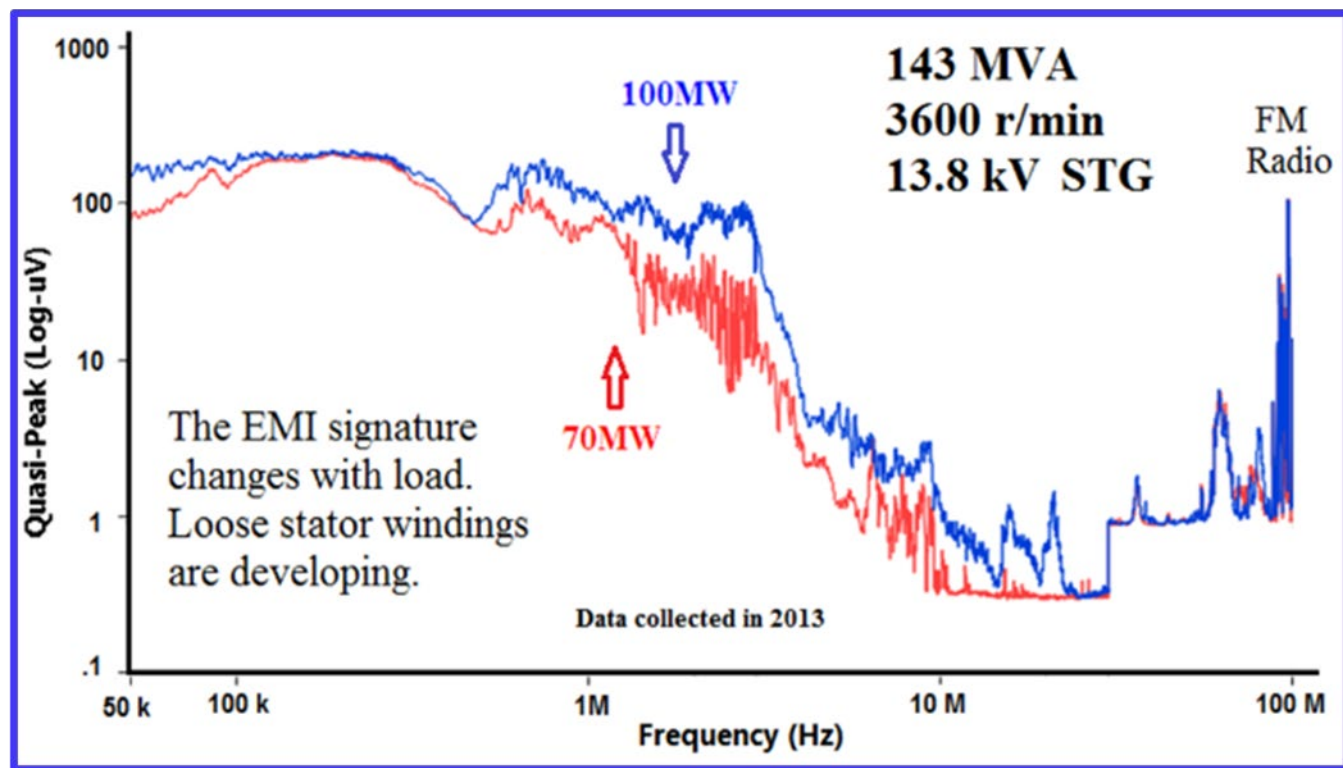
Data Analysis

One of the methods to determine the condition of a generator is the comparison of EMSA data at two different loads. This system has no problems. Note how strong the radio stations are compared to the system activity.



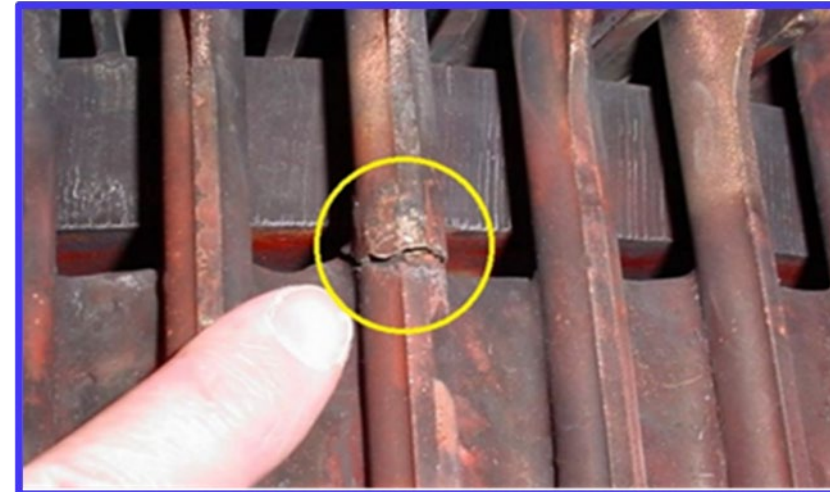
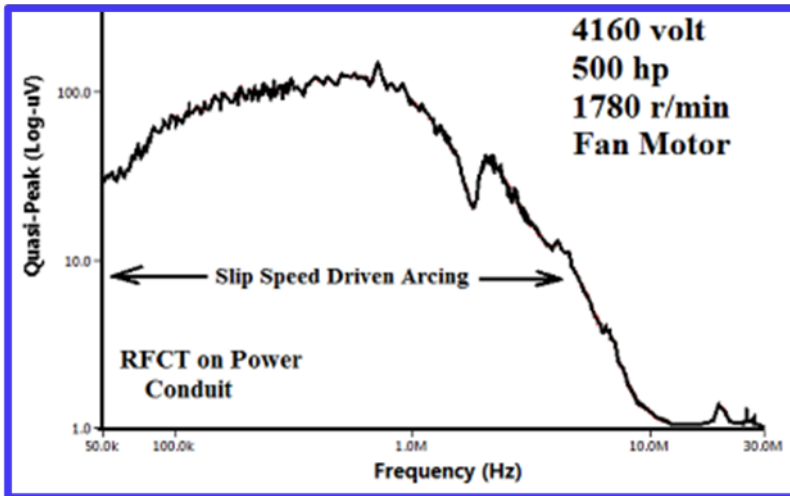
Generator Stator Winding Issues Identified

This generator has loose windings in the slots and core edge.
Stator maintenance should be scheduled.



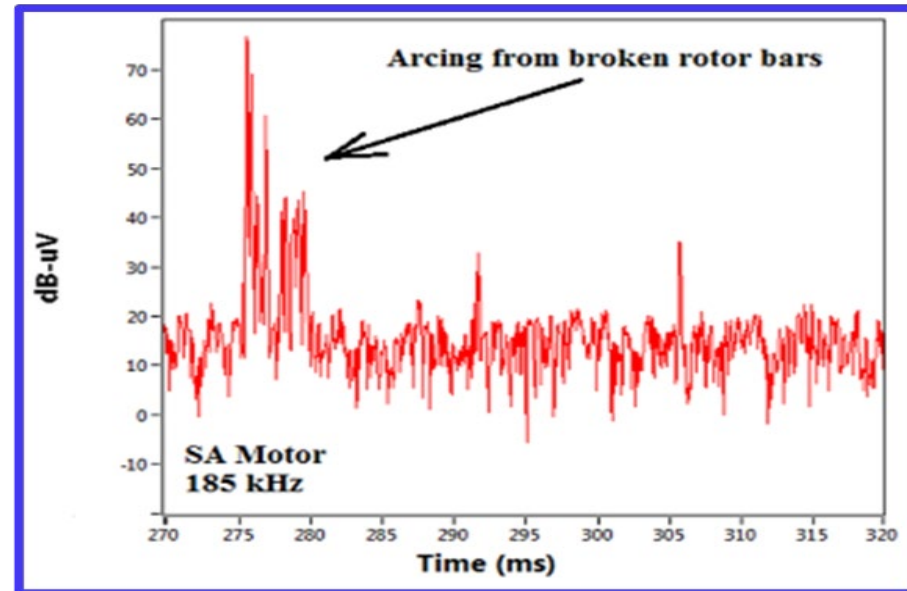
Motor Testing

Motors with problems can be identified with one data analysis.
This one has broken rotor bars. Past repairs were unsuccessful.



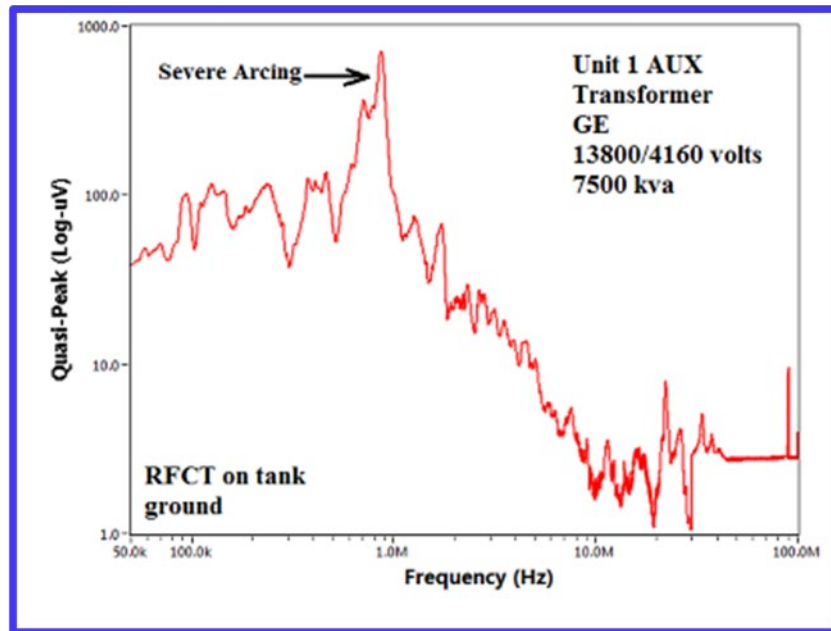
Verification

This condition is verified by measuring the radiated RF fields with an EMI pulse detector and looking at the real time patterns.



Transformer Testing

The severe arcing detected on this transformer was traced to the bus connections. An inspection ASAP was strongly recommended. There had been a failure there before.



Emergency Diesel Testing

Detected EMI radiating from the engine indicating alignment, lubrication, bearing, and turbo problems.



Deep Blue EMSA/RF & Acoustic Monitoring System

The Deep Blue RF Monitoring System™ (Deep Blue) by AI Advanced Electrical Systems USA (AI AES USA) is a highly complex, Artificial Intelligence (AI) based, advanced electromagnetic signal diagnostic and acoustic sound online monitoring system.

The system monitors critical electrical assets around the clock providing online, real-time condition assessment of asset health under actual operating conditions.

Streaming data is captured by advanced high-speed hardware and is analyzed by proprietary software and is sent to the cloud.

The data and sound is parsed and processed using an artificial intelligence engine created specifically for the advanced testing and monitoring system.



Real Time Testing, Monitoring, & Analysis – Deep Blue



RFCT Outdoor Mount



RFCT Permanent Installation



EMSA/RF & Acoustic Monitoring System

All data values are evaluated, and any questionable data is flagged by the system for analysis by Subject Matter Experts (SME's).

The AI-based advanced monitoring system is designed to identify and trend anomalies, incipient faults, or previously developed faults before they become catastrophic.

The system performs a comparative data analysis against a well-defined library of findings utilizing complex AI-driven Electromagnetic Signature Analysis and Acoustic Spectral diagnostic techniques.

The testing/monitoring/analytics system goes far beyond any other online or offline electrical testing technology available on the market today.



EMSA/RF & Acoustic Monitoring System

24/7 Online assessment of electrical asset health being monitored in real time, under real conditions.

Data is sent to a Command Center via the cloud for further analysis by qualified engineers to review at a moments notice; this review can also be performed virtually anywhere in the world.

The client is notified immediately if alarm condition requires attention.

Detects anomalies in generators, motors, bus systems, transformers, switchgear and switchyards.

State-of-the-art high-speed proprietary hardware, software and analytic technologies.



EMSA/RF & Acoustic Monitoring System

Acoustic Spectral Analysis: This technique involves using Fast Fourier Transforms (FFTs) to convert time domain signals into frequency domain signals, allowing users to visualize the frequency content of the acoustic signal.

The signal is processed further utilizing AI technology to minimize nuisance alarms; maximize signal processing; and learn the systems with expert oversight.



Generator Conditions Detected with EMSA Diagnostics

STG, Hydro, CTG, Air, Water, H₂ Cooled

1. Slot discharges resulting from side pack deterioration
2. Slot discharged resulting from stator bar coating deterioration
3. Stator bar vibration sparking
4. Loose end windings (broken ties)
5. Loose stator bars / coils (loose wedging)
6. Loose phase rings (circuit rings)
7. Verify maintenance corrected specific winding defects
8. Loose flux shield ground
9. Broken/shorted stator bar sub-conductors (strands)
10. Foreign metal objects on end windings
11. Shaft oil/hydrogen seal rub
12. Arcing shaft grounding brush
13. Shaft currents through bearings/seals
14. Verify shaft grounding maintenance eliminated bearing currents
15. Contamination on windings (dirt, water, break dust & oil) cleaning recommended
16. Contamination in insulation (wet stator bar insulation)
17. No contamination present (no maintenance necessary)
18. Arcing on alternator exciter or main field sliprings
19. Verify field ground was/was not present
20. Rotor fan blade corona
21. Foreign object on rotor
22. Defective alternator exciter diodes present
23. Loose brushless exciter components
24. Loose static exciter power circuits
25. Open exciter diode fuses
26. Defective voltage regulator components and / or control settings
27. Incorrect dc exciter brush adjustment
28. High dc exciter commutator segment
29. Loose generator breaker parts
30. Loose neutral grounding resistor connection



Induction & Synchronous Motor Conditions Detected with EMSA Diagnostics

1. Dirty stator windings
2. Loose windings in slots and end-arms
3. Broken rotor bars
4. Synchronous motor field ground
5. Rotor not set on magnetic center
6. Frame had loose foundation (soft foot)
7. Wiped bearings
8. Shaft currents present, shaft grounding needed
9. Defective outboard bearing insulation (or insulation shorted)
10. Bearing, oil seal rub,
11. Exciter drive shaft weather seal rub
12. Coupling misalignment with driven gear box, pump, fan
13. Defective or missing coupling insulation
14. Circulating currents in driven pumps, coal mills, gearboxes, fans
15. Magnetized gear box shafts / gears
16. Loose neutral connections
17. Loose crimp / bolted line connections
18. Loose surge / power factor capacitor connections
19. Abrasive erosion of stator windings
20. Defective motor lead insulation
21. Detect wet power cables
22. Detect sea water in terminal box
23. Detect 13 kV cable stress cone deterioration
24. Verify correct maintenance was or was not performed



Isolated Phase Bus, AUX Bus and Substation Conditions Detected with EMSA Diagnostics

1. Loose support insulators
2. Broken support insulators
3. Contaminated insulators (dirt, cement dust, water)
4. Loose generator isolated phase bus hardware
5. Corroded isolated phase bus hardware
6. Stray circulating currents outside isolated phase bus
7. Defective isolated phase bus enclosure insulation
8. Foreign metal objects inside bus enclosure
9. Defective bus potential transformer connections
10. Open PT high voltage fuses
11. Loose AUX transformer connections
12. Loose GSU transformer shield ground
13. Defective surge capacitor connections
14. Defective load tap changer
15. Loose disconnect switch components
16. Defective lightning arrester
17. Loose safety ground on unused 230 kV line
18. Verify correct maintenance was / was not performed
19. Verify no bus, transformer maintenance was necessary





DEEP RF BLUE

MONITORING SYSTEM™

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THANK YOU!

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