Introduction

The International Monitoring System (IMS) Network of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) is consistent of 337 monitoring facilities, scattered around the globe, of four different technologies. The Provisional Technical Secretariat (PTS) in cooperation with the Station Operator and Host Country ensures that the global network remains operational and reliable. Optimal and cost effective sustainment of the network can only be achievable through proper planning and execution. The IMS Monitoring Facilities Support maintenance team is responsible for the oversight associated with maintenance of the monitoring facilities. We highlight examples preventative maintenance. These approaches have important long term benefits and ensures that the CTBT network remains operational, reliable and credible.

Improvements to power quality

Issues related to power has been a frequent cause of station downtime. RN stations are equipped with auxiliary power sources. Due to inadequate service, large switchovers, transients and poor supply regulation has been observed in generator supplied power. These anomalies have resulted in damage to UPS systems, gamma detectors and other sensitive electronics.

To prevent this power conditioners are being installed at susceptible stations. These power conditioners provide additional protection and could result in a lower number of failures and reduced downtime.

Improvements to grounding and lightning protection at IS41

Many of the IMS monitoring stations Many IMS stations are located in areas with high annual ground flash density. Lightning is a serious threat to IMS station equipment. In particular, stations using intra-site radio communication have antenna towers erected in open exposed locations. These systems may be affected by lightning currents and surges. Problems observed have included damage to infrastructure, equipment and have resulted in significant downtime.

The infrasonic station IS41 in Villa Florida, Paraguay, is located in an area of high lightning activity, so lightning needs to be considered as a serious threat. In 2014, the station was hit by several lightning strikes, occurring primarily at communication links.

In order to reduce the probability of further damage from lightning strikes, PTS upgrades were performed at IS41, including: (1) replacement of the earth-termination system at all sites, (2) installation of improved air-termination and down-conductor system and (3) installation of adequate surge protection devices (SPD) at all incoming and outgoing power and data lines.

Station specific documentation project

A program is underway to provide validated, maintainable documentation (as required by IMS Operational Manuals) for stations. These documents will be made available to Station Operators and PTS staff. This project will enable PTS to implement knowledge management and to allow for better sustainment of IMS stations.

UPS and UPS battery recapitalization

All mains powered data acquisition equipment is powered by Uninterruptible Power Supply (UPS) which powers the equipment from batteries to secure data acquisition in case mains power is lost. UPSs communicate with acquisition computers to shut down gracefully and prevent equipment failure. Online state of health data is available to facilitate remote troubleshooting and support.

Based on expected and demonstrated useful life time UPS’s are to be replaced every 8 years and batteries every 4 years. All primary stations in the IMS network were reviewed for UPS and battery age using the Database of the Technical Secretariat (DOTS), finding 22 stations to have UPS or batteries replaced.

Some IMS stations installed in harsh environmental conditions or with frequent power outages have decreased battery life and these were also taken into consideration. Procedures for UPS checks were revised to include the health of batteries to provide valuable information for planning replacement of degraded UPS battery.

Sparlax and SAUNA noble gas system was found to be designed with different UPS models. This raised a suggestion to standardize the UPS for all NG systems. Standardization will simplify logistics and reduce spares inventory.

Caelu Kuwait RN40

The radionuclide station in Kuwait is located in a harsh environment. Even though the UPS is located in an air-conditioned building, the ambient air is dusty and salt laden. The UPS began to show failures and was replaced before the expected lifetime.

Case 2 Japan RN38

This UPS was overdue for replacement (11 years old). One month before delivery of a new UPS, communication between UPS and acquisition computer started to fail and resulting in the station shutting down unintended. This case outlines the importance of appropriate preventive maintenance.

PS09 preventative maintenance upgrade

Description of the Station Prior to Upgrade

The station was originally constructed in 1962. The station consisted of:

- 18 short-period (SP) sites making use of GeoTech S-13 vertical seismometers and Nanometrics Inc RD-3 digitizers
- In addition 4 broadband (BB) sites each with:
  - Three Streckeisen STS-3 seismometers, using the Canadian Geological Survey’s “Geophysical Digitizer”
  - The array elements were powered using propane-burning thermo-electric generators (TEG) whose propane tanks were re-fuelled once a year by the array staff which proved to be logistically very challenging.

Data was transmitted via fixed-frequency RF radio links to the Central Recording Facility (CRF), and then forwarded to the IDC in Vienna. The Nanometric RD-3 digitizers were obsolete and the infrastructure was in various stages of disrepair. Therefore it was deemed necessary to upgrade the entire station.

Description of the Upgraded Station

The new upgraded seismic array makes use of:

- 18 short period elements (same sites as before), but making use of:
  - Guralp CMG-DME4-EAM digitizer with GeoTech S13 seismometers
- Only two broadband seismic elements were upgraded, making use of:
  - Guralp CMG-DME4-EAM digitizer with GeoTech S13 seismometers
- A hybrid power system was installed at each element, consisting of:
  - Solar array (6 x 135W)
  - A hybrid powered thermo-electric generator
  - 0.000Ah battery bank

The data from each element is transmitted back to the central recording facility using high bandwidth Wi-Lan Ethernet spread spectrum radios.

This data is collected at the CRF, using a proprietary data collection system with data documentation and certification of equipment should help sustain a reliable IMS network.

Conclusion

While sustaining the network, key areas are identified where Preventative Maintenance can be effectively applied. These include improving power quality, lightning protection and grounding, detector shipping cases and better handling of detector systems, improved sensor communications hardware, and advanced technical training on detector systems. These improvements in conjunction with maintenance planning can contribute to long term benefits and ensure the CTBT network remains operational, reliable and credible.

In the future, the PTS, together with relevant Stakeholders, will continue to identify such areas based on historical data from the field and lessons learnt. Furthermore, internally in the PTS, these lessons learnt and expertise gathered with IMS technologies could be applied elsewhere, for example with the OSI techniques, to support predictive, preventive and corrective maintenance for specific needs of the On-site Inspection equipment.

A Maintenance Strategy, including an effective Preventive Maintenance Program needs to be continuously developed. This together with efficient inventory management, calibration, documentation and certification of equipment should help sustain a reliable IMS network.

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Preventive Maintenance for Sustaining the International Monitoring System

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