



The InsuLogix® VAULT

ABSTRACT

As the modern world becomes increasingly “wired”, more critical systems and infrastructure are linked via the internet. While that has given rise to incredible new technology efficiency and capability, it has also meant that more countries are vulnerable to hacking and cyber attack. The InsuLogix® VAULT is a state-of-the-art transformer controller and monitoring integrator designed to meet the pending U.S. NERC CIP cyber security requirements for grid devices, providing a platform to monitor a utility’s entire fleet.

The most advanced and secure solution for your transformers against the threat of cyber attack

As the modern world becomes increasingly “wired”, more critical systems and infrastructure are linked via the internet. While that has given rise to incredible new technology efficiency and capability, it has also meant that more countries are vulnerable to hacking and cyber attacks.

In a recent briefing to the U.S. House Permanent Select Committee on Intelligence, NSA Director Navy Admiral Michael

Rogers told the House that a number of foreign governments had already managed to penetrate U.S. energy, water and fuel distribution systems, which has potential to damage essential services.

As recently as December 23, 2015 Ukrainian Power Companies experienced unscheduled power outages leaving 700,000 people without power. Public reports indicate that the Black Energy (BE) malware was discovered

InsuLogix® VAULT – Transformer Security

Make your transformer the most secure asset in your substation by complying with NERC Critical Infrastructure Program Standards.

The InsuLogix® VAULT is designed to meet CIP-002 thru CIP-011 (cyber) and CIP-014 (physical) standards as well as IEEE 1686.

As Admiral Rogers stated: “This is not theoretical, this is something that is impacting our nation and those of our allies every day.”

In today’s world, reliability in our electrical grid requires cyber security. A cyber attack on devices that protect and control equipment in the electrical grid could result in significant outages and damage to equipment. This is especially true for Substation Class Medium and Large Power Transformer (LPT). LPTs are custom-designed equipment that entail significant capital expenditures and long lead times due to intricate procurement process. Pricing varies by size and manufacturer but such units can cost millions of dollars and weigh between 100-400 tons. Procurement and manufacturing is a complex process that could extend lead-times to 20 months. Although the cost of replacing transformers can be considered substantial, it pales in comparison to an actual outage in a large city when multiple units are taken down.

Protecting transformers from cyber attack should be a top priority for the owner of these critical assets.

WEIDMANN ELECTRICAL TECHNOLOGY INC. has teamed up with SYNEXXUS Inc., a leading provider of integrated systems for the U.S. military, to develop and produce the most comprehensive transformer health monitoring and security system solution in the market. The WEIDMANN InsuLogix® VAULT is the first solution of its kind to bring together transformer condition monitoring, controls, and substation security in a cyber-secure platform that exceeds North American Electric Reliability Corporation (NERC) security requirements, all in an integrated, interoperable, and extensible hardware and software architecture. The InsuLogix® VAULT meets or exceeds U.S. Department of Defense requirements for

development, sourcing and production of technology driven products.

The InsuLogix® VAULT promotes interoperability through its ability to run both WEIDMANN and third party developed applications in a cyber-secure software platform. It is designed to accept input sources from the widest possible array of third party devices, monitoring equipment, and physical security tools, such as cameras and access control systems.

Advanced cyber-secure software running on the InsuLogix® VAULT integrates inputs from WEIDMANN and other intelligent electronic devices used in monitoring and controlling electrical assets and yard security in electrical substations. Key features include monitoring of a transformer’s operating condition, control of cooling, alarms, recording of events such as through-faults, AC metering and power quality, local weather, and physical security – including live video and event triggered video recording. The InsuLogix® VAULT controller is a compact, solid-state device impervious to physical damage and electronic intrusion with proper installation.

Bestselling investigative reporter, Ted Koppel, speculates in his newly published book, *Lights Out*, that a major cyber attack

on the company’s networks. A report by Bloomberg News noted a cyber attack which caused a British Petroleum owned gas pipeline in Turkey to explode. At the time, this pipeline running from Baku-Tbilisi-Ceyhan was thought to be one of the most secure in the world. In December 2014, amid the much publicized massive hack of Sony Pictures by North Korea, the German government released a report describing a successful cyber attack that infiltrated the industrial controls of a German steel mill. The report said the attack caused “massive” damage by making it impossible to shut off the blast furnaces and at the same time over working and sacrificing the life of the furnace transformer that supports the mill.

“It is the policy of the United States to enhance the security and resilience of the Nation’s critical infrastructure and to maintain a cyber environment that encourages efficiency, innovation, and economic prosperity while promoting safety, security, business confidentiality, privacy, and civil liberties.”

President Barack Obama
Executive Order 13636, February 2013

on America's power grid is not only possible but likely, and paints a picture of a U.S. utility infrastructure that is shockingly unprepared. However, given the electric utility industry's exceptional track record, proactive efforts by NERC to advance security measures, and the availability of technology solutions like the InsuLogix® VAULT, the doomsday scenario imagined by Koppel underestimates the resilience of, and ongoing advancements for, our nation's electric grid.

The InsuLogix® VAULT provides transformer security now and into the future

The InsuLogix® VAULT is designed to support not only the security standards levied on Bulk Electric System (BES) transformers, but on transformers of all sizes and applications, as standards and grid reliability expectations are likely to be placed on smaller systems over time. In addition, to ensure compliance with future regulations, the InsuLogix® VAULT has implemented security controls that meet or exceed policies and standards for a BES Medium Impact Cyber System per CIP-002-5 Cyber Security, and BES Cyber System Categorization. The InsuLogix® VAULT provides cyber-secure data storage, web-based front-end applications, and associated analytic tools hosted on cyber-secure systems that are compliant with Criminal Justice Information System Policy, CJISD-ITS-DOC-08140-5.4.

The InsuLogix® VAULT also provides physical security of your transformer and substation through use of video and access control. The InsuLogix® VAULT provides three video and access control packages –

InsuLogix® VAULT - Flexibility

The InsuLogix® VAULT can acquire, aggregate, record and make available key data to SCADA, EMS, and DCS data from WEIDMANN or third party monitors and sensors. Examples of sensors/monitors that can be connected to the InsuLogix® VAULT include:

- Gas monitors
- Moisture monitors
- Fiber optic temperature monitors
- Online bushing and lightening arrestor monitoring systems
- Voltage and current sensors
- Connections to cooling devices such as fans



Remote Command Telemetry Unit (RCTU)

Basic, Enhanced, and Pro – offering customers security capabilities at lower prices than previously possible by leveraging the InsuLogix® VAULT's in-place processing and communications architecture.

The InsuLogix® VAULT features the ability to optimize the transformer's utilization rate by helping to find the acceptable balance of insulation loss of life and risk. The system uses WEIDMANN Optimum Performance Monitor™ (OPM) and eNamePlate™ software that can simulate and help plan various dynamic loading scenarios before a critical loading decision is made. The results of that decision in terms of the actual loss of life are then calculated and communicated to the user. The InsuLogix® VAULT can be optionally configured with WEIDMANN's SmartInsulation™ system of fiber optic sensors embedded directly in the transformer

windings. These sensors can measure Temperature (T), Moisture (M) directly in the insulation, and winding clamping Force (F), to generate critical transformer health information.

Maximize your transformer's performance level with the InsuLogix® VAULT through real-time and future load planning

The OPM software embedded in the InsuLogix® VAULT is designed specifically for Load Planning and for Asset Managers to simulate and verify transformer performance over a broad range of operating parameters. Typical output would include real-time thermal margins, present and accumulated insulation loss-of-life, predicted maximum normal and emergency loading levels and insulation loss-of-life at future loads all allowing the operator to respond to emergency situations. Utilization of the InsuLogix® VAULT will allow asset owners to increase peak MVA load capacity, extend individual life of transformers, and balance load across the entire fleet. The InsuLogix® VAULT can simulate a variety of operating conditions based on data obtained from the unit specific factory (heat run) test data, and when combined with ambient temperature forecast, perform a location based loading assessment. The InsuLogix® VAULT provides the asset owner with transformer digital or dynamic nameplate (as compared to analog or static transformer nameplate) for normal and emergency loading scen-

arios. In addition, the InsuLogix® VAULT will fuse all of the health monitoring information under one platform by eliminating the necessity of having multiple “loaner” devices and multiple algorithms to interpret data from each connected transformer. Ultimately, this could lead to a reduction in resource demands required to monitor multiple devices installed on transformers.

The InsuLogix® VAULT will reduce overall costs by consolidating several individual devices into one box

The InsuLogix® VAULT enables simplification of a transformer control design through the following functionalities: loss of voltage or time delay relay, thermal monitor, advanced power meter, annunciator, transformer monitor, voltage regulation, touch screen control functions, Ethernet Switch, cellular modem, access control, video monitoring and security alerts. The InsuLogix® VAULT is a third party-friendly platform that enables customers to continue using industry-leading sensors from other manufacturers.

The InsuLogix® VAULT will simplify hardware configuration during ordering and installation. The InsuLogix® VAULT remote command telemetry unit (RCTU) comes standard with redundant AC and DC power supply inputs, 32 digital inputs, 16 relay outputs, 8 analog inputs, dedicated metrology inputs (3 phase voltage and 4 current inputs), 8 resistance tem-

perature detector (RTD) inputs, 4 serial ports, an 8 port Ethernet switch, a cellular modem. This flexibility allows you to reduce and simplify the total footprint of the control box. The InsuLogix® VAULT provides a scalable platform that allows for most functions found in a typical transformer

control system. Taking full advantage of system capabilities reduces the number of single purpose devices required while also reducing the overall size and consequently the cost of the control cabinet.

By enabling the user to conduct convenient, remote site inspections with cameras in the substation, the InsuLogix® VAULT reduces asset physical inspection and maintenance costs. Rather than dispatching a team to collect data, remote operators can access complete/synchronized transformer system information. Data can be analyzed in fleet views and custom reports through the remote interface to compare performance of similar units. In addition, transformer drawings, test reports and instruction manuals can be downloaded from the remote interface transformer archive “drop box”. The InsuLogix® VAULT utilizes a transformer’s wellness history, sensory data and trending, and capitalizes on the advanced analytics of the system’s OPM diagnostic engine in order to justify a transition from calendar-based maintenance to condition-based maintenance.

InsuLogix® VAULT - Enhanced Reliability

The InsuLogix® VAULT utilizes Optimum Performance Monitoring (OPM) software to establish a WEIDMANN Health Index for your transformer. The OPM software provides “true” real-time health monitoring of your transformer by utilizing key information directly from your transformer. This information is consolidated to provide a WEIDMANN Health Index that will assist Asset Managers to make ever more strategic decisions on transformer loading.



InsuLogix® VAULT Monitor



InsuLogix® VAULT Optional Smart Display

“The VAULT effectively becomes the transformer’s brain, storing and recalling every data point, every event in the life of the transformer. It can then analyze that data, act and learn, protect itself, and communicate by text or email.”

K. Shane Smith
Manager of Delta Star’s Customer Solutions Group

The InsuLogix® VAULT system inputs can be utilized to trigger alerts to an individual or group. The alerts can be in the form of text messages or email messages such as open door alerts, access control denial of service, annunciation event, and motion detection, to name a few. A good example is false pressure relief and sudden pressure alarms. The InsuLogix® VAULT makes it possible to configure the system to send an email or text message so that maintenance teams can be dispatched to the substation when an alarm is raised. A camera can be configured to pan-tilt-zoom (PTZ) to see if the Pressure Relief Device (PRD) flag is raised. With the addition of an analog pressure sensor to the control scheme, it is now possible to review current system pressure and review recent history for sudden changes.

As an early adopter of the InsuLogix® VAULT, Delta Star, Inc. has started deploying the InsuLogix® VAULT at scale on specified transformers, including mobile transformers and mobile substation equipment. According to K. Shane Smith, Manager of Delta Star’s Customer Solutions Group, “the InsuLogix® VAULT is a key component of Delta Star’s intelligent, secure transformer. Today’s transformer owners and operators are under increasing pressure to deliver safe and reliable energy more efficiently while maintaining the security of the infrastructure. Our industry is the best in the world when it comes to dependable service, so the bar is already set very high. Delta Star has been custom designing and manufacturing transformers and transformer control systems for decades; never has there been a comparable platform that combines industry-leading interoperability, defense-proven cyber protection, video capability, and redundancy in communications with advanced analytics. The InsuLogix® VAULT



RCTU and Display

effectively becomes the transformer’s brain – it can store and recall every data point, every event in the life of the transformer – then analyze that data, act and learn, protect itself, and communicate by text or email. All of this while sim-

plifying the overall transformer control scheme. If the response to the product unveiling at the 2016 IEEE Transmission and Distribution Conference in Dallas is any indication, the industry is eager to embrace and realize the benefits.”

Authors



Chris Amend attended the University of Cincinnati and received his B.S. in Aerospace Engineering. He assumed his current role of Director of Project Management at SYNEXXUS in 2014. Prior to coming to SYNEXXUS, he spent 10 years working for the U.S. Department of Defense. His work included the design, integration, test and management of several satellite programs at the Naval Research Laboratory Spacecraft Engineering Division. He also has worked as a Senior Engineer as a member of the F-18 Fleet Support Team providing in service sustainment support of aircraft sub-systems. He holds a Professional Engineering license in the state of Virginia as well as a Program Management Professional certification.



Robert Begin attended Clarkson University and received his B.S.E.E. in Electrical and Computer Engineering in 1991. After graduating from Clarkson, he joined EHV-WEIDMANN Industries as a Technical Service Engineer with focus on transformer insulation system design. In 1996 he joined WEIDMANN Systems International as a Sales Account Manager for the Power and Distribution Transformer markets in North America. In 2004 he accepted a position with WEIDMANN-ACTI Inc. as the Business Development Manager for products and services related to transformers in the utility and industrial marketplace. In 2007 he became the Sales Manager for the Power market in the U.S. and Canada and continues to work in this capacity for WEIDMANN Electrical Technology.