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The **Road** to Safe, Reliable Digital Protection Relays

Our robust programmatic approach to integration and implementation

The Road to Safe, Reliable Digital Protection Relays

Framatome and electrical protection industry leader Schweitzer Engineering Laboratories (SEL) are teaming together to bring qualified protection solutions for safety and non-safety nuclear applications.

Utilities are facing aging and obsolescence challenges with existing electromechanical relays. There are also equipment reliability issues, such as drift and unexpected failure, as well as high, in-kind replacement costs.

Framatome is a proven supplier of digital technology and long-standing integrator of nuclear electrical systems. We are now providing SEL digital relays to the nuclear industry through a robust qualification and Commercial Grade Dedication (CGD) program.

There have been significant advances in modern digital protection relay technology. Digital protection relays offer reduced lifecycle costs, increased reliability and improved operational flexibility compared to existing electromechanical protection equipment.

Replacement of existing relays with digital protection relays is the optimal solution to ensure safe, reliable, long-term plant operation. The transition supports the renewal of nuclear power plants' operating licenses and allows utilities to reduce lifecycle costs for electrical distribution assets.

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SEL SCHWEITZER ENGINEERING LABORATORIES

Harness our technical, licensing and installation expertise to reach your desired destination.

The Framatome and SEL safety-related digital protection relay program is outlined in this brochure. Topics include:

- Framatome's qualification and CGD difference
- Your pathway to integration and installation
- Framatome-qualified SEL relay models and accessories
- Features of SEL relays

Benefits of upgrading to modern digital protection relays

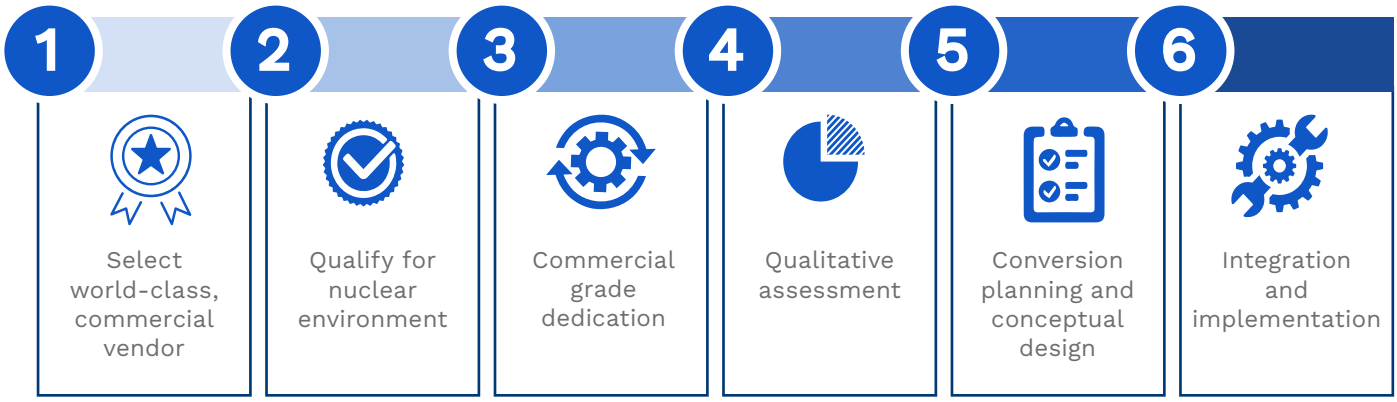
- Supports safe, long-term operation
- Addresses obsolescence of existing electromechanical relays
- Increases electrical system reliability
- Improves operational flexibility
- Reduces lifecycle cost

Framatome's Robust Programmatic Approach

With our robust technical approach, Framatome is uniquely positioned to support you on your journey down the road to installation. Our team provides:

- Unmatched equipment qualification and CGD expertise
- Engineering design change, licensing and installation support
- In-depth knowledge of digital technology, relays and relay installation

Here is your six-step path to success:



1 Framatome selected a world-class, commercial vendor with the highest quality product for teaming.

SEL specializes in creating digital products and systems that protect, control and automate power systems around the world. This technology improves power system reliability and safety at a reduced cost. Headquartered in Pullman, Washington, SEL manufactures products in the United States and serves customers worldwide.

SEL is committed to designing and manufacturing the highest quality protective relays and related products. This commitment is demonstrated through the value of their 10-year warranty and lifetime support. SEL is dedicated to empowering customers with the educational tools they need to maximize their investment.

The products are field proven since 1984 with product reliability calculated from field experiences, not predicted from models.

Framatome also evaluated and selected SEL based on their robust quality program:

- SEL QMS - ISO 9001:2015
- Certificate No: FM613641

In addition, SEL offers complete design, manufacture and configuration management control for all of their products. With support centers located worldwide, SEL offers free customer support over the lifespan of every product.

2 Framatome qualified SEL relays in accordance with nuclear industry standards

SEL has provided proven digital protection relays to industries throughout the world, including a significant non-safety installed base. Framatome has taken SEL's robust family of products and qualified them for the nuclear environment, including applications such as generator, motor, feeder, transformer and bus protection.

Digital relay qualification includes hardware and built-in software/firmware. Framatome performed the relay seismic, environmental and electromagnetic compatibility (EMC) qualifications under long-standing industry standard requirements.

For software/firmware, Framatome utilized a proprietary technical requirements matrix (TRM) to fully assess SEL's software development program for compliance with vendor specific Appendix B requirements. The TRM is based on regulatory guide and endorsed industry-standard requirements. This approach differs from standard software verification and validation (V&V) by allowing for greater flexibility in your product selection as well as the use of any product firmware versions in the SEL product family.

In addition, the Framatome qualification program evaluated the SEL software/firmware development program for compliance with vendor specific cybersecurity requirements of NEI 08-09.

Lastly, this was all performed in accordance with Framatome's 10 CFR 50 Appendix B and ASME NQA-1 programs.

Framatome Qualification Program

General Characteristics

- Normal Temperature Limit: 104°F (40°C)
- Abnormal Temperature Limit: 120°F (48.9°C)
- Qualified life: 20 years
- MTBF: varies by model. Contact Framatome for model specific reliability information.
- TID: < 1.0E+5 rad
- Electrical: Specific model data sheets available online

Reference Standards

- Software/firmware: RG 1.152 and IEEE 7-4.3.2, RG 1.168 and IEEE 1012/1028, RG 1.169 and IEEE 828, RG 1.170 and IEEE 829, RG 1.171 and IEEE 1008, RG 1.172 and IEEE 830, RG 1.173 and IEEE 1074
- Environmental: IEEE 323, RG 1.97, C37.105
- Seismic: IEEE 344, C37.98
- EMC: EPRI 102323, RG 1.180, IEC 61000-6-2 and IEC 61000-6-4
- Cybersecurity: NEI 08-09

3 Framatome's CGD Program for nuclear safety-related digital relays

Framatome conducts CGD tests and inspections for validation of hardware critical characteristics. Our Commercial Grade Survey (CGS) of SEL validates the critical characteristics of built-in software/firmware quality.

CGD Operational Testing

The testing validates that the relay will operate properly in safety-related applications by testing parameters, such as:

- Input measurement accuracy
- Various signal inputs/outputs
- Timed and instantaneous overcurrent
- Over and undervoltage
- Ground fault
- Parameter testing will be based on customer protection needs and functions being replaced by the SEL relay.

Commercial Grade Survey

The CGS validated that SEL software/firmware development is being performed in accordance with the procedures and processes identified within the compliance statements of the Framatome proprietary TRM. The SEL software/firmware development program surveyed by Framatome encompasses all SEL products.

Framatome has determined that the initial product software/firmware as well as any software/firmware upgrades are sufficient to meet nuclear industry requirements upon successful CGD by Framatome.

This enables greater flexibility for product selection and addresses future firmware upgrades for long-term operation, while minimizing any additional utility effort.

4 Framatome developed a generic qualitative assessment

Framatome has developed a generic product qualitative assessment for justification of SEL product reliability. The qualitative assessment has addressed defense-in-depth concerns for the digital SEL products through evaluation of product reliability information, allowing the multifunction capability of the SEL product (i.e., overcurrent, undervoltage, ground fault) to be used for electrical protection function consolidation.

In addition, the qualitative assessment similarly addressed diversity concerns to allow for the use of identical SEL products in redundant safety trains in place of differing products to address software common cause failure.

This generic qualitative assessment provides the reliability information needed for your plant-specific assessment. The data included provides the critical input for your 50.59 licensing evaluation, supporting a design change performed under 50.59 rather than with a license amendment.

5 Framatome provides digital relay conversion planning and conceptual design

Framatome can provide you with planning for electromechanical to digital conversion and configuration. Our plan helps you determine the best applications and features to maximize your return on investment and realize economies of scale.

In addition, Framatome can provide a functional matrix to provide a roadmap between existing electromechanical functions to the new digital functions in support of your conceptual design process based on your specific licensing basis requirements.

6 Framatome assists with digital product integration and implementation

Framatome can support the successful licensing, engineering and installation of digital protection relays:

- Functional matrix (if applicable), input into the evaluation of plant requirements, Framatome/SEL drawings and relay settings calculations
- Critical Digital Asset (CDA) cybersecurity assessment
- 50.59 screen/evaluation Input
  - Plant-specific qualitative assessment to support 50.59 evaluation
- Framatome document package includes:
  - Certificate of conformance
  - CGD reports
  - Qualification reports (hardware and software)
  - Installation and operating manuals
  - Technical documentation
- Framatome can support your installation needs by providing:
  - Framatome/SEL relay commissioning and support (includes future firmware upgrades)
  - Framatome/SEL complete digital relay training

Framatome-Qualified SEL Relay Models

Click model name to see specific data sheets

SEL-351-7 Feeder Protection System

The SEL-351 is the protection standard for utility and industrial electrical systems around the world, and the SEL-351-7 builds upon that standard by further optimizing protection, automation and breaker control. The relay includes built-in ethernet and IEEE C37.118 synchrophasors, and is ideal for directional overcurrent applications.

SEL-751 Feeder Protection Relay

The SEL-751 is the right solution for industrial and utility feeder protection, with conventional/low-energy analog (LEA) current and voltage input support, flexible I/O options, easy mounting and fast settings. The SEL-751 provides complete protection for varying types of distribution circuits. It offers arc-flash mitigation, fault location, high-impedance fault detection, broken conductor detection, event analysis and more.

SEL-587Z High-Impedance Differential Relay (Bus Protection)

The SEL-587Z high-impedance differential relay is an economical and flexible relay that combines time-proven, high-impedance analog technology with the advantages of microprocessor technology. Apply the SEL-587Z Relay for single-zone bus protection or sensitive restricted earth fault protection on grounded, wye-connected power transformer windings. Use event reports and the Sequential Events Recorder (SER) for quick post-event analysis.

The SEL-400G Advanced Generator Protection

The SEL-400G offers primary and backup protection for generators of all sizes and types, including emergency diesel and steam turbine generators. It combines generator, bus and step-up transformer protection in one package, making the relay an economical solution for an entire generation unit.

The SEL-300G Generator Relay

Apply the SEL-300G for comprehensive protection and control of small, medium and large generators. It provides proven primary and backup protection for utility and industrial generators to IEEE turbine protection standards.

SEL-710-5 Motor Protection Relay

Protect asynchronous (induction) and synchronous motors with one SEL-710-5 motor protection relay. Features include broken rotor bar detection and variable-frequency drive (VFD) support as well as options for arc-flash detection (AFD), differential protection and synchronous motor protection. The synchronous option supports power factor regulation and includes a voltage divider accessory to interface with the motor excitation system.

SEL-487E-3 Transformer Protection Relay

Protect and monitor transformers with the powerful SEL-487E-3. It offers up to five, three-phase restraint inputs, three independent restricted earth fault (REF) protection elements and two, three-phase voltage inputs, all with synchrophasors. The SEL-487E-3 limits transformer damage by responding to internal fault conditions in less than 1.5 cycles. The relay also helps avoid catastrophic transformer failure by detecting turn-to-turn faults involving as little as two percent of the total winding.

SEL-787-3 Transformer Protection Relay

Protect and monitor most three-winding transformers with the versatile SEL-787-3 platform. It provides advanced automation and flexibility, asset management data and easy retrofitting of most electromechanical relays. The 5-inch, 800 × 480 color touchscreen display option allows you to directly set, monitor and control your system, including up to five two- or three-position disconnect switches.

Framatome Qualified Relay Accessories

Click model name to see specific data sheets

Remote I/O Modules

SEL-2505 Remote I/O Module: The module has eight digital inputs, eight digital outputs and a fiber-optic communications port.

SEL-2507 High-Speed Remote I/O Module: The module has eight inputs and eight outputs with an optional fiber-optic communications port. Connect the SEL-2507 to another SEL-2507 at 115.2 kbps to provide ultra-high-speed remote I/O.

Resistance Temperature Detector (RTD) Module

SEL-2600: Measure and transmit data from up to 12 resistance RTDs and a single contact status located in transformers, breakers, motors, generators or other system apparatus.

Transceivers

SEL-2814 Fiber-Optic Transceivers with Hardware Flow Control: Improve safety, signal integrity and reliability by using two optical fibers instead of wire to transfer bidirectional serial data plus hardware flow-control signals. Apply for instrumentation, protection, automation and other applications that benefit from economical fiber-optic links up to four kilometers long.

Fiber-Optic Cables

SEL-C807 62.5/200 µm Multimode Fiber-Optic Cable: 62.5 µm fiber-optic cable assemblies terminated with ST connectors in customer-specified lengths.

SEL-C808 62.5/125 µm Multimode Fiber-Optic Cable: Apply for lengths of 15 kilometers or less for communications links and Ethernet networks.

SEL Relay Features

SEL relay features include multifunction capability, continuous self-diagnostics, event recording, asset monitoring and performance. The benefits of these features include:

Multifunction capability

- Better performs traditional functions
- Simple designs
- Lower-burden devices
- Lower cost than replacing obsolete electromechanical relays

Continuous self-diagnostics

- Enabled LED
- Alarm contact with health status
- Diagnostic self-test alarm monitoring
- Periodic I/O checks
- SCADA monitoring for comprehensive relay test coverage
- Self-check thousands of times per minute
- Complies with NERC 12-year maintenance interval

Reportability: event reports and sequential event recorder for analysis

- Aids in commissioning of wiring checks
- Validate proper operation for faults
- Determine root cause of misoperation
- Motor-start reports
- Metering and monitoring data
- Asset monitoring
- Transformer thermal monitoring tracks wear
- Through-fault monitoring measures stress based on IEEE curves
- Reduce inefficient and costly breaker maintenance
- Prevent unexpected DC failures by monitoring DC control power

Additional features

- 10-year SEL warranty
- Long-term availability
- Arc flash protection
- Wider and continuous setting ranges
- More precise settings and greater sensitivity
- Faster reset times
- Built-in synchronism-check function to supervise breaker closing
- Multiple setting groups
- Timestamps

Before

Streamlined

About Framatome

Framatome is an international leader in nuclear energy recognized for its innovative, digital and value added solutions for the global nuclear fleet. With worldwide expertise and a proven track record for reliability and performance, the company designs, services and installs components, fuel, and instrumentation and control systems for nuclear power plants.

Its more than 15,000 employees work every day to help Framatome's customers supply ever cleaner, safer and more economical low-carbon energy.

Visit us at www.framatome.com, and follow us on Twitter and LinkedIn.

Framatome is owned by the EDF Group (75.5%), Mitsubishi Heavy Industries (MHI – 19.5%) and Assystem (5%).

About SEL

SEL specializes in creating digital products and systems that protect, control, and automate power systems around the world. This technology prevents blackouts and improves power system reliability and safety at a reduced cost. A 100 percent employee-owned company headquartered in Pullman, Washington, SEL has manufactured products in the United States since 1984 and serves customers worldwide.

As part of our commitment to designing and manufacturing reliable, high-quality products, we research, design, build, test, distribute, teach, and support each of our technologies at SEL facilities. Assembled SEL products travel directly from our hands to where they need to be, so we feel confident that you and your customers can rely on them to keep critical systems fully operational.

Our Commitment

Our commitment is to continue to focus on safety and quality, leading to the highest levels of performance to deliver the results that you expect. Our team stands ready. With Framatome's robust program, we welcome the opportunity to support you in bringing this state-of-the-art technology to your plant.

Scan to learn more or visit https://bit.ly/3caUJnS

SEL SCHWEITZER ENGINEERING LABORATORIES

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