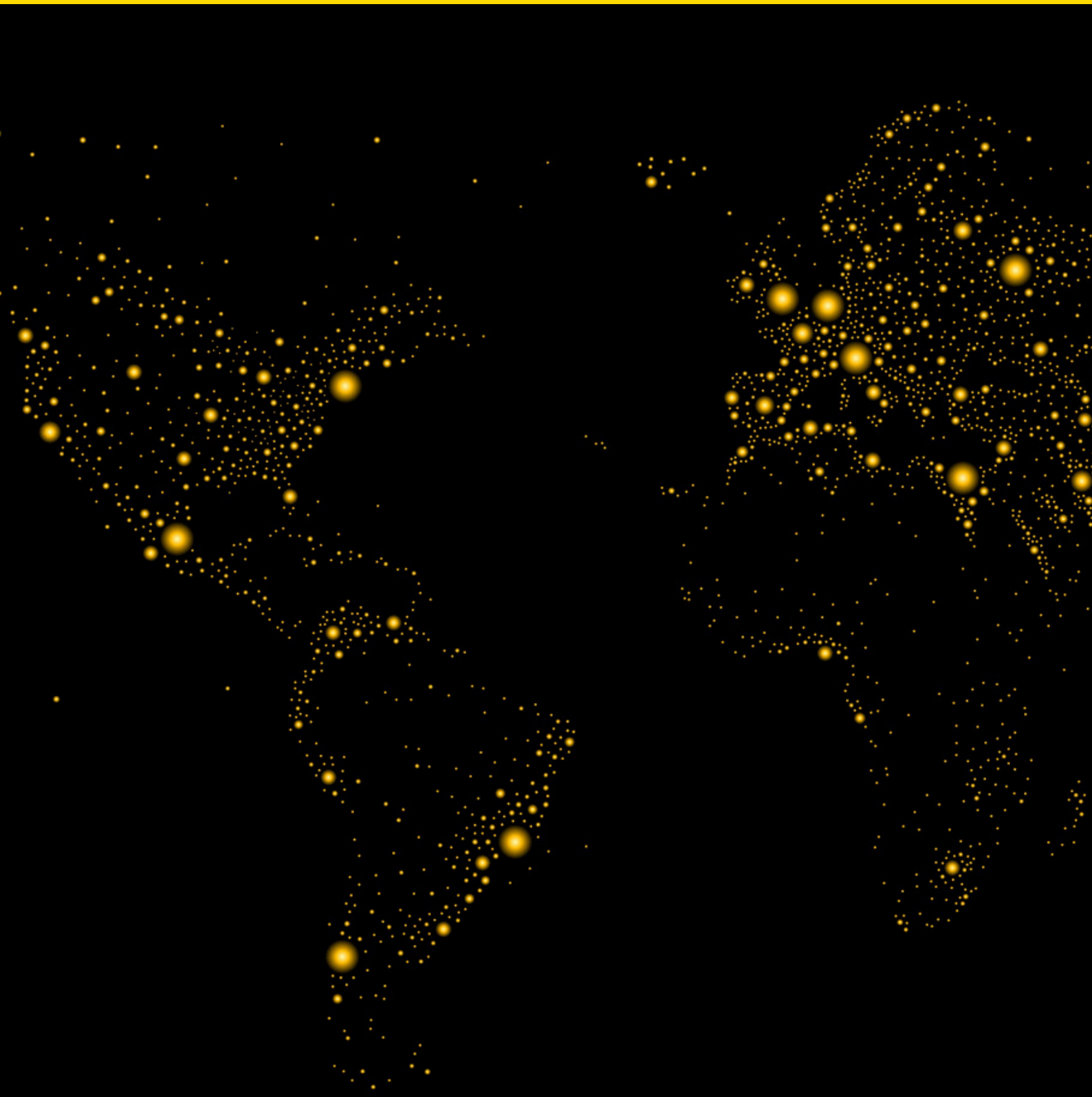


Guardline I&C platform for safety systems



Guardline I&C platform for safety systems

OVERVIEW

Ultra Energy's Guardline safety system platform is the evolutionary pinnacle of our nearly 70 years' experience developing I&C technology for deployment on nuclear power plants (NPP) across the world.

Guardline safety systems are built from a wide range of individual modules with different characteristics. Each is pre-qualified and mutually compatible with the rest of the range. This means modules can be rapidly selected and assembled to deliver functional units. These units are then interconnected to complete the system.

The high level of choice and seamless interoperability of the Guardline platform makes it extremely customizable, ensuring a vast range of customer-specific requirements can be met more easily and quickly than with alternative methods.

Guardline's power to deliver custom solutions is welcomed by operators looking to replace legacy systems in operational plants, as well developers of traditional, next generation and small modular reactors.

Due to its inherent flexibility, Guardline systems can fulfil a wide range of safety applications within nuclear power plants, from primary protection, diverse protection, post accident monitoring and priority logic through to diesel generator management.

Application specific cabinets are environmentally qualified for EMC, temperature and seismic by test or analysis. The platform can take inputs from a wide variety of sensor types across multiple environmental, radiological, and nucleonic domains. Safety systems requiring redundancy can be implemented within the platform, together with the necessary separation and electrical isolation between redundancy groups. The fail-safe voting between redundancies is factory configurable and can support 1oo2, 2oo2, 2oo3 and 2oo4 voting schemes.

Through its modularity, Ultra Energy's platform is designed and qualified to enable diagnostic and monitoring functionality of each module at the unit level. This is achieved while maintaining signal isolation, ensuring safety functionality is unaffected by any monitoring system failures.

System (96 series)

Customer specific configuration of modules, units, and sub-systems to provide a low risk, tailored solution.



Unit (95 series)

Configurable sub-systems of modules, mounted in 19-inch chassis, in 3U or 6U configurations.



Module (94 series)

The building blocks of the architecture is a catalogue of 3U-high modules, designed to perform a given functional task.



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SAFETY PRINCIPLES

Our platform is architected as a modular platform, providing significant flexibility to meet a wide range of safety applications requirements within NPPs. It is specifically designed and pre-qualified to implement Category A, B and C functions.

- The platform allows system architectures with redundancy to be implemented
- Fail-safe voter and guardline that is factory configurable into various standard voting schemes
- Separation and electrical isolation of safety functions and monitoring systems - no failure of the monitoring system can cause a failure of the safety function
- Separation and electrical isolation of redundancies - failure of a single redundancy cannot cause a failure of another redundancy
- In-built diagnostics with high fault coverage
- Fail-safe and self-testing designs
- Pre-qualified platform to IEC suite of NPP standards
- Provides low response time from change in input to activation of an actuator
- Provides high accuracy and stable sensor measurement
- Fail-safe hardwired priority logic to safely allow different category I&C system to interface to the same actuator
- Platform supports both on-line and off-line end-to-end surveillance testing
- Electrical isolation on the modules' inputs and outputs to avoid fault propagation



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MAIN APPLICATIONS

We work with customers to develop a configuration of the platform's modular building blocks to meet their requirements. Below are a few examples of the potential configuration applications.

Primary protection system

Our platform allows a Category A/Class 1 protection system to be realized to meet the required application safety functions. Its modular approach allows the implementation of varied application specific system architectures for the main reactor protection system. It supports multiple redundancies and provides configurable voting schemes between these redundancies; it has four redundancies and 2oo4 voting that is required for a Category A main reactor protection system on NPP.

Diverse protection system

The platform can provide diversity to a programmable main reactor protection system. The platform can interface to simple control room operator displays such as analog meters or programmable display screens.

Post accident monitoring system

Our platform allows post-accident monitoring systems to be realized. It enables operators to monitor application specific range and type of parameters. It can also provide simple control room operator displays such as analog meters or programmable display screens.

Severe accident monitoring system

The platform allows severe accident monitoring systems to be realized by enabling operators to use manual controls to activate mitigating application specific actions.

Priority logic

The platform provides dedicated modules to realize a priority logic system. This allows the application specific NPP actuators to be controlled by separate I&C systems. The priority order on the inputs is pre-configured at the factory.

Diesel generator system

Our platform can also be used to realize an I&C system to control diesel generators in the case of grid power failure. The platform will be uniquely configured to meet the application specific requirements for the logic solver, with standard modules and units providing sensor interfacing, voting, priority logic and actuation.

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EXAMPLE ARCHITECTURE SYSTEM CONFIGURATION

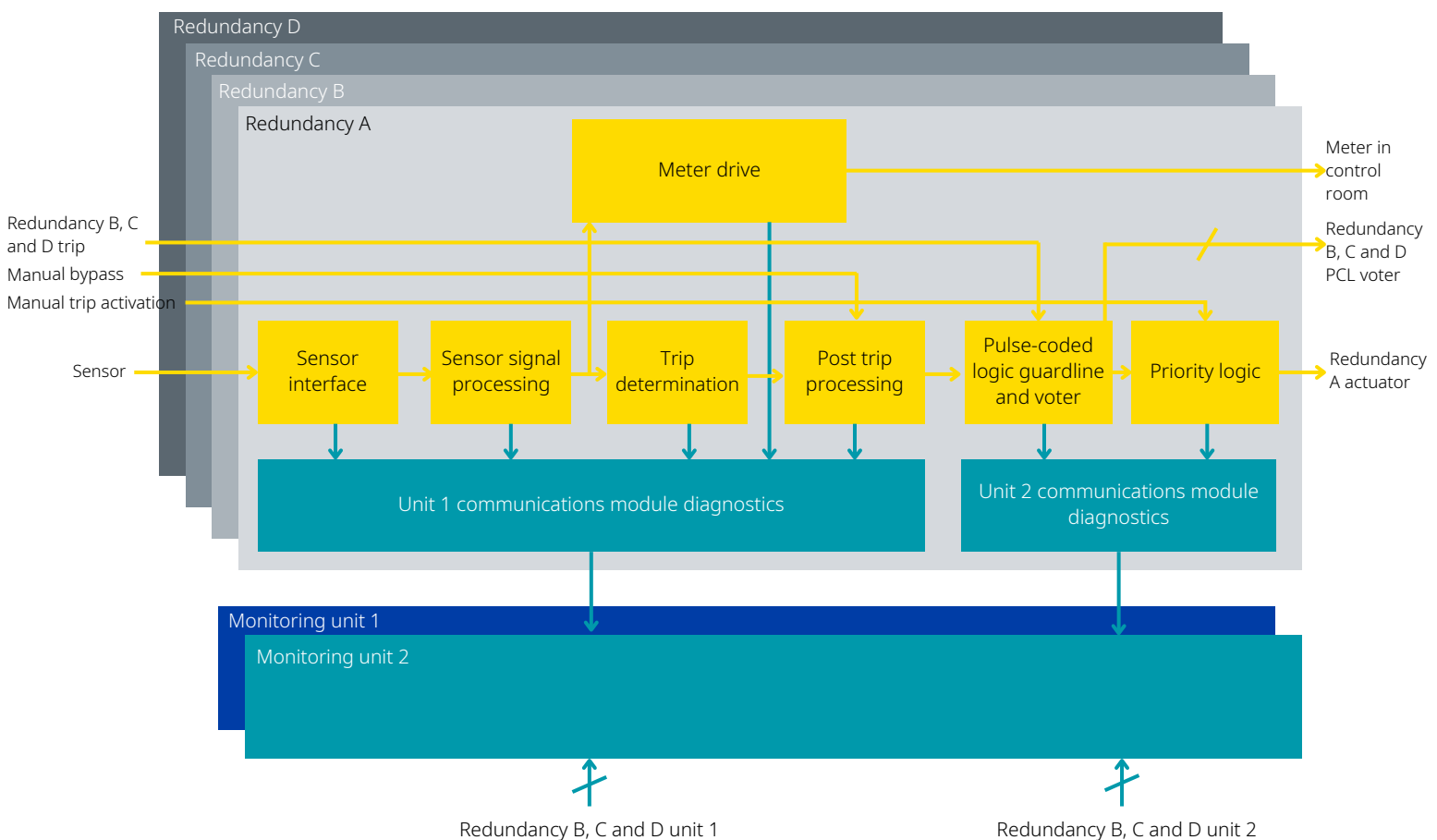
Due to its modular nature, the platform is flexible to support a range of applications, from small systems with just a few modules and no redundancy, to full scale safety systems with multiple redundancies.

In this example configuration, there are four redundant channels with dual monitoring units:

- Provision of Category A safety function with a single sensor input and trip
- Four redundancy groups, with 2oo4 voting
- Manual bypass on each redundancy trip
- Actuator activation by the automatic system (highest priority) and manually (lowest priority)
- Control room HMI and plant network interface

Each module within a unit is connected to a unit communications module which gathers the diagnostic data from each module. Each unit within the system provides monitoring and diagnostic information to one or more programmable Category B monitoring units.

Monitoring units provide a local display of the data to allow effective maintenance of the system. They can also provide display screens within a control room to provide operators with system operational and status information. In multiple redundancies configurations, the monitoring unit provides additional diagnostic features such as cross-channel comparisons.



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TECHNICAL FEATURES

Human-machine interface (HMI)

Our platform provides a range of HMI options across module, unit and system levels. A configuration can encompass a variety of these, from directly embedded safety-rated analog meters, through to non-safety, SCADA based systems, providing diagnostic data remote to the platform.

Each module within a unit is connected to a unit communications module that gathers its diagnostic data. Each unit provides monitoring and diagnostic information to one or more programmable Category B monitoring units. Monitoring units provide a local display of the data to allow effective maintenance of the system. The monitoring unit can also provide display screens within a control room to provide operators with system operational and status information. In multiple redundancies configurations, the monitoring unit provides additional diagnostic features such as cross-channel comparisons.

Module level

Each module will typically show its health status and the input parameter in engineering units on an analog meter.

Unit level

The platform allows the option of a unit providing multiple analog displays showing the value of key parameters in a single place within a cabinet rather than on multiple modules. For a monitoring unit, a display screen shows the unit data it has received and the result of its own diagnostics, such as cross-channel comparisons.

System level

For control rooms, the platform directly supports simple displays such as analog meters directly from the non-programmable part of the platform or on display screens using the programmable monitoring unit.

At higher plant levels, the monitoring unit provides an industry standard interface to higher level plant function. This allows I&C data to be gathered by other plant systems to be displayed locally or remotely to the plant as required by the application.



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Technical features

Pulse Coded Logic (PCL) hardwired logic trip and guardline system. Using dynamic digital codes to detect fault conditions, the system is self-testing and is inherently fail-safe.

Hardwired (analog) neutron monitoring system covering start-up, intermediate, and power flux ranges.

Specialist low-RFI matched signal cabling and connectors for both mild and harsh environments.

Hardwired IEC 61508 SIL 2 qualified gamma radiation monitoring systems; Area Gamma Monitor (AGM) and Continuous Monitoring System (CMS). Combination of these two diverse technologies provide redundant gamma measurement to achieve IEC 61508 SIL 3.

Fail-safe hardwired (analog and digital) interfacing to sensors. The technology uses a fail-safe analog to digital converter. Signal processing and post trip processing is performed using fail-safe hardwired digital.

A programmable safety display suitable for Category B functions. The technology removes the traditional microprocessor/software and graphics co-processor and replaces this with programmable logic. It has been designed to display numeric data, icons showing valve or breaker states and trend graphs on factory configured screen layout. The screen layouts are configurable without changing the programmable logic.

A programmable monitoring unit implemented in programmable logic rather than microprocessors and software. This provides predictable low latency between the module's information and this information being available on an operator's display.



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Technical functions
Sensor interface - temperature, pressure, flow rate, level, rod position, ground acceleration, gamma radiation and neutron flux sensors and detectors supported as standard.
Sensor signal processing – functionality includes sensor matching, calibration, cold-junction compensation for thermocouple temperature measurements and neutron flux measurements over the full range from startup to full power.
Trip determination - trips are configurable as high or low with a static setpoint against a single input parameter. The platform also offers a dynamic trip with the setpoint varying depending on a single parameter while the trip is determined on a different parameter. The trips have a pre-set hysteresis.
Post trip processing – functionality provides voting schemes such as 3oo3 or 1oo3 and logical functions such as OR. The functionality allows bypassing of trips and voting between multiple sensors inputs trips within a redundancy.
Pulse-coded logic guardline and voter - a fail-safe guardline function combines multiple trips within a redundancy to generate a single trip. The fail-safe voting scheme between redundancies is factory configurable as 2oo3 and 2oo4.
Priority logic – the factory-configured hardwired function that provides five priority levels with up to six input sources. The functionality allows multiple I&C systems to activate an actuator. The platform also provides a programmed priority logic function to support diversity.
Actuator command control – providing an interface to the plant actuator to activate or deactivate an actuator. The fail-safe condition of the command is configurable. The function provides a factory configurable minimum delay between activation and de-activation.
Control rooms – provides hardwired displays and controls for Category A functions and display screens for lower category functions.
System monitoring – a Category B monitoring system that gathers status data from each module and implements diagnostic tests. The system can provide the data to higher level plant I&C systems and control room displays.

Guardline I&C platform for safety systems

LIFETIME SUPPORT

Our platform's modular nature enables multi-decade operational lifetime. Ongoing design maintenance and backwards compatibility of technology refreshes enable a range of support service levels, all embodying a long-term, integrated and risk-based approach in three areas, equipment condition monitoring, reparability and spares availability. This approach ensures the lifetime requirements for critical equipment are met.

Component monitoring

Ultra Energy's component management team actively monitors and reacts to component obsolescence in our products, pre-emptively purchasing end of life stock (short term measure) and initiating engineering activities to provide modifications and long term replacement.

Equipment condition monitoring

We monitor the general condition of equipment, inspecting it for aging affects, overheating and any signs of degradation or damage. At a minimal level, this is conducted on units returned for repair. With higher level plans, we inspect spares inventory and visit customer sites to test live equipment.

Failure rate monitoring

We record incidents of equipment failure to ensure systematic failures or aging effects are understood and risks addressed before an issue develops.

Continued supportability

We maintain SQEP and appropriate testing facilities to enable us to repair equipment.

Risk based approach

We use all available data monitoring (active and passive) within support plans to inform our customers of key risk areas and possible mitigations to ensure continued power generation over the life of the plant.

Equipment modification, refurbishment or replacement

In the event of supportability issues, we will carry out modifications or refurbishment of existing equipment with mechanisms to trigger full replacement for longer term needs.

Third party equipment

Ultra Energy can support third party equipment on a case by case basis. Using analysis and reverse engineering, we can support equipment that is no longer supported by the original suppliers.

Guardline I&C platform for safety systems

LIFETIME SUPPORT

We offer three levels of through-life support with varying levels of after-deployment support. All of our support levels operate on a risk-based approach allowing support and funding to be most effectively deployed where needed.

Feature	Level 1	Level 3	Level 3
Component monitoring	<ul style="list-style-type: none"> Obsolescence and last buys 	<ul style="list-style-type: none"> Obsolescence and last buys 	<ul style="list-style-type: none"> Obsolescence and last buys Preemptive purchases Spare stock monitoring
Failure rate monitoring	<ul style="list-style-type: none"> Returned units 	<ul style="list-style-type: none"> Returned units Spares holding of failed components 	<ul style="list-style-type: none"> Returned units Spares holding of failed components Customer failure report analysis
Equipment condition monitoring	<ul style="list-style-type: none"> Returned units 	<ul style="list-style-type: none"> Returned units Sample units 	<ul style="list-style-type: none"> Returned units Sample units Onsite inspections
Equipment repair		<ul style="list-style-type: none"> Included 	<ul style="list-style-type: none"> Included
Proactive management		<ul style="list-style-type: none"> Through-life management plan 	<ul style="list-style-type: none"> Through-life management plan Risk based monitoring at appropriate level (fleet, reactor, site or equipment) Modification, refurbishment, replacement planning
Continued supportability			<ul style="list-style-type: none"> Testing facilities Knowledgebase (SQEP)
Onsite support			<ul style="list-style-type: none"> Included

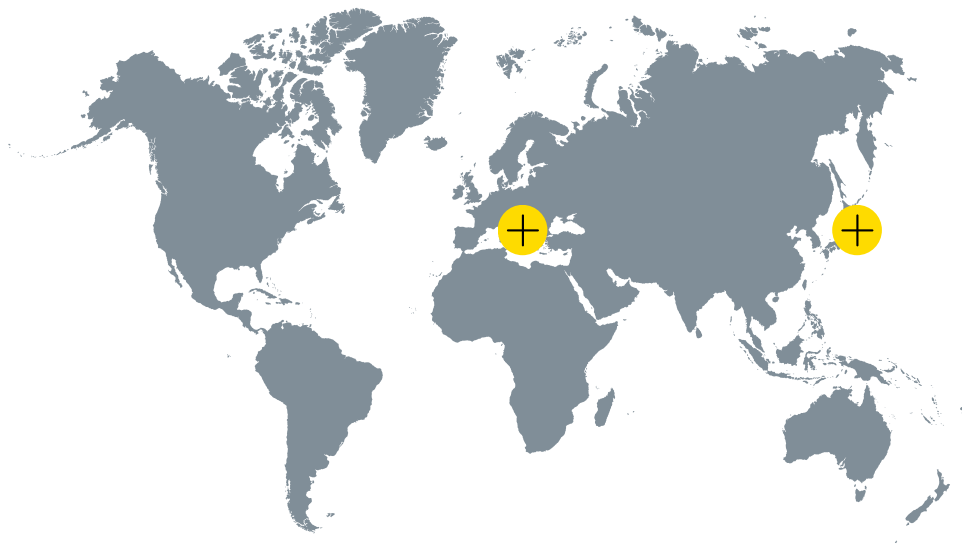
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PROVEN IN USE

Ultra Energy's nuclear expertise extends back to 1956 with the founding of Plessey's nucleonics division in the UK when it acquired the UK Atomic Energy Authority's IP and design authority in neutron monitoring and protection systems.

This later passed into Winfrith Safety Systems, which was acquired by Ultra in 2006 with its experience across a range of nuclear safety systems forming the basis of Ultra Energy.

Our safety system platform has seen over 10 million hours of operational safety duty use in the UK Advanced Gas Reactor fleet alone, with many tens of millions of hours use internationally across various configurations in both safety-critical and safety-related roles.



Deployed internationally

In addition to use in the UK, our safety platform technology has also been deployed to nuclear plants in Italy and Japan.

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About Ultra Energy

Organizations working with nuclear and industrial technologies must deliver reliable operations at the same time as safeguarding people, the environment and infrastructure. We develop and manufacture measurement and control solutions that give our customers complete, long-term control over systems operating in harsh environments, helping them operate safely and increasing the value derived from their investments over their total lifespan.

Part of Ultra Group, a global electronics company, Ultra Energy has worked with nuclear and industrial customers for nearly 70 years. We support customers across the world from facilities located in the US and UK. Our solutions are embedded in strategic national infrastructure and our people are active partners in customer programs that are focused on delivering advanced future nuclear and industrial capabilities.