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M Resort, Henderson, NV | June 15 – June 18

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HIPS Safety I&C Platform

Architecture, Real-World Applications & 10 CFR 50.59 Licensing Success at Duke Oconee

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Mirion Connect | Annual Users' Conference 2026

Henderson, NV

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Annual Users' Conference

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The Next 90 Minutes

TWO SESSIONS, ONE STORYLINE

- **1:00 – 2:00 | HIPS Platform.** What HIPS is, why FPGAs change the safety case, how the architecture works, and where it is running today.
- **2:00 – 2:30 | Licensing Pathway.** How Duke Oconee replaced an obsolete safety system under 10 CFR 50.59 — no License Amendment Request — and what that playbook means for your plant.
- **Then tonight.** The HIPS demonstration chassis is on the floor at the Technology Hub grand opening, 5:30–8:30 PM..

HIPS Safety I&C Platform

Architecture & Real-World Applications

The Modernization Squeeze

The drivers

- **Aging analog.** Safety I&C designed in the 1970s–80s is past design life across the fleet.
- **Vanishing support.** OEM spares, repair paths, and component sources are disappearing.
- **Workforce turnover.** The technicians who know these systems are retiring.
- **Fleet-wide demand.** Nearly every U.S. unit faces digital upgrades over its remaining life.

The constraints

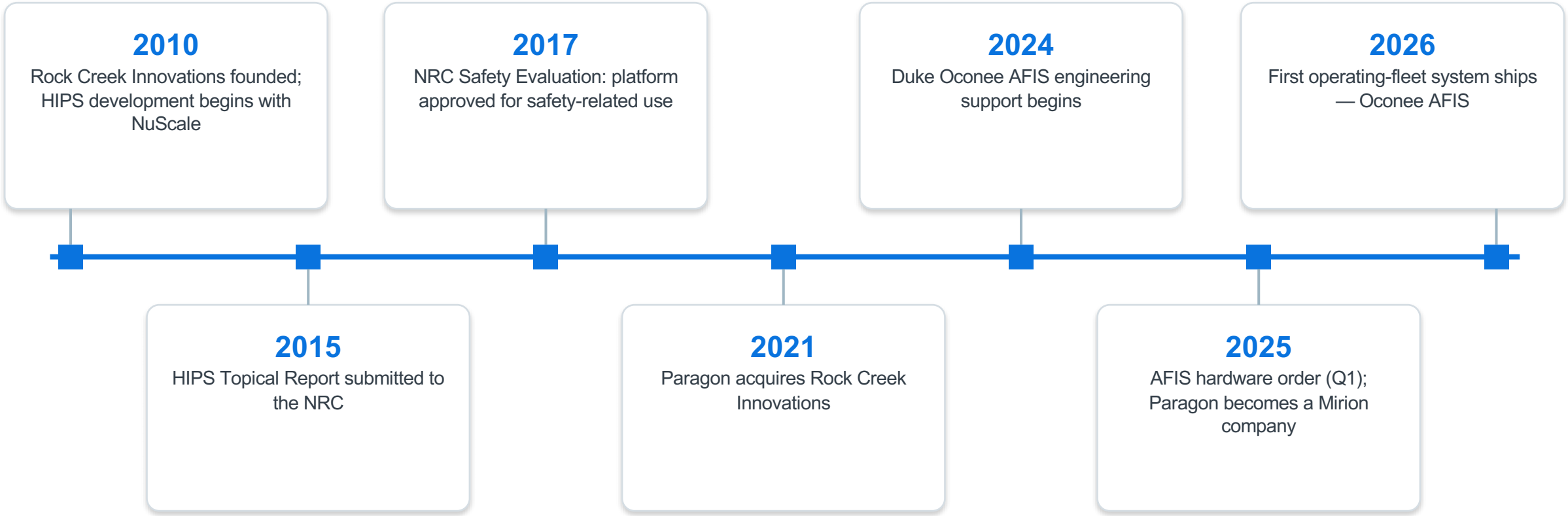
- **Review timelines.** License amendment reviews run up to 12 months under revised NEIMA targets.
- **NRC staffing.** Reviewer capacity is constrained as demand grows.
- **Framework in motion.** EO 14300 has the NRC executing a wholesale revision of its regulations.
- **Outage windows.** Capital and implementation windows keep getting tighter.

How do we do MORE digital modernization, safely, with LESS resources and SHORTER timelines?

— The question industry posed to the NRC (NEI, Accelerating NRC Reform, 2025)

From SMR Origins to the Operating Fleet

A PLATFORM WITH A FIFTEEN-YEAR PEDIGREE



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What the 2017 NRC Approval Covers

Approved at the platform level

- **Module family.** FPGA-based modules with no executable software in the runtime environment.
- **Design principles.** Independence, redundancy, diversity & defense-in-depth, predictability — on a foundation of simplicity.
- **Communications.** Triple safety data buses plus dedicated monitoring and calibration/test buses.
- **Self-testing.** The built-in self-test and diagnostics approach.

Defined per application

- **Architecture.** Single channel up to four separation groups voting into two divisions.
- **Functional logic.** Application logic, setpoints, and voting arrangements.
- **Qualification.** Environmental and seismic envelope for the installation.
- **Licensing pathway.** 50.59 evaluation, license amendment, or new-build certification.

Every project starts from an NRC-reviewed foundation — the review burden shifts to the application.

FPGA vs. Microprocessor — Why It Matters Here

Microprocessor-based systems

- **Sequential software.** Code executes in loops with jumps and interrupts — watchdogs guard the program counter.
- **Shared processor.** One CPU and operating environment serve every function it hosts.
- **Single point of logic.** Loss of the main processor can defeat all hosted functions.
- **Broad cyber surface.** Code, operating system, and communication stack are all attack surface.

FPGA-based systems

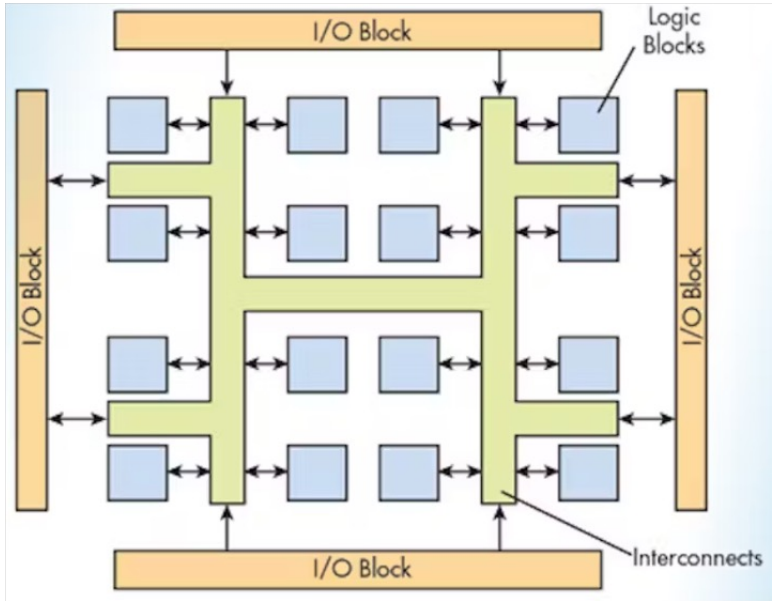
- **Parallel hardwired logic.** Finite state machines — a circuit, not a program.
- **Dedicated logic per function.** Functions execute independently and simultaneously.
- **Deterministic timing.** Fixed-duration transactions; behavior is predictable by construction.
- **Logic burned in.** Configuration cannot be modified while installed in the chassis.

There is no executable software in the HIPS runtime environment.

Inside an FPGA

THREE BUILDING BLOCKS, ONE CONFIGURABLE FABRIC

- **Logic blocks.** Configurable cells of gates, flip-flops, and look-up tables that implement the function.
- **I/O blocks.** Buffer and condition the interfaces to field signals and buses.
- **Interconnects.** The configurable fabric that wires blocks into the application.
- **HDL, not code.** The configuration is written in a hardware description language — you are designing a circuit.
- **Obsolescence resilience.** HDL is chip-independent: proven logic ports to a new device when silicon retires.



User Configuration.HDL
– Perform Function A
– Perform Function B
…
- Perform Function XXX

FPGA structure — Mirion DI&C training, 2026

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Why Regulators — and Cyber Teams — Favor FPGAs

THE NRC PERSPECTIVE, IN PRACTICE

- **Simpler safety demonstration.** Implement only the functionality the application requires — nothing extra to analyze.
- **Deterministic fault handling.** Fault detection and isolation are hardware-based and predictable.
- **Credible diversity.** Inherent diversity between FPGA technologies gives a robust answer to common-cause failure concerns.
- **Strong cyber posture.** One-way communications, no remote access, and logic that cannot be altered in service.
- **Established review framework.** FPGA systems review cleanly against ISG-04, BTP 7-14, RG 1.152, and IEEE 603 / 7-4.3.2.

Synthesis of NRC staff perspectives presented in Mirion DI&C training, February 2026

Five Module Roles, One Chassis

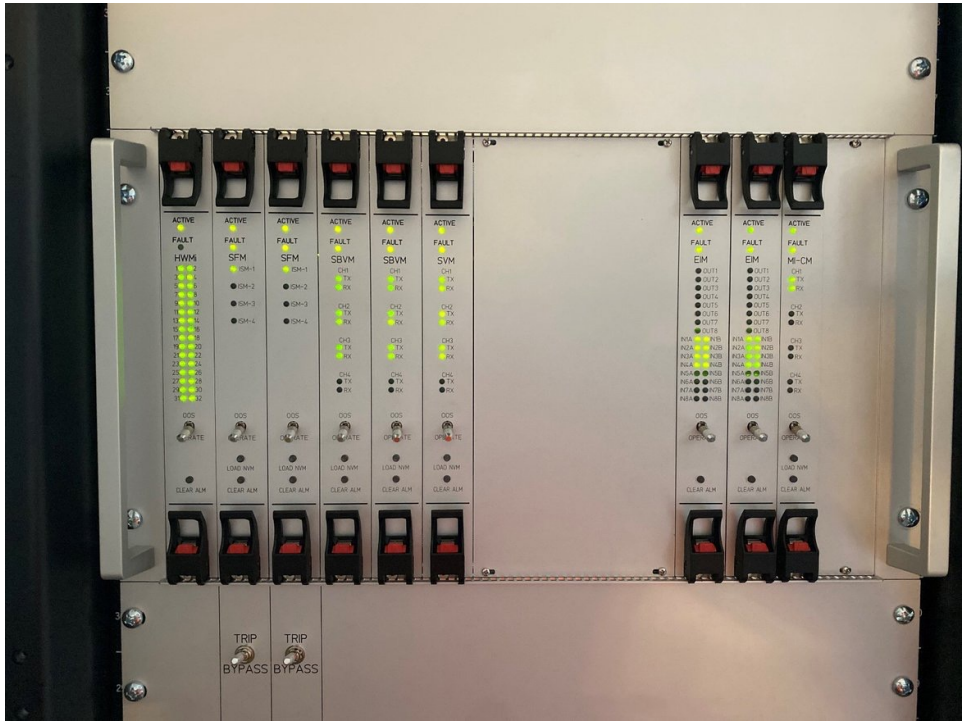
SFM Safety Function Module — conditions field inputs and makes the partial trip determination.

SBVM Scheduling, Bypass & Voting — runs the safety data buses, manages bypass, feeds the vote.

EIM Equipment Interface Module — 2-out-of-3 vote and final actuation through discrete priority logic.

MICM Monitoring & Indication — collects diagnostics; provides the in-chassis calibration path.

HWM Hard-Wired Module — contact inputs on dedicated traces; all analog, no FPGA.



HIPS modules in chassis — the same hardware is on the floor at the Technology Hub tonight.

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One Motherboard, Configured to the Application

MODULAR BY DESIGN — AND NEWER THAN THE TOPICAL REPORT

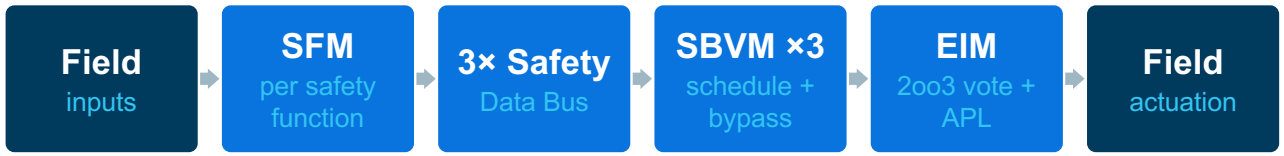
- **Common motherboard.** Every module is built on the same UNO2 base card.
- **One logic submodule slot.** Carries the FPGA — flash-based or SRAM-based, chosen per channel.
- **Four I/O submodule slots.** Analog input, discrete input, and discrete output submodules per the application.
- **Configuration, not new hardware.** A new application is a new arrangement of proven cards.
- **Same catalog at every scale.** From a single-function AFIS to a full plant protection system.

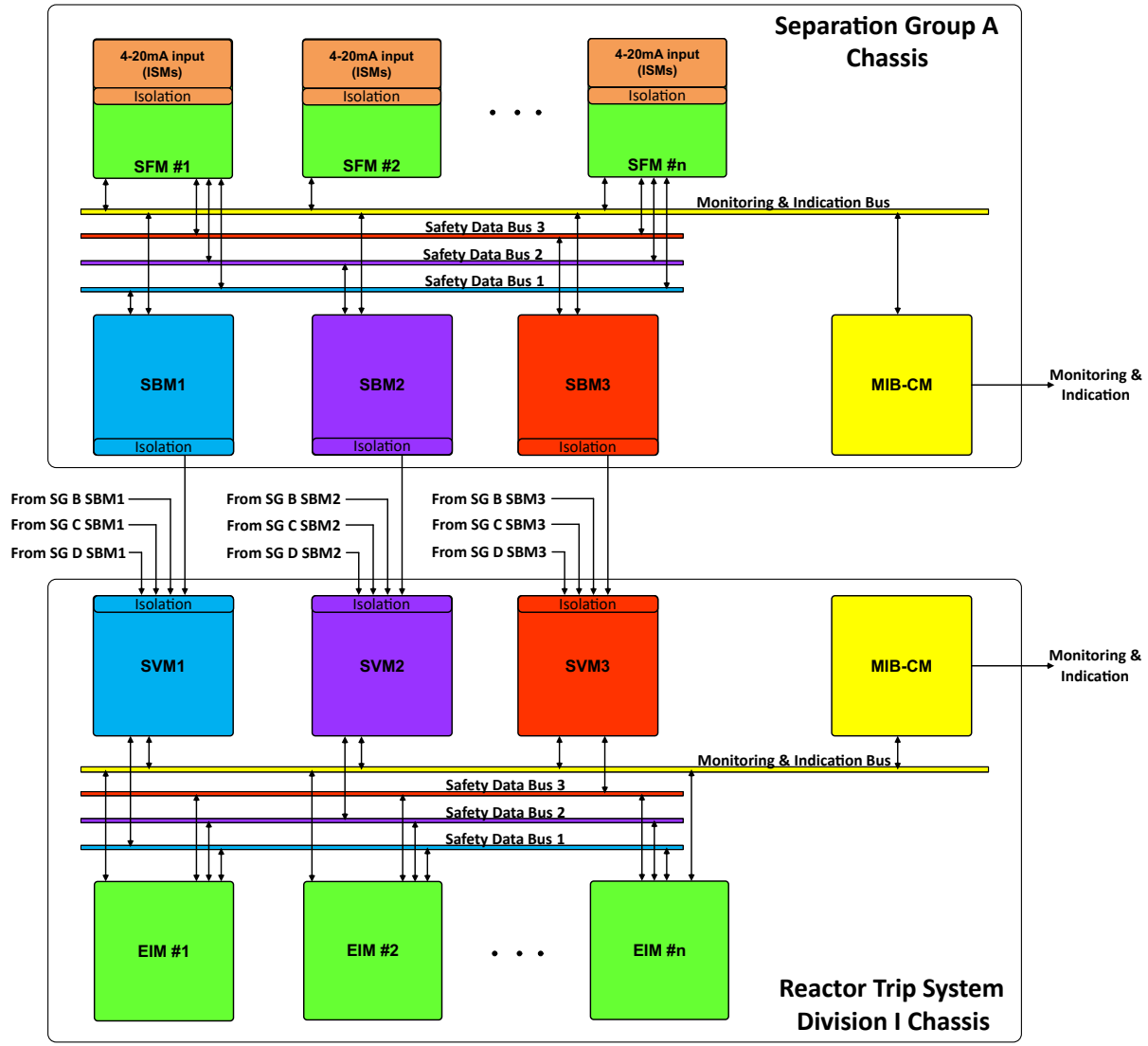
A HIPS module: UNO2 motherboard with logic and I/O submodules seated — handle one tonight at the Technology Hub.

Architecture: How a Trip Travels

TRIPLE DATA PATHS IN, VOTED ACTUATION OUT

- **Error detection built in.** Triple-redundant data paths detect communication errors and confine a fault to a single bus.
- **Fail-sensible.** Loss or removal of a module raises an alarm — it does not actuate the end device.
- **Maintainable online.** Redundant paths are what make hot-swap and simple self-testing possible.
- **Scales with the mission.** Single channel up to four separation groups voting into two divisions — same modules throughout.





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Diversity by Design

The CCF question

- **The central concern.** Software-logic common-cause failure is the issue that drives digital licensing policy.
- **A narrow exposure.** In HIPS, only the FPGA logic is exposed to logic-based CCF — nothing else runs logic.
- **Quality is not enough.** Policy has leaned on diversity since SECY-93-087 — so the platform supplies it.

The HIPS answer

- **Two FPGA technologies.** Flash-based and SRAM-based logic submodules across redundant channels.
- **Different physics.** Flash retains its configuration unpowered; SRAM reloads from configuration memory at every power-up.
- **Different everything else.** Different manufacturers, logic fabrics, and development toolchains — inherent and intentional diversity.
- **Proven at Oconee.** AFIS Digital Channel 1 is flash-based; Digital Channel 2 is SRAM-based.

Diversity is engineered into the platform — not bolted onto the project.

Independence and Communications

ISG-04 BY CONSTRUCTION

- **No shared processor.** Each safety function lives on its own SFM with a unique FPGA image — losing one module loses one function.
- **Isolation throughout.** Galvanic and optical isolation between field inputs, logic, and outputs.
- **Receive-only voters.** EIMs are receive-only on the safety data buses.
- **One-way out.** Interdivisional and external data leaves only through one-way isolated paths — no path back in.
- **Discrete priority logic.** Manual actuation connects through discrete actuation priority logic — it never passes through an FPGA.
- **No remote access.** FPGA logic cannot be modified while a module is installed in the chassis.

Built for the People Who Own It After Startup

WHAT CHANGES ON THE MAINTENANCE FLOOR

- **Hot-swap under power.** Replace a module online — redundant paths keep the function available.
- **Per-function bypass.** A trip/bypass switch per SFM, with automatic alarm at the voter.
- **In-chassis calibration.** Tune setpoints with the SFM out of service; values live in non-volatile memory.
- **Always self-testing.** Continuous checks on communications timing and integrity, memory, and cross-channel comparison.
- **Honest indications.** Front-panel LEDs separate vital failures from non-vital faults — no detective work.

Module replacement — try it yourself at the Technology Hub.

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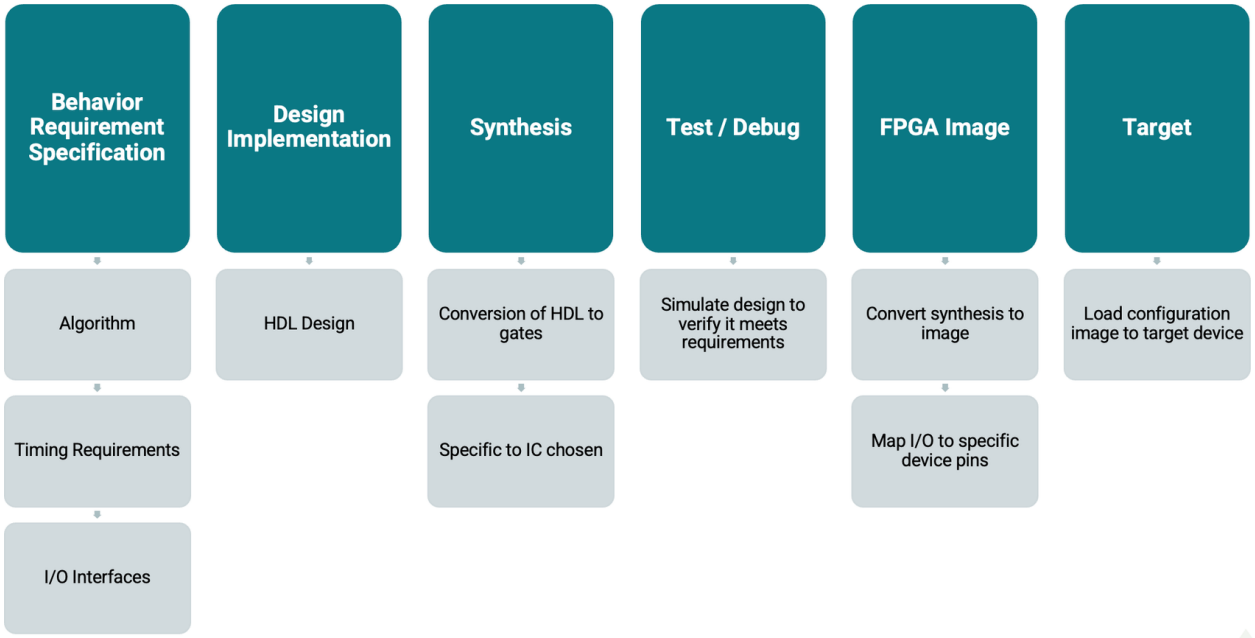
Engineered Through a Disciplined Lifecycle

A LIFECYCLE BUILT TO BE CREDITED

- **Model-based design.** Requirements → model → HDL → bitstream, in one traceable thread.
- **Independent V&V at every gate.** Design verification packages reviewed at model, HDL, bitstream, and programmed-FPGA stages.
- **Total acceptance coverage.** All functions, signal ranges, voting combinations, and defined failure responses are tested.
- **Evidence does double duty.** The same lifecycle record becomes the licensing record — remember that for the next section.



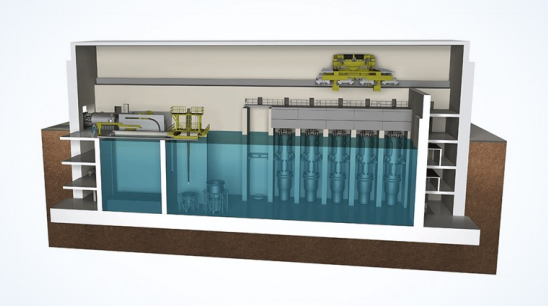
Real-World Applications

Meeting Customers Where They Are

Same engineering bench — four different answers, each shaped by the customer's constraint.

NuScale

Full digital plant protection — the Module and Plant Protection Systems HIPS was created for.



Duke Energy — Oconee

A single-function FPGA retrofit of an obsolete system, licensed under 10 CFR 50.59.

X-energy

HIPS-based protection system work for the Xe-100 advanced reactor.

New Nuclear: Where the Platform Was Born

NuScale

- **The origin mission.** HIPS was created for the NuScale Module Protection System and Plant Protection System.
- **Certification pedigree.** The platform underpins safety I&C in the first NRC-certified SMR design.
- **Multi-module scale.** Full-scope digital safety I&C across a multi-module plant.

X-energy

- **Publicly announced.** HIPS-based protection system work supporting the Xe-100 advanced reactor.
- **Pedigree carries over.** The platform approval and lifecycle evidence travel into the advanced-reactor framework.
- **Same catalog.** The identical module set serving the operating fleet serves Gen IV.

One approved platform — from new builds to the operating fleet.

Start Small, Scale to Full RPS/ESFAS

A PLATFORM DECISION IS NOT AN ALL-OR-NOTHING DECISION

- **Entry points everywhere.** AFIS, ICCMS, sequencers, PAMS, partial RPS — pick the system that hurts most.
- **Reuse compounds.** Each project reuses the same modules, lifecycle, and licensing evidence as the last.
- **Build toward the big one.** Partial upgrades are the on-ramp to full RPS/ESFAS replacement — start small, think big.
- **On your schedule.** Retire obsolescence one system at a time, aligned to your outage windows.

The platform has been approved since 2017.

The differentiator today is the licensing pathway.

10 CFR 50.59 Licensing Success

Duke Oconee — Automated Feedwater Isolation System (AFIS)

Why the Pathway Is the Prize

The license amendment path

- **Prior NRC approval.** The project waits on the regulator before it can proceed.
- **Long clocks.** Review targets run up to 12 months — before requests for additional information.
- **Scope creep.** Reviews tend to drift from the specific change toward a full design review.
- **Risk lands on you.** Schedule uncertainty sits on the project and the outage plan.

The 50.59 path

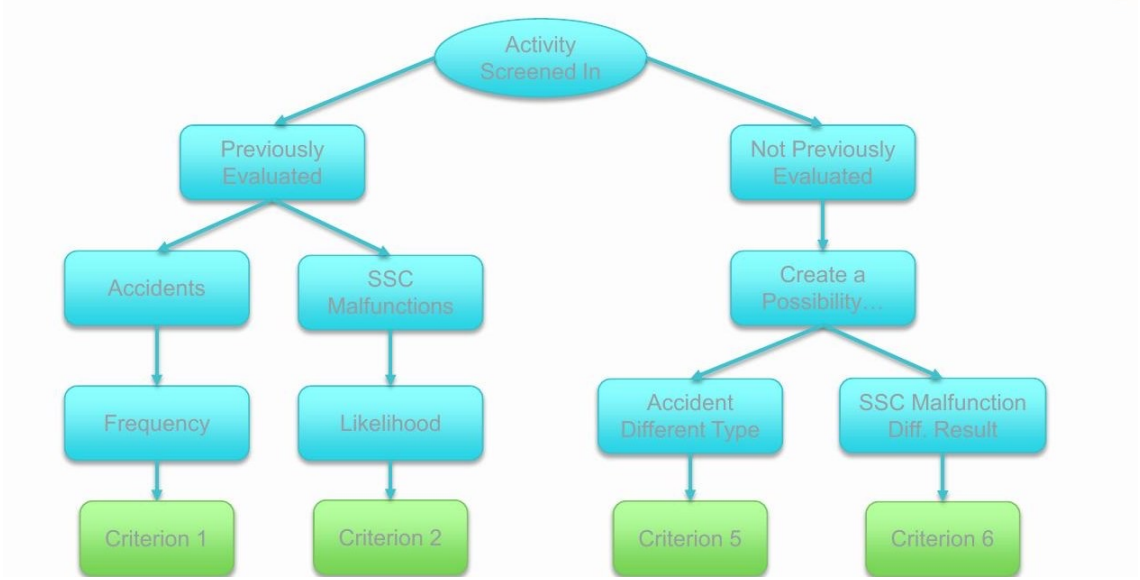
- **Licensee-controlled.** The evaluation is yours to perform and document.
- **Focused questions.** Disposition the specific criteria — not a re-review of the design.
- **Predictable economics.** Schedule certainty and substantially lower licensing cost.
- **Earned in design.** Available when the design keeps all eight criteria untripped.

The pathway decision is made — or lost — in the design phase.

10 CFR 50.59 in One Slide

SCREEN FIRST — EVALUATE ONLY WHAT SCREENS IN

- **The policy frame.** Digital CCF in safety-related SSCs is treated by Commission policy as a beyond-design-basis event.
- **Why that matters.** BDBEs sit outside the accident set that Criteria 1 and 5 ask about.
- **Where evaluations turn.** On credible failure modes at the level of the UFSAR-described FMEA — not on hypotheticals.
- **The design connection.** Preserve redundancy, separation, and independence, and the criteria stay untripped.



Digital 50.59 evaluation focus areas — Source: NEI, Accelerating NRC Reform reverse drop-in, Sept 2025

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The Oconee Problem

THE LAST OF ITS KIND — AND THAT WAS THE PROBLEM

- **The mission.** On a main steam line break, AFIS isolates main and emergency feedwater to the affected steam generator — a low-safety-significance, well-bounded function.
- **The history.** A digital system installed in 2002 — under a License Amendment Request. Remember that.
- **The equipment.** The last Framatome Safety STAR application in service: obsolete, spares unavailable, OEM repair no longer viable.
- **The tech specs.** Non-standard surveillances that never benefited from improved technical specifications.
- **The daily pain.** Surveillance testing chained to an aging Calibration and Test Computer.

Original AFIS equipment — courtesy Duke Energy, INPO DI&C forum

Why Duke Chose HIPS for AFIS

THE SELECTION CRITERIA, AS DUKE PRESENTED THEM

- **Cyber first.** FPGAs chosen for low cyber risk and low cyber OT burden.
- **No scheme change.** No change to the existing protection scheme or redundancy — the design basis stays recognizable.
- **Approved foundation.** The NRC-approved HIPS platform (NuScale SER) as the starting point.
- **Speed.** A fast-tracked schedule: two years from procurement to implementation.
- **Diversity included.** Hardware diversity available within the platform itself — flash and SRAM channels.

The Licensing Strategy: Four Deliverables

GUIDANCE: RIS 2002-22 SUPP. 1 · NEI 96-07 APP. D R1 · RG 1.187 R3

1 · Applicability Whitepaper

Demonstrated AFIS is outside RPS/ESFAS and not high safety significance — unlocking the RIS 2002-22 qualitative method.

2 · 10 CFR 50.59 Screen

Run on Duke's plant template; isolated two potentially adverse aspects for evaluation.

3 · Digital Qualitative Assessment

Design attributes, quality of design process, and operating experience — per RIS 2002-22 Supp. 1.

4 · 50.59 Evaluation

Both aspects assessed against the eight criteria, with NEI 01-01 App. A questions — no LAR required.

- **Design attributes credited.** Hardware diversity, FPGA design diversity, functional diversity, communication independence, built-in self-test.
- **Scope discipline.** Plant procedure impacts deliberately excluded — the evaluation stayed on design features and licensing justification.

The result: a documented basis that the likelihood of digital CCF is sufficiently low.

What Screened Out — and What Did Not

Screened out: nearly everything

- **Nothing moved.** Setpoints, logic algorithms, field instrumentation, and field cabling — all unchanged.
- **Analysis intact.** The existing accident analysis remained bounding — no re-analysis, no methodology change, no tech spec changes.
- **Interfaces cleared.** Operator and maintenance interfaces, qualification envelopes, and the signal isolators all screened out.

Two aspects required evaluation

- **Common source logic.** The same high-level descriptive language used in the diverse FPGA boards of both trains — the residual common element, dispositioned through the qualitative assessment.
- **Interposing relays.** A genuinely new failure mode between HIPS outputs and the existing actuation relays — evaluated on its own merits.

Outcome: no criterion tripped. No License Amendment Request.

Execution Lessons Worth Stealing

WHAT DUKE'S ENGINEERING TEAM WOULD TELL YOU

- **Integrate early.** Joint team input at conceptual, 30/60/100% design phases caught issues while they were cheap.
- **Consolidate interfaces.** Eight serial gateways collapsed into virtual Modbus servers — the first gateway elimination, and a capital-funding win.
- **Mind the cabinet.** Significant reductions in heat and power loads came along for the ride.
- **Bring maintenance in.** I&E maintenance and implementation teams shaped the design — including the maintenance test panels.
- **Train ahead of need.** The maintenance training system was delivered aggressively early.
- **Show up at FAT.** Active customer participation surfaced human-factors issues at the factory, not in the field.

Drawn from Duke Energy's project lessons, INPO Digital I&C forum

Where It Stands Today

FROM STRATEGY TO SHIPPING DOCK

- **Licensed.** Implemented under 10 CFR 50.59 — no License Amendment Request.
- **Qualified.** Equipment qualification is complete.
- **In fabrication.** Production hardware is being built now at our Texas facility.
- **Shipping.** The first system ships September 2026 — for installation in the Unit 1 outage, Q4 2026.
- **Scaling.** Multi-unit rollout follows across the Oconee station.

AFIS system build — Paragon, a Mirion company

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Where the Industry Is Heading

AN ADVOCATE'S VIEW — AND YES, I AM ONE

- **The directive.** EO 14300 directs the NRC toward determinate, data-backed thresholds focused on credible, realistic risks.
- **The industry position.** Digital CCF in safety-related SSCs concurrent with a design basis accident is not a credible, realistic risk.
- **The legal footing.** The CCF treatment lives in Commission policy and staff guidance — not in regulation.
- **Proposals on the table.** Remove the RPS/ESFAS exclusion from RIS 2002-22 Supplement 1; update NEI 96-07 Appendix D; focus LAR reviews on the specific criteria that drove them.
- **What it would mean.** The Oconee playbook — extended to reactor protection and ESFAS.

Positions per NEI, Accelerating NRC Reform DI&C recommendations, September 2025

Is Your System a Candidate?

Six markers of a strong 50.59 digital upgrade. Most plants have several sitting on the shelf.

Obsolescence-driven

Aging or unsupportable equipment is the trigger — not new functionality.

Bounded function

A well-defined safety function with clean interfaces to the rest of the plant.

Redundancy preserved

No reduction in redundancy, separation, or independence of design functions.

FMEA-stable

UFSAR-described failure modes stay recognizable after the change.

Diversity available

Platform-level diversity supports the digital CCF disposition.

Maintenance upside

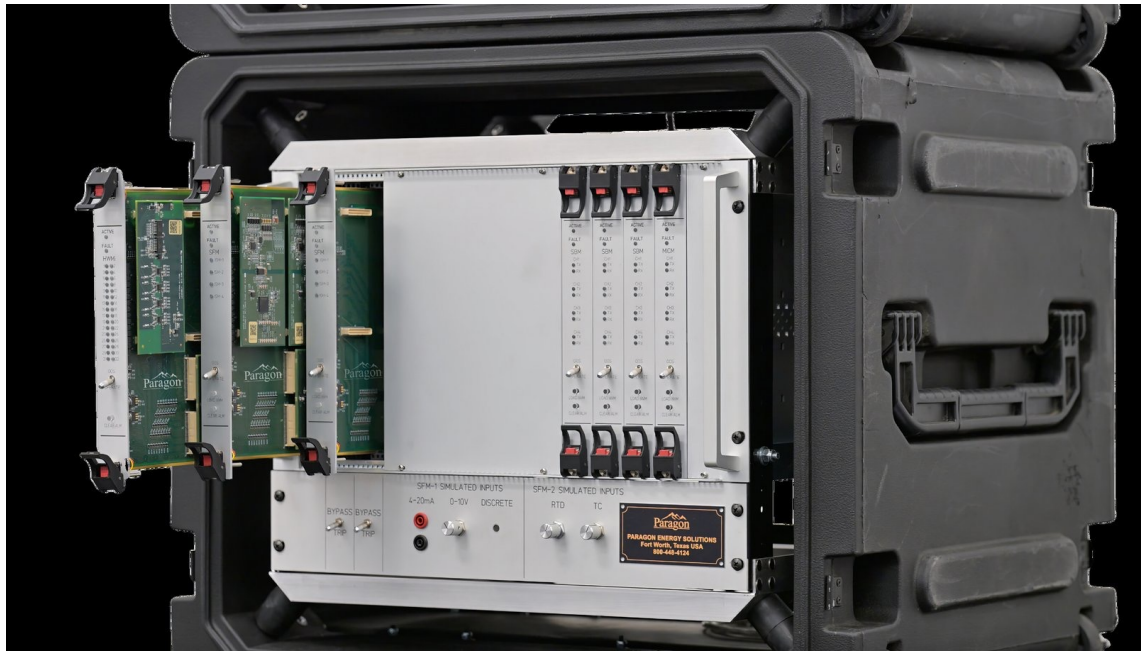
Surveillance pain and spares risk the upgrade permanently retires.

The Ask

WHAT I WOULD LIKE FROM THIS ROOM

- **Bring us one candidate system.** This week — a hallway conversation is enough to start.
- **We return a credible proposal.** Feasibility, a licensing-pathway assessment, and rough-order scope and schedule — something you can take to your station.
- **The licensing legwork is proven.** Applicability whitepaper, screen support, qualitative assessment, evaluation support — the same four deliverables that carried Oconee.
- **What we need from you.** A system description, the tech specs, the obsolescence drivers, and the licensing-basis touchpoints.

See It Tonight: The Technology Hub



The HIPS demonstration chassis

- **Tonight, 5:30–8:30 PM.** Technology Hub grand opening — then open all day Wednesday and Thursday.
- **Hands on.** Pull a module under power. Watch the diagnostics respond.
- **People on hand.** Mirion and Paragon engineers staffing the floor.
- **Bring your candidate system.** Start the conversation while the hardware is in front of you.

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Thank you