Current Fleet I&C Research

Stephen Lopez

Senior Technical Leader

Electric Power Research Institute

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Agenda

- Overall plant modernization effort
- Specific I&C research areas for the existing fleet
- Where to find out more

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The Modernization of Nuclear Plants

VISION

Achieve economic viability of nuclear power through RADICAL and TIMELY transformative innovation & modernization, including:

- Business Process Transformation
- Monitoring
- Analytics
- Automation
- Integration

GOALS

Achieve local market economic competitiveness through cost reductions

COMMON ENABLERS

- CIM — Common Information Model
- Agile Business Processes
- Connectivity
- Common Integrated Tools/Applications
- Digital Upgrade
- Inform Regulatory Change

FUNCTIONAL AREAS

- Operations
- Radiation Protection
- Emergency Preparedness
- Maintenance
- Security
- Outage Management
- Engineering
- Work Management
- Warehouse & Supply Chain
- Chemistry
- NDE
- Training

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Demonstration Tasks

CIM
Common Information Model

Agile Business Processes

Connectivity

COMMON ENABLERS

Common Integrated Tools/Applications

Digital Upgrade

Inform Regulatory Change

Automated Chemistry
PHASE 1 — Common Enablers

Staffing Study
PHASE 1 — Common Enablers

Advanced Automation of Radiation Measurements
PHASE 1 — Common Enablers

Structural Health for Weld Monitoring
PHASE 1 — Common Enablers

Integrated Radiological Information System (IRIS)
PHASE 2 — Common Enablers

Monitoring to Replace Maintenance
PHASE 2 — Common Enablers

Risk Informed Engineering
PHASE 1 — Common Enablers

Chemistry Advanced Analytics
PHASE 2 — Common Enablers

Corrosion Monitoring
PHASE 2 — Common Enablers

GOALS
Achieve local market economic competitiveness through cost reductions

KEY DELIVERABLES
1. Roadmap defining concrete actions to drive digital transformation and fully modernize nuclear plants
2. Lessons learned from deployments and initial demonstrations
3. Application examples with business cases that can be tied to specific labor and material savings

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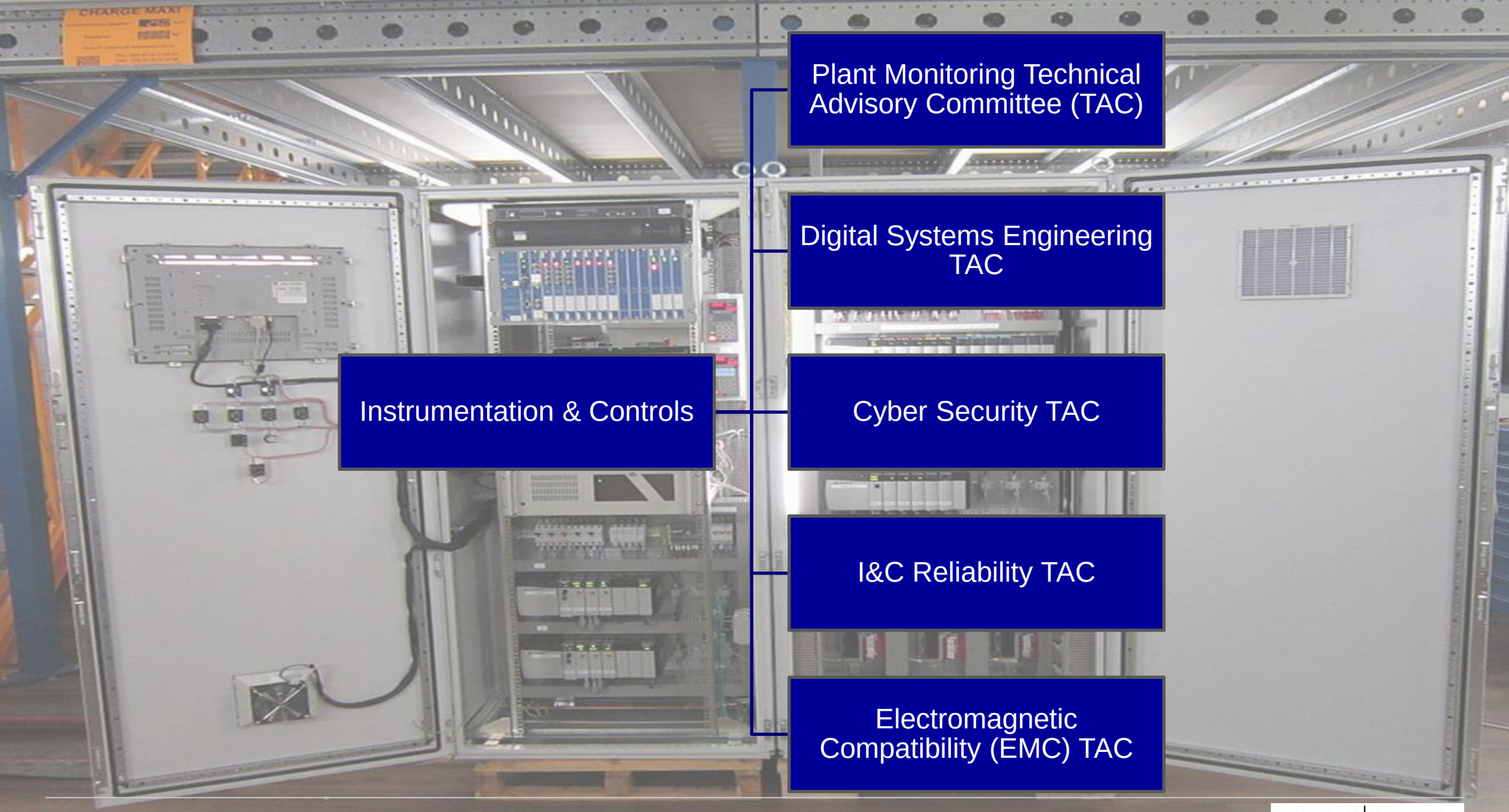
Instrumentation & Controls

Utilize advanced instrumentation, controls, information & communication technology to improve safety and reduce costs in nuclear power plants



Instrumentation & Controls

- Plant Monitoring Technical Advisory Committee (TAC)
- Digital Systems Engineering TAC
- Cyber Security TAC
- I&C Reliability TAC
- Electromagnetic Compatibility (EMC) TAC

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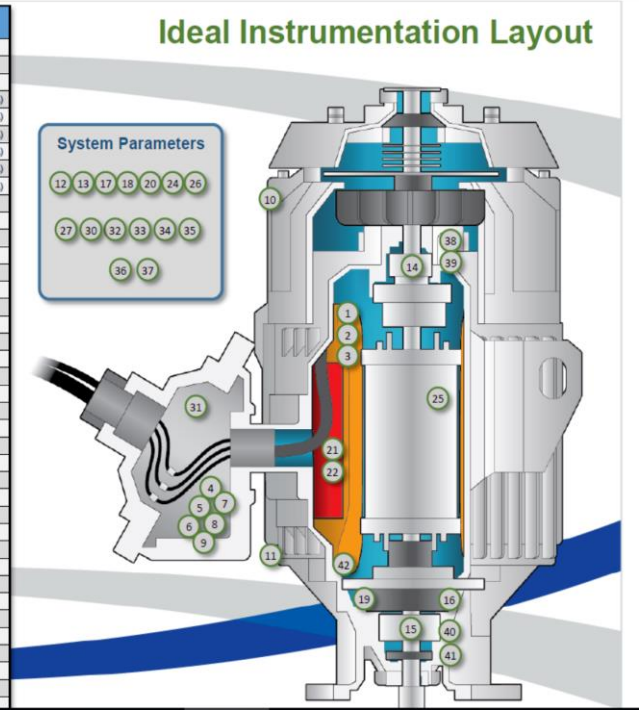
Plant Monitoring

- Many plants monitor for reliability & failures, but also can reduce maintenance activities
- Existing Key Products
  - On-Line Monitoring Program Guide (300200577)
  - “Quick Guides” (Appendices to 3002012560)
  - Wireless Sensor Survey & General Specification (3002011818)
  - Standard Design Packages for wireless sensors & distributed antenna system (3002011820)

- 2018 – 2019 Key Work
  - Pilot monitoring to reduce maintenance
  - Data analytics tool evaluations

Sensor Number	Sensor	Technology
1	Stator Winding Temperature A	Temperature
2	Stator Winding Temperature B	Temperature
3	Stator Winding Temperature C	Temperature
4	A Phase Voltage	Elec. Signature Analysis (ESA)
5	B Phase Voltage	Elec. Signature Analysis (ESA)
6	C Phase Voltage	Elec. Signature Analysis (ESA)
7	A Phase Current	Elec. Signature Analysis (ESA)
8	B Phase Current	Elec. Signature Analysis (ESA)
9	C Phase Current	Elec. Signature Analysis (ESA)
10	Triaxial Accelerometer 1	Vibration-Absolute
11	Triaxial Accelerometer 2	Vibration-Absolute
12	Lube Oil Supply Temperature	Temperature
13	Lube Oil Supply Pressure	Pressure
14	Bearing Metal Temp - Upper	Temperature
15	Bearing Metal Temp - Lower	Temperature
16	Bearing Metal Temp - Thrust	Temperature
17	Oil Viscosity	Oil Analysis
18	Oil Wear Particle Count	Oil Analysis
19	Thrust Position	Thrust Position
20	Electromag. Sig. Analysis (EMSA)	EMSA
21	Partial Discharge Monitor (PD)	PD
22	Stator Core Temperature	Temperature
23	Shaft Torque	Torque
24	Acoustic Monitor	Acoustics
25	Rotor Core Temp	Temperature
26	Air Filter DP	Pressure-Differential
27	Lube Oil Filter DP	Pressure-Differential
28	RPM (key phasor)	Speed
29	Torsional Vibration	Torsional Vibration
30	Flux	Flux
31	Terminal box temp	Temperature
32	Ambient Air Temp	Temperature
33	Relative Humidity	Humidity
34	Unit MWe	Load
35	Electromagnetic Antenna	EM
36	Oil Level	Level
37	Oil Temp Return	Temperature
38	Proximity Probe (Upper X)	Vibration-Relative
39	Proximity Probe (Upper Y)	Vibration-Relative



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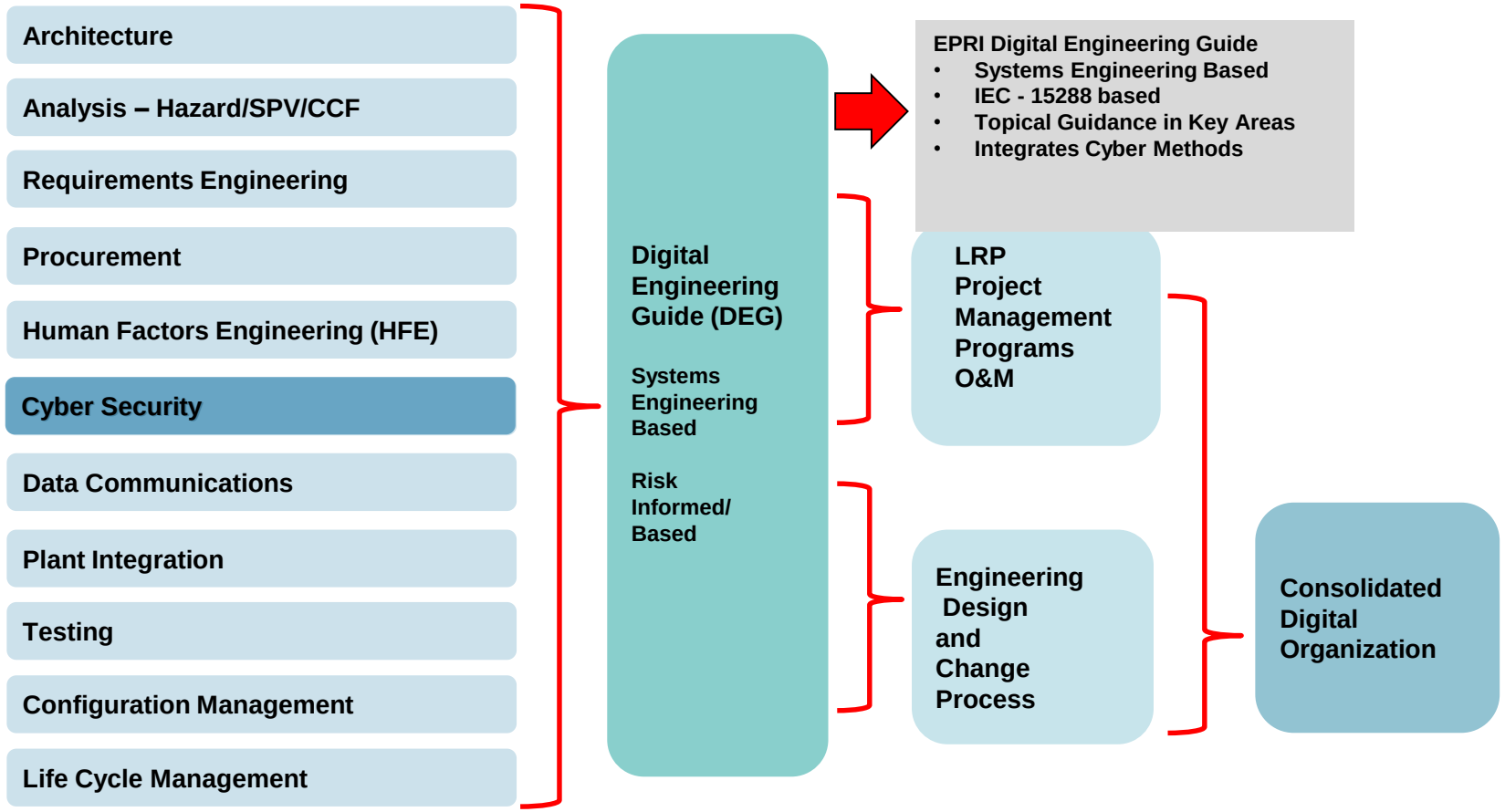
Digital Systems Engineering



Research has shown that a well developed Digital Design and Implementation covers the <u>technical and hazards analysis needed</u> for an <u>effective cyber security assessment</u>.

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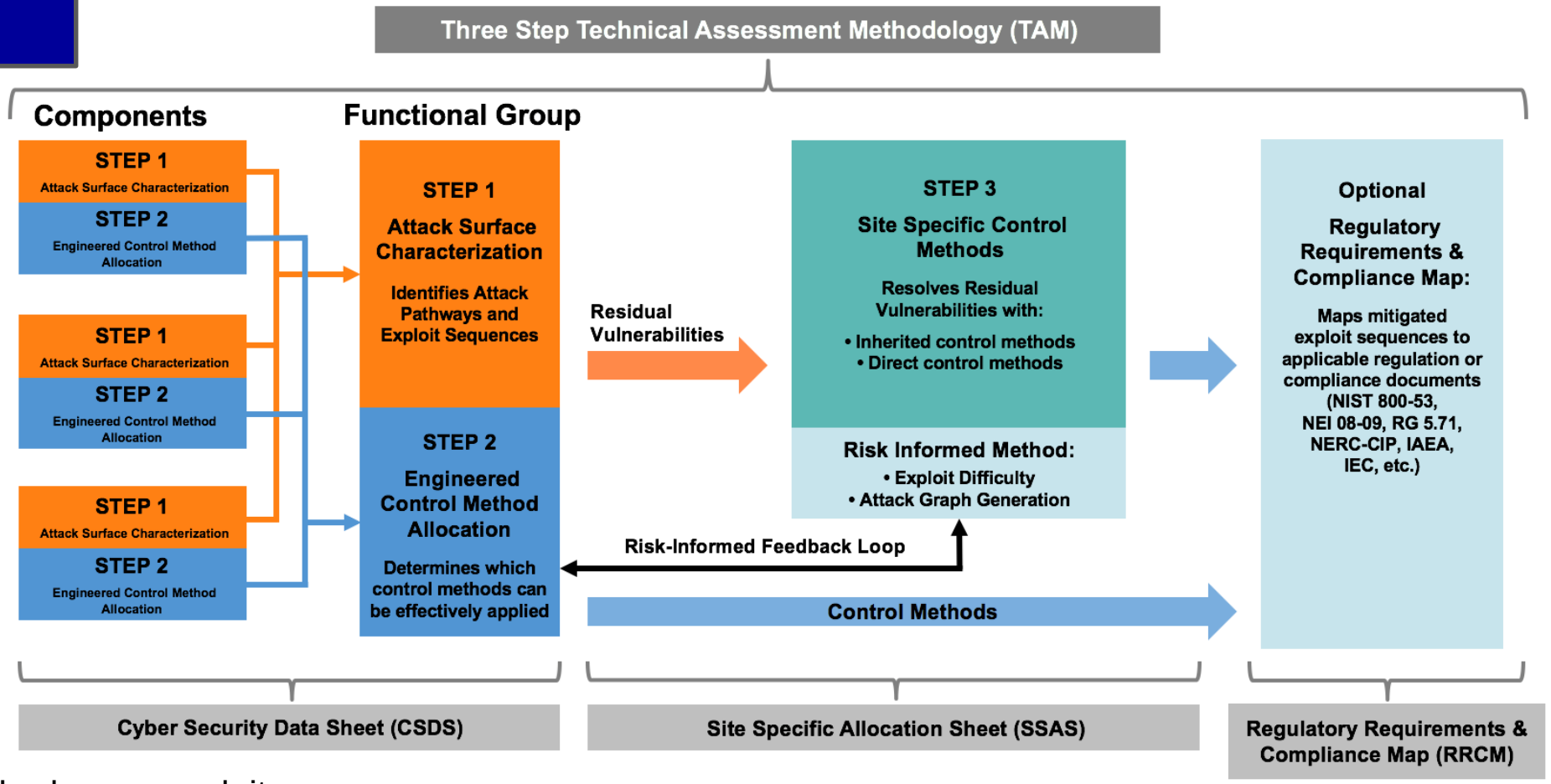
Cyber Security



- EPRI three-step method, uses exploit sequences
- Performance-based, regulator independent, efficient
- New build users: Barakah (UAE), Vogtle 3&4 (US)
- Vendor users: OSISoft, Fisher Valve, others in discussion

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Digital Systems Engineering

Cyber Security

- 3002002989, Digital Instrumentation and Control Design Guide. Oct 2014
  - Rev 1 sch. Aug. 2018, 3002011816
- 3002008023, Technical Assessment Methodology (TAM), Oct. 2016
  - Rev 1 sch. Oct. 2018, 3002012752
- 3002008020, Nuclear Cyber Security Exercise Scenarios, Aug. 2016
- 3002008206, Cyber Security- Isolation for Maintenance, Monitoring, and Diagnostic Applications in Nuclear Power Facilities, Nov. 2016
- 3002012755, HAZCADS-Hazards and Consequences Analysis for Digital Systems, Dec. 2018
- 3002001824, Cyber Security Procurement Methodology, Rev. 1, Dec. 2013
  - Rev 2 sch. Dec. 2018, ID TBD
- 3002010470, Advanced Nuclear Technology: Guidance for Cyber Security During New Nuclear Plant Construction, Aug. 2017

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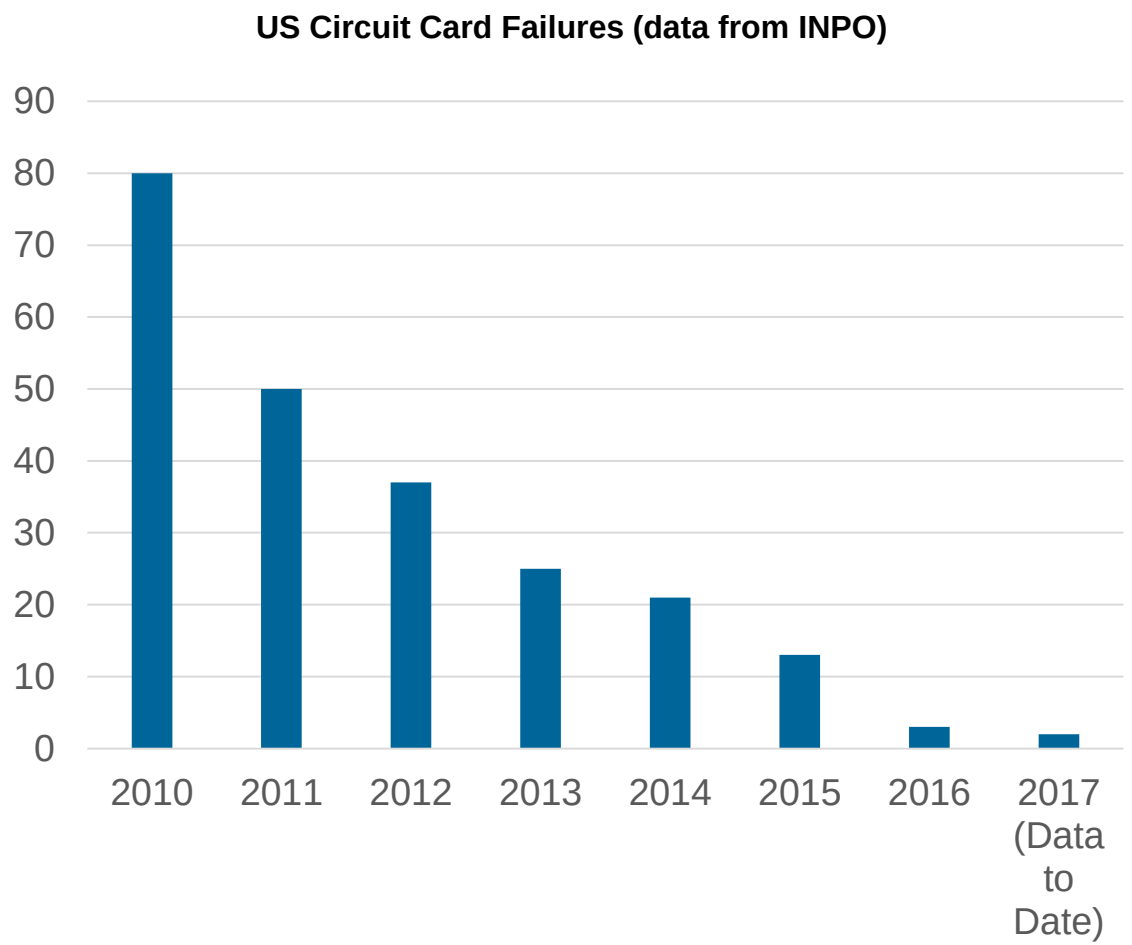
I&C Reliability



- Improve reliability of I&C components to avoid trips and down-powers
- Existing Key Products
  - Circuit card work, including Gold Card Project (1022990), I&C Reliability Lessons Learned from China (3002008025)
- 2018 and 2019 Key Work
  - Digital system maintenance & reliability
  - Preventive Maintenance templates updates

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Electromagnetic Compatibility (EMC)

- Ensure performance, longevity of I&C equipment, reduce O&M and equipment replacement costs
- Existing Key Products & Work
  - *Guidelines for Electromagnetic Compatibility Testing* (EMC guide), 3002000528, et al
  - Computer Based Training Modules for EMC Guide (3002008024, being moved to EPRI's Learning Management System)
  - Technology assessment for new / evolving wireless applications (ongoing)
- 2018 and 2019 Work
  - Re-establish nuclear plant electromagnetic "baseline" environment
  - Support mobile wireless device integration
  - Update EMC guidance, training

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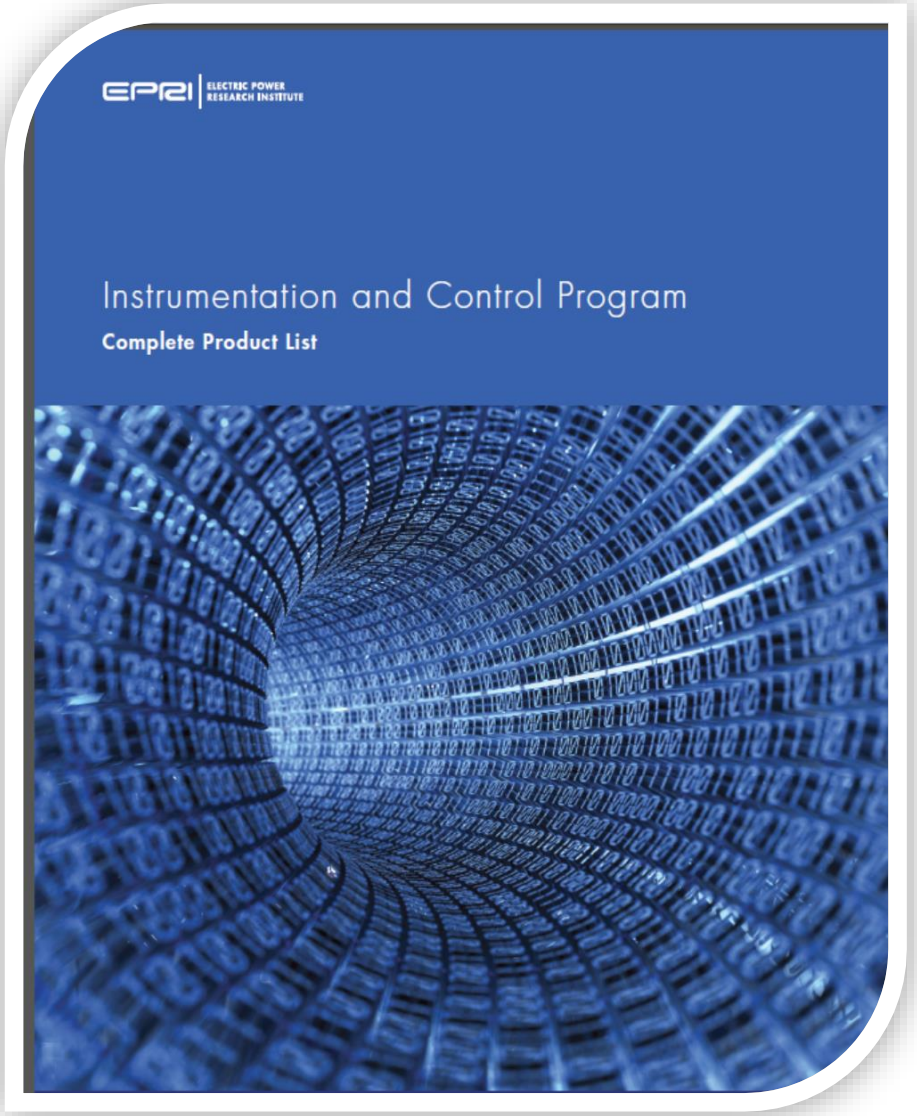
How to engage with EPRI I&C?

- I&C Integration Committee & Technical Advisory Committees (TACs)
  - Plant Monitoring
  - I&C Reliability
  - Digital Systems
  - Cyber security
  - Electromagnetic Compatibility
- I&C product guide (3002006581)
- EPRI Portfolio http://www2.epri.com/Our-Portfolio/Pages/Portfolio.aspx?program=065770
- I&C Program Cockpit (EPRI user id & membership required) https://membercenter.epri.com/programs/065770
- Monthly I&C Newsletter
- Call or e-mail us…



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EPRI I&C Contacts

Name	Role	E-mail	Phone
Mark Woodby	Program Manager (Acting)	mwoodby@epri.com	+1-980-495-7444
Matt Gibson	Technical Executive, Digital Systems TAC Lead	mgibson@epri.com	+1-704-595-2951
Stephen Lopez	Senior Technical Leader, I&C Reliability, EMC TAC Lead	slopez@epri.com	+1-704-595-2975
Michael Taylor	Principal Technical Leader, Plant Monitoring TAC Lead	mtaylor@epri.com	+1-704-595-2157
Michael Thow	Senior Technical Leader, Cyber Security TAC Lead	mthow@epri.com	+1-704-595-2967

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