



HF Controls

# Proceed With Caution: Disaster Recovery Applications in Nuclear Control Systems





# Presentation Outline

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- **Doosan HF Controls**
  - ❖ **Overview**
  - ❖ **Products & Services**
- **Snapshots of the Nuclear Industry**
  - ❖ **Worldwide Nuclear Power Plants**
  - ❖ **Recap of Japan's Fukushima Daiichi Accident**
  - ❖ **Impact to the Nuclear Industry**
- **"Beyond-Design-Basis" Applications**
  - ❖ **Potential Applications**
  - ❖ **Passive Wireless Technologies**
    - ✓ **Applicable Areas**
    - ✓ **Advantages and Considerations**



## Doosan HF Controls

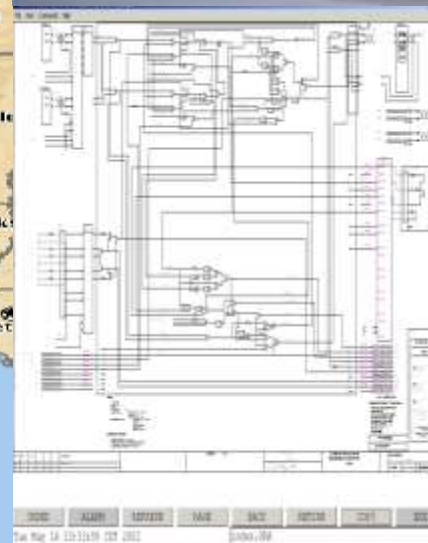
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- Overview
- Products and Services

# Doosan HF Controls Home Office

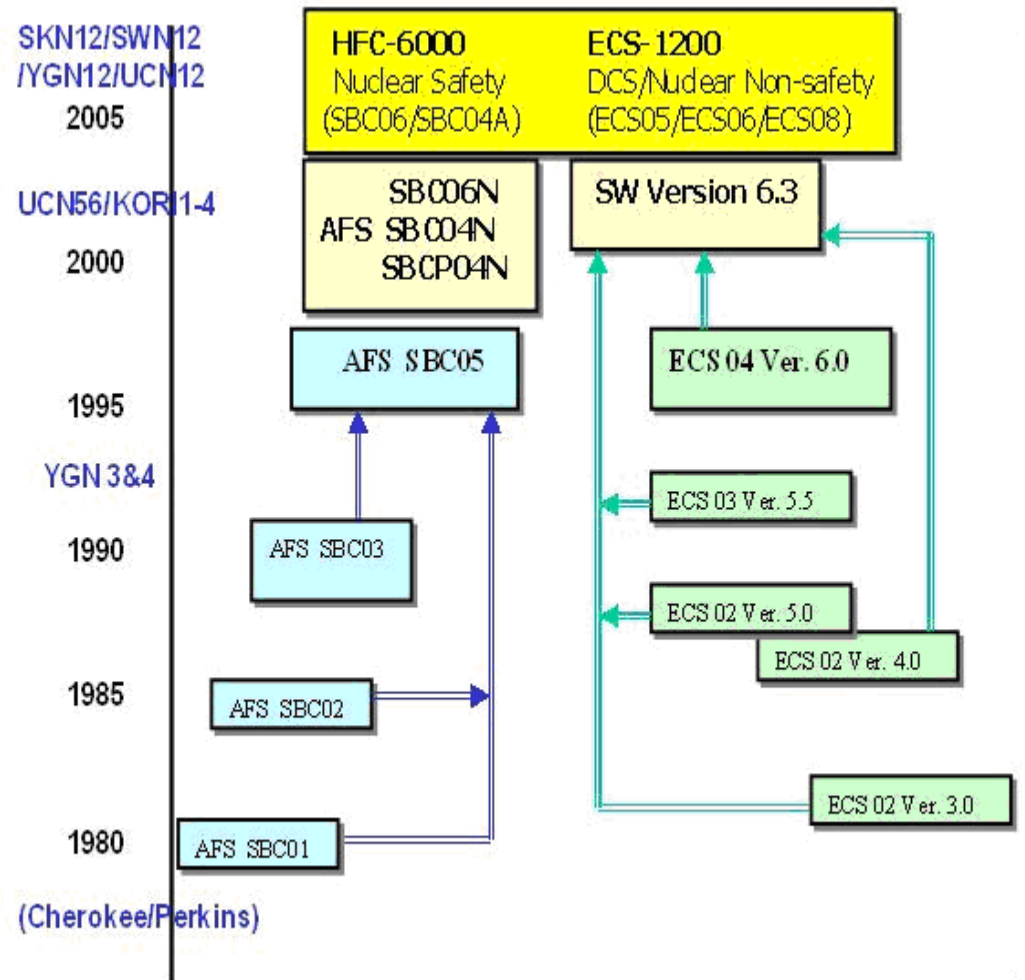
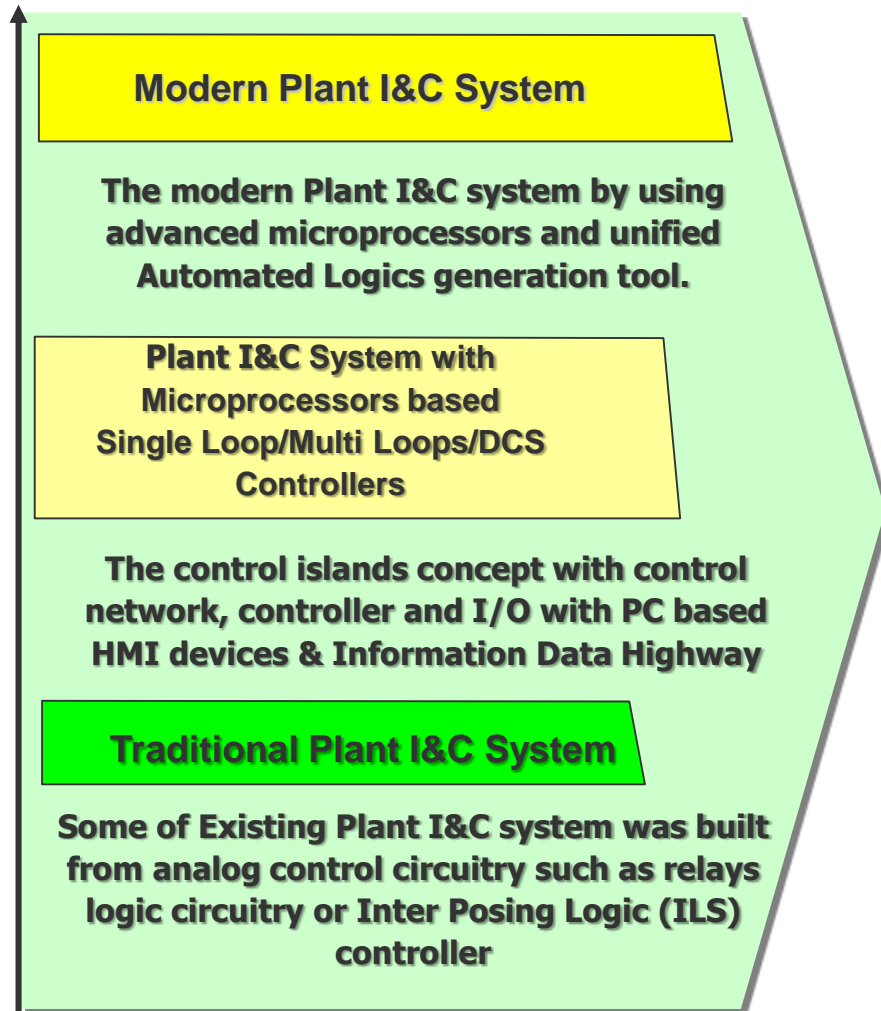
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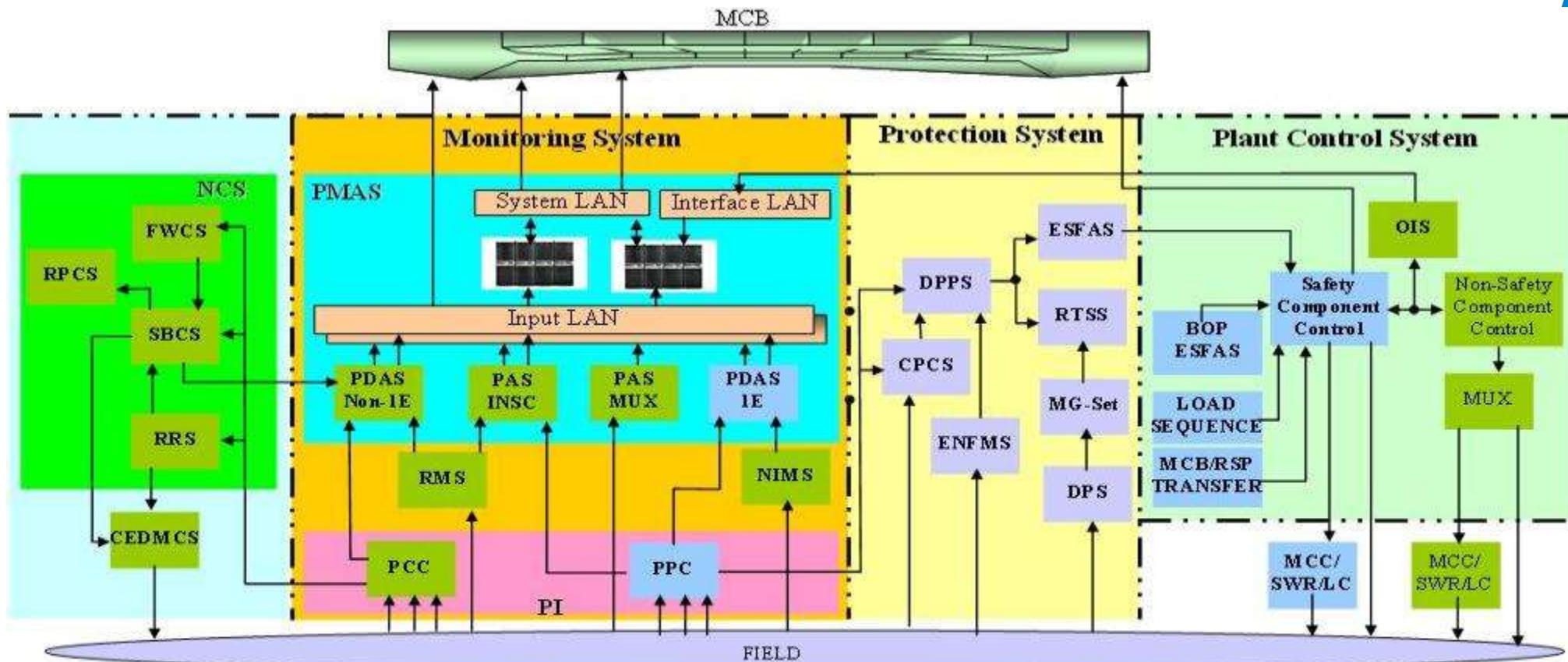
# Brief History



# Products and Services

System	Overview	Certification and Installment
HFC- 6000	<ul style="list-style-type: none"><li>• Nuclear safety class 1E qualified</li><li>• Redundant and Triple Redundant</li><li>• Safety Loop Applications</li><li>• Tools for Application Design</li><li>• Superior Response time</li></ul>	<p>Nuclear Safety System Approved by NRC</p> <p>TÜV Certified</p> <p>Multiple KNSP PCS I&amp;C Installations in Korea</p>
ECS-1200	<ul style="list-style-type: none"><li>• Scalable DCS System</li><li>• Complete I/O library cards</li><li>• Redundant and Triple Redundant</li><li>• Comprehensive Applications</li></ul>	<p>TÜV Certified</p> <p>Worldwide Installments</p>

# Nuclear I&C Applications



APC : Auxiliary Protection Cabinet  
 BOP : Balance Of Plant  
 CEDMCS : Control Element Drive Mechanism Control System  
 DPS : Diverse Protection System  
 DPPS : Digitalized Plant Protection System  
 ESFAS : Engineered Safety Feature Actuation System  
 FWCS : Feed Water Control system

MCR : Main Control room  
 MG-Set : Motor Generator-Set  
 MUX : Multiplexer  
 LAN : Local Area Network  
 PAS : Plant Annunciator System  
 PCC : Process Control Cabinet  
 PCS : Plant Control System

PDAS : Plant Data Acquisition System  
 PPC : Plant Protective Cabinet  
 RPCS : Reactor Power Cutback System  
 RRS : Reactor Regulating System  
 RTSS : Reactor Trip Switchgear System  
 SBCS : Steam Bypass Control System



# Nuclear I&C Manufacturing Facility



HF Controls





## Snapshots of the Nuclear Industry

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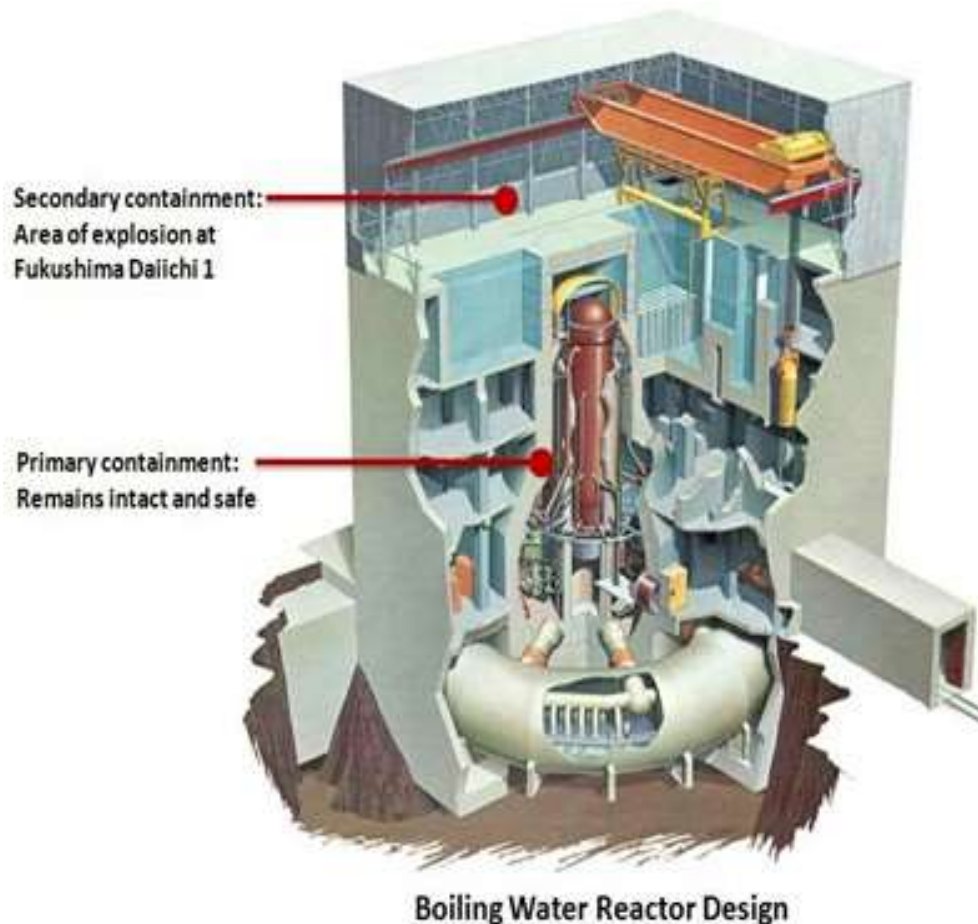
- **Worldwide Nuclear Power Plants**
- **Recap of Japan's Fukushima Daiichi Accident**
- **Impact to the Nuclear Industry**

# Worldwide Nuclear Power Plants

COUNTRY	Nuclear Electricity 2010 billion kWh	Reactors							
		Operable 1 July 2011		Under Construction 1 July 2011		Planned July 2011		Proposed July 2011	
		No.	MWe net	No.	MWe gross	No.	MWe gross	No.	MWe gross
USA	807.10	104	101421	1	1218	6	7200	28	38600
France	410.10	58	63130	1	1720	1	1720	1	1100
Japan	280.30	51	44642	2	2756	10	13772	5	6760
Russia	155.40	32	23084	10	8960	14	16000	30	28000
South Korea	141.90	21	18716	5	5800	6	8400	0	0
India	20.50	20	4385	5	3900	18	15700	40	49000
Canada	85.50	18	12679	2	1500	3	3300	3	3800
United Kingdom	56.90	18	10745	0	0	4	6680	9	12000
Germany	133.00	17	20339	0	0	0	0	0	0
Ukraine	71.00	15	13168	0	0	2	1900	20	22800
China	468.30	14	11271	26	28710	52	59990	120	123000
Others	384.35	72	52842	9	8770	38	36783	87	106295
World	2630.00	440	376422	61	63334	154	171445	343	391355

Data from World Nuclear Association as of July 1, 2011

# Recap of Japan's Fukushima Daiichi Accident



March 11, 2011 in Japan FD plant

- 9.0 Magnitude Earthquake hit Japan
- All units of FD plant were undergone the automatic shutdown (trip) sequences
- Tsunami of heights more than 18 feet hit the plant and destroyed the backup diesel generator
- Emergency battery power kicked in but lasted no more than 8 hours
- Insufficient power for the cooling system to contain the heat
- Spent fuel pools were reported overheated
- Explosions were heard...

# Impact to the Nuclear Industry



## Europe

- Germany put 7 reactors offline quickly and reconsidered their nuclear energy plans, and have indicated plans to be completely independent of nuclear energy in the near future.
- UK ordered new safety reviews of their nuclear power plants.



## China

- Announced to revise energy policy to ensure safety reviews are conducted properly in their nuclear power plants. New nuclear power plants are “expected” to be slowed down for 2 years.
- No noticeably slow down in actual implementations.



## Korea

- Plans to spend 1 trillion won (\$922 million) over the next five years to upgrade safety facilities at reactors.
- “Rapid deployment” of early warning/detection systems such as Automatic Seismic Trip Systems (ASTS).



# Impact to the Nuclear Industry

## United States

- Shortly after the event, US indicated slowdown in new plant approvals.
- On July 12, 2011, NRC released a 96-page report: “Recommendations for Enhancing Reactor Safety in the 21<sup>st</sup> Century”. Highlights:
  - New regulations on “beyond-design-basis” for addressing severe accident issues.
  - Requirements on Station Black Out (SBO) mitigation capability for existing and new reactors for design-basis and “beyond-design-basis” natural events.
  - Requirements on facility emergency plans address prolonged station blackouts and events involving multiple reactors.
  - Requirements on enhanced instrumentation of spent fuel cooling.
  - Requirements on enhancement in onsite emergency response capabilities such as emergency operating procedures, severe accident management guidelines and extensive damage mitigation guidelines.



## **“Beyond-Design-Basis” Applications**

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- **Potential Applications**
- **Passive Wireless Tags**

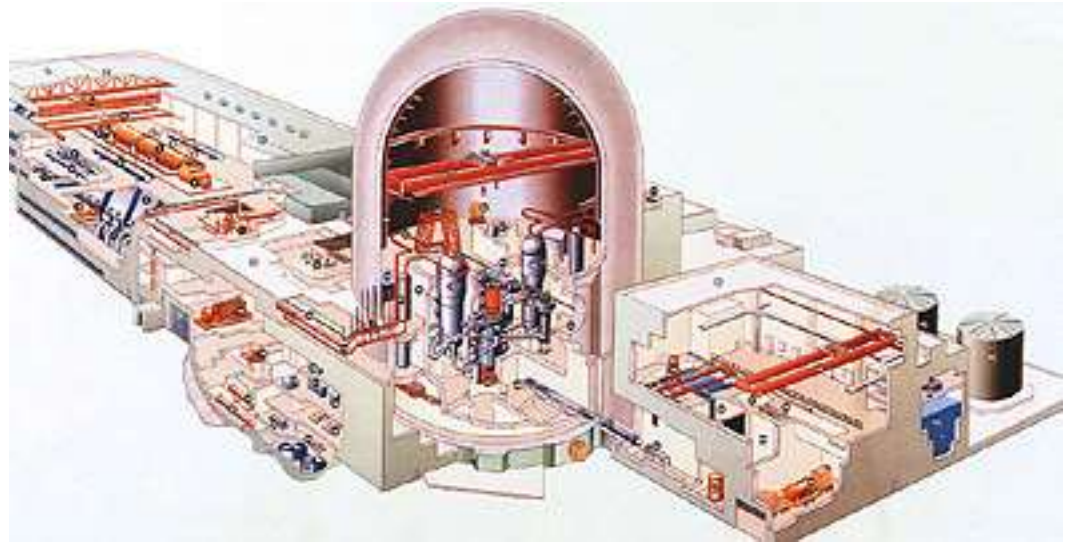
# Beyond-Design-Basis Applications

- **Disaster Environment Profiling**
- **Contamination and Containment Forecast**
- **Evacuation Process Monitoring**
- **Disaster Recovery Operations**

# Disaster Environment Profiling

## ➤ Profiling Elements

- Temperature
- Radioactivity
- Others



## ➤ Profiling Conditions

- Operating Stage: After “Shutdown” sequences are initiated
- Power Source: With or without main power source
- Coverage: All plant units
- Security: Low



# Contamination and Containment Forecast

- **Real-time Analyses**
  - **Real-time Contamination and Containment (CC) Report**
  - **CC Forecast:**
    - **Trend-based Simulation**
    - **Scenario-based Simulation**
- **Station Black Out (SBO) Actions**
  - **Equipment Location Identification**
  - **Equipment Security Access**
  - **Unmanned Operations**



# Evacuation Process Monitoring & Disaster Recovery Operations

## ➤ Evacuation Process Monitoring

- Nuclear Power Plants
  - Plant Personnel
  - Equipment
- Evacuation Zones
  - People
  - Buildings

## ➤ Disaster Recovery Operations

- Hazardous Equipment
  - Identification
  - Transportation



# Passive Wireless Technology

## Applicable Areas

- **Extension of Existing Applications (NUREG/CR-6882)**
  - **Inventory management system.**
  - **Condition-Based maintenance (CBM) – employs equipment condition data to predict impending faults and failures for providing maintenance schedule before failure occurs.**
  - **Wireless teledosimetry systems – provides real-time radiation data and can be integrated as part of a nuclear facility's as low as reasonably achievable (ALARA) program.**
  
- **New areas specifically for “Beyond-Design-Basis” Applications**

# Advantages and Considerations

- **Permissible Wireless Spectrum**
  - All safety-related nuclear equipments are required to qualify EMI/RFI tests:
    - Emission Threshold Tests
    - Susceptibility Threshold Tests
- **Security**
  - Access Restriction
  - Safety Control Isolated
- **Radiation Hardened**