

# Design Characteristics and Classification Issue of the I&C Systems for the JRTR

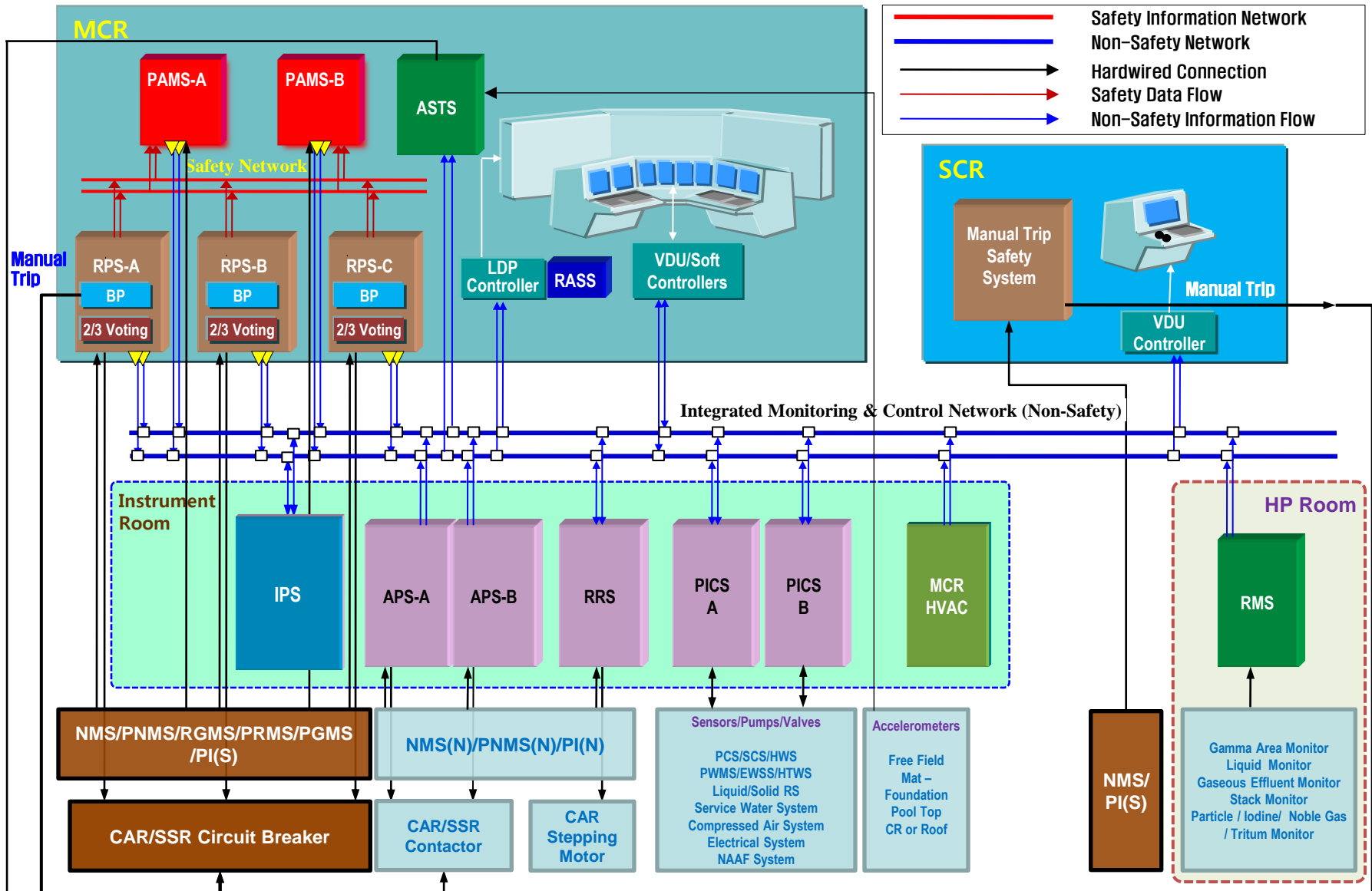
J. Y. Keum\*, J. Y. Park\*, H.S. Kim\*\*, and Y. K. Kim\*

\* Republic of Korea, Korea Atomic Energy Research Institute

\*\* Republic of Korea, Chungnam National Univ.

- **Overview of JRTR I&C**
  - \* **Configuration of JRTR I&C Systems**
  - \* **Main I&C Classification Issue**
- **Design Features and Classification of JRTR I&C Systems**
- **Conclusion**

# Configuration of JRTR I&C System



# Main I&C Classification Issue (1)

## □ Design Basis for I&C Safety Classification

- IAEA Safety Standards No. NS-R-4, “Safety of Research Reactor”, 2005.
- ANSI/ANS 51.1(1983) – Nuclear safety criteria for the design of stationary pressurized water plants
- 2012-09 MEST Notice, Korea  
MEST (Ministry of Education, Science and Technology)

ORGANIZATIONS AND/OR COUNTRIES	CLASSIFICATION			
IAEA	Systems Important to Safety		Systems not important to safety	
	Safety system	Safety related system		
IEC	Category A	Category B	Category C	Unclassified
France	1E	2E	IFC/NC	
European Utilities Requirements (EUR)	F1A (Automatic)	F1B (Automatic and Manual)	F2	Not Classified
UK	Category 1		Category 2	Not classified
USA	1E	Non-nuclear safety		

*Safety Classification of Important Functions in NPPs*

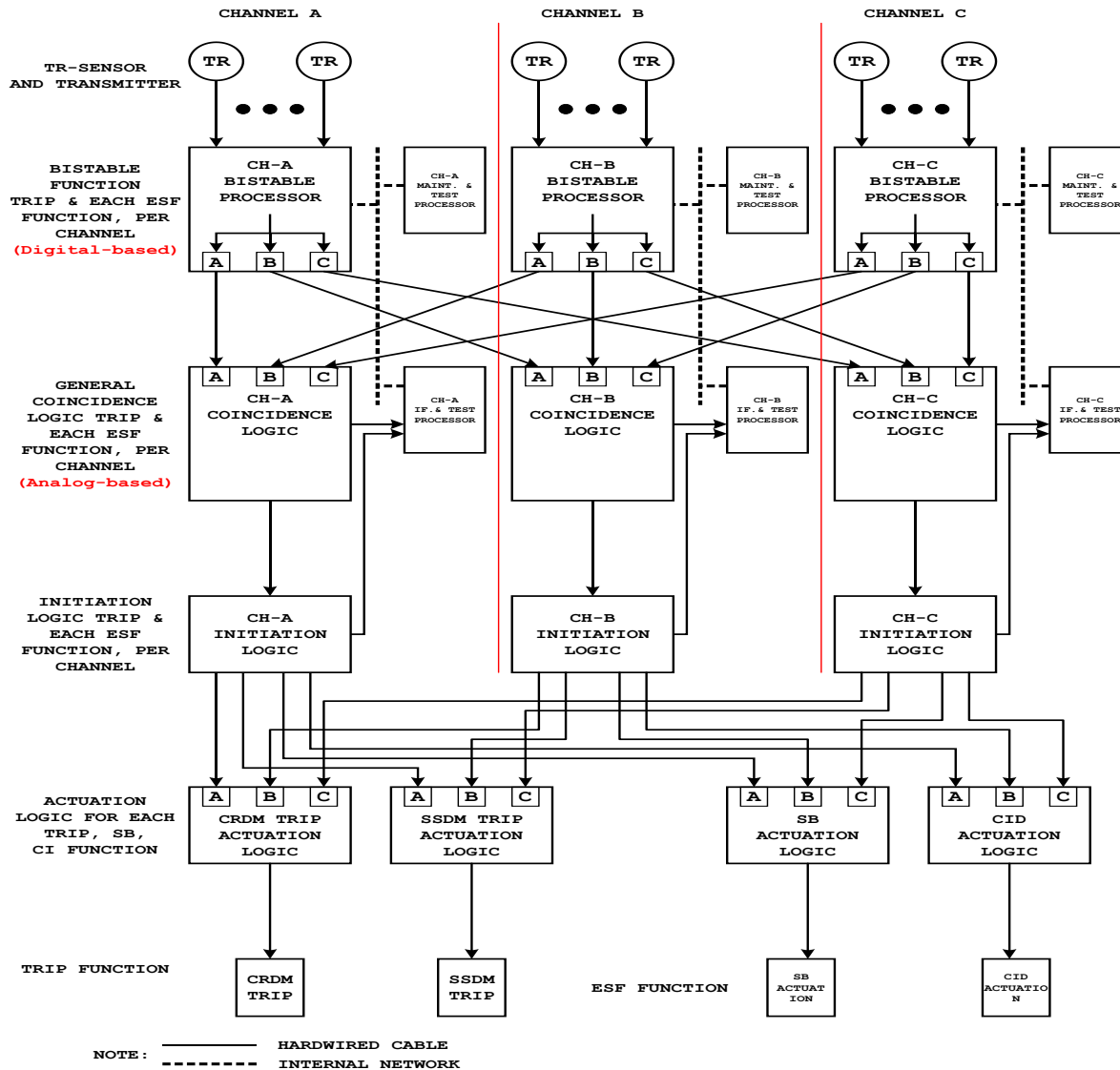
Table 1. Correspondence of JRTR Classification to IAEA and US Classifications

IAEA general concept (for instance, in NS-R-4)	Items important to safety		Items not important to safety
	Safety system	Safety-related items	
	↕	↕	↕
JRTR	Safety Class 3 (Quality Class Q)	NNS Class with specified functions (Quality Class T/Q)	NNS Class (Quality Class S)
	↕	↕	↕
ANSI 51.1	Safety Class 1, 2 and 3 (ASME NQA-1)	NNS Class with specified functions (selected requirements from ASME NQA-1)	Other NNS Class items

□ **Items for Quality Class T based on ANSI/ANS 51.1 & MEST (2012-09) MEST Notice, Korea – Some NNS equipment has one or more selected, but limited, requirements that are specified to ensure acceptable performance of specific NNS functions below**

1. Processing of radioactive waste
2. Purification of radioactive material during normal operation
3. Processing of radioactive waste from irradiated neutron absorbers for reuse
4. **Monitoring of radioactive effluents -> (RMS)**
5. Resisting the failure of SC-1/2/3 equipment's safety functions
- .
- .
- .
12. Protecting SC-2/3 equipment for safe shutdown following fire
13. Monitoring of Variables :
  - **plant operating conditions on technical specification limits -> (PICS & IPS)**
  - **status of protection system bypasses -> (IPS-BISI)**
  - **status of SC-1/2/3 equipment -> (IPS from RPS & PAMS)**
  - **aid in determining the cause or consequences of events for post accident investigation -> (IPS – Type D of PAMS)**

# Reactor Protection System



## Design Features

- 3 Redundant Channels
- Hybrid of Digital and Analog
- Provisions of Manual Initiation
- ESF Actuation

## Classification

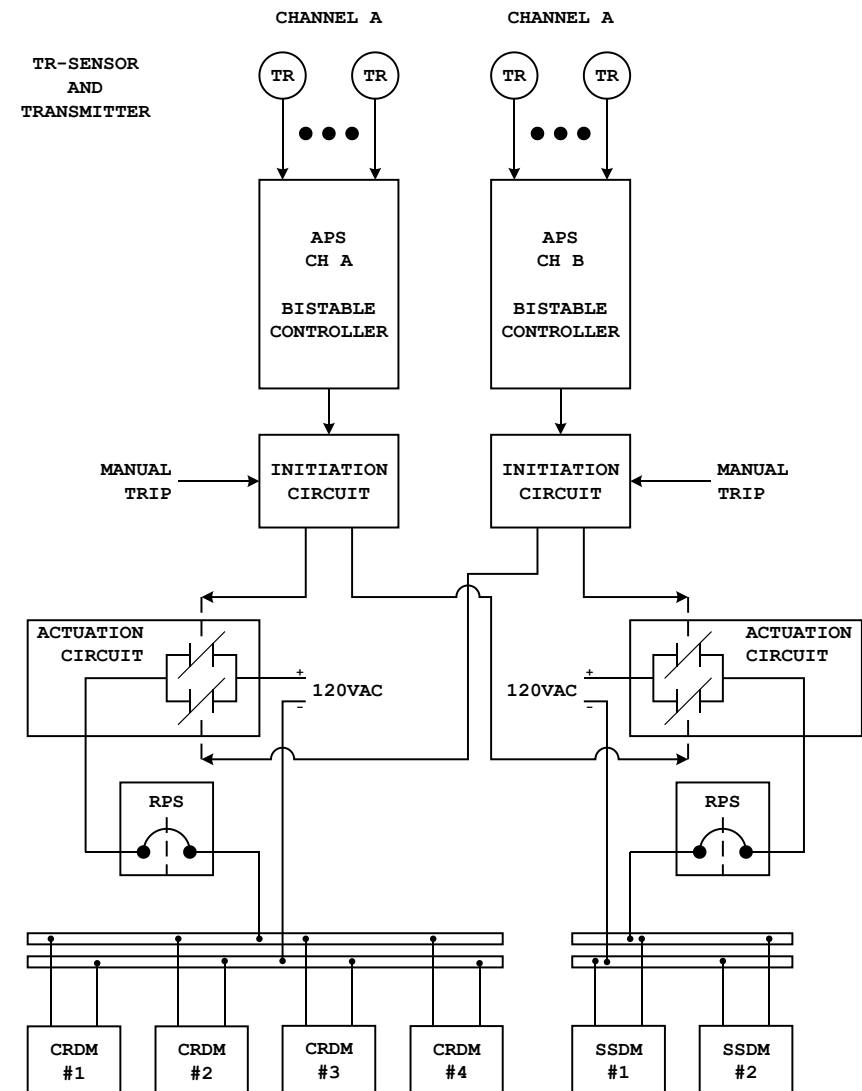
- Safety Class: 3
- Seismic Category: I
- Quality Class: Q



# Alternate Protection System (1)

## □ Design Features

- Diverse protection against a CCF of RPS
- Two Redundant Channels with 2-out-2 Coincidence Logic
- Physical separation and electrical isolation from the RPS
- Manual initiation
- APS trip parameters to be selected by DID & Diversity (D3) analysis
- No credit in safety analysis



## Bases on Classification

- ▶ Diverse mean to act against the software CCF of RPS, which is **beyond design basis accident** (Not for DBA)
- ▶ USNRC-0800 (SRP) allows it **non-safety feature but a special QA requirements** as per NRC Generic Letter 85-06 under 10CFR 50.62.
- ▶ Korean (US-based) practice on the non-safety ATWS to NPPs
- ▶ A safety-grade second protection system need **not a mandatory** but an option depending on the characteristics of research reactor.



## Classification

- ▶ Safety Class  
**NNS** from Korean (US) regulation  
Item important to safety (**safety related**) from IAEA
- ▶ Quality class : **T**
- ▶ Seismic category : **Non-Seismic**



# Post Accident Monitoring System (1)

## □ Design Features

- 2 Redundant Channels
- Digital computers
- Critical analog displays in SCR

## □ Classification

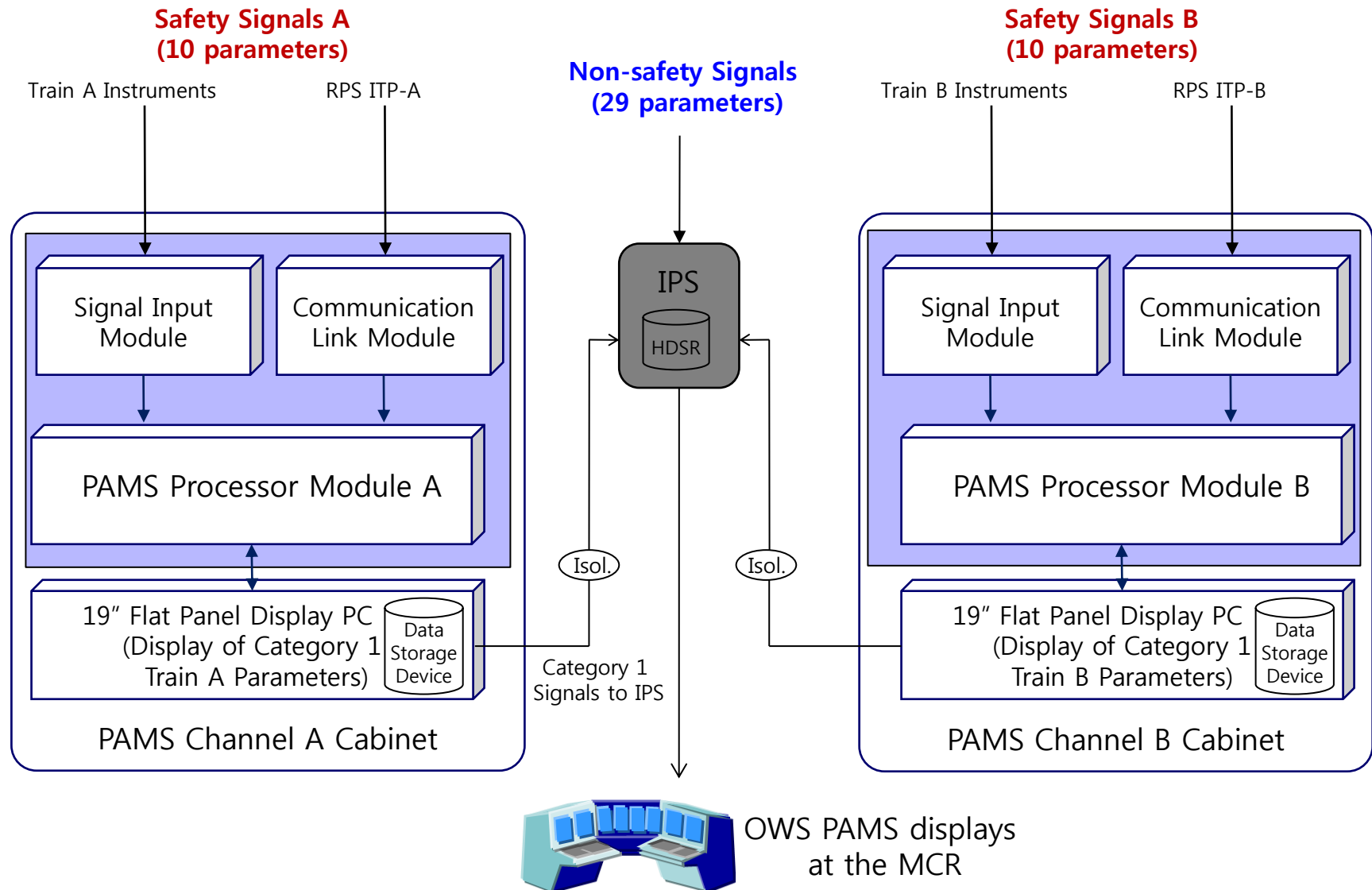
- Safety Class: 3
- Seismic Category: I
- Quality Class: Q

*"10 Safety Parameters"*

*"23 Non-safety Parameters"*

Type	Subgroup	Category	PAMS Variables
Type A	Plant Specific	-	N/A
Type B	Reactivity Control	1	Ex-core neutron
		1	PCS flow
	Core Cooling	1	Core differential pressure
		1	Reactor outlet temperature
		1	PAMS pool level
		1	Flap valve 1 position
		1	Flap valve 2 position
Type C	Confinement Integrity	1	Confinement isolation damper position
	Fuel Cladding	1	Pool surface radiation
Type D	PCS Boundary Integrity	1	PCS neutron (FFDS)
	Reactivity Control	3	CAR 1 down position
		3	CAR 2 down position
		3	CAR 3 down position
		3	CAR 4 down position
		3	SSR 1 down position
		3	SSR 2 down position
	Core Cooling	2	EWSS pool level
		2	Pool water temperature
		3	Flap valve 1 position
		3	Flap valve 2 position
	Auxiliary/Emergency Water Supply System	2	EWSS flow
		2	EWSS injection valve position
		3	DWST water level
		3	Service pool water level
	RCI Ventilation	3	Service pool water temp.
		2	RCI ventilation recirculation mode
		2	EPS status
Type E	Power Supplies	3	EPS oil status
		2	UPS status
	Area Radiation	2	Reactor hall gamma activity
	Airborne Radioactive Materials Released from Plant	2	Stack particulate activity
		2	Stack iodine activity
		2	Stack noble gases activity

# Post Accident Monitoring System (2)



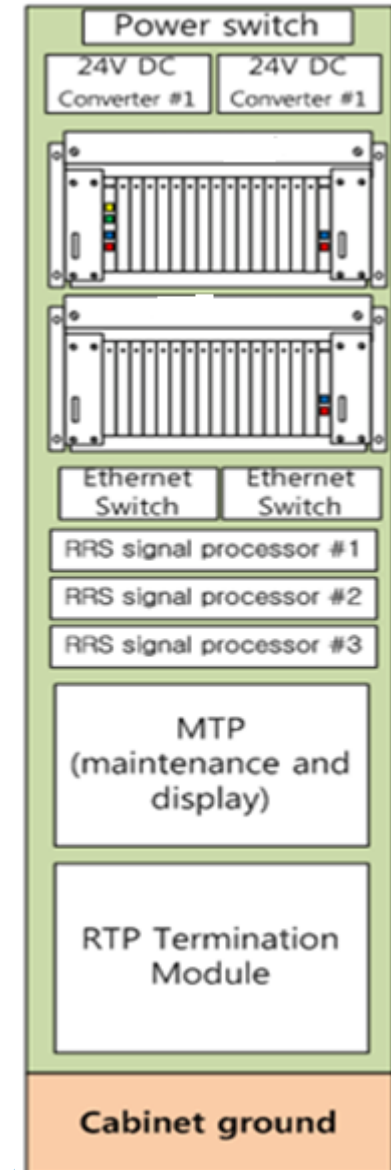
# Reactor Regulating System

## ☐ Design Features :

- Dual redundant system
- Reactor power control using a closed loop feedback control algorithm
- Stepping motor mechanism

## ☐ Classifications :

- Safety Class : Non-nuclear safety
- Seismic Category : Non
- Quality Class : T



# Process Instrumentation & Control system

## □ Design Features :

- Dual Redundant digital computer system
- Control of process systems' equipment (pumps, valves, fans, heaters and etc.)
- Continuous monitoring of process
- Data and Alarm processing
- No credit in safety analysis

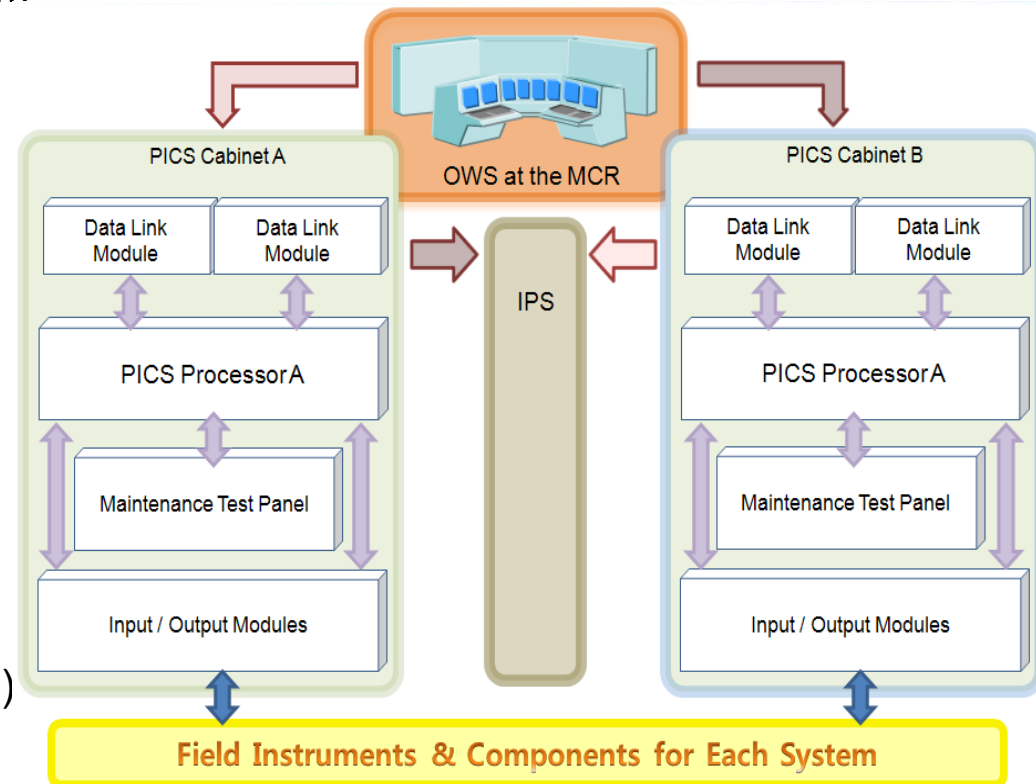
## □ Classification :

- Safety Class

Non Nuclear Safety from Korean regulation

Item important to safety (**safety related**) from IAEA

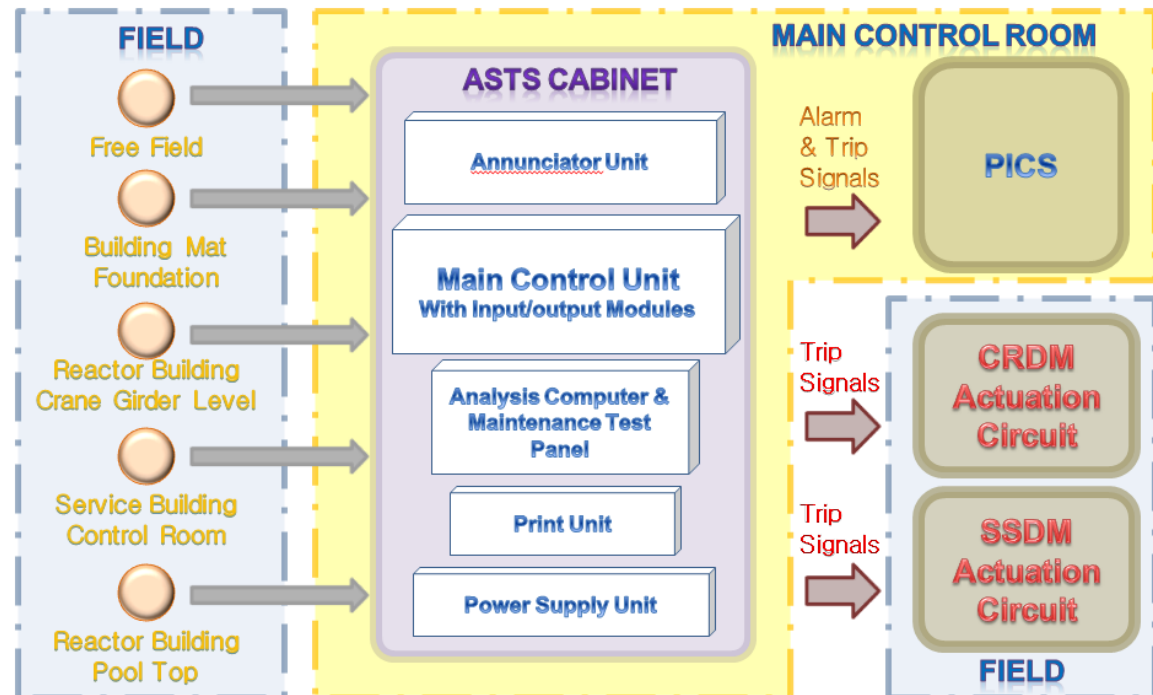
- Seismic Category : Non Seismic
- Quality Class : T



# Automatic Seismic Trip System (1)

## □ Design Features

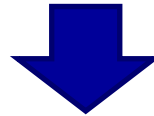
- Reactor trip if the earthquake motion exceeds the level of OBE at the site.
- Monitoring and analysis of the seismic motion of the site in a continuous basis.
- Major components of ASTS
  - Five (5) tri-axial accelerometers
  - One (1) seismic switch for OBE
  - One (1) ASTS cabinets



# Automatic Seismic Trip System (2)

## Bases on Classification

- ▶ Earthquake is classified to a special event (**not a DBA**), which is not required safety SSCs in the Korea regulations.
- ▶ ASTS component considered **to be at mild conditions** during the earthquake
  - ☞ No need to apply the EQ requirements for safety system but enough with seismic qualification
- ▶ USNRC RG1.12 & ANS 2.2 considered enough as the SMS(Seismic Monitoring System for power plant. ( No requirement of shutdown at earthquake)
- ▶ Korean (US-based) practice on the non-safety ASTS to NPPs



## Classification

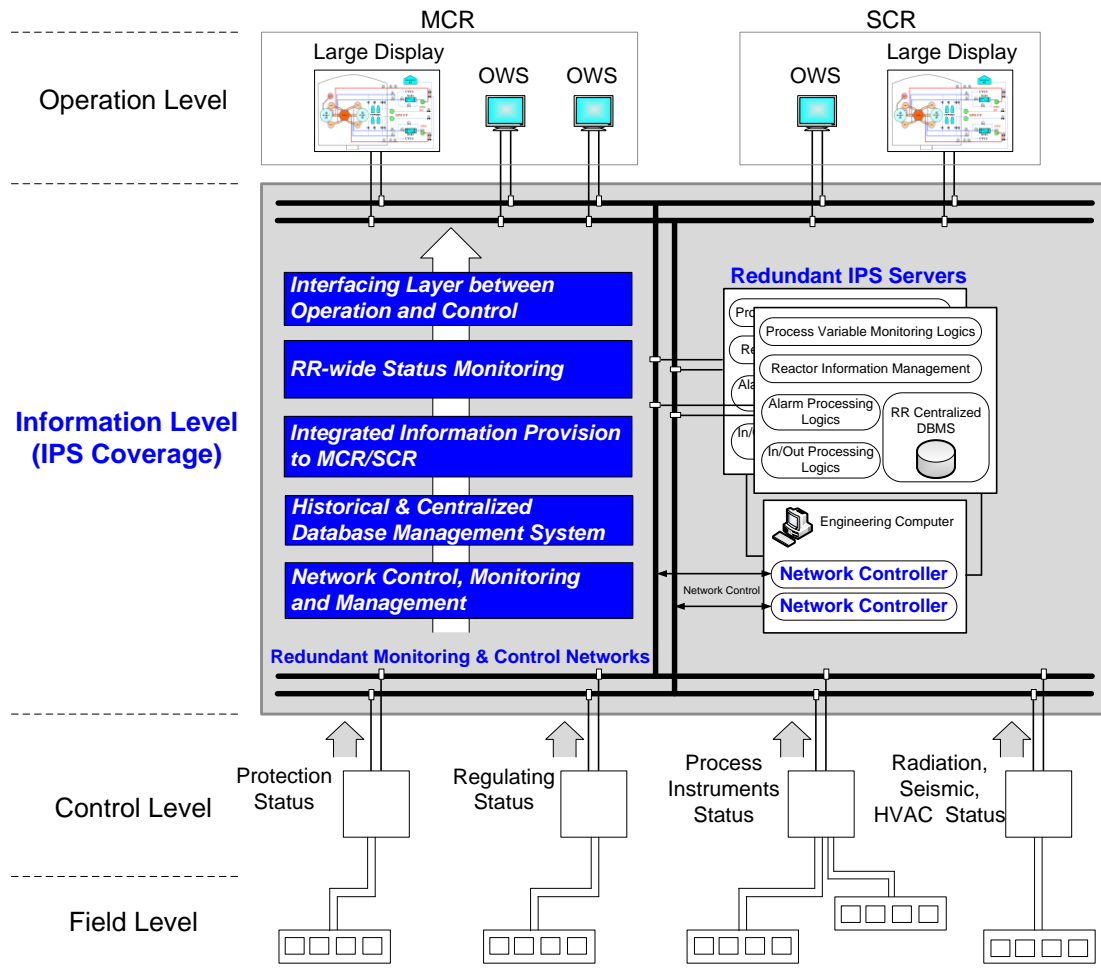
- ▶ Safety Class
  - NNS** from Korean (US) regulation
  - Item important to safety (**safety related**) from IAEA
- ▶ Quality class : **T**
- ▶ Seismic category : **I**



# Information Processing System (1)

## □ Design Features

- Plant information processing (collecting, recording, retrieval)
- Alarm processing
- Providing key process variables to ERFs
- Redundant architecture for high availability
- Isolation from safety systems



## Bases on Classification

- ▶ No safety functions (No credit in safety analysis)
- ▶ Comparison & Korean practice



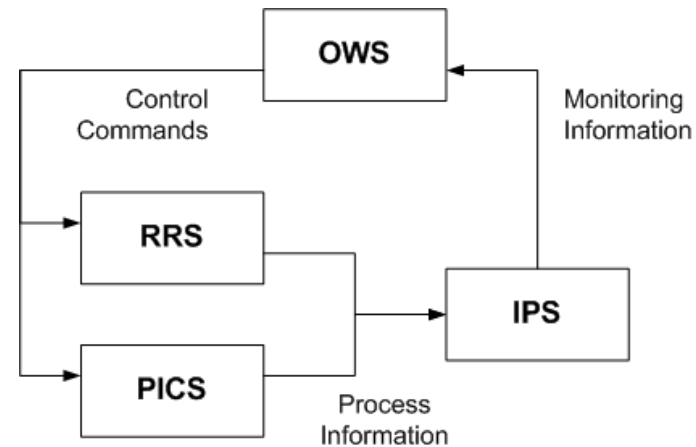
## Classification

- ▶ Safety Class  
**NNS** from Korean (USNRC) regulation  
**Safety Related from IAEA**
- ▶ Quality class : **T**
- ▶ Seismic category : **II** (Operator security)

# Operator WorkStation (1)

## ● Functions

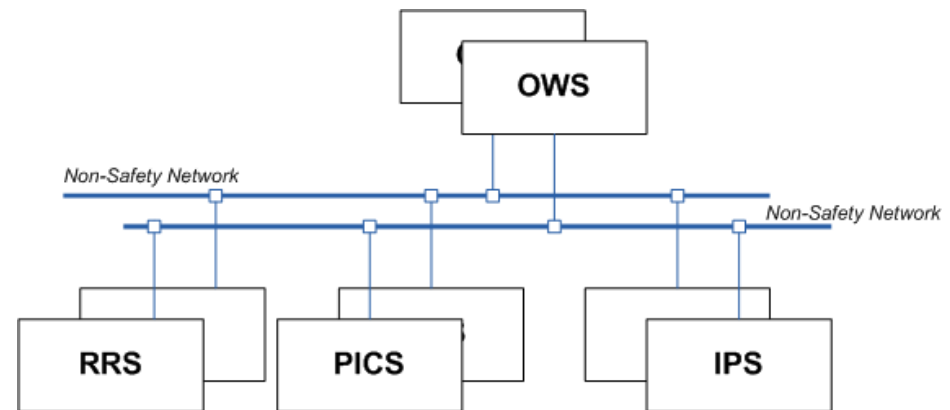
- To display monitoring information received from IPS
- To display control interfaces for control commands to be sent to RRS and PICS



< Data flow diagram >

## ● Interfacing Systems via non-safety networks

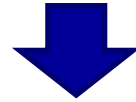
- IPS: monitoring information
- PICS: control commands
- RRS: control commands



< Interfacing systems via networks>

## Bases on Classification

- ▶ No safety functions (No credit in safety analysis)
- ▶ Korean practice



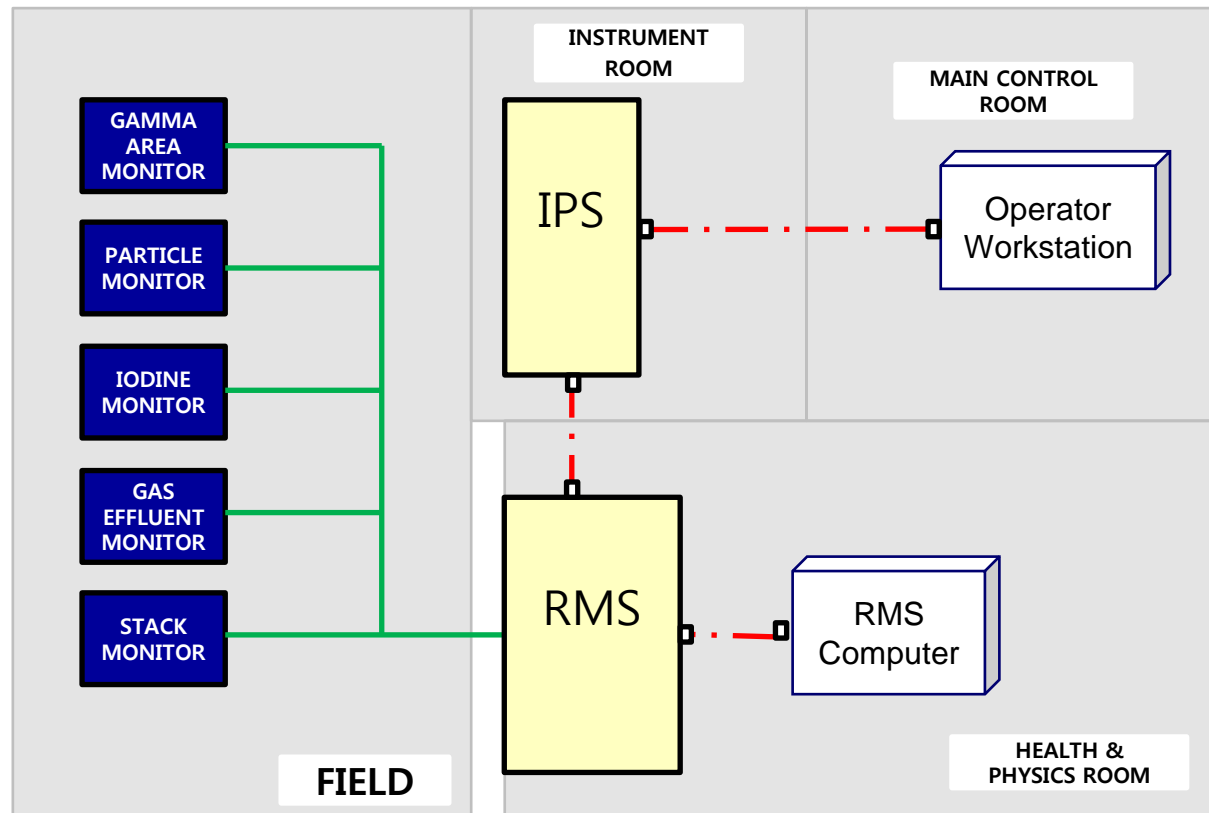
## Classification

- ▶ Safety Class  
**NNS** from Korean (USNRC) regulation  
**Safety Related from IAEA**
- ▶ Quality class : **T** (Reinforcing QA activities required)
- ▶ Seismic category : **II** (Operator security)

# Radiation Monitoring System (1)

## □ Design Features

- Measuring, indicating and alarming radiation level to H/P room and MCR
- Data Acquisition
- Functions of monitors
  - Gamma Area monitoring
  - Gas effluent monitoring
  - Stack monitoring
  - Iodine monitoring
  - Particle monitoring
- Safety-related monitors designated to RPS
- Independent network
- Local alarms



## Bases on Classification

- ▶ No safety functions (No credit in safety analysis)
- ▶ All the safety related radiation channels (RGMS, PNMS, PRMS, PGMS) are classified to safety class as the RPS trip parameters



## Classification

- ▶ Safety Class  
**NNS** from Korean (USNRC) regulation  
Item not important to safety from IAEA
- ▶ Quality class : **S**  
※ The effluent monitoring channels are the quality class T.
- ▶ Seismic category : **Non-Seismic**



# Concluding Remarks

System	Safety Class		Seismic Category	S/W Class	Quality Class	Remark
	USNRC	IAEA				
RPS	SC-3	Safety system	I	SC	Q	
PAMS	SC-3	Safety system	I	SC	Q	
RRS	Non-Safety	Safety related	Non	NS	T	
APS	Non-Safety	Safety related	Non	ITS	T	
IPS	Non-Safety	Safety related	Non	NS	S->T	Quality Upgrade
ASTS	Non-Safety	Safety related	I	ITS	T	
PICS	Non-Safety	Safety related	Non	NS	S->T	Quality Upgrade
RMS - Area Monitor	Non-Safety		Non	NS	S	
RMS – Effluent Monitor	Non-safety	Safety related	Non	NS	S->T	Quality Upgrade
OWS	Non-Safety	Safety related	II	NS	S->T	Quality Upgrade
LDP	Non-Safety		II	NS	S	