

국민에게 신뢰받는 안전 최우선의 KINS

Introduction to NPP system

System basic

Electrical system summary



Contents

I

Electrical System Outline

II

Off-site Power System

III

On-site Power System

IV

EDG/AAC DG

국민에게 신뢰받는 안전 최우선의 KINS

I. Electrical System Outline

1. Electrical System Outline

- **Voltage classification (based on Shin-Kori Units 3 and 4)**

Voltage(AC)		Voltage(DC)
Off-site	On-site	
765kV	24kV	125V
345kV	13.8kV	250V
154kV	4.16kV	
	480V	
	208V	
	120V	

1. Electrical System Outline_Function

- ◆ **Transmitting the power produced by the main generator to the outside through the peripheral voltage and the switch yard**
- ◆ **Power supply to safety related equipment**
 - Supply via 765 kV switchyard, unit auxiliary transformer (UAT)
 - Supply via 154 kV switchyard and stand-by auxiliary transformer (SAT)
 - Power supply to safety-rated power source via EDG/AAC DG
- ◆ **Power supply to non-safety related equipment**
 - Supply via 765 kV switchyard, main transformer, unit auxiliary transformer (UAT)
 - Supply via 154 kV switchyard and stand-by auxiliary transformer (SAT)
 - Power supply to non-safety grade power source through N-1E DG (limited to turbine auxiliary system)

1. Electrical System Outline_Components

• Off-site Power system

- 765 kV Switchyard(Voltage varies by power plant: 765, 345, 154 kV)

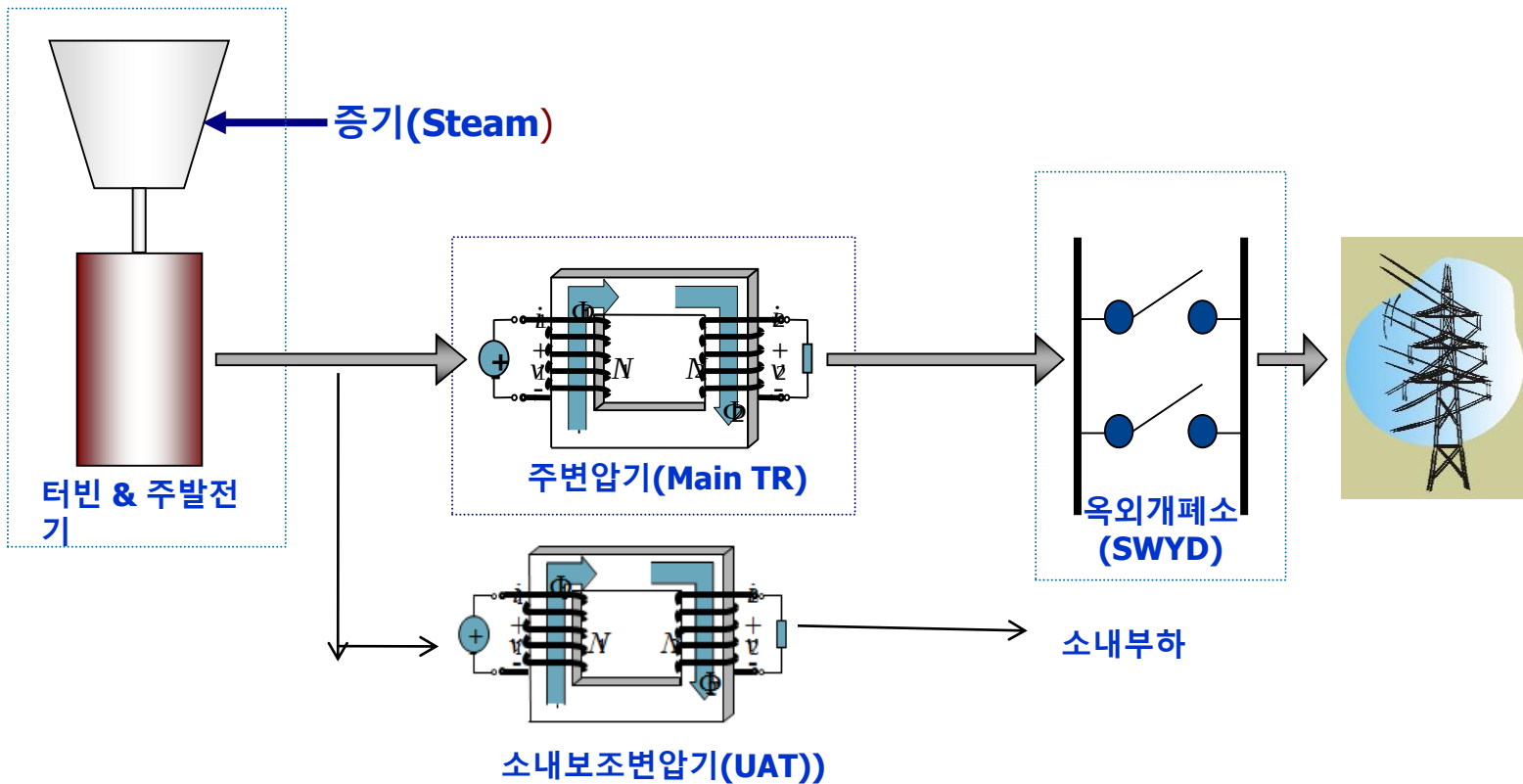
• On-site Power system

- Main Power System: Main generator, Main transformer
- 13.8 kV Switchgear
- 4.16 kV Switchgear
- 480 V Load Center
- 480 V Motor Control Center
- I&C Power System
- DC power supply system

• EDG/AAC DG

1. Electrical System Outline

• Power generation and transmission path



1. Electrical System Outline

◆ Main components

Equipment	Capacity
Generator	24kV/43,000A/1,690MVA(Hydrogen Pr. 75psig)
GCB	230kA
Main Transformer	$Y/\Delta(\frac{800}{\sqrt{3}}\text{kV}/24\text{kV})/1,670\text{MVA}/1,870\text{MVA}$
Aux Transformer	UAT: 58MVA, SAT: 56MVA
Emergency Power	EDG: 8000kW, AAC DG: 7200kW, Non-1E DG: 700kW
Switchgear	○ Safety 4.16kV: 4면 ○ Non-safety 4.16kV: 4면 ○ Non-safety 13.8kV: 4면
LC/MCC	○ LC: Safety/Non-safety 480V ○ MCC: Safety/Non-safety 480V
Switcho-yard	○ 765kV, 154kV GIS

국민에게 신뢰받는 안전 최우선의 KINS

II. Off-site Power System

2. Off-site Power System _SWYD

◆ Function

- Transmitting the power produced by the power plant to the power transmission system
- Supplying off-site power to the AC distribution system in the power plant

◆ Components

- Power Transformer
- Circuit Breaker
- Disconnect Switch
- Earthing Switch
- Lightning Arrester
- Current/Potential Transformer
- Gantry Tower, Take off tower
- Protection, control and power supply facilities

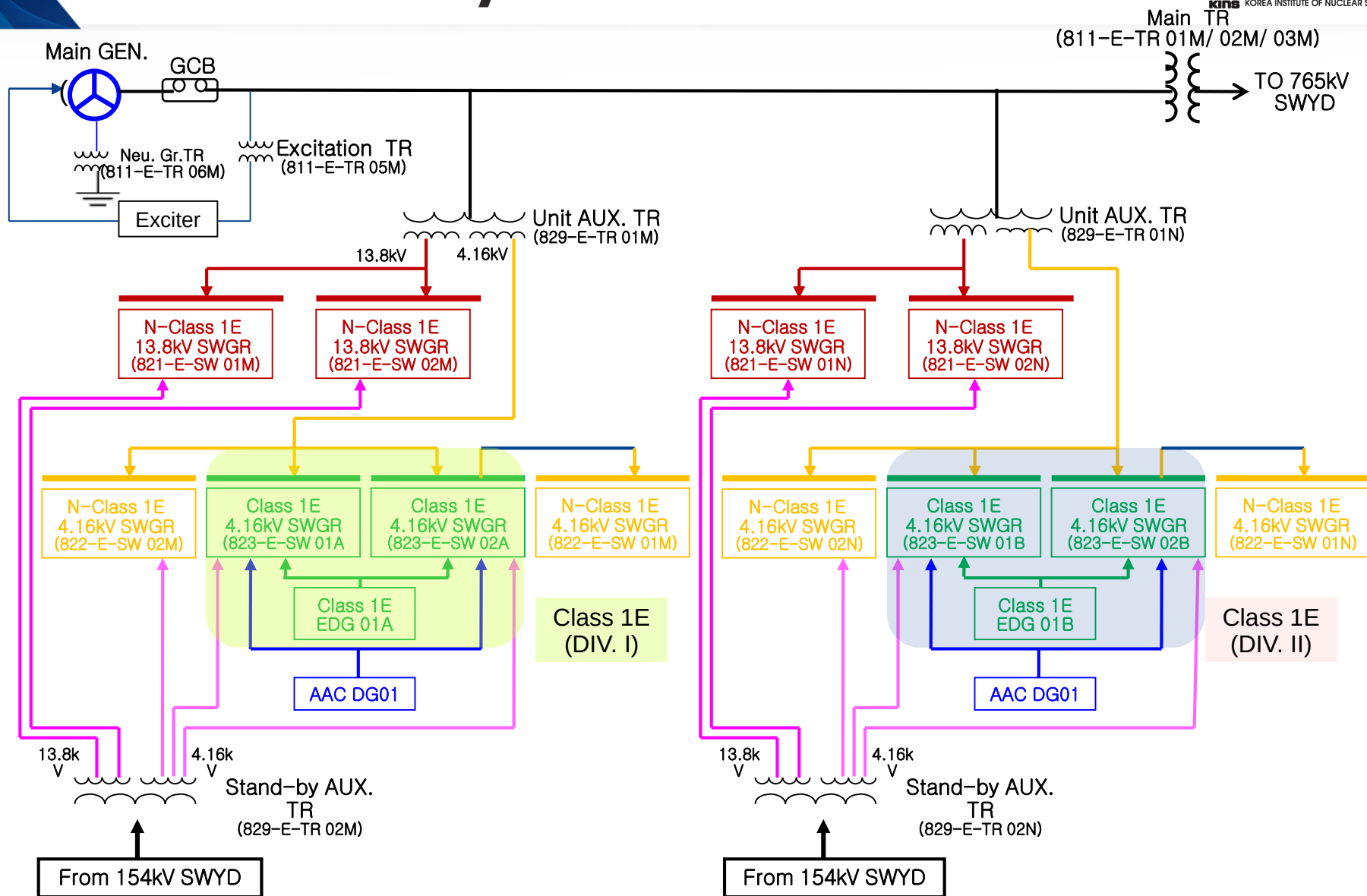
2. Off-site Power System _SWYD

- ◆ **Configuration method and main design features**
 - **1.5 Breaking method**
 - 3 breakers per 2 feeders are used for double busbars (shared interruption breakers)
 - **GIB Type SWYD**
 - **SWYD voltage: 154/345/765 kV mixing**
 - **Transmission and reception via 765 kV SWYD**
 - **Power supply on site through SAT from 154 kV SWYD**

국민에게 신뢰받는 안전 최우선의 KINS

III. On-site Power System

On-site Power System Outline



3-1. On-site Power System_AC

◆ Function

- Reliable power supply to loads required for power plant safety and operation

◆ Composition

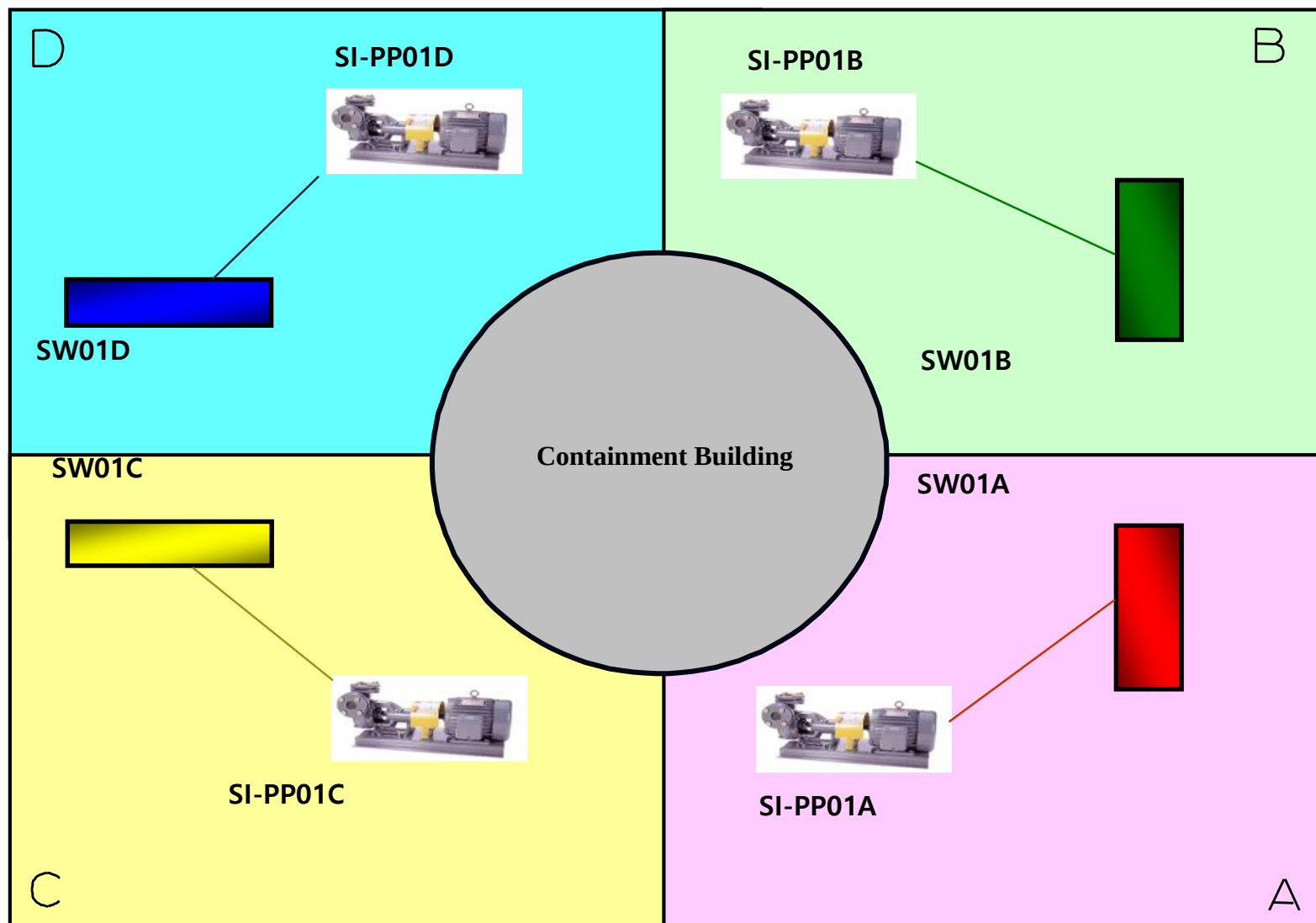
- Main Power System: Generator-GCB-Isolated phase bus(IPB)
 - Equipment including main transformer, control equipment, protection equipment
- Aux-Power System
 - All on-site AC systems except the main power system
 - Consists of 4 channels of 2 series (Div. I/II) identical to the emergency core cooling system
 - UAT/SAT, Power distribution equipment(SWGR, L/C, MCC 등),
On-site standby power (EDG, AAC D/G, Non-E D/G)
- DC/IP(UPS) system: Class 1E Consists of 4 independent channels (A, B, C, D)
Non-Class 1E Div. I/II 2 channels

3-1. On-site Power System_Load by power

- ◆ **4.16 kV – Composed of 4 sides (per unit) based on high-voltage breaker**
 - 250-2,750 (HP) large electric motors
 - Main loads: SIP, AFWP, CSP, CHG PP, CCWP, ESWP, SCSP
 - Control power: C-1E 125V DC power

	SW01A	SW01B	SW02A	SW02B
Main load	SI 펌프 02A ESW 펌프 01A AF 펌프 02A 충전펌프 01A SC 펌프 01A CCW 펌프 01A 필수냉방기 01A	SI 펌프 02B ESW 펌프 01B AF 펌프 02B 충전펌프 01B SC 펌프 01B CCW 펌프 01B 필수냉방기 01B	SI 펌프 02C ESW 펌프 02A CS 펌프 01A CCW 펌프 02A 필수냉방기 02A	SI 펌프 02D ESW 펌프 02B CS 펌프 01B CCW 펌프 02B 필수냉방기 02B

3-1. On-site Power System _C-1E load placement



3-1. On-site Power System _ Load by power

- ◆ **N-1E 13.8 kV – Composed of 4 sides based on high-voltage breaker**
 - A large-capacity motor of 3,000 (HP) usually
 - Main loads: RCP, COP, MFWBP, CWP
 - Control power: N-1E 125V DC power

	SW01M	SW01N	SW02M	SW02N
Main load	RCP 01A RCP 02A	RCP 01B RCP 02B	COP 01P CWP 01P, 03P CWP 05P FW booster P/P 01 FW booster P/P 03	COP 02P, 03P CWP 02P, 04P CWP 06P FW booster P/P 02 Start-up P/P

3-1. On-site Power System _ Load by power

- ◆ **N-1E 4.16 kV – Composed of 4 sides based on high-voltage breaker**
 - 250~2,750(HP) large electric motors
 - Main load: AAC DGsub-system, CV chilled water, air compressor, TBCCW air conditioner for complex building
 - Control power: N-1E 125V DC power

	SW01M	SW01N	SW02M	SW02N
Main load	Central CH 1, 2	Central CH 3, 4	TGBCCW P/P 1	TGBCCW P/P 2

3-2. On-site Power System _DC

◆ Function

- DC MOV
- I&C
- Turbine/Generator Emergency Load
- Some emergency lighting circuits

◆ Composition

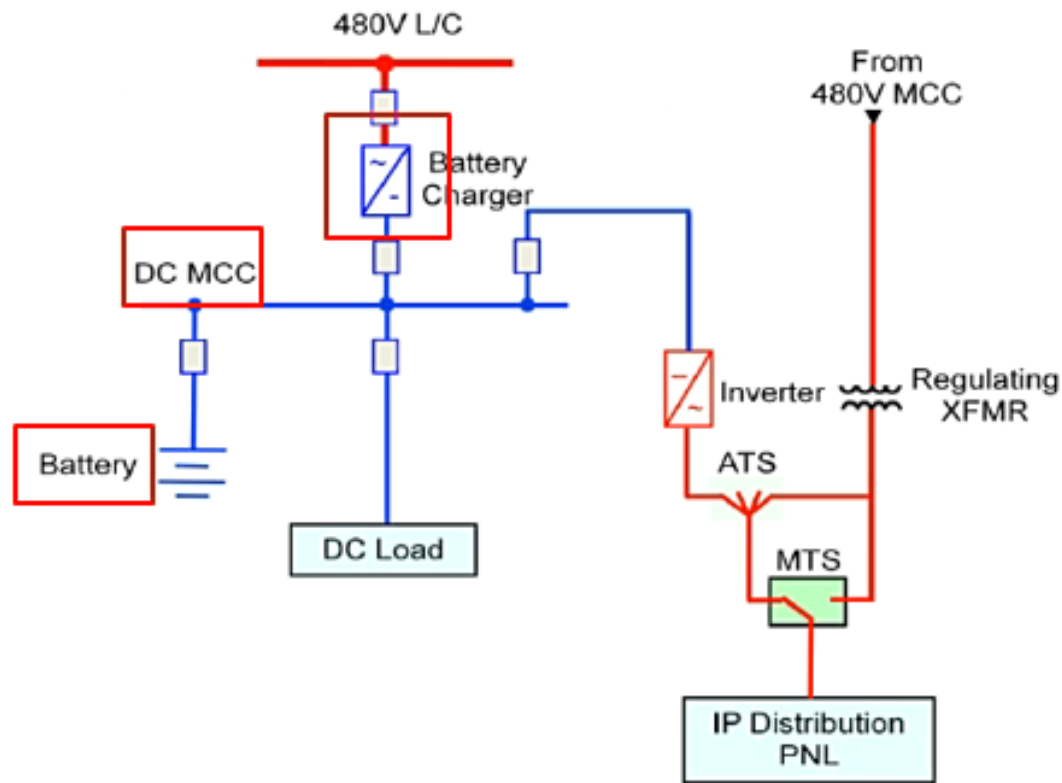
- C-1E 125V DC
- N-1E 125V DC
- N-1E 250V DC

전 원	부하명	위 치
Class 1E 125V DC (호기당)	3-841-E-MC01A	AB 78'(DIV. I)
	3-841-E-MC01C	AB 78'(DIV. I)
	3-841-E-MC01B	AB 78'(DIV. II)
	3-841-E-MC01D	AB 78'(DIV. II)
전원	부하명	위치
N-1E 250VDC (호기당)	3-841-E-MC02N	TBN 100'
10000 0000 00 N-1E 125VDC (호기당)	3-841-E-MC01M	AB 100'
	3-841-E-MC01N	
N-1E 125VDC	0-841-E-MC01N	CPB 120'
(공용건물)	0-841-E-MC02N	AAC DG 100'

3-2. On-site Power System _DC

◆ Composition

- Battery charger: 480V AC current supply
- Battery
- DC control panel



3-2. On-site Power System _DC_N-1E

◆ 125V N-1E DC Function

- N-1E class measurement, control, information processing system
- C power to 125V DC, 120V AC inverter

◆ 250V N-1E DC Function

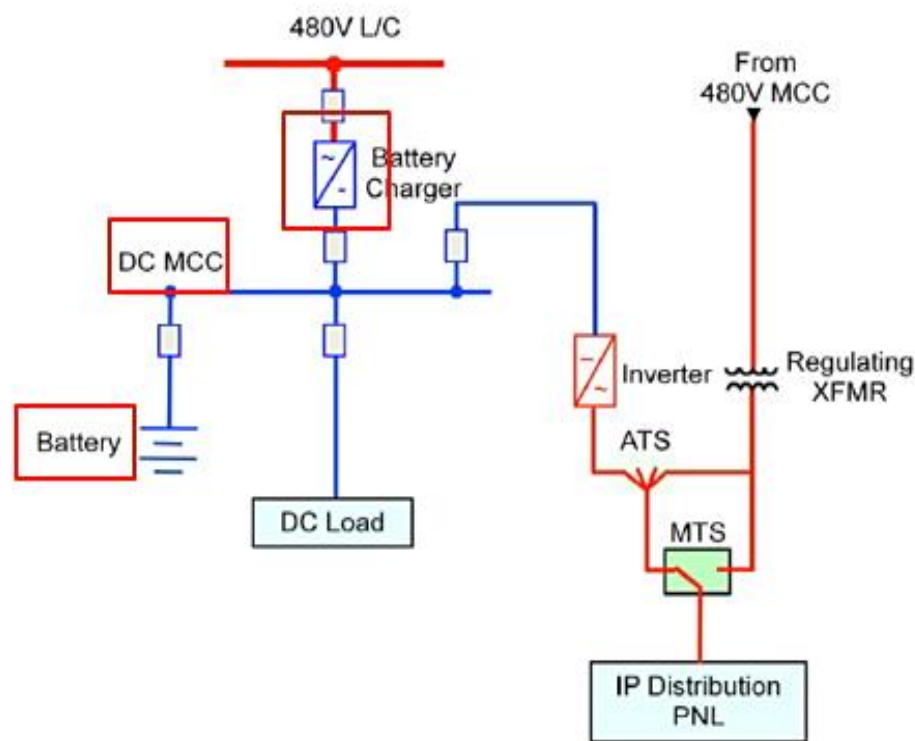
- Supplying power to a DC load with high current used as an aftermarket for the AC load

3-3. On-site Power System _Instrument power system

- ◆ **Consists of 4 independent 120V AC distribution boards**
 - Powering equipment requiring uninterruptible power
 - At rated full load with a power factor greater than 0.8, the output frequency is $60\text{Hz} \pm 0.5\%$, and the voltage fluctuation is designed within $\pm 2\%$.

- ◆ **Composition**

- Inverter
- voltage regulation transformer
- Manual and automatic transfer switch



국민에게 신뢰받는 안전 최우선의 KINS

IV. EDG/AAC DG

4. EDG/AAC DG

◆ Function

- In case of loss of off-site power accident (LOOP) or engineering safety facility operation signal (ESFAS), the emergency power required for essential load operation of the primary system requiring the following requirements within 17 seconds (10 seconds for standard type) is supplied to the on-site safety bus (C-1E). SWGR BUS)
 - Safely trip the reactor
 - Maintaining the reactor in a safe shutdown condition where off-site radiation exposure can be sustained within the 10CFR100 limit
 - At the discretion of the operator, power supply to selected critical non-safety class (N-1E) loads, such as pressurizer heaters.

4. EDG/AAC DG

◆ Rating

- **Consecutively(22hr) : 6,500 kW, Short time(2hr): 7,150 kW (OPR)**
8,000 kW/8,800 kW (APR)
- **Voltage, Frequency: 4,160 V, 60 Hz**
- **Revolution: 1,200 rpm**

◆ Composition

- **Fuel system, Low-temp. cooling water(LT) system, High-temp. cooling water(HT) system, Starting air system, Lube-oil system, Combustion air intake and exhaust system**

4. EDG/AAC DG

◆ Stop signal(Normal operation)

- Excitation loss, generator overvoltage/undervoltage, generator phase imbalance, generator low frequency, generator voltage restraint overcurrent, generator bearing high temperature, generator overcurrent, excitation fault, generator grounding overvoltage, generator reverse power, electrical overspeed, low temperature water pressure-low, engine Lubricating oil pressure-low, engine lubricating oil level-low, engine crank pressure-high, engine fuel oil single tank oil level-low-low, engine fuel oil pressure-low

◆ Stop signal(Emergency operation)

- Bypass most trip conditions
- Engine overspeed, Generator differential protection, Emergency stop push button, Stop lever

4. EDG/AAC DG

◆ Load Sequence

- 1 step(0 sec): EDG PCB Close
- 2 step(5 sec): HPSI PP
- 3 step(10 sec): AFWP
- 4 step(15 sec): CSP
- 5 step(20 sec): LPSI PP, CSP
- 6 step(25 sec): CCW PP
- 7 step(30 sec): ESW PP
- 8 step(35 sec): ECW CH
- 9 step(40 sec): CSP, AFWP

4. EDG/AAC DG

◆ Comparison of on-site generators

항 목	비상디젤발전기(EDG)	대체교류전원(AAC)	비안전급 디젤발전기
정 격	■ 4.16kV, 6000kW	4.16kV, 6000kW (APR : 7200kW)	■ 0.48kV, 600kW
구 성	■ 2대(Div. A/B 각 1대)	■ 1대(2호기 공용)	■ 1대(Div. A/B 공용)
기 능	소외전원 상실(LOOP *) 시 발전소 안전정지에 필요한 부하에 전력공급	<u>소내</u> 및 소외 전원 완전 상 실(SBO*)시 비상정지에 필 요한 부하에 전력공급	교류전원 상실시 T/G, 통신설비, 컴퓨터 등의 부하에 전력공급
설 계 기 준	전원상실 이후 10초 이내 기동(APR 1400은 22초) "Q" Class, 내진해석 적용	SBO 이후 10분 이내에 기동 "R"/"T" Class, <u>비내진해석</u>	기준 없음
운전방식	자동	수동	자동
설치근거	- Reg.Guide 1.32 - IEEE 308	Reg. Guide 1.155	없음

Thank You

