

# Development of Multi-Alarm Pattern Card for an Effective Selection of Abnormal Operation Procedure in MCR



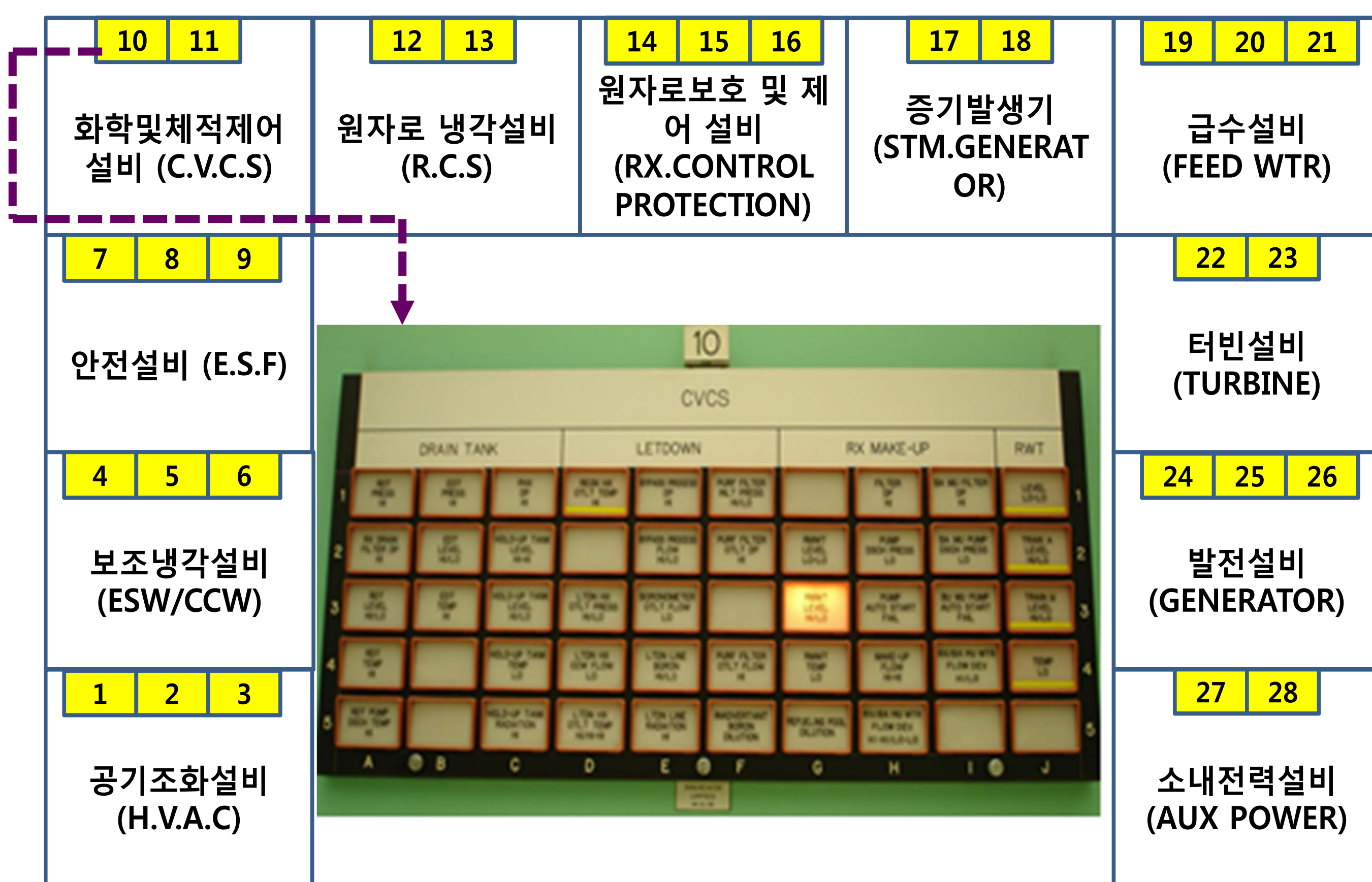
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## Purpose of Paper

- To develop a multi-alarm pattern card to select an appropriate AOP effectively when multiple alarms occur in a single upper layout (UL) of an MCR
- It can be applied for an operation support tool as well as an education tool

## MCR Alarm Window



UL Configuration of an OPR 1000 & Alarm Configuration of UL-10

## Key Point of Multi-Alarm Pattern Card

- It is not well organized for operators to select a proper AOP from alarms occurring in an MCR during an abnormal plant status
  - The number of AOPs are too much
  - Relation between AOPs and multi-alarms is complicated
- When multiple alarms related to a subcategory of causes of an abnormal status occur in a single UL, it will be more effective to select a proper AOP

## Multi-Alarm Pattern Card

INST AIR (IA)	MAIN TURBINE (TA)						TURBINE EHC (TH)		MISC			
1 RECEIVER DSCH HDR PRESS LO	DIFF EXPANSION HI	LP EXH HOOD VACUUM LO	BRG VIBRATION HI TRIP	MASTER TRIP BUS TRIPPED	TURBINE TRIPPED	HFP 01/02 DSCH FLTR DP HI	HYD FLUID PMP DSCH PRESS HI	GC SYSTEM CLG WTR CDTY HI	GEN PROTECTION CIRCUIT ENERGIZED	TC SYSTEM SEAL OIL PRESS LO		
2 COMPRESSOR 01 /DRYER VLV TRIP	STEAM SEAL HDR PRESS LO	TURNING GEAR TROUBLE	LP EXH HOOD TEMP HI TRIP	BRG VIBRATION HI	MARK V POWER LOSS	TBN OVERSPEED TRIP	HFP 01/02 MTR OVERLOAD /TEMP HI	HYD FLUID AIR COOLER TROUBLE	GC SYSTEM CLG WTR TEMP HI	GC SYSTEM STATOR CLG WTR TROUBLE	TC SEAL OIL SYSTEM TROUBLE	
3 COMPRESSOR 02 /DRYER VLV TRIP	SPE FAN MOTOR STOP/TEMP HI	TURNING GEAR NOT ENGAGED	LP EXH HOOD SPRAY VLV OPEN	THRUST BRG WEAR HI TRIP	STEAM PKG EXH VACUUM LO	ELECTRICAL LOCKOUT VLV LOCKED	HYD FLUID TANK LEVEL HI-HI	HYD FLUID PUMP 01/02 NOT IN AUTO	GC SYSTEM PUMP 01/02 AUTO START	GEN GAS SYSTEM TROUBLE	TC SYSTEM ESOP PWR LOSS/MTR OVERLOAD	
4 CLCS COMMON TRBL	SYSTEM TRBL/DIS	VLV POSITION LIMIT LIMITING	POWER LOAD UNBALANCE ACTUATED	BRG METAL TEMP HI	GLOBAL ALARM	MECHANICAL LOCKOUT VLV LOCKED	HYD FLUID TANK LEVEL HI/LO	HYD FLUID PUMP 01/02 AUTO START	GC SYSTEM PUMP 01/02 TRBL/DIS	GEN LIQUID DETECTOR FULL	TC SYSTEM TRBL/DIS	
5 SYSTEM TRL/DIS	I/A CNMT ISOL VLV NOT FULLY OPEN	THROTTLE PRESS LIMIT LIMITING	MW LOAD LIMIT LIMITING	SHAFT ECC HI	TBN LOAD HOLD	CV #1 NO LOAD INTERLOCK	HYD FLUID TANK TEMP HI/LO	SYSTEM TRBL/DIS	GC SYSTEM LPO1 CONTROL POWER LOSS	SA SYSTEM TRBL/DIS	GEN SEAL OIL DP LO	

Example of Multi-Alarm Pattern Card for MCR Operation

**The Front**

INST AIR (IA)	MAIN TURBINE (TA)						TURBINE EHC (TH)		MISC			
1 RECEIVER DSCH HDR PRESS LO	DIFF EXPANSION HI	LP EXH HOOD VACUUM LO	BRG VIBRATION HI TRIP	MASTER TRIP BUS TRIPPED	TURBINE TRIPPED	HFP 01/02 DSCH FLTR DP HI	HYD FLUID PMP DSCH PRESS LO	GC SYSTEM CLG WTR CDTY HI	GEN PROTECTION CIRCUIT ENERGIZED	TC SYSTEM SEAL OIL PRESS LO		
2 COMPRESSOR 01 /DRYER VLV TRIP	STEAM SEAL HDR PRESS LO	TURNING GEAR TROUBLE	LP EXH HOOD TEMP HI TRIP	BRG VIBRATION HI	MARK V POWER LOSS	TBN OVERSPEED TRIP	HFP 01/02 MTR OVERLOAD /TEMP HI	HYD FLUID AIR COOLER TROUBLE	GC SYSTEM CLG WTR TEMP HI	GC SYSTEM STATOR CLG WTR TROUBLE	TC SEAL OIL SYSTEM TROUBLE	
3 COMPRESSOR 02 /DRYER VLV TRIP	SPE FAN MOTOR STOP/TEMP HI	TURNING GEAR NOT ENGAGED	LP EXH HOOD SPRAY VLV OPEN	THRUST BRG WEAR HI TRIP	STEAM PKG EXH VACUUM LO	ELECTRICAL LOCKOUT VLV LOCKED	HYD FLUID TANK LEVEL HI-HI	HYD FLUID PUMP 01/02 NOT IN AUTO	GC SYSTEM PUMP 01/02 AUTO START	GEN GAS SYSTEM TROUBLE	TC SYSTEM ESOP PWR LOSS/MTR OVERLOAD	
4 CLCS COMMON TRBL	SYSTEM TRBL/DIS	VLV POSITION LIMIT LIMITING	POWER LOAD UNBALANCE ACTUATED	BRG METAL TEMP HI	GLOBAL ALARM	MECHANICAL LOCKOUT VLV LOCKED	HYD FLUID TANK LEVEL HI/LO	HYD FLUID PUMP 01/02 AUTO START	GC SYSTEM PUMP 01/02 TRBL/DIS	GEN LIQUID DETECTOR FULL	TC SYSTEM TRBL/DIS	
5 SYSTEM TRL/DIS	I/A CNMT ISOL VLV NOT FULLY OPEN	THROTTLE PRESS LIMIT LIMITING	MW LOAD LIMIT LIMITING	SHAFT ECC HI	TBN LOAD HOLD	CV #1 NO LOAD INTERLOCK	HYD FLUID TANK TEMP HI/LO	SYSTEM TRBL/DIS	GC SYSTEM LPO1 CONTROL POWER LOSS	SA SYSTEM TRBL/DIS	GEN SEAL OIL DP LO	

**The Back**

- ◆ 3511A: Turbine Generator Trip
- ★ 3511B-1: Turbine High Vibration - Alarm before Turbine Generator Start
- ⊗ 3511B-2: Turbine High Vibration - Turbine High Vibration Alarm
- ▲ 3511B-3: Turbine High Vibration - Turbine High Vibration Trip
- △ 3513-1: Turbine Generator H2 Leak - H2 Leak by Turbine Generator Frame and Gas Piping
- 3513-2: Turbine Generator H2 Leak - H2 Leak by Abnormal Turbine Generator Seal Oil System
- ▶ 3513-3: Turbine Generator H2 Leak - H2 Leak through Stator Cooling System
- ▷ 3515A-1: Turbine Control Hydraulic Fluid Pressure Low/Leak - Control Hydraulic Fluid Pump Trip during Operation
- 3515A-2: Turbine Control Hydraulic Fluid Pressure Low/Leak - Control Hydraulic Fluid Supply Piping Rupture
- 3517: Loss of Stator Cooling
- ▼ 3518A-1: Loss of Generator Seal Oil - Main Seal Oil Pump Trip during Operation (MSOP : PP02)
- ▽ 3518A-2: Loss of Generator Seal Oil - Main/Emergency Seal Oil Pump Trip (MSOP : PP02/ESOP : PP01)
- ◀ 3518B: Loss of Seal Oil Float Trap Control
- < 3596A: Total Loss of Instrument Air IA 비정상(완전상실)
- ◆ 3596C: Air Compressor Trip/Surge

Example of Multi-Alarm Pattern Card for Education

SAFETY INJECTION(SI)										
						SIT 1A	SIT 1B	SIT 1C	SIT 1D	
						A	B	C	D	
1		LPSI PUMP 01A DSCH F	LPSI PUMP 01B DSCH F	HPSI HEADE IR 1 PRESS HI	HPSI HEADE	PZR PRESS HI	PRESS HI/HI-HI	PRESS HI/HI-HI	PRESS HI/HI-HI	PRESS HI/HI-HI
Subcategory ID	(AOP-3431A-RCS leak)	Subcategory Description		# of Alarms	# of ULs	OP 1 P LO LT OP	PRESS LO/LO-LO	PRESS LO/L O-LO	PRESS LO/L O-LO	PRESS LO/L O-LO
1	RCS Leak inside Containment			2	1	OP 2 P LO LT OP	LEVEL HI/HI-HI	LEVEL HI/HI-HI	LEVEL HI/HI-HI	LEVEL HI/HI-HI
2	PZR Safety Valve Leak			9	2	OL VLV OSE	LEVEL LO/LO-LO	LEVEL LO/L O-LO	LEVEL LO/L O-LO	LEVEL LO/L O-LO
3	PZR Safety Relief Valve Leak			4	2	SUCT LI OL VLV PEN	OTLT PRESS HI	OTLT PRESS HI	OTLT PRESS HI	OTLT PRESS HI
4	Reactor Vessel Flange Leak			1	1					
5	Safety Injection Tank Outlet Valve Leak			4	1					
6	SG tube leak			3	3					
Total				19	6					

Alarms Related with 'Safety Injection Tank Outlet Valve Leak' of AOP-3431A

## Conclusion

Site	Total Number of AOPs	Total Number of Subcategories of AOPs	Number of Subcategories Covered by Multi-Alarm Pattern Card	
			Number of Subcategories Covered	Coverage (%)
A	101	170	91	53
B	104	152	62	41
C	99	209	139	67
D	101	186	118	63
E	100	174	106	61

Coverage of Multi-Alarm Pattern Card against Abnormal Situations for OPR1000 Plants