

The improvement of PWR(OPR-1000) Local Control Panel

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1. Introduction

The KHNP(Korea Hydro & Nuclear Power Co., Ltd) have built KSNP(Korea Standard Nuclear Power Plant) and been operating from Hanbit unit 3,4 to Shin-wolsung unit 1, 2. Operators of NPP are divided MCR operator and field operators, the operators closely shared rapid information of the normal, abnormal and emergency situation of the plants to contribute safety operation.

The malfunction of feature in NPP could be occurred by physical aging, electrical false signal and natural disaster. The first recognition of malfunction is almost done by alarm system. Due to the importance of alarm system, design basis of alarm system is described in FSAR 18.1.4.20(alarm system design review). Operators can recognize malfunction of feature and importance of alarm in short distance. The sound of alarm is also changed depending on frequency so it contributes recognition of alarm. But the design of alarm was only applied in MCR alarm system. The white alarm lamp is supplied to the local control panel except some package feature. This system is not helpful in recognition of alarm for filed operators.

In this study, the way that FSAR(priority of alarm and color indication) is also applied on local control is suggested. The alarm sound considering field situation, alarm name, status indication in circuit breaker are suggested to improve overall local control panel. These can contribute to safety operation.

2. Methods and Results

2.1 The current situation of local control panel

2.1.1 The color of alarm panel

In Hanul unit 5 and 6, when malfunction is occurred, the alarm and alarm sound is designed to confirm that whether it's good or bad condition. The alarm control panel is presented in Fig 1. Although importance alarm such as "turbine tripped" is included, all of the alarm color is light green. It could not easily confirm whether it is critical alarm or not in short distance. So, it is necessary that operators can judge importance of alarm by only alarm color in short distance.

	A	B	D	E
1	TURBINE TRIP	TURBINE POWER BELOW 15%	DRAIN VALVES CTRL PWR LOSS	EXHAUST HOOD VACUUM LO
2		15% TEN LOAD SIG BYPASSED		
	A	B	D	E

Fig. 1. TBN AUX. SYS. LCP Alarm Tile

In Fig 2, the alarm color of CVCS is showed amber. But according to FSAR(Chart 18.1-3), The amber color alarm means that application of LCO or action needed instantly. This is not matched with FSAR, so it needed to be changed in white alarm.

	A	B	C	D
1	AUX. CHRG PUMP PKG LUBE WATER TROUBLE	AUX. CHRG PUMP AUX LUBE OIL TROUBLE	BAC ION EX DP HI	MAKE UP WATER FLOW HI
3	BA BATCHING TANK MIXER TROUBLE	HOLD UP PUMP PP11 TROUBLE		RWT HEATER HX01 TROUBLE
4	BA BATCHING TANK HEATER TROUBLE	HOLD UP PUMP PP12 TROUBLE	HOLD UP TK04 HT 01/02/03/04 TROUBLE	RWT HEATER HX02 TROUBLE
	A	B	C	D

Fig. 2. CVCS LCP Alarm Tile

2.1.2 The alarm sound of local control panel

The alarm of local control panel could be supplied not only visual recognition but also sense of hearing. In NPP, due to the various noise such as pump, fan and flow transfer in pipe, it is difficult to recognize the sound of local control panel. So, it is needed that the sound of local control panel is much higher about 10 dB than surrounding noise.

2.1.3 The alarm name of local control panel.

The consecutive year of shift operator is shorter than rule work operator especially harder in new built plant. In case of field operator(Hanul NPP 3), they are working less than 3years. In Fig 3, the name of local panel is difficult to understand for new employee, so it is necessary that the name of alarm has to be changed easily for employees who are working under 3years.

Supplier (EDG)	DG Set Bearing Temp 2nd Stage	The '2nd Stage' isn't understand
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Fig. 3. EDG LCP(one part of alarm name)

2.1.4 The marking of the circuit breaker number and location in status lamp.

There are many operating features in NPP. The variety of features are affected each other. The overall feature that directly influenced plant operation is controlled in MCR. The feature that relatively less influenced plant operation is controlled in local control panel. The feature that could control in local is started or stopped by hand-switch. The status of operation can easily confirmed by observing status lamp. In Fig 4, The red lamp means that this is operating now.



Fig. 4. Equipment Status Lamp

When status lamp is off condition due to the electrical signal false in circuit breaker, field operators could check for circuit breaker depending on priority and have to reset the false signal instantly. But in Fig 4, the location of circuit breaker is not indicated in status lamp. So we don't know that the location of circuit breaker unless confirming other diagram to check location. If the indication of circuit breaker is indicated in status lamp, operators could find the location more instantly than before. It helps operators to proper respond in plant condition.

2.2 The improvement of local control panel

2.2.1 The change color of local control panel

The Fig 5 shows that the change of alarm color according to FSAR chart 18.1-3, the Fig 6 shows that examples for change of alarm color.

구분	변경안		
	우선순위	색	적용
A E	1	적색	발전정지, 공학적 안전설비 동작, 방사능 누출
	2	호백색	TS 적용, 적시조치 필요
	3	흰색	기기또는 계통의 문제점 단순표시
FSAP 표 18.1-3(경보창 우선순위 색깔표식)에 따라 구분			
공급사	경보명에 따른 기기연동 등을 고려, 필요시 색 변경		

Fig. 5. The change of alarm color according to FSAR chart 18.1-3

구분	변경前	변경後	변경사유
AE (터빈)	EXHAUST HOOD VACUUM LO	EXHAUST HOOD VACUUM LO	터빈정지와 연관
공급사 (각급건물 냉방기)	BEARING TEMP. HIGH	BEARING TEMP. HIGH	기기정지와 연관 (냉방기 정지신호)

Fig. 6. Examples for change of alarm color

2.2.2 The alarm sound of local control panel

The Fig 7 shows the surrounding noise data that detected in local. The data indicates that if the alarm sound can be controlled 10 dB higher than surrounding noise, it could be possible to recognize alarm sound by just local sound.

LCP Name	Surrounding [dB]
CVCS LCP	85
SGBD LCP	92
TBN SYS. LCP	88
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MFWPP TBN LCP	95
CPP LCP	88
EDG LCP	84
MCR HVAC LCP	78/87

Fig. 7. Surrounding noise data that detected in field

2.2.3 The alarm name of local control panel

The Fig 8 shows the example of change in alarm name.

Before Change	After Change
DG Set Bearing Temp 2nd Stage	DG Bearing Temp Hi-Hi

Fig. 8. The change of alarm name in EDG LCP

The Fig 9 is the example of turbine auxiliary alarm panel that changed alarm color and name in accordance with FSAR chart 18.1-3.

	A	B	D	E
1	TURBINE TRIP (터빈정지 표시)	TURBINE POWER BELOW 15%	DRAIN VALVES CTRL PWR LOSS (개방상태에서 동작불능시 RCS 과냉)	EXHAUST HOOD VACUUM LO (배입중가에 따른 저압터빈 회송단 회전력 손실 우려)
2		15% TBN LOAD SIG BYPASSED		

Fig. 9. Example of TBN AUX. alarm panel that changed alarm color

2.2.4 The marking of the circuit breaker number and location in status lamp.

The Fig 10 is the example of the marking of the circuit breaker number and location in status lamp.

변경前	변경後	비고(표식사양)
		<ul style="list-style-type: none"> · 크기 : 5×1.5cm(가로×세로) · 글자 : 견고딕, 10 pt, 흑색 · 배경 : 흰색

Fig. 10. Example of the marking of the circuit breaker number and location in status lamp

3. Conclusions

This paper is made from improvement items of local control panel in the sight of field operator. The research of local panel is necessary to apply these improvements and the collaboration of related department is also needed. In this study, The alarm sound considering field situation, alarm name, status indication in circuit breaker are suggested to improve overall local control panel based on Hanul Unit 6. If the improvement is applied, the qualitative effect of safe operation will be increased, and fatigue of work stress will be lower.

REFERENCES

- [1] Hanul NPP 3 FSAR Chart 18.1-3, 'Priority of Alarm and Color Indication'
- [2] Hanul NPP 3 FSAR 18.1.4.20, 'Alarm System Design Review'