STANDARD

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Relative Comprehensive Safety Risk Assessment Methodology for Fire Area of Nuclear Power Plant

방화지역별 상대적 종합안전위험도 평가방법

(KNS 2024 Autumn Meeting)

화재방호 안전현안 및 규제활동 지원용 전산프로그램 개발

Dev. of a computer program to support the FIRE protection safety issues and regulatory activities

2024. 10. 25.

|주|스탠더드시험연구소

STANDARD TESTING & ENGINEERING INC.

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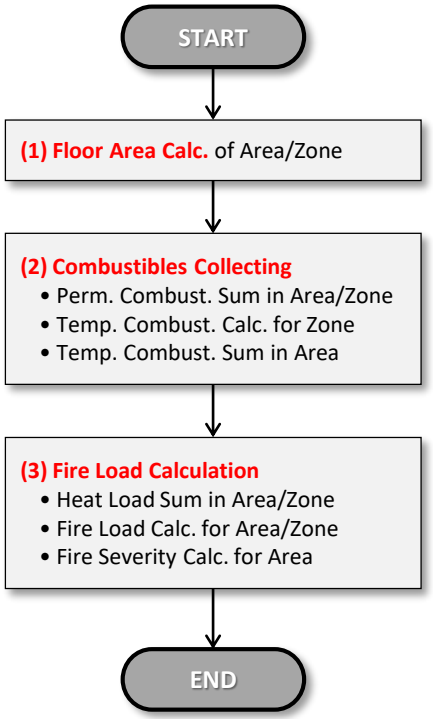
Relative Comprehensive Safety Risk Assessment Methodology for Fire Area of Nuclear Power Plant

Fig. Work-flow of General Fire Hazard Analysis Process

1 Introduction

Relative Comprehensive Safety Risk Assessment Methodology for Fire Area of Nuclear Power Plant

▪ Fire Load Calculation



방화지역번호 Fire Area ID

방화지역명 Fire Area Name Eng.

Fire Area Name Kor.

가. 상존가연물

번호	가연물 종류	가연물 수량	단위 열하중 (Btu/unit)	열 하중 (Btu)
1	케이블 절연체(전력 및 제어)	ft	1,612	Class C
2	케이블 절연체(계측)	ft	907	
3	케이블 절연체(패널)	lb	10,990	
4	윤활유	gal	155,000	
5	그리스	lb	20,000	
6	변압기 오일	gal	143,000	Class B
7	디젤 연료유	gal	146,000	
8	제2 연료유	gal	155,000	
9	[illegible]	lb	18,000	
10	고효율 입자 [illegible]	module	16,000	
11	활성탄필터	module	16,000	
12	[illegible]	[illegible]	14,000	Class A
13	나무/종이	lb	[illegible]	
14	플라스틱	lb	[illegible]	
15	의류	lb	7,200	
16	고무	lb	[illegible]	
17	공업용 세정액	gal	155,000	Class B
18	페인트	L	46,257	
19	덕트 내부라이닝(가스킷)	lb	8,000	
20	차음 블랑킷류	lb	10,000	Class A
21	플렉시블접속체(HVAC)	lb	10,000	
22	P-10	L	35	Class B
23	신너	L	155,000	
합계				0

Fire Load Calculation Sheet for 418 Zones & 282 Areas

나. 임시가연물

1	케이블 절연체			
2	윤활유 및 그리스			
3	부수 가연물			
합계				0

다. 총 발열량 (Btu) 0

라. 바닥 면적 (ft2)

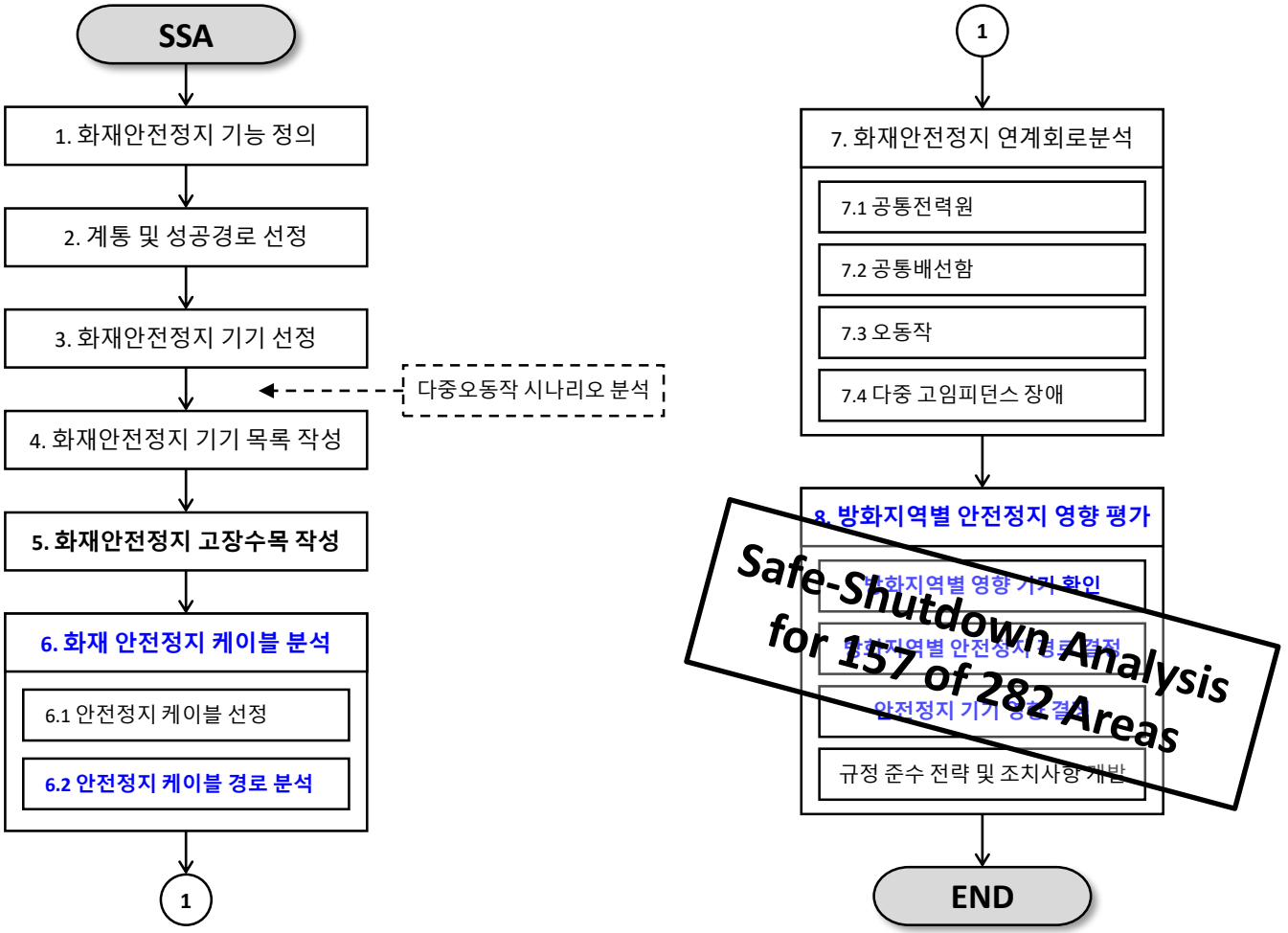
마. 화재하중 (Btu/ft2)

바. 화재심각도 (min.)

1 Introduction

Relative Comprehensive Safety Risk Assessment Methodology for Fire Area of Nuclear Power Plant

▪ Fire Safe-Shutdown Analysis



1 Introduction

Relative Comprehensive Safety Risk Assessment Methodology for Fire Area of Nuclear Power Plant

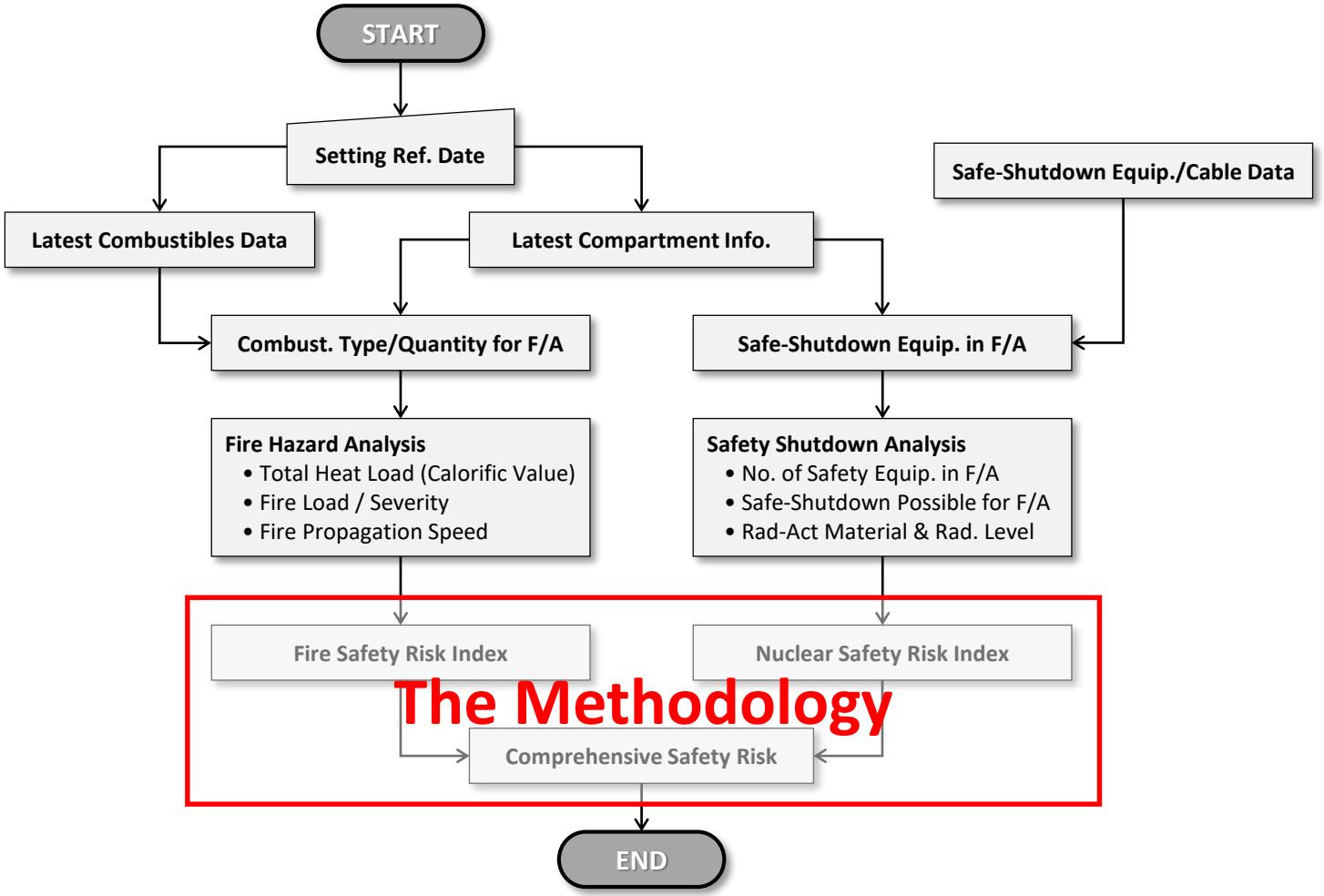


Fig. Work-flow of relative comprehensive risk assessment for fire area

2. METHODOLOGY

2 The Methodology

Relative Comprehensive Safety Risk Assessment Methodology for Fire Area of Nuclear Power Plant

2.1 Fire Safety Risk

- Identifying Fire Safety Risk Factors
- Estimating Fire Safety Risk

2.2 Nuclear Safety Risk

- Identifying Nuclear Safety Risk Factors
- Estimating Nuclear Safety Risk

2.3 Relative Comprehensive Safety Risk by Combination Both Risk

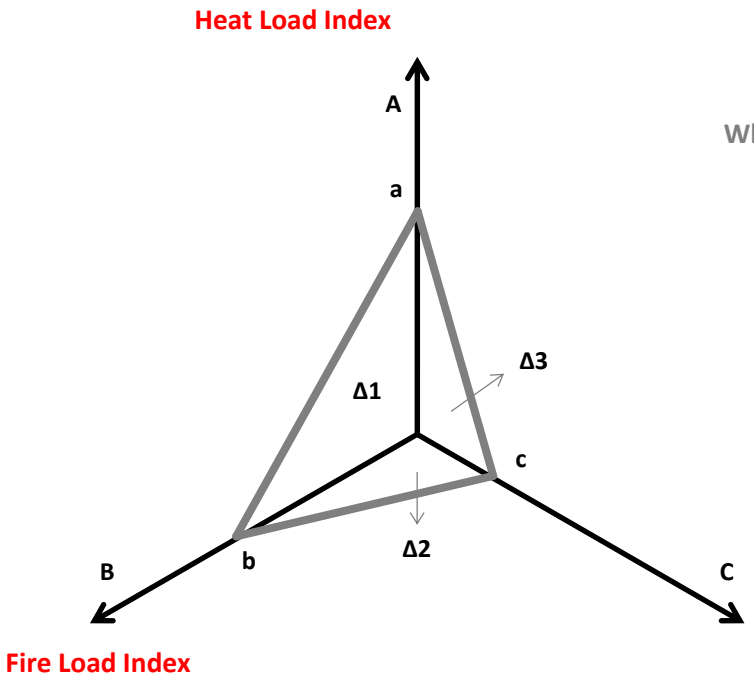
Risk Assessment Items		Safety Risk Assessment Method		
Fire Safety Risk Factors	1. Total Heat Load	F_1	Fire Safety Risk (F is Area of $\Delta F_1 F_2 F_3$)	Relative Comprehensive Safety Risk $\left(A = \sqrt{(F \times w_F)^2 + (N \times w_N)^2}\right)$ ※ w_F, w_N : Relative weighting factor
	2. Fire Load	F_2		
	3. Fire Growth Rate	F_3		
Nuclear Safety Risk Factors	1. Safety Shutdown Success	N_1	Nuclear Safety Risk (N is Area of $\Delta N_1 N_2 N_3$)	
	2. Safe Equip./Cable Density	N_2		
	3. Radiation Level	N_3		

2 The Methodology

Relative Comprehensive Safety Risk Assessment Methodology for Fire Area of Nuclear Power Plant

2.1 Fire Safety Risk

- Fire Safety Risk Factors: Heat Load Index, Fire Load Index, Fire Growth Rate
  (A) (B) (C)



When given the length of 2 sides and the angle between them,

Area of Δ abc = Δ1 + Δ2 + Δ3

Δ1 = (a b sin 120°) /2

Δ2 = (b c sin 120°) /2

Δ3 = (c a sin 120°) /2

Fig. Fire Safety Risk estimation by area of triangle with 3 vertex for Fire Safety Risk Factors

2

The Methodology

2.2 Nuclear Safety Risk

- Nuclear Safety Risk Factors: Safe Shutdown (A), Safe Equip/Cable Density (B), Radiation Level (C)

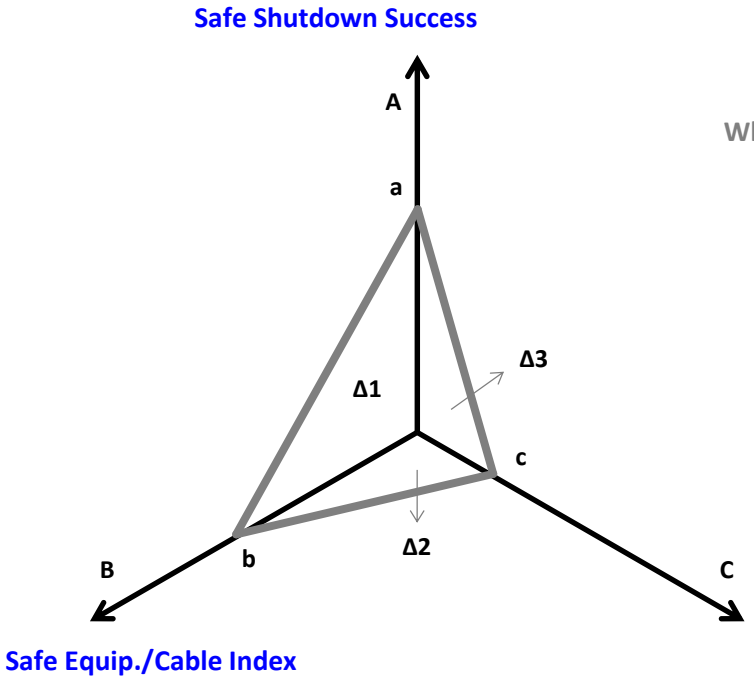


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Fig. Nuclear Safety Risk estimation by area of triangle with 3 vertex for Nuclear Safety Risk Factors

2 The Methodology

Relative Comprehensive Safety Risk Assessment Methodology for Fire Area of Nuclear Power Plant

2.3 Comprehensive Safety Risk

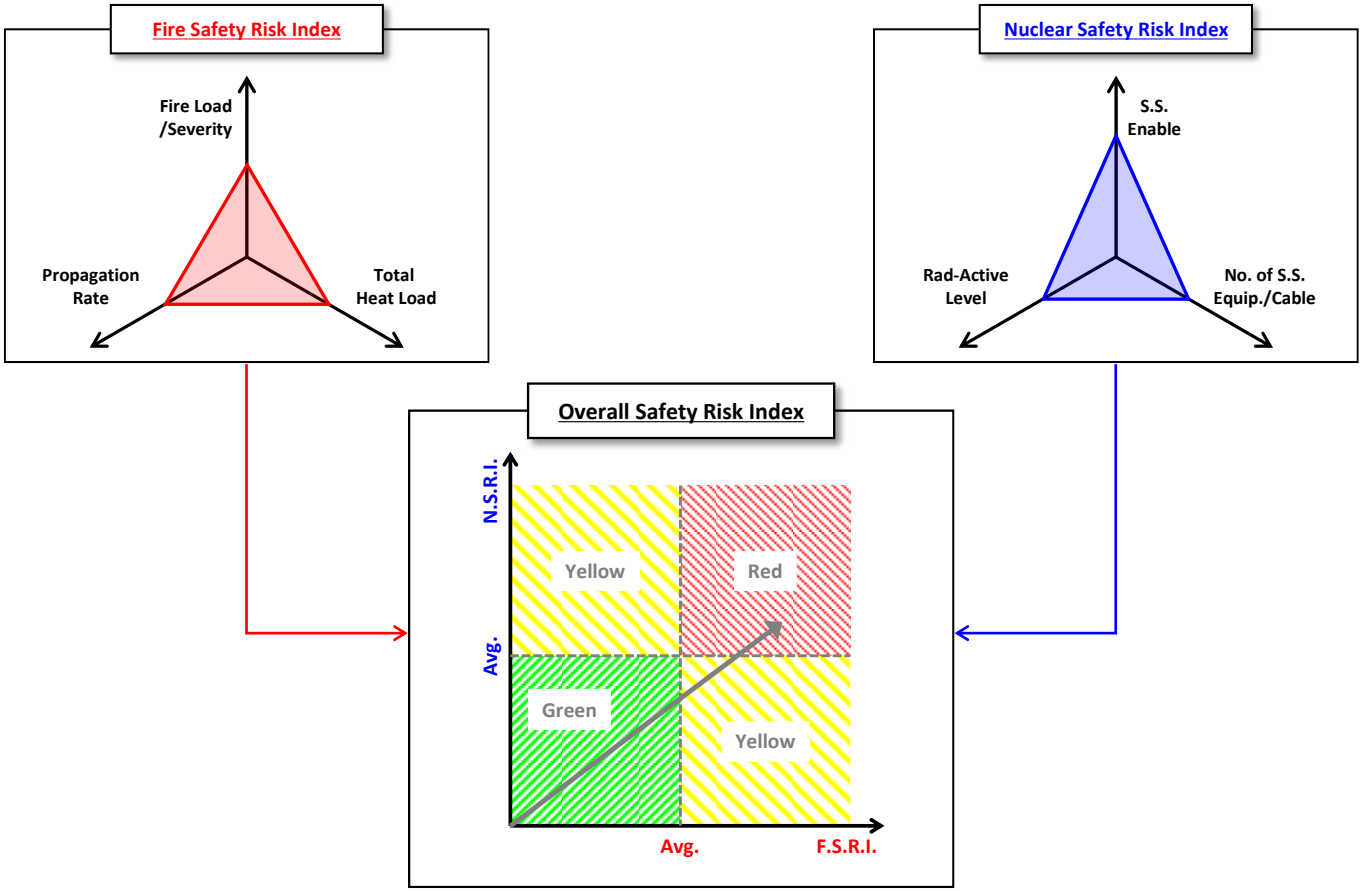

Fig. Relative Comprehensive Safety Risk deriving Method based on the Fire & Nuclear Safety Risk

2 The Methodology

Relative Comprehensive Safety Risk Assessment Methodology for Fire Area of Nuclear Power Plant

2.3 Comprehensive Safety Risk

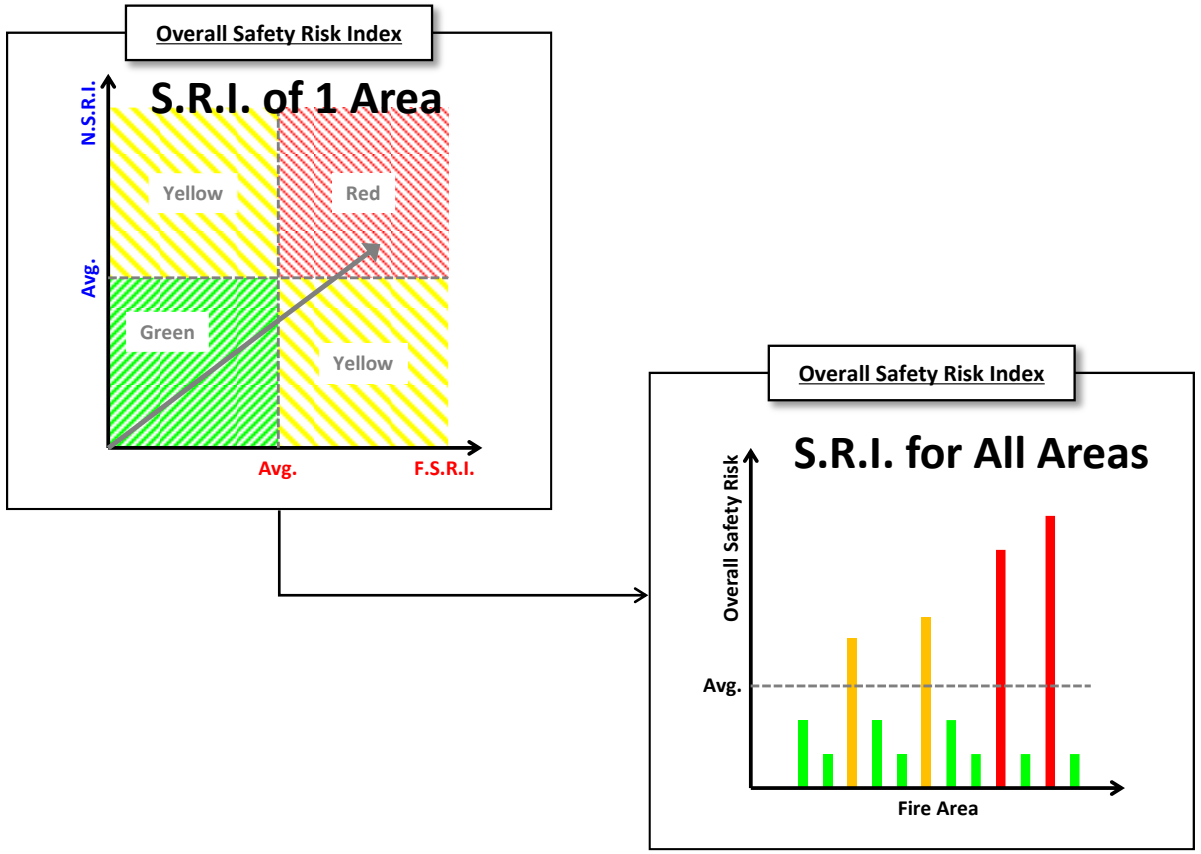

Fig. Relative Comprehensive Safety Risk deriving Method based on the Fire & Nuclear Safety Risk

3. EXAMPLE

3 Example

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Relative Comprehensive Safety Risk Assessment Methodology for Fire Area of Nuclear Power Plant

3.1 Fire Safety Risk

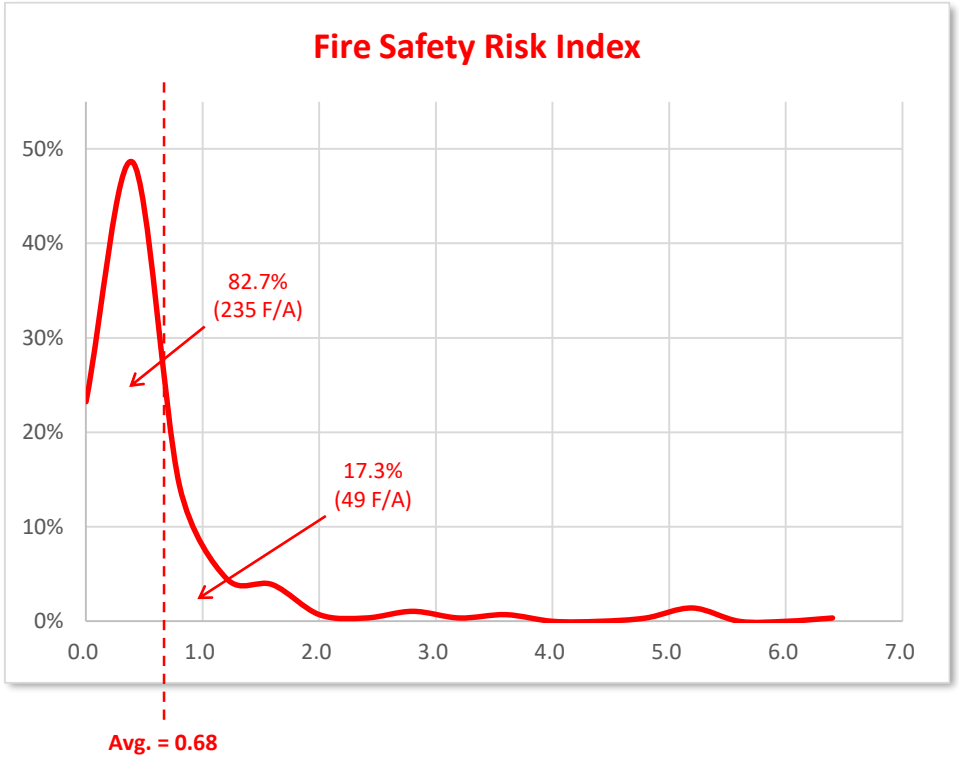

Fig. Example of Fire Safety Risk Distribution of OPR-1000

3 Example

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Relative Comprehensive Safety Risk Assessment Methodology for Fire Area of Nuclear Power Plant

3.2 Nuclear Safety Risk

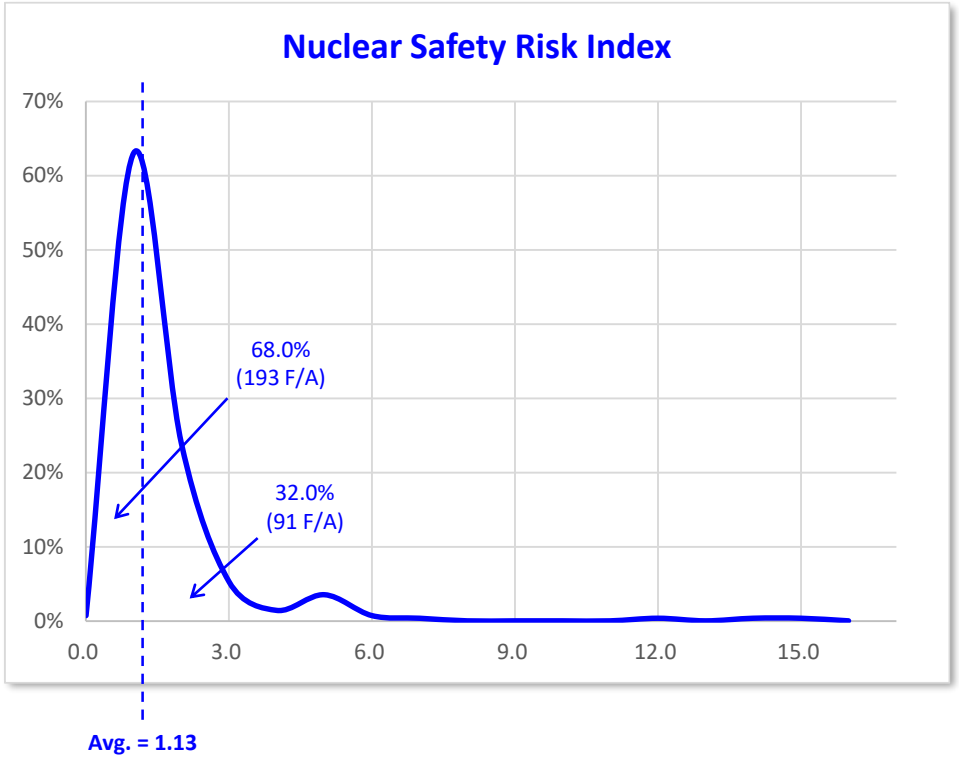

Fig. Example of Nuclear Safety Risk Distribution of OPR-1000

3

Example

3.3 Relative Comprehensive Safety Risk

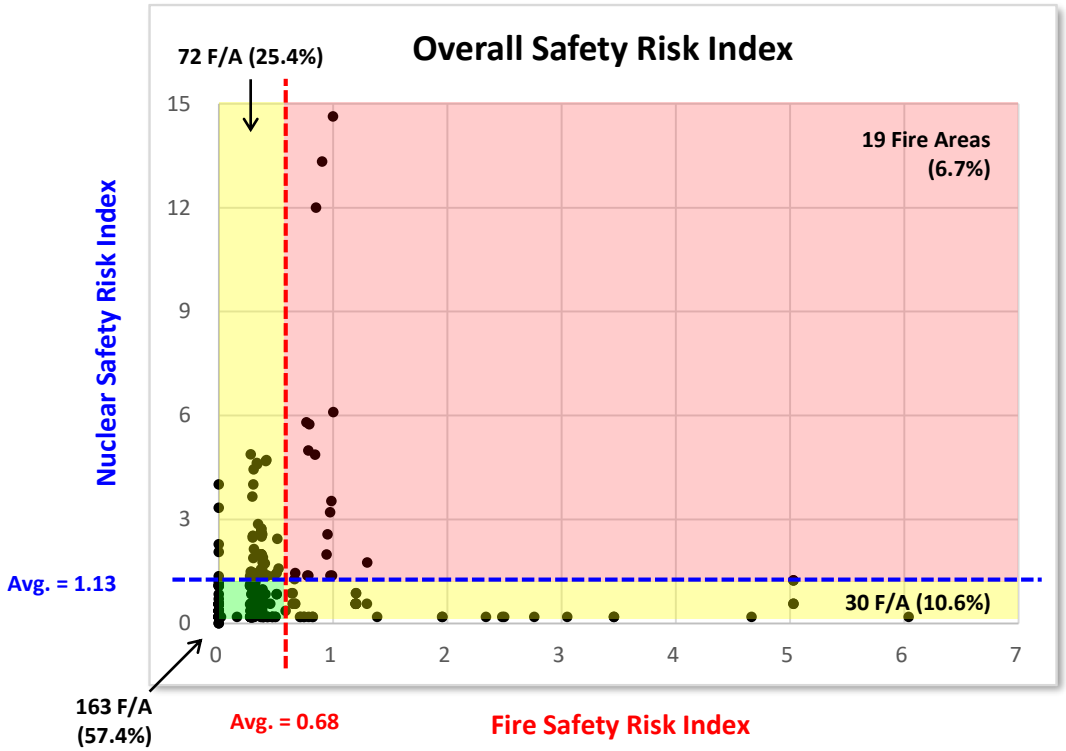

Fig. Example Graph of the Fire & Nuclear Safety Risk of OPR-1000

3

Example

3.3 Relative Comprehensive Safety Risk

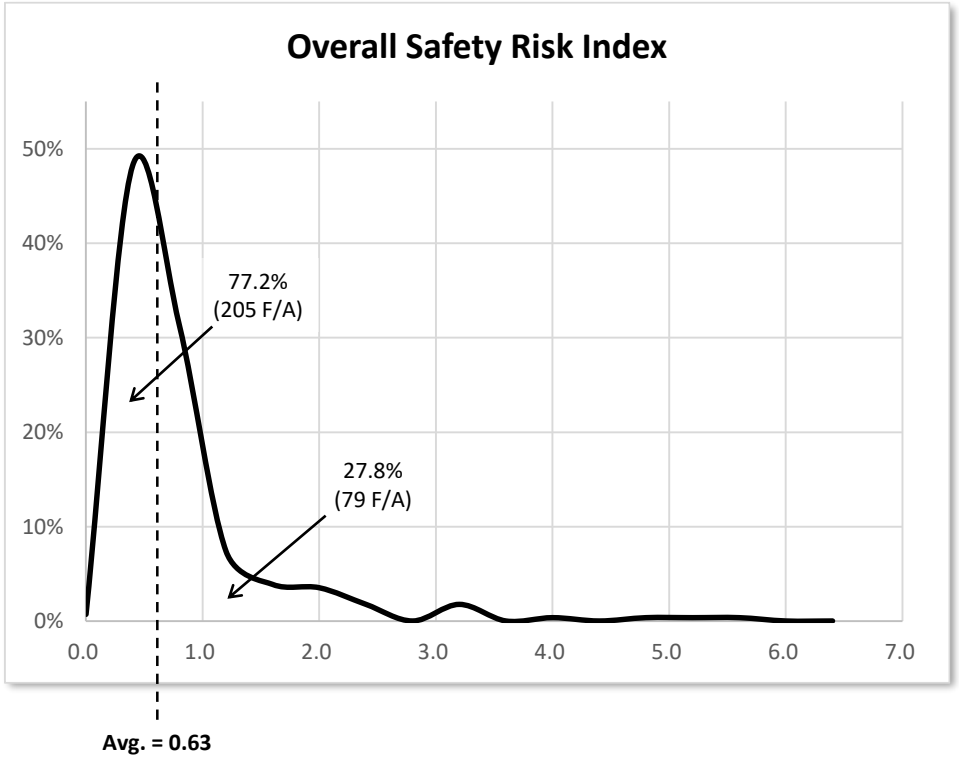

Fig. Example of Relative Comprehensive Risk Distribution of OPR-1000

4. CONCLUSION

4 Conclusion

- ❖ Fire & Nuclear Safety Risk Factors
- ❖ Fire & Nuclear Safety Risk derived by the Factors
- ❖ Relative Comprehensive Safety Risk Assessment based two Safety Risk
- ❖ Applying the Methodology on OPR-1000
- ❖ The Risk of all fire areas in NPP can be sequenced, assign management priority
- ❖ More efficiently & concentrated management on high-ranking fire areas with high risk

감사합니다

이 논문은 대한민국 정부(원자력안전위원회)의 재원으로 한국원자력안전재단의 지원을 받아 수행된 연구인 "**화재방호 안전현안 및 규제활동 지원용 전산프로그램 개발**" (과제고유번호 1075001519, 1075001697, 2070000093) 과제의 성과임을 밝힙니다.

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