

Task Analysis and Classification of Emergency Tasks in Nuclear Power Plants for Human Error Analysis

150

(Structured Information Analysis)

72 가

86

Abstract

For human error analysis, the structure and situation of a task should be analyzed in advance. The paper introduces Structured Information Analysis (SIA) as a task analysis method for error analysis, and delineates the result of application on the emergency procedure of Korean Standard Nuclear Plants (KSNPs). From the task analysis about emergency procedure of KSNP, total 72 specific task goals were identified in the level of system function, and 86 generic tasks were classified from the viewpoint of physical sameness of task description. Human errors are dependent on task types so that the result of task analysis would be used as a basis for the error analysis on the emergency tasks in NPPs.

1.

()
가

가

가

가
(Human Reliability Analysis : HRA)

HRA

[1,2,3].

가

가

HRA

HRA

HRA

가

(task analysis)

가

HRA

(SIA)

72

가

86

2.

가

[4].

(interaction)

가

가

가

가

[5].

(HTA)

[4]

가

PSA

가

가

가

가

가

가

(goal

oriented)

가

가

, MMI

HRA

가

가

Rasmussen

[9]

(observation; O),

(state identification; I),

(planning; P)

(detection; D),

(execution; E)

가

가

1 HRA

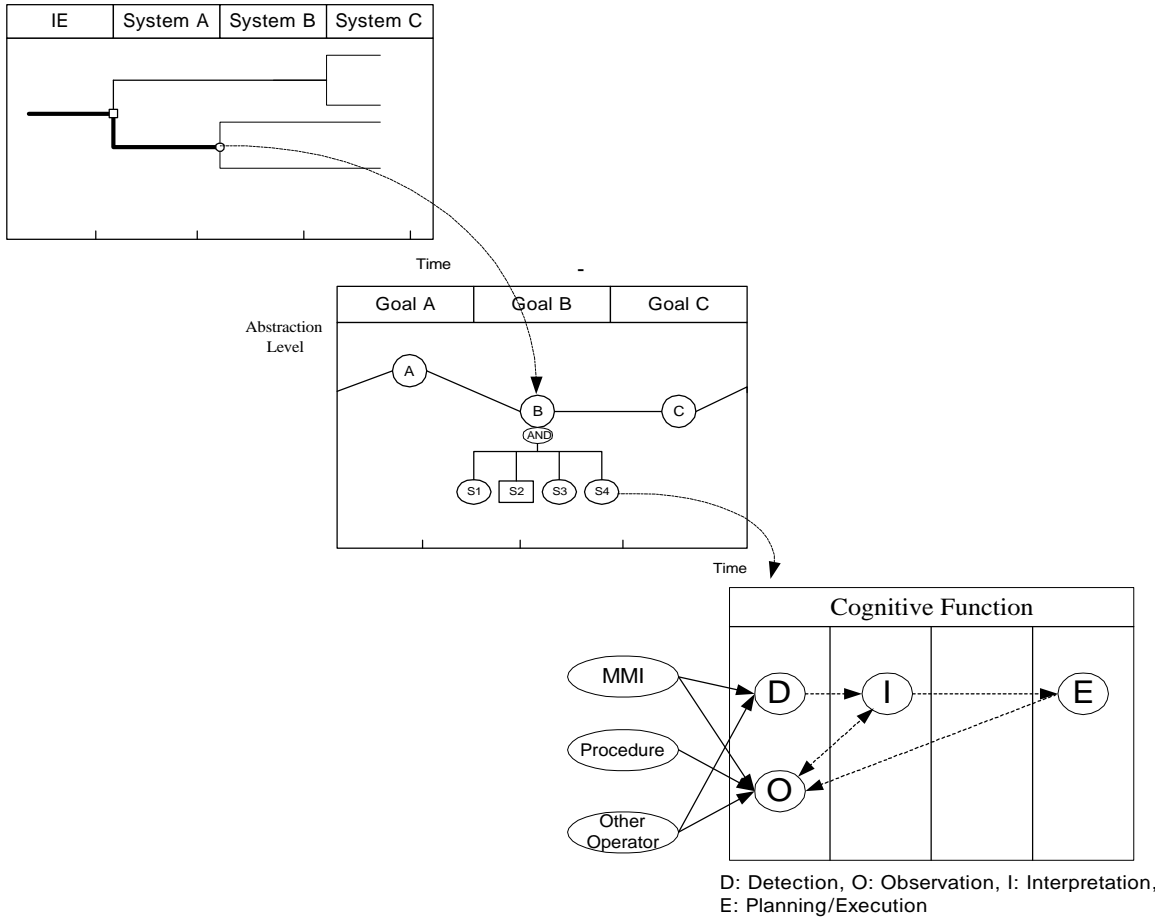
가

가

, HRA

가

가



1. (SIA)

4.

가

2

[10]

(safety function)

(abstraction level)

4.1

가
(multiple barriers)

가

가
(safety function)

1.

RCS	(RCS)	
RCS	RCS	가
	RCS	
RCS	RCS	

가

01, 02 7

-01 10 2

가

2. 3,4

-01		
-02		-01 ~ -07
-01	()	()
-02	(LOCA)	
-03		
-04		
-05		
-06		
-07		
-01		가
-02		
-03		
-04	RCS	RCS
-05	RCS	RCS
-06	RCS	RCS
-07		
-08		
-09	가 가	가 가
-10		

4.2

-

가

가

가

- Abstraction level : (mass) (energy)
- Process function level : (mass) (energy) (flow)
- System function level : (function) (state)
- Component state/control level :

level , 67 system/component function level , 8 abstraction level , 27 process function 가 3

3. 3,4

Ultimate Goal		Abstract Function (AF)	Process Function (PF)	System Function (SF)	Related System/Component (CF/CM)
Limit Radioactive Release	Maintain Fuel Integrity	Maintain Core Heat Removal	Maintain Primary Circulation	Provide Forced Circulation	RCP
				Provide Natural Circulation	SG
		Supply Emergency Core Cooling Water	Provide HPSI Flow	HPSI, SIAS	
			Provide LPSI Flow	LPSI	
			Provide SIT Flow	SIT	
			Maintain ECC Water Source	RWT, SIT	
			Provide Hot/Cold Leg Recirculation	HPSI, LPSI	
			Provide Long-term Recirculation	CTMT Sump, RAS	
		Maintain Subcriticality	Shutdown Reactor	Insert Control Rod	CRDM
			Supply Emergency Borated Water	Provide HPSI Flow	HPSI
	Supply Boron Source			RWT	
	Supply CVCS Emergency Boration			CVCS	
	Prohibit RCS Boron Dilution		ESFAS Reset	HPSI	
			Monitor RCS Boron Concentration	RCS	
		Check Boron Dilution in Cross-over Leg	RCS, RCP		
	Maintain Reactor Pressure Boundary	Maintain RCS Inventory	Supply Emergency Core Cooling Water	Provide HPSI Flow	HPSI, SIAS
				Provide LPSI Flow	LPSI
				Provide SIT	SIT
				ESFAS Reset	HPSI, LPSI, SIT
		Control PRZ Level	Control Charging & Letdown Flow	CVCS	
Control SI Flow			HPSI		
Identify/Isolate LOCA		Isolate RCS from Interface Systems	SDS, SCS isolation valves		
		Monitor Coolant Leakage to CCW	CCW Radiation Alarm, CCW Surge Tank		
Identify/Isolate Faulty SG		Identify/Isolate Faulty SG	SG, MSS, AFWS, MFWS		

(goal)

(mean)

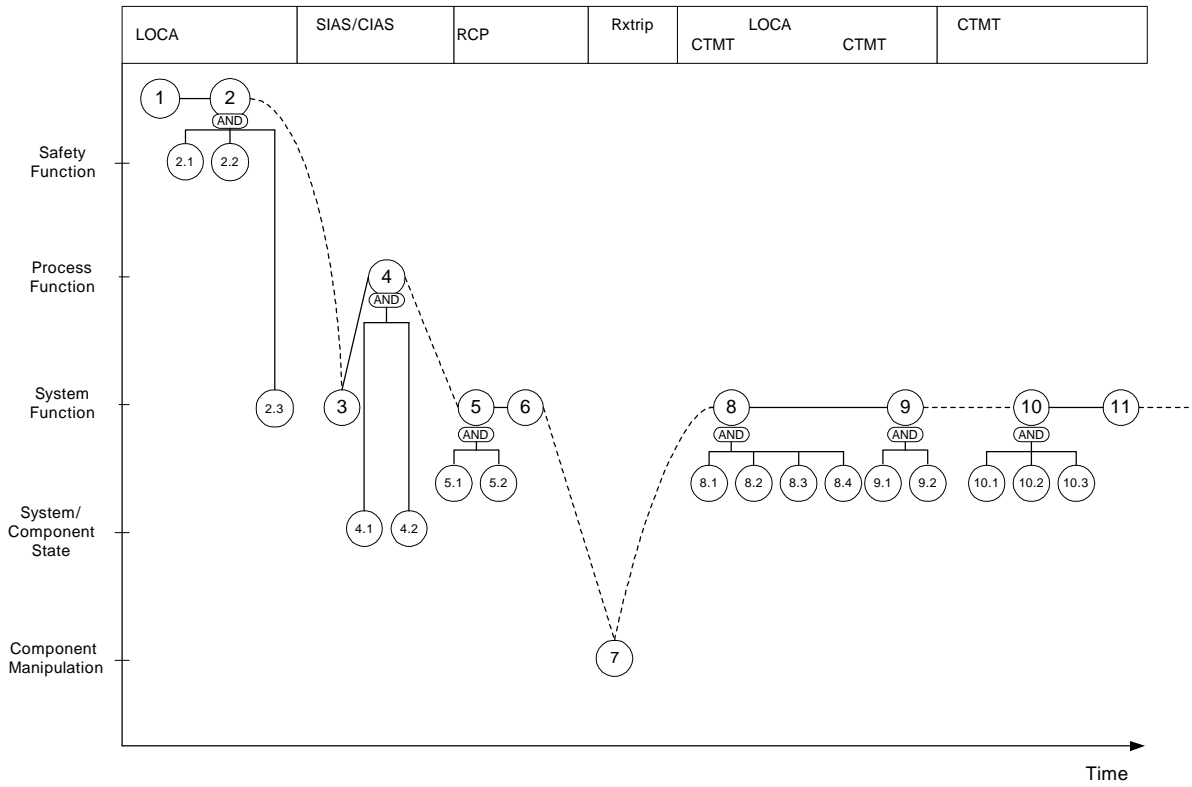
(step)

2

2

-03 (

)



2. LOCA

4.3

-

가

70

86 가 7

가 500

86 가 86 (generic task)

4

72 5

86 가 LOCA, SGTR, ESDE 86

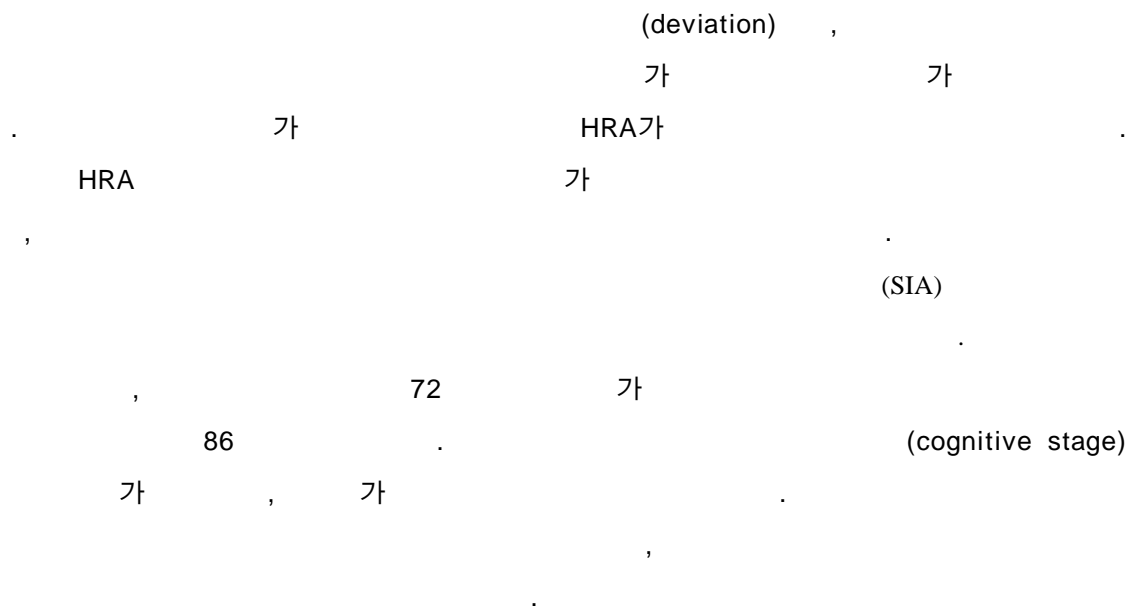
4.

Pressurizer (PRZ)	Maintain PRZ Pressure	Maintaining PRZ Pressure
	Maintain PRZ Level	Maintaining PRZ Level
Steam Generator (SG)	Isolating Faulty SG	Isolating Faulty SG
		Isolating Faulty SG and Establishing Heat Sink for RCS Cooldown
		Maintaining SG Level (in case of SGTR)
	Maintain Feed Water Supply	Verifying Main/Auxiliary Feed Water Provision
		Establishing SG Feed Water Source
	SG Cooldown and Depressurization	SG Cooldown and Depressurization (in case of SGTR)
		Establishing Heat Sink for RCS Cooling
RCS Inventory	Control CVCS flow	Controlling Charging and Letdown
		Establishing Letdown Flow via CVCS
		Providing (Injecting) Coolant using Charging Pumps
		Establishing Water Source for Charging Pumps
	Establishing and Control SI flow	Controlling (Throttling) HPSI Flow
		Maintaining HPSI Flow Rate
		Establishing Coolant using SI and CVCS
		Establishing Coolant using SI and CVCS to Ensure Heat Sink for RCS Cooldown
		Controlling SI Flow
		Injecting Coolant using SI Pumps
		Ensuring SI Flow Rate through SIAS Activation
		Establishing RCS Coolant Injection Flow Rate

5.

No					
59	SIAS/CIAS	LOCA 4 SGTR 4 ESDE 4	가 A , SIAS (8, 9).	123.9 kg/cm ² 가 SIAS/ CIAS	가 123.9 kg/cm ² A SIAS CIAS가 , SIAS CIAS SIAS : EF-HS-102A/102B/102C/102D. CIAS : EF-HS-104A/104B/104C/ 104D
60	SI >=	LOCA 5 SGTR 5 ESDE 5	SIAS가 SI : (2,3) 가 HPSI LPSI 가	SIAS , HPSI/LPSI , SI , Chg	SI , SI : SI SI , SI , SI 가
61	가 <= 121 kg/cm ² A RCP	LOCA 6. SGTR 6. ESDE 7.	SIAS가 가 121 kg/cm ² A , RCP 1 RCS 가 15 , RCP	가 , RCS RCP	

5.



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