

**Supplemental Table S1: HAZOP analysis for emergency response process**

Stage	Parameter	Guide word	Deviation	Causes	Consequences
Receive the emergency information	Information	Less	Incomplete alarm information	1) Alarm personnel panic 2) Incomplete inquiry by the police receiver	Not timely to the scene
	Time		Alarm not in time		
Preliminary emergency assessment	Operation	Less	Unreasonable preliminary assessment of disaster	Improper command of emergency center	Insufficient emergency rescue equipment
	Procedure		Situation on site not identified	Weak operator safety skills	1) Incomplete gas dilution 2) Inaccurate gas concentration monitoring
Rush to the scene	Time	Less	Not timely to the scene	1) Road traffic accident 2) Traffic congestion	Delay emergency rescue

Emergency Response center	Procedure	Reverse	No Emergency center established in advance	Improper command of emergency center	Improper command of emergency center
	Time	Less	No Emergency center established in time	Improper command of emergency center	Delay emergency rescue
Advance disposal	Time	Less	Mass evacuation not in time	Improper command of emergency center	Casualties
			Traffic control not in time	Improper command of emergency center	Delay emergency rescue
	Operation	Less	Warning area too small	Unreasonable assessment of hazard scope	Casualties
			Unreasonable division of warning area	Unreasonable assessment of hazard scope	Affecting the lives of residents
	Personnel	Less	Incomplete mass evacuation	1) Improper command of emergency center 2) Situation on site not identified	Casualties
Hazard mitigation operations.	Operation	No	Flammable gas concentration not monitored	1) Emergency Personnel Paralysis 2) Situation on site not identified	Accident expansion
		Reverse	Not cutting off the gas source first	1) Serious damage to valves, pipelines and other facilities 2) Emergency Personnel Paralysis	Accumulation combustible gas

		Less	Inaccurate gas concentration monitoring	Unreasonable gas monitoring way	Accumulation combustible gas
			Incomplete fire extinguishing	Firefighters paralysis	Accident expansion
			Incomplete gas dilution	1) Inaccurate gas concentration monitoring 2) Situation on site not identified	1) Accumulation combustible gas 2) Personnel suffocation
	Time	Less	Fire extinguishing not in time	1) Unreasonable preliminary assessment of disaster 2) Insufficient emergency rescue equipment 3) Improper command of emergency center	Accident expansion
	Procedure	Other than	Unreasonable fire extinguishing method	1) Unreasonable preliminary assessment of disaster 2) Firefighters misjudgment	Accident expansion
Organize rescue	Time	Less	Improper placement of personnel	1) Improper command of emergency center 2) Insufficient emergency rescue equipment	Casualties
	Procedure		Insufficient emergency rescue equipment	Unreasonable preliminary assessment of disaster	1) Unreasonable Distribution of Wounded 2) Late treatment for the wounded

Shunt the wounded	Time	Reverse	Late treatment for the wounded	1) Emergency search and rescue not in time 2) Insufficient emergency rescue equipment	Casualties
	Operation	Other than	The wrong way of treatment	Misjudgment of medical staff	
Unreasonable Distribution of Wounded					
Post-disaster recovery	Operation	No	Gas supply not restored	1) Improper command of emergency center 2) Post-disaster reconstruction personnel paralysis	Affecting the lives of residents
	Operation	Less	On-site cleaning recovery incomplete	Post-disaster reconstruction personnel paralysis	Accident hazards like reburning
	Procedure	As well as	Accident hazards like reburning	1) Emergency Personnel Paralysis 2) Incomplete leak stoppage and repair of gas pipeline 3) On-site cleaning recovery incomplete	Accident expansion
	Time	Less	Site cleaning recovery slow	1) Incomplete leak stoppage and repair of gas pipeline 2) Accident expansion	Affecting the lives of residents



**Conditional probability of node D2**

C2	True		False	
C3	True	False	True	False
True	0.6	0.4	0.4	0.01
False	0.4	0.6	0.6	0.99

**Conditional probability of node D1**

C2	True		False	
C3	True	False	True	False
True	0.8	0.6	0.6	0.01
False	0.2	0.4	0.4	0.99

**Conditional probability of node D3**

C4	True	False
True	0.6	0.01
False	0.4	0.99

**Conditional probability of node D4**

C5	True	False
True	0.6	0.01
False	0.4	0.99

**Conditional probability of node D5**

C1	True		False	
C6	True	False	True	False
True	0.7	0.6	0.7	0.01
False	0.3	0.4	0.3	0.99

**Conditional probability of node D6**

C4	True	False
True	0.55	0.01
False	0.45	0.99

**Conditional probability of node D7**

C4	True	False
True	0.55	0.05
False	0.45	0.95

**Conditional probability of node D8**

C7	True	False
True	0.7	0.05
False	0.3	0.95

**Conditional probability of node D9**

C7	True	False
True	0.6	0.04
False	0.4	0.96

**Conditional probability of node D10**

C8	True	False
True	0.65	0.04
False	0.35	0.96

**Conditional probability of node D11**

C8	True	False
True	0.55	0.02
False	0.45	0.98

**Conditional probability of node D12**

D4	True		False	
C4	True	False	True	False
True	0.7	0.55	0.65	0.08
False	0.3	0.45	0.35	0.92

**Conditional probability of node D13**

D4	True		False	
C11	True	False	True	False
True	0.8	0.6	0.6	0.01
False	0.2	0.4	0.4	0.99

**Conditional probability of node D14**

C11	True		False	
C10	True	False	True	False
True	0.8	0.7	0.65	0.05
False	0.2	0.3	0.35	0.95

**Conditional probability of node D15**

C12	True	False
True	0.8	0.08
False	0.2	0.92

**Conditional probability of node D16**

C9	True	False
True	0.65	0.01
False	0.35	0.99

**Conditional probability of node D17**

D4	True	False
True	0.75	0.65
False	0.25	0.35

**Conditional probability of node D18**

C4	True				False			
D3	True		False		True		False	
D21	True	False	True	False	True	False	True	False
True	0.8	0.7	0.7	0.6	0.7	0.6	0.6	0.1
False	0.2	0.3	0.3	0.4	0.3	0.4	0.4	0.9

**Conditional probability of node D19**

D3	True			False	
C13	True	False	True	False	
True	0.8	0.65	0.7	0.01	
False	0.2	0.35	0.3	0.99	

**Conditional probability of node D20**

C4	True			False	
D21	True	False	True	False	
True	0.7	0.6	0.6	0.01	
False	0.3	0.4	0.4	0.99	

**Conditional probability of node D21**

D3	True	False
True	0.65	0.01
False	0.35	0.99

**Conditional probability of node D22**

D21	True			False	
C14	True	False	True	False	
True	0.8	0.65	0.7	0.01	
False	0.2	0.35	0.3	0.99	

**Conditional probability of node D23**

C15	True	False
True	0.7	0.01
False	0.3	0.99

**Conditional probability of node D24**

C15	True	False
True	0.65	0.01
False	0.35	0.99



**Conditional probability of node D25**

C4	True	False
True	0.6	0.01
False	0.4	0.99

**Conditional probability of node D26**

C16	True	False
True	0.6	0.01
False	0.4	0.99

**Conditional probability of node D27**

D26	True				False			
C17	True		False		True		False	
C11	True	False	True	False	True	False	True	False
True	0.8	0.7	0.7	0.6	0.7	0.6	0.6	0.01
False	0.2	0.3	0.3	0.4	0.3	0.4	0.4	0.99

**Conditional probability of node D28**

C17	True	False
True	0.65	0.01
False	0.35	0.99

**Conditional probability of node S1**

D13	True																False															
D16	True								False								True								False							
D18	True				False				True				False				True				False				True				False			
D19	T <sup>a</sup>	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F		
D27	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F		
<b>True</b>	0.99	0.95	0.95	0.8	0.95	0.8	0.8	0.7	0.95	0.8	0.8	0.7	0.8	0.7	0.8	0.6	0.95	0.8	0.8	0.7	0.8	0.7	0.7	0.6	0.8	0.7	0.7	0.6	0.7	0.6	0.6	0.01
<b>False</b>	0.01	0.05	0.05	0.2	0.05	0.2	0.2	0.3	0.05	0.2	0.2	0.3	0.2	0.3	0.2	0.4	0.05	0.2	0.2	0.3	0.2	0.3	0.3	0.4	0.2	0.3	0.3	0.4	0.3	0.4	0.4	0.99

<sup>a</sup> T represents True, F represents False.

**Conditional probability of node S2**

D8	True																															
D10	True																False															
D20	True								False								True								False							
D22	True				False				True				False				True				False				True				False			
D23	True		False		True		False		True		False		True		False		True		False		True		False		True		False		True		False	
D24	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F
<b>True</b>	0.99	0.95	0.95	0.9	0.95	0.9	0.9	0.8	0.95	0.9	0.9	0.8	0.9	0.8	0.7	0.6	0.95	0.9	0.9	0.8	0.9	0.8	0.7	0.6	0.9	0.8	0.8	0.7	0.8	0.7	0.6	0.5
<b>False</b>	0.01	0.05	0.05	0.1	0.05	0.1	0.1	0.2	0.05	0.1	0.1	0.2	0.1	0.2	0.3	0.4	0.05	0.1	0.1	0.2	0.1	0.2	0.3	0.4	0.1	0.2	0.2	0.3	0.2	0.3	0.4	0.5

**Continue to the above table:**

D8	False																															
D10	True								False																							
D20	True				False				True				False																			
D22	True		False		True		False		True		False		True		False																	
D23	True	False	True	False	True	False	True	False	True	False	True	False	True	False	True	False																
D24	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F				
True	0.95	0.9	0.9	0.8	0.9	0.8	0.8	0.7	0.9	0.8	0.8	0.7	0.8	0.7	0.7	0.6	0.9	0.8	0.8	0.7	0.8	0.7	0.7	0.6	0.8	0.7	0.7	0.6	0.7	0.6	0.6	0.01
False	0.05	0.1	0.1	0.2	0.1	0.2	0.2	0.3	0.1	0.2	0.2	0.3	0.2	0.3	0.3	0.4	0.1	0.2	0.2	0.3	0.2	0.3	0.3	0.4	0.2	0.3	0.3	0.4	0.3	0.4	0.4	0.99

**Conditional probability of node S3**

D11	True				False			
D25	True		False		True		False	
D28	True	False	True	False	True	False	True	False
True	0.8	0.7	0.7	0.6	0.7	0.6	0.6	0.01
False	0.2	0.3	0.3	0.4	0.3	0.4	0.4	0.99

**Conditional probability of node S4**

D17	True	False
True	0.65	0.1
False	0.35	0.9

**Conditional probability of node S5**

D14	True				False			
D15	True		False		True		False	
D17	True	False	True	False	True	False	True	False
True	0.8	0.7	0.7	0.6	0.7	0.6	0.6	0.01
False	0.2	0.3	0.3	0.4	0.3	0.4	0.4	0.99

**Conditional probability of node S6**

D5	True				False			
D7	True		False		True		False	
D9	True	False	True	False	True	False	True	False
True	0.8	0.7	0.7	0.6	0.7	0.6	0.6	0.01
False	0.2	0.3	0.3	0.4	0.3	0.4	0.4	0.99