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Research on SLP-based Equipment Layout Method of Decontaminating Station

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Abstract: In order to satisfy the requirement of equipment layout of the decontamination station, using SLP theory and method to transform the decontamination objects and decontaminant into logistics objects, and the internal equipment layout of the decontamination station is designed. First, determine the decontamination process. Then, divide decontamination operation units and analyze closeness of the logistics and non-logistics relationship between the units to generate a comprehensive relationship diagram of the operation units. Finally, two layout schemes are designed considering the actual constraints of the decontamination operation, and the evaluation method was carried out by using the hierarchical weighted factor comparison evaluation method to obtain the optimal scheme.

1. Introduction

The decontamination station is a place to decontaminate people, weapons and equipment that are contaminated with pollutants. For a long time, the decontamination station mainly relies on subjective experience and objective constraints to conduct the layout of equipment and facilities, with insufficient quantitative analysis and scientific, systematic and targeted equipment layout, which directly affects the efficiency of decontamination operations. Through research, this paper finds that the production logistics planning and production facility layout design is very similar to the equipment layout of the decontamination station. The system layout planning method [1] can be used to consider the decontamination operation process as a product production process, the decontamination object, the decontamination liquid, the water and the waste liquid are converted into product materials, the logistics relationship data is analyzed, the correlation diagram of the decontamination operation unit is drawn, and the optimal layout plan is obtained through comprehensive analysis, comparison and calculation.

This paper assumes that in a certain anti-chemical rescue team handling the leakage accident of chemical plant, a certain number of personnel, vehicles, equipment are contaminated, the superior instruct to use Type-A vehicle decontamination vehicle, Type-B vehicle decontamination vehicle, Type-C personnel decontamination vehicle, and Type-D personnel decontamination vehicle, and to open the decontamination station from the appropriate location of the water source. According to the actual application of the decontamination station, a vehicle decontamination (the artificial vehicle pre-decontaminating method is adopted, the Type-A vehicle decontamination vehicle is responsible for the water washing and the decontamination washing, and the Type-B vehicle for complementing decontaminating and water transportation), two personnel decontamination line (Type-B for complementing decontamination supply water for Type-D personnel decontamination vehicle, Type-A for water washing supply water for Type-C personnel decontamination vehicle) and an equipment decontamination line are opened. Assume that the wind direction is northeast, the site use area in natural conditions is relatively sufficient, the preparatory work such as simple self-consumption, intercommunication, and deconstruction grouping in the early stage have been completed, the probability of personnel complementing decontamination is 7.7%, the probability of equipment decontamination is 5%, and the probability of vehicle decontamination is 12%, both water and decontamination liquid are measured by water.

2. Procedure Analysis of Decontamination Operation

According to the external army decontamination operation process [2], combined with the needs of the decontamination object, a brief analysis of the decontamination operation process is carried out. Among them, the vehicle does not return to the vehicle decontamination line when the vehicle is decontaminating, and the supplementary decontamination point method is adopted separately for local decontamination.

(1) Personnel sterilization operation procedure. Contaminated personnel is grouped and decontaminated uniformly. There are 10 steps, including small-sized equipment (hereinafter referred to as “equipment”), taking off protective clothing, taking off mask, taking off clothes, personnel taking shower and decontaminating, wearing clothes, personnel contaminant inspection, unqualified personnel returning to decontamination, claiming individual suits, and arriving gathering area.

(2) Vehicle sterilization operation procedure. Except drivers, other vehicle personnel is grouped in personnel decontamination area. There are 8 steps for vehicle decontamination, including vehicle pre-decontamination, vehicle decontamination with decontamination liquid, chemical reaction waiting, vehicle precision instrument decontamination, vehicle water decontamination, vehicle contaminant inspection, unqualified vehicle for complementing decontamination, arriving gathering area.

(3) Equipment sterilization operation procedure. Equipment and mask decontamination area mainly sets three equipment decontamination area, the first area is responsible for equipment decontamination and the second and the third area for mask decontamination.

3. SLP-based Decontamination Station Layout

3.1 Layout pattern

Since there are certain procedures in the decontamination operation, it is most reasonable to conduct the process-oriented layout. At the same time, according to the four types of linear, U-shaped, circular and serpentine layout, the decontamination operation is basically a single logistics direction, which is restricted by various factors such as wind direction, water source and area, and is suitable for linear and serpentine shapes to meet the synchronous flow requirements of vehicles, personnel, and equipment decontamination.

3.2 Operation unit division

3.2.1 Operation unit division

The operation unit division refers to classifying all the equipment and auxiliary facilities in the decontamination station according to functions, forming several independent areas, so that the system can analyze the logistics and non-logistics relationship between them. According to the decontamination operation process and the decontamination station layout pattern determined, the decontamination station is divided into 29 operation units, shown in Table 1.

Table 1 Job unit partition table

No.	Job unit name	Equipment type	Quantity	Area requirement(m^2)	No.	Job unit name	Equipment type	Quantity	Area requirement(m^2)
1	Waiting area			a	16	Equipment decontamination area Ⅰ	Equipment wiping tool		p
2	Vehicle pre-washing	Manual brushing, disinfectant bucket		b	17	Equipment decontamination area Ⅱ	Mask wiping tool		q
3	Vehicle decontamination	Type-A vehicle decontamination vehicle	α	c	18	Equipment decontamination areaⅢ	Cleaning mask disinfectant bucket, clear bucket		r
4	Chemical reaction zone			d	19	Equipment Contaminant inspection	Contaminant alarm	θ	
5	Vehicle precision instrument decontamination			e	20	Equipment drying area			s
6	Vehicle water washing	Type-A vehicle decontamination vehicle	β	f	21	Vehicle pre-washing seepage pit			t
7	Vehicle pollutant inspection	Contaminant alarm		g	22	Vehicle decontamination seepage pit			u
8	Supplementary decontamination vehicle	Type-B vehicle decontamination vehicle	γ	h	23	Vehicle water washing seepage pit			v
9	Equipment stacking area			i	24	Personnel decontamination seepage pit			w
10	Protective clothing undressing area	Buried pit		g	25	Supplementary decontamination vehicle seepage pit			x
11	Mask stacking area			k	26	Equipment decontamination seepage pit			y
12	Personnel decontamination area Ⅰ	Type-D personnel decontamination vehicles	τ	l	27	Assembly area			z
13	Personnel decontamination area Ⅱ	Type-C personnel decontamination vehicles	ε	m	28	Water source (river)			
14	Personnel contamination inspection	Contaminant alarm	η	n	29	Pulling water cart	Type-B vehicle decontamination vehicle		
15	Receiving equipment	Receiving masks and equipment		o					

3.2.2 Decontamination operation process

According to the decontamination operation process of the decontamination object, the decontamination operation process diagram is drawn according to the operation unit division, shown in Figure 1.

Table 2 Job process diagram symbol

No.	Symbolic name	Symbol	Content
1	Operation	○	Indicates that the decontamination objects are brushed, processed, etc.
2	Handling	⇨	Indicates that the object is transported, transported, etc.
3	Detection	◇	Indicates that the decontamination object is tested for contaminants
4	Parking	▭	Indicates the temporary parking of the decontamination object in the area
5	Storage	▽	Indicates that the object is stored in a safe place in the storage area.
6	Synchronize	⬚	Indicates synchronization

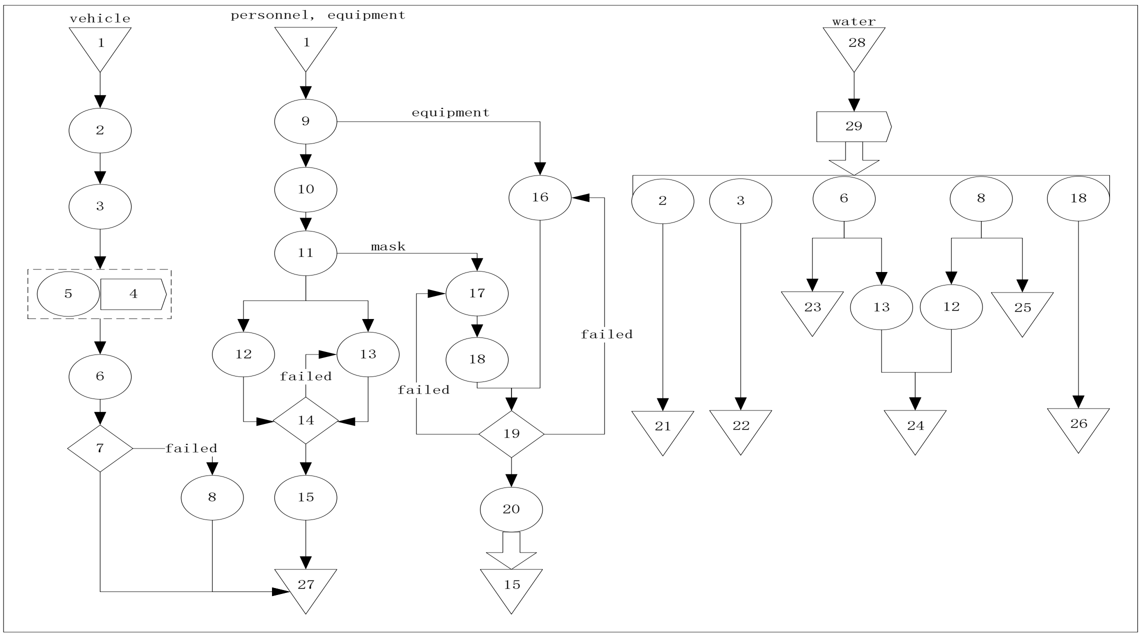

Figure 1 Decontamination process

3.3 Correlation analysis of operation unit

3.3.1 Logistics intension analysis

The decontamination operation process and the operation unit are relatively fixed, and the decontamination object and the water (collectively referred to as logistics) promote the various processes of the decontamination process, so the logistics is an important basis for analyzing the closeness of the decontamination operation units. The logistics intensity is divided into five grades, which are represented by the symbols A, E, I, O, and U, the A grade is 4 points, the E grade is 3 points, the I grade is 2 points, the O grade is 1 point, and the U level is 0 point, corresponding to ultra-high logistics intensity grade, extra high logistics intensity grade, large logistics intensity, general logistics intensity and negligible logistics [3]. Considering the time of decontamination operation and the consumption of water are closely related to the volume of the object. The logistics quantity of vehicle, personnel, and equipment lines is transformed into volume to measure, and perform threshold method dimensionless processing for horizontal comparison of logistics intensity. By calculation, the decontamination operation logistics from the table (Table 3) and the operation unit logistics degree of correlation table (Table 4) are obtained. After analysis, the logistics degree of correlation table (Table 5) and the logistics correlation chart (Figure 2) are obtained.

Table 3 Decontamination operation logistics from the table to the table

job unit name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1		2500							506.13																				
2			2500																		500.56								
3				2500																		500.64							
4					2500																								
5						2500																							
6							2500						500.56										500.64						
7								714.29																			2285.71		
8												500.55													500.58		714.29		
9										506.12						500.01													
10											506.12																		
11												503.03	503.06				500.02												
12														503.03										500.55					
13														503.53										500.56					
14													500.47		506.09														
15																											506.13		
16																			500.01										
17																		500.02											
18																			500.02							500.32			
19																500.00	500.00			500.03									
20															500.03														
21																													
22																													
23																													
24																													
25																													
26																													
27																													
28																													500.83
29								500.29																					
total		2500	2500	2500	2500	2500	2500	1214.58	506.13	506.12	506.12	1003.58	1504.09	1006.56	1006.12	1000.01	1000.02	500.02	1000.03	500.03	500.56	500.64	500.64	1001.11	500.58	500.32	3506.13		500.83

Table 4 Summary of the logistics strength of the decontamination operation unit

No.	Logistics route	Material flow	Grade	No.	Logistics route	Material flow	Grade
1	1-2	2500	A	22	17-18	500.02	O
2	2-3	2500	A	23	18-19	500.02	O
3	3-4/5	2500	A	24	19-16	500.00	O
4	5-6	2500	A	25	19-17	500.00	O
5	6-7	2500	A	26	19-20	500.03	O
6	7-8	714.29	E	27	20-15	500.03	O
7	7-27	2285.71	E	28	28-29	502.83	I
8	8-27	714.29	E	29	29-2	0	O
9	1-9	506.13	E	30	29-3	0	O
10	9-10	506.12	E	31	29-6	0	O
11	10-11	506.12	E	32	29-8	500.28	O
12	11-12	503.03	I	33	29-18	0	O
13	11-13	503.06	I	34	2-21	500.56	I
14	12-14	503.03	I	35	3-22	500.64	I
15	13-14	503.53	E	36	6-23	500.64	I
16	14-13	500.47	O	37	6-13	500.56	I
17	14-15	506.09	E	38	13-24	500.56	I
18	15-27	506.13	E	39	8-12	500.55	I
19	9-16	500.01	O	40	8-25	500.58	I
20	11-17	500.02	O	41	12-24	500.55	I
21	16-19	500.01	O	42	18-26	500.32	O

3.3.2 Non-logistics correlation analysis between operation units

The non-logistics correlation levels of the operation units into A, E, I, O, U, and X, which are absolutely important, particularly important, important, generally close, less important, and negatively close (not to approach), the corresponding scores and ratios are 4 (2-5%), 3 (3-10%), 2 (5-15%), 1 (5-80%), 0, -1. Due to the special nature of contaminants, in order to prevent problems such as diffusion and secondary pollution, strict operation procedures and configuration orientations are necessary. The non-logistics correlation between the operation units also have a greater impact on the layout. For the decontamination station layout, such factors shall be considered as the use of same equipment or sit; relative centralized safe storage of contaminants; the easy generation of interference between each other; distance factor between decontamination operation stations, mainly objective restricting factor of the size and adjustment distance of decontamination object; and the convenient decontamination and command management. This paper focuses on the non-logistics correlation from the first four factors, and it is easy to get the non-logistics analysis table of the operation unit (Table 6), and can be directly converted into the non-logistics correlation summary table between the operation units (Table 7).

According to the analysis results of Table 7, a non-logistics degree of correlation table (Table 8) is obtained, and a non-logistics correlation figure (Fig. 3) is drawn.

Table 5 Logistics related proximity

Job unit name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1		A/4	U/0	U/0	U/0	U/0	U/0	U/0	E/3	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
2	U/0		A/4	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	I/2	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
3	U/0	U/0		A/4	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	I/2	U/0	U/0	U/0	U/0	U/0	U/0	U/0
4	U/0	U/0	U/0		A/4	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
5	U/0	U/0	U/0	U/0		A/4	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
6	U/0	U/0	U/0	U/0	U/0		A/4	U/0	U/0	U/0	U/0	U/0	I/2	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	I/2	U/0	U/0	U/0	U/0	U/0	U/0
7	U/0	U/0	U/0	U/0	U/0	U/0		E/3	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	E/3	U/0	U/0
8	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	I/2	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	I/2	U/0	E/3	U/0	U/0
9	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		E/3	U/0	U/0	U/0	U/0	U/0	0/1	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
10	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		E/3	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
11	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		I/2	I/2	U/0	U/0	U/0	0/1	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
12	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	I/2	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	I/2	U/0	U/0	U/0	U/0	U/0
13	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		E/3	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	I/2	U/0	U/0	U/0	U/0	U/0
14	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	0/1		E/3	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
15	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	E/3	U/0	U/0
16	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	0/1	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
17	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		0/1	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
18	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		0/1	U/0	U/0	U/0	U/0	U/0	U/0	0/1	U/0	U/0	U/0
19	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	0/1	0/1	U/0		0/1	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
20	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	0/1	U/0	U/0	U/0	U/0		U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
21	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
22	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	U/0	U/0	U/0	U/0
23	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	U/0	U/0	U/0
24	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	U/0	U/0
25	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	U/0
26	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0
27	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0
28	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		I/2
29	U/0	U/0	U/0	U/0	U/0	U/0	U/0	0/1	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	
total	0	4	4	4	4	4	4	4	3	3	3	4	5	5	3	1	1	0	0	0	2	2	2	4	2	1	9	0	2

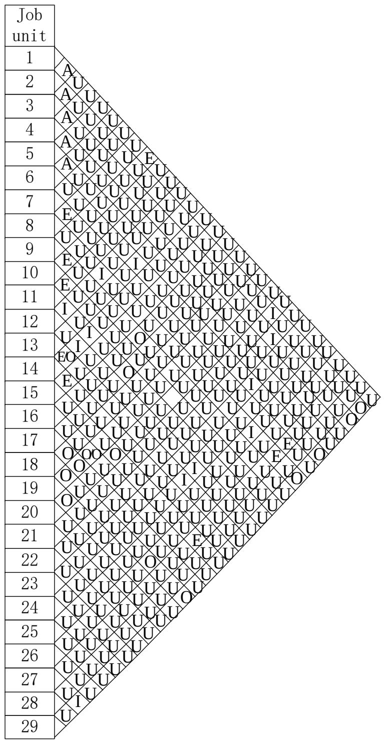

Figure 2 Logistics related

Table 6 Non-logistics analysis of operating units

Grade	Job unit pair	reason
E	6-13、8-12、4-5、19-20	Use the same equipment or venue
I	12-13、16-18、21-22、23-25	Relatively concentrated and safe storage of pollutants
O	2-3、3-4、3-5、5-6、6-7、7-8、9-10、9-11、15-20	Distance factor between decontamination operation units
	14-24、7-25、19-26	Interference between each other
X	1-2、1-9、1-27、15-27、8-27、7-27	Distance factor between decontamination operation units (the waiting area of the decontamination station and the assembly area are required to be separated from the entrance and exit)

Table 7 Summary of non-logistics relationship of decontamination operation unit

No.	Job unit pair	Grade	No.	Job unit pair	Grade
1	4-5	E	14	7-8	O
2	6-13	E	15	9-10	O
3	8-12	E	16	9-11	O
4	19-20	E	17	15-20	O
5	12-13	I	18	14-24	X
6	16-18	I	19	7-25	X
7	21-22	I	20	19-26	X
8	23-25	I	21	1-2	X
9	2-3	O	22	1-9	X
10	3-4	O	23	1-27	X
11	3-5	O	24	15-27	X
12	5-6	O	25	8-27	X
13	6-7	O	26	7-27	X

Table 8 Non-logistics related proximity

Job unit name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1		X/−1	U/0	U/0	U/0	U/0	U/0	U/0	X/−1	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	X/−1	U/0	U/0
2	U/0		0/1	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
3	U/0	U/0		0/1	0/1	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
4	U/0	U/0	U/0		E/3	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
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6	U/0	U/0	U/0	U/0	U/0		0/1	U/0	U/0	U/0	U/0	U/0	E/3	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
7	U/0	U/0	U/0	U/0	U/0	U/0		0/1	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	X/−1	U/0	X/−1	U/0	U/0
8	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	E/3	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	X/−1	U/0	U/0
9	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		0/1	0/1	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
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13	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
14	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	X/−1	U/0	U/0	U/0	U/0	U/0
15	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	U/0	0/1	U/0	U/0	U/0	U/0	U/0	U/0	X/−1	U/0	U/0
16	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	I/2	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
17	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
18	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
19	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		E/3	U/0	U/0	U/0	U/0	U/0	X/−1	U/0	U/0	U/0
20	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0
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23	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	I/2	U/0	U/0	U/0	U/0
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25	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0	U/0
26	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0	U/0
27	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0	U/0
28	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0		U/0
29	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	U/0	

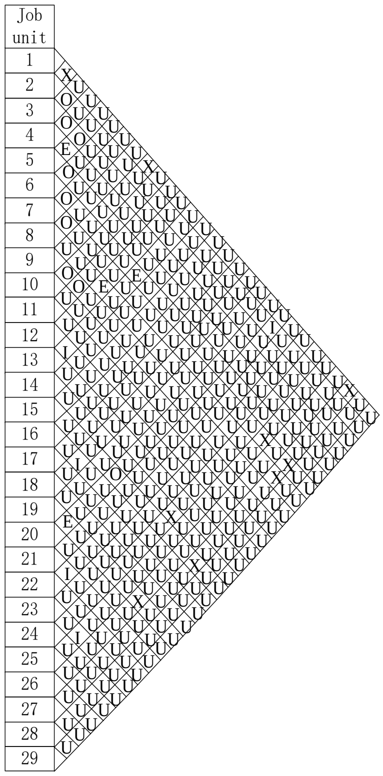

Figure 3 Non-logistics related

3.3.3 Comprehensive correlation analysis of operation unit

The comprehensive correlation includes the relationship between logistics and non-logistics, mainly using weighted values to reflect the importance of the relationship between the two. For the actual operation of the decontamination station, the logistics relationship is basically determined, and the non-logistics relationship limits the layout and location of most equipment. Therefore, the non-logistics relationship (n) has a greater impact on the layout than the logistics relationship (m), and the weighted value is taken as m: n is 1:2. The calculation equation of comprehensive correlation score is $TP_{ij} = mMP_{ij} + nNP_{ij}$, TP_{ij} represents the comprehensive correlation score between the operation unit i and the operation unit j; mMP_{ij} represents the score corresponding to logistics relationship level between operation unit i and the operation unit j; and nNP_{ij} represents the score corresponding to non-logistics relationship level between operation unit i and the operation unit j; According to the data of Table 5 and Table 8, the weighted value calculation is used to obtain the operation unit comprehensive degree of correlation ranking table (Table 9), and the comprehensive correlation diagram (Fig. 4) is drawn.

3.4 Position correlation figure of operation unit

According to the wind direction, contaminant damage and other constraints, the degree of correlation between Table 9 (the operation unit with high score should be in the center position in the layout, and the lower value is at the edge position), using four (purple), three (red), two (green), and one (blue) parallel lines indicate the relationship of A, E, I, and O, respectively. The U-level relationship is not connected. The dotted line (brown) indicates the X-level relationship, and position correlation figure of operation unit is drawn in Figure 5.

Table 9 Sorting order of work unit comprehensive relationship

Job unit name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1		O	U	U	U	U	U	U	O	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	X	U	U
2	U		E	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	O	U	U	U	U	U	U	U	U
3	U	U		E	O	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	O	U	U	U	U	U	U	U
4	U	U	U		A	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
5	U	U	U	U		E	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
6	U	U	U	U	U		E	U	U	U	U	U	A	U	U	U	U	U	U	U	U	U	O	U	U	U	U	U	U
7	U	U	U	U	U	U		E	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	X	U	O	U	U
8	U	U	U	U	U	U	U		U	U	U	A	U	U	U	U	U	U	U	U	U	U	U	U	O	U	O	U	U
9	U	U	U	U	U	U	U	U		E	U	U	U	U	U	O	U	U	U	U	U	U	U	U	U	U	U	U	U
10	U	U	U	U	U	U	U	U	U		E	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
11	U	U	U	U	U	U	U	U	U	U		O	O	U	U	U	O	U	U	U	U	U	U	U	U	U	U	U	U
12	U	U	U	U	U	U	U	U	U	U	U		I	O	U	U	U	U	U	U	U	U	U	O	U	U	U	U	U
13	U	U	U	U	U	U	U	U	U	U	U	U		I	U	U	U	U	U	U	U	U	U	O	U	U	U	U	U
14	U	U	U	U	U	U	U	U	U	U	U	U	O		I	U	U	U	U	U	U	U	U	X	U	U	U	U	U
15	U	U	U	U	U	U	U	U	U	U	U	U	U	U		U	U	U	U	O	U	U	U	U	U	U	O	U	U
16	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U		U	I	O	U	U	U	U	U	U	U	U	U	U
17	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U		O	U	U	U	U	U	U	U	U	U	U	U
18	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U		O	U	U	U	U	U	U	O	U	U	U
19	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	O	O	U		A	U	U	U	U	U	X	U	U	U
20	U	U	U	U	U	U	U	U	U	U	U	U	U	U	O	U	U	U	U		U	U	U	U	U	U	U	U	U
21	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U		I	U	U	U	U	U	U	U
22	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U		U	U	U	U	U	U	U
23	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U		U	I	U	U	U	U
24	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U		U	U	U	U	U
25	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U		U	U	U	U
26	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U		U	U	U
27	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U		U	U
28	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U		O
29	U	U	U	U	U	U	U	O	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	
Proximity	0	2	6	6	12	6	6	6	1	5	5	10	15	5	4	2	2	5	2	9	2	6	2	2	0	-1	1	0	2

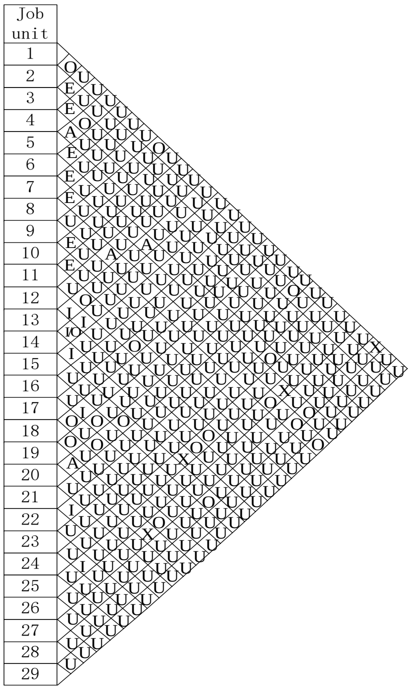

Figure 4 Comprehensive relationship

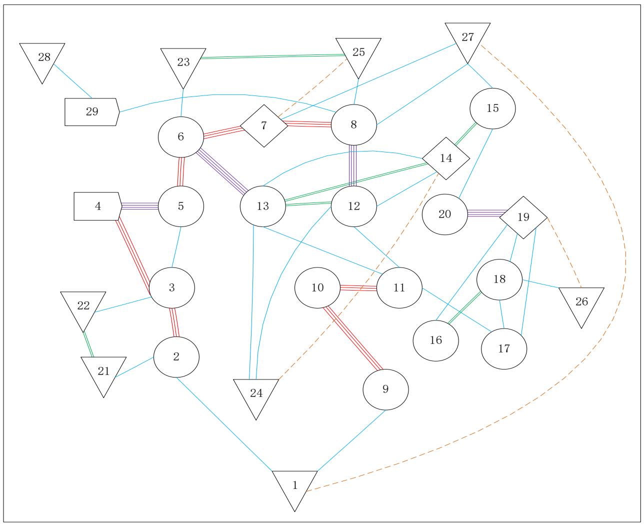

Figure 5 Job unit related location map

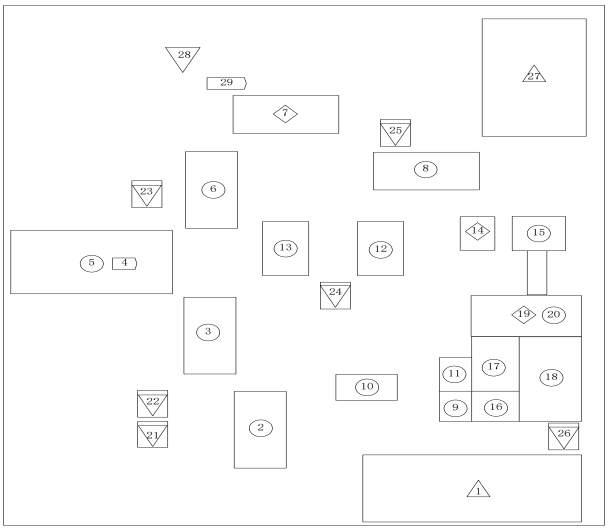

Figure 6 layout scheme I

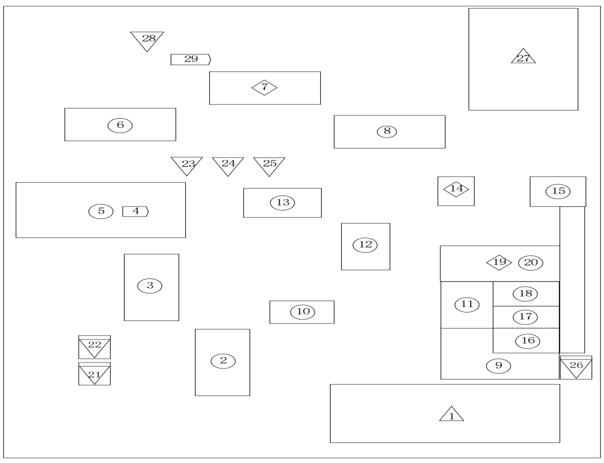

Figure 7 layout scheme II

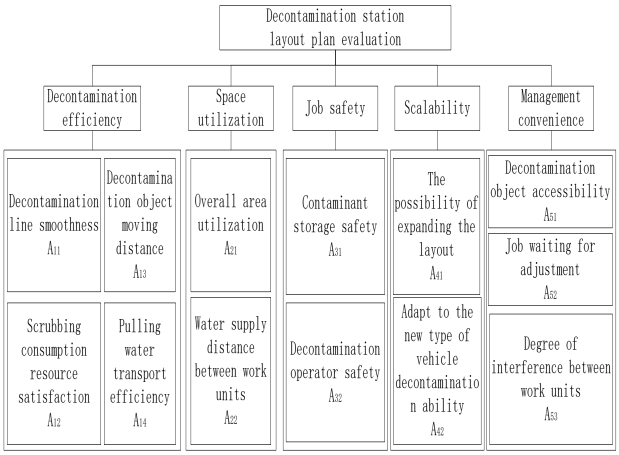

Figure 8 hierarchical evaluation model

4. Comparison of Equipment Layout Scheme of Decontamination Station

According to the position correlation figure of the operation unit, combined with the area requirement, the equipment layout scheme of the decontamination station is drawn, shown in Fig. 6 and Fig. 7.

In order to realize the qualitative and quantitative comprehensive analysis of the above two schemes, the two schemes are selected by the hierarchical weighted factor comparison evaluation method [4, 5]. Firstly, to establish the stratification evaluation model of the layout scheme, shown in Fig. 8, the model consists of two levels, and the five first-level evaluation indicators are A_1 decontamination efficiency, A_2 space utilization, A_3 operation security, A_4 scalability, and A_5 management convenience. Secondly, according to the evaluation model, the first-level evaluation indicators are weighted, and the weights of the first-level indicators are allocated as $\delta=[0.9, 0.5, 0.6, 0.1, 0.3]$. Thirdly, to determine the evaluation value of relative evaluation index of the two schemes, and obtain the second-level single factor evaluation matrix $E_i=(A_{ij1}\ \ A_{ij2})$ by the expert scoring method, among which, A_{ij1} is the score of the scheme I on the evaluation factor A_{ij}. The result of the first-level evaluation factor is $Y_i=P_{ij}\cdot E_i=(y_{i1}\ y_{i2})$, among which, P_{ij} is the weight of evaluation factor A_{ij}, so $Y_i=\begin{bmatrix}0.71 & 0.38 & 0.45 & 0.50 & 0.16\\ 0.69 & 0.35 & 0.16 & 0.20 & 0.37\end{bmatrix}^{\mathrm{T}}$. Fourthly, to integrate the evaluation values of the indicators of each level and calculate the final result of the evaluation of the two layout schemes $G=\delta\cdot Y_i=\delta\cdot(y_{i1}\ y_{i2})=(1.307\ \ 1.023)$, and it can be seen that the scheme I value is slightly higher than scheme II. Therefore, Scheme II is the optimal scheme.

5. Conclusion

This paper, focuses on the insufficient quantitative analysis for the equipment layout of the decontamination station, adopts the SLP method, fully considers the logistics and non-logistics factors affecting the equipment layout, through analysis, design, comparison, determines the reasonable equipment layout scheme, and uses the hierarchical weighting factors to compare and evaluate the design scheme and selects the optimal scheme to realize the goal of creating a decontamination station that is convenient, safe, reasonable, efficient and effective in utilizing resources and space, and provides a scientific method for the construction of the decontamination station.

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