Designing Facility layout and effective material handling for a ceramic insulator plant

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Abstract - Material handling is a necessary and significant component of any productive activity. It is something that goes on in every plant all the time. Material handling is the art and science of moving, storing, protecting, and controlling material.

Our project focuses on effective material handling, more specifically material movement within the plant. In this regard firstly the whole system was studied and the manufacturing process of insulators was studied in detail from raw materials till finished goods. This system study gave us input for our project as to improve the material movement in glazing, loading and kiln section. As the layout of the plant was the main obstacle in this regard, we thought of designing a new optimum layout which would reduce the material handling effort. The methodology use was systematic layout planning (SLP) given by Richard Muther. This methodology has three stages analysis, search and selection of layout. In analysis stage the inputs were collected, sequence of operation was charted using flow process chart (chart which uses flow process symbols of note the sequence of operations using operation, transportation, inspection, delay and storage) and also flow diagram of the area of consideration was drawn. The relationship between each workstation was understood and a relationship chart (chart which shows the relationship between each machine with every other machine) was drawn. Using these as basis activity relationship diagram (diagram which shows each activity as a square and their relationship using lines) and space relationship diagram were drawn. Instead of manual placement of departments that is on trial and error method we used ALDEP software to get optimum layout. With this as input we have designed three proposed layouts by taking all limitations into consideration. The evaluation is done by a senior manager in that origination.

Key Words: Facility **Layout, Systematic Layout Planning**

1. INTRODUCTION

It is the physical arrangement of equipment and facilities within a plant. Optimizing the layout of a plant can improve productivity, safety and quality of products. Un-necessary efforts of material handling can be avoided when the plant layout is optimized .Plant layout techniques apply to the case where several physical means have to be located in a certain area, either industrial processes or services. The basic objective is to ensure a smooth flow of work, material, people and information. There are probably two levels at which layouts are required. In one, the various departments have to be sited, and in other the items of equipment within a department need to be located.
Criteria for a good layout

1. Maximum flexibility: A good layout will be one which can be rapidly modified to meet changing circumstances.
2. Maximum co-ordination: Entry into, and disposal from, any department or functional area should be in such a manner that it is convenient to the issuing or receiving departments. Layout requires to be considered as a whole and not partially.
3. Maximum use of volume: Facilities should be considered as cubic devices and maximum use made of the volume available. This principle is particularly useful in stores, where goods can be stacked at considerable heights without inconvenience, especially if modern lifting devise are use. In offices, racking can be installed to minimize use of floor space.
4. Maximum visibility: all the people and materials should be readily observable at all the time; there should be no 'hidden place' into which goods or information can get mislaid. Criteria for a good layout.
5. Maximum accessibility: All servicing and maintenance points should be readily accessible. For example, equipment should not be placed against a wall in such a manner that necessary maintenance cannot easily be carried out.
6. Minimum distance: All movements should be both necessary and direct. Handing work adds to cost but does not increase value; consequently any unnecessary or indirect movements should be avoided.

1.1 TECHHNOLOGIES- THE STRENGTH OF EPD

The manufacturing process of EPD employs state of art technology for insulators. The result of the same is evident wherein, BHEL-EPD indigenously developed the HVDC insulators used in transmission of power at 500kv first time in the county and EPD being only third company in the world to develop.

Insulators and certain are manufactured using the classical ceramic processing technologies viz. grinding, dewatering, shaping, dry finishing, glazing, firing and assembly, the equipment and facility control on the process, energy and emission parameters can be controlled for optional performance.

1.2 DATA COLLECTION AND ANALYSIS

1.2.1 SLP METHODOLOGY

We followed SLP methodology given by Richard Muther. It has three stagesAnalysis, Search and Selection stages.

ANALYSIS STAGE

In this stage input data is collected, flow of materials is known by drawing flow process chart and activity relationship chart is drawn.

Step 1: Gathering Inputs

In this regard BHEL EPD manufacturers a large range of products from 33kV to 800kV insulators. The area we concentrated on, manufactured hollow and station post insulators and also based on the specific orders they manufactured special type of insulators as per the requirements.

Quantity of products manufactured was based on the order received and on product availability (stock of finished goods).

The routing process of material was understood in the system study where we studied every single operation which was being carried out.

Our area of consideration was from drying chamber to loading to insulators into respective kilns. The activities in this area are dry finishing which required 2 operators for each machine, dust removal requires 1 operator, and glazing operation requires 2 operators for each machine, sanding operation requires 2 operators and stamping operation requires 1 operation. Loading operation requires 3 operators.

Time required for each operation from dry finishing till loading to kilns is charted in the flow process chart. Insulators get dried in tunnel dryer, and for every 4hrs one insulator comes out and a new insulator is put inside. Tunnel drier has a capacity to put 4 insulators at a time. Dry Finishing operation takes 9.1 minutes for one insulator and dust removal operation takes 3.9 mm, glazing operation takes 10.4 mm for one insulator, sanding 12.4 mm and stamping takes 3 mm. insulators are stored in storage room based on the kiln availability

Step 2: Determining physical Flow

In this step physical flow of material was determined using flow diagram and process steps were studied in detail then charted using material flow process chart. The flow of the materials on the present layout as shown in the Fig 5.1. The flow chart is shown in Fig 5.2. Flow process chart was drawn and is as shown in the Fig 5.5.

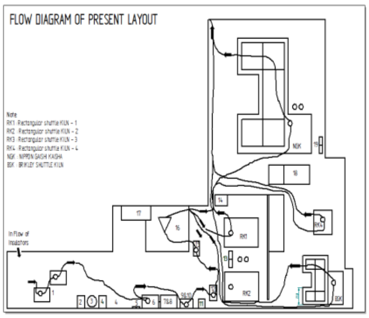

Fig 1.1 Present Layout

Step 3: Determining physical requirements

As it is improving of present layout the number of machines and workers are fixed by management. The volume of products to be manufactured is based on the orders got.

Step 4: Determining support activities required

The supporting activities such as maintenance, cleaning, quality control works are done regularly and are scheduled on daily, weekly and on monthly basis.

Step 5: Creating Physical flow Relationship Charts

The second main phase of SLP is creation of relationship chart. This was drawn as shown in the Fig 5.4. The Figure depicts the sequenced process flow of insulator manufacturing, the close link between each machines and separation of materials which have be kept apart.

Step 6: identify physical space requirements

The area of each equipment and facility was measured and is shown in the table 5.1. The total floor space available from tunnel dryer to assembly section was 5745 square meter as shown in the Fig 5.3.

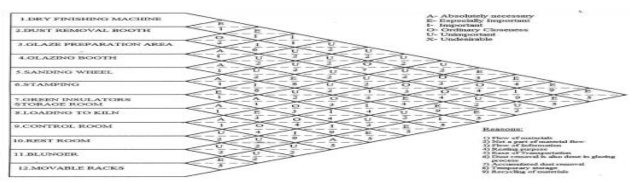

Fig 1.2 : ACTIVITY RELATIONSHIP CHART

Based on space relationship diagram, facilities are cut to the scale based on its area on a card board and were manually moved on the layout so as to get proposed layouts. We also took the help of ALDEP software to evaluate the relationship between each department. Based on the output of ALDEP which is shown in the Fig 5.9 we modified the layout taking all building constraints in to account. The total material handling effort of present layout is shown in the table 5.2.., which is the product of frequency and distance travelled.

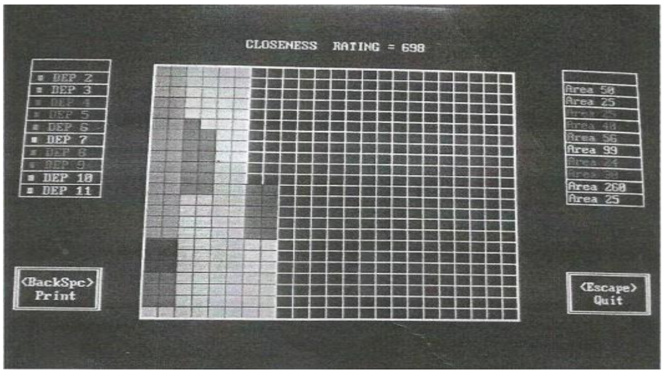

Fig 1.3: A screenshot showing the optimum layout as an output from ALDEP software with closeness rating 698.

Step 10: Modify layouts to meet practical limitations.

The kilns such as NSK, RK-1, RK-2, RK-4 and BSK cannot be moved as the cost for moving them will be high and there is lot of risk involved. Taking the aforementioned fact "THREE PROPOSED" layouts were designed and modified so as to reduce the material handling effort. The first proposed layout is shown in Fig 5.10. The second proposed layout is shown in the Fig 5.11 and modified second layout is shown in Fig 5.12 and the third proposed layout in Fig 5.13.The material handling efforts of first, second, second modified and third proposed layouts are shown in Table 5.3, 5.4, 5.5, 5.6 respectively.

Table 1: Table showing material handling of present layout

FROM	TO	DISTANCE	FREQUENCY	MATERIAL HANDLING Effort
Dry chamber	Dry Finishing Area	26.7	24	640.8
Dry Finishing Area	Blunger Tank	44.8	3	134.4
Blunger Tank	Dust Removal Booth	29.4		0
Dust Removal Booth	Dipping and Glaze Preparation Booth	24.4	21	512.4
Dipping and Glaze Preparation Booth	Glazing Booth	14	19	266
Glazing Booth	Rest room	18.4		0
Rest room	Sand groging area	6.4		
	stamping and groging	14.2	19	269.8
	Storage room	28.6	18	514.8
storage room	NGK KILM	42.3	1	42.3
storage room	RK1	21.7	1	21.7
storage room	RK2	32.3	1	32.3
storage room	RK 4	63.7	1	63.7
storage room	BSK Kiln	57	1	57
				TOTAL =2555.2

Fig 1.4: First proposed layout

Table 2: Table showing the material handling effort of first proposed layout

Fig 1.5: Second proposed layout

Table 3: Table showing the material handling effort for second proposed layout

FROM	TO	PROPOSED DISTANCE	PRESENT DISTANCE	REDUCED	FREQUENCY	MATERIAL HANDLING EFFORT
Dry chamber	Dry Finishing Area	27.6	26.7	0	24	662.4
Dry Finishing Area	Blunger Tank	12.7	44.8	32.1	3	38.1
Blunger Tank	Dust Removal Booth	11.01	29.4	18.39		0
Dust Removal Booth	Dipping and Glaze Preparation Booth	15.57	24.4	8.83	21	326.97
Dipping and Glaze Preparation Booth	Glazing Booth	4.56	14	9.44	19	86.64
Glazing Booth	Rest room	12.01	18.4	6.39		0
Rest room	Sand groging area	21.5	6.4	0		0
	stamping and groging	0	14.2	14.2	19	0
	Storage room	5.72	28.6	22.88	18	102.96
storage room	NGK KILM	23.61	42.3	18.69	1	23.61
storage room	RK1	9.28	21.7	12.42	1	9.28
storage room	RK2	5.35	32.3	26.95	1	5.35
storage room	RK 4	59.43	63.7	4.27	1	59.43
storage room	BSK Kiln	28.97	57	28.03	1	28.97
				TOTAL =202.59		TOTAL=1343.71

Fig 1.6: Modified Second layout

Fig 1.7 : Modified second proposed layout

Table 4: Table showing material handling effort of modified second proposed layout

FROM	TO	PROPOSED DISTANCE	PRESENT DISTANCE	REDUCED	FREQUENCY	MATERIAL HANDLING EFFORT
Dry chamber	Dry Finishing Area	27.6	26.7	0	24	662.4
Dry Finishing Area	Blunger Tank	12.7	44.8	32.1	3	38.1
Blunger Tank	Dust Removal Booth	11.01	29.4	18.39		0
Dust Removal Booth	Dipping and Glaze Preparation Booth	15.57	24.4	8.83	21	326.97
Dipping and Glaze Preparation Booth	Glazing Booth	4.56	14	9.44	19	86.64
Glazing Booth	Rest room	12.01	18.4	6.39		0
Rest room	Sand groging area	21.5	6.4	0		0
	stamping and groging	0	14.2	14.2	19	0
	Storage room	5.72	28.6	22.88	18	102.96
storage room	NGK KILM	23.61	42.3	18.69	1	23.61
storage room	RK1	9.28	21.7	12.42	1	9.28
storage room	RK2	5.35	32.3	26.95	1	5.35
storage room	RK 4	59.43	63.7	4.27	1	59.43
storage room	BSK Kiln	28.97	57	28.03	1	28.97
				TOTAL =202.59		TOTAL=1343.71

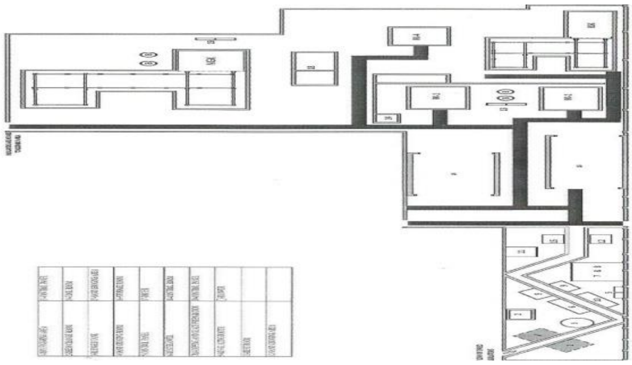

Fig 1.8: Third proposed layout

Table 5: Table showing the material handling effort for third proposed layout

FROM	TO	PROPOSED DISTANCE	PRESENT DISTANCE	REDUCED	FREQUENCY	MATERIAL HANDLING EFFORT
Dry chamber	Dry Finishing Area	10.87	26.7	0	24	260.88
Dry Finishing Area	Blunger Tank	8.3	44.8	36.5	3	24.9
Blunger Tank	Dust Removal Booth	17.15	29.4	12.25		0
Dust Removal Booth	Dipping and Glaze Preparation Booth	15.02	24.4	9.38	21	315.42
Dipping and Glaze Preparation Booth	Glazing Booth	11	14	3	19	209
Glazing Booth	Rest room	13.05	18.4	5.35		0
Rest room	Sand groging area	11.29	6.4	0		0
	stamping and groging	0	14.2	14.2	19	0
	Storage room	9.7	28.6	18.9	18	174.6
storage room	NGK KILM	23.61	42.3	18.69	1	23.61
storage room	RK1	9.28	21.7	12.42	1	9.28
storage room	RK2	12.35	32.3	19.95	1	12.35
storage room	RK 4	59.43	63.7	4.27	1	59.43
storage room	BSK Kiln	28.97	57	28.03	1	28.97
				TOTAL =182.94		TOTAL=1118.44

3. CONCLUSIONS

Systematic layout planning techniques we were able to design an improved plant layout and were able to overcome all the constraints of the existing plant layout. Hence optimum utilization of the layout and better material handling were achieved.

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