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CHEMICAL SAFETY ANALYSIS IN WATCH MANUFACTURING INDUSTRY

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Abstract - *The objective of the project is to analyze the chemical in various aspects and identify the safety improvements need to be done in the chemical handling process like Loading / unloading, Storing, Transporting, and Disposal. In watches and wearables unit there are number of active chemicals used for the manufacturing or supporting the manufacturing process. In the project, main area of focus is the most active chemical usage in various departments and their divisions. In the area, 53 percentage of total chemical handling and usage was happening so the area was having high risk of accidents and possible health hazard among workers who handling and working with chemical. Through GAP analysis workbook we can obtain the safety gaps between the current state and the ideal state. At the end, the safety GAPs were recommended with the solution in the hierarchy of Elimination, Substitution, Engineering Control, Administrative Control, and PPE.*

***Key Words*: chemical analysis, Gap assessment, flammable and toxic chemicals**

1.INTRODUCTION

In watches and wearable division mainly focus on producing wrist watches and wearables. In a process of manufacturing involves with few toxic and flammable chemicals it is having some significant risks during chemical storing, handling, transporting and disposing. In the watch and wearable division there are number of chemicals for the process usage. This project mainly focused on the safety improvements need to be done for reducing the risk for the workers in the process of chemical handling in watch and wearable division.

The process of chemical work doing inside the factory was classified as follows

- Purchasing and receiving the chemical for the storage area
- Storing the chemical in the chemical storage area
- Handling of chemical (loading and unloading of chemical from/to shop floor)
- Transportation of chemical from storage to work location
- Disposal of chemical from empty storage section

2. METHODOLOGY

A gap analysis is a method of assessing the performance of a business unit to determine whether business requirements or objectives are being met and, if not, what steps should be taken to meet them. A gap analysis may also be referred to as a need's analysis, needs assessment or need-gap analysis. The "gap" in the gap analysis process refers to the space between "where we are" as a part of the business (the present state) and "where we want to be" (the target state or desired state). GAP analysis is a formal way to identify the current gaps between desired levels and actual levels of performance it can be apply for all kind of industries and organization to analysis from certain process to whole system performance.

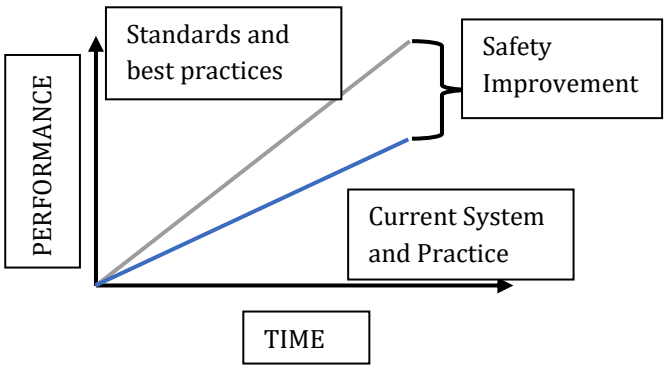


Fig 1: Gap Analysis Chart

2.1 STEPS TO CONDUCT THE PROCESS

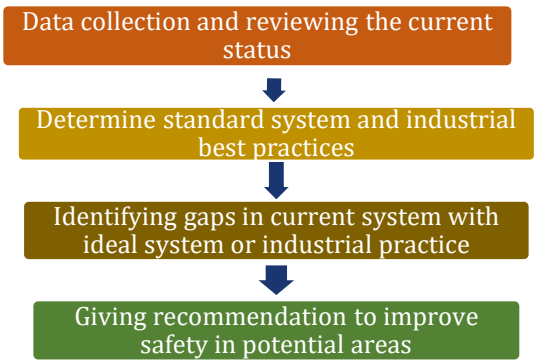


Fig 2: Process Steps

2.1.1 Data collection and reviewing the current status

The next step is to analyze current processes by collecting relevant data on performance levels and how resources are presently allocated to these processes. This data can be collected from a variety of sources depending on what is being analyzed

2.1.2 Determine standard system and industrial best practices

Chemical handling process for all chemicals used in production site was assess by using the Legal requirements, MSDS and industrial best practices. Ideal state of the chemical handling process was identified by using the literature papers and applicable standards.

2.1.3 Identifying gaps in current system with ideal system or industrial practice

The comparision was done between the current practices, existing safety devices and PPE's with the standard ideal state and Industrial best practices in chemical handling. As a result we obtained the gap between the ideal and the present state.

2.1.4 Providing Suitable Recommendation to improve safety in potential areas

Safety gap obtained from the GAP assessment workbook was identified with best engineering solution. Recommendation for the gap fulfilment was assist by hierarchy of Elimination, Substitution, Engineering Control, Administrative control, and PPE.

3. DATA ANALYSIS

The analysis can be done through various prospect like properties, chemical group, state of matter, and through NFPA rating

Step 1: Analysis the chemical based on state of matter like solid, liquid and gas

Physical state	Count of CHEMICAL
GAS	5
LIQUID	166
SOLID	132
Grand Total	**303**

Table 1: State of Matter

Step 2: Analyze the chemical based on chemical group

Chemical group	Count of CHEMICAL NAME
In-Organic Acid	17
In-Organic Base	5
In-Organic Compound	77
Remaining	157
Organic Acid	9
Organic Compound	38
Grand Total	**303**

Table 2: Chemical group

Step 3: Analyze the chemical based on the properties of chemical

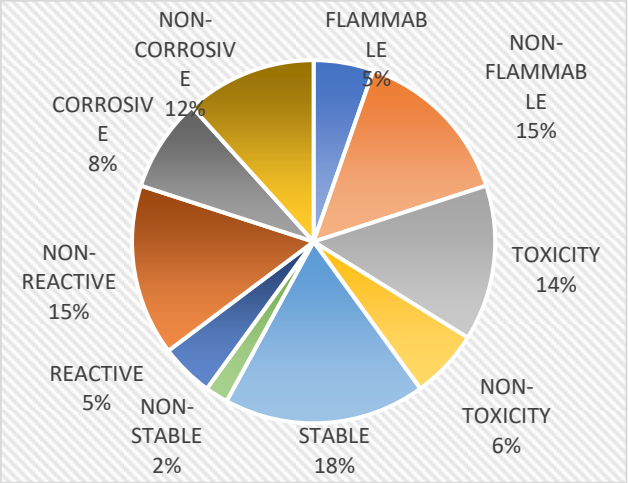


Chart 1: Properties of Chemical

PROPERTIES	Count of CHEMICAL
Flammable	81
Non-flammable	222
Non-toxic	93
Toxic	210
Non-stable	31
Stable	272
Non-reactive	231
Reactive	72
Corrosive	126
Non-corrosive	177
Grand total	**303**

Table 3: Properties of chemical and Number of chemicals

STEP 4: Find out highly flammable, highly toxic, and highly reactive

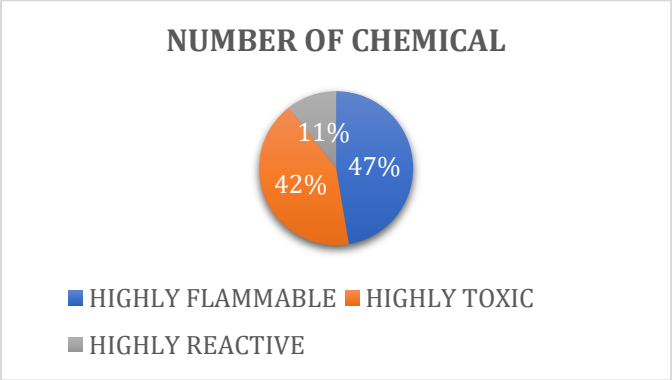


Chart 2: Properties, Number of chemicals

HIGHLY FLAMMABLE CHEMICAL USED INSIDE THE PREMISES BASED ON NFPA RATING (LEVEL 4)

1) 1-butanol
2) Ammonium sulphide
3) Boron nitride spray
4) Formic acid
5) Formic acid - LR grade
6) GTN stripper
7) Met strip s-60
8) Nickel additive - 22
9) Niplex a 20

HIGHLY HEALTH HAZARD CHEMICAL BASED ON NFPA RATING (LEVEL 4)

1) Hydrofluoric acid - comm. Grade
2) Hydrofluoric acid - LR / SQ grade
3) Mercuric sulphate crystals -
4) Niplex b
5) Nitric acid - AR grade
6) Nitric acid - cp grade
7) Silica gel blue 5-8 mesh
8) Standard potassium dichromate (k2cr2o7)

HIGHLY REACTIVE CHEMICAL BASED ON NFPA RATING (level 3)

1) GTN stripper code: 129
2) Silver nitrate - 25 grams
3) The graph shows the remaining chemicals NFPA level vs No of chemical.

The following tables shows the remaining level of chemical based on NFPA rating:

Flammability rating	No of chemical
LEVEL 0	145
LEVEL 1	97
LEVEL 2	24
LEVEL 3	27
LEVEL 4	9

Table 4: Flammability level

Reactivity Rating	No of chemical
LEVEL 0	202
LEVEL 1	75
LEVEL 2	23
LEVEL 3	2

Table 5: Reactivity level

Toxicity Rating	No of chemical
LEVEL 0	23
LEVEL 1	155
LEVEL 2	74
LEVEL 3	42
LEVEL 4	8

Table 6: Toxicity level

STEP 7: TO FIND OUT THE HIGHLY FLAMMABLE LIQUID AND THEIR USAGE INSIDE THE DEPARTMENT

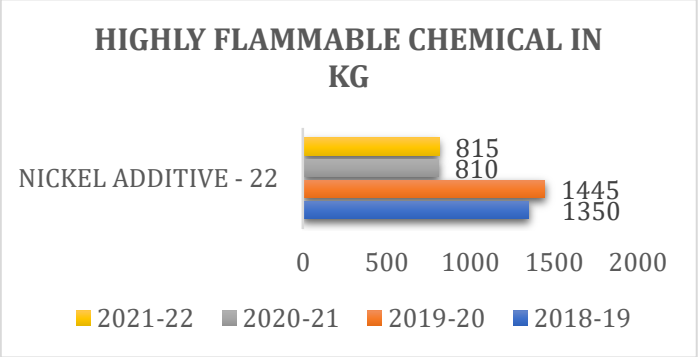
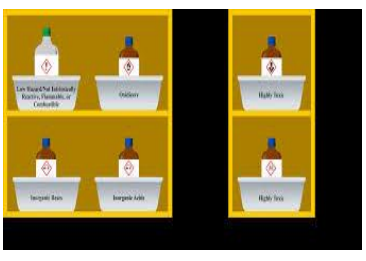
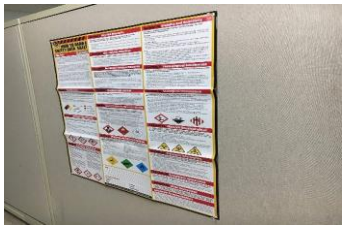


Chart 3: Highly Flammable Chemical and their Uses

LOGO	GAP ASSESSMENT FOR CHEMICAL HANDLING		
	DEPARTMENT : SAFETY	Doc no:	Rev:
		Date	Page no:
	PROCESS: STORAGE	Classification:	Referance :
		Location:	

S.no	Current Practice	From Standard (Safety Gap)		Recommendation (As Per IS Standard)
1	No adequate space inside the storage room The worker couldn't walk freely. 	The drums should be stacked in an orderly manner so that all parts of the storage space are accessible	OISD 6.2 Storage of hazardous chemicals	Adequate space for storage and pathways 
2	Poor maintenance of chemical spill way 	There should be provision to collect accidental spills for safe disposal.	OISD 6.2 Storage of hazardous chemicals	Provision for accidental spills of chemical should be maintained properly 
3	No availability of chemical spill kit 	There should be provision to collect accidental spills for safe disposal.	OISD 6.2 Storage of hazardous chemicals	Chemical spill kit must be used for collecting the chemical 
4	Excess storage of chemical 	chemical should not stored excessively beyond the allocated area	Industrial best practice	Store appropriate containers within the allocated space. 
5	Containers placed randomly one over another 	Chemical containers must be arranged in manner that it should not collapse.	Industrial best practice	Stored a chemical in well alligned way 

6	storage area not enclosed 	chemical should be stored under enclosed place to avoid fall of sunlight and foreign material intrusion	Industrial best practice	Storage area must be enclosed 
7	oil spillage in storage area 	oil spillage in the storage room could lead to slip,trip, and fall	Industrial best practice	Need of good house keeping 
8	chemical containers are closely arranged 	The drums should preferably be stored in a well ventilated shed (preferably away from process units) with impermeable floor sloping away from drums.	OISD 6.2 Storage of hazardous chemicals	chemical containers should be arranged with adequate space 
9	Chemical containers kept under direct sunlight 	(c) Toxic Substances : These substances must be stored in well ventilated areas, preferably cool and certainly away from direct sun rays.	OISD 6.2 Storage of hazardous chemicals	Encloser to avoid sunlight intrusion 
10	Chemical container are not segregated as per composition 	The tanks should be located so as not to pose safety problems due to leakage and reaction with other chemicals stored nearby. The environment at the location must be compatible with the chemical stored.	OISD 6.2 Storage of hazardous chemicals	chemical containers must be stored seperately based on chemical composition 

11	Use of poor electrical extension 	(a) All electrical apparatus shall either be excluded from the area of risk or they shall be of such construction and so installed and maintained as to prevent the danger of their being a source of ignition;	TN factories rule 1950 Schedule XXIV	Use of appropriate fire proof electrical apparatus 
12	Chemical containers left too long in its place. 	Requirements relating to possible physical and chemical changes in stored chemicals (e.g. not to store beyond the expiration period recommended on the label and the chemical safety data sheet);	ILO 6.7. Control measures for the storage of hazardous chemicals	Expired chemical containers must be removed from storage area 
13	empty cans placed without chain guard 	Empty cans should not be stored without chain in a rack. Force wind may move empty containers out of its place	Industrial best practice	Provide chain guards and store under enclosed place 
14	Non availability of smoke detectors in storage area 	Smoke detectors can reduce the consequences of fire	Industrial best practice	Installation of smoke detectors 
15	Non availability of PPEs in its place and first aid box. 	Use suitable personal protective clothing / equipment. Suitable breathing canisters and first aid box must be available at site for use in case of emergency.	OISD 6.3 Handling of hazardous chemicals	Make sure the availability of PPEs in its place 
16	Non availability of MSDS in storage area 	MSDS will be helpful in emergency situation such as accidental spill, treatment, putting off	Industrial best practice	Make availability of MSDS in an easy access area 

LOGO	Gap Assessment For Chemical Handling		
	Department : Safety	Doc no:	Rev:
		Date	Page no:
	Process : Transportation	Classification:	Referance :
		Location:	

S.no	Current Practice	From Standard (Safety Gap)		Recommendation (As Per IS Standard)
1	transporting chemical barrel in a pallet trolley 	workers should attach handles or holders to loads.	OSHA 2236 Material Handling and Storage	Use suitable cardles or drum handling equipments 
2	transporting chemical without PPEs 	workers should always wear appropriate personal protective equipment and use proper lifting techniques.	OSHA 2236 Material Handling and Storage	Use appropriate PPEs while transporting chemicals 
3	Manual handling of heavy chemical containers. 	Lifting of 50 litre chemical containers causes workers discomfort and back pain	Industrial best practice	Use mechanical handling equipments 
4	Placing chemical pump over the chemical container 	Keeping the chemical pump over the chemical container and moving may cause roll and fall of pump from its place.	Industrial best practice	chemical pump must be handled seperately. 
5	No stopping mechanism 	There is no stoping mechanism attached to the trolley	Industrial best practice	stopping mechanism will help in a steep way to avoid undesired movement 

LOGO	Gap Assessment For Chemical Handling		Doc no:	Rev:
			Date	Page no:
	Department : Safety		Classification:	Referance :
	Process : Disposal		Location:	

S.no	Current Practice	From Standard (Safety Gap)		Recommendation (As Per IS Standard)
1	Chemical containers are not disposed safely. 	Safe disposal of empty containers of hazardous chemicals should be done based on guidelines given by the Vendors.	Oil Industry Safety Directorate 6.3 Handling of hazardous chemicals	Empty containers should be disposed off as recommended by the vendor
2	stored container with used chemical in it 	Empty drums should be removed away and made free of its contents before being kept in safe place.	OISD 6.2 Storage of hazardous chemicals	Used drums must be drained off to a safe place and seggregated

CONCLUSION

In this watch manufacturing industry, there are 303 active chemicals inside the premises and 122 active chemicals inside the department and their divisions having its own potential hazards at every places and workers who handling with chemicals. By the analysis for chemical in various aspects and gap analysis by comparing the current practice with Indian standards to indicate the safety gap in the process. More reduce the safety gap, greater the safety would implement in the system. For every step, the hierarchy of principle has been taken into consideration for providing a solution.

REFERANCES

- Balaji G*, Potdar Aditee and Unnikrishnan Seema "Environmental Legislation for Chemical Management in India: An Agenda for Reforms" Journal of Environmental Research and Development Vol. 9 No. 02, October-December 2014 page No 494-506.
- Ranjith RamaVarma,Dr, Dr, Dr. N. A. Siddiqui "Study of gap analysis on HSE management system- consolidated contractors' company clean fuel project Kuwait" IJISET – International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 2, February 2016 page No 535-542.
- Miroslav Hernciar "Gap analysis of approaches to implementation of management systems" ResearchGate DOI: 10.12776/QALI.V1. #5 page No 52-61
- Maurizio BRUGLIERI, Roberto MAJA, Giovanna MARCHIONNI, Giovanni RAINOLDI Safety in Hazardous Material Road Transportation: State of the Art and Emerging Problem" ResearchGate January 2008.
- Manufacture, Storage and Import of Hazardous chemical rule 1989.
- Hazardous waste management Rule 2016
- "Technical EIA guidance manual for isolated storages handling Hazardous chemicals" Prepared for the ministry of Environment and forests, Government of India.