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HANDLING, STORAGE AND DISPOSAL OF CHEMICALS IN ELECTRONIC MANUFACTURING INDUSTRY

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ABSTRACT

This document specifies requirements for an occupational health and safety (OH&S) management system, and gives guidance for its use, to enable organizations to provide safe and healthy workplaces by preventing work-related injury and ill health, as well as by proactively improving its OH&S performance. This document is applicable to any organization that wishes to establish, implement and maintain an OH&S management system to improve occupational health and safety, eliminate hazards and minimize OH&S risks (including system deficiencies), take advantage of OH&S opportunities, and address OH&S management system nonconformities associated with its activities. This document helps an organization to achieve the intended outcomes of its OH&S management system. Consistent with the organization's OH&S policy, the intended outcomes of an OH&S management system.

KEYWORDS: Health, PPE, Hazards & Exposure.

1. INTRODUCTION

Hi-P established its industrial roots as an insert molding and metal forming tool maker founded in 1980. In 1983, current Executive Chairman and Chief Executive Officer, Yao Hsiao Tung acquired management of company. After the worldwide recessions of the mid 80's, Hi-P's success flourished with the expansion of overseas manufacturing facilities in 1993. Robust growth throughout the next 10 years, Hi-P is now known as one of the many defining moments, a listing on SGX, the Singapore stock exchange. Today, as a leading contract manufacturing provider, Hi-P maintains a clear focus in contributing to our clients' competitive advantage by developing and providing manufacturing solutions of exceptional value. An efficient, continuous work flow, utilizing the latest in technology and waste-free operations are the hallmark of the company. Coupled with its solid relationships with clients, these elements have provided the economic support to allow Hi-P to grow as a business that lives by its core values of integrity and finding the best possible solutions for our customers.

EXECUTION FOUNDATION - A strong Execution Foundation has been the cornerstone of the successful implementation of our corporate strategy over the years. At Hi-P, we are performance driven and yet, people-centred. Our people seek continuous improvement in all areas so as to maximize results. The principles of our execution foundation are applied consistently throughout all functional areas, from Finance, HR, Supply Chain, Quality, IT, to Business Development and Operations.

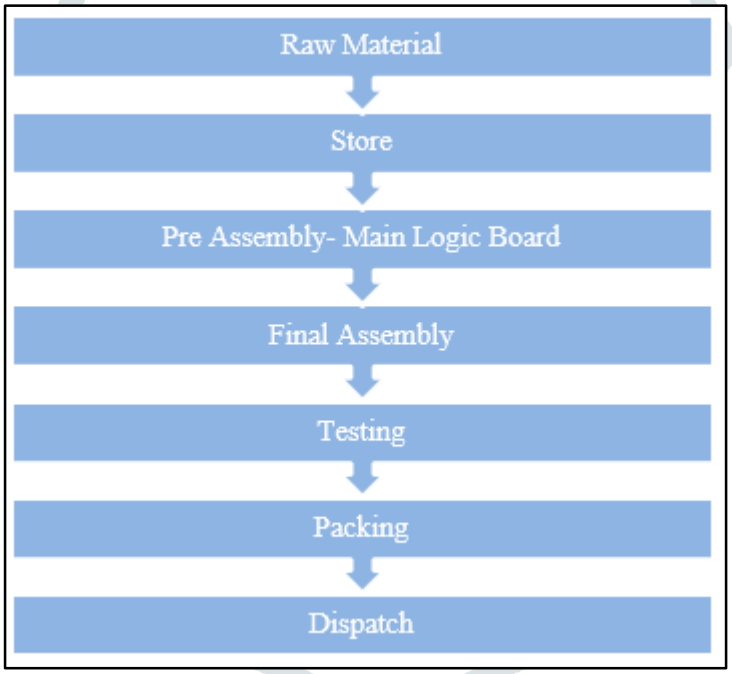
BUSINESS UNIT - Hi-P employs a business group strategy that maximizes the economies of scale of our centralized core services, such as manufacturing, procurement, logistics and IT and customized, market-specific capabilities. This structure enables us to deliver highly competitive services in an increasingly complex industry with an optimal customer in each unit. It also allows us to make fast, flexible decisions in response to changing market condition. To that end, Hi-P provides value-added service to support our customers through the following four business unit.

GREATER CHINA BUSINESS UNIT - Great China Business Unit covers industries in mobile phones and wearable electronics to home entertainment equipment in China and Taiwan region. It mainly served customers from Greater China industry leaders and helping them bring new business models and products to market. It deliver solutions vary from complex printed circuit board assembly to simple product integration, with production capabilities of several thousand units.

CONSUMER ELECTRONICS BUSINESS UNIT - Consumer Electronics Business Unit covers home appliances, computing peripherals and medical industries. With industry-leading experience in fully integrated in computing solutions, vertical integration of key enabling technologies, including tool design, mechanical and global sourcing with supply chain expertise; It specializes in manufacturing lower volume, highly mixed products for all industries.

EMS/ODM BUSINESS UNIT - EMS and ODM business unit mainly covers the customer in wireless devices including smartphones, tablets wearables and other immersive wireless devices. With our extensive electronic and mechanical design capabilities, we can support customers in original design manufacturing and joint design manufacturing projects using industry-leading technologies. With the support of Hi-P Singapore design center and EMS Suzhou Site, this business unit produces complete integrated product solutions that reduce project complexity and enhance time-to-market

2. PROCESS FLOW



The process flow of the industry explains the total process of the industry. Raw materials are procured from various vendors. Thus, the procured material is stored in the respective department warehouse. In PCB making stage, there are various assembly lines which carries out its specific operations like paste and glue coating over PCB, Inspection of coating, heating in Oven, Cleaning PCB using Strong Solvents, UV Inspection and curing. After all this process the board is transferred to FATP stage. In Final Assembly, testing and packing Stage, components other than PCB in a Smartphone's can be assembled, tested and packed efficiently. These all process are carried out in a Dust free environment named as FFU (Fan Filter Unit). Thus, after packaging thus products are moved to dispatch section. In that dispatch section the finished products are directed to the Supplier (Apple). These are the process flow in the industry.

3.LITERATURE REVIEW

"SAFETYCULTURE BEHAVIOR IN EMS" IS THE PAPER THAT HAS BEEN PUBLISHED BY YUSUF HJ OTHMAN IN THE YEAR OF 2016. This paper implementation of Occupational safety and health (OSH) in the organization, there have been an improvement in term of safety in the workplace. However, there are still some cases of accident being reported even after the organization management provided training, introducing stricter rules and regulation regarding safety, and provides proper equipment to the employee. Based on the findings, several recommendations are being put forward in order to improve the safety culture behavior among employees in the organization. For future research in the same area, it is being recommended to include management commitment,

leadership, safety education, and training under scrutiny in order to understand its relationship with safety culture behaviour among employees.

"SAFETY AND HEALTH AT WORK" IS THE PAPER THAT HAS BEEN PUBLISHED BY KIM EUN-A IN THE YEAR OF 2018. This paper present the scientific research to improve workers heath and safety by eliminating occupational accidents and diseases, pursuing a better working life, and creating a safe and comfortable working environment. The journal focuses primarily on original articles across the whole scope of occupational health and safety but also welcomes up-to-date review papers and short communications and commentaries on urgent issues and case studies on unique epidemiological survey methods of accident investigations and analysis. High priority will be given to articles on occupational epidemiology, medicine, hygiene, toxicology, nursing and health services, work safety, ergonomics, engineering of safety (mechanical, electrical, chemical, and construction), safety management.

"ERGONOMICS IN ELECTRONIC INDUSTRY" IS THE PAPER THAT HAS BEEN PUBLISHED BY V.L. PAQUET IN THE YEAR OF 2006. This paper presents that Electronics manufacturing often requires small batch sizes and a large variety of products that change quickly with time, and therefore highly automated manufacturing systems are not often used to produce such products. The processes often require manual assembly tasks performed by operators that could potentially lead to work related musculoskeletal disorders (WMSDs) and the implementation of an ergonomics program in an electronics assembly and manufacturing plant to prevent WMSDs. The program comprises of ergonomics job evaluations, job rotation, ergonomics design, guidelines and training; each implemented with a varying degree of success. The results indicate that relatively simple tools can be used to identify effective ergonomics solutions, particularly when a participatory approach is used.

"WORLD AT WORK" IS THE PAPER THAT HAS BEEN PUBLISHED BY D KOH IN THE YEAR OF 2004. This paper presents an effective occupational health and safety programmed within the electronics workplace will involve the integration of specific programmers, for example, those targeting chemical safety and improved ergonomics, health surveillance, etc into a coherent and comprehensive health and safety management system. In addition, well informed workers and an effective surveillance system can prevent work related diseases and accidents.

4.PROBLEM IDENTIFICATION

4.1 IDENTIFICATION OF PROBLEMS

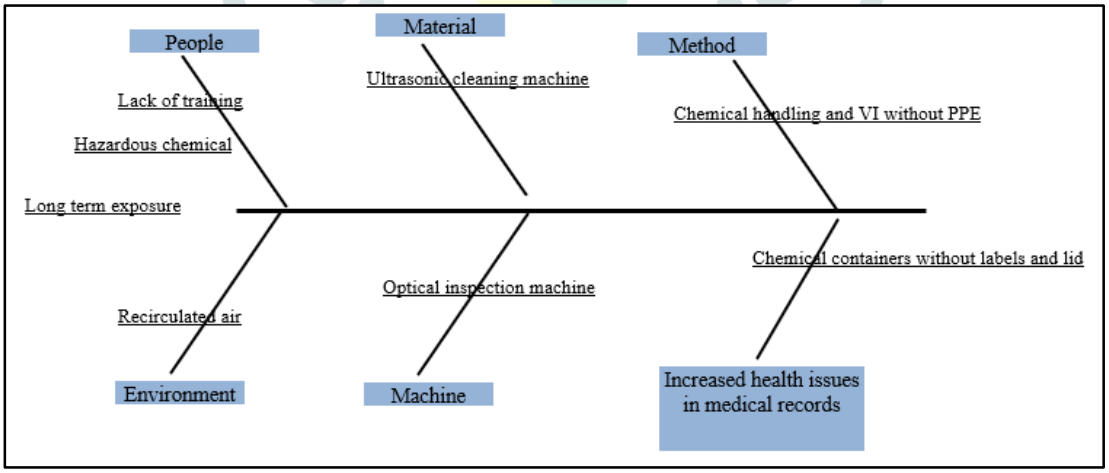


FIG:1 FISHBONE ANALYSIS

From the fish bone analysis, the root cause of the increased health issues in medical records are

Inadequate PPE when expose to hazardous chemicals and manufacturing process.
Lack of training and awareness about the hazards in the manufacturing process.
Long term exposure to recirculate air.

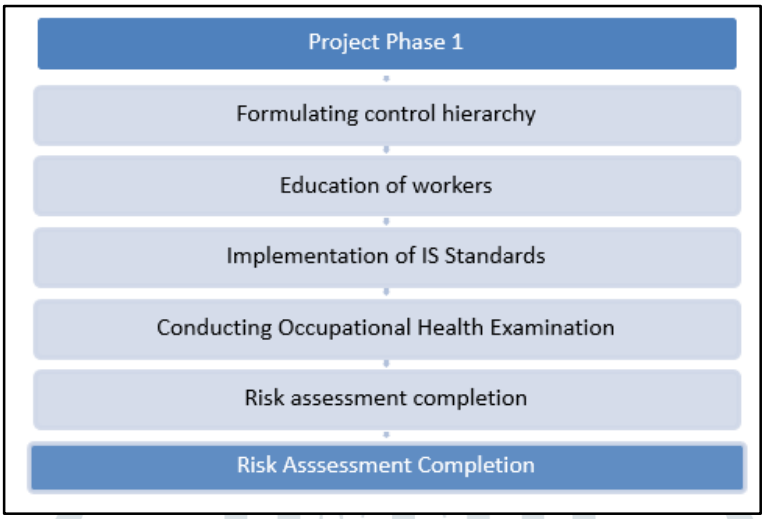
4.2 IDENTIFICATION OF PROBLEMS

Control actions need to be determine for reducing the skin problems, dizziness and eye problems related to their hazardous process and promote safety of the employees working in the electronic manufacturing area. Thus,

the problems of personal exposure to hazardous factors which are to be corrected to reduce those mentioned hazards in electronic manufacturing process.

5. METHODOLOGY

The proposed methodology is presented in below diagram. This describes the procedure in which the work would be carried out.



5.1 FORMULATING CONTROL HIERARCHY

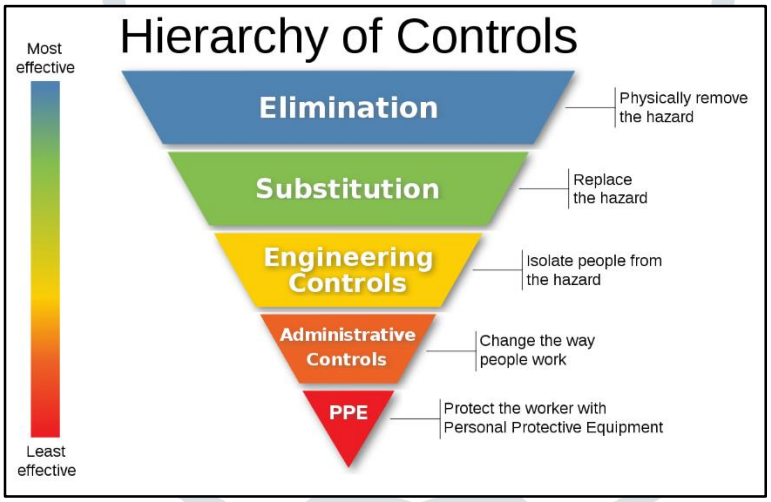


FIG:1 CONTROL HIERARCHY

The best method of controlling potential occupational safety and health hazards is through the implementation of the hierarchy of controls, i.e., elimination, substitution, engineering controls, administrative controls, and personal protective equipment. The elimination of hazards is ideal. However, where this cannot be achieved, substitution of less hazardous substances for more toxic substances provides important protection to workers. Engineering controls are widely utilized in semiconductor operations. Engineering controls are design methods such as the enclosure of hazardous substances and the implementation of local exhaust ventilation systems that prevent harmful worker exposures. Ideally, the proper time to establish engineering controls is when the workplace is being designed. However, quite often this is either not done or not possible. In these circumstances, the following measures should be considered:

5.2 IMPROVEMENTS IN CHEMICAL HANDLING

Always label all containers with chemicals.
Use protective equipment's for eye protection and make sure to wear a laboratory coat.
Avoid intentional smelling, inhaling and tasting of chemicals.
Always avoid direct contact with chemicals, far from your hands face, clothes and shoes.
Hazardous chemical should be used only as directed.
Use separate cabinets for acid solutions with concentration more than 6 M.

Mark the date on all containers upon receipt and again when reopened.

Attach chemical labels with all necessary information to all containers.

Immediately read the warning labels when opening newly received reagent chemicals. This will help to be aware of any special storage precautions such as refrigeration or inert atmosphere storage.

A periodic check on chemical containers for rust, corrosion, and leakage is a must.

Store bottles in chemical safe bags especially those hazardous and moisture-absorbing chemicals.

Avoid use of mouth suction to fill a pipette. Use a pipette bulb or other filling devices.

Smoking, drinking, eating and the application of cosmetics is forbidden in areas where hazardous chemicals are used or stored.

Always use chemicals with adequate ventilation. Check with the MSDS and also the Standard Operating Procedure to work out what type of ventilation is required.

Whenever you leave the lab after handling any chemicals wash thoroughly with soap and water. Keep your hands and face clean free from any trace of chemicals.

5.3 **IMPROVEMENTS IN STORAGE OF CHEMICALS**

Label all chemical containers fully. We recommend including the owner's or user's name along with the date received.

Provide a specific storage space for each chemical, and ensure return after each use.

Store volatile toxics and odoriferous chemicals in ventilated cabinets. Please check with your environmental health and safety personnel for specific guidance.

Store flammable liquids in approved flammable liquid storage cabinets. Small amounts of flammable liquids may be stored in the open room. Check with your local authority (e.g., fire marshal, EH&S personnel) for allowable limits.

Separate all chemicals, especially liquids, according to compatible groups. Follow all precautions regarding storage of incompatible materials. Post a chemical compatibility chart for reference, both in the lab and next to chemical storage rooms.

Use appropriate resistant secondary containers for corrosive materials. This protects the cabinets and will catch any leaks or spills due to breakage.

Sea containers tightly to prevent the escape of vapors.

Use designated refrigerators for storing chemicals. Label these refrigerators CHEMICAL STORAGE ONLY—NO FOOD. Never store flammable liquids in a refrigerator unless it is specifically designed and approved for such storage. Use only explosion-proof (spark-free) refrigerators for storing flammables.

5.4 IMPROVEMENTS IN DISPOSAL OF CHEMICAL WASTE

Store chemical wastes in appropriate containers; plastic bottles are preferred over glass for storing hazardous waste when compatibility is not an issue. Segregate chemical waste by compatibility, and not alphabetically.

Chemical waste containers must be labeled with the following information:

Full chemical name and quantity of the waste. For mixtures, each chemical must be listed. Abbreviations, acronyms and ditto marks ("") to replace words are not allowed, as this does not comply with The Hazard Communication Standard;

Date of waste generation;

Place of origin (department, room number);

PI's name and telephone number;

The tag or label must have the words: "Hazardous Waste."

A completed Hazardous Waste Information Form must be submitted to the EHS office (Instructions are on the back of the form). On this form, please include:

Full chemical name and quantity of the waste. For mixtures, each chemical and its volume or weight must list. Abbreviations, acronyms and ditto marks ("") to replace words are not allowed, as this does not comply with The Hazard Communication Standard;

Date of waste generation;

Place of origin (department, room number);

PI's name and telephone number;

A contact name is required to answer any questions or open the door;

Bottle number (in numerical order) assigned on bottle; and

A speedtype or account number.

Send the completed form to the Environmental Health and Safety OfficeThe form must be received by EHS by Tuesday at noon. Chemical waste removal will then happen on Thursday of that week. Each container must be listed separately, tagged and sealed. Leaking or open containers will not be removed.

The disposal of chemicals by sanitary sewer is only possible with written permission from EHS. Contact the Director or Chemical Waste Manager for more information.

Submit a complete list of all chemicals to be disposed of to EHS.

EHS will review and provide written approval on a case by case basis.

Any change in formulation (volume of chemical, new chemical), will require a fresh review by EHS.

Disposal of any chemical into the solid waste disposal system is not allowed.

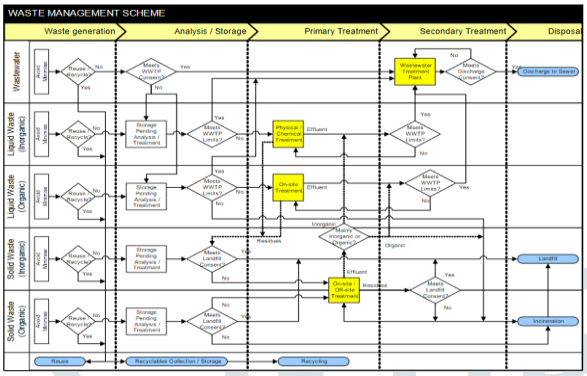


FIG :2 WASTE DISPOSAL METHODS

6.1 PERSONAL PROTECTIVE EQUIPMENT

When it is not possible or feasible to eliminate hazardous levels of air contaminants or other hazards from the workplace, it may become necessary for the employer to provide personal protective equipment so that toxic exposures may be minimized. However, personal protective equipment should only be used when it is not possible to implement elimination, substitution, engineering, or administrative controls. Personal protective equipment does nothing to minimize or eliminate the source of the problems, i.e., the hazard. Thus, if the personal protective equipment fails to work properly, the worker suffers immediate exposure to the toxic substances. Personal protective devices include eye and face protection such as safety glasses, goggles, and face shields; hearing protection like ear muffs and ear plugs; protective clothing such as gloves, coveralls, aprons, and boots; protective creams and lotions; and respirators. It is extremely important that the employer furnishes the proper type of personal protective equipment for specific work operations and exposures. For example, when an employee is working with a particular solvent, she/he should be provided the proper gloves to prevent the substance from seeping through the gloves and causing harmful skin contact. More and more, employers have begun emphasizing the use of respirators rather than implementing adequate engineering controls. Respirators should not be viewed as substitutes for engineering controls. Rather, when used, they should be seen as offering only short-term or emergency protection. An approved respirator should be appropriate for the particular hazard or work environment in which the respirator is to be utilized (e.g., dust masks should not be used to protect against chemical exposures).

6.2 OTHER CONTROLS PROCEDURES INCLUDE

MEDICAL SURVEILLANCE- The development and implementation of a comprehensive medical surveillance program is an essential element of an employer's workplace safety and health program. Such a program should include baseline and follow-up medical examinations for all workers. Exams should include a thorough medical and work history- including information on work with/exposures to hazardous substances. Results from these examinations provide baseline data that will allow for the detection and evaluation of the harmful effects of particular work operations/exposures upon individual workers. In turn, with the permission from individual workers, the union can use an individual's medical information to pressure employers to provide safe and healthful working conditions. In addition to periodic medical examinations, employers should conduct initial and periodic exposure monitoring tests where hazardous substances are use or contained. Where this monitoring is conducted in active work areas, instrumentation/industrial hygiene equipment should be equipped with an alarm mechanism that triggers a warning if contaminant concentrations reach or exceed safe levels- providing for the implementation of emergency response procedures. Monitoring data can be effectively used to help identify and control hazardous workplace exposures.

MAINTENANCE - All employers should make sure that adequate maintenance procedures and schedules are established and adhered to. Poor maintenance of workplace equipment usually results in the inadequate operation of machinery and, in turn, causes increased worker accidents and illnesses. A regular maintenance schedule should include periodic shutdowns of all equipment. In addition, employees performing maintenance should be provided with the necessary personal protective equipment.

GOOD HOUSEKEEPING - Employers should establish and maintain good housekeeping practices. Proper good housekeeping procedures include a thorough cleaning of the workplace, adequate washing, toilet, eating, and waste disposal facilities. Employers should ensure that toxic substance spills are cleaned immediately. Work practices should also be in effect for the safe disposal of toxic chemicals and other hazardous substances.

PERSONAL HYGIENE - Employers should make hand-washing facilities readily available to employees working with or near toxic substances. It is important that workers be able to wash promptly in case of accidental splashes of toxic substances. Where called for, convenient access to emergency showers should be provided. Also, eating and storage or drinking of foods and liquids should be forbidden where toxic substances are used.

EDUCATION OF WORKERS - Education of workers related to personal exposure of hazardous process has done to all employees. The following information was communicated in training:

Ability to recognize hazards
Acute vs. chronic hazards
Routes of exposure
Hazard signage and Pictograms
Material Safety Data Sheet (MSDS)
Emergency mock drill- chemical spill, fire, etc.
Basic first aid
Importance and usage of PPE

6.3 IMPLEMENTATION OF IS STANDARDS

Sl.no.	Activity	IS Standards (IS 4209-2013)	Deviations	Corrected action
1	Chemical handling	**5.8.2** Always use the Safety appliances recommended while handling chemicals and avoid skin contact with chemical substances	No safety appliance for chemical handling and chance of expose to skin while handling chemical	PPE's Given with training
2	Chemical container	**5.8.3** Chemical should only be used when the container containing them are clearly labelled and their identity confirmed	Chemical container with no label	Label Posted in appropriate containers
3	Control of chemical Spill	**5.8.4** Keep suitable material to chemically treat spillage, or physically containing, if necessary	No spill kit found	Spill Kit Pasted
4	Volatile Chemical handling	**5.8.9** The containers of chemicals that are highly volatile or decompose or moisture sensitive should be carefully opened and isolated from the surrounding.	Volatile chemical are used in open containers and left in a container without lid	Containers with Lid placed
5	Transfer of chemical	**5.8.10** Whenever chemicals are transferred from old containers to new containers, all relevant details should be transferred to labels on new container.	Details not to be transferred from old container to new container.	Details are transferred
6	Storage of Chemicals	ANNEX A [Clauses 4.2 and 4.3 (c)] INCOMPATIBLE CHEMICALS	Chemicals are not stored as per Compatible chart.	Compatible Chart made as per the nature of Chemicals and pasted
7	Disposal of Chemicals	**4.3.1** Liquid and solid wastes should be kept separate. 4.3.2Chemicals for disposal must be placed in a Non-reactive, sealed container with a screw type cap. Waste container must be kept closed. Attach a tag to each and every container of the chemical waste. The outside of the containers must be clean and free of chemical Contaminants and residues. Date and label each container(Form 3 &8 TNPCB).	Stored in the Same Place No Flame proof Container provided for reactive and Non-reactive Chemicals. No Form 3 & 5 is followed	Flame proof cabinet placed Form 3 & 5 followed.

OCCUPATIONAL HEALTH EXAMINATION - Employee details who are all involved in hazardous process were collected for the occupational examination. According to the factories act 1948 and Tamil Nadu factory rules 1950, **Form no 27** certificates of fitness (prescribed under rule no 95: dangerous operation) were filled and occupational medical examination was done for those who involved in hazardous process. Operators with deviated results are planned to do a job rotation

7. RESULTS AND DISCUSSIONS

OUTCOME AFTER IMPLEMENTATION OF TRAINING

We can clearly see the reduction in risk of each hazard after a period of 5 months from November 2023 to March 2024 in which proper training were provided to employee.

DESCRIPTION	HANDLING VIOLATION	STORAGE VIOLATION	DISPOSAL VIOLATION
BEFORE TRAINING & IS STANDARDS IMPLEMENTATION	20	6	12
AFTER TRAINING & IS STANDARDS IMPLEMENTATION	0	0	1

FIG:3 OUTCOME AFTER TRAINING TO EMPLOYEE

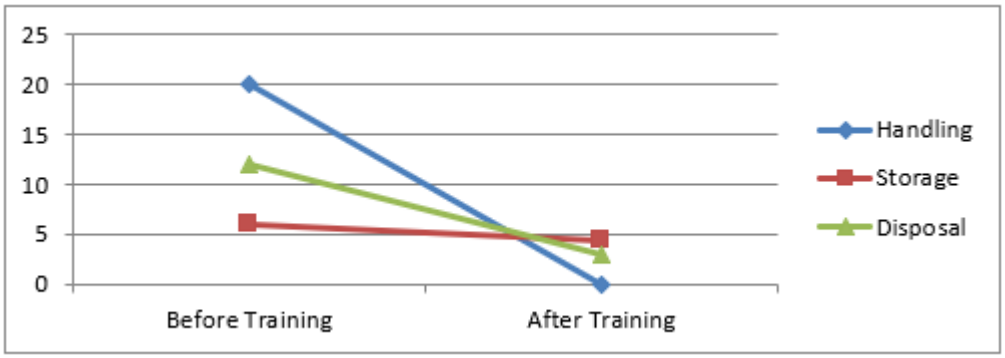


FIG.4.TRAINING RESULT

8. CONCLUSION

Thus, the problems are identified through

Formulating control hierarchy for provide an improvement in a manufacturing unit.

Control measures were planned to overcome the root cause are identified by Fishbone analysis.

Procedure for Hazardous process were corrected based on IS 4209:2013 the deviation from legal standards.

Job Specific Trainings and right tools were implemented to reduce violations.

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