

Content-5: Introduction to Chemical Hazards Orientation

What can this unit help you with?

You may use this unit if you

- Have to know what chemical hazard is;
- Have to know the classification of chemical hazards and hazard bands;
- Have to identify hazard bands;
- Have to prioritize chemicals.

Intended results of the unit

- Students have an understanding of chemical hazards and hazard bands;
- Students are capable of identifying hazard bands;
- Students are capable of prioritizing chemicals using hazard banding tool.

Input

Chemical hazard refers to a type of occupational hazard caused by exposure to chemicals in the workplace. We can understand the hazard associated with the chemical by checking what chemical it is, whether it is mixed with any other chemical and if it is in a mixture then what its relative portion is.

In other words, we can say, hazard means the potential of a substance to harm and damage. The below diagram shows the classification of types of hazards along with their identifying characteristics.

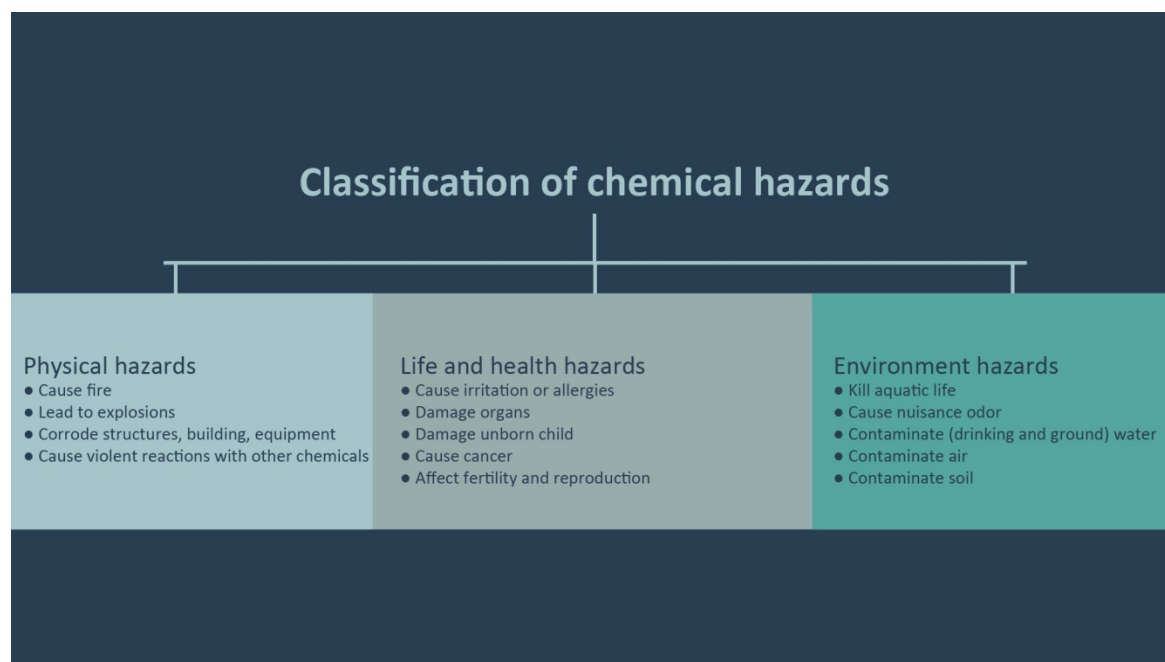


Figure 1: Classification of chemical hazards. Information Source: Resource Efficient Management of Chemicals in Textile and Leather Sector Companies by GIZ

Classification of Chemical Hazards

Generally, if any substance leads to explosions or fires, corrodes buildings or equipment or causes a violent reaction with other chemicals; then, they possess physical hazards.

On the other hand, if any chemical causes irritations or allergies or damages organs or affects fertility, and in most serious cases cause cancer or lead to irreparable damage of an unborn child, it is referred to as a health hazard.

Lastly, if the concerned chemical kills aquatic life, creates nuisance odour, or contaminates water, soil, air, then it means it possesses an environmental hazard.

Identification of Types of Hazard: Coding Structure

One can identify the type of hazard by using a coding structure. Two things are observed while identifying types of hazards. One is the R phrase, and the other is the hazard statement. R phrases refer to phrases indicating the risks of hazardous preparations and substances. For example, R1 means explosive when dry.

A hazard statement is a phrase that describes the nature of the hazard in the substance or mixture. For example, H200 means unstable explosive.

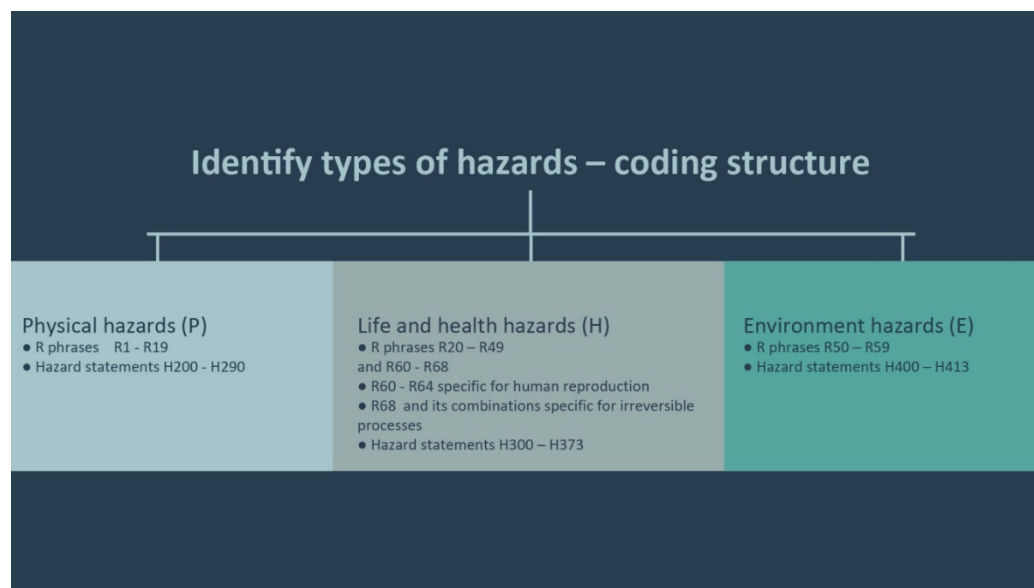


Figure 2: Identify types of hazards-coding structure—source: Resource Efficient Management of Chemicals in Textile and Leather Sector Companies by GIZ

Here in the figure, we can see the identification of types of hazard using R phrases and hazard statements. We have some designated codes for each type of hazards. For example, R1-R19 refers to Physical hazard.

An Overall Scenario of Chemical and Potential Hazards and Their Effect on Our Ecosystem

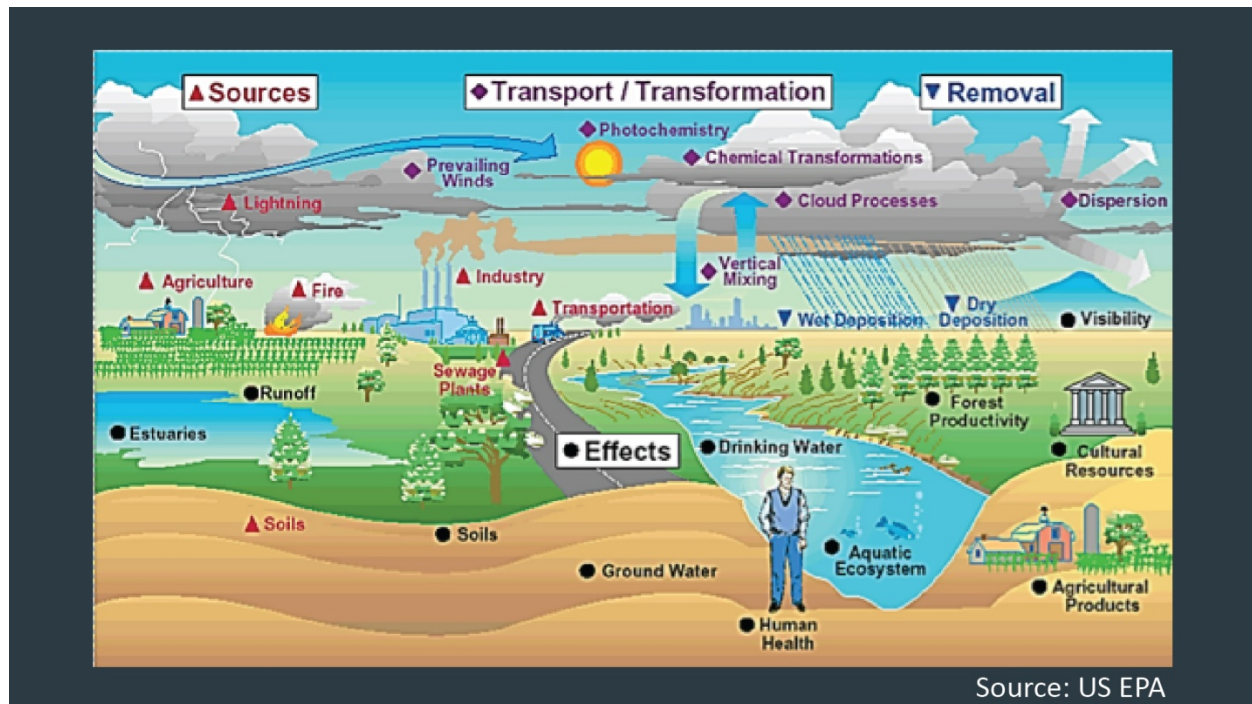


Figure 2: Chemicals and potential hazards in our ecosystem. Source: US EPA, Resource Efficient Management of Chemicals in Textile and Leather Sector Companies by GIZ

The figure shows an overall scenario of chemical and potential hazards and their effect on our ecosystem. It is a representative of all chemically hazardous situations and an estimation of its effect.

Steps to Identify the Types of Hazards

Identifying types of Hazards	
1	Use the label and/or consult the SDS to identify hazard(s)
2	Check series of codes or phrases indicating hazardous properties of a chemical, the so called Hazard (H) statements (in GHS)
3	Verify information in SDS on health effects on humans, environment and risks of fire/explosion

Figure 3: Identifying types of Hazards Source: Resource Efficient Management of Chemicals in Textile and Leather Sector Companies by GIZ

Type of hazard can be identified by checking the label or consulting the SDS of the chemical. Hazard statements are checked to find hazardous properties. Lastly, the information obtained from SDS regarding humans, environment or risks of fire/explosion is verified.

Prioritizing Chemicals Using Hazard Banding Tool

We can rank and prioritize chemicals by hazard levels with the help of a simple tool called the hazard banding tool. With this tool, we can further categorize the chemicals by their hazard severity levels using the H-statements. This procedure can help us decide which chemicals we may want to focus first, such as possible substitution or other interventions.

Hazard banding refers to categorizing chemicals by bands of hazards using H-statements describing physical, health, environmental effects. This tool helps to decide which chemical to prioritize and look for possible substitution if needed. It is a widely used tool, and it is quite simple.

In the following learning cards, we will look into an example to learn how to use hazard banding tool. The sample we will work on is Acetone, a chemical used in the printing area of a factory. The information about its usage area is collected from eco-mapping and flow diagrams.

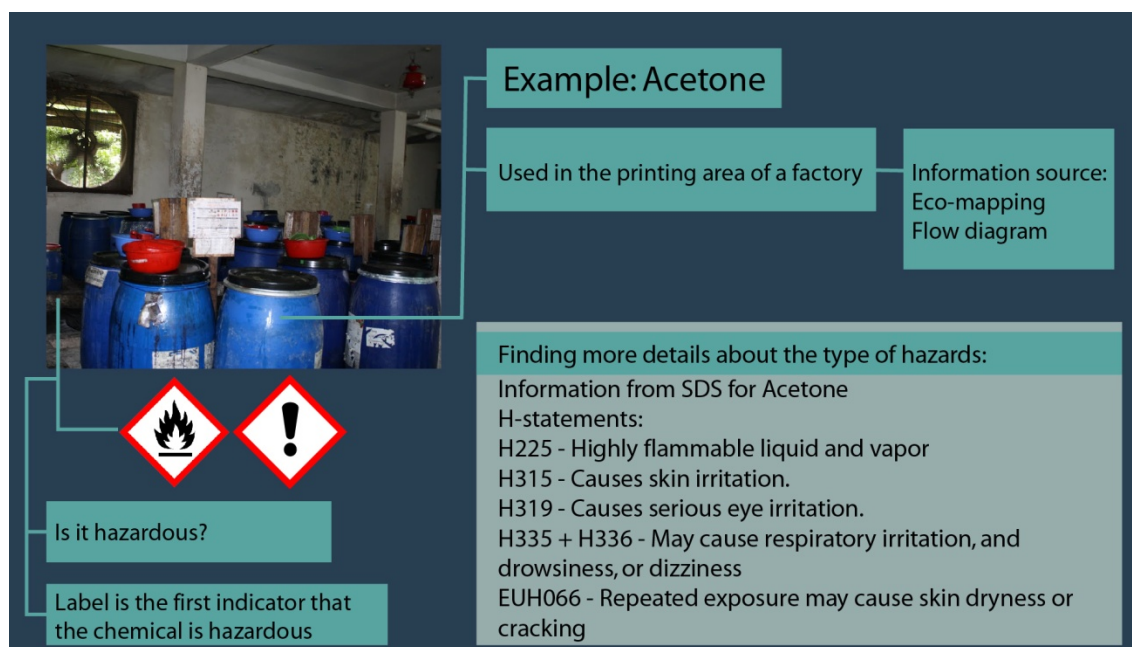


Figure 4: Example for hazard banding. Photo of chemical container source: Reed Consultancy Bangladesh. Collage courtesy: Kazi Farhan Hossain Purba.

The first thing we need to find is whether the chemical is hazardous or not. We can understand it from the label. The label is the first indicator that it may be hazardous. In this case, from the hazard symbol, we can say that the chemical is flammable and possesses a health hazard.

The next thing is to find more information about the type of hazard. For this, we will take help from the SDS (Safety Data Sheet). The hazard statements are extracted from SDS for Acetone, which gives insights into what this chemical can do. It indicates mostly health hazards.

Area/ Section	Name	SDS yes/ no	H- statement	P	H	E	Hazard group/ band			
Printing	Acetone										

Source of information:
Eco-mapping
Flow diagram
....

Area/ Section	Name	SDS yes/ no	H- statement	P	H	E	Hazard group/ band			
Printing	Acetone	Yes	H225 H315 H319 H335 H336 EUH066	✓	✓ ✓ ✓ ✓ ✓ ✓						

Source of information:
Safety Data Sheet
Internet Data Base
....

Figure 5: Tables prepared using the information collected so far. Collage courtesy: Kazi Farhan Hossain Purba.

Here we can see a chemical inventory table containing the information collected so far. The table contains the area, name of the chemical, availability of SDS, H-statement, type of hazard and hazard band. In the case of Acetone, we can see that it is used in the printing section and contains only one physical hazard; the rest are all health hazards. After we have collected all the necessary information, we need to work on the BAUA Column Model.

BAUA Column Model

Hazard banding is a process intended to quickly and accurately assign chemicals into specific categories (bands), which correspond to a range of exposure concentrations designed to protect workers' health. These bands are assigned based on a chemical's toxicological potency and the adverse health effects associated with exposure to the chemical.

Risks/GHS	Health hazard						Environmental hazards	Fire and explosions hazards	Exposure potential	Hazards caused by procedures
	Inhalation	Skin	Eyes	Ingestion	Chronic	Gas release				
Very high risk (5/E)	H330, H350	H310, H350, H340		H300	H350, H340, H350	EUH032	With warning symbol H410 H400 WGK 3 H410, H411, EUH 059	H200, H201, H202, H203, H234, H235, H231, H234, H240, H241, H250, H260, H271	Gases Liquids with vap. Pressure > 250 hPa (eg. Dichloro methane) Dust producing solids Aerosols Liquid with vap. Pressure of 50...250 hPa (eg. Methanol)	Open processing possibility of direct skin contact application on large area
High risk (4/D)	H330, H331, H334, EUH071 Preparations containing respiratory tract sensitizing substances in a conc. > 1% (in case of gases > 0.2%)	H311, H317, H360 Preparations containing skin sensitizing substances in a conc. > 1%	H318	H301	H351, EUH070, H360, H360F, H360D, H360F+D, H360DF, H341, H372, H370	EUH029		H222, H228, H228, H242, H251, H252, H270, H272, EUH001, EUH006, EUH014, EUH019, EUH044		
Medium risk (3/C)	H332 Non toxic gases, many cause suffocation by air displacement (eg. Nitrogen)	H321, H314		H302, H362	H362, H361D, H3611, H3614, H371, H373		H412, WGK 2	H223, H226, H228, H242, H252, H261, H272, H280, H281, H290	Liquids with vap. Pressure 10...50 hPa. Except water (eg. toluene)	Closed processing but exposure possibilities eg. When filling sampling or cleaning
Low risk (2/B)	H335, H336	H315	H319	H304	EUH066 Chronically affecting substances (no R Phrase, but nonetheless a hazardous substance)		H413, WGK 1	Hardly flammable substances/preparation (Flashpoint 55, 100 degree celsius)	Liquids with vap. Pressure 2...10 hPa. (eg. xylene)	Closed processing but exposure possibilities eg. When filling sampling or cleaning
Negligible risk (1/A)	Harmless substances by experience (eg. Water, sugar, paraffin, similar)						Not water polluting substances/preparations (NWG, formerly WGK 0)	Inflammable or very hardly flammable substances/preparations (for liquids flashpoint > 100 degree celsius)	Liquids with vap. Pressure < 2hPa. (eg. Glycerol) Solids releasing no dust	Tightly closed equipment closed equipment with exhaust facilities at points of emissions

Figure 6: BAUA Column Model. Source: Resource Efficient Management of Chemicals in Textile and Leather Sector Companies by GIZ

BAUA column model is such a tool and is a table that shows the classification of different types of hazards by H-statements, exposure potentials, and the levels of risk indicated by them. This figure shows the BAUA column model, which we will use to find the hazard band associated with Acetone.

The yellow rectangle shows H225 which we found from SDS for Acetone. H225 is under the column of fire and explosion hazards, and according to the table, we can see that it possesses a high risk that is represented by 4/D.

Again, in this model, we can see the red rectangles indicating the remaining H-statements found from the SDS for Acetone. H335, H336, H315, EUH066 refer to low risk (2/B). Moreover, from the health hazard column, it is observed H335 and H336 are related to the inhalation problem. H315 is referring to a skin problem, and EUH066 is chronic.

Area/ Section	Name	SDS yes/ no	H-statement	P	H	E	Hazard group/ band			
Printing	Acetone	Yes	H225	✓			4/D				
			H315		✓		2/B				
			H319		✓		2/B				
			H335		✓		2/B				
			H336		✓		2/B				
			EUH066		✓		2/B				

Source of information:

- BAUA Column Model
- COSHH Model
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Figure 7: Chemical inventory is completed by putting the information of hazard band corresponding to the hazard statements.
Source: Resource Efficient Management of Chemicals in Textile and Leather Sector Companies by GIZ

Based on the information collected from BAUA column, the table found in figure 7, which is a chemical inventory, is completed by putting the information of hazard band corresponding to the hazard statements in the above table.

In this way, we can find out the hazard band for each hazardous chemical and prioritize according to the level of their risks from very high to negligible risk, respectively.

Conclusion

To identify hazard type, we will check the labels and markings on the containers, safety data sheets and manufacturer or supplier information. If we want to assess the hazard level, we can take help from SDS or GHS documentation or internet sources and applications.

We can do the same for all the hazardous chemicals we have in our factory, just the way we have found the hazard band for Acetone. After finding the hazard band using BAUA column model and inserting all the information about H-statements and hazard bands in the chemical inventory, useful information can be retrieved when we need. We also can prioritize chemicals from there and look for possible substitution if needed.

Didactical Elements

Quizzes and Self-Tests:

True-False:

1	Generally, if any substance leads to explosions or fires, corrodes buildings or equipment or causes violent reaction with other chemicals; then, they possess health hazards.	
	<ul style="list-style-type: none">▪ Correct▪ False	False
2	Hazard means the potential of a substance to harm and damage.	
	<ul style="list-style-type: none">▪ Correct▪ False	Correct
3	Hazard bands are assigned based on a chemical's toxicological potency and the adverse health effects associated with exposure to the chemical.	
	<ul style="list-style-type: none">▪ Correct▪ False	Correct
4	BAUA column model is a table that shows the classification of different types of hazards by H-statements, exposure potentials, and the levels of risk indicated by them.	
	<ul style="list-style-type: none">▪ Correct▪ False	Correct
5	Hazard banding refers to categorizing chemicals by bands of hazards using H-statements describing the mental effects of the workers.	
	<ul style="list-style-type: none">▪ Correct▪ False	False

Open Questions:

1	How can you find Hazard bands using BAUA column model?	
	<i>Open text</i>	At first, I need to find H-statements from the Safety Data Sheet for the selected chemical. Then I will have to locate H-statement in the BAUA column model. Lastly, I will have to check the hazard band level from that table. Thus, I can determine the Hazard bands that correspond to the H-statements of that particular chemical.

Choose Multiple:

	What are the identifying characteristics of life and health hazards? (Choose multiple)	
	<ul style="list-style-type: none"> ▪ Cause irritation or allergies ▪ Kill aquatic life ▪ Damage organs ▪ Damage unborn child ▪ Contaminate air ▪ Cause cancer ▪ Contaminate soil ▪ Affect fertility and reproduction 	<p>Answer:</p> <ul style="list-style-type: none"> ▪ Cause irritation or allergies ▪ Damage organs ▪ Damage unborn child ▪ Cause cancer ▪ Affect fertility and reproduction

Sorting Tasks:

Sort the words to the correct sentences:

nuisance	exposure	environmental	occupational	catastrophic	aquatic
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1. Chemical hazard refers to a type of ___ hazard caused by ___ to chemicals in the work-place.
2. If the concerned chemical kills ___ life, creates ___ odor, or contaminates water, soil, air, then it means it possesses an ___ hazard.

Answers:

1. occupational, exposure
2. aquatic, nuisance, environmental

Exercise:

Read the situation below and complete the tasks:

Welcome to 'Beautiful Colours', a small textile company which specializes in dyeing and printing fabrics. The top management of "Beautiful Colors", has engaged you for helping them in chemical management. To better understand the situation at hand, you are organizing a meeting with the company management and visit the factory. During the first walk-through of the factory, you have observed and noticed the following:

1. There is a general storage area, where the raw material and chemicals are received. When chemicals are delivered by the suppliers, the company workers straight-away places these in store without any further quality control. One of the workers points out the red symbol with the black exclamation mark on a chemical bag, wondering its meaning, but the store supervisor does not know. The storage area is quite full. In the front yard, the workers have stored two containers with Aniline and Acetone.
2. All the dyes and chemicals are stored in bags and containers next to the fabric material, directly on the floor. Since the last rainy season, the roof of the storage area has been leaking. A few bags got wet and were put aside in a corner. New materials have already been ordered. John, the most skilled worker, is the only one who can identify different chemicals even though labels or markings on many chemical containers are damaged, missing or in a foreign language.
3. Because of his long experience, John hands out the chemicals needed in the dyeing or printing process to each worker individually. In case of any questions regarding the chemicals, everybody checks with him. When inquiring with him about material safety data sheets, he indicates that there seems to be a folder somewhere in the manager's office, but he does not know exactly. You see some chemical containers with acetic acid and dyestuff such as reactive black and basic yellow.
4. Once the workers have received the chemicals, they carry these in open and unmarked buckets to the respective production areas. In the dye kitchen, the colour baths are prepared by mixing water with dyes and auxiliary chemicals. Jeff is responsible for preparing the chemicals used in these operations –a task that demands most of his time and which is done according to recipes based on long years of working experience. After all these years, Jeff is not very enthusiastic about his job. He sometimes does not pay attention to mixing the exact quantities of chemicals, adding more or less than "usual". Sometimes he lets one of the helpers do the mixing. The staff keeps a few open bags and containers of powdery dyestuffs and other chemicals in the mixing place. Sometimes, bags get spoilt when they have been lying on the wet floor for too long. To clean the dye kitchen from dust and spilt materials, the floor is swept by the cleaning personnel every week. When you leave the dye preparation area, you notice that your white shirt is covered with black dye particles.

5. Abebe, responsible for dyeing the fabric, wears boots, saying it makes him feel better and safer, unlike his colleagues, who wear open sandals. Abebe adds other auxiliary chemicals (salt) for colour fixation during the dyeing process and regulates the temperature of the heated dye bath in the machine. Dyeing is done in old, open machines, which use large amounts of water. Every now and then the machines start leaking. When the leakage in the machines gets too big, it just gets fixed in an improvised way by Beca, who is in charge of general maintenance. Occasionally, when the colouring vessels are filled too much, liquids spill out of the vessels onto the floor. Lots of water and spillages end up on the floor, making it slippery and keeping the cleaning staff very busy all day. Once the process is complete, the waste dye liquor is drained into the drainage going to the treatment plant. It is estimated that up to 40% of the dyes and 80% of the auxiliaries end up in the wastewater.

6. The cleaners also hose the floor, with the wash water flowing out into the sandy factory yard. The cleaning effluent goes directly into the nearby drainage. The drainage is often blocked by some old packaging, and the cleaning effluent flows into the yard.

The next step after dyeing is drying the fabric, which is done outside in the open air, before going to printing. While you walk from the dyeing to the printing area, you slip several times on the wet floor.

8. In the printing area, you meet Caleb, who is the production supervisor. There is a small “colourful” area at the entrance of the printing areas where a helper is mixing the printing paste as per instructions from Jeff. Apart from a container with 2-Naphthol and Sodium hydroxide, there is one more chemical container without a label, but some handwritten sign. You observe how several female workers carry out manual screen printing. You immediately notice the solvent smell in the air. An exhaust fan is mounted on the rear wall, which blows the air to the outside toward the neighbouring building. On the rear side of the room, you also see some containers with dry printing paste lined up. When inquiring about the containers with the workers, they indicate that quite often they prepare too much printing paste. The left-over paste is collected and thrown out with the waste into the yard every now and then. Since you start feeling dizzy in the printing area, you proceed to the backyard.

9. On the way to the backyard, you pass the product storage area, the entrance to the product storage area, and the walkways are rather narrow, so workers carry heavy bundles of materials in an out. Apart from the final products and some spare parts, you also see one container with Citric acid and one container without any label.

10. The factory has a simple wastewater treatment plant (ETP) which has been built ten years ago located in the backyard. Beca, who is in charge of general maintenance, also seems responsible for running the effluent treatment plant. During the treatment process, the ETP staff adds some chemicals to adjust the pH and some other chemical to help the settling of solids. You note that the electrical control panel is quite corroded and hangs on one hinge. It seems that it will fall off anytime. Also, the railings of the walkways over the treatment tanks are quite cor-

roded and partly missing. The treatment sludge from the wastewater treatment process is dried and stored in the factory yard and taken away for some land-filling. Some solid wastes, including the packages of some hazardous chemicals, collected every week by the local garbage collector.

11. According to the manager, the company gets its process water from a ground well in its compound. Electricity is provided through the company's own diesel generators. When the chemical containers in the storage area are empty, some workers take them home to use them as storage for drinking water. Before doing so, they do some basic cleaning of the empty containers by washing off the remainder chemicals with tap water in the factory yard. Empty chemical bags are thrown out into the factory yard and burned in the corner of the yard from time to time, and other types of waste (e.g. plastic wrappings, office papers) collected from the different parts in the factory.

12. On your way home, you stop at the tea stall next to the factory and get in conversation with some local people from the neighbourhood who share their concerns about the daily colour changes of the river water and the chemical smell from the factory.

Tasks:

1. Identify the class of hazards (physical, human health, environment)
2. Determine the hazard band of each chemical used in 'Beautiful Colours'.

Hotspots:

According to the SDS of Sodium hydroxide, its hazard statement is:

H314: Causes severe skin burns and eye damage.

Risks/GHS	Health hazard					
	Inhalation	Skin	Eyes	Ingestion	Chronic	Gas re-lease
Very high risk (5/E)	H330, H350i	H310, H350, H340		H300	H350, H340, H350i	EUH032
High risk (4/D)	H330, H331, H334, EUH071 Preparations containing respiratory tract sensitizing substances in a conc.> 1% (in case of gases> 0.2%)	H311, H317, H360 Preparations containing skin sensitizing substances in a conc.> 1%	H318	H301	H351, EUH070, H360, H360f, H3600, H360FD, H360Fd, H360Df, H341, H372, H370	EUH029
Medium risk (3/C)	H332 Non toxic gases; many cause suffocation by air displacement (eg. Nitrogen)	H321, H314		H302, H362	H362, H361d, H3611, H361fd, H371, H373	

Table 1: A part of BAUA Column Model. Source: Resource Efficient Management of Chemicals in Textile and Leather Sector Companies by GIZ

Using this part of BAUA Column Model, what should be the hazard band?

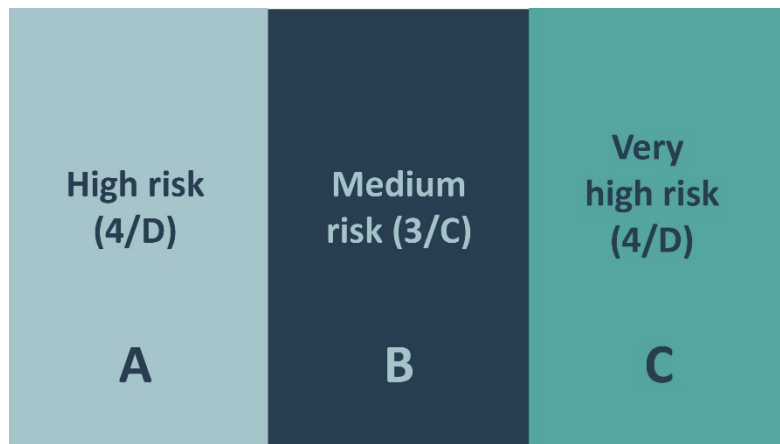


Figure 8: Hotspot. Picture courtesy: Kazi Farhan Hossain Purba.

Answer: B- Medium risk (3/C)

References/Additional Literature/Links

1. More information on hazard banding can be found from this link: <https://www.sia-tool-box.net/solution/resource-efficient-management-chemicals-textile-and-leather-sector-companies>. By downloading the REMC Company Handbook from the 'Further information section', you can read sections 3.1 and 3.2 for that purpose.
2. To know more about GHS Hazard Classification, you can visit this link: [https://www.era-environmental.com/blog/ghs-hazard-classification#:~:text=GHS%20uses%20three%20hazard%20classes,Physical%20Hazards%20and%20Environmental%20Hazards.&text=Health%20hazards%20present%20dangers%20to,body%20\(like%20skin%20corrosion\)](https://www.era-environmental.com/blog/ghs-hazard-classification#:~:text=GHS%20uses%20three%20hazard%20classes,Physical%20Hazards%20and%20Environmental%20Hazards.&text=Health%20hazards%20present%20dangers%20to,body%20(like%20skin%20corrosion))
3. To know more about GHS Hazard Statements, you can go to this link: https://www.chemicalsafetypro.com/Topics/GHS/GHS_hazard_statement_h_code.html#:~:text=GHS%20hazard%20statement%20means%20a,and%20followed%20by%203%20digits.

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