



SAFE STORAGE & TRANSPORT OF CHEMICALS

November 2017



LEARNING OUTCOME & RESOURCES

Learning Outcome



- Knowledge on all aspects of good transportation and storage of chemicals.
- Knowledge on the checkpoints for chemical store.

Resources

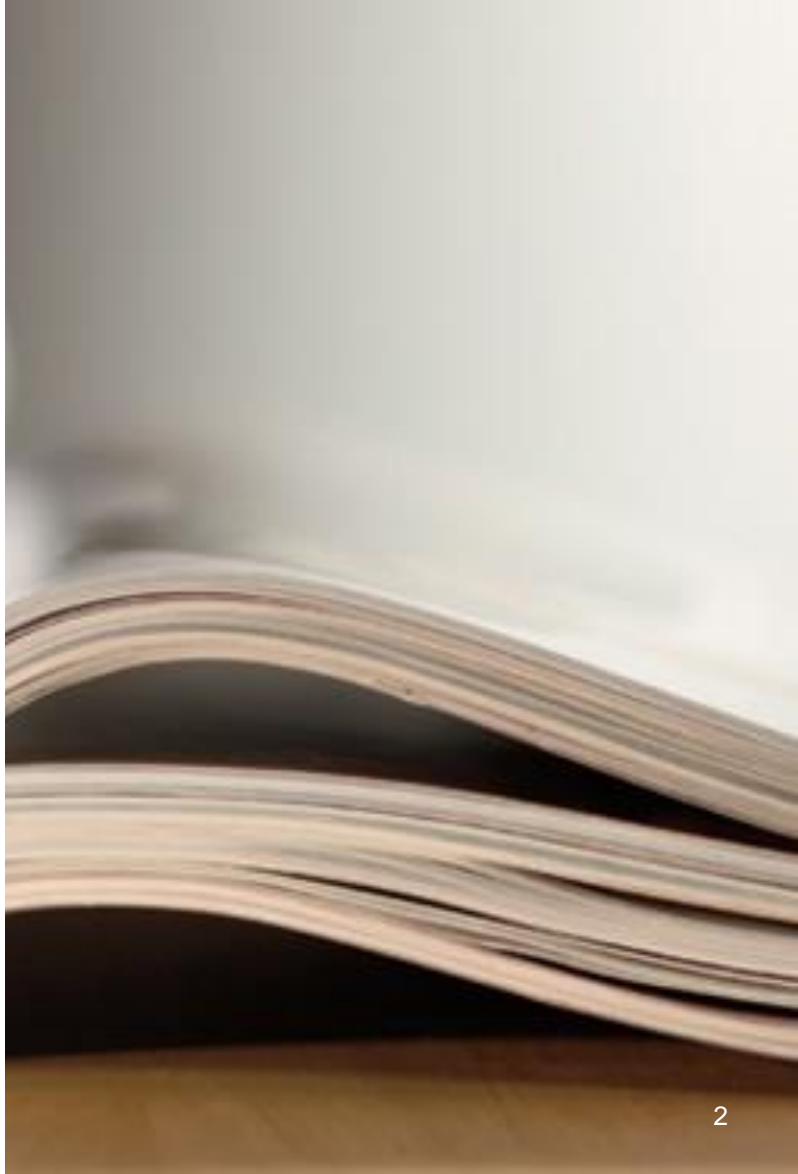


- REMC Company Handbook.
- ZDHC Chemical Management Systems Guidance Manual.

Workbook



Refer to complimentary excercises in your workbook.



ZDHC REQUIREMENTS



ZDHC 3.5.5 - Chemical Transport

- Procedure for Chemical Transportation and Training on Transport of a Chemical.

ZDHC CMS 3.5.4 - Chemical Storage

- Procedure for Chemical Storage.





**What problems may occur if
chemicals are not transported
safely?**



Brainstorm as a group and
make notes in your workbook,
exercise (12-1).

Chemical Transport

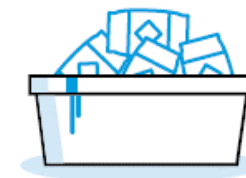
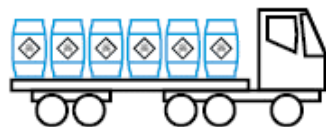
TYPE OF TRANSPORT OF CHEMICALS AND WASTE



Chemical Supplier

Facility

Waste Facility



External

Transport of chemicals and chemical waste to/from your company.

Internal

- Receiving and unloading of chemicals.
- Internal transport and conveyance of chemicals and waste, e.g. transport to warehouse, from warehouse to production areas, within production areas, etc.

TYPICAL CHEMICALS IN PRODUCTION TO CONSIDER



- Ammonia Liquid
- Formic Acid
- Glacial Acetic Acid
- Hydrochloric Acid
- Hydrogen Peroxide 50%
- Phosphoric Acid
- Sodium Hydroxide (NaOH)
- Sodium Silicate
- Sulphuric Acid
- Oxidizing agents
- Reducing agents
- Solvents





SODIUM HYDROXIDE (NaOH)

Description	Material of Construction (MoC)
Storage	Mild steel, butt-welded tanks.
Pumps	Steel or cast iron centrifugal pumps.
Piping	Seamless carbon steel, butt-welded Schedule 40 pipe.
http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh_04fa/0901b803804fa679.pdf?filepath=causticsoda/pdfs/noreg/102-00011.pdf&fromPage=GetDoc	

SULPHURIC ACID



Description	Material of Construction (MoC)
Storage	MoC depend on concentration for storage Carbon steel. [Sulphuric acid (>70%)] High-density, cross-linked polyethylene. (HDXPE) [For small tanks below 95%]
Pumps	A centrifugal, seal less magnetic-drive pump.
Piping	MoC are dependent on fluid flow velocities and quality concerns. Seamless carbon steel piping, 316 SS, Alloy 20, Teflon®-lined pipe.
http://www2.dupont.com/Clean_Technologies/en_US/assets/downloads/Equipment_FAQs.pdf	



HYDROCHLORIC ACID

Description	Material of Construction (MoC)
Storage	Lined steel (Vinyl ester, epoxy or ebonite as liners) Glass Fiber Reinforced Polyester with a PP or a PVC lining. Spiral wound extruded HDPE
Pumps	Pumps made of PVC, PVDF, PTFE, PP or graphite
Piping	Glass Fiber Reinforced Polyester with a PP or a PVC lining. HDPE
http://www.solvaychemicals.com/Chemicals%20Literature%20Documents/Chlorinated_inorganics/DOC-1300-0003-W-EN_WW_.pdf	



GLACIAL ACETIC ACID

Description	Material of Construction (MoC)
Storage	Type 316 L Stainless Steel
Pumps	Type 316 L Stainless Steel
Piping	Type 316 L Stainless Steel
http://www.valve-world.net/pdf/10063.pdf	

FORMIC ACID



Description	Material of Construction (MoC)
Storage	Type 304 stainless steel.
Pumps	Cast alloy 20.
Piping	Alloy 20, 28, 904 L or 825.
http://www.valve-world.net/pdf/10063.pdf	

SODIUM SILICATE



Description	Material of Construction (MoC)
Storage	Tanks may be constructed of 1/4" mild steel but 3/8" gauge preferred. Plastics tanks made from alkali resistant polyethylene or polypropylene may also be used.
Pumps	A centrifugal, seal less magnetic-drive pump Positive displacement pumps for small quantities.
Piping	Standard steel piping.
http://www2.dupont.com/Clean_Technologies/en_US/assets/downloads/Equipment_FAQs.pdf	

PHOSPHORIC ACID



Description	Material of Construction (MoC)
Storage	Rubber lined or constructed of stainless steel or fiberglass-reinforced polyester.
Pumps	316L or alloy 20 stainless steel.
Piping	316L or alloy 20 stainless steel.
http://techsheets.simplot.com/Plant_Nutrients/12010_MGA0-52-0.pdf	

HYDROGEN PEROXIDE 50%



Description	Material of Construction (MoC)
Storage	High purity aluminum, and 304 and 316 stainless steels
Pumps	A mechanical seal of stainless steel, with glass filled polytetrafluoroethylene (PTFE) and ceramic (silicon carbide) faces, is recommended for centrifugal pumps.
Piping	304L and 316L stainless steel
http://www.fpl.fs.fed.us/documnts/pdf2010/fpl_2010_anderson001.pdf	

THERMOPLASTIC PIPING FOR THE TRANSPORT OF CHEMICALS (1/2)



Hydrochloric Acid 30% :	Sulphuric acid 50% :	Phosphoric Acid 50%	Acetic acid Glacial:	Acetic acid 25% :
ABS	ABS	ABS	PP	CPVC
CPVC	CPVC	CPVC	PVC	PP
PP	PP	PP	PE	PVC
PVC	PVC	PVC	PB	PE
PE	PE	PE	PVDF	PB
PB	PB	PB	PEX	PEX
PVDF	PVDF	PVDF		
PEX	PEX	PA11		



Hydrochloric Acid Conc.:	Sulphuric acid 94% - 98% :	Formic acid 10% & 50% :
PEX	CPVC	PVDF
	PP	PEX
	PE	
	PVDF	

Abbreviations:

ABS - acrylonitrile-butadiene-styrene,
 CPVC - chlorinated polyvinyl chloride,
 PP – polypropylene,
 PVC - polyvinyl chloride,
 PE – polyethylene,
 PB – polybutylene,
 PVDF - poly vinylidene fluoride,
 PEX - crosslinked polyethylene
 PA11 - polyamide 11

THERMOPLASTIC PIPING FOR THE TRANSPORT OF CHEMICALS (2/2)



**NaOH
40 %**

ABS
CPVC
PP
PVC
PE
PB
PEX

**Ammonia
Liquid
100%**

ABS
PP
PE
PB
PEX
PA11

**Hydrogen
Peroxide
50%**

CPVC
PP
PVC
PE
PVDF
PEX

**Sodium Silicate
50%**

PVDF



Abbreviations:

ABS - acrylonitrile-butadiene-styrene,
CPVC - chlorinated polyvinyl chloride,
PP – polypropylene,
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PVDF - poly vinylidene fluoride,
PEX - crosslinked polyethylene
PA11 - polyamide 11

External Transport

CONSIDERATIONS: PROCEDURES AND PRACTICES (1/2)



- Who is **responsible**? Refer to scope of your chemical management system.
- Does your company **provide instructions** for the safe external transport of chemical?
-
- What are the **national requirements** for the safe transport of chemicals and waste?
- Making and labelling of packages during transport.
- **Vehicle requirements** (such as transport documents, transport, emergency provisions).
- **Qualification of drivers** (e.g. special license, training).
- **Loading requirements** with regard to quantity, mixing with other loads (e.g. compatibility issue).



CONSIDERATIONS: PROCEDURES AND PRACTICES (2/2)



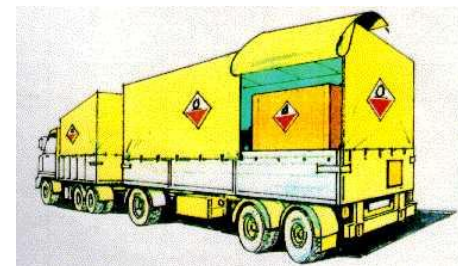
- **Before transport**, SDS and labels needs to be checked.
- All **broken, torn or incorrectly** located labels need to be replaced.
- During the transport of a chemical **proper PPE safeguards** need to be available in case of leakage or unexpected spill or rupture of the container.
- It needs to be ensured that all **chemical containers are properly closed** before transportation.
- **Mode of transport needs to be secure**: e.g. wheels on a trolley must be fully functioning.
- **Material of Construction (MoC)** of transportation of chemicals need to be looked at carefully to avoid contamination as well as accidents.





EXAMPLE: SAFE TRANSPORT OF CHEMICALS

Example: Labels and placard on vehicle transporting caustic soda flakes to your company.



80
1823

Substance identification code as assigned by the United Nations Committee of Experts on the Transport of Dangerous Goods.

ADR Kemler Code

First figure identifies primary hazard

- | | |
|--------------------|-----------------------|
| 2 Gas | 5 Oxidising substance |
| 3 Flammable liquid | 6 Toxic substance |
| 4 Flammable solid | 8 Corrosive |

The second and third figure indicate secondary hazards

- | | |
|---|----------------------------|
| 0 First digit adequately describes hazard | 6 Toxic risk |
| 2 Gas may be given off | 8 Corrosive risk |
| 3 Fire risk | 9 Risk of violent reaction |
| 5 Oxidising risk reaction | |

X = Reacts dangerously with water

Where the first and second digit are the same, an intensification of the primary hazard is indicated. For example 33 indicates highly flammable.

Blank plates (without any numbers) are displayed when the vehicle is carrying dangerous load (drums, packages, etc.).

Internal Transport

CONSIDERATIONS: PROCEDURES AND PRACTICES



- Chemicals transported **by forklift truck should travel on clearly marked passageways**, of adequate width, to reduce the possibility of collision and spillage.
- **Containers for flammable** liquids should be **specially constructed** with spring-located caps and flame arresters in their spouts.
- The **transfer of flammable liquids** should only be conducted in **well-ventilated areas with the containers** earthed and bonded.
- **Avoid shaking hazardous chemicals** to prevent leaking due to over volatilisation.
- **Leak-proof equipment** should be used when transporting small amounts of hazardous chemicals.

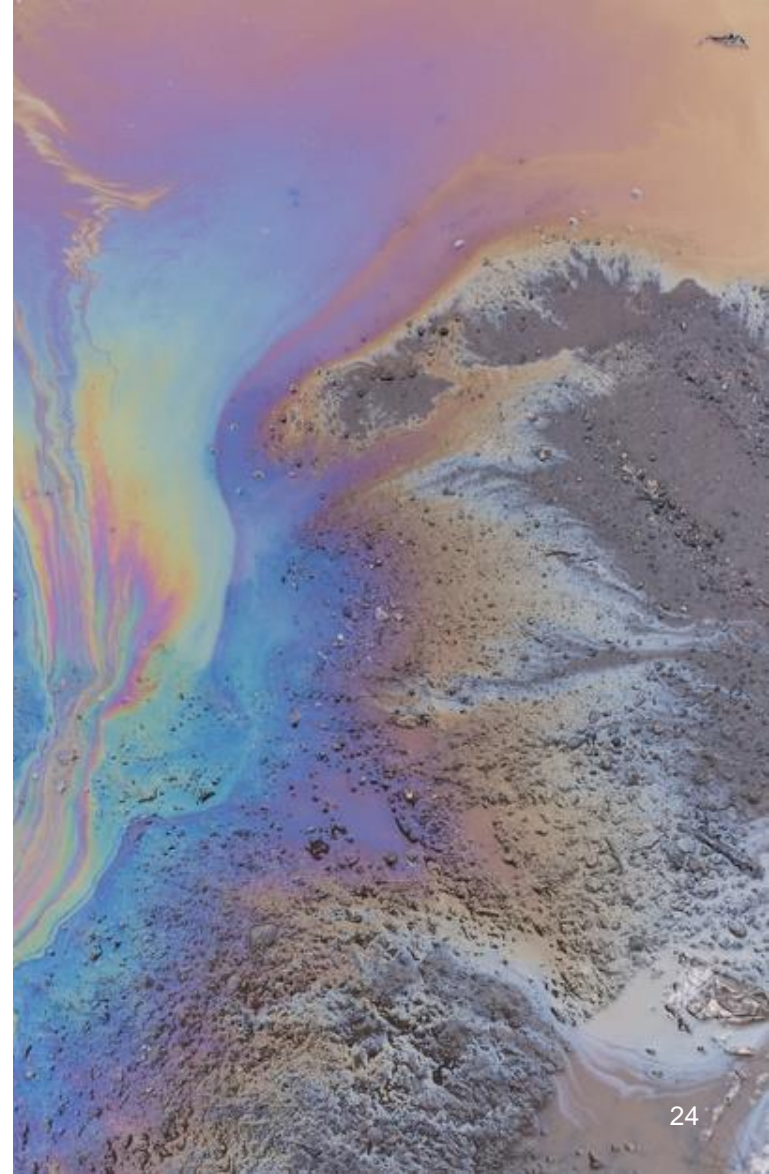


CONTAMINATION FROM TRANSPORT



Spillage and/or contamination during transport from:

- Insufficient maintained transport equipment (e.g. wheels of trolley not running well).
- Surfaces not smooth.
- Material of construction of containers not appropriate for the type of chemical.





PIPELINE CONVEYANCE

- Establish a standard colour coding system for everybody in your factory to clearly identify what the respective pipe may contain.
- Failure to correctly identify the service of a pipe work system can be the cause of plant upsets and safety incidents.

Example for colour coding of pipes

Color	Pipe content
Red	Fire quenching fluids
Dark blue	Potable, cooling, boiler feed and other water
Yellow	Toxic & corrosive fluids
Orange	Flammable fluids
Dark grey	Combustible fluids
Blue	Compressed air
Black	Waste water
Light blue	Dyestuff

For further information:

HSE (UK) HSG71 - Chemical warehousing guideline

<http://www.hse.gov.uk/pubns/priced/hsg71.pdf>

ISSA Storage of Chemicals - Guidelines for good practices

http://safety-work.org/fileadmin/safety-work/documents/BGRCI/storage_of_chemicals/BG_Storage_Chem_A5_

Chemical Storage



What are examples of good chemical storage practices?



GOOD CHEMICAL STORAGE PRACTICES

- Information provided in the SDS.
- SOPs and checklists.
- Ventilation and grounding.
- Separation of incompatible chemicals.
- Handling spillages and leaking containers.
- Provision for a draining system connected to the effluent treatment plant.
- Adequate storage of halogenated solvents.
- Adequate storage of flammable liquids.
- Fire protection measures.

COMMON CAUSES OF INCIDENTS DURING STORAGE OF CHEMICALS



- Lack of awareness of the properties of the dangerous substances.
- Operator error, due to lack of training and other human factors.
- Inappropriate storage conditions with respect to the hazards of the substances.
- Inadequate design, installation or maintenance of buildings and equipment.
- Exposure to heat from a nearby fire or other heat source.
- Poor control of ignition sources, including smoking and smoking materials, hot work, electrical equipment etc.
- Horseplay, vandalism and arson.





What are examples of good chemical storage conditions?



GOOD STORAGE CONDITIONS

Ventilation:

- Reduction of accumulation of dust or vapours.
- Controlled temperature and humidity.
- Combination of roof and wall ventilation.

Floors:

- Impermeable to liquids.
- Made from concrete and sealed with resin.
- Resistance against organic solvents.
- Smooth surface, but not slippery.
- Free from cracks to allow for easy cleaning.

Layout

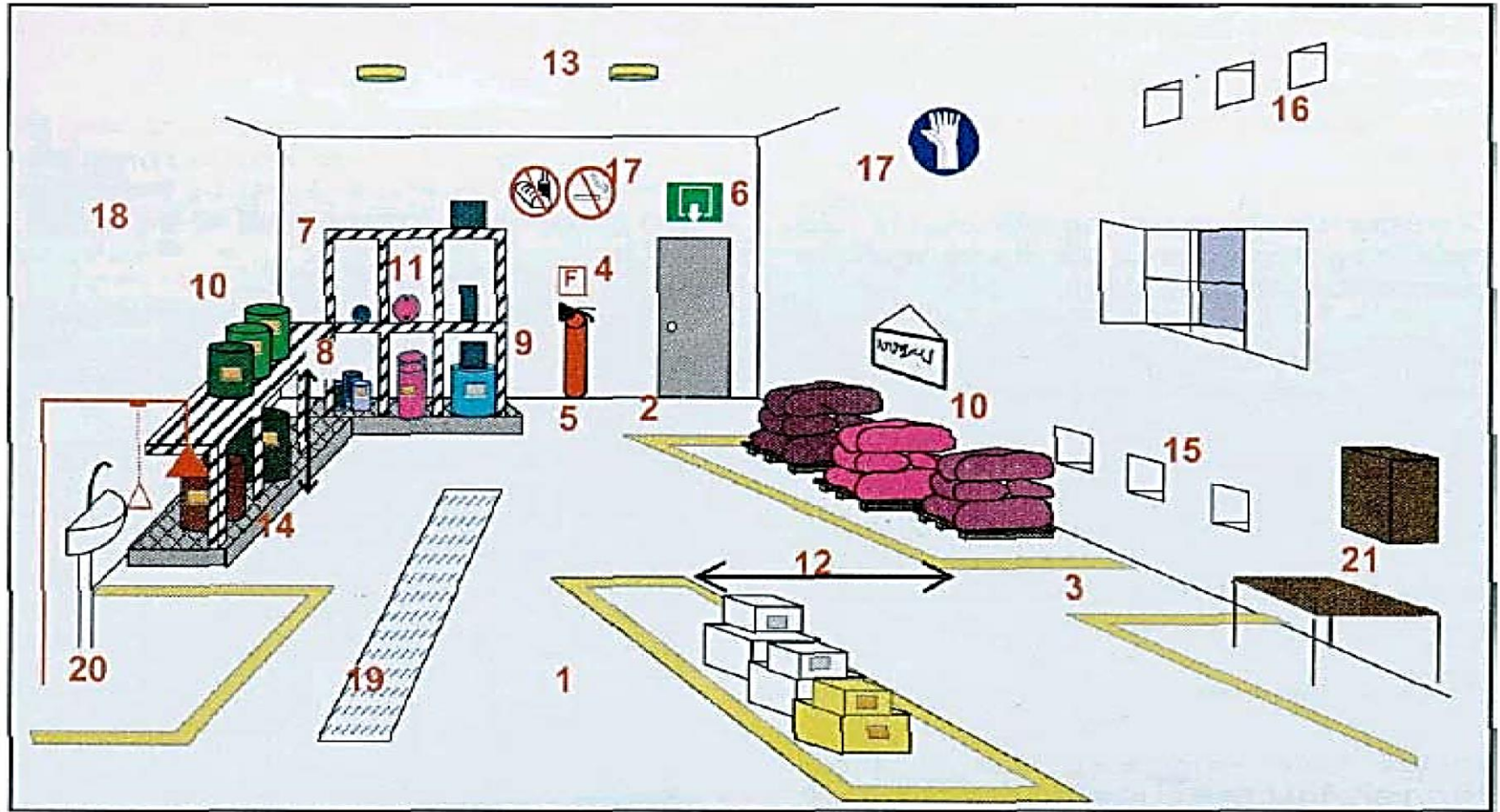
- Plan storage layout.
- Assign areas for storage and movement.
- Use colour markings.
- Allow for storage on pallets for easier rearrangement .

Consult the SDS or chemical suppliers for recommended storage conditions.





MODEL LAYOUT OF A CHEMICAL STORE





EXAMPLES OF GOOD PRACTICES





GENERAL STORAGE PRACTICES

Regular clean-out:

- Dispose of expired chemicals in timely manner.
- Inventorise all unwanted chemicals.
- Remove spills immediately.

Separate incompatible chemicals:

- Materials should always be segregated and stored according to their chemical family or hazard classification.
- Do not store chemicals alphabetically unless they are compatible.
- Most common hazard classes include: flammables/ combustibles, corrosive acids, corrosive bases, toxics, highly toxics, oxidizers, compressed gases, cryogenics, pyrophorics, water reactive, explosives.





CHEMICAL COMPABILITY CHECK

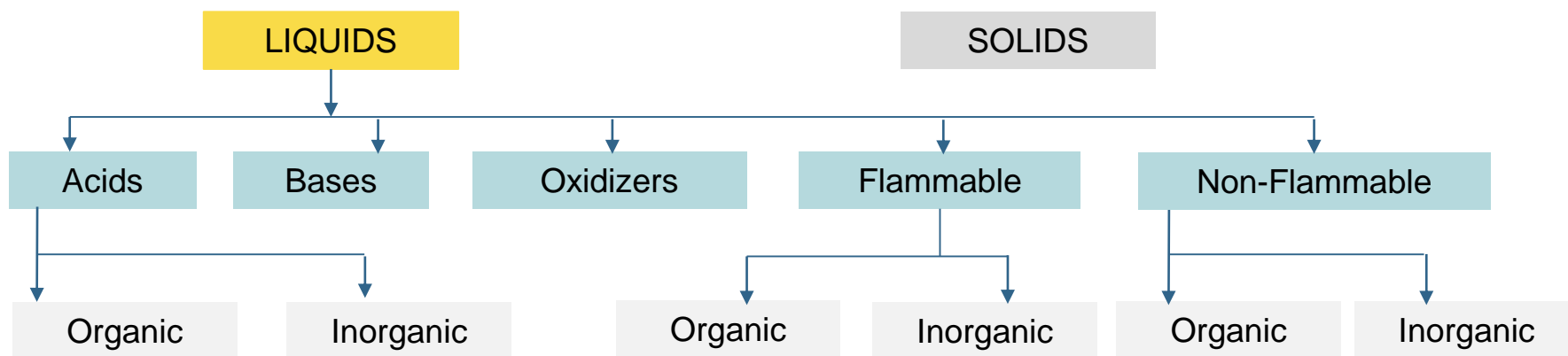
			C	Xi, Xn	T, T+	F, F+	O	E
C			✓	✓	o	✗	✗	✗
Xi Xn			✓	✓	✓	✓	o	✗
T, T+			o	✓	✓	o	✗	✗
F, F+			✗	✓	o	✓	✗	✗
O			✗	o	✗	✗	✓	✗
E			✗	✗	✗	✗	✗	✓

- C** Corrosive
- Xi** Irritant
- Xn** Harmful
- T** Toxic
- T+** Highly toxic
- F** Flammable
- F+** Highly flammable
- O** Oxidizing
- E** Explosive
- ✓ Are allowed to be stored together
- o Are allowed to be stored together, subject to special precautions
- ✗ Are not allowed to be stored together

CHEMICAL COMPATIBILITY STORAGE GUIDELINES



Store Materials Outlines by Boxes Separately



Solids Low tendency for reaction (when dry) so most can be shelved alphabetically, exceptions:

- Sulfides should be stored away from acids
- Cyanide compounds must be segregated from acids, especially liquid acids
- Phenol crystals must be stored separately from oxidizers

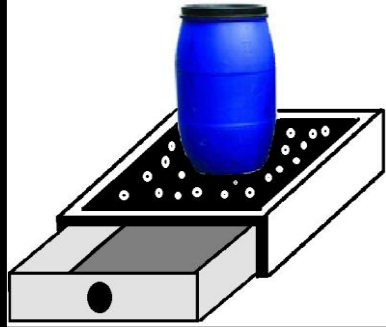
Liquids Store liquid chemicals below shoulder height.

Acids Separate organic acids from inorganic acids, e.g., acetic from nitric. Per chloric acid should be stored alone

Flammable Liquids The excess of 10 liters must be stored in safety cabinets or in safety cans.

Oxidizers Keep away from acids, bases, organics, and metals Store in cool place

SECONDARY CONTAINMENT OF HAZARDOUS



Leakage sources:

Spill buckets	43%
Piping	16%
Dispensers	12%
Tanks	12%
Line Leak Detectors	3%
STPs	3%
Delivery Vehicles	3%
Flex Connectors	2%
Other	6%

Occurrence rates are FL Report data quoted in Oil Express, Oct 9, 2006

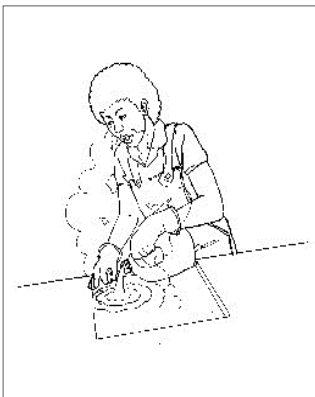


LOCAL EXHAUST VENTILATION (LEV)

- Remove contaminants from breathing zone of workers.
- Limit access of workers to affected area.
- Reduce exposure time of workers.
- Combine local exhaust ventilation with PPE for operators.
- Suitable for small tasks.

Good LEV design is important:

- Keep distance between source and hood as small as possible.
- Consider air velocity.
- Apply LEV at source of exposure.
- Avoid air drafts interfering with the LEV.



Improvement of working conditions with LEV

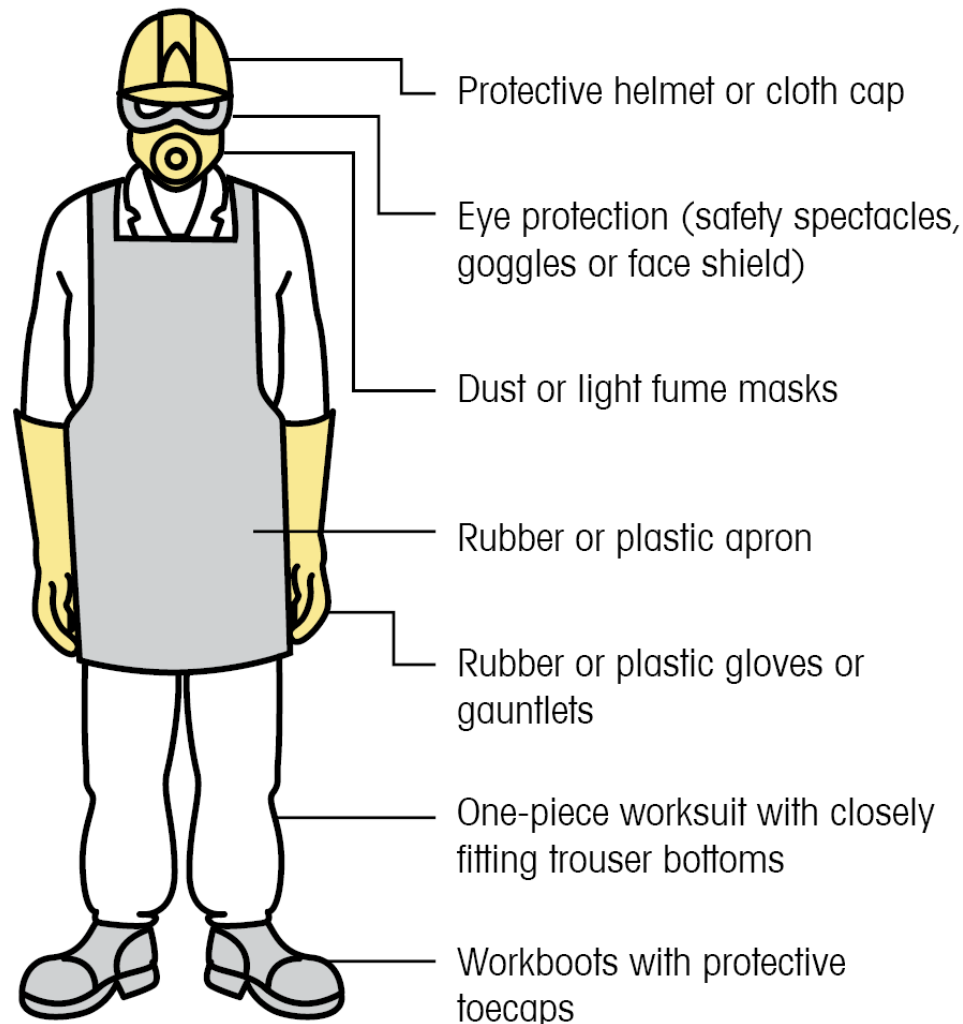




PERSONAL PROTECTION EQUIPMENT

Provision and use of personal protection equipment by all staff as per safety instructions and specific for each chemical substance:

- Chemical resistant overalls.
- Eye protection (safety goggles).
- Dust or fume masks.
- Chemical resistant rubber or plastic gloves according to each chemical.
- Rubber or plastic apron.
- Safety or work boots with protective caps.





GAS CYLINDER STORAGE

Gas cylinders:

- Gas cylinders to be stored upright in separate location.
- Stored cylinders to be secured by chain.

LPG gas cylinders:

- Stored upright, preferably in open air on concrete or load-bearing surface.
- Protected from direct sunlight.
- Separated from flammable liquids, combustible, corrosive, oxidising materials, toxic materials or other compressed gas.
- Maximum size of any stack not exceed 30,000 kg (outdoor storage).





OUTDOOR STORAGE

- Products stored **outdoors must be protected from sun and rain.**
- **Store upright** on pallets.
- Outdoor storage, especially in tropical areas, exposes product to high temperatures, therefore **fast degradation, shorter shelf life.**
- **Avoid contamination of soil and water:**
 - Heat and water resistant material.
 - Equipped with controlled drain system.
- Storage area **clearly marked and secured/fenced** to prevent unauthorised access.
- **Flammable liquids and solvents shouldn't be stored outdoors.**



PREVENTION OF SPILLAGES AND LEAKING CONTAINERS



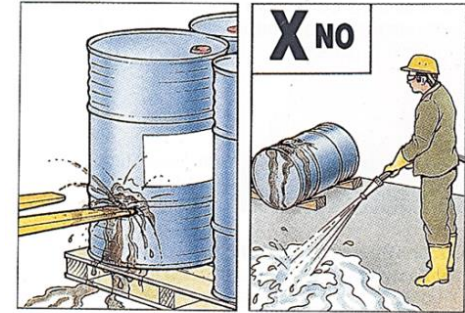
- Check containers on delivery.
- Use good quality containers.
- Ensure good and careful handling practices.
- Bad handling and long storage under bad conditions might result in risk of spills and leaks.
- Inform yourself in advance on measures and provisions in case of spillages or leakages: Material Safety Data Sheet and Manufacturer's instructions for corrective action.





HANDLING SPILLAGES AND LEAKING CONTAINERS (1/2)

- Collect with solid absorbent such as clay, sand, sawdust, (refer to recommendation in (M)SDS).
- Decontaminate area according to information in (M)SDS.
- Do not use water to wash away liquid spills.
- Remove solids with industrial vacuum cleaners.
- Collect solid contaminated materials in “old-open Top drums” until final disposal.
- Dispose waste according to manufacture’s instruction and/or legal requirements.
- Some local regulation request facility to inform local government for emergency case.



HANDLING SPILLAGES AND LEAKING CONTAINERS (2/2)



- Some chemical releases can be cleaned up, whereas other releases create an emergency (evacuate).
- Should a release occur, determine what can and cannot be cleaned up.
- Materials used to clean-up chemical spills must be treated as hazardous waste, placed in the proper container, labelled, and provided to the responsible department.
- Paper towels or other materials used for clean up should not be placed in the normal trash.
- Oily rags must be placed in a metal safety can that has a self closing lid until provided to chemicals management in a proper waste container.





CONTAMINATION FROM STORAGE

- Wherever there is leakage of oil you should have the secondary contaminant system which helps you ensure that any spillage will not go to Effluent Treatment Plant (ETP).
- Repacking/relabelling of any dyes or chemical should be avoided.
- Modification of the original containers of chemical to facilitate the ease of use/dispensing should be avoided.
- Having separated weighing accessories for each dyestuffs and chemicals, would lowers the chances of contamination during weighing.
- Automation/auto dispensing is also one of many viable options to prevent contamination.
- Storage of hygroscopic agents in the dyestuff storage area can help to minimize moisture levels in the area.
- Material of Construction (MoC) of the chemicals used for storage if not properly designed could cause the contamination of heavy metals.



CONTROL APPROACHES

Control approaches relate to:

- Access.
- Design and equipment.
- Maintenance.
- Examination and Testing.
- Cleaning/Housekeeping.
- Personal Protective Equipment (PPE).
- Training and supervision.

Example:

- Removal/ reduction of contaminants in the general works area using general ventilation.
- General cleanliness of workplaces.
- Simple preventive and control measures, e.g. close lids of chemical containers.
- General guidance and awareness creation .



EXAMPLES - CONTROL APPROACHES (1/2)



Dust collector in dyestuff weighing area



Exhaust system for leather spraying





EXAMPLES - CONTROL APPROACHES (2/2)



Fume hood for resin spraying in a denim laundry

Storage Checklist



CHECKLIST – SAFE CHEMICAL STORAGE

	Yes	Further action needed	No action needed	What action do you propose?
Responsibilities assigned				
Have you assigned a person exclusively being in charge of the chemical store(s)?				
Do you know the qualification this person?				Please specify for your own reference!
Is the person regular employee?				
Chemical supply				
Do verify that only properly labeled chemical containers are being allowed into your factory?				
Do you use mechanized means of unloading the chemicals? (e.g. forklift, crane) If not, do you use an elevated unloading platform with a ramp?				
Are the chemicals being unloaded by your own workers?				
Are the workers being supervised by an experienced supervisor or person in charge of chemical store while handling chemicals?				

The complete checklist can be found in your workbook.



REFLECTION

Take notes!
Workbook,
Exercise (12-2).

Review your MAP. What areas of improvement have been identified in relation to chemical storage and transport?

Discuss appropriate actions with your peers.

Open To Questions

SUMMARY



Every participant to feedback with one key learning from the session.



Take notes in your workbook, exercise (12-3).

