Guidance on Laboratory Safety

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1. Introduction

Safety management within the printing ink and coatings industry is given a high priority. Review of incident records shows that a significant number of injuries and incidents occur within laboratories. This guidance has been established to give advice on various aspects of laboratory safety and is intended to be supplementary to applicable national or European legislation. It covers both formulation situations most commonly met in paint and inks daily practice: either formulation of a new product or a change to an existing formulation. The Health, Safety and Environmental (HSE) principles are the same in both cases. Valid European and national legislation has to be taken into account, as well as industry documents such as the EuPIA Exclusion Policy and any national specific norms and guidances

2. Safe Formulating Principles

As industry good practice as well as according to the legislation in force, the use of chemicals hazardous for humans or for the environment should be avoided or, if this is not viable, hazardous raw materials should be substituted by less dangerous or non-harmful ones. Classification and labelling is compulsory for all containers of substances and mixtures which are hazardous.

In formulating a new product some general HSE principles must be adhered to:

a. Add high conductivity solvents first, then low conductivity ones.

   This is in order to maintain the level of conductivity of the system as long as possible. Reference: EuPIA Guidance for Safety in Handling of Flammable Liquids.

b. Add more soluble resins first, then less soluble ones.

   This is in order to have less suspended solids, which contribute to solution electrostatic charging.

c. Charge high density raw materials as last item, under stirring.

   If settlement is possible, remember that dry running (due to settlement) may lead to overheating and thermal decomposition.

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d. Nitrocellulose presents particular dangers in this respect.

   In case of a nitrocellulose-based formulation choose the solvents carefully. The first goal is to have this resin fully dissolved in order to avoid its possible thermal decomposition. Reference: EuPIA Guidance for the Safe Handling of Nitrocellulose-containing Raw Materials.

e. Powder charging has to be carefully considered.

   Dusts, when introduced into an industrial process, may bring risks connected to explosions as well as to electrostatic charging. Reference: EuPIA Guidance on Loading of High Resistivity Powders.

f. Consider different geometrical properties of lab equipment compared to industrial ones when proposing a new formulation.

   Remember that for a container surface increases by a square factor, whilst volume by a cubic factor. This may lead to problems in removing heat within an industrial batch.

g. Indicate maximum allowable process temperatures, to avoid dangerous side reactions or decompositions.

h. Metallic pigments may react with bases and need a specific firefighting agent.

   Never disregard chemical interactions with the binder, which may be reactive with them, e.g. Nitrocellulose.

i. Pigmented chips bring to the mixture characteristics coming from both pigment and resin, so for nitrocellulose chips observe precautions laid down for pure nitrocellulose and metallic pigments.

j. Reactive systems, like two component inks and varnishes or UV/energy curing systems, need specific care in order to avoid reactions which may lead to safety or health problems.

   Particular attention must be given to the issue of respiratory or skin sensitizing properties of reactive components. If these are used remarkably high protection standards are needed in the lab and later in production and application of the products. Reference: EuPIA Guidance for printing ink manufacturers on safe handling of UV and EB printing inks and their corresponding raw materials and intermediate products.

k. Corrosive materials deserve attention when used in formulations as they may require different personal protective equipment and different container materials for lab samples as well as sales containers.

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3. Storage Conditions

3.1. Introduction

Of the accidents or incidents that have been reported in areas where chemical products have been stored, most could have been avoided with foresight and planning for both normal working situations and emergency conditions. The causes of such accidents could mainly be attributed to inappropriate packaging materials and/or storage cabinets, and general neglect where substances had been hidden away and forgotten about.

The primary way to control storage is to purchase only the amounts that are absolutely necessary, discard materials that are no longer needed as soon as possible and follow the guidance below.

Hazardous substances must be stored in a safe place and in such a way that they pose no risk to human health or the environment. Their storage must fulfil minimum requirements, for example, that chemicals must be protected from direct sunlight, from atmospheric agents and from accidental contact with personnel or moving parts. _It must be kept in mind that some chemicals (e.g. nitrocellulose or ethers) may react or self-react over the time and may decompose which will affect laboratory safety

3.2. Scope

This guidance is intended to give advice to those who may work with or are responsible for chemically hazardous materials stored within laboratories, in order to store and handle them in a safe manner.

3.3. Hazards

Information about the hazards of chemical materials can be found in a number of ways including:

- Product labelling – CLP Regulation using GHS pictograms and H- and P-Statements
- SDS review – review of H & S statements, safe handling, specific information etc.
- Chemical Risk Assessments

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The name of the chemical together with the hazard symbol and the associated hazard designation should be stated on the containers. According to European Union legislation a label reporting them is compulsory unless the volume is lower than 150 ml.

To have the situation of dangerous substances or mixtures under control it is highly recommended to have an inventory of all chemicals present within the storage. It is up to the responsible person to choose the way to organize it, but all chemicals must be mentioned, also for running an incompatibility check (see following point (v) for further details about this topic).

3.4. Types of storage

a. Flammables storage

In case there is the need for flammable liquids storage (e.g. solvents), the cabinet should be of metal construction, built in agreement to local legislative and insurance requirements. It should be lockable if required, with trays/lips for containers to sit inside should breakage or spillage occur, with retention suitable for the stored quantities. The location of flammables must be recorded on a site plan, either centrally for the building, and/or on the door of the room involved. All flammable substances must be stored in the designated cabinet at the end of each day.

b. Bench storage

In a laboratory it is common practice to store standard chemicals for daily use on dedicated lipped shelves behind the work bench. This is only deemed satisfactory if these are limited to the original labelled containers, or clearly labelled (with hazard signage) made-up mixtures. The quantities must not exceed daily use limits (e.g. not many containers, reaching 30 L of a single solvent).

c. Corrosive storage

These materials should be kept on a corrosive-resistant surface in a well-ventilated space. Preferably dedicated closed and well-ventilated chemical resistant cabinets must be used. The surface should have a lip or tray capable of withholding any spillage and made of a resistant material e.g. appropriate plastic. Ideally this should be within a cabinet. These must never be stored above eye-level. Incompatible substances with corrosive properties must not be stored together (e.g. strong acids with strong bases, etc.).

d. Toxic materials

Special cabinets should be acquired for such materials and should be designed to cope with any other significant properties other than just the toxicity. The major concern for all these materials is security and this must be taken into account when considering the accessibility

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of the area and the materials themselves to staff and visitors (planned or malicious). Access should be managed by a robust key management system, avoiding access of unauthorized personnel. If needed, an access register can be utilised. This will apply in particular for substances with higher hazards, such as carcinogenic, mutagenic or reprotoxic substances, that may be present in analytical lab storage as standards.

e. Environmentally hazardous materials

Appropriate storage should be considered for materials classified as environmentally hazardous. This includes floor openings without direct access to sewer systems, the use of retention basins and spill control kits, according to dimensions and the quantities involved.

f. Outside storage

Such dedicated stores are preferential from a primary safety viewpoint but can present secondary problems that may well outweigh the benefits e.g. accessibility for vandalism or the area being remote from the responsible person. Such external stores might be used e.g. for gas cylinder or nitrocellulose storage cages, or dedicated brick-built solvent stores.

g. Gas cylinders

The best practice for gas cylinder storage is an external storage location, built in concrete, with a labyrinth entrance so that, in case of leakage or explosion, no employee transiting in front of the storage will be directly affected. So, where practicable, these should be stored outdoors, and then preferably plumbed into the building so that they do not need further handling. If this is not feasible, then cylinders can be safely transported into the building to be used locally but must be subject to a risk assessment and subsequent training e.g. on manual handling of the cylinders, and the safe fitting of regulators. It is unacceptable to leave a gas cylinder free-standing: they should always be clamped into position and held secure by a strap or chain. A periodic check of gas cylinders storage (fixing, covers, etc.) must be inserted either in safety audits or in routine safety checks. As gas cylinders are pressure resistant containers, their periodic check for revision is also necessary.

If it is planned to leave the cylinders in place, either attached and 'working' or not, then the risks (namely including asphyxiation) must also be assessed and some infallible method of safety controls instigated; this may include extra fail-safe ventilation, or monitoring / alarms with all the associated documented procedures in case of emergency. The length of any pipework must be kept to a minimum. Those technical measures are mandatory when highly flammable technical or analytical grade gases are stored, e.g. hydrogen for gas-chromatography or other highly dangerous gases.

The permanent location of all hazardous vessels must be recorded on a site plan, either centrally for the building, and/or on the door of the room involved.

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h. Refrigerators

Domestic type refrigerators are not designed to hold flammable materials. They contain electronic components that will cause a spark; the thermostat and the light and its switch are unprotected. If such a spark occurs and there has been any leakage or evaporation within the sealed fridge, it can cause a very powerful explosion and fire, with the clear risk to personnel and property.

- Before storing any flammable or explosive materials at low temperature, a full risk assessment must be carried out taking account of the physical properties. This will identify the most appropriate type of storage; on no account is it acceptable to store highly flammable products in a domestic-type fridge. There is a wide range of suitable laboratory fridges available that are deemed spark resistant as they do not have any internal electronics.
- Fridges kept for domestic purposes close to a technical environment (lab or workshop) should be labelled to clearly state their purpose and avoid misuse by the personnel.
- Note also that domestic fridges not used for food/drink must also have a risk assessment before being used to store other materials and should be labelled accordingly so there is no risk of confusion, i.e. a notice indicating that “No food or drink to be kept in this fridge”.

3.5. Incompatibility and instability

a. Incompatibility

Where practicable, materials should be stored like-for-like in areas separate from other groups. This is not always possible, so if not the following advice should be applied. All significant incompatibilities should have been established on the SDS (data sheet) as part of the chemical risk assessment, but there are certain general rules to follow, as shown in the schematic below:

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	Chemical Group																								
1	Inorganic Acids	1																							
2	Organic Acids	X	2																						
3	Caustics	X	X	3																					
4	Amines & Alkanolamines	X	X		4																				
5	Halogenated Compounds	X		X	X	5																			
6	Alcohols, Glycols, and Glycol Ethers	X					6																		
7	Aldehydes	X	X	X	X		X	7																	
8	Ketone	X		X	X			X	8																
9	Saturated Hydrocarbons									9															
10	Aromatic Hydrocarbons	X									10														
11	Olefins	X			X							11													
12	Petroleum Oils												12												
13	Esters	X		X	X									13											
14	Monomers and Polymerizable Compounds	X	X	X	X	X	X								14										
15	Phenols			X	X			X							X	15									
16	Alkylene Oxides	X	X	X	X		X	X							X	X	16								
17	Cyanohydrins	X	X	X	X	X		X									X	17							
18	Nitriles	X	X	X	X												X		18						
19	Ammonia	X	X					X	X					X	X	X	X	X		19					
20	Halogens			X			X	X	X	X	X	X	X	X	X	X				X	20				
21	Ethers	X													X						X	21			
22	Phosphorus, Elemental	X	X	X																	X		22		
23	Sulfur, Molten									X	X	X	X				X						X	23	
24	Acid Anyhdrides	X		X	X		X	X							X		X	X	X	X					24
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

Chemical Storage Compatibility Chart

X Represents Unsafe Storage Combinations

Represents Safe Storage Combinations

Additional information on compatibility / incompatibility of chemical substances may be found on the UK HSE authorities website, including a useful chart in the freely-downloadable document HSG 71 (Chemical Warehousing)[1].

b. Instability

Some chemicals are unstable and so have very specific storage requirements that are designated either for safety purposes or for the preservation of the material itself (possibly with no safety implications). These may involve specifics of temperature, air or water (inclusion or exclusion) and should all appear in the specification as issued by the supplier / manufacturer. Requirements will appear in the SDS (Section 10) if the material could degrade to an unsafe derivative, and this advice must be strictly followed.

Other materials may have a designated "shelf-life" after which they have the potential to become unsafe. A typical example of this might be pre-polymers (e.g. varnishes or glues) that may expand as they auto-polymerise thus carrying the risk of splitting or shattering their container. Also over-aged nitrocellulose samples may start degrading, smoldering and eventually burning. This applies also to some solvents, e.g. ethers, which over the time may develop peroxides and become very dangerous. In such cases, on the chemicals inventory, the shelf life must be recorded and periodically reviewed.

[1] Chemical warehousing: The storage of packaged dangerous substances - HSG71 (hse.gov.uk)

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For any of these materials, it is imperative to firstly know the hazards of the materials, and secondly to be able to perform a suitable and sufficient risk assessment and act on the findings to adequately control the risk. They will inevitably call for a robust system of stock control.

3.6. Emergency arrangements

a. Fire

You must account for the effects of a fire when considering selection of the storage type and the materials. If incompatible materials are kept at storage distances considered safe under normal working conditions, a fire might cause further complications i.e. subsequent mixing of incompatible materials following plastic containers melting or even igniting. The consequences should be subject to a risk assessment. The chemical risk assessments must include emergency risks and thus have appropriate firefighting provisions, ascertained from SDS. Specific characteristics of single materials must be considered in this regard: materials for which water isn't the preferred extinction material in case of fire must be kept in separate storage or protected against water jets/curtains/sprinklers in case of use in a fire situation.. Appropriate emergency firefighting and labelling for such storage areas/cabinets has to be included.

The departmental positioning of fire detection and firefighting equipment should take account of where storage facilities are, and not just where materials may be used. Conversely, if a new storage facility is to be installed, then the proximity of these measures should be considered before finalising the plans. Special precautions (automated systems and/or specialised suppressants according to material type) may be deemed necessary after performing the (fire) risk assessment.

b. First aid

First Aid kits, including eyewashes, must be held in a place that is not only suitable for persons using hazardous materials, but also close enough to the storage facility if an accidental chemical exposure should happen. The kits must include special provisions if their need has been identified on the risk assessment because of the local use of particularly hazardous materials. It may be necessary to have emergency showers local to the storage facility, dependent on the risk assessment.

c. Spillage

As identified in the risk assessment, a spillage procedure should be established, and there should be a suitable spill kit readily available that contains appropriate spillage treatment materials and equipment. Adequate placards must indicate spillage kit position.

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3.7. Safety management.

It has been established that there is the potential for significant levels of risk to be posed by storage of the chemical products held, even after the amount of materials has been kept to a practical minimum by good stock control. Adopting the following aspects of safety management will demonstrate best practice.

a. Risk Assessment of materials/ facility

If this is done to a suitable and sufficient standard, then all potential risks should have been identified and estimated; all the controls as follow should be adopted to reduce the risk. A full inventory should be established of chemicals stored in the workplace. An up-to-date copy of the safety data sheet for each material should be maintained. Self-igniting materials like some pigments, unstable materials like nitrocellulose and all substances with particular dangers (pyrophoric ones) must be taken into account in ordinary and emergency conditions.

b. Inspection

To confirm continuing efficiency of the storage facility an inspection regime should be implemented to assess risk management continuity. Inspection should be documented and recorded, in order not to lose historical records/accidents/near misses.

c. Signage

Appropriate signs as designated in the regulations must be attached to the outside of storage compartments, and also if it is felt necessary for the safety of occasional visitors (cleaners or the Emergency Services) on the outside door of the room. However these must not be overpowering or confusing, so the door must only describe the primary safety concern within that room.

d. Operating Instructions/Procedures

As best practice, an Operating instruction or a procedure should describe operations within chemical storage, clarifying storage criteria, operations allowed or forbidden, and correct operational behaviours within the storage, including non-standard conditions and emergencies.

e. Training, Toolbox talks

An induction for newcomers as well as a training for all personnel about correct storage procedures and behaviours must be performed and periodically repeated, even as short toolbox talks. Particular attention must be paid to behavioural topics, as shortcuts (pouring a liquid in a small container within the storage, incorrect storage, etc.).

f. Housekeeping.

Ongoingly attention must be paid to good laboratory practices for housekeeping, especially stock control, correction if containers are damaged or improperly labelled, cleanup of spillages, proper waste management.

3.8. Location of stores

Storage facilities are provided to ensure the health and safety of persons working with or requiring access near to hazardous materials, and as such the store should be located safely so as to not present any increased risk. For example a flammable store should not be kept on a fire exit route.

3.9. Conclusion

Although most chemicals have inherent hazards, the risks involved with using, storing, and disposing of them can usually be controlled to acceptable levels using the guidance listed.

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4. Equipment Operation and Maintenance.

4.1. Identification of equipment and records

Each piece of mechanical or electrical laboratory equipment should be identified with a unique reference and a means to indicate its maintenance and calibration status (usually via clear labelling). A reference list of laboratory equipment should be maintained by the Laboratory Manager – this list shall be traceable to maintenance and calibration records.

4.2. Maintenance of equipment.

a. Maintenance categories.

Laboratory equipment should be maintained according to one of the following categories, which should be included within its identification status:

a) Preventive maintenance by a qualified engineer to a specified procedure and frequency

b) Preventive maintenance prior to use by a qualified engineer

In addition, user checks before use may be required – these checks should be specified in the equipment operating instructions, and they should be documented when necessary and required.

It is recommended that preventive maintenance procedures for each piece of equipment are approved by the Laboratory manager and where necessary an appropriately qualified engineer.

b. Additional requirements.

Portable electrical equipment should be inspected and tested in accordance with European and National legislation.

All safety critical devices (guarding, interlocks, emergency stops, fume hoods etc.) should be clearly identified and included in preventive maintenance procedures – there should be effective and periodic checks in place to confirm that these devices are working correctly.

Any pressure systems, lifting gear, gas supply, exhaust ventilation, water supply and fixed electrical installations used by the laboratory should be included in the preventive maintenance schedule, in accordance with European and National legislation.

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4.3. Risk assessment and operating procedures.

a. Maintenance categories.

All laboratory activities, including laboratory equipment and its use, should be covered within the site risk assessment programme to meet the requirements of European and National legislation.

b. Operating instructions/procedures.

Suitable operating procedures, approved by the Laboratory Manager, should be provided for laboratory equipment. These procedures may be taken directly from the operating manual supplied by the equipment manufacturer and/or in-house operating procedures written by the user laboratory – in both cases, all safety requirements and precautions specified by the equipment manufacturer should be reviewed by a safety professional and followed.

c. Equipment changes/new equipment.

All new equipment, or equipment that is modified or changed, should be subject to a Management of Change process that includes a review of risk assessment (including measures to mitigate identified risks), operating procedures, maintenance and training requirements.

4.4. Training.

Laboratory personnel should be appropriately trained on risks associated with laboratory equipment and on their safe use (including operating instructions) and confirmed by the trainer to be competent before being allowed to use any piece of laboratory equipment.

Records of personnel training and competence should be retained by the Laboratory Manager or according to company policies.

Note:

The requirements of the European Machinery and ATEX directives should be taken account of and complied with in any proposed installation and use of laboratory equipment:

- http://ec.europa.eu/growth/sectors/mechanical-engineering/machinery/index_en.htm

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- Directive 94/9/EC / Directive 2014/34/EU on equipment and protective systems intended for use in potentially explosive atmospheres
- Directive 1999/92/EC on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres

  http://ec.europa.eu/growth/sectors/mechanical-engineering/atex/index_en.htm

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5. Risk Assessment and Training

5.1. Risk assessment

All laboratory activities, as per the following sections, must be risk assessed. Risk assessment should be performed by person(s) competent for the task and involve the lab workers who are exposed to the risks. A possible path for activities can be:

1. Define all routine & non-routine laboratory activities.

2. For each activity identify all associated hazards such as:

- Work environment hazards: e.g. noise, vibration, lighting & ergonomics, emergency escape routing
- Hazardous substances: e.g. flammables, sensitizers, corrosive materials
- Work equipment: e.g. machines, tools, glassware, gas cylinders, workplace transport.
- Energy sources: e.g. electricity, compressed air & pressurized fluid lines.
- Work activities: e.g. manual handling & lone working.
- Consider ordinary activities, extraordinary ones and possible deviations (that can be reasonably foreseen).

3. For each activity identify the population/group of people at risk including:

- Laboratory staff.
- Maintenance staff.
- Contractors.
- Temporary staff.
- Cleaners.
- Visitors/public.
- Special cases/vulnerable persons e.g. young persons, expectant & nursing mothers, disabled workers and lone workers.

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4. Risk assess each activity, identifying main risks and prioritizing them. Existing control measures, such as fume hoods, LEV and others must be taken into account, considering also their efficiency in hazard protection. Use of a risk matrix approach (usually likelihood vs severity) is recommended.

5. Reduce to a minimum all possible sources of risks, implementing an action plan. If, after such measures, the risk would still be unacceptably high, consider working in a different way or rethinking the whole operation.

6. Check the effects of risk reduction measures and that residual risk levels are acceptable.

7. Review the risk assessment when there are significant changes to the hazard classification, type or volume of chemical, equipment, processes, or people exposed to the hazards identified. A periodic review of the risk assessment should also be done in a frequency adequate for the identified risks, standard recommendation is 3 years.

5.2. Training.

Following the risk assessment, appropriate training must be conducted covering all relevant health, safety and environmental aspects identified. Laboratory signage and classification and labelling requirements must form part of the training.

Training must not only be scheduled and organized according to the Risk Assessment outcomes but must be held by qualified personnel with training skills and must be followed by a training comprehension test. Training must be repeated in a defined frequency, for practical and legal reasons annually. No-one should be allowed to conduct a task without adequate training from a safety point of view.

EuPIA OSRA Working Group, May 2024

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