

Laboratory Safety

Laboratory Safety Webinar
for Organisations

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by Richard Greenwood



Richard Greenwood

Consults in workplace chemical
hazards and safety.

Accredited Member of the
Australasian Institute of
Dangerous Goods Consultants





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In thinking about the whole question of safety in the Laboratory, the approach that comes to mind as a consultant in this area, is to think about some of the issues that have arisen in previous investigations and contacts with laboratories throughout the full scope of my working life.

This started with working in laboratories, so there is still a background memory of the particular advantages and limitations that most laboratories face.

I will not focus on what the regulations say you must do, because the regulations are not terribly helpful on: "How you do it?" or "Why you do it?" or what the safety issues really are. What has helped me to understand why the regulations are as they are, is an understanding of why hazards arise as they do, why cabinets are designed the way they are, why they fail and what the circumstances are where users push their use beyond their capability to provide safety. Cabinets are often altered without an understanding of how the alteration has compromised the safety provided by it.

We will focus on a few specific issues that arise to illustrate how this compromise of safety can unwittingly occur.

In Australia, Laboratory safety regimens have changed over time and increasingly adopted the Globally Harmonised System (GHS) system. Some states still use the Dangerous Goods storage and handling system (DGHS) but in the main the GHS has been adopted. It has not made a huge amount of difference regarding what we need to do, or the background information provided and what is accepted as good practice.



Segregation

If we look at the Work Health and Safety Regulations or the Victorian and Western Australian Dangerous Goods Storage Regulations, one of the key issues that applies in laboratories is the requirement to segregate. The application of this in all cases is not well understood.

Chemical Segregation in Workplace Regulation

Requirement to segregate spill containment of chemicals which are not compatible:

“compatible, for 2 or more substances, mixtures or items, means that the substances, mixtures or items do not react together to cause a fire, explosion, harmful reaction or evolution of flammable, toxic or corrosive vapour.”

WHS, Victorian and WA Dangerous Goods Storage Regulations



On consulting the regulations, you will see that the requirement to segregate is specifically applied to containment of spills. In effect, the regulation is focusing on storage, although ‘storage’ normally applies within workplaces to chemicals not directly in use. The definitions are working backwards (upstream) for the situation in a typical workplace. It states that segregation is related to the containment of spills of chemicals which are not compatible, but then goes on to define which chemicals are compatible! That is: “two or more substances, mixtures or items means that they do not react together to cause a fire, explosion, harmful reaction, or evolution of flammable toxic or corrosive vapor.”

That actual wording is pretty consistent in the regulations of all States and territories and the Commonwealth, no matter where your regulations are issued. At least there is some agreement somewhere even if the names of the regulations differ and the particular diamond shaped signs specified vary as well.

Flammable Liquids

The first key group of chemicals to consider in laboratories is flammable liquids. Regardless of whether they appear with a dangerous goods diamond sign, or the flame pictogram sign in both cases the term is misleading. The definition 'flammable liquid' is applied to a liquid that produces sufficient vapor that can burn.

This definition is very clear in the GHS system where the actual hazard statements refer to 'highly flammable liquid and vapor.'

In training in laboratories, it is good to note that this GHS sign reminds you that when you see this label on a liquid it is the vapor that is the primary safety concern. It also means that where there's vapors present there is a risk of inhalation. This risk of inhalation applies to any flammable liquid, if it can produce sufficient vapor to burn, and the chemical has associated negative health effects. The function of the lungs is to allow chemicals in and out of the body, so inhalation of the vapor is the route that will produce these negative health effects in the body.

Regarding the fire risk, it is the vapor that burns. Key considerations for fire prevention come down to ventilation of the storage area, good seals on the storage device and direct seals on the chemical containers. The aim is to ensure that vapor release is going to be minimal.

The flashpoint is a key consideration in accident prevention. The flashpoint is the temperature at which sufficient vapor has been released to burn and sustain a fire. The percentage of vapor that provides this condition is typically just a few percent of the vapor in the air. This flashpoint temperature should be listed in section 9 of the safety data sheet (SDS) in the section on physical properties. For flammable liquids, the flash point is usually below 60 degrees Celsius.

A highly flammable liquid and vapor may have a flashpoint around 23 degrees, meaning that it will have sufficient vapor to burn any time of the year and not just at the height of summer. It is possibly a significant hazard even in winter.

The greater the spill area, the greater the spread of material is and the faster the vapor release will be. The greater surface area is not only a larger area for the vapor to be released from but will also have a larger area of contact with the surface e.g., the floor. This increased surface contact allows greater energy transfer between the bulk material and the surface, and this can cool the liquid faster than it would cool through evaporation, slowing the vapor release. If it is in contact with the floor, it will tend to stay at the same temperature as the floor.

As mentioned, the fact that you have got vapor means you have got potential health effects in commercial environments and also in laboratories. Those health effects may even exist at temperatures below the flashpoint and even below the flammable limits in air. Even if you do not have enough vapor to burn and blow yourself up, you may still have long term health effects. This needs to be considered.

It is the vapor which actually burns, but it does not burn without an ignition source. The problem we are considering is caused by individual molecules of the vapor in air. We are not considering a bulk material that has to be heated up to a problematic temperature. This would require a lot more energy and is far less likely to occur. That is the point. Flammable liquids will produce enough vapor to cause a fire under ordinary conditions. In the right mix of vapor and air, the amount of energy required for a fire is very little indeed.

Sparks, hot work, welding, grinding and equipment that is not built to be electrically safe will cause ignition.

There are several ways to protect against ignition occurring. The most common one for flammable vapors would be to build the equipment so that it is sealed in such a way that the vapor cannot enter the location of live electrical componentry.

This is done with a variety of electrical equipment, but it does not make for cheap design and such a luxury is not standard or common. for a variety of equipment.

It is certainly a concern that the growing use of electronic equipment in stores and laboratories is problematic because though much of that equipment might have been designed to handle flammable liquids internally but not necessarily to handle vapors externally. This class of equipment includes laboratory fridges and that may concern you if you happen to have one.

Vapors of flammable liquids are typically heavier than air, one exception being methanol. Methanol is about the only flammable liquid light enough that the vapor is about the same density as air. Ethanol is about one and a half times denser and acetone about twice as dense. To consider the density, it is as simple as looking at the comparison of molecular weight of the chemical vapor in comparison to the standard gas mix in air. This means that for benchtop use of chemicals where a fume hood is not in use, even in a ventilated room the vapor will stay low and spread low and along the benchtop at the benchtop height. If the chemical is being used under the benchtop or there is a spill on the floor the vapor will spread low and at floor height and then gradually diffuse up. This may even result in levels of vapor building up at breathing zone height (nose height) that can be smelt and inhaled.

In a fume hood of course, where there is specific extraction ventilation and quite strong air flows that arise as part of the design of the fume hood, the vapor will not build up. Vapor levels low down at the point of release will be a lot higher and will spread at that level specifically. The greatest area of concern regarding ignition sources therefore is sources that are located over the benchtop where chemical use is at the benchtop of low-level ignition sources for spills and releases at ground level.

One obvious hazardous location for an ignition source is actually near a chemical storage cabinet. So often these are the items that we are relying on to give segregation from incompatible materials and to give the needed containment of spills to ensure that the spill does not spread into an incompatible material that it may react with or spread to another ignition source that it may ignite or be ignited by.



Chemical Cabinets

The primary design feature of a chemical storage cabinet is located underneath the bottom shelf where there is a space for the containment of liquid spills.

It is critical that the bottom shelf is not removed, even if there are bigger bottles to fit into that cabinet. The top shelf can be removed to provide for these bigger bottles and if that does not provide enough space then another cabinet is needed.

The bottom shelf should not be removed since its removal takes away the spill bund provided to collect spills. Another aspect of the design of the bottom shelf is that it directs drainage of the spill into the bund rather than allowing the chemicals to spill out through the doors.

The cabinet itself is designed to keep the vapor in. To achieve this, the Australian standard requires that flammable liquids cabinets have self-closing and latching doors and that, if either of those things do not work, then the cabinet no longer complies. In practice they are a pain and impact on workflow since you must lean against the door to keep it open while you are accessing materials in your flammable liquids' cabinet. This is, at the very least, awkward, and sometimes annoying when you have got to go back multiple times, because every time you go back to the cabinet you must reopen the door and rearrange yourself so that you can lean against it and keep it open. The purpose of this design feature is to ensure that closing the doors cannot be forgotten and that they cannot be left open and left unlatched. It ensures that the latches cannot create a gap where the vapor can be released. The whole purpose of the design is to keep the vapor in.

If you have stored an open container in the cabinet then it is still going to fill to a saturated vapor pressure of that particular vapor over time, and when the doors are opened all that vapor will be released into the workspace.

The design includes the requirement that the shelf above the bung should have drainage holes only. This is to limit the rate at which the vapor continues to come out of the cabinet after the initial rush. Once again, if that shelf is removed, then the situation is the same as if you just had an open liquid in the cabinet with the doors held open. This will result in ongoing replenishment of the vapor that has already been released.

It is important that when accessing materials in the cabinet, it is done by a trained operator aware of the hazard and who knows how to respond if hit by a large amount of vapor when the doors are opened. This person would recognize that the situation is clearly unusual and that it is caused by open containers or that spilling has occurred. They would assess the consequences at this point, shut the door to prevent any further vapor getting out, and will then assess the safety of continuing to access and/or will choose a time at which to clean up the spill.

If the cleanup is going to be problematic, there is the option of ventilation. Since the vapors are heavier than air you should use the bung holes on either side of the cabinet provided typically as part of the design. One of them is low and should be just above the containment area. That is the one to extract from if connecting to a ventilation system. The lower bung hole is used since the vapor levels will be higher down there and the extraction will be more effective. Choosing to extract from the higher bung hole would allow the entire cabinet to fill up to a high vapor loading and the final release of vapor will be greater.

The first and second purpose of the cabinet was to contain spills and capture vapor from the flammable liquids. A third purpose is fire PROTECTION.

The robust construction of the cabinet provides fire resistance to allow for initial response in case of a fire.

If the fire can be dealt with using a fire extinguisher and it is only a nearby fire, it will be safe to deal with the fire that way for a period of time, that is assuming that the person knows how to use a fire extinguisher and has chosen the correct one. If that fails and the fire continues to increase, then the cabinet will still provide protection of the flammable liquids, allowing sufficient time to escape the scene.

There is a key issue of noncompliance that often arises and often so with cabinets that otherwise comply. (Some standards require that this stipulation should be painted on the cabinet to ensure it is not forgotten.) The flammable liquids cabinet is meant to bear the statement that it has to be located 3 meters away from ignition sources, that is three meters laterally and one meter vertically. Frankly, that distance is the same no matter the size of the cabinet, which could be anything from a 30 liter under bench cabinet to an 850-liter capacity, 2-meter-high cabinet. The uniformity of that requirement does seem a little odd as the volume of chemicals and cabinet dimensions vary so greatly from one extreme to the other. It may be that the requirement is accounting for a worst case or that perhaps the distances are excessive for small cabinets. Some calculations can be done to determine that.

Primarily what I am concerned about when going into laboratories, is not so much people carrying mobile phones in the vicinity of a flammable liquids' cabinet, but rather the permanent ignition sources. I challenge whether there is permanently sited electrical equipment close to the flammable liquids cabinet and base the judgement on its size and whether it is at ground level, in particular fridges, dishwashers, and other such appliances.

Another consideration is whether there is equipment directly above the cabinet, for example in the case of an under-bench cabinet.

In reality though, the 1-meter vertical requirement would require an incredibly serious amount of vapor release from within a cabinet to get to a flammable zone at 1-meter above the cabinet. The room would have to be filled to that height with the vapor, or at least for long enough for the vapor to diffuse up to that height.



More often, there will be ground level ignition sources that will be closer and even if not closer will be more relevant because that is where the flammable vapor path is going to be and once the vapor has ignited, it will flashback to where the liquid is and it will start heating the liquid, making the liquid produce much more vapor. The fire will escalate very rapidly from there.

Knowing that that is the situation, knowing that that is the intended mode of operation and the mode of safety provided by the cabinet helps in a situation where you are faced with a problematic situation. When the cabinet is full of vapor and it has done its job, it has contained the spill, it has contained the vapor up until this point, where you have become aware of it, the safe option may still be shutting the doors and having a meeting to discuss what we can turn off, what we can remove and how we clean up the spill and what we can do from this point on.

Extraction ventilation can be fitted, it does not have to operate all the time, but it should be operating for some time before the cabinet is being used. Just switch it on when in the morning and turn on other equipment. It is not advisable to take the bung out to get a ventilated cabinet since this will create a situation where vapor will be released at times when there is no personnel present and that might sound like it is great for their health, but it is not, if there is a fire.

The fire will be able to enter the flammable liquids cabinet and directly burn the materials in the cabinet until the cabinet fails, which from the inside could happen very quickly indeed.



Corrosive Liquids

The next problematic common class of chemicals is corrosives. It is a recurring theme that comes up when visiting laboratories.

With corrosives we are dealing with severe damage to skin. If it can eat through the dead layer on your skin, then it can certainly cause severe and permanent damage to your eyes as well, since there is no dead layer on the eyeball, and it will directly attack live tissue. It may also eat through metals, and it may do so through metals, even at dilution levels where it no longer eats through skin.

In considering the corrosive classification, common inorganic acids in particular, the final concentration is not at the point when it stops eating into skin. This is not the concentration limit that the GHS talks about, the GHS refers to the limit where it stops eating into metals sufficiently. It does not just consider any amount of corrosion to metals but includes the time factor as well. The corrosion has to be fast enough to consider it a problem, and typically that does still happen at lower concentrations.

But body contact issues are the most immediate concern and the most direct concern in workplaces.

To deal with this the obvious one is the choice of personal protective equipment. If body contact issues are the chief concern and depending on the length of time exposure will or has occurred special care may be made in the selection of gloves, for example to give the right level of care.

After considering the careful choice of personal protective equipment and eye protection in particular, the next consideration will be the options around eyewash and sufficient first aid response to match the chemicals being used.

Take for example a corrosive material that has a suggested requirement of fifteen minutes for eye washing. A Saline wash bottle even with two liters of wash and with an eye wash attachment, might give you two minutes of washing. And that is an important initial response, but we still need to have your plan for what you do for the other thirteen minutes, let alone what the ambulance people may decide when you arrive. First aid response may also require that the skin be washed, but if there is a choice between skin and eyes, go for your eyes first. They will be damaged in a lot less time.

With corrosive chemicals there also arise equipment maintenance issues, particularly where you are not using cabinets. Several of the corrosive's have volatile vapors which they give off as well. Hydrochloric acid is the usual culprit, but by no means the only one. To deal with this it may be decided to store it in other areas. It is easy to tell whether hydrochloric acids have been stored over a period of time or stored in cupboards because all the metal hinges will show distinct signs of attack.

Hydrochloric acid will also release hydrogen chloride which has a clear odor. In storage there will be temperature fluctuations resulting in slight pressure buildups that will sort release past the lid rather than rather than pressurize the bottle in general.

The key second issue laboratories face as soon as they get a corrosive cabinet is the understanding that there is an immediate need for two Dangerous Goods storage cabinets and the GHS does not really help here either. They do not really distinguish between acids and alkalis or bases,

And we have the problem that we have an inbuilt incompatibility if we are talking concentrated acids and alkalis. The reaction is violent enough to produce a lot of heat.

In addition to that reaction, there is a possible reaction with metals, which may produce flammable hydrogen gas in the spills. When building a corrosive cabinet, it is necessary to either very strongly protect the metal in any metal components that it is made from or make it out of plastic. Cheaper plastic cabinets on the market have concerns about their fire control as they flex overtime with heavy bottles inside them. With time the doors no longer shut, creating other concerns.

In Australia, an interesting situation has arisen. Dangerous goods is the older system around here, and it literally only recognizes metal and skin corrosion for the definition of a Class 8 corrosive in Dangerous Goods but the dangerous goods pictogram in the GHS recognizes that there are some materials which will not eat through skin, do not sufficiently eat through, or quickly enough eat through metals, but can result in permanent eye damage. And the requirement is that people respond to those in same way as they have traditionally responded to skin corrosives, particularly in choice of PPE, and awareness of First Aid options. Consequently, the choice is to use the same pictogram and same symbol, even though there is not a specific eye on the pictogram and the skin and metal that are shown may not apply.

To make the point it must be treated as if it is a corrosive material, it will probably cause skin irritation, at least and then it certainly will cause slow metal corrosion over storage times, which may not be taken into account in the classification.

One of the key issues though is, this incompatibility issue in this requirement to have two cabinets if we are going to rely on them for segregation the storage of these materials. The segregation is certainly justified for concentrated acids and all bases, including concentrated acids with non-concentrated bases, when the reaction may produce dangerous quantities of heat. Heating up the remainder or the excess of concentrated acid may in fact lead to release of corrosive and toxic vapors, the amount of heat may cause failure of components or pressure buildups, and explosive releases of corrosive material under pressure and a fairly nasty situation all around.



It is obvious that in dealing with dilute solutions, this does not really apply. In performing titrations of acids and alkalis, fairly dilute solutions, they get warm, and that heat may even be felt, but it is not 'a fire explosion or harmful reaction.' In fact, it is the reverse of a harmful reaction. We are neutralizing the material.

This leads to the question: "If we do not have to segregate all acids and alkalis, if we do not have to do it for dilute ones, how dilute are we talking about? And what is a reasonable sort of thing to think about and choice to make if we are limited in what we can put in segregated areas?"

"Do we have to segregate, in working laboratories, where they're not holding onto concentrated materials, for example?"

So how dilute do they mean and how much heat are we actually talking about here?

Take for example standard, reasonably concentrated solutions for laboratory use. Two molar hydrochloric acid, two molar sodium hydroxide, which is in fact more concentrated than we would allow in most school laboratories for student use these days. Two molar sodium hydroxide is easily strong enough to still be corrosive and eat holes in you, and two molar hydrochloric acid maybe not, but I would not want it in my eyes and to be risking permanent damage there. If you combine them, how much hotter could they actually get as a worst case?

And it is an easy bit of physical chemistry and an easy Internet search to look up to find the heat of neutralization. In the specific case mentioned the answer comes out less than 14 degrees Celsius. So, if you take equimolar amounts of those substances, you get a worst case of the most amount of heat that they could produce, and the biggest temperature rise that they could produce over the combined volume. A 14-degree Celsius temperature increase could be hazardous in a production volume in a production area, or it could be hazardous in pipework where perhaps there is not provision for expansion and release of pressure.

But if we are talking about open containers and handling with non-thermal gloves, we are not talking about a harmful reaction there, we are talking about 20-degree reagents, and they are not going to be that warm in laboratories at the moment, this time of year, then the combination of these reasonably concentrated solutions is not going to bring the temperature up to body heat even. So, there is no option for thermal burns, and we do not have to worry about the corrosive burns because we just said its Equimolar concentrations resulting in a totally neutral reaction product.

From a laboratory point of view, if the solutions are two molar or less then in general, it is not about a harmful reaction and heroic efforts for segregation are really not justified.

The problem we have is that we go from an observation that concentrated acids and bases are incompatible to a general rule that acids and bases require segregation.

It is not justified in the regulations for more dilute solutions and if somebody tries to force that on you, you have just got to out science them, frankly.

To calculate this, all that is needed is to look at the heat of neutralization and then consider the heat capacity of water, a remarkably simple calculation.

There are exceptions to this. Cases where even the dilute solutions may present issues. A classic is Cyanides and dilute acids. We may be complacent about cyanides because most cyanide solutions are only toxic if swallowed. However, you can make them toxic by inhalation with dilute acids. So that will be a problem. Then there are reactive metals and dilute acids. The problem here is the production of hydrogen gas. Examples are bleach solutions or pool chlorines mixed with dilute acids because of the release of toxic chlorine gas.

And the important one is still corrosives. I am not saying that 36% hydrochloric acid and two molar sodium hydroxide is safe. I am saying that if two molar hydrochloric and two molar sodium hydroxide is mixed it does not represent a harmful reaction outside those areas and therefore the segregation is not justified for all acids and all alkalis.



Oxidizing Agents

The next problem group are oxidizing agents. These are problems due to the broad range of materials that they react with and their propensity to react slowly and create unstable materials in storage or from contamination or in waste streams.

Importantly, they react dangerously with a very broad range of materials and not just flammable liquids. It is all very well to highlight the importance of segregation of oxidizing agents and flammable liquids as long as you go on to point out that in fact you must do that for any combustible material. Potentially any of those could lead to a fire.

Some of them may be slow but solid materials tend to react slowly. These solutions tend to be faster.

Obviously, concentrated solutions react faster still. Dilute solutions tend not to be oxidizers by the official definition because the official definition says it makes things burn faster, and if you have enough water that will not happen because water is really good at absorbing all that excess energy that oxidizing agents produce.

The key issues are segregation into a clean and clear area away from any concentration of combustible waste. That means away from where you store wastepaper, waste plastic, rubber waste material. Have an area where it is clean and very easy to clean so it is available if there is a spill of the oxidizer. The classic list of oxidizers applies. There have been examples, particularly of liquid oxidizers like hydrogen peroxide, which have a spontaneous reaction catalyzed by rust, and even though we do not normally consider iron Oxides as particularly good catalysts, it does not have to be particularly good for hydrogen peroxide breakdown, and you get a lot of heat and a lot of oxygen then any combustible material in range is likely to catch fire.

Contamination in waste is also an issue. One aspect of this that often arises in laboratories is this issue of isolation. So again, the regulations talk about providing Safety in your hierarchy of controls. Isolation is one of the higher controls you know. If you cannot eliminate or find safer substitutes, isolation is one of the next things that you look at.

The key thing to understand here is that the storage cabinet itself is a source of isolation. An alternative where you do not have a storage cabinet could be sufficient distance to ensure that the spills do not combine. The regulation requires that materials that are not compatible are not allowed to combine in your storage, but that can be done either through sufficient distance or through a cabinet.

It is not both. If you are using cabinets, cabinets of incompatible materials are permitted to be adjacent.

If they are, it is worth understanding that access is to only one cabinet at a time, so we do not have the most obvious sort of case where there could still be contact when trying to access both cabinets at the same time. Two bottles have spilled and can become a combination of incompatible materials, but they can be adjacent if you are accessing both cabinets simultaneously. The spills will need to be managed accordingly to reflect that hazard.

The actual presence of the cabinet is the isolation you want.

The source of those 3 meters and five meters segregation distances is from a specific Australian standard that says this standard does not apply to laboratories. So, the application of those distances to laboratories is not compatible or consistent with any Australian standard. But they are the numbers that get thrown up everywhere else, so those numbers have filtered down to laboratories as well.

Previously we had advice in the safety and laboratory storage Standard, Part 10, which no longer exists. It has been combined into the new part one I believe. It specified what levels in laboratories should be considered before you start considering getting a cabinet. What levels? What package sizes before cabinet storage was justified? That was removed from the recent update to the consternation of some of the people on the committee, but that was where it went.

Storage cabinets are great alternatives and may be useful, so order based dilute solutions, low reactivity materials. Not everything needs to go into a storage cabinet. It is not always justified so tubs or trays for containment of that spill, just to make it easy to clean up. And ensure that sort of residues aren't left behind, which might concentrate as they gradually die out.

Look at the materials that you know do not produce flammable toxic corrosive vapors. They can sort of be out in the open. Solids are particularly of low reactivity, separate from liquids and above liquids if they are going to be stored together. Liquids. There is a general agreement that Liquids should not be stored above solids.

Ensure acids do not create additional hazards if you are going to store them in tubs or trays. Allow sufficient room for access or easier removal of the tub to where you can readily get the bottle out rather than having to reach in and drag a bottle over other bottles or drag a bottle out on its side so the materials in contact with the cap, just as you are about to take the cap off and use the material.

If we are talking about storage on shelves, obviously non-hazardous materials, materials with no spill hazard are your best choice.



The other observation here is if we are talking corrosive or even irritant materials, do not store at or above head height, the most sensitive part of your body is the eye, if you are wearing safety glasses, they are good for a direct splash, but they can be circumvented as materials splash around and things can get behind them. You do not want to be handling or accessing material at the perfect height to splash in your eye or get past glasses or gloves?

That is a quick summary of a lot of the hazards.

In the previous presentation of this topic, most of the questions that we got afterwards related to storage of materials with more than one property.

When you have flammable corrosives, where do they go? I would say this becomes a risk assessment, of at least the other materials that you have there.

If you have oxidizing acids such as nitric acid, then I would say a flammable acid would be better when in flammable cabinet than in your acid's cabinet. The greater risk of reaction between the oxidizing and the flammable properties would override. In general, you know most flammable liquids are relatively inert, apart from reaction with oxygen and reaction with a simple acid. It usually is not a significant problem, particularly and so if it is flammable as well, that will be fine.

I would just remark though that looking at the material of construction of your flammable liquid cabinet, because the other thing you have to consider is, if that acid is flammable, the fact that it is flammable means it is going to have some volatility, it is going to have levels of vapor and those vapors are going to be corrosive, if there's exposed metal components inside a flammable liquid cabinet, potentially they are exposed to attack. If you are going to go that way, inspect and make sure there are no signs of attack.

Then you can increase the time between inspections as you get comfortable that that is not going to occur.

Richard Greenwood
RG Chemical Consultants.



Westlab Chemicals

Westlab also has its own range of chemicals with a unique label. There are up to 75 chemicals in the range currently and they are growing rapidly.

Key features here are the **big, clear, bold text** - one of the main requirements and then the inclusion of the molecular weight on the front of the label.

This was very highly requested when we did a survey, with a lot of lab managers and lab staff Australia wide saying that it should obviously be on the label front.

A color-coding system has also been added to the label, such as the green strip around the top of the bottle label in the picture. Some have a black strip and some with yellow. This relates back to the actual class of the chemical: 'miscellaneous' is green, yellow is 'oxidizing', tying back into the dangerous goods classification, and then the 'corrosive chemicals' are black.

Discover the Westlab Chemical Range

Discover the wide range of chemicals designed for lab techs



Westlab Products for Chemical Storage

Westlab Offer several options for chemical storage. There are three different ranges of chemical storage cabinets. The middle range is good for storing all the different types of dangerous goods chemicals, called the Mod-U-Lab 4-in-1. There are also the non-metal ranges, the modular non middle range, and the Polycom range.



Modulab 4-in-10 Metal Cabinet



Modulab Non-Metal Cabinet



PolyChem Corrosive Cabinet

Mod-U-Lab 4-in-1

If we start with the four in one really quickly a lot of you may have seen this cabinet before.

This cabinet is in a lot of Australian labs already.

It has a neutral color, white and is supplied with all the relevant Dangerous Goods (DG) labels to allow labelling to suite whatever is being stored in the cabinet. There are five different sizes. 30-liter, 60-liter, 100 liters, 160 liter and a big one the 250 liters.

Modular nonmetal cabinet

This cabinet is used solely for storing Class 8 Chemicals. These cabinets are made of high-density polyethylene, giving a much longer life span than metal cabinets when storing corrosive substances. There are four different sizes: 50-liter, 100-liter, 160-liter, and 250-liter. The 100-liter cabinet does fit underneath benches, laboratory benches.

The newest range is the Polychem range.

This is a non-metal cabinet also made from high density polyethylene and is used for storing class 8 chemicals. But the difference with this cabinet here is the storage option inside, with an option to store all the chemicals or chemical bottles in Grattells tubs. This tub is a high density, polypropylene tub that is fully chemical resistant as well. Additionally, it acts like a small spill tray, so if the bottle is leaking or if there is a spill in the cabinet, it catches it in the tray and saves it from spilling throughout the rest of the cabinet.

This nice simple range has three sizes.

The single door cabinet is 40-liter. Then an 80-liter with a double door, and a big one, the 180-liter.



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National Lab Safety Webinar

22 June 2022



Chemical Storage Checklist

Follow this easy checklist to ensure your chemicals are stored safely.

- ☐ Considering equipment at floor level and below the level of the top of the cabinet, are flammable liquids cabinets situated within 3m of a powerpoint, light switch or active electrical equipment?

- ☐ Do you use flammable liquids on benchtops, within 3m of benchtop equipment?

- ☐ Does your storage of oxidizing agents ensure that spills of different families of oxidiser will remain separate??

- ☐ If you have limited space for segregated storage of corrosives, have you prioritised segregation of concentrated forms?

- ☐ Have you made an action list of items that need attention to enhance the safety arrangements in your laboratory?

Webinar Q&A

Find the answers to the questions asked at Laboratory Safety Webinar

Is there a limit to how many flammable cabinets you can have in a confined space? We have 2 that are side by side in a very small chemical storage room, but it is ventilated by a wall fan

AS1940 guidance limits to 850L on ground floors, per 250m³ total floor space.

Is a light switch in the storeroom considered an ignition source when chemicals are also in a Flammables cabinet?

Yes.

Are Hot Plates considered an ignition source?

They will be an ignition source – the thermostat will switch power on and off. Just being a hot surface is sufficient for some flammable vapours.

Is proximity to an ignition source the only deciding factor for ventilation a flammables cabinet? Are there other factors that mean you should install ventilation from the bung?

ASNZS 2243.10 (no longer current): "If ventilation is an essential risk control measure (such as could be the case for volatile, extremely toxic or corrosive substances), the cabinet shall be vented to the external atmosphere."

What temperature should our chemical storeroom be kept at? What is the highest humidity that is acceptable in a chemical storeroom?

Some chemicals may require storage below a specific temperature, typically 30°C but potentially lower. This should be indicated on the SDS. Examples are chemicals that break down, such as peroxides. The humidity should not be a problem with properly sealed containers, but I accept that in practice there may be slow absorption of moisture that may render some chemicals unusable. It can also promote corrosion of fittings and shelving. I don't know of specific guidance in either temperature or humidity.

How detrimental is it for a chemical storeroom to have a north facing window (along one whole side)? Should it be boarded/blocked off in order to extinguish exposure to sunlight?

Not many common lab chemicals are light sensitive – hydrogen peroxide and silver salts are the main ones I can think of. Heating in summer is probably the more important issue. I personally love natural light in workspaces, so if it can be shaded with slats or a veranda to limit direct light and heating that should be enough.

OFFICES

Australia

1800 358 101
sales.au@westlab.com
www.westlab.com.au

Canada

1 877 822 1455
sales.ca@westlab.com
www.westlab.com

New Zealand

09 972 7682
sales.nz@westlab.com
www.westlab.co.nz

United States

646 568 5391
sales.us@westlab.com
www.westlab.com

Webinar Q&A (cont.)

What is the formula to calculate temperature change?

I calculate it this way:

50mL 2M NaOH (0.1mol) and 50mL 2M HCl (0.1mol) generates -57.9kJ mol⁻¹ energy, so releases 5.79kJ in 100mL water from 0.1mol reacting. 4.184 kJ will heat 1kg of water by 1°C, so this amount will heat 100mL by 13.8°C. This temperature increase is independent of scale, and is the maximum temperature possible for these

Where and what is the best place and way to store 70% Nitric Acid in a chemical storeroom safely? (We don't have a small separated corrosive cabinet.)

All oxidisers are problematic for storage, due to the wide range of potential harmful reactions. 70% nitric acid is compatible with mineral acids such as sulfuric acid and hydrochloric acid, but not compatible with organic acids such as acetic acid. It is also not compatible with a number of other oxidisers, such as hypochlorites.

If it is possible to eliminate organic acids from your acid cabinet, I would say that is the best place. The organic acids can be stored elsewhere, particularly where they are also flammable liquids. It is always difficult to be 100% definitive here, because certain chemicals may have specific reactivity that makes this unsuitable.

Where should Calcium carbide be stored?

Protection from moisture and humidity are the primary issues. It is a solid, so a casual spill is less of a concern. I'm not certain about heat sensitivity of it, but given its properties, I'd recommend in a tub so it can be sealed.

Where should 35% hydrogen peroxide and bromine water be stored?

Hydrogen peroxide should be in an oxidisers cabinet and kept dark and cool.

If necessary, it should be kept with containment separate to other oxidisers in the cabinet, with the containment covered so that no contaminating material can fall into where a spill may occur.

Bromine water acts as an oxidiser in organic reactions but does not classify as one for Dangerous Goods or GHS purposes due to the high water content. It is corrosive, and generally quite reactive with the option of producing corrosive and toxic gases which is the main hazard. Keep cool and sealed. My apologies, my usual sources are drawing a blank on this one for further details and advice, including whether it should be isolated from acids or alkalis.

Another curly one, how should Glacial Acetic acid (flam & corrosive) be stored?

It is compatible with acids other than oxidising acids such as concentrated nitric acid, but also generally compatible with flammable liquids. If you have either an Acid cabinet or flammable liquids cabinet, put it there so long as an acid cabinet does not include oxidising acids. Note that if you have to store it with flammable liquids, inspect the inside of the cabinet every six months for any sign of corrosion to components.

OFFICES

Australia

1800 358 101
sales.au@westlab.com
www.westlab.com.au

Canada

1 877 822 1455
sales.ca@westlab.com
www.westlab.com

New Zealand

09 972 7682
sales.nz@westlab.com
www.westlab.co.nz

United States

646 568 5391
sales.us@westlab.com
www.westlab.com

Webinar Q&A (cont.)

Should corrosive solids be stored in a cabinet also, or only corrosive liquids? If so, can the solids be stored in the same cabinet on a shelf some way above the liquids?

Corrosive solids are certainly less of an immediate issue than corrosive liquids, but in order to protect them from interaction with incompatible materials (they are in their most concentrated form, after all), then on a shelf above compatible corrosive liquids is the recommendation – obviously it is critical to isolate acids from alkalis here.

What is the safest way to store the lower concentrations of Hydrogen Peroxide H_2O_2 , (15% and lower)? Some say it can be stored in a fridge that is only used for scientific materials (no food or drink) others say it belongs with the 35% Hydrogen Peroxide H_2O_2 . Who's right?

It depends on what else is in the fridge. H_2O_2 reacts with a broad range of other materials, not just flammable or combustible liquids.

Should hydrogen peroxide be stored in a fridge?

General advice is to store cool. Though the material is considered stable at normal temperatures, it loses activity over time, and this will happen more quickly at higher temperatures. Unless contaminated, it will not decompose dangerously if stored out of direct sunlight and not heated.

Are you suggesting we shouldn't keep isopropyl alcohol (used in DNA experiment) in a fridge, perhaps only to cool it in a fridge short term prior to using for an experiment?

Isopropyl alcohol and ethanol are okay in fridges while they are working, as they will be well below the flash point. The problem can arise in an extended power outage, where the contents of the fridge come up to room temperature. If the pressure build-up causes a vapour release, particularly if it pops the top off the container, then you may have sufficient vapour inside to ignite when the power comes back on. Even under these circumstances, this is a rare combination of events, but it is possible and so technically you have stored a flammable liquid exposed to an ignition source. Remember though, that if you don't have a flammable liquid cabinet, or your cabinet is within 3m of an ignition source, the fridge is NO WORSE for these liquids. This argument does not apply to lower flash point materials such as acetone, where the flash point is $-20^{\circ}C$, and there is always enough vapour to be ignited.

Do you have a suggestion on how and where to store an Iodine solution and in its solid form since it sublimates and defaces labels over time?

Ideally the containers should be sealed so this does not occur. I don't know another way of preventing it.

Is glacial acetic acid to be stored in an acid cabinet as some tables say it is not to be treated as an acid?

Answered previously – not compatible with all acids. Generally compatible with flammable liquids, but vapours may affect cabinet construction.

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1800 358 101
sales.au@westlab.com
www.westlab.com.au

Canada

1 877 822 1455
sales.ca@westlab.com
www.westlab.com

New Zealand

09 972 7682
sales.nz@westlab.com
www.westlab.co.nz

United States

646 568 5391
sales.us@westlab.com
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Webinar Q&A (cont.)

How would you recommend storing Sodium lumps?

While it is a Dangerous Goods 4.1 and can be stored in a cabinet is not intended for storage with a Dangerous Goods 4.3 material. Sodium metal is reducing rather than oxidising, so is not likely to react dangerously with most flammable solids.

Use-by/shelf-life details of chemicals are not on their label or in their SDS. Some manufacturers offer a recommended shelf life after requesting it. It's hard to know how long a chemical can be kept for, for use in secondary school laboratories. Some chemicals become unsafe and some lose their potency. What guide can you offer on this?

Reactive chemicals such as peroxides, in particular, may lose activity over time. Most mineral salts are entirely stable for years, though they may be hygroscopic.

Does ChemWatch have access to the SDS for Westlab's chemical range?

Via the ChemWatch site, you can access the Westlab SDSs - search by name or product code.

What is the maximum flammable liquid volume that can be stored in cabinets in school laboratory?

If storing the liquid in a working laboratory rather than a storeroom, previous guidance was 250L/kg total Dangerous Goods within a 10m radius. This could all be flammable liquids if there were no other Dangerous Goods present. This seems excessive. Do not exceed the capacity of cabinets, and don't remove bottom shelving to fit more in.

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Australia

1800 358 101
sales.au@westlab.com
www.westlab.com.au

Canada

1 877 822 1455
sales.ca@westlab.com
www.westlab.com

New Zealand

09 972 7682
sales.nz@westlab.com
www.westlab.co.nz

United States

646 568 5391
sales.us@westlab.com
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