DRILLING DOWN INTO HAZARDS & RISK – LOW PROBABILITY / HIGH CONSEQUENCE(LPHC)

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Introduction:

Many safety people believe that they have identified all hazards and associated risk in their workplaces. But have they really? What you most likely have done is identified everything that you can see, what about all the things that you cannot see? Hidden things, some tangible, and some intangible, things that can still present hazards, and carry their own associated risks. In this eBook we shall drill down to assist you to find those hidden hazards that have a low probability and high consequence of injury. Unfortunately these areas are rarely mentioned when formulating a risk assessment or creating a hazard analysis, but they are as important to identify as any other hazard or risk.

What is a low probability hazard?

Low probability hazards are those that may never have caused an injury or a problem in a workplace, or may have done many years ago, so long ago, that no one can remember when it took place. These hazards are not so much hidden, but due to them never causing a problem, they are mostly either ignored or never identified to begin with. Or they are classed as intangible, therefore why should we even bother with them, as nothing ever happens. That is the point of identifying them, knowing about them allows the safety person to put in place control measures, just in case they do one day cause a problem.

Low probability and high consequence hazards:

Can we really identify intangible hazards? Yes you can, by using a “What If” analysis, what if this happens, using this method, you should be able to look at a hazard and define what could happen in a given set of circumstances, after all, when formulating a Risk Assessment, that is exactly what you need to do to formulate controls, here we are just going deeper.

Low probability and high consequence hazards examples:

To give an example of what a ***tangible*** low probability and high consequence hazard is, let us look to shipping.

To the north west of a navigation channel is a reef, this reef is marked by a lit buoy marking its whereabouts, years ago there was a small light house there, it is also marked on navigation charts. To minimize the risk of a vessel hitting this reef, mariners use GPS Navigation. This is a ***tangible*** risk, and no vessel has hit the reef for over two hundred years. Now let us put into place some intangibles, the cable holding the buoy has snapped through lack of maintenance, and drifted away, an old cargo vessel is navigating through the channel, it has no GPS, but is looking for the marker buoy, the vessel strikes the reef, and sinks. There is oil spillage, and some sailors lose their lives.

This is a high consequence accident caused by a low probability hazard, and the people that installed the buoy, had a maintenance plan for someone to carry out, but they did not take into account the “What If” what if there was no maintenance, what if the cable rusted through? What would be the consequence? You cannot take everything into consideration, but to show that you tried, is the important thing here, it is called due diligence and doing everything reasonably practicable.

To give an example of what an ***intangible*** low probability and high consequence hazard is, let us look to the following scenario.

A worker whose job it is to dispense various chemicals for a production process.

1. Wears correct PPE as issued to safely carry out the job
2. The worker is trained in chemical handling and how to read an SDS

During the dispensing process, minute splashed droplets strike his exposed skin and clothing, at the end of the day, the workers has a shower and gets changed, he bags his dirty clothes and takes them home to be washed, as work does not have laundry facilities. He has been doing this job for a number of years, and always enjoyed good health.

His wife washes his clothes in hot water; she is always complaining that when she does so, the whole house stinks of chemicals. She also has been doing this for as long as her husband has had the chemical dispensing job. One morning she complains to her husband that she is not feeling well, and she will go to the doctors that day. The doctor finds minute rashes on her skin and orders a blood test. The test comes back to advise that the woman has high concentrations of chemicals in her system, the doctor questions her as to where they came from, and she explains what her husband does for work and how she washes his clothes. The doctor determines that she is inhaling chemical residue present in the steam from the hot water, he asks for her to make an appointment for her husband to also get tested.

The blood test from the husband shows extremely high concentrations of chemical residue in his system, he receives more tests and these show that his liver, fatty tissue and reproductive organs are being affected from the chemicals in his blood.

Both go to see a solicitor who starts to investigate the employer in prelude to lodging a claim. It is found that the employer had nothing in place to allow workers to wash contaminated clothes at work, that the hazards and risks were not identified, that nothing was in place to allow workers to be tested for residual chemical contamination.

A scenario just like this was played out not so long ago with a worker, working with asbestos, both the worker and his wife had asbestosis, the worker from working with asbestos, and the wife who used to shake his clothes prior to washing also had the disease.

Finding those hidden hazards and risks:

There are a number of ways to find low probability and high consequence hazards, by creating a hazard register listing all of the hazards you can find in your work place, then listing beside them the LPHC (low probability and high consequence hazard) If you get stuck, look to available injury data associated with your industry, and do a comparison with what you have found. For an example low probability and high consequence hazard table, let us use a company manufacturing chemicals. I deliberately chose the chemical scenario, as it is one I know well, and has the greatest consequence, for humans and flora & fauna.

Hazard	Risk	Control	LPHC	LPHC Control
Storage of chemicals	Leakage/Spillage	Chemicals must be separated for storage, including Bunding/Air/Wind block. Area must be kept clean	Airborne Contamination of area and workers inhaling residue, lung and tissue damage	Air Quality sampling and Testing
Handling of Chemicals	Contamination of clothing/skin of workers	Correct Chemical Handling PPE & Training	Residual chemical effects on workers blood, tissue and organs	Blood tests of workers Hygiene program
Chemical Interaction	Explosion/Vapours	Air Extrusion Fans	Injuries/burns chemical contamination of workers having physical and biological short and long term effects on worker physiology/biology/and psychology	Blood tests of workers Hygiene program Training in chemical interaction
Environmental	Contamination of water ways/ work/storage area	Sumps/spill kits socks/mop sheets	Residual impact of contamination on humans/Flora & Fauna	Environmental Audits/Soil sampling
Disposal of Containers	Chemicals carried off site	Contractors disposing of containers must submit SWMS and proof of environmental compliance	Residual chemical effects on workers blood and organs. Residual impact on humans/Flora & Fauna	Blood tests of workers Environmental Audits/Soil sampling
Cleaning of Plant &	Worker contamination,	Capture of all liquid used in cleaning/	Residual chemical effects on	Environmental

Equipment Used for Manufacture	environmental contamination	disposal as hazardous waste	workers blood and organs. Residual impact on humans/Flora & Fauna	Audits/Soil sampling

In order to understand the LPHC of chemicals, we need to understand what chemicals are, what they do, and how they can affect us, in the short or long term.

What is a chemical?

Everything in the physical world around us is made of chemicals. The earth we walk on, the air we breathe, the food we eat, the cars we drive, and the houses we live in are all made of various chemicals. Living organisms such as plants, animals, and humans are also made of chemicals.

Some of the chemicals we contact in our daily lives are man-made. These include some drugs, cosmetics, workplace chemicals, household cleaning agents, and so on. Many more chemicals which we are exposed to each day occur naturally and are found in our food, in the air, and in water. There are far more natural chemicals in our environment than man-made ones. Both man-made and natural chemicals can have poisonous effects.

What makes chemicals poisonous?

There are several factors which can influence the degree of poisoning caused by a chemical. These are as follows:

•Route of entry into the body

•Amount or dose entering the body

•Toxicity of the chemical

•Removal from the body

•Biological variation

What are the routes of entry into the body?

No chemical can cause poisonous effects without first coming into contact with the body.

Breathing of contaminated air is the most common way that workplace chemicals enter the body. Some chemicals, when contacted, can seep through the skin. Less commonly, workplace chemicals may be eaten if food or cigarettes are contaminated. The eyes may also be a route of entry. Usually, however, only very small quantities of chemicals in the workplace enter through the mouth or the eyes.

Why does the amount or dose entering the body matter?

The amount or dose of a chemical entering the body is probably the single most important factor which determines whether a chemical will cause poisoning. The amount of a chemical which causes poisoning depends on the chemical.

Consider, for example, what happens when water is drunk on a warm summer day. The water cools the body and quenches the thirst. Normally, water would be classified as a harmless chemical. What if instead of just one glass, many glasses were consumed one after the other, non-stop. A point would be reached where beneficial effects would disappear and harmful effects would start to be noticed. Drinking too much water causes water intoxication. In severe cases, this kind of poisoning causes convulsions and seizures. There are reports of such poisoning in small children and in psychiatric patients. The reason water "changes" from being harmless to being harmful is directly related to the amount of it taken into the body at one time. Drinking "too much" water causes the toxicity. Taking "too much" of a chemical into the body causes toxicity. This relation is true for all chemicals regardless of whether they are natural or man-made.

What is the toxicity of the chemical?

Toxicity is a measure of the poisoning strength of a chemical. Chemicals that are only weakly toxic require large doses to cause poisoning. Strongly toxic chemicals only need small doses to cause poisoning.

Toxicologists often use animal tests to determine whether small or large doses of a particular chemical cause toxicity. One such test measures the dose of a chemical that causes death to 50% of the animals being tested. This test is called the "Lethal Dose 50" (LD50).

There is a tendency to think of chemicals in terms of those which are poisonous or toxic and those which are harmless. These categories are used for convenience, but they imply that toxicity or its absence is an all-or-nothing property of a chemical. This is not the case because any chemical can cause poisoning if a sufficient dose of it is taken into the body.

To put it another way, all chemicals can be toxic. It is the amount or dose taken into the body that determines whether or not they will cause poisonous effects. Poisoning, then, is caused not just by exposure to a particular chemical, but by exposure to too much of it.

What is meant by the rate of removal from the body?

Many workplace chemicals which enter the body are excreted unchanged. Others are broken down. The breakdown products may be more toxic or less toxic than the original chemical which entered. Other chemicals still are stored temporarily in body organs and are removed over a short period of time. Eventually most chemicals and their breakdown products are removed as waste in the faeces, urine, sweat or exhaled breath. A few chemicals such as graphite or silica dusts can be inhaled into the lungs where they lodge for many years and may never be completely removed.

As a general rule there is less risk of chemically caused disease if the body can do one or both of the following:

• break down the chemical into less toxic products

• rapidly remove the chemical from the body.

What is biological variation?

Several characteristics of the exposed person or animal can influence the degree of poisoning which occurs. These include age, sex and individual susceptibility.

How are we exposed to amounts of chemicals sufficient to cause poisoning?

There are two main ways that too much of a chemical can enter the body and cause poisonous effects:

By sudden or short term exposures

A one-time exposure to relatively large amounts of the chemical can overwhelm the body. In the workplace this may happen through improper handling of the chemical, or when there is an accidental spill or a leak from a valve or pipe carrying chemicals. It might also happen during maintenance or cleaning of equipment that normally contains chemicals (such as a solvent vat). The ill-health effects caused by one-time, sudden, high exposures are often called "acute toxicity" effects. Some examples of acute toxicity are listed below:

• Inhalation of high concentrations of acid vapours might cause serious burns of the mouth and airways leading to the lungs.

• Skin contact with substantial amounts of certain organic solvents that are absorbed through the skin may cause dizziness and nausea.

•Inhalation of dusts can cause irritation of the respiratory tract, dryness in the throat, and coughing.

By repeated exposures over a long period of time

A repeated exposure over a long period of time can also cause too much chemical to enter the body and produce poisoning. This kind of poisoning occurs because the exposure is repeated day after day over many years. The exposure levels may be too small to cause any acute toxicity. Ill-health effects caused in such situations are often called "chronic toxicity" effects. The following are some examples of chronic toxicity:

•Inhalation of certain acid vapours at concentrations which do not cause acute toxicity may, over long periods of time, cause loss of tooth enamel, eventually leading to extensive tooth decay.

•Inhalation and skin absorption of some organic solvents at concentrations which do not cause acute toxicity may, over long periods of time, cause damage to nerve tissue.

•Repeated exposure to dusts containing quartz can cause scar tissue in the lungs. This leads to severe and permanent lung damage.

What else do we know about acute and chronic toxicity?

Most chemicals can cause both acute and chronic toxicity depending on the conditions of exposure. The adverse health effects caused by the chemical in the two types of toxicity are often quite different. It is not usually possible to predict what the chronic toxicity of a chemical might be by looking at its acute toxicity, or vice versa.

Acute toxicity

In most cases, much more is known about the acute toxicity of a chemical than its' chronic toxicity. The understanding of acute toxicity usually comes from studies with animals exposed to relatively high doses of the substances. Accidental overexposure, spills and emergencies have added to our knowledge of acute toxicity in humans. The health effects may be temporary, such as skin irritation, sickness or nausea, or they may be permanent: blindness, scars from acid burns, mental impairment and so on.

Acute toxicity is often seen within minutes or hours after a sudden, high exposure to a chemical. However, there are a few instances where a one-time high-level exposure causes delayed effects. For example, symptoms of high exposures to certain pesticides may not appear for several days.

Chronic toxicity

Much of the knowledge we have about chronic toxicity comes from animal experiments. In addition, much has been learned from studying groups of people occupationally exposed to a chemical for many years. As a general rule, chronic toxicity appears many years after exposure first began. The resulting disease occurs only because the exposure has taken place repeatedly over many years. Chronic toxicity diseases do not seem to be caused by sudden one-time exposures. Chronic toxicity is thought to occur in one of two main ways. These can be explained by using sodium fluoride and n-hexane as examples.

•Sodium fluoride, at very low concentrations (such as in toothpaste or drinking water), causes no noticeable adverse health effects, even after years of exposure. Indeed, at these low levels, the effects are considered beneficial for teeth. However, if much higher concentrations of sodium fluoride enter the body repeatedly, they deposit and build up in the bones. At first, the amount of fluoride in the bone may not cause any problems, but after years of repeated high exposure, symptoms of bone disease may appear.

•On the other hand, the chemical n-hexane is not deposited or accumulated in the body. It is broken down in the liver. One of the breakdown products can "attack" nerve cells in the fingers and toes. These kinds of cell are not replaced easily. With continued exposure for many years the damage to the cells increases until a point is reached where symptoms appear in the nerves of the fingers and toes.

One special case of chronic toxicity is cancer. Repeated exposure to some chemicals for long periods of time may cause cancer. Often people express concern about cancer developing after a one-time exposure to a cancer-causing agent. While there is no absolute proof that cancer will not occur from a one-time exposure, most of the evidence indicates that repeated exposure over a long period of time is necessary before cancer develops.

What are the differences between toxicity and hazard?

There is a tendency to believe that if only small amounts of a chemical are needed to cause poisoning, then the chemical is highly hazardous. This is not necessarily so. A highly toxic chemical can have a low health hazard if it is used with proper precautions and care. On the other hand, it is possible that a chemical of low toxicity may present a high health hazard if it is used carelessly or inappropriately. Toxicity is a measure of the poisoning strength and is an unchanging characteristic of a chemical. Hazard is not the same. It is a variable feature of a chemical. Hazard is the likelihood that a chemical will cause poisoning, given its poisoning strength and the amounts and manner in which it is used, stored and handled. The toxicity of a chemical cannot be changed, but the hazard it presents can be controlled and minimized.

Understanding the LPHC in hazards:

As you can see from the above, identifying LPHC hazards is not easy, and some research will need to be done for the LPHC consequences, unless you are extremely confident in your area of operations as a safety person.

There are many areas to research your findings, Wikapedias, Insurance injury reporting data, treatment data from doctors and hospitals, manufacturers etc.

By identifying LPHC hazards, you can implement many more ways to ensure that any risks are kept to a minimum, as far as is humanly possible in your work environment.

And if the worst case scenario ever happens and you need to stand up in a court room to justify your actions, you can comfortably say, that everything that could reasonably be done, was done.

Now, you need to go forth and revisit all your hazard analysis and risk assessments documentation, create a table to list all your hazards, risk, controls and your LPHC results and controls.