EXAMPLE 1. LABORATORY SCALE ACCIDENT
WASTE CHEMICALS
Chemical research laboratory explosion in a Finnish University
Internal accident investigation report
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1. Description of the accident

Accident took place after business hours and thus there were no people in this laboratory. Sound of the explosion was heard by nearby researchers who equipped themselves with personal protective equipment and went to check the space. When opening the laboratory door, they noticed immediately that the waste bottles on the washing table were broken and there were several liters of liquid on the floor, as well as scattered glass pieces. Researchers closed the door and called the Fire Department Emergency number. FD arrived in 15 min to the spot and absorbed the fluids and most of the glass chips and isolated the area.

Chemicals that may have been used in the laboratory (list of all chemicals in the chemical stock listed in this laboratory):

- Acids: nitric acid, sulphuric acid, hydrochloric acid, acetic acid
- Bases: Ammonia
- Flammable solvents: Acetone, 2-propanol, methanol, ethanol, butanol, tetrahydrofuran, toluene, dimethylformamide
- Reacts with water: thionylchloride

According to the laboratory staff, the waste was stored in such a way that the solvents were in their own bottles (halogenated in their own bottles and other solvents in a different bottle), acids separately and bases separately. In broken waste bottles, according to the staff, there were chemicals in the list above; possibly several but not necessarily all.

Fig. 1 (left). A washing bottle with acetone is on top of the hot plate in the cupboard.
Fig. 2 (right). Chemical waste bottles on laboratory tables and on the floor. Below is a normal drain.

2. Cause of the explosion

Photographs (Fig. 1 and 2) were taken from the space immediately after the accident. In the nearby laboratory, there was a similar waste chemical collection point. There were written instructions, which chemicals can be combined in the same waste flask. At the explosion site there was no such instructions, nor did the staff explain with certainty how the waste chemicals had been receipted to the same flask. Based on this data and the mapping visit, the probable cause of the explosion could be inferred.

It is noted that the chemicals used constitute many possible explosive pairs. The intensity of the reaction depends on the quantities and concentrations of the substances. These were not found in the mapping. Based on the foregoing, the authors of the report estimated the reaction of the relatively small quantities/dilute solutions in question took place in a 2.5 dm^3 chemical glass bottle used as a waste container. The explosion was likely to be a pressure explosion: the glass chemical bottle exploded when the pressure formed by the reaction exceeded the structural pressure of the bottle. Primary explosion broke also some other bottles in the table. This is likely because:

- The explosion occurred with a delay, not immediately after reagent insertion
- Fire is not lit, no marks of fire in the residues
- Damages relatively small
- Chemical explosion with liters of flammable liquids would have broken the windows etc.
- The overpressure duration of the glass chemical bottles is comparatively good (3 – 5 bar)

3. Damages

The personal damages were avoided only because the explosion occurred when the laboratory was unmanned. Flying glass chips, chemical spills (especially acid) and chemical vapors (acid/base/solvent) could have caused serious injury. Damage to the eye and respiratory system, as well as poisoning could have been very possible.

Based on the images and studies in venue, material damage remained also low. In the laboratory, no major mechanical or chemical structural damage abnormal from normal wear was observed after cleaning. There was some corrosion caused by chemicals (acid/base/solvent) in the floor coating and the wall paint of the venue.

4. Elimination of Causes of explosion

In this 40 m^2 research laboratory there were conventional quantities of hazardous chemicals, flammable liquids (different species 1-10 dm^3 scale) and gases (50 dm^3/200 bar cylinders each) in use. Based on the mapping made, the following measures are proposed and further adapted to ensure that they are implemented.

Need for harmonization in the accounting, handling and storing of chemical hazardous waste was identified. A successful solution requires written instructions to the level of each research group and laboratory. The authors of the report also recommend systematic mapping and a self-monitoring system for the laboratories. Guidance and periodic follow-up should be centrally managed.

Instructions for chemical waste handling should be a part of experiment planning. Risk analysis of the chemical work and processes should also cover the education of the researchers involved. Supervisors are noticed that there must be a person with a degree in chemistry involved.

Chemical waste should not be accumulated to laboratories but taken to dedicated chemical waste storage. Chemical waste must be discarded to certified waste treatment plant at least once each year. There should be chemical spill mats available to block the floor drains in case of a larger spill.