Azide Explosion

What happened?

Researcher #5 attempted to assist a colleague (who worked for a different PI) by synthesizing tert-butyl azide on a large scale, alone at night, without knowledge of permission of the colleague's PI. The potentially highly hazardous synthesis was covered by a detailed written procedure (SOP), explicitly stating numerous safety precautions, which the researcher was not trained on and did not follow. Precautions included accurate temperature control, use of a blast shield, and slow addition of reagents. NOTE: The SOP had been provided to the colleague by the colleague's PI, but with written instruction that the procedure was hazardous and not to be carried out except in the physical presence of the PI.

The synthesis called for the formation of a cold solution of hydrogen azide (volatile, highly toxic, highly sensitive explosive) in aqueous sulfuric acid. The azide source was sodium azide, and the procedure specifically noted that the sodium azide must be rendered free-flowing and completely free of lumps before addition, or it might not dissolve properly. Disregarding the SOP, Researcher #5 added agglomerated sodium azide, which failed to dissolve at a satisfactory rate.

Researcher #5 removed the open-neck flask of reaction mixture from the fume hood and placed it in a sonicator on the open benchtop, to try and speed the dissolution of sodium azide lumps. Immediately the sonicator was activated, the flask detonated in Researcher #5's hand. Being in an unfamiliar lab, Researcher #5 failed to use the safety shower/eyewash right outside. Researcher #5's lab was close by and Researcher #5 went there to wash eyes and body, before alerting the colleague at the other end of the building who then called PD.

Azide Hazards

- Organic azides vary widely in their stability and explosive power, depending on the molecular structure. For alkyl azides, such as are used in "click chemistry", the general rule is that the bigger the nitrogen to carbon ratio, the more explosive the compound is.
- Hydrogen azide (hydrazoic acid) is an extremely volatile liquid (boiling point 37 °C) which is a powerful and very sensitive explosive when pure; the vapor can also explode when present at a concentration of more than 15% in air or nitrogen. It is soluble in water, and the solution becomes less unstable on dilution. A ≤10% solution is regarded as safe to handle, whereas ≥20% solutions are explosively unstable. Addition of strong acid to sodium azide results in immediate formation of hydrogen azide in solution, with concomitant vapor evolution.

Injury

Serious injuries to both eyes from sulfuric acid and superficial cuts on hand and face were sustained. Eye injuries eventually healed, but took weeks before sight returned to normal.

Contributing Factors

- Failure to follow verbal and written instructions from PI
- No eye protection worn
- Modification of detailed written procedure for a hazardous experiment without knowledge or approval of PI
- Carrying out hazardous work alone after hours

- Working in a lab of another PI without permission or lab-specific training
- No blast shield
- Removal of flask of volatile, toxic, explosive solution from fume hood to open benchtop.

Corrective Actions

- Re-iterate appropriate restrictions on performing hazardous work alone or out-of-hours.
- Re-iterate that personnel may not work in other PIs labs without the PIs knowledge and permission.
- Recommend that face shield plus goggles be used for work with potentially explosive materials in any significant quantity (e.g., > 50 mg).
- Blast shields must be appropriately employed when working with potentially explosive materials.

Quick Tips

PPE appropriate to the hazards must be worn at all times. Indirectly vented goggles are appropriate for splash hazards whereas safety glasses are **NOT** appropriate for this type of hazard. For serious splash hazards (e.g. when using large volumes of acid) and explosion hazards, a face shield should be worn over goggles and a blast shield should be employed. PI should ensure personnel have individual access to goggles; EH&S can provide a sample. Note: A fume hood sash is **NOT** a substitute for protective eyewear