ICE gases - *Please see end of document for further information on common products/sources of some materials*

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| Gas | Method | Comments |
| Carbon Monoxide | * Disposable BBQs etc * Reaction between Zinc metal (often powdered zinc) and lime (calcium carbonate CaCO3) – when heated * Water heaters/Boilers etc. | CO incidents have included the curing of concrete flooring |
| Hydrogen Sulphide (H2S) | * Sulphur and sulphur salts (bath salts etc), reaction with hydrochloric acid-based brick cleaner * Sulphur based fungicide (turf and plants) and HCl * Fumigation cartridges containing sulphur and HCl * Metal Sulphides (incl. those found in cigarette ash), reacts with acids (vinegar, brick cleaner – NOT BATTERY ACID) * Bacterial action – slurry or sewage treatment | Reaction of ‘free’ sulphur containing substances with a strong acid (commonly hydrochloric acid). Common misconception that Sulphuric acid (battery acid), will produce H2S. Often sulphuric acid decomposes or reacts to produce Sulphur Oxides (SO2/SO).  Some new magnesium-ion batteries (mostly for professional large-scale storage), are using Copper Sulphide (CuS) cathodes. Any reaction with CuS and a non-sulphuric acid, acid will generate H2S. |
| Sulphur Dioxide (SO2) | * Burning Sulphur   + Flour of sulphur, sulphur fungicides, [fumigation sulphur candles](https://www.google.com/search?q=sulphur+candles&rlz=1C1GCEU_en-GBGB915GB917&oq=sulphur+candles&aqs=chrome..69i57.1825j0j9&sourceid=chrome&ie=UTF-8), decomposition of sulphate salts (Epsom salts – magnesium sulphate and gypsum – calcium sulphate >1100oC) * Reacting plaster of paris or gypsum, in the presence of sand and charcoal (carbon), will liberate SO­2 => disposable BBQ + Sand + Plaster (<1100oC) * Hot battery acid (sulphuric acid) and copper = SO2 * It is a preservative (E220) – forms acid when it dissolves into the foodstuff (mostly used in wine), and as a bleaching agent for flour. Incidents may lead to accidental exposure. * Thiosulphate reaction with hydrochloric acid (sodium thiosulphate used as a dechlorinator for aquariums) | I have a strong suspicion that a lot of ICE incidents intending on producing H2S produce SO2 instead. This is yet to be confirmed but producing SO2 is a lot easier than H2S. This is due to when sulphates decompose under burning and when sulphur burns or is heated and reacts with oxygen in the air. Most H2S generators relies reactions with other substances, simply burning or heating sulphur produces SO2.  Significant levels of SO2 can bleach pH paper |
| Hydrogen Cyanide (HCN) | * Reaction of metal cyanide salts with acid (all types of acid, from vinegar to sulphuric) – the salts need to be acidified to form HCN   + Illegal cyanide fishing   + Very common and popular in pharmaceuticals – sodium cyanide is used in many organic synthesis processes.   + Electroplating – often a solution made from cadmium cyanide into the electroplating baths generate free CN- ions – source of metal cyanide compounds * Acetone Cyanohydrin is used in the plastics industry to supply HCN in the production of acrylic plastics – made by reactions with metal cyanides and acetone (not very likely source)   + HCN is therefore a combustion product of acrylic based plastics and paint * Cigarette smoke * Vehicle Exhausts * Heating cyanoacrylate-based adhesives (superglues etc) liberate HCN (>200oC) – both cured and liquid forms * Food sources of HCN from cyanogenic compounds (notably high levels):   + Cassava   + Almonds   + Stoned fruits | The food doesn’t contain cyanide, but cyanide (CN-) is produced in the body from breaking down the cyanogenic compounds. This of course can be done externally, and hydrogen cyanide extracted. |
| Chlorine (Cl2) | * Hypochlorites and strong acids (hydrochloric, sulphuric, nitric and phosphoric acid) – weak acids like vinegar (acetic acid), or citric acid (both found in other cleaning products), don’t tend to release chlorine but form hypochlorous acid instead.   + Hypochlorites can be commonly found as bleach solutions (sodium hypochlorite 1%-4% in household bleach) and bleaching powders (calcium hypochlorites, used in laundry and hair dye) – other metal hypochlorites are available mostly as solutions but some are solid * Chlorine based pool chemicals include direct solutions (25L drums etc), of hypochlorite (up to 15%!!), and stabilised chlorine tablets (chlorinated isocyanurate) * Electrolysing salt water – passing a high amp current through a saturated solution of salt water (NaCl or CaCl [de-icing salt]), will produce chlorine gas, hydrogen gas and sodium hydroxide (remains in solution) * If HCl is heated above 450oC in the presence of copper (culinary mixing bowl etc), it can decompose to form Cl2 | The ability of hypochlorite substances to release chlorine gas in contact with acids relies on the concentration and strength of the acid. It is possible for weak acids to produce Chlorine, but it must be highly concentrated. The most ‘acid’ available to the hypochlorite, the more likely chlorine will be produced. |
| Phosphine (PH3) | * Fumigation industry – fumigation of commodities such as grain and other foodstuff storage is often done with phosphine gas   + Phosphine gas is available as a diluted gas in a cylinder or solid metal phosphides (below) * Metal phosphides reacts water and acids (strong and weak), producing phosphine   + Pesticides – aluminium, calcium and zinc phosphide   + Indium and Gallium Phosphide (InP and GaP respectively), are used in the semi-conductor industry (as a dopant)   + Metal phosphides will also produce phosphine with alkali **solutions** due to the presence of water * White phosphorus and concentrated sodium hydroxide (caustic soda) * Methamphetamine (Red Phosphorus method) – when phosphorus containing reagents react with an intermediate chlor-ephedrine (produced from ephedrine). Chlor-ephedrine is then converted to methamphetamine | Several police officers in the states have taken ill due to low level phosphine exposure and delayed latent pulmonary constriction when investigating meth labs  Pure phosphine doesn’t smell of anything, but phosphine will have a decaying fish odour due to diphosphane molecules (P2H4). The odour threshold is 0.15ppm (0.000015% - 0.2mg/m3)  As phosphine is alleged to not leave any residue and due to its high toxicity, it is mainly used in fumigation and the pesticide industries and respective locations – large food storage facilities, ground keeping and agriculture |
| Sodium Azide – Hydrazoic acid (to be precise) | * Hydrazoic acid is produced from sodium azide when in contact with water (in large amounts) or acids like HCl.   + Very volatile and toxic liquid (bp 37oC)   + Sodium azide is found in airbags (obviously), agriculture as a pesticide and is used in laboratories and hospitals as a preservative (used to stabilise proteins extracted from biological fluids). | Hydrazoic acid is also extremely explosive if isolated |
| Phosgene | * Thermal decomposition of chlorinated solvents above 500oC but below 900oC – above 900oC yields high proportions of hydrogen chloride   + Chlorinated solvents come from industries including, textile, pharmaceuticals, pesticides and adhesives. Often they are used within cleaning and degreasing products notoriously in the motor industry * Phosgene can be made from high intensity UV rays on chlorinated solvents in the presence of oxygen – UV from arc-welding is also initiates this reaction. * Legacy air conditioning units and refrigeration units using chloromethanes (such as Freon), when involved in fire produce phosgene. * Any burning of chlorinated plastics | Like chlorine and phosphine, delayed onset respiratory conditions can occur up to 24hours after exposure.  Difficult to produce phosgene chemically, it does not occur naturally, and industrial production is with carbon monoxide and chlorine gas reacting over a bed of activated carbon at high temperatures!  Concentrations around 0.5ppm have been characterised by a freshly mown grass or hay type smell.  The gas is used in the production of certain chemicals and is used to make toluene isocyanate, which is a precursor to polyurethane resins, adhesives, coating etc. It is mainly used within the agricultural, textile and pharma industries. A lot of potential for accidental exposure. |
| Hydrogen Chloride (HCl gas) | * Sodium chloride and sulphuric acid (table salt and battery acid) – this liberates HCl gas and is also used in the one-pot meth method to salt out the product * HCl and sulphuric acid generates HCl gas – brick cleaner and battery acid, the sulphuric acid must be concentrated in order to dehydrate the HCl and liberate the free gas. * Calcium Chloride (de-icing salt) and HCl – the CaCl2 dehydrates the HCl and liberates the free gas * Magnesium Sulphate (Epsom salt) and HCl – again the salt dehydrates the HCl * Boiling brick cleaner * Acetyl Chloride and Methanol/Ethanol (at room temp) * Thionyl Chloride and water (HCl and SO2) | In theory, any viable method of dehydrating HCl solution will liberate gas, remember that in practice, only a max. of 37% is usually attainable, the rest is water. You reduce the water, you limit the ability for HCl to dissolve and hey presto, HCl gas.  The other ways to generate HCl gas (listed as the bottom two methods), are not as easily as the above mentioned – individuals will need specific access (lab or school etc) or prepared to use the dark web to get some of the ingredients. |
| NO2 – Not to be confused with N2O (laughing gas) | * Boiling Nitric acid * Conc. Nitric acid and some metals like copper, tin and zinc * Zinc (>300oC), copper (>170oC) and iron (>160oC) nitrates thermally decompose to release NO2   + Other metal nitrates (calcium, potassium, sodium etc.), are quite stable and require temperatures exceeding 500oC to decompose. * Potassium Nitrate (stump remover), sulphuric acid and sodium metabisulphite (preservative for food and wine) release NO2 * Some sources state heating ammonium nitrate and conc. HCl will do the trick, but others say nothing will happen (yet to substantiate). |  |
| Ammonia (NH3) | * Heating Ammonium chloride (used in glue, food additive for bread or other yeast processes, medicine and more – easy to get hold off) and a metal hydroxide (sodium hydroxide [caustic coda], calcium hydroxide [slaked lime] etc) generates ammonia * Heating conc. ammonia solution to around 40oC (ammonium hydroxide) * Heating Ammonium Carbonate liberates ammonia (1:2 ratio) * Mixing and heating ammonium chloride and calcium carbonate liberates ammonia |  |
| Chloroform | * Acetone (freely available) and the addition of either sodium hypochlorite (liquid bleach), calcium hypochlorite (bleaching powder) or ‘pool’ chlorine in a 2:1 ratio (meaning use half the amount of acetone for the amount of chlorinated salt. | In bucket amounts (1-5 litres), this can yield a decent amount of Chloroform with an IDLH of 500ppm and an AEGL (lvl2) in 10 minutes of 120ppm. This will also generate a lot of heat and spatter all over the place, increasing the risk of cross-contamination. |

**Common Sources of chemicals**

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| Rating | Chemical | Relevant Gas | Possible Sources/Industries\* - the internet is deliberately excluded |
| 1 | Aluminium phosphide | PH3 | Found in pellet, tablet, powder or cartridge form mainly as a pesticide for fumigation – agriculture, large food storage, marine environments (rodenticides). |
| 1 | Calcium Carbonate (lime) | CO | Professional and consumer substance - present in cement mixes and as a building material, used in ceramics also and is widely available |
| 1 | Calcium Chloride | HCl, Cl2 | Most notable use as de-icing salt. Used in food packaging, and in swimming pools to increase water hardness and as a pH buffer |
| 1 | Calcium Hypochlorite | Cl2 | Professional and consumer substance used mainly as bleaching and disinfectants within wastewater treatment, swimming pools and cleaning. |
| 1 | Calcium Phosphide | PH3 | Use mainly as a rodenticide (rats are drawn to the pungent smell, but other animals are deterred), this is also a component in fireworks and is used in various incendiary devices and self-igniting naval flares. |
| 1 | Calcium Sulphate | SO2, HCl | Commonly known as Gypsum and plaster, it is also present with other building materials |
| 1 | Chlorinated Isocyanurate | Cl2 | Notably used within the bleaching and sanitising industry, mostly known as pool chlorine tablets. Also used in professional dishwashing and other disinfecting cleaners. |
| 1 | Fumigation Cartridges | H2S, PH3, NH3, Cl2 | Gas cartridges, smoke bombs, smoke pellets. A lot contain ammonium chloride and potassium chlorate and ignited, this is very worrying, not only will the ammonium chloride partially decompose to NH3, but there may be a chance for ammonium chlorate to be produced, which ignites very readily and has the potential to detonate – it also release chlorine when it decomposes. |
| 1 | Fungicides | H2S | Sodium hydrosulphide-based fungicides |
| 1 | Magnesium Sulphate | SO2, HCl | Better known as epsom salts in the cosmetic and beauty industry, magnesium sulphate is readily available and is naturally occurring in the ocean. It has a high affinity to water (extremely soluble) and is used to dehydrate other substances in reactions and purification processes. |
| 1 | Sodium Chloride | HCl, Cl2 | Table salt |
| 1 | Sodium Hypochlorite | Cl2 | Bleach – household bleach such as Domestos for example contains 1-5% sodium hypochlorite (average content). 5000ppm (0.5%), is enough to kill most viruses (well over 25) and bacteria including tuberculosis and salmonella. Often household bleach needs to be diluted at least by 1:10 and sometimes by 1:100 depending on the application, many people I don’t think realise this. |
| 1 | Sodium Thiosulphate | SO2 | Widely available, ironically used as a medication to cyanide poisoning, water treatment and also in photographic development of silver film. |
| 1 | Sulphur (flour) | H2S, SO2 | Extensive uses, widely available, can be found in bath salts, free sulphur powder and fumigation candles (sulphur powder mixed with beeswax and other waxes then burnt). Advertised for greenhouses and the consumer market. |
| 1 | Zinc (powder) | CO | Widely available; mainly used in galvanisation, die casting, making brass, in medicines, in cosmetics, and as micronutrients for animals, plants and humans. |
| 2 | Ammonium Carbonate | NH3 | Predominantly found as baker’s ammonia, a predecessor to today’s baking powder and often is still used for crisp crackers and cookies (widely available). Ammonium carbonate is used also in smelling salts, fire extinguishers, ammonium casein glue, ceramics, and textile dyeing |
| 2 | Ammonium Chloride | NH3 | Professional and consumer product - found in agriculture within fertilisers and used to prevent urinary stones in goats, sheep etc. It can also be found in cold and cough medicines as well as in galvanising and soldering fluxes. |
| 2 | Ammonium Hydroxide solution | NH3 | Professional substance found in many laboratories including teaching and research |
| 2 | Ammonium nitrate | NO2 | Fertiliser |
| 2 | Iron Sulphide | H2S, SO2 | Used mainly in the production of sulphuric acid and as a semi-conductor dopant, in addition, fool’s gold (Iron disulphide), can be heated and acidified to release both SO2 and H2S |
| 2 | Potassium Cyanide | HCN | Mainly used within organic synthetic, it is widely used in electroplating and photographic development in the collodion process. It has smaller application in jewellery for gilding and buffing. It is also extensively used in gold mining. Available to buy. |
| 2 | Sodium Cyanide | HCN | Similar to potassium Cyanide, used in fumigation and photographic development. |
| 2 | Zinc phosphide | PH3 | Used primarily in rodenticides for professionals and consumers, often discourages other animals but attracts rodents like rats, squirrels, mice and voles. Phosphine has been cited in veterinary journals as a hazard to vets from family pets and animals ingesting zinc phosphide specifically. Intended for outdoor use, but we all know how far that guidance will go. |
| 3 | Calcium Cyanide | HCN | Professional substance used as a fumigant, insecticide and in the steel processing industry and mining industry |
| 3 | Copper | SO2, HCl, Cl2 | DIY shops etc. (copper pipe is suited to the reactions), copper lined bowls. Copper turnings is also available |
| 3 | Cyanoacrylates | HCN | Acrylic adhesives/paints, Loctite, most fast acting ‘super glues’ (not epoxys) |
| 3 | Sodium Azide | Hydrazoic Acid | Extractable from air bags, sodium azide is also used in industrial organic synthesis and as a preservative in laboratories and hospitals for biological samples. |
| 3 | Zinc nitrate | NO2 | Mostly used in liquid fertilisers and dyes. Zinc nitrate is easily procured. |
| 4 | Aluminium Sulphide | H2S | Professional Substance - Primarily used as a source of H2S and as a reagent in the tanning and papermaking industry and production of various mercaptans (stenching agents).  *Can be made from a thermite-like reaction between aluminium and sulphur – readily hydrolyses in the air to produce H2S gas* |
| 4 | Cadmium Cyanide | HCN | Professional substance used in electroplating; a solution of cadmium cyanide is used. |
| 4 | Copper Nitrate | NO2 | Mostly professional use within glass, textiles and ceramic industry. It is also known to be used as a fungicide and wood preservative. |
| 4 | Iron Nitrate | NO2 | Used in waste water treatment of sulphides, tanning and dyeing industry, exhaust gas purification catalyst and can be found in most teaching laboratories. |
| 4 | Potassium Nitrate | NO2 | AKA salt petre, widely available. Used as a stump remover, within fireworks, main component of gun powder. It is also used for processing meat – provides extra pinky looking meat |
| 4 | Sodium Metabisulphite | NO2 | Widely available as a preservative (E223) and disinfectant |
| 5 | White Phosphorus | PH3 | Specialty chemical, not widely available, not easily procured. |
| 5 | Acetyl Chloride | HCl | Professional substance – found in industries such as pharmaceuticals, textiles and agriculture. Can be found in most teaching labs. |
| 5 | CFCs | Phosgene | Refrigeration units |
| 5 | Chlorephedrine + phosphorus chlorides | PH3 | Hazard present within the red phosphorus method of methamphetamine manufacture |
| 5 | Chlorinated ssubstances | Phosgene | Professional and consumer substances used for cleaning metals and in the production of thermoplastics, lacquers, perfumes and PVC products. A few examples include; tetrachloroethene (PCE) and trichloroethene (TCE). Other chlorinated substances include professional weed killers. |
| 5 | Copper Sulphide | H2S | Professional use within the semiconductor industry for solar panels, photodetectors, electrodes (magnesium-ion batteries) and microwave absorbers. But, also used in ammonia gas sensors |
| 5 | Ethanol | HCl | Vodka, widely available solvent |
| 5 | Methanol | HCl | Huge application as a solvent and industrial reagent, not as easily to get hold of than ethanol. More professional uses and is restricted as a precursor to many illicit drugs. |

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|  | Acids/Bases |  |  |
|  | Ethanoic Acid (Acetic Acid) - Vinegar | H2S, HCN, Cl, PH3, Hydrazoic Acid | Vinegar (apple cider, clear, malt etc.). Very easily obtainable in its isolated form and not in a product |
|  | Hydrochloric Acid | H2S, SO2, HCN, Cl, PH3, Hydrazoic acid, HCl, NO2 | Brick cleaners, toilet cleaners, ceramic and tile cleaners, pool sanitation and pH adjuster and can be found in the food processing industry as an acidifier for many sauces, vegetable juices and canned goods. It is also used in the production of calcium chloride (de-icing salt). Very easily obtainable in its isolated form and not in a product |
|  | Nitric Acid | H2S, HCN, Cl, PH3, Hydrazoic Acid, NO2 | Not prominent in the consumer market (can be obtained easily however). Very easily obtainable in its isolated form and not in a product |
|  | Sodium Hydroxide (caustic soda) | NH3 | AKA Lye, used as a drain cleaner, oven cleaner, degreaser (saponifies fats and oils), used in soap production. Many, many uses of sodium hydroxide and very easily obtainable. Very easily obtainable in its isolated form and not in a product |
|  | Sulphuric Acid | SO2, HCN, Cl, PH3, Hydrazoic Acid, HCl | Most common acid in household cleaners, drain, toilet bowl, pipe cleaners etc. also found as battery (lead-acid) acid (approx. 35%), used also in production of soaps, present in some laundry detergents and dishwashing liquids. Very easily obtainable in its isolated form and not in a product |

\**This is list is non-exhaustive and does not represent all locations where the chemicals maybe located and used – all the mentioned chemicals can be located and bought cheaply on the internet/dark web*