



Gas Leak Detection: Human Factors' Considerations

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SCENARIO

It was a hot, humid August day in Smithton, Arkansas. Richard Brown was working on a project outside. Richard's wife, Liz, was in the basement doing routine laundry. Their two kids were in their bedrooms. The time was 4:25 pm. Suddenly, the area exploded with fire around her. After a couple of seconds, she realized her clothes were on fire. She screamed as she ran up the stairs and out of the house. Hospital records describe severe burns with treatment involving multiple skin grafts and several more surgeries are required. She describes the pain as intense and unbearable. She is reminded of her disfigurement every time she dresses and moves her legs. The scar tissue is not as elastic as her other skin.

INCIDENT ANALYSIS

Investigation yielded a corroded, cracked copper pipe supplying propane (LP) gas to the dryer. According to one engineer, based on electron micrography showing discoloration, corrosion, and fracture marks, moisture, vibrations, and other environmental agents combined to cause the pipe to degrade. He concluded that the flash fire was caused by a propane leak from this location. The gas-air mixture was ignited by a spark when Ms. Brown started the dryer.

The gas company, Apex Energy ("Apex"), has been delivering propane to the Brown's house for about 15 years. Apex owns the tank and it is kept full. Ms. Brown reports knowing what propane smells like, having smelled it when starting the kitchen stove. She did not smell gas before the explosion.

Poster reference: Wogalter, K. R., & Laughery, K. R. (March, 2011). Gas leak detection: Human factors' considerations. Odor Masking Workshop. National Institute of Standards and Technology (NIST), Boulder, CO.

DETECTION FAILURE

Propane is an odorless gas. Ethyl mercaptan, is added to give it a stench-like odor to aid in leak detection. Gas companies advise that when gas is detected, people should vacate quickly, and not use any electrical switches that could create a spark, including telephones. After vacating, the gas company should be called.

Odorized gas does not always work as an effective warning system. Leaks and resulting fires/explosions still occur even with ethyl mercaptan added. Indeed, trade associations (e.g., NFPA, PERC) publish pamphlets stating that detection of leaked gas by smell is not 100% reliable.

Olfactory sensitivity can be reduced by several factors (e.g., Dalton, 2004; Doty et al., 1984; Fang, Clausen, & Fanger, 1998; Gilbert & Wysocki, 1987; Gunnarsen & Fanger, 1992; Murphy & Cain, 1980; Stevens & Cain, 1985; Stone & Bosley, 1965):

- Some people are born without the ability to detect some or all odors.
- Illness and syndromes (e.g., colds, allergies) can swell or clog the nasal passages; extra mucus can limit odors from reaching the olfactory receptors.
- Chronological age reduces olfactory sensitivity.
- Competing odors in the environment such as tobacco smoke and cooking smells could disguise, mask, or interfere with detection.
- People may detect the smell but not recognize it as gas or not recognize it as a serious hazard.
- "Odor fade," a phenomenon in which the odorant is lost due to adsorption onto surfaces or absorption into materials.
- "Odor fatigue," when the olfactory sense adapts or habituates to an odor reducing awareness of its presence.
- Persons asleep may not detect the odorant; and when newly awakened, may not detect or recognize it.
- Other persons (family members or visitors) may not detect or recognize the odor or realize the hazard.

Everyone is susceptible to one or more of ways that the odorant is not detected (e.g., sleep or nasal congestion). Thus, people can be exposed to a leak hazard about which they are unaware. Fortunately, electronic LP gas detectors are available. One type costs about \$55 at a major hardware retailer. These devices can do the sensing when humans may not be able to do so, and placed in locations where people may not be.

The Browns' testified that they did not know that electronic LP gas detectors were available on the market. They did not know the numerous reasons for not smelling leaked propane gas. If they had been made aware of the need for electronic gas detectors, they said would have purchased them. The Browns characterized themselves as safety conscious. They had two working smoke detectors and a CO detector in their home.

The Browns' attorney argued that a conspicuous, clear message about electronic LP gas detectors was needed to reduce the risk. The company should have informed customers about their availability, why they are needed, and where to purchase them.

Electronic devices are not perfect, however. They may false alarm (i.e., alert people when there is no hazard) or miss detection (e.g., due to batteries, or when the gas is in a different place from the detector). Some houses may need several detectors. They could be misrecognized as a smoke or CO alarm. People may over-rely on them. Proper installation instructions and a description about limitations are necessary.

The gas company over-relied on smell to detect leaks. Apex's employees testified the odorant to be adequate, and that there was little or no need for a gas detector. Apex had information from industry trade groups indicating electronic detectors' value, but the company failed to relay this information to its customers

Human Factors professionals (www.hfes.org) could assist the gas industry in delivering better warning information.

Authors' Note: Names of entities and details have been changed to protect privacy and confidentiality rights. The scenario and description are based on several prototypical LP gas fire and explosion cases.