OTD Operations Technology Development

Ignition Testing of Electronic Devices

In this project, handheld electronic devices were tested to determine if ignition occurs in the presence of a flammable methane/air mixture. Laboratory tests demonstrated a large margin of safety under the scenarios investigated.

Project Description

Natural gas distribution companies issue electronic devices (e.g., cell phones, smart-phones, and data collectors) to employees for use in day-to-day activities, including entry into spaces that on rare occasions contain flammable mixtures of 4.5%-14.5% methane and air. Cell phone manufacturers issue a general warning that the product should not be used in the presence of flammable gases; for example, at gasoline stations. Utilities instruct employees to turn off the cell phone before entering a basement.

The industry would benefit from information that helps to understand the likelihood that these devices could act as a source of ignition under various operating conditions. However, determining the intrinsic safety of an electrical device is a complex process. To be classified as intrinsically safe, a device cannot have any component with stored energy greater than the minimum ignition energy. Often, the battery used to power the electronic device exceeds this energy level. Therefore very few electronic devices are intrinsically safe.

This project involved a straight-forward approach to testing by operating electronic devices in the most hazardous conditions (9% methane in air) and monitoring for ignition.

The results of this project do not certify the devices as intrinsically safe but provides operators with testing results under specific conditions.

Deliverables

The results of testing program will be compiled into a report. Information was presented to sponsors through a webinar and video documentary.

Benefits

Project results provide operators with information to assist with the development of company policies regarding electronic-device usage in various situations. The project results can be used to better understand the risk associated with the use of electronic devices in the presence of natural gas.

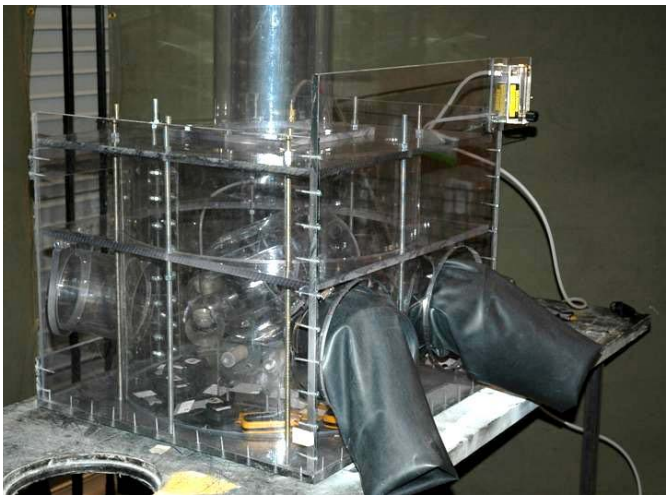
Technical Concept & Approach

Several potential laboratories were investigated to provide the testing, with the research team choosing a laboratory with experience testing in the presence of other explosive materials.

A survey was conducted to help select the 12 phones to use in the testing.

The equipment manufacturers were informed of the project work and invited to participate as advisors.

Testing was performed to determine if ignition occurs under the most hazardous natural gas operating condi-



A special chamber was designed and built to conduct the measurements and tests in a flammable mixture.

A variety of electric devices were tested.

tions. The approach was to build a facility specific to natural gas to create and maintain a flammable mixture, while permitting operation of an electronic device.

Each electronic device was operated multiple times and subjected to a variety of tests and conditions while in the 9%-gas mixture. Specific testing (involving battery removal, a drop and impact test, and use of a controlled mechanism to jar internal components) was conducted to determine if sparks can occur because of damage during use.

Results

Tests were performed in this project to determine what types of cell phone activities can cause an ignition. All tests were performed in a mixture containing 9% to 10% methane in air. (This ratio was selected because it is the easiest to ignite.)

Four cell phone models were selected based on a survey of the sponsors. Three samples of each model were tested. Before testing, each unit had its back removed and was placed in the flammable mixture for 15 minutes so the flammable gas mixture could diffuse into the phone interior. The first tests performed all of the activities and features provided by the units (e.g., , turning the unit on and off, making calls, receiving calls, and receiving data).

One area of concern is disconnecting and reconnecting the battery, since the battery is the most likely source of ignition energy in the cell phone. The 4.1-volt cell phone battery was removed, wires were attached to each terminal, and the two wires brought close and then shorted together. In each of the multiple tests performed, a spark was observed; however, no ignition occurred. Similar tests were performed with three 9-volt batteries wired in series (yielding 27 volts). A continuous series of sparks was observed, but no ignition.

Following a standard test procedure, each of the 12 phones was dropped six times in a flammable mixture from a height of 40 inches onto concrete. During each drop, the phone was constrained to land on one edge. Because a cell phone has six sides, each phone was dropped six times. Next, each phone was placed in a tumbler inside the flammable mixture for 15 minutes. None of these tests resulted in an ignition. The testing may not have created all scenarios for ignition; however, these tests demonstrate that it would take very unusual conditions for ignition to occur. It should be noted that some sparks do not have sufficient energy to cause ignition of natural gas.

An igniter was used after each series of tests to demonstrate that ignition would have occurred with a sufficiently energetic spark.

Status

All planned testing has been completed. A video documentary is available that summarizes the results.

Based on the results of this project, it appears difficult for one of the cellular devices in this study to cause an ignition in flammable mixtures of natural gas, either under routine usage scenarios or under common scenarios in which the phone may incur damage by dropping.

It is recommended that each utility develop its own policies on using electronic devices in hazardous natural gas environments. However, if devices such as those tested in this report are used in flammable mixtures, there appears to be a large margin of safety under the scenarios investigated within this work.

It is recommended that additional testing of cell phones be conducted with super-capacitor LED flash units if utilities issue them.

For more information:

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