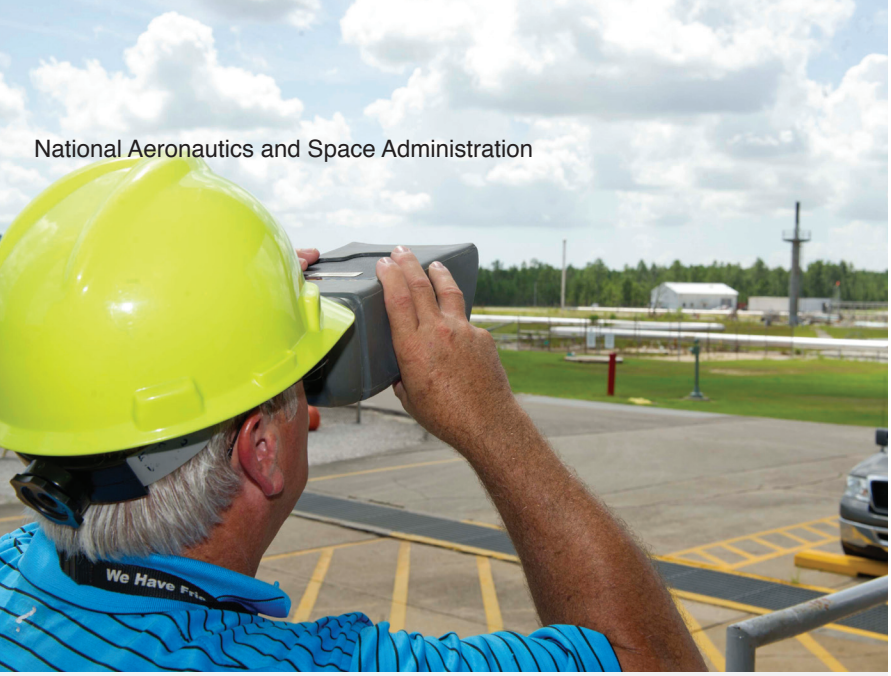

Instrumentation

Hand-held Hydrogen Flame Imager

Detects flames not seen by the naked eye

NASA's John C. Stennis Space Center invented a hand-held fire imaging system which enables the user to visually determine the existence, size and location of a hydrogen fire flame; the visible light emitted by a hydrogen fire is so dim, nearly invisible, that this type of fire cannot be seen by the human eye unaided — at least, not in bright daylight. Stennis operates numerous facilities where hydrogen fires pose a threat, and needed a device that would safely indicate the exact location and magnitude of these invisible flames. While fire detectors do exist, they do not provide a reliable method for locating hydrogen fire flames or determining their extent. This NASA-developed technology was designed to provide a low-cost, hand-held system specifically designed to image hydrogen flames and the background scene under low light and day light conditions. Used like binoculars, this instrument can be used to view a hydrogen flame only 8 inches (20 cm) long from a distance of 50 feet (15 meters), in full sunlight. In this way, the user can visually determine the location, size and growth rate of the flame during daylight conditions without endangering the operator's safety.

BENEFITS

- **Portable:** The device is packaged like binoculars and powered by a re-chargeable battery
- **Light:** Entire instrument weighs five pounds
- **Inexpensive:** Uses widely available video camera technology
- **Adaptive:** Operator can switch modes for "sunny" and "cloudy" weather conditions
- **Versatile:** Has the ability to image hydrogen, alcohol and hydrocarbon fuels, as well as "hot spots" and "embers"
- **Visually Unconstrained:** Able to "see" through water spray and fog, and provides clear night vision using infrared illumination
- **Reliable:** Operational for two hours; power can be verified/tested with a cigarette lighter
- **Remotely Operative:** Can be outfitted with wireless audio and video with home base 1,000 - 5,000 feet away; communicates with remote command and control centers
- **Quick:** Start up is less than 5 seconds
- **Hazardous Operation:** Designed for operation in Class I, Division II, Group B hazardous environments

technology solution

THE TECHNOLOGY

The technology is a hand-held fire imagining system, specifically designed for detecting hydrogen flame. Hydrogen flame emissions are not visible to the human eye because reflected solar radiation obscures the visible hydrogen flame emission. However, a hydrogen flame can be detected in several infrared regions where the hydrogen flame emissions are greater than the solar background radiation.

There are non-imaging fire detectors available that can sense the presence of a hydrogen flame, however, these detectors do not display the size and location of the fire. Additionally, most commercially available imaging devices only produce a thermal image that often exaggerates the size of the flame, require a skilled operator to interpret, are costly, and are not designed for portable operation and/or for use in an emergency situation or in hazardous environments.

The hand-held flame imaging instrument that Stennis developed was designed to operate at infrared wavelengths where hydrogen fires appear bright, relative to solar background light. The imager consists of two low-light, black and white, silicon charge-coupled-device (CCD) cameras that operate simultaneously. The CCD cameras are packaged in a casing similar to a pair of binoculars, and operate at infrared wavelengths to detect hydrogen fire flames, or other flames that are nearly impossible to see with the naked eye. One CCD camera, the "cloudy" CCD camera, uses a 800 nm long-wavelength pass filter which during overcast conditions block sufficient background light so the hydrogen flame is brighter than the background light. The second CCD camera, the "sunny" CCD camera, uses a 1,100 nm long-wavelength pass filter, which blocks the solar background in the presence of full sunshine conditions so that the hydrogen flame is brighter than the solar background. Two electronic viewfinders convert the signal from the camera into a visible image. A switch enables the user to select the appropriate camera to use depending on current light conditions.. The instrument also includes a nonimaging, Indium gallium arsenide (InGaAs)-based photodetector that has a field of view 40° wide, which is preceded by a bandpass filter with a nominal pass wavelength of 1360 nm, which is the wavelength of a peak in the emission spectrum of a hydrogen flame. This photodetector provides yet additional spectra discrimination of a hydrogen flame. When a flame is detected, an audible alarm sound is triggered and a visible flash by light-emitting diodes (LEDs) is seen inside the viewfinders; this feature helps to prevent the user from overlooking a small hydrogen flame. Optionally, both cameras and their viewfinders can be used simultaneously for binocular viewing. A 12 volt battery located within the housing provides power to the components. A video output port is located on the housing which allows a video monitor or a video recorder to be connected to the flame imager so the signal can be remotely viewed or recorded. The cost effectively developed hand-held flame imaging detector enables users to safely distinguish between background images and nearly invisible hydrogen fire, regardless of lighting conditions.

APPLICATIONS

The application of invisible flame detection can be used in any industry that uses liquid hydrogen or alcohol:

- Transportation applications using hydrogen/alcohol as energy sources
- Propulsion
- Automotive/Racing
- Power generation application using hydrogen as an energy source
- Chemical manufacturing including petrochemical, food, metal processing, fertilizer, semiconductor manufacturing, ammonia and hydrogen production Cosmetics
- Research applications including cryogenics
- Utility companies

The device also has applications for fire fighters, chemical-petroleum plant response teams, and hazardous materials teams to:

- Use the device as a search, surveillance and navigation tool
- Detect smoldering embers and hot spots in a traditional fire
- Remotely scan a scene and measure surface temperatures

PUBLICATIONS

U.S. Patent No. 5,726,632

More Information

National Aeronautics and Space Administration

NASA John C. Stennis Space Center

AA01/Office of the Center Chief Technologist
Stennis Space Center, MS 39529
228.688.1929
ssc-technology@nasa.gov

http://technology.nasa.gov/

www.nasa.gov

NP-2014-08-1147-HQ

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

SSC-00040