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WHITE PAPER

Fire and gas protection in wastewater applications:

How to meet the latest safety standards

Wastewater treatment plants (WWTPs) and collection facilities need to be protected against the dangers of combustible and toxic substances. This is the role of a fire and gas protection system as defined for WWTPs by NFPA® 820 and other standards organizations.



No matter where they are located or how they are designed, the tens of thousands of wastewater treatment plants (WWTPs) around the world all have one thing in common: they can be dangerous places due to toxic and combustible substances processed or present onsite. It's no surprise that regulations governing WWTP operations call for the deployment of gas, flame and/or smoke detection equipment to protect personnel in a variety of plant areas.

This paper reviews the main substances of concern found at WWTPs, some of the codes and standards that address the dangers posed by these substances, and the fire and gas safety system components that help WWTPs minimize the risks to workers, facilities and ongoing operations.

What are the hazards?

Many processes within wastewater plants produce or require the use of toxic or combustible substances. Chlorine and ammonia are commonly used to treat the wastewater. Hydrogen sulfide is a deadly toxic gas which is present in untreated wastewater containing raw sewage, and can also be generated as a byproduct of sludge treatment processes. Methane gas is also produced as a by-product of raw sewage and sludge decomposition.

Each of these hazardous substances requires protection for WWTP personnel in multiple areas of the plant. Parts per million (PPM) monitors are typically utilized to alert workers and safety personnel if these gases reach toxic levels. Oxygen levels are also monitored in enclosed spaces where inert or noxious gases are produced to ensure workers' safety isn't compromised. But, there are also specific standards for an overall fire and gas safety system that coordinates inputs and takes actions as required for safety.

What are the safety standards?

In the U.S., WWTP personnel can turn to NFPA® 820 (2016), entitled "Standard for Fire Protection in Wastewater Treatment and Collection Facilities." An update of a 1999 NFPA standard of the same name, the latest version of NFPA 820 provides guidelines for the areas of WWTPs that should have gas, fire and/or smoke detection systems. The guidance is provided in three tables covering different parts of a WWTP operation: 4.2.2 (collection systems), 5.2.2 (liquid stream treatment processes), and 6.2.2(a) (solids treatment processes).

Other codes and standards that provide guidance in dealing with these substances include IEC 60079-10-1 (2015) from the International Electrotechnical Commission, which classifies areas where explosive gas atmospheres can be found. This international standard is commonly used in regions outside of North America.

The process flow diagram (see Figure 1) was created using NFPA 820 (2016) as a reference. This diagram can help users determine the type of hazard-detection equipment needed at various stages of a typical wastewater treatment

process. Below is an overview of the various detection equipment that can be included in an overall fire and gas safety system — smoke detectors, flame detectors and gas detectors — plus the system controller needed to gather inputs, provide notification and initiate actions.

Smoke detection — expanded requirements

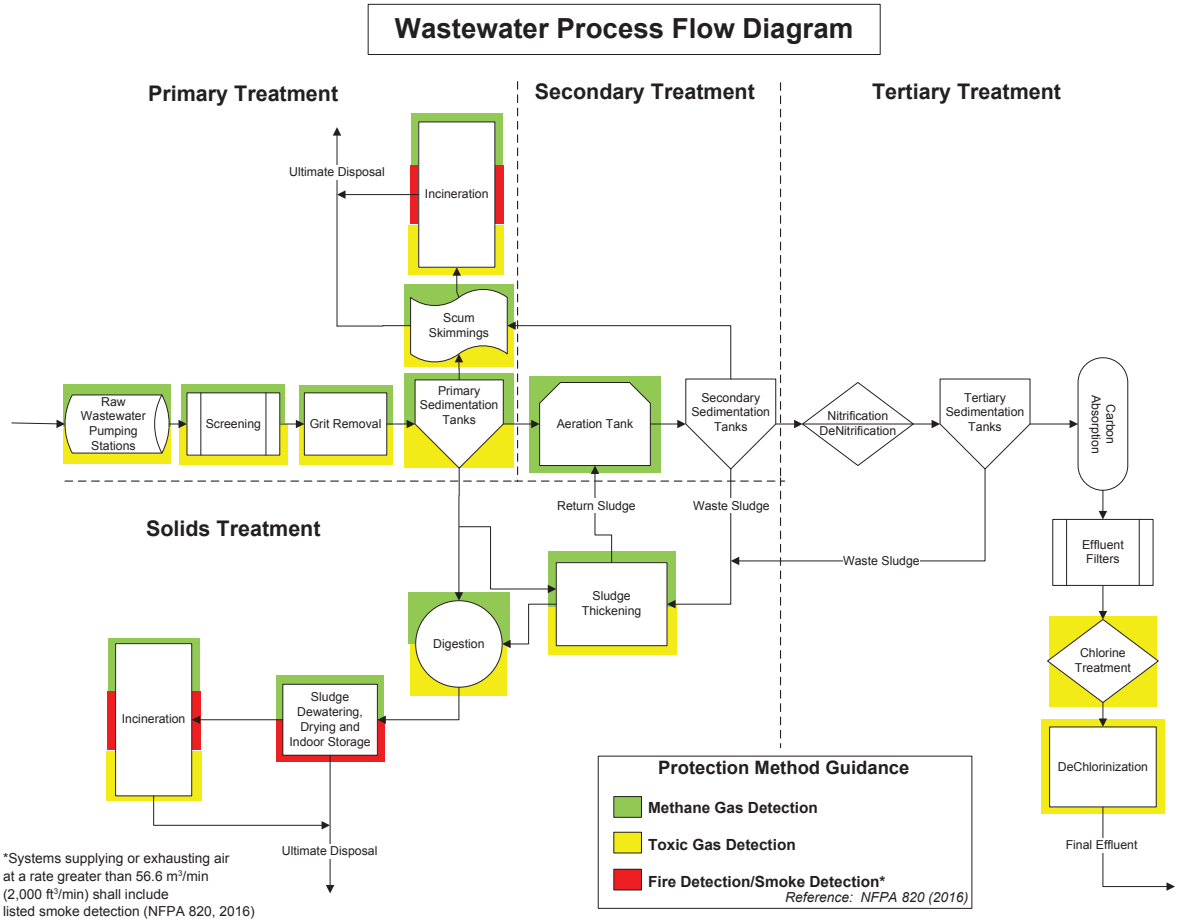
A major addition to the latest version of NFPA 820 is a smoke-monitoring requirement for high-velocity ventilation ductwork in WWTPs. According to the standard, systems supplying or exhausting air at a rate greater than 56.6 m^3/min (2000 ft^3/min) should include smoke-detection devices. If smoke is detected, these devices activate smoke or fire dampers to prevent the smoke from harming plant personnel. The presence of these devices also makes it less likely that fire will spread through a facility's heating, ventilating and air conditioning (HVAC) system.

In addition to HVAC ductwork, smoke detection is recommended for sludge-processing areas, incinerator buildings and underground tunnels. Requirements for these areas can vary depending on the WWTP location. As with all detectors used in high-risk locations, smoke detectors should have the necessary performance approvals to certify that they will operate safely and effectively in their intended locations. For WWTP applications, smoke detectors may need to be suitable for use in Class I Division 1 or 2 locations. (For information about hazardous area classifications, see NFPA 70 in References section.)

Smoke detectors can be designed to detect smoke either in a defined area or within ductwork. The devices detect particles produced by combustion using a variety of technologies, including ionization, photoelectric light obscuration and scattering, and video image detection.

To be effective, smoke detectors should be located and spaced in anticipation of airflow from sources likely to present fire risks. In addition, the detectors should be located in a manner that will minimize false alarms, according to NFPA 72, which provides detailed guidelines

Figure 1: Based on NFPA 820 (2016), this process flow diagram shows the various stages in a typical wastewater treatment process, as well as the type(s) of detection needed at those stages.



and configuration rules for the placement of smoke detectors and other fire safety devices.

IEC 61508 and 61511 provide functional safety requirements for fire and gas (F&G) safety products designed for hazardous industrial applications. Valid third-party product certification is important because it establishes a systematic means to evaluate safety at the extremes and for special-use conditions. Product-certifying organizations include Factory Mutual (FM), exida, SIRA, Underwriters Laboratories (UL) and TÜV Rheinland. These product certifiers are accredited as able to assess and audit products, services and systems to ensure that they meet functional safety requirements.

Thermal detection — spotting flames quickly

In addition to smoke detectors, F&G systems for WWTPs often include thermal detection equipment such as heat detectors and optical flame detectors. In open or drafty areas, heat and smoke from a fire can dissipate, significantly delaying detection by conventional ceiling-mounted flame detectors, or preventing detection altogether. Even in a best-case scenario, it can take minutes for conventional flame detectors to respond to fires—a delay that can have catastrophic consequences in hazardous areas. In areas where methane gas is used or produced, WWTPs may find it necessary to install a special type of flame detector designed to provide rapid and accurate notification of fire.

Optical flame detectors can respond to fires in seconds. Instead of depending on the movement of heat or smoke away from a fire, optical detectors pick up flame emission traveling at the speed of light. As described in NFPA 72, these radiant energy-sensing detectors are line-of-sight devices that can employ several sensing technologies: ultraviolet (UV), infrared (IR), ultraviolet/infrared (UV/IR) and multi-spectrum infrared (MIR).

While NFPA 820 does not specifically prescribe optical flame detection, it does recommend fire detection systems and/or fire suppression systems for some areas, which under certain conditions, could include optical flame detection as an initiating device. In addition to meeting requirements for rapid fire detection, these detectors are designed to be resistant to false alarms. They can also detect relatively small fires that are fairly long distances away, making it possible for a small number of them to protect a large space.

Gas detection — requirements and options

No less important than smoke and flame detection at WWTPs is accurate detection of both combustible and toxic gases. NFPA 72 describes a gas detector as "a device that detects the presence of a specified gas concentration." In WWTPs, PPM monitors are typically used to alert workers and safety personnel in the event gases reach toxic levels. Oxygen depletion is also monitored to ensure the safety of workers in enclosed spaces where inert or noxious gases are produced. In addition, methane gas levels are measured and controlled during some WWTP processes to ensure that they do not reach combustible levels.

Gas detection technologies commonly used at WWTPs include:

Line-of-sight gas detection technology continuously monitors combustible gas levels between two points at ranges as far as 120 meters apart.

Fixed-point detection of a toxic or combustible gas by electrochemical, catalytic, or infrared technologies. Detectors employing these technologies activate when gases come in contact with them.

Each of these detection technologies has benefits and limitations, depending on the specific application and environmental factors. So an optimal solution may involve the use of more than one of them, with the different technologies placed in locations that maximize their effectiveness.



Sludge dewatering is one of the wastewater treatment stages specifically called out in NFPA 820 for fire protection including smoke detectors.

Controlling the fire and gas safety system

Whatever their function, detectors used at WWTPs aren't meant to stand alone. To be useful, they must be tied to a system that can make decisions and take actions based on detection data. In some advanced F&G safety setups, this system is a programmable logic controller that is third-party approved to monitor signals from fire and gas detectors and to process those signals to determine the proper resulting actions Also included in the system are a variety of I/O modules, displays, switches and status-indicating devices, all of which should be approved for use with the controller. The controller software provides real-time F&G system status and diagnostics and also allows programming and configuration of gas, flame and smoke detectors, as well as other field devices.

In some cases, an F&G controller may need to interface with and integrate hundreds of individual detectors, along with fire suppression devices and notification appliances. When necessary, the controller should be fit for use to activate audible and visual alarms and to send signals to start pumps, open deluge valves, close HVAC dampers and notify authorities. The F&G controller should also be capable of communicating safety system information to WWTP process control systems.

Conclusion

Normal WWTP operations can present considerable risks to workers and facilities. But, these risks can be minimized by adhering to the latest NFPA standards for fire protection in wastewater treatment facilities. Deploying advanced detectors and utilizing a plant fire safety system that can monitor and, when necessary, take action on detector data, is the best line of defense for WWTP personnel and facilities.

Disclaimer

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About Det-Tronics

Det-Tronics is a global leader in fire and gas safety systems, providing premium flame and gas detection and hazard mitigation systems for high-risk processes and industrial operations. The company designs, builds, tests and commissions SIL 2 Capable flame and gas safety products ranging from conventional panels to fault-tolerant, addressable systems that are globally certified. Det-Tronics is a part of Carrier, a leading global provider of innovative HVAC, refrigeration, fire, security and building automation technologies.

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DET-TRONICS

Carrier

Adaptive Industrial Solutions
sales@adaptiveind.com
(877) 818-5009

det-tronics.com

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