CASE STUDY

Explosion and Fire in West Carrollton, Ohio

(Four Workers Injured, Community Damage)

2009-10-I-OH
JULY 21, 2010

Photo Courtesy of Ohio State Fire Marshal

This case study examines an explosion and fire at the Veolia ES Technical Solutions, LLC, facility in West Carrollton, Ohio, that severely injured two workers and slightly injured two others. Eight structures at the plant sustained damage, as did approximately 20 residences and businesses offsite.

Veolia Technical Solutions, LLC

West Carrollton, Ohio
May 4, 2009

INSIDE …

Key Issues:

- Unsafe Building Siting
- Atmospheric Relief Systems
- Plant Emergency Procedures

1.0 Introduction

At about 12:07 a.m. on May 4, 2009, highly flammable vapor, released from a waste recycling process, ignited and violently exploded, severely injuring two employees and slightly injuring two others at Veolia ES Technical Solutions, LLC. Multiple explosions afterward significantly damaged every structure on the site. Residences and businesses in the surrounding community also sustained considerable damage. The fire was declared under control by 10:38 a.m. that day.

1.1 Veolia Corporation

The West Carrollton facility opened in 1979 as Solvent Resource Recovery and, after several name changes, became Chemical Waste Management (CWM) Resource Recovery in 1988. In 1999, Vivendi, a French company purchased the facility as part of a larger acquisition and transferred the assets to Onyx Environmental Services, L.L.C. (OES). On July 1, 2006 the site was renamed Veolia ES Technical Solutions, L.L.C. (VESTS)—a subsidiary of Veolia Environmental Services North America Corp. (VESNA). VESNA is a publicly traded subsidiary of Veolia Environnement, which employs more than 300,000 worldwide.

1.2 Company Background[1]

The Veolia facility is approximately 7 miles southwest of Dayton, Ohio, and is located on Infirmary Road, 0.7 miles north of the intersection with Farmersville West Carrollton Road. The surrounding land is used for residential, industrial, and farming purposes.

The company provided hazardous waste services for industrial and municipal customers. The Veolia site, an estimated 20 acres, employed about 72 workers on the day of the incident. Six employees were at work on the night of the incident. Veolia is a member of the Environmental Technology Council (ETC), a national trade association of commercial environmental firms that recycle, treat, and dispose of industrial and hazardous waste.

The CSB issued two recommendations to ETC as the result of an investigation of a fire in 2006 at a hazardous waste facility located in Apex, North Carolina. ETC has not acted upon either of these recommendations to date.

Governed by U.S. Environmental Protection Agency (EPA) regulations authorized by the Resource Conservation and Recovery Act (RCRA), Veolia is a state-permitted treatment, storage, and disposal facility (TSDF). The site was subject to inspections by the Ohio EPA twice a year, and customers audited between 20 and 40 times a year. The site provided the following services to waste generators:

- **Fuel Blending:** Received flammable and combustible waste streams (liquids, solids, and sludge), consolidated them into marketable waste-derived fuels, and shipped them for burning in energy-recovering cement kilns. Bulk and containerized wastes arrived in liquid, solid, or sludge/slurry form.
- **Solvent Recovery:** Distilled and reclaimed liquid waste solvents that arrived in loads. The facility had three distillation units that produced usable solvent from this waste material.
- **Waste Consolidation**: Consolidated like materials into larger containers, usually 55-gallon drums. If possible, the consolidated material was blended or recovered onsite; otherwise, it was transported to other locations.
- **Waste Material Transfer**: Received, stored, packaged, and transferred waste which did not require treatment, fuel blending, or disposal.

[1] Part of the facility is being rebuilt and some is still in operation, but for the sake of consistency, and to avoid confusion, past tense will be used throughout this document.

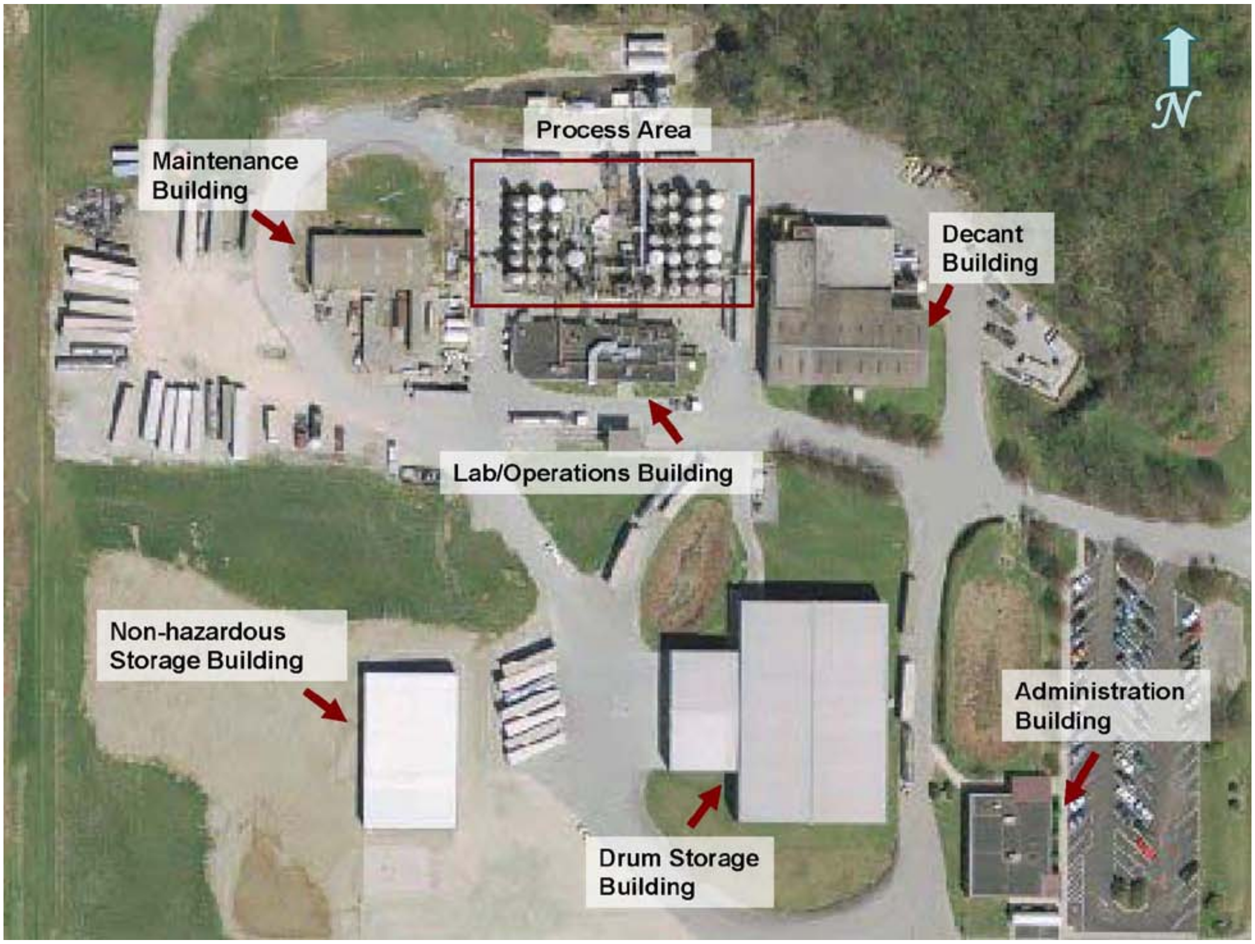

Figure 1. Aerial view of the Veolia facility (Montgomery County, OH GIS Photo)

1.3 Facility Description

Employees occupied a number of structures at the site depending on the time of day. The lab/operations building and the administration building were the two with the most employees.

The lab/operations building was a multi-use structure that served as the primary workstation for lab technicians, lab managers, production clerks, plant operators, and supervisors. The building also housed a control room, break/dining area, laboratory, and locker rooms. Eight offices were contained within the building.

Three boilers were located in the northwest section of the lab/operations building. The north wall of this building was less than 30 feet from the operating units.

The administration building, located about 500 feet south of the operating plant, provided office and meeting space for plant management, technical, accounting, environmental health and safety, and other personnel.

The remaining structures were the decant, drum storage, non-hazardous waste processing, and maintenance buildings. The processing area consisted of two tank farms and three solvent recovery units.

2.0 Process Discussion

2.1 Solvent Recovery Process Description

Veolia processed hazardous and non-hazardous waste products at the West Carrollton site. The facility received waste solvent in bulk tanker trucks and drums. The waste streams received for recovery were dirty or spent solvents from industrial generators. Typical solvent blends consisted of aliphatic hydrocarbons, chlorinated hydrocarbons, esters, ketones, and alcohols. The residue, or "still bottoms," that remained after onsite distillation consisted of plasticizers, resins, pigments, and residual solvents.

Tanker trucks were unloaded directly into bulk storage tanks (dirty tanks) at the trailer containment areas. Drums were unloaded into receiving areas for temporary staging. Waste was then decanted into bulk storage tanks or repackaged for shipment offsite. Veolia either returned clean solvent to the generator for reuse or sold the product to other industrial users after purifying it by distillation. Veolia also transported non-distillables to an offsite permitted hazardous waste facility for combustion either in a supplemental fuels program or in a hazardous waste incinerator for safe destruction.

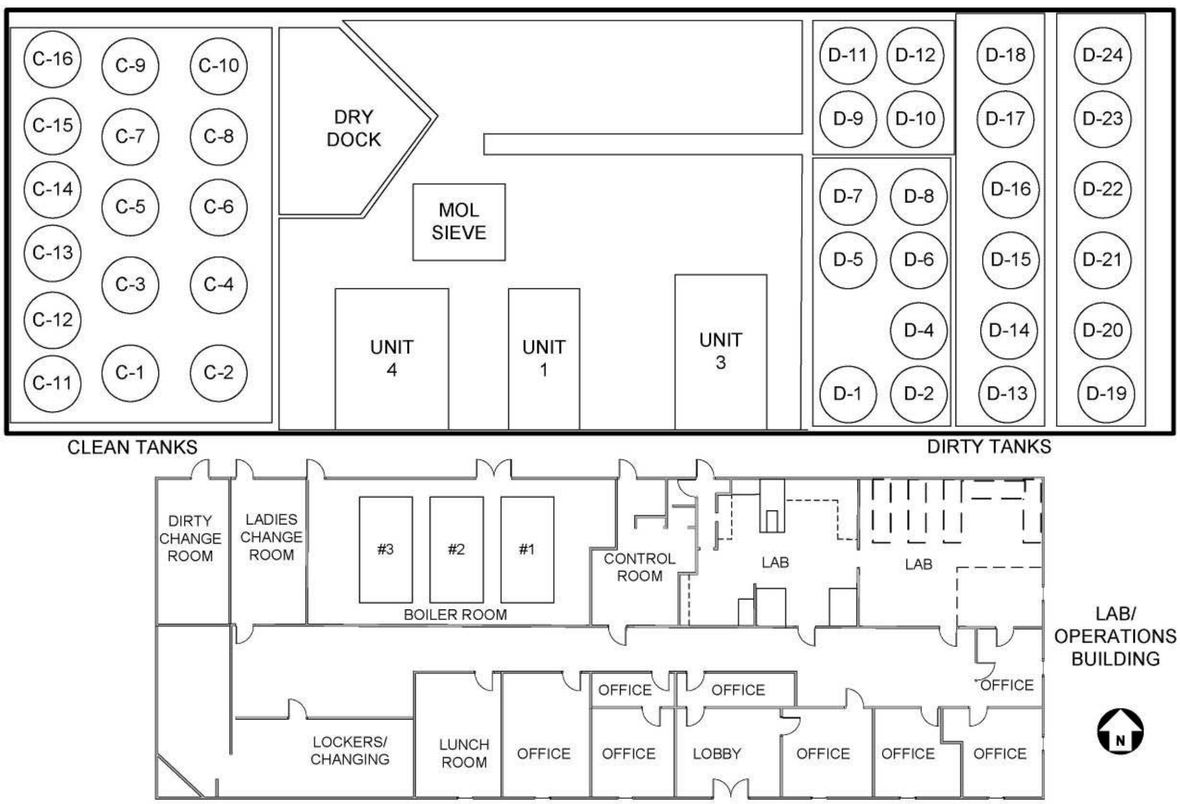

Figure 2. Plot plan of Units 1, 3, and 4; clean and dirty tanks; and the lab/operations building (not to scale)

Veolia recovered and recycled waste solvents to 95 to 99 percent concentration. Twenty-three carbon steel "dirty" tanks and 16 stainless steel "clean" tanks ranging in capacity from 8,000 to 20,000 gallons abutted Units 1, 3, and 4 to the east and west, respectively (Figure 2). Incoming solvents were unloaded into tanks in the dirty tank farm. Dirty tanks acted as feed tanks for the solvent recovery process, and clean tanks received and stored recovered product.

A three-inch vapor-piping manifold, called the "vapor balance system," equalized the gas pressure above the liquid contents when loading and unloading the tanks. The dirty tank farm and the clean tank farm had independent vapor balance pipe systems, though the dirty tank vapor balance system was connected to the molecular sieve unit and the drum disposal unit at the decant building.

Units 1, 3, and 4, the three distillation units, and one molecular sieve processed the dirty solvents. The molecular sieve removed water from certain solvent streams and was connected to the dirty tank vapor balance system. Processed solvents were then stored in stainless steel tanks in the clean tank farm.

Units 1 and 3 operated continuously while Unit 4 used a batch process. Unit 1 was composed of a thin film evaporator and condenser.[2] Unit 3 consisted of a wiped film evaporator, fractionating distillation column, and condenser.[3] Unit 4 used a 12,000-gallon batch still, reboiler, fractionating distillation column, and condenser.[4] One operator was responsible for operating all units under the direction of a shift supervisor and a reclaim supervisor. The units operated 24 hours a day, seven days a week as needed to meet production demands.

Three natural gas-fired tube boilers produced 120-psig steam for both process use and building heat. A Therminol 55® hot oil unit provided process heat for evaporators in Units 1 and 3. The facility used nitrogen to regenerate the molecular sieve, blanket the hot oil unit, and purge the drum disposal unit.

3.0 The Incident

The incident occurred at about 12:07 a.m. on May 4, 2009, when highly flammable vapor released from a waste recycling processing area in the dirty tank farm ignited and violently exploded, severely injuring two Veolia employees. One employee suffered first-degree burns and a second broke his pelvis. Multiple explosions ensued, significantly damaging a majority of the facility, surrounding businesses and residences.

The two most severely injured were both in the lab/operations building at the time of the incident. One worker was in the control room, located about 25 feet from the operating unit, when the escaping vapor ignited. He reported being enveloped "[in a] fireball that…went through the building [and that] seemed to stop as fast as it started." Shortly after the first series of explosions, this worker was seen exiting the area to a pre-arranged assembly point at the main gate. West Carrollton Fire Department (WCFD) Emergency Medical Services (EMS) immediately transported him to Miami Valley Hospital.

WCFD EMS examined two other Veolia employees. One, whose hands were cut after he jumped a fence topped with barbed wire, was treated and released. The second, who experienced breathing difficulties, was treated with a nebulizer and released.

One severely injured employee heard the sound of a release and detected a very strong odor as he left for a meal break in the area south of the lab/operations building about three minutes before the explosion occurred. He saw a white vapor cloud in the dirty tank farm advancing toward the lab/operations building. He returned to the lab/operations building to notify the shift supervisor and other personnel, and to retrieve a respirator. When the vapor ignited, a bank of personnel lockers fell over, briefly pinning the employee and breaking his pelvis.

Unable to walk, the worker sought shelter underneath a tractor-trailer after he dragged himself out of the southwest door of the lab/operations building. When he saw flames

[2] Thin film evaporators heat the raw material on the internal surface of a heated tube until the lower boiling component starts to evaporate.

[3] Wiped film evaporators increase evaporation or separation of heat-sensitive liquids. Feed flows down the inside of a cylindrical vessel wall, while rotating wiper blades spread the material across the wall and maintains a uniform film of the material.

[4] OSHA Process Safety Management (PSM) covered process.

advancing toward him, he continued his egress along the property fence-line on the southwest portion of the facility until he found help near the administration building about two hours after the incident.

An employee standing at the northwest corner of the lab/operations building reported that the sound of the release subsided noticeably just before the first explosion. He then saw the double-doors of the room housing three natural gas-fired boilers blow open. (Two of the boilers were in service at that time.) A few seconds after the first event, he saw a subsequent, larger explosion that appeared to originate in the dirty tank farm. The worker saw a flame-front that extended to the north wall of the drum storage building, which exhibited extensive damage during post-incident inspections.

Neighboring property security/surveillance media recorded multiple explosions after the initial event. These recorded events proceeded for roughly 45 minutes after the initial explosion.

3.1 Operations at Time of Incident

The plant operators worked 12-hour shifts; day shifts started at 5:00 am and night shifts started at 5:00 p.m. At shift change before the incident, the dayshift operator told the nightshift operator that something had dislodged in the Unit 3 evaporator, causing an intermittent rattle in the sludge pump during his shift.[5] When the day shift operator noticed the unusual sound, he contacted the reclaim supervisor by phone at home, who advised him to continue operating Unit 3 as outlined in the operating plan unless the pump was disrupting plant operation.

To demonstrate the rattle to the nightshift operator coming on shift, the dayshift operator pressured nitrogen back through the pump suction to the vessel serving as the source of material to the pump.

Immediately prior to the release that led to the explosion, the unit operator had commenced the shutdown of a tetrahydrofuran (THF) solvent recovery process on Unit 3 when test results indicated that the material had reached the desired azeotropic[6] state.

Unit 3 was processing a THF and water mixture that was stored in dirty tank 14 (D-14). The intent was to recover THF from the mixture for a customer. The THF was transferred to a mixing tank in the clean tank farm where fresh water was added re-dilute the mixture to 20 percent THF and 80 percent water. The THF and water mixture was decanted back to D-14 for processing in Unit 3. When the THF and water mixture reached its azeotrope of 5.3 percent water in THF, further distillation was no longer effective in Unit 3 and the recovery process was transferred to the molecular sieve to break the azeotrope and dry the THF to a water content of 0.03 percent

5 The CSB investigators discovered that the cause of the rattling was a sheared bolt used to secure a blade in the evaporator.

6 An azeotrope is the threshold ratio of two or more liquids (chemicals) such that simple distillation cannot further change their composition. When two substances reach azeotrope, the boiled vapor has the same ratio of constituents as the original mixture.

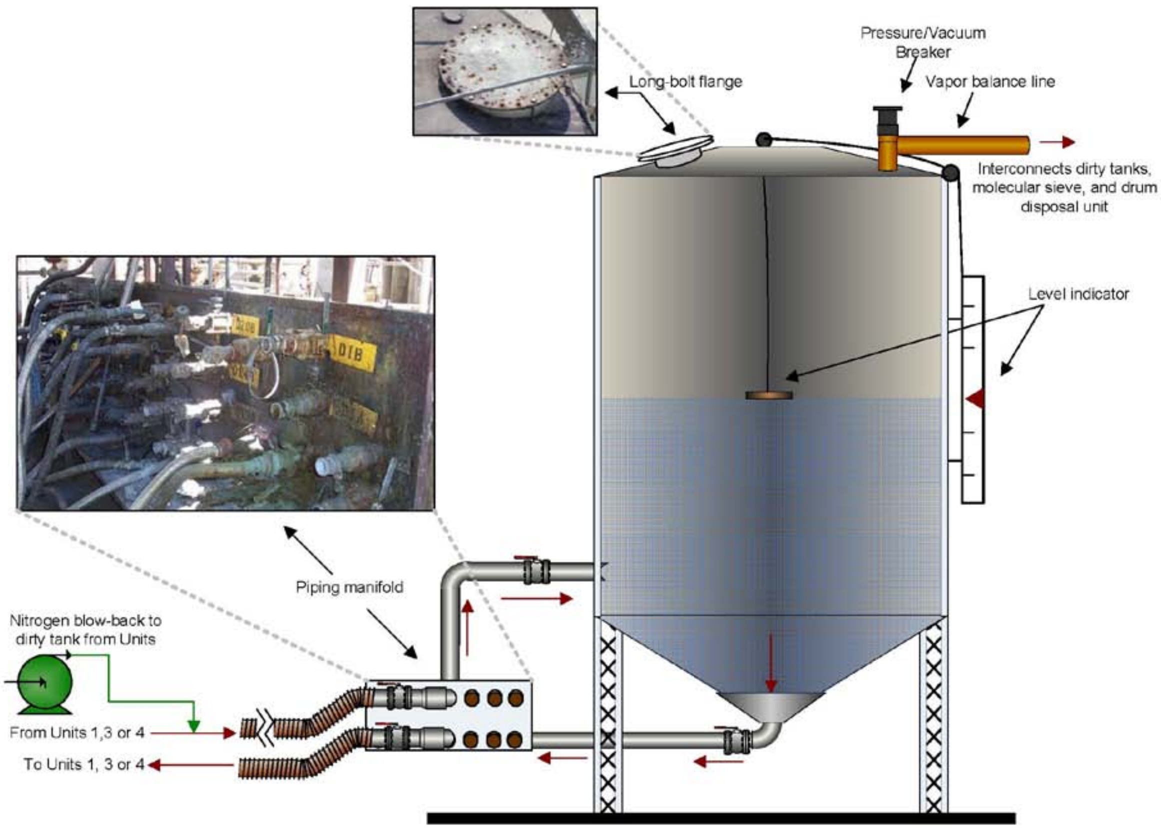

Figure 3. Dirty tank, manifold, and relief systems

After completing the run, the Unit 3 shutdown process required clearing the pipe of remaining process materials. This was accomplished by back-blowing nitrogen through the circulation piping into the dirty tank prior to closing valves to isolate the tank from the operating unit. The vapor release occurred shortly after the unit operator started the flow of nitrogen back to the dirty tank.

Employees present at the time of the incident reported that, about two minutes before the explosion, they heard a loud vapor release. Some also recalled a very strong THF odor and reported the source of the release to be in the dirty tank area, which is about 80 feet northeast of the three natural gas-fired boilers located in the lab/operations building. In addition, they reported the vapor drifting back to ground level made normal breathing difficult for them. The overpowering odor knocked several employees to their knees.

3.2 THF Characteristics

THF, a general purpose, flammable, organic solvent, is a colorless, water-miscible, stable liquid. THF reacts readily with oxygen (e.g., on contact with air) to form unstable peroxides (predominantly hydroperoxides). Adding certain stabilizers inhibits the formation of peroxides. THF has a flammability rating of 3 in accordance with NFPA 704, and is a class 1B flammable liquid.

A solution of THF in water is flammable in concentrations of only 0.3 percent. Escaping vapors can flow along surfaces to distant ignition sources and result in a flashback fire.

THF vapors form an explosive concentration in air between 2.3 and 11.8 percent at 20 °C (68 °F). As a liquid, THF is less dense than water, and THF vapors are heavier than air.

Transportation, handling, and storage precautions for THF urge the exclusion of atmospheric oxygen. THF guidance also suggests that reducing water content from THF or THF mixtures can leave behind high-boiling inhibitors and concentrated peroxides, which increase the possibility of violent explosions. Many incidents associated with the distillations of peroxidizable materials occur when peroxides become concentrated in distillation residue. However, dilution, frequent peroxide testing, and nitrogen flushing reduce the hazards.[7]

Veolia procedures for THF recovery in Unit 4 included safeguards to prevent peroxide formation such as purging with nitrogen, testing for peroxides every two hours, and adding inhibitor as needed. Pure processed THF was stored in a clean tank and could be isolated with valves from the vapor balance line. Under normal operations, the water concentration in Unit 3 could not drop below the azeotrope of 5.3 percent water. Given that the THF was not concentrated beyond the azeotrope during this distillation phase, precautions for peroxide formation were not included in the Unit 3 operating procedure.

3.3 Relief Systems

The U.S. Chemical Safety Board (CSB) concluded that uncontrolled venting allowed vapors to accumulate to explosive concentrations outside process equipment. Relief valves and rupture disks protected equipment in Units 1, 3, and 4 and relieved to the atmosphere. A two-inch pressure/vacuum vent relief device provided protection for "normal breathing" when pressure exceeded 0.5 psig or vacuum exceeded 1.55 mmHg for each tank in the dirty and clean tank farms. This device relieved pressure whenever an unbalanced transfer occurred or brought in ambient air to avoid tank collapse under negative pressure. On the dirty tanks, 18-inch "long-bolt" manways[8] provided emergency venting. The weight of the manway cover kept the opening sealed against the gasket. When pressure developed to lift the cover, the bolts allowed the cover to lift at least 1.5 inches. Both of these relief devices vented directly to the atmosphere.

All relief valves and rupture disks for pressure vessels relieved directly to the atmosphere. Units 3 and 4 rupture disks were oriented upward toward the north while the relief valves vented to the east or the north. Tanks and vessels that suffered the most severe damage were located near the D-14 tank that served as the source of feed to Unit 3. The unit operator blew nitrogen into this tank just prior to the release.

[7] BASF. "Tetrahydrofuran (THF) Storage and Handling," BASF Corporation Chemicals Division, 1998.

[8] A manway is a large opening at the top of the tank to allow access.

4.0 Consequences

4.1 Onsite Damage

Most of the buildings on the site were constructed of steel frames with metal siding. Overpressure damage to these buildings was extensive, most notably to the decant building, located about 75 feet due east of the likely source of the release. Overpressure forces hit the steel frames on the western side of this building with such force that their anchoring tore loose from the foundation and deflected to the east.

The explosion and fire damaged all buildings and operating units at the site. These areas included the administration, drum storage, decant storage, maintenance, and non-hazardous waste processing buildings, and Units 1, 3 and 4, where several dirty tanks were destroyed. The tops of two stainless steel clean tanks also blew off during the incident.

Solvent mixtures spilled from the damaged tanks and pooled under the dirty tanks. Tank legs in the area immediately east of Unit 3 sagged from the intense heat generated by the pool fire that erupted after the flammable vapor ignited. Several tanks appear to have toppled due to the intense heat. When falling over they released material that fueled a pool fire, which extended the burn time of the fire.

The lab/operations building, which is likely the point of origin for the initial ignition of flammable vapor, was also severely damaged. The interior of the structure displayed minimal fire damage based on post-incident inspection; however, the masonry block, drywall, and doors in the boiler room deflected in an outward direction from the center of the room (Figure 4). Walls throughout the structure were similarly oriented outward, including most of the exterior south wall of the lab/operations building. Roof panels above the boiler area blew upward. The north side of the building, directly facing the operating plant, remained intact with the exception of the northeast corner, which was due south of the suspected source of the release (Figure 2).

The Veolia facility has a water storage tank intended for use during a fire, which normally contains about 500,000 gallons of water. Rendered inoperative due to ruptured pipes, the system failed to suppress the fires

Figure 4. Boiler and locker room damage

4.2 Community Damage

The West Carrollton Code Enforcement Officer and company records estimate that about 20 residences sustained damage from the explosion. Residents reported broken windows, bent garage doors, and chimney detachment. The Code Enforcement Officer condemned the garage of one residence. About five neighboring businesses also sustained damage. One local business less than a quarter-mile away suffered extensive damage, including cracked masonry block walls, broken windows, cracked walls, misaligned doors, broken ceiling light fixtures, foundation shift, bent steel framing, and fallen ductwork. Some offices displayed damage, suggesting workers may have been injured had they been present at the time of the explosion. Preliminary estimates, including lost production, property damage, and business disruption, place total costs at about $27 million**.**

Figure 6. Neighboring business office damage

Figure 5. Residential damage

5.0 Emergency Response

The WCFD dispatch center received the first 9-1-1 calls at 12:07 a.m. on Monday, May 4, 2009. Engine and truck companies from the WCFD were the first to respond. Upon arrival, WCFD officers immediately activated the National Incident Command System (NIMS) and assigned roles and responsibilities to manage the incident. All responding jurisdictions were conversant and compliant with NIMS, and all facets of the response were conducted through a multi-jurisdictional Unified Command Structure with no reported logistical, jurisdictional, or communication issues.

Shortly after their arrival, West Carrollton responders directed a request to the Montgomery County Sheriff's Office Foam Bank[9] to help extinguish the fire in the dirty tank area. Based on air sampling and observations, responders did not issue a shelter-in-place during the response to this incident.

Mutual aid response to the incident included:

- Miami Township Fire Department
- Moraine Fire Department
- Miamisburg Fire Department
- Dayton Regional Hazardous Material (HazMat) trailer and foam truck

Other responding agencies included

- U.S. EPA
- Ohio State EPA
- Ohio State Fire Marshal
- Occupational Safety and Health Administration (OSHA)
- U.S. Department of Homeland Security
- Department of Power and Light
- Vectren (gas supplier)
- Jefferson Regional Water

Due to environmental concerns, responders allowed the fires on the Veolia property to burn without applying water because of the proximity of the facility to a nearby creek and the high area water table. Firefighters applied foam at about 10:00 a.m. the next day to extinguish the remaining fires in the dirty tank farm.[10]

The EPA, notified by the National Response Center, deployed a trailer to sample the air around the perimeter of the plant, and found no hazardous concentrations of toxins.

[9] A foam bank is a storage system that maintains a supply of fire-fighting foam intended for use by a network of firefighting agencies.

[10] Ohio State Fire Marshal's Office report.

6.0 OSHA PSM Standard

In a post-incident inspection, OSHA issued citations for numerous violations of the Process Safety Management (PSM)[11] Standard. The OSHA PSM Standard (29 CFR 1910.119) requires employers to prevent or minimize the consequences of catastrophic release of highly hazardous chemicals as well as flammable liquids and gases. Hexane and acetone are listed chemicals, and Unit 4 processed more than the threshold quantity so the PSM standard applied.

The citations alleged that the company failed to conduct compliance audits every three years to ensure that policies and procedures were in place for the handling of flammable liquids. They also cited worker training deficiencies, inadequate testing and inspections of piping and processes, a lack of written standards for operating procedures, maintaining mechanical integrity of equipment, and other items involving process safety.

[11] Process Safety Management is a regulation promulgated by the U.S Occupational Safety and Health Administration (OSHA). A process is any activity or combination of activities including any use, storage, manufacturing, handling or the on-site movement of Highly Hazardous Chemicals (HHCs) as defined by OSHA and the Environmental Protection Agency.

7.0 Findings

7.1 Veolia

- The vent devices were not designed to contain or control hazardous and/or toxic vapor.
- Two natural gas-fired boilers were in service in the lab/operations building at the time of the incident and most likely provided the ignition source.
- The lab/operations building, which housed the source of the ignition, was located about 30 feet south of the operating plant and served as a mixed-use structure, which was occupied primarily by non-essential personnel throughout the day shift.
- The operating plant had an electrical classification of Class 1, Division 1[12] and was compliant with electrical code requirements. However, the lab/operations building was not classified under the National Electrical Code (NFPA 70).
- No record existed of a process hazard analysis (PHA) to evaluate the siting of the lab/operations building so close to the operating units.
- The two most seriously injured workers were in the lab/operations building at the time of incident. While one worker was attempting to mitigate the vapor release in the plant, the second was donning personal protective equipment (PPE) to assist in the effort.

[12] NFPA 70, National Fire Protection Association *National Electric Code* designation for the location and necessary protection of electrical equipment in areas where flammables are likely to exist.

Figure 7. Roof and north wall of lab/operations building and boiler room

8.0 Analysis

8.1 Overpressure Event

The CSB was unable to determine conclusively the cause of the overpressure event due to the extensive damage in the process area. Based on employee observations and the characteristics of the materials being processed, two possible scenarios could have resulted in a release of flammable vapor during the nitrogen blowback process:

- Accumulated THF residue containing peroxides suddenly became active when exposed to oxygen through the vacuum breaker or long-bolt manway.

- The line to the dirty tank was inadvertently mis-manifolded prior to the nitrogen blowback, resulting in the pressurization of a nearby dirty tank containing unprocessed, flammable, or peroxide-containing liquid.

8.2 NFPA

The National Fire Protection Association (NFPA) is an international, nonprofit organization that develops, publishes, and disseminates more than 300 consensus codes and standards intended to minimize the possibility and effects of fire and other similar risks. NFPA also provides research, training, and education and has a membership of over 75,000 individuals around the world.

NFPA codes and standards are widely adopted because they are developed using an open, consensus-based process, in accordance with American National Standards Institute standard development process. Volunteer committee members, with a wide range of professional expertise develop and review all NFPA codes and standards.

Currently, there are no industry standards available to TSDF owners, permitting agencies, and local fire officials to establish safety requirements addressing fire and similar risks. While the NFPA does publish occupancy standards for many industrial facility types (e.g., NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities), there is no standard specific to TSDFs.

NFPA 30, Combustible Liquids Code, applies to the storage, handling, and use of flammable and combustible liquids. As defined by NFPA Section 3.3.6.1, Veolia considered the lab/operations structure an "important building." An important building is an occupied structure where egress within two minutes cannot be reasonably expected, or process control buildings that require skilled personnel for the orderly shutdown of important or hazardous processes.[13]

- Once the unit operator discovered the release, he began efforts to mitigate the leak by approaching shut-off valves located in the plant, but could not because of the overpowering odor of the released material. If the lab/operations building had a centralized shutdown capability and was located farther away from the operating plant, the unit operator would have been

[13] NFPA 30, *Flammable and Combustible Liquids Code*, Annex A.

able to conduct a safe and orderly shutdown of the plant.

NFPA 30, Section 22.4.1.1, guidance for control room location, allows for siting as close as 10 feet to an operating unit processing "stable combustible liquids."

- While Veolia appeared to be compliant with NFPA guidance for stable combustible liquids using Class 1, Division 1 guidance for the operating units, the location of the electrically unclassified lab/operations building less than 30 feet away provided multiple potential ignition sources (including three-fired boilers) for any released material.

8.3 Center for Chemical Process Safety (CCPS)

The Center for Chemical Process Safety (CCPS)is a division/directorate of the American Institute of Chemical Engineers, which is a 501 (c)(3) not for profit educational organization. The organization identifies and addresses process safety needs within the chemical, pharmaceutical, and petroleum industries through the development of best practice guidelines to prevent or mitigate catastrophic chemical releases. The CCPS publication, "Guidelines for Evaluating Process Plant Buildings for External Explosions and Fires," provides guidance for siting buildings in areas processing Class 1B liquids. All criteria listed in an example for Class 1B liquids would have been met by Veolia under the summary statement that "a long and successful operating history exists to support the low explosion potential of NFPA Class 1B flammable liquids when handled under the conditions indicated."[14] These criteria state that explosions are extremely unlikely because:

- Potential for a vapor cloud explosion (VCE) is low due to the inherent properties of Class 1B liquids under storage and release conditions (lack of confinement, congestion, and release of material under low pressure).
  - However, at the West Carrollton facility, considerable congestion and confinement was created by tanks, pumps, and related equipment.
- The material being released has no potential for chemical reactions or for condensed-phase explosions.
  - However, the materials processed at the West Carrollton facility sometimes had the potential for chemical reaction.
- In addressing the fact that the potential for explosions cannot be entirely eliminated, a reliance on alarms and operating procedures along with procedures to minimize potential ignition sources was considered sufficient.
  - However, the electrically unclassified lab/operations building was close enough to the plant to provide the initial source of ignition for the incident.

[14] Center for Chemical Process Safety, Evaluating Process Plant Buildings for External Explosions and Fires, New York, 1996.

9.0 Recommendations

9.1 Veolia ES Technical Solutions

2009-10-I-OH-R1

During the rebuild of the plant, revise policy to restrict occupancy of non-essential personnel in buildings in close proximity to operating plants.

2009-10-I-OH-R2

During the rebuild, design and install a closed relief system and develop a policy for safe venting (e.g., use of a flare) for relief systems to the atmosphere.

2009-10-I-OH-R3

Conduct a process hazard analysis on all OSHA Process Safety Management covered processes to ensure all buildings and structures at the West Carrollton facility are located and designed in accordance with electrical classification and spacing as defined in NFPA 70.

9.2 NFPA

2009-10-I-OH-R4

Revise NFPA 30, Chapter 17, to include a section requiring a written engineering analysis to determine the safe separation distance for occupied buildings, control rooms, and operating areas. The analysis must be acceptable to the authority having jurisdiction.

9.3 Center for Chemical Process Safety (CCPS)

2009-10-I-OH-R5

Revise control room siting guidelines to reflect the diversity of characteristics that Class 1B flammable liquids can exhibit (e.g., heavy vapor, and plant areas that provide congestion and confinement).

9.4 Environmental Technology Council

2009-10-I-OH-R6
(Supersedes 2007·01·I·NC·R2)

Petition the National Fire Protection Association, following the guidelines of their "Codes and Standards Development Process" (www.nfpa.org), to develop an occupancy standard specific to hazardous waste treatment, storage, and disposal facilities. The purpose of the standard would be to prescribe technical requirements for the safety to life and property from fire, explosion, and release; and to minimize the resulting damage from a fire, explosion, and release. At a minimum, but not limited to, the standard should address:

- Hazard Identification
- Chemical Fire and Release Protection and Prevention
- Facility and Systems Design
- Employee Training and Procedures
- Inspection and Maintenance

2009-10-I-OH-R7
(Supersedes 2007·01·I·NC·R3)

Develop and issue standardized guidance for the processing, handling and storage of hazardous waste to reduce the likelihood of fires, explosions, and releases at hazardous waste treatment storage and disposal facilities. Include the incident findings, consequences, conclusions, and recommendations from the CSB investigations of the Environmental Quality facility and the Veolia ES Technical Solutions.

The U.S. Chemical Safety and Hazard Investigation Board (CSB) is an independent Federal agency whose mission is to ensure the safety of workers, the public, and the environment by investigating and preventing chemical incidents. The CSB is a scientific investigative organization; it is not an enforcement or regulatory body. Established by the Clean Air Act Amendments of 1990, the CSB is responsible for determining the root and contributing causes of accidents, issuing safety recommendations, studying chemical safety issues, and evaluating the effectiveness of other government agencies involved in chemical safety.

No part of the conclusions, findings, or recommendations of the CSB relating to any chemical accident may be admitted as evidence or used in any action or suit for damages. See 42 U.S.C. § 7412(r)(6)(G). The CSB makes public its actions and decisions through investigation reports, summary reports, safety bulletins, safety recommendations, case studies, incident digests, special technical publications, and statistical reviews. More information about the CSB is available at www.csb.gov.

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