



## NASA SAFETY CENTER SYSTEM FAILURE CASE STUDY

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# A Loaded Magazine

## The Honolulu Fireworks Disposal Explosion

April 8, 2011, Waipahu, Island of Oahu, Hawaii: Six workers were disassembling imported fireworks seized by federal law enforcement personnel during the previous summer. Without specific safety standards or contract stipulations to guide disposal efforts, the workers used unsafe practices and amassed large quantities of explosive material near tools and in containers that were capable of producing sparks, friction, and static electricity. The explosive material detonated in a mass explosion, killing five workers and injuring one other.

### PROXIMATE CAUSE

- Accumulated explosive material exploded likely from a spark or friction when improper tools and equipment were in close proximity.

### UNDERLYING ISSUES

- Inadequate contractor selection and oversight
- Deficit of industry regulation

### AFTERMATH

- Recommendations to the Department of the Treasury, the prime contractors, the National Fire Protection Association, the U.S. Environmental Protection Agency, and the Bureau of Alcohol, Tobacco, Firearms and Explosives, pertaining to the creation of or modification to regulations to include best practices, guidance, required safety reviews for soliciting organizations and organizations storing, transporting, and disposing of contraband and waste fireworks

### BACKGROUND

#### Contraband Fireworks and Disposal Contract

In the 1970s, increased federal regulation of fireworks manufacturing and lower overseas labor costs gave rise to an increase in firework importation that continued for decades. Fiscal year 2011 U.S. International Trade Commission statistics obtained and published by the American Pyrotechnic Association show that 98 percent of all consumer fireworks and 75 to 80 percent of commercial display fireworks used in the U.S. are manufactured in and imported from China. Moreover, importation of illegal fireworks has also continued to rise, resulting in an increased burden on government agencies to screen, seize, and dispose of contraband fireworks.

Between 2007 and 2010, federal law enforcement agents from the U.S. Customs and Border Protection (CBP) and the U.S.

Immigration and Customs Enforcement Homeland Security Investigations (ICE/HSI) conducted three separate firework seizures in Honolulu, Hawaii. These three shipments, en route from China, were labeled as consumer-grade fireworks; however, the shipments contained fireworks that possessed the physical characteristics of more hazardous display-grade fireworks.

Since both agencies participate in the Treasury Forfeiture Fund, a seized asset distribution service established to disrupt and dismantle criminal enterprises, the shipments were placed under the authority of the VSE Corporation (VSE), the prime federal contractor responsible for locating vendors to transport, store, and/or destroy seized assets. In March 2010, VSE awarded a subcontract

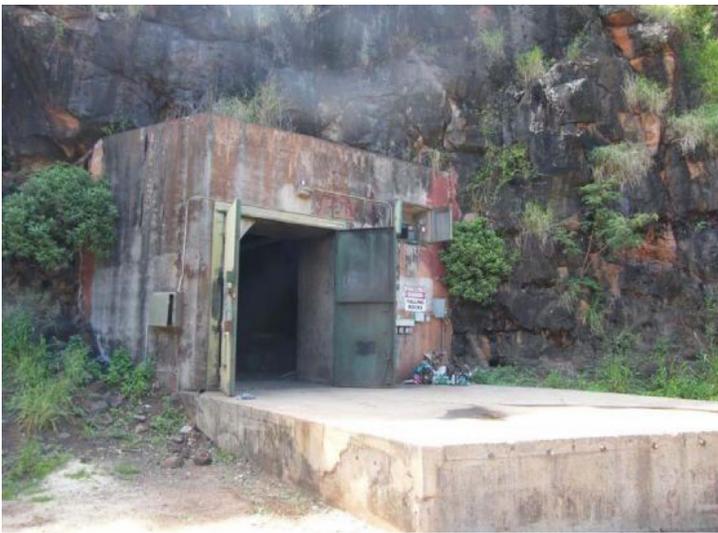


Figure 1. The location of the explosion was the Magazine A-21 at the Waikele Self Storage complex. Source: CSB.

to Oahu-based Donaldson Enterprises, Inc. (DEI) to dispose of the shipments.

DEI provided environmental and Unexploded Ordnance (UXO) mitigation services throughout the Pacific Basin employing fewer than 20 full-time workers with experience in both civilian and military UXO clearance operations. The company was typically hired to determine the presence and extent of UXO in a given environment and also provide escort services to individuals without UXO qualifications. Prior to VSE's contract, DEI's work did not include disposal of fireworks.

## Seized Fireworks

The fireworks involved in the mishap were "cake-type" devices comprising mortar tubes packaged together and designed to fire consecutively. Mortar tubes consist of a black powder lift-charge (typically 75 percent potassium nitrate, 15 percent charcoal, and 10 percent sulfur) and an aerial shell, or cartridge, which contains a pyrotechnic composition. The ignited lift-charge propels the shell into the sky where the shell explodes with bright colors and report.

## DEI Disposal Process

In June 2010, the State of Hawaii Department of Health issued DEI a 90-day emergency hazardous waste permit, authorizing thermal treatment of the shipments at a local shooting range. DEI's thermal treatment involved separating firework tubes from the cakes and soaking them in diesel for 1 to 2 days (to desensitize the material and allow for slow burning) while in storage, and then transporting them to the firing range, and burning them in a 55-gallon drum or portable incinerator (a Thermal Flash Unit).

DEI planned to perform disassembly and soaking activities on the cement loading dock in front of the Waikele Self Storage magazine where the fireworks were stored. These 250-foot-long magazines were built during WWII and were used for U.S. Navy munitions storage.

While disposing of the first shipment during summer 2010, DEI experienced minor explosions while burning the fireworks, even

after diesel soaking for 1 week, and altered its process, opting to disassemble the tubes and separate the explosive components. DEI personnel slit the aerial shells with box cutters to improve diesel penetration during soaking. The black powder was collected in plastic containers lined with plastic garbage bags and stored at the back of the magazine in lieu of disposal. VSE was aware of this change, but expressed no concern. The permit did not evaluate or address fireworks disassembly or diesel soaking and DEI had no plan to dispose of the black powder. The initial shipment was destroyed by December 2010 without incident.

DEI began work on the next shipment in December 2010, once again altering its process in early 2011 to expedite the rate of disposal by separating the powder and shells into boxes and storing them in the magazine while simultaneously soaking batches of shells. Specifically, DEI workers took three boxes of fireworks at a time from the magazine and disassembled them back into three repurposed firework boxes: one box contained scrap cardboard tubes and packaging, one box contained the aerial shells, and one box was lined with a plastic garbage bag and contained the black powder. Garbage bag linings full of black powder were periodically relocated from firework boxes to plastic containers and stored near the middle of the magazine. When DEI workers had finished disassembling three boxes of fireworks, they took the boxes of components to the magazine for storage and pulled three more boxes for disassembly. Once again, VSE was aware of the change, but expressed no concern.

After reviewing DEI records and interviewing witnesses (after the incident), the Chemical Safety Board (CSB) investigators determined that the amount of unpackaged and accumulated explosive materials DEI placed in a single container scaled the explosive potential by 456 times the potential of the materials in their original packaging.

## WHAT HAPPENED

On the morning of April 8, 2011, five workers were cutting 1-inch firework tubes and separating the explosive components while a sixth worker cleaned and stacked boxes of disassembled components inside the magazine. The contractors were able to disassemble six to seven boxes of fireworks before it began



Figure 2. DEI workers disassembling firework mortar tubes and separating the contents. Source: CSB.

to rain. DEI workers quickly moved tools, chairs, boxes of shells, black powder, and partially disassembled fireworks into the entrance of the magazine. Five of the workers stayed inside the magazine while the project supervisor walked outside onto the loading dock to make a phone call. Seconds later, at approximately 8:50 a.m. Hawaii-Aleutian Standard Time, an explosion and fire occurred inside the magazine.

The five workers inside the magazine did not survive—three sustained fatal burn injuries and two succumbed to carbon monoxide poisoning. The supervisor sustained minor injuries.

The third shipment awaiting disposal was also located in the same magazine; however, it was farther back in the magazine and remained undamaged.

## PROXIMATE CAUSE

The CSB investigation's final report determined that changes in DEI's fireworks disposal process resulted in the accumulation of a large quantity of explosive components just inside the magazine entrance, creating the essential elements for a mass explosion and deflagration. DEI's hazard analysis of its fireworks disposal process was insufficient. DEI failed to identify key hazards of handling, disassembling, and storing explosive material, and did not adequately control the identified and evaluated hazards. DEI personnel disposing of the fireworks lacked the training, experience, and knowledge of procedural safeguards for the safe conduct of the fireworks disposal.

The CSB, along with the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) and the Hawaii Occupational Safety and Health Division, identified a number of possible ignition sources in the magazine at the time of the incident, including sparking tools, a metal hand truck, a rolling office chair, and plastic bags capable of producing static discharge that likely struck or sparked on loose explosive material that had fallen on the magazine floor.

## UNDERLYING ISSUES

DEI introduced significant hazards to its fireworks disposal process without adequately identifying or effectively controlling those hazards. They were able to do so because federal contractor selection and safety oversight requirements for hazardous activities were insufficient and a significant gap existed in regulatory and industry standards pertaining to fireworks disposal.

### Inadequate Contractor Selection and Oversight

VSE's procurement office selected DEI as the fireworks disposal subcontractor because DEI submitted the lowest-cost and most time-efficient bid. Additionally, the company was already storing the three shipments of seized fireworks under a separate contract with VSE during the selection process. VSE procurement personnel were unaware that DEI



Figure 3. Aerial shells in a plastic container awaiting diesel soaking. Source: CSB.

had no prior fireworks disposal experience when it awarded the subcontract and did not have personnel with the technical background or expertise to properly select and oversee subcontractors performing work with hazardous materials such as fireworks. Further, VSE did not consult with or hire anyone with firework disposal expertise, or confirm that DEI had any expertise with firework disposal.

VSE's procurement office conducted a non-technical review of DEI that did not address health and safety. According to the CSB, the contractor deferred to the subcontractor as the expert in fireworks disposal and was unaware of the hazards of disassembly, accumulation of explosive material, and poor storage practices.

### Deficit of Industry Regulation

Federal contractor selection regulations did not require VSE procurement personnel to conduct safety related review of DEI prior to awarding the company the subcontract. Although DEI provided a brief document presenting a hazard review of its fireworks disposal activities when awarded the subcontract, this analysis did not consider the safety implications of cutting into the fireworks and accumulating their explosive components.

The CSB found that DEI would have greatly benefitted from Process Safety Management (PSM) or Management of Change (MOC), which would have required a safety review of disposal activities and the changes to them. But, because the Occupational Safety and Health Administration (OSHA) PSM standard does not apply to activities conducted under the umbrella of fireworks disposal (only fireworks manufacturing), DEI was not required to conduct a robust Process Hazard Analysis, which would have helped in identifying, evaluating, and controlling the hazards involved in its fireworks disposal activities or a formal MOC analysis when it modified its processes.

Neither the Federal Acquisition Regulation, nor the Department of the Treasury Acquisition Regulation supplement, impose sufficient requirements for safe practices and subcontractor selection and oversight with respect to the unique hazards associated with handling, storing, and disposing of hazardous materials.

The CSB found a lack of regulations or industry standards that adequately address safe fireworks disposal. Federal or local codes, regulations, or industry standards do not establish safety requirements, provide guidance on proper ways to dispose of fireworks, or address the hazards associated with the disassembly of fireworks and the accumulation of explosive components.

Emergency hazardous waste disposal permits are granted in Hawaii and throughout the country to entities seeking to dispose of seized contraband fireworks because they are considered an imminent threat to human health and the environment. However, the Resource Conservation and Recovery Act does not incorporate PSM-type elements in its hazardous waste permitting process, despite the extremely hazardous nature of the materials covered by these permits. DEI's 90-day hazardous waste permit actually expired on September 5, 2010, before the first shipment was destroyed. Although the permit lapsed, the CSB determined that DEI's failure to renew the permit was not causal to the incident.

## AFTERMATH

Historically, U.S. Military Explosive Ordnance Disposal (EOD) technicians assisted in the disposal of fireworks confiscated by local and federal law enforcement. However, on July 29, 1980, an explosion and fire involving contraband fireworks disposal killed three EOD technicians leading the military to halt the storage, transport, or disposal of contraband fireworks, shifting all disposal activities to permitted commercial entities and law enforcement agencies.

The CSB recommends that government acquisition regulations must emphasize safety system management to improve the selection of commercial contractors. Federal agencies, such as the Treasury, that require contractors to deal with explosives and hazardous materials should adopt stringent safety and oversight provisions such as those in the Defense Federal Acquisition Regulation Supplement.

As a result of this investigation, the CSB made several recommendations to the Federal Acquisition Regulatory Council, the Department of the Treasury Office of the Procurement Executive, Treasury Executive Office for Asset Forfeiture, VSE Corporation, the National Fire Protection Association, the U.S. Environmental Protection Agency, and the ATF.

The recommendations pertain to the creation of or modification to existing regulations to include best practices, guidance, and required safety reviews for soliciting organizations

and organizations storing, transporting, and disposing of contraband and waste fireworks.

## RELEVANCE TO NASA

In March 2013, the Office of the Inspector General (IG) released its Review of NASA's Explosives Safety Program. The review drew attention to violations at four NASA Centers. Some of these violations included the storage of incompatible energetic material together, the storage of explosives at a facility not originally designed to house energetic material, and the storage of decomposing and potentially highly unstable energetic materials. The IG found that in addition to a lack of resources, a lack of oversight and training were the primary contributing factors to the violations.

NASA has technical standards and procedures that govern the use and handling of energetic and hazardous material. The Agency is working through a series of actions to correct the deficiencies found by the IG. It is imperative that the Centers work together to share expertise, training, and lessons learned.

Additionally, as old projects and programs end, it is imperative that we remove any remaining energetic material not needed for NASA work. Furthermore, it is vital that personnel identify lapses in correct storage and handling processes and procedures and establish means of mitigation. By doing so, they will help NASA Centers and Facilities protect their operations, their fellow NASA personnel, and the public.

## REFERENCES

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Review of NASA's Explosives Safety Program. National Aeronautics and Space Administration. Office of Inspector General. March 27, 2013.

## SYSTEM FAILURE CASE STUDY



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Thanks to Sandra Hudson for her contribution to this study.

This is an internal NASA safety awareness training document based on information available in the public domain. The findings, proximate causes, and contributing factors identified in this case study do not necessarily represent those of the Agency. Sections of this case study were derived from multiple sources listed under References. Any misrepresentation or improper use of source material is unintentional.

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