

Louisiana Hazardous Substances Emergency Events Surveillance (LaHSEES) System

**Acute releases of hazardous substances related to Hurricanes
Katrina and Rita**

**Louisiana Department of Health and Hospitals
Office of Public Health
Section of Environmental Epidemiology & Toxicology**



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INTRODUCTION

Located along the Gulf Coast, Louisiana has traditionally been a center of commerce and trade. It is home to a diverse group of industries including petrochemical production, commercial fishing, tourism, shipbuilding, production of minerals, forestry, the production of wood products such as paper and plywood, agriculture, and general manufacturing. Louisiana ranks second in the United States for petroleum refining capacity with eighteen active refineries representing 16.9% of the total U.S capacity [1]. Louisiana also manufactures one-quarter of the countries petrochemicals, and ranks third in the nation in production of natural gas and fourth in the nation in the production of crude oil [1,2].

Louisiana's geographic location in the Gulf Coast puts these assets at risk. This risk was internationally realized on August 29, 2005 when Hurricane Katrina hit Southeast Louisiana as a Category 3 hurricane and then again on September 24, 2005 when Hurricane Rita came ashore in Southwestern Louisiana as a Category 3 hurricane [3,4].

Hurricane Katrina breached the levees of the city of New Orleans, rapidly flooding the city to depths greater than 11.5 feet in certain areas [5]. Because New Orleans is below sea level, water had to be pumped out of the city, taking this highly industrialized, urban area 43 days to be “unwatered” by the U.S. Army Corps of Engineers. As of the writing of this document, over 1,464 people were confirmed dead [6].

Before making landfall, Hurricane Rita skirted the Louisiana coastline causing additional flooding to the southeastern coastal communities already impacted by the surge from Hurricane Katrina. The approach of Hurricane Rita generated one of the largest evacuations in U.S. history. After making landfall, the storm surge of Hurricane Rita devastated entire communities in coastal areas of southwestern Louisiana. Seven fatalities were directly attributed to the forces of Rita with another 55 fatalities indirectly reported [4].

Thousands of homes and businesses throughout southern Louisiana were damaged or destroyed due to these two hurricanes. One of Louisiana's top industries, oil and gas, was greatly affected by both hurricanes due to evacuations, flooded refineries, damaged platforms, and crippled pipelines. Orphan drums of unknown origin and content were found scattered throughout Louisiana's coastal communities. To date, 4,652,523 hazardous waste containers were collected and 17,952,138 pounds of hazardous waste were disposed [7]. These unprecedented hurricanes resulted in many unintended chemical releases. However, due to the severity of these storms and their impact on the infrastructure of the affected communities, many releases went unreported.

The magnitude of these natural disasters reinforced the need for greater preparation to secure the chemical infrastructure of Louisiana and the Gulf Coast against potential natural disasters and terrorist events. Louisiana Hazardous Substances Emergency Events Surveillance (LaHSEES) data were analyzed to describe the characteristics of releases associated with Hurricanes Katrina and Rita.

METHODS

Since 1990, the Agency for Toxic Substances and Disease Registry (ATSDR) has maintained an active, state-based HSEES system to describe the public health consequences of acute releases of hazardous substances. The Louisiana Department of Health and Hospitals, Office of Public Health, Center for Environmental Health Services, Section of Environmental Epidemiology and Toxicology has participated in this surveillance system since 2001. A HSEES event is defined as an uncontrolled or illegal acute release of a hazardous substance (excluding petroleum, when petroleum is the only substance released). Releases of any amount of a substance listed on the HSEES Mandatory Chemical Reporting List are recorded. Substances not on the mandatory list are included if a chemical release involves amounts greater than or equal to 10 lbs or 1 gallon. Threatening releases of qualifying amounts are included if the threat leads to an action (e.g., evacuation) to protect the public's health. Petroleum-only releases are not included because of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) legislation. [Note: The Petroleum Exclusion clause of CERCLA

excludes any form of petroleum that has not been refined to the point of becoming single-chemical product].

Various data sources were used to obtain information about these events. These sources included the Louisiana Department of Public Safety and Corrections, Office of State Police, the Louisiana Department of Environmental Quality (LDEQ), the U.S. Coast Guard National Response Center, and the U.S. Department of Transportation Hazardous Materials Incident Reporting System (HMIS). Census data were used to estimate the number of residents in the vicinity of most of the events. All data were computerized using a web-based data entry system provided by ATSDR. Information collected for each event included the location, substance(s) released, victims, evacuations, industry involved in the event, and contributing factors for the event.

HSEES defines victims as people who experience at least one documented adverse health effect within 24 hours after the event or who die as a consequence of the event. The HSEES system collects data on the root factor and the immediate contributing factor of an event. The 2002 North American Industry Classification System (NAICS) was used to categorize industries.

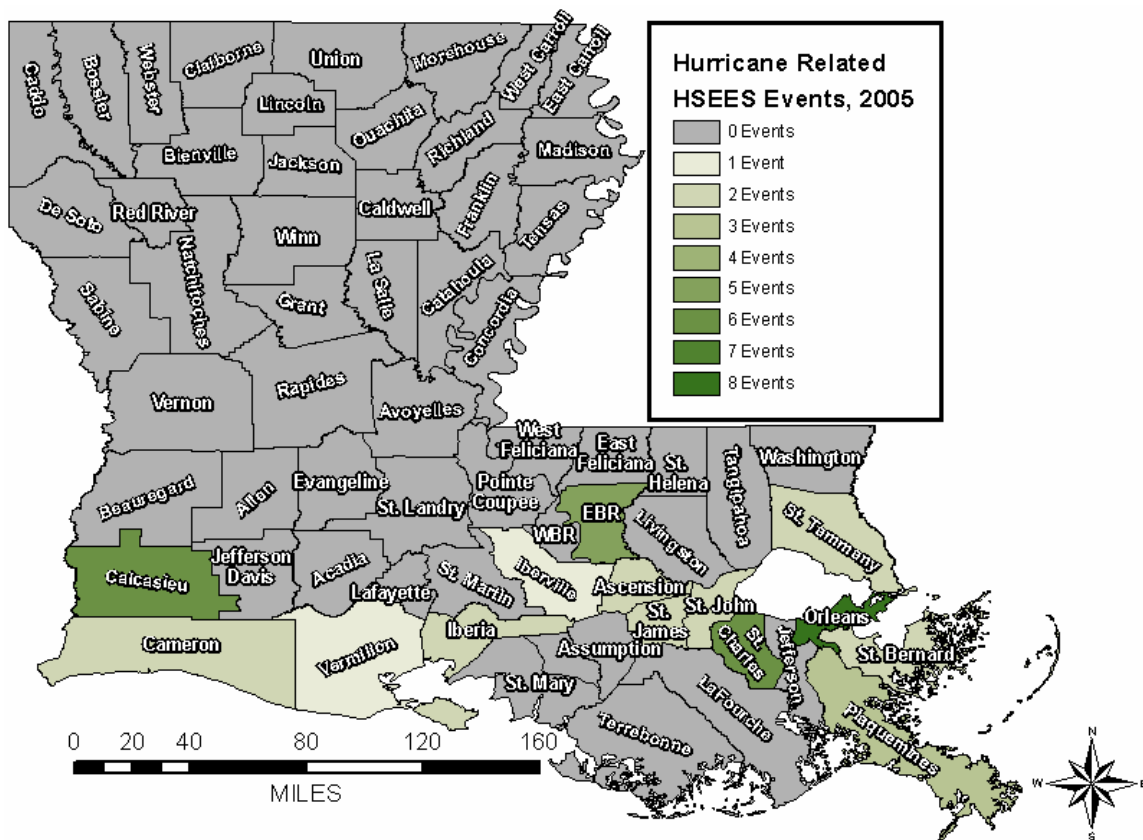
For data analyses, the substance(s) released were categorized into 13 groups. The category “mixture” comprises substances from different categories that were mixed or formed from a reaction before the event; the category “other inorganic substances” comprises all inorganic substances except acids, bases, ammonia, and chlorine; and the category “other” comprises substances that could not be grouped into one of the other existing categories.

Louisiana HSEES 2005 data were analyzed to describe the characteristics of events associated with Hurricanes Katrina and Rita. Events were identified as hurricane-related based on the date of occurrence and incident reports.

RESULTS

Louisiana HSEES screened over 500 reports related to Hurricanes Katrina and Rita from August through December 2005. Forty-four of those hurricane-related events, representing 5.1% of all 2005 HSEES events in Louisiana, met the HSEES surveillance definition. Thirty (68.2%) events were related to Hurricane Katrina, 13 (29.5%) to Hurricane Rita, and one (2.3%) to both hurricanes. The parishes with the most events were Orleans (8 [18.2%]), Calcasieu (6 [13.6%]), and St. Charles (6 [13.6%]) (Figure 1).

Figure 1-Distribution of hurricane related events- Louisiana Hazardous Substances Emergency Events Surveillance, 2005.



Industries

The largest proportion of hurricane related events was associated with the manufacturing (29 [65.9%]) industry (Table 1). Within manufacturing, chemical manufacturing (21 [72.4%]) accounted for most of the events followed by petroleum manufacturing (7 [24.1%]) and soft drink manufacturing (1 [3.4%]).

Table 1.-Industries involved in hurricane-related acute hazardous substance events, by category- Louisiana Hazardous Substances Emergency Events Surveillance, 2005

Industry Category	Number	%
Construction	1	2.3
Manufacturing	29	65.9
Mining	4	9.1
Public Administration	2	4.5
Retail trade	1	2.3
Utilities	1	2.3
Wholesale trade	3	6.8
Not an industry	1	2.3
Not Identified	2	4.5
Total	44	100.0

For industrial related events (mining, utilities, construction, and manufacturing), one or two choices could be selected to describe the type of area where the event occurred or the equipment involved with the event. Of the 35 industrial related events, 30 (88.6%) reported one type of area, 3 (8.6%) reported a combination of two area types, and the area was not recorded for one (2.9%) event. The areas reported most often were ancillary process equipment (13 [38.2%]) and storage areas above ground (12 [35.3%]) (Table 2). Most of the events reported as ancillary process equipment involved releases from a flare stack.

Table 2-Areas involved in hurricane-related industrial events - Louisiana Hazardous Substances Emergency Events Surveillance, 2005.

Area Involved	Number	%*
Ancillary process equipment	13	38.2
Storage area above ground	12	35.3
Process vessel	5	14.7
Piping	5	14.7
Incinerator	1	2.9
Heating/cooling for building	1	2.9
Total	37	108.8

*Percentage total greater than 100% because multiple areas could be reported per event.

There were nine hurricane-related events that were not industrial related; 3 (33.3%) were associated with wholesale trade, 2 (22.2%) with public administration, 1 (11.1%) with retail trade, and 3 (33.3%) were either not an industry or the industry was unknown. Events associated with both retail and wholesale trade involved the release of chemicals from hurricane damaged buildings. In two events, 125 gallons of hydrochloric acid and 900 pounds of calcium hypochlorite, respectively, were swept from industrial machinery and equipment merchant wholesalers by Hurricane Rita flood waters. In a third event, flood water dissolved and dispersed pool chemicals inside a chemical and allied products merchant wholesaler warehouse. In a similar event at a garden center/farm supply retail store, pesticides mixed with ammonium nitrate in the flood damaged building produced a strong odor. The fire department responded to secure the release.

Contributing Factors

Root and immediate contributing factors were reported for each event. The most common root factors for hurricane-related events were bad weather (29 [65.9%]) and intentional (8 [18.2%]) (Table 3). The most common immediate contributing factors were system start up or shutdown (9 [20.5%]) and power failure (6 [13.6%]). Of the 9 events where system start up or shutdown was an immediate contributing factor, 6 (66.7%) were shutdowns in preparation for Hurricane Katrina, 1 (11.1%) was a shutdown in preparation for Hurricane Rita, and 2 (22.2%) were start ups after Hurricane Rita.

Table 3-Root and immediate contributing factors in hurricane-related events, Louisiana Hazardous Substances Emergency Events Surveillance, 2005.

Root factors	Number	%
Bad weather conditions	29	65.9
Equipment failure	3	6.8
Human error	4	9.1
Intentional	8	18.2
Total	44	100.0
Immediate factors	Number	%
Equipment failure	4	9.1
Fire	2	4.5
Human error	1	2.3
No secondary factor	17	38.6
Power failure	6	13.6
System start up/shut down	9	20.5
System/process upset	4	9.1
Unknown	1	2.3
Total	44	100

Substances

A total of 79 substances were released in 44 hurricane-related events, of which 3 (3.8%) substances were reported as threatened to be released. The number of chemicals released per event ranged from 1 to 8, but, in most events, only one chemical (n=30, 68.2%) was released. Substances were grouped into 13 categories. The substance categories most commonly released these events were volatile organic compounds (32 [40.5%]) and other inorganic substances (20 [25.3%]) (Table 4). The most frequently released individual chemical was sulfur dioxide (6 [7.6%]) (Table 5). Most releases were air releases (70.9%); 24.1% were spills, 3.8% were threatened to be released, and 1.3% involved both an air release and a fire. The amount of chemicals released ranged from less than one pound to 187,531 pounds. The majority (32.1%) of releases were between 10-99 pounds. The amount released was missing for 26 (32.9%) chemicals.

Table 4-Category of chemicals released in hurricane-related events, Louisiana Hazardous Substances Emergency Events Surveillance, 2005.

Chemical category	Number	%
Acids	4	5.1
Ammonia	4	5.1
Bases	1	1.3
Chlorine	1	1.3
Hetero-organics	1	1.3
Hydrocarbons	3	3.8
Mixture	2	2.5
Other inorganic substances	20	25.3
Other	5	6.3
Oxy-organics	3	3.8
Pesticides	1	1.3
Polymers	2	2.5
VOCs	32	40.5
Total*	79	100.1

*Percentages do not total 100% due to rounding

Table 5-Individual chemicals released in 4 or more hurricane-related events, Louisiana Hazardous Substances Emergency Events Surveillance, 2005.

Chemical	Number	%
Sulfur Dioxide	6	7.6
Ammonia	4	5.1
Asbestos	4	5.1
Benzene	4	5.1
Ethylene	4	5.1
Nitrogen Oxide*	4	5.1

*Includes nitrogen oxide, nitrogen oxides, oxides of nitrogen

Response, evacuations

One category of responder was reported for most (39 [88.6%]) events; 11.4% (n=5) reported 2 or more categories of personnel who responded, 6.8% (n=3) reported 3 or more categories, and 4.5% (n=2) reported 4 categories. The most frequent personnel responding to events was the company's response team (20 [45.5%]) followed by fire departments (5 [11.4%]) (Table 6). No one responded in 16 (36.4%) events.

Environmental sampling was conducted in 5 (11.4%) events.

Table 6-Distribution of personnel who responded to hurricane-related events, Louisiana Hazardous Substances Emergency Events Surveillance, 2005.

Responder Category	Number	%*
Certified Hazmat team	3	6.8
Company response team	20	45.5
Department of Public Works/transportation	1	2.3
Environmental Agency	2	4.5
Fire department	5	11.4
Law Enforcement	3	6.8
No responder	16	36.4
Poison Control Center	1	2.3
Third party cleanup contractor	3	6.8

*Percentages total greater than 100% because multiple responder categories could be reported per event

In one event, a fire broke out in a sulfur dioxide storage tank at a copper ore mining facility damaged by hurricane Katrina. The company response team, fire department, law enforcement, and the department of works responded to assist in fire suppression and minimize the release. Less than five employees were at the facility when the fire broke out, all of whom evacuated for approximately 2 hours. In another event, a certified HazMat team, a law enforcement agency, a fire department, and an environmental agency all responded to a leaking drum displaced by Hurricane Katrina. A member of the recovery team was injured in this event.

Areas Impacted

In six industrial events, the substance(s) released extended beyond the facility. In one event, 10 pounds of nitrogen oxide and 500 pounds of sulfur dioxide were released during the shutdown of a petroleum refinery in preparation of Hurricane Katrina. In another event, 270 pounds of ammonia and 75 pounds of nitrogen oxides were released from a chemical product and preparation manufacturer when the ammonia storage tank routed to the flare due to a shutdown of the compressors. The facility had been evacuated due to Hurricane Katrina. An oil and gas support operation released 759 pounds of zinc bromide from storage tanks that were washed away from the facility during Hurricane Katrina. Power failure at a nitrogen fertilizer manufacturer resulted in the loss of refrigeration to ammonia storage tanks causing the release of ammonia to the flare.

Hurricane Rita caused a power outage at a nitrogen fertilizer manufacturer resulting in the plant tripping offline and the loss of key monitoring equipment. The flare on the ammonia tank was blown out from the high winds contributing to the release of 789 pounds of ammonia. Power failure at an alkalis and chlorine manufacturing plant due to Hurricane Rita caused excess pressure on a chlorine storage tank. One thousand eighty-two pounds of chlorine was manually vented from the storage tank to reduce pressure and protect the tank integrity.

Victims

Seven victims were reported in 2 events. In one event responders were recovering an orphan drum displaced by Hurricane Katrina containing a mixture of hydrocarbons, hydrogen sulfide, and water. One of the responders began to feel nauseous and was transported to a hospital for observation. It is unknown whether or not the responder wore proper personal protective equipment (PPE) or if proper PPE was worn and failed. In another event, six career firefighters were sleeping in a camper overnight after assisting with Hurricane Katrina-related recovery operations. A neighboring camper had the exhaust from a generator routed underneath their camper exposing the firefighters to carbon monoxide. All 6 experienced a combination of symptoms such as nausea, dizziness, and headache and were admitted to a hospital for treatment.

DISCUSSION

A total of 44 hurricane-related events were recorded by LaHSEES in 2005; 30 were attributed to Hurricane Katrina, 13 to Hurricane Rita, and 1 to both hurricanes. Due to the severity of these storms, many releases went unreported as communications were limited throughout the state. Most (75.0%) hurricane-related events that were captured by LaHSEES occurred in industrial settings (manufacturing and mining industries). The immediate contributing factor reported most frequently for these events was system start up or shutdown (20.5%). Most releases were air releases (70.9%), and volatile organic compounds (40.5%) was the category of chemicals most frequently released. There were 7 victims reported in 2 hurricane-related events. The majority of businesses, facilities,

and homes were evacuated before the hurricanes which may have led to fewer injuries associated with these events.

Approximately one-quarter of the events were caused when shutting down or starting up major processes at manufacturing facilities due to hurricanes Katrina and Rita. Shutting down and starting up these complex industrial processes require a high level of care and attention beyond normal operations due to the numerous activities occurring simultaneously and many automatic systems being put under manual control [8]. In the wake of the 2005 hurricane season, the U.S Chemical and Safety and Hazard Investigation Board (CSB) issued a safety bulletin for oil and chemical facilities to take special safety precautions during startups [9]. CSB recommends that facilities should establish, maintain, and update startup procedures and checklists and carefully perform pre-startup safety reviews. More specifically, facilities should have adequate staffing and expertise before starting up, and evacuate nonessential personnel from the vicinity of process units that are starting up. CSB also recommends that all process equipment should be thoroughly evaluated prior to startup. Storage tanks and pressure vessels should be evaluated for evidence of floating, displacement, or damage. Sewers, drains, piping, furnace systems, electric motors, switchgear, conduit and emergency equipment should be evaluated for trapped floodwater and/or debris.

Given that several releases involved power outages, improved backup power systems could prevent future releases [10]. Other recommendations include storing dry chemicals off the floor in a dry room that is protected from flooding, securing equipment and piping to withstand high winds, and properly labeling all bulk storage tanks to aid in identification should they be moved by wind or flood water [11].

To prevent injuries when responding to a disaster-related release, it is important for all responders to follow safety practices including wearing proper protective equipment. Portable generators are commonly used during cleanup and recovery after disasters such as hurricanes; however, if not properly ventilated, they can cause negative health effects.

Portable generators should not be used indoors; near doors, windows or vents; and should have 3 to 4 feet of space on all sides for ventilation [12].

Business and industries in Louisiana, especially those in coastal communities should 1) assess the potential hazards of acute chemical releases during disasters, 2) design and maintain safe facilities, and 3) take steps to prevent and minimize acute chemical releases during future hurricanes. Responders should take special precautions including wearing appropriate PPE when responding to acute chemical releases after major disasters. Properly preparing for hurricanes and the worst-case scenario aftermath could help prevent chemical release and associated injuries.

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