Graniteville, SC

Train Derailment and Chlorine Release: Lessons Learned

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SC Department of Health and Environmental Control
Graniteville Derailment

- Overview of the Incident
- Response Issues
- Lessons Learned
- Questions
Moment of impact

At 2:39 a.m. Thursday, Norfolk Southern 192 crashed head on into a locomotive and two cars on a siding in Graniteville. Nine people, including the engineer, have died from exposure to chlorine gas.

Stationary train
A local crew (engineer, conductor and brakeman) parked a locomotive and two cars on a siding near the Avondale Mills Stevens Steam plant and went off duty at about 7 p.m. Wednesday.

Impact
Routed by the switch to the spur line, Norfolk Southern 192 plowed head on into the stationary train. Just before the crash, officials say, the engineer applied the train’s emergency brake. Fourteen cars derailed and a chlorine tanker ruptured, releasing a deadly cloud of gas.

Switch
NTSB officials investigating the crash say the rail switch was locked into the position which directs trains to the siding.

Trapped
Two automobiles were demolished after derailed freight cars brought down trees on top of them. One injured driver crawled from his vehicle to safety; the other driver remained trapped in her car for two hours until authorities rescued her.

Norfolk Southern 192
Early Thursday, a train consisting of two locomotives and 42 cars leaves Augusta bound for Columbia. Among the cars are three tankers filled with 270 tons of pressurized liquid chlorine.

The cargo on Norfolk Southern 192

<table>
<thead>
<tr>
<th>Locomotives</th>
<th>Boxcars and tankers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressurized liquid chlorine</td>
<td>Sodium Hydroxide</td>
</tr>
</tbody>
</table>

Sources: The Augusta Chronicle research
Initial Incident Timeline

January 6, 2005
- 2:39 AM – Derailment
- 3:50 AM – Notification to DHEC Spill Hotline by Railroad
- 4:05 AM – DHEC ERT Notified/Dispatched
- 4:12 AM – National Response Center Report #746298
- 4:24 AM – DHEC Media Relations Dispatched
- 4:35 AM – USEPA Responding
- 5:30 AM – Aiken County EOC Activated
- 6:42 AM – Reverse 911 Call to Community
- 8:00 AM – State EOC Activated
- 11:00 AM – FEMA ROC Activated
- 12:00 PM – Governor’s Executive Order Declared an Emergency
Train

- 2 locomotives
- 42 Railcars
- Total 2553 ft
- Total 3521 tons

- 14 Cars Derailed
  - 3 Chlorine
  - 1 Sodium Hydroxide
  - 2 Kaolin
  - 3 Particle Board
  - 3 Coiled Steel
  - 2 Empty
Contents Concerns

- Chlorine
  - Released from Railcar #9
  - Railcar Capacity 17,400 gallons (~90 tons)
  - Approximately 60%-70% of contents released
- Sodium Hydroxide
- Kaolin
- Cresol
- Diesel fuel
Chlorine

- 2.47 Vapor Density
- -29.3°F Boiling Point
- 10 ppm IDLH
- Odor Threshold 0.06-3.5 ppm (varies by source)
- 11.48eV Ionization Potential
- 450-500:1 Expansion Ratio (Liquid-Gas)
- Contact escaping compressed liquid can cause frostbite and/or chemical burns to the eyes and skin
- Strong Oxidizer
- Extremely Water Soluble
- Non-Persistent
### Chlorine Concentration Effects

<table>
<thead>
<tr>
<th>Concentration (ppm)</th>
<th>Effect Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2-3.5 ppm</td>
<td>Odor detection (some tolerance develops)</td>
</tr>
<tr>
<td>1-3 ppm</td>
<td>Mild mucous membrane irritation that can be tolerated for up to 1 hour</td>
</tr>
<tr>
<td>3 ppm</td>
<td>Extremely irritating to the eyes and respiratory tract</td>
</tr>
<tr>
<td>5 ppm</td>
<td>Severe irritation of eyes, nose, and respiratory tract; intolerable after a few minutes</td>
</tr>
<tr>
<td>14-21 ppm</td>
<td>Immediate irritation of the throat; Dangerous if exposed for 30-60 minutes</td>
</tr>
<tr>
<td>15 ppm</td>
<td>Irritation of the throat</td>
</tr>
<tr>
<td>30 ppm</td>
<td>Moderate irritation of the upper respiratory tract; Immediate chest pain, vomiting, dyspnea, cough</td>
</tr>
<tr>
<td>35-50 ppm</td>
<td>Lethal in 60-90 minutes</td>
</tr>
<tr>
<td>40-60 ppm</td>
<td>Toxic pneumonitis and acute lung injury; dangerous for even short periods</td>
</tr>
<tr>
<td>430 ppm</td>
<td>Lethal over 30 minutes</td>
</tr>
<tr>
<td>1,000 ppm</td>
<td>Fatal within a few minutes</td>
</tr>
</tbody>
</table>

Source: MEDITEXT ® - Medical Management

Promoting and protecting the health of the public and the environment
Evacuation

- 1 Mile Radius
- Approx 5400 Residents
- Curfew Between 1 and 2 Mile Radius
- Lasted up to 14 days
Human Health Issues

- Decontamination
- Transport and Treatment
- Rapid Epidemiological Assessment
- Follow-Up Investigations
- Community Health Assessment
## Patients Treated at Emergency Departments within 24 Hours

<table>
<thead>
<tr>
<th>Facility (n=263)</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aiken Regional Medical Center</td>
<td>109</td>
<td>(41)</td>
</tr>
<tr>
<td>Other SC hospitals</td>
<td>8</td>
<td>(3)</td>
</tr>
<tr>
<td>Augusta, GA hospitals</td>
<td>146</td>
<td>(56)</td>
</tr>
</tbody>
</table>
## Method of Transport to Medical Facility – First 24 Hours

<table>
<thead>
<tr>
<th>Method of transport (n=150)</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Privately owned vehicle</td>
<td>94</td>
<td>(63)</td>
</tr>
<tr>
<td>Emergency medical services</td>
<td>51</td>
<td>(34)</td>
</tr>
<tr>
<td>Other (police, company vehicle)</td>
<td>5</td>
<td>(3)</td>
</tr>
</tbody>
</table>
### Exposure Categories

<table>
<thead>
<tr>
<th>Category (n=292)</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = No known exposure</td>
<td>27</td>
<td>9</td>
</tr>
<tr>
<td>2 = Mild exposure</td>
<td>120</td>
<td>41</td>
</tr>
<tr>
<td>3 = Moderate exposure</td>
<td>67</td>
<td>23</td>
</tr>
<tr>
<td>4 = Severe exposure</td>
<td>36</td>
<td>12</td>
</tr>
<tr>
<td>5 = Extreme exposure</td>
<td>42</td>
<td>14</td>
</tr>
</tbody>
</table>

**Low**

**High**
<table>
<thead>
<tr>
<th>Category (n=435)</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = Deceased</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>2 = Ventilator/ICU/3+ nights</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>3 = Hospitalized 3+ nights</td>
<td>27</td>
<td>6</td>
</tr>
<tr>
<td>4 = Hospitalized 1-2 nights</td>
<td>29</td>
<td>7</td>
</tr>
<tr>
<td>5 = ED repeat visits</td>
<td>69</td>
<td>16</td>
</tr>
<tr>
<td>6 = ED w/ significant Sx</td>
<td>67</td>
<td>15</td>
</tr>
<tr>
<td>7 = ED w/ moderate Sx</td>
<td>121</td>
<td>28</td>
</tr>
<tr>
<td>8 = ED w/o Sx</td>
<td>61</td>
<td>14</td>
</tr>
<tr>
<td>9 = Physician office visit(s)</td>
<td>37</td>
<td>9</td>
</tr>
</tbody>
</table>
Follow-up Investigations

- Secondary Mailed Survey
- DHEC Graniteville Train Wreck Registry
- Graniteville Community Health Assessments
Graniteville Community Health Assessments

- Performed at local area churches and a clinic
- Included:
  - assent/consent
  - vital signs
  - medical/exposure history
  - physical exam
  - collection of exhaled breath condensates
  - pulmonary function testing
  - psycho-social morbidity screens
  - clinical and psychological consultation
  - subsequent methacholine challenge test at Aiken Regional Hospital in medically eligible
Graniteville Community Health Assessments

- 260 people received a free health assessment
- >60 received methacholine challenge testing
- Have detected patients with RADS, PTSD, and other illnesses that have required clinical follow-up
Animal Issues

❖ Pets
  ❖ Feeding
  ❖ Retrieval
❖ Wildlife
Owners called in on three dedicated phone lines, filled out information, and for indoor animals, delivered keys for teams to retrieve pets.
Retrieval teams reached owners by phone and arranged pick-up at the staging area.

Animals were unloaded and held at the staging area until owners arrived to reclaim. Animals were given a brief exam by local veterinarians.

Total of several hundred animals were retrieved and returned to owners.

More than 30 animals were either retrieved dead or died or were euthanized at local veterinary hospitals.

More than 30 animals were treated for symptoms consistent with chlorine exposure.
Reported Impact to Pets

- Dogs: 7 died, 10 sick, 2 missing
- Cats: 10 died, 1 missing
- Fish: died in 2 aquariums and 1 stream/pond
- Rabbit: 1 sick
- Rooster: 1 died
- Frog: 1 died
Unified Command

- Command Post
  - Honda Cars of Aiken
  - The “Old K-Mart” Parking Lot
    - Command Post Vehicles
  - Leased the “Antique Mall”
- Brought together reps from various agencies to coordinate the incident and prioritize activities
- DHEC EQC maintained 24-hour presence for 10 days and daytime presence for the duration
Clean-Up and Remediation

Emergency Phase Plan included:

• Recovery of tank car inventories
• Removal of diesel affected soils and asphalt
• Removal of kaolin clay
• Removal of chlorine impacted soils
• Removal and disposal of debris and cross ties
• Removal and disposal of dead animals
Breached Chlorine Car
Patched Car
Chemical Transfers

- Jan 9 – Temporary patch
- Jan 10-12 – Liquid transfers
- Jan 12 – Permanent patch on leaking car
- Jan 13 – Re-occupation begins
- Jan 19 – Product transfer complete
Wastes

- Crossties and rails
- Locomotives and railcars
- Approx 120 tons Kaolin
- Approx 260 tons steel coils
- 3000 gallons diesel
- 16 loads diesel contaminated soil
Water Sampling

- Baseline data for Horse Creek routinely collected on 1/5/05
- Total residual chlorine increased
- pH lowered
- Horse Creek neared baseline by 1/10/05
Re-Occupation

- Gradual reoccupation of evacuation areas allowed
- Transitioned areas over multiple days
- Control points allowed residents into areas
- Roadblocks kept residents out of areas still evacuated
Re-Occupation

- Fliers handed out at town meetings, at traffic control points, by community liaisons, and building samplers
- Instructed residents on some precautions to take when returning home
- Coordination of multiple agencies
Re-Occupation-Building Sampling

Mission:
- Sample buildings to ensure no chlorine or hydrochloric acid or vapor present.

Composition:
- 1 Contractor
- 1 Government
- Building Codes Inspectors
Re-Occupation - Community Outreach Liaisons

Mission:
- Talk to residents and explain what has happened, home inspection procedures, answer questions, and provide assistance.

Composition:
- DHEC EQC Regional staff

Promoting and protecting the health of the public and the environment
Impacts

- 9 Deaths
- 569 Hospital ER Visits
  - 72 Hospitalized
- Norfolk-Southern estimated $40M in claims
- Avondale Mills
  - Reported $52.5M clean-up costs in FY2005
  - 6 of 7 mills in Graniteville to close (1650 workers)
- Cities around the country prohibiting trains carrying hazmat in their jurisdiction
NTSB Report

Recommendations:

• Require RR to install device to convey position of the switch along main lines in non-signaled areas
• Require trains to operate at speeds where they can be stopped in advance of misaligned switch
• Position tank cars to rear of train and reducing speed in populated areas
• Provide escape masks to train workers
Lessons Learned Summary

- Need info immediately
- Don’t rush in without PPE
- Warning to public must be timely
- Shelter-in-place vs Evacuation
- Establish Unified Command early
- Unified Command needs a common workspace
Lessons Learned Summary

- Start logistics early
- Constant reevaluation of incident
- Activities must be prioritized and coordinated among agencies (IAP)
- Develop communications plan early
- Regional cooperation among states
- Consider non-traditional responders
Lessons Learned Summary

- Make responders visible to community
- Control access to incident scene
- Law Enforcement (Traffic/Crowd Control, Curfew Enforcement, Insurance Fraud)
- PPE must be available
- Brief news media early and often
- Involvement of elected officials
Lessons Learned Summary

- GIS played a major role
- DHS’s Pre-positioned Equipment Program
- Rejection of Presidential Disaster Declaration
- Consider animal issues
- Consider reoccupation needs of public
- Develop demobilization plan/exit strategy
Questions