



## National Transportation Safety Board

Office of Railroad, Pipeline, and Hazardous Materials Investigations  
Human Performance and Survival Factors Division  
Washington, DC. 20594

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### Survival Factors<sup>1</sup> Factual Report

28 Sept 2005

*Collision of Norfolk Southern Train 192P005 with unoccupied Norfolk Southern Train P22005,  
and Subsequent Hazardous Materials Release,  
in Graniteville, SC, on January 6, 2005*

NTSB Accident Number: DCA 05 MR 008

Compiled by:           // s //           Date:   09/28/2005  .

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<sup>1</sup> The Survival Factors Factual Report exclusively addresses the emergency preparedness and response, and railroad equipment crashworthiness elements of the investigation.

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Note – Photographs compiled during the investigation by the Survival Factors Working Group will be forthcoming in a separate Addendum to the Survival Factors Factual Report.

#### Select acronym nomenclature used in this report

AAR	Association of American Railroads <sup>2</sup>
BP	barometric pressure
Cl <sub>2</sub>	chlorine
EOC	Emergency Operations Center
EST	eastern standard time
ft	feet
GVWFD	Graniteville, Vaucluse, and Warrenville Volunteer Fire Department
Hazmat	hazardous materials
HP	Horsepower
hr	hour
IAFC	International Association of Fire Chiefs <sup>3</sup>
IC	Incident Command
in. Hg	inches of mercury [barometric]
mi	mile (statutory)
MP	milepost [railroad]
mph	miles per hour [velocity]
NS	Norfolk Southern Railway
NaOH	sodium hydroxide (commonly known as “caustic soda” or “lye”)
NFPA	National Fire Protection Association <sup>4</sup>
POV	personally owned vehicle
recon	reconnaissance
RH	relative humidity
SCBA	self contained breathing apparatus
USCA	University of South Carolina [Campus] at Aiken

<sup>2</sup> a nonprofit industry trade association comprised of railroad operators (see Internet: <http://www.aar.org/>)

<sup>3</sup> a nonprofit [professional] organization comprised of chief fire and emergency officers (see Internet: <http://204.2.107.138/home/index.asp>)

<sup>4</sup> an international nonprofit organization, which produces and advocating scientifically-based consensus codes and standards, many of which have been adopted as a required safety standard by various municipal and jurisdictional authorities (see Internet: <http://www.nfpa.org>)

**A. Accident Reference Information**

NTSB Accident Number:	DCA 04 MR 010
Location:	Graniteville, South Carolina
Date:	January 6, 2005
Type of Incident:	Collision
Railroad Property:	Norfolk Southern Railway Company (NS)

**B. Synopsis**

About 2:39 a.m. EST, on January 6, 2005, northbound Norfolk Southern Railway (NS) freight train 192P005 derailed after encountering an open switch and colliding with a parked train on an industrial track, in Graniteville, South Carolina. The train was in NS non-signaled track warrant territory with a timetable speed of 49 mph. The 42-car train, consisting of two locomotives, 25 loads and 17 empties, with a crew of an engineer and a conductor, originated in Macon, Georgia, and was destined for Columbia, South Carolina.

About 7 hours before the accident, a local NS train, P22005, had used the switch, which is near milepost (MP) 178.2, to enter an industrial track at that location. After servicing a local industry, the crew secured their train and departed the area around 7:00 p.m. The crew was transported by a van to their home terminal, where they cleared their track warrant at 7:53 p.m. No other trains had used the main track from the time the local train was parked in the industrial track until the arrival of the accident train. The engineer of NS train 192P005 initiated an emergency application of the brakes as his train neared the switch and the industrial track. While in emergency braking, the train diverted through the open switch and onto the sidetrack, where it struck the parked local train locomotive. The two locomotives and the first 16 cars from train 192P005 derailed. The locomotive and one of the two cars of train P22005 also derailed. Included in the derailment of train 192P005 were three cars of chlorine and one car of sodium hydroxide. A breach of a tank car of chlorine, the 9<sup>th</sup> car behind the locomotives, resulted in a release of chlorine gas (a hazardous substance). This prompted an evacuation of about 5,400 people within a one-mile radius of the site, which continued for at least 7 days. The NS engineer and eight other people were fatally injured by the inhalation of chlorine. The NS conductor and approximately 550 other people, and 5 firefighters, were transported to local hospitals with respiratory difficulties, with 75 of those persons admitted for treatment.

This accident received regional and national news media attention. Board Member Hersman accompanied the investigative team. Parties to the investigation include the Federal Railroad Administration, Norfolk Southern Railway, the Brotherhood of Locomotive Engineers and Trainman, the United Transportation Union, General American Transportation, Union Tank Car Company, Trinity Industries, Olin Chemical, the Graniteville, Vacluse, and Warrenville Volunteer Fire Department of Graniteville, SC, and the Aiken County [SC] Sheriff's Office.

## C. Survival Factors -- Working Group Participants

### Group Chairperson

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<sup>5</sup> Parent company of Norfolk Southern Railway Company

## D. Facts of the Investigation

### 1.0 Railroad Operations - Summary Overview

#### 1.1 Railroad Owner<sup>6</sup>

The owner and operator of the trains involved in this accident is the Norfolk Southern Railway Company (NS). The NS operates approximately 21,300 route miles of track (38,235 total track miles operated) in 22 eastern states, the District of Columbia and Ontario, Canada. The NS owns and/or leases 3,755 locomotives and 100,229 freight cars<sup>7</sup>, and has operating rights on other railroads<sup>8</sup>.

A schematic map, illustrating the NS Railway system, is provided in Exhibit 1.

#### 1.2 Train Locomotive Owner / Operator

The locomotives of both trains involved in the accident were owned by the NS, and were operated by crewmembers employed by the NS.

### 2.0 Accident Site

The accident occurred on industry-owned industrial track<sup>9</sup> proximate to its junction with the NS mainline track<sup>10</sup>. The NS mainline track in that proximity is a single-track route, on the R Line of the Piedmont Division<sup>11</sup>. Additional information on the accident site locality is as follows.

#### 2.1 Locale General Description

##### 2.1.1 Municipality

The accident occurred on NS track within the unincorporated community of Graniteville<sup>12</sup>, South Carolina, which is located in Aiken County (see § 2.1.3). Graniteville is about 4.5 miles west of the commercial retail district<sup>13</sup> of the City of Aiken, SC, and is about 9.8 miles northeast of the commercial retail district of the City of Augusta, Georgia. The mainline track right-of-way in this vicinity traverses through the center of the community (as further described in this report;

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<sup>6</sup> Source [information as of 21 April 2005], and for further information: Internet: <http://www.nscorp.com/nscorp/index.jsp>, and other sources, as noted.

<sup>7</sup> Source: Internet: [http://www.nscorp.com/nscorp/application?pageid=About%20NS&category=About%20NS&contentId=english/nscorp/about\\_ns/corporate\\_profile.html](http://www.nscorp.com/nscorp/application?pageid=About%20NS&category=About%20NS&contentId=english/nscorp/about_ns/corporate_profile.html)

<sup>8</sup> a common Agreement in railroading, under what is referred to as an “overhead trackage rights” agreement, whereby a railroad owning track allows another railroad the right to operate its trains on that track.

<sup>9</sup> known as the “Avondale Mills / Gregg Industry plant” industrial track.

<sup>10</sup> NS advises that pursuant to the industrial trackage agreement of 1924, NS owns only up to the clearance point of that trackage, which is about 150 feet from the switch, and that the industry owns the track beyond that point.

<sup>11</sup> the industrial track is referenced in NS Railway map and timetable documentation as being located at Milepost 178.3 on the R Line of the Piedmont Division

<sup>12</sup> “New Hope” is identified in local maps as a locale proximate to Graniteville, although the local residents consider the locality identity to be Graniteville.

<sup>13</sup> as clarification, the City limit [statutory boundary] of Aiken is about 2 miles from the accident site



see § 2.1.2), with the community located in a somewhat mixed rural and suburban area of western South Carolina.

As a general observation, proximate to the accident site, residential properties are located to the east of the mainline track right-of-way, and a small commercial retail district is located adjacent to the trackage right-of-way to the north<sup>14</sup>. Proximate to the accident site, and situated parallel and immediately adjacent to the mainline trackage right-of-way, are two principal north / south roadway thoroughfares (Canal Street and Trolleyline Road) that traverse the community.

Proximate to the accident site are several moderate- to large-size industrial plant facilities, which maintain somewhat of a continuous 24 hr / day – 7 day / week operation, which are situated to the west of the trackage right-of-way and extending in a northerly direction. The identified plant facilities include the Avondale Mills / Woodhead Division, Avondale Mills / Hickman Division, Avondale Mills / Gregg Division, and the Avondale Mills / Stevens Steam Plant, all of which are affiliated to textile products production<sup>15</sup>. An industrial track (the site where the accident occurred), which diverges from the mainline track, services these industrial facilities, as further described in this report. Access (for emergency services vehicles) to the accident site was afforded by a number of paved roadways within the municipality. In proximity to the accident site, several municipal streets, that utilize roadway grade crossings, traverse both the mainline track and the industrial trackage right-of-way. No highway vehicles traversing any of the roadway grade crossings proximate to the accident site were involved in this accident<sup>16</sup>.

### 2.1.2 Topographical<sup>17</sup>

The community of Graniteville is located within a shallow valley that encompasses a stream, known as Horse Creek, which also somewhat parallels the mainline trackage right-of-way to the west by approximately 1000 ft. Horse Creek flows [downstream] toward the south, with the terrain generally gaining elevation to the east and to the west of the Horse Creek streambed. The Horse Creek streambed directly west of the accident site is at an elevation of about 190 ft (above sea level). The mainline trackage right-of-way proximate to the accident site is geographically oriented in an approximate north / south (compass) direction, with the mainline trackage identified as tangent proximate to the accident site. The mainline trackage proximate to the accident site is at an elevation of about 225 ft [above sea level], which increases in elevation (moderately) progressing in a northerly direction. The industrial trackage, proximate to the accident site, is at an elevation of about 225 ft at the southern end, and decreases in elevation (moderately) progressing in a northerly direction.

Two maps of the accident site and vicinity are provided in Exhibit 2.

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<sup>14</sup> located about 1000 ft due north of the collision site

<sup>15</sup> see also § 7.6.4

<sup>16</sup> an automobile, containing a male driver, was found proximate to the Canal Street grade crossing, which had wedged beneath branches of a toppled tree (which apparently had been struck by the derailed wreckage). The investigation identified that the vehicle became wedged beneath the tree as a result of a post-event motor vehicle accident (the driver was attempting to flee the area, when, in darkness and in the dense haze of released Cl<sub>2</sub> gas, he inadvertently drove the vehicle into the toppled tree); the driver was subsequently rescued by emergency responders.

<sup>17</sup> Source: Aiken County Planning & Development, GIS Mapping Division. Internet >>  
<http://www.aikencountysc.gov/DspDept.cfm?qDeptID=PND> (and for further information)

Additional detail information on the track and railroad right-of-way is provided in the Track Group - Factual Report for this investigation.

### 2.1.3 Aiken County<sup>18</sup>

The Aiken County seat is located in the City of Aiken, which adjoins the community of Graniteville to the east by a distance of about two miles<sup>19</sup>. Aiken County is governed by the County Council, which is comprised of an elected-at-large Council Chairman and eight members elected from single-member districts. Services for Aiken County constituents are provided for by the various departments (“Offices”) of the County Government, which, for emergency services, include the Aiken County Sheriff’s Office, and Aiken County Emergency Services. The component Divisions of the Emergency Services department include the Emergency Medical Service (EMS”), Emergency Management, and the Hazmat Team, as further described in this report.

## 2.2 Industrial Track Description

The accident occurred on the “Avondale Mills / Gregg Industry plant” industrial track, between the Canal Street grade crossing and the Hickman Street grade crossing, as further described below.

The industrial track diverges from the mainline track at a track turnout<sup>20</sup>, which is located near NS milepost 178.2. Upon departing from the mainline track at the turnout, the industrial track immediately traverses Canal Street<sup>21</sup> at a roadway at-grade crossing<sup>22</sup> and progresses in a northwesterly direction. The industrial track then traverses Hickman Street at a roadway at-grade crossing<sup>23</sup>, and then progresses in a northwesterly direction toward several industries (and additional track turnouts). The distance of the industrial track<sup>24</sup>, between the Canal Street roadway grade crossing (edge of pavement) and the Hickman Street roadway grade crossing (edge of pavement), measured about 328 ft<sup>25</sup>.

### 2.3 Meteorological<sup>26</sup>

The weather [at the nearest reporting station<sup>27</sup>] at the time of the accident<sup>28</sup> was reported as darkness, dry (no active precipitation), clear sky, with a visibility of 8 mi, wind from the

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<sup>18</sup> Source: Internet >> <http://www.aikencountysc.gov/> (and for further information)

<sup>19</sup> as clarification, the Aiken City limit [statutory boundary] is about 2 miles from the accident site, whereas the downtown area of the City of Aiken is located about 4.5 miles from Graniteville.

<sup>20</sup> a No. 10 turnout switch (ref Track Group Factual Report).

<sup>21</sup> a paved municipal street; ref provided as a location landmark only.

<sup>22</sup> protected by ‘passive warning devices’ (railroad “cross buck” devices); ref provided as a location landmark only.

<sup>23</sup> a paved municipal street not protected by active warning devices; ref provided as a location landmark only.

<sup>24</sup> as measured along the track [alignment centerline] datum

<sup>25</sup> ref Track Group Factual Report.

<sup>26</sup> Source (except sunrise data): NOAA -Record of Climatological Observations [weather data archive] for station site “Daniel Field Airport”, located at Augusta, GA [lat/lon: 33°28’N / 82°02’W], for Jan. 6, 2005 at 01:53 hrs, ASOS, station ref WBAN ID # 13837 [Internet: <http://nndc.noaa.gov/?http://ols.ncdc.noaa.gov/cgi-bin/nndc/buyOL-001.cgi>]. Note – the data contained a notation that this weather station shared its data with “Bush Field” (Augusta).

southwest (230° true) at 6.9 mph, a ground level atmospheric temperature of 59 °F, a RH of 93%, and a BP of 29.56 in. Hg. Sunrise was reported<sup>29</sup> to occur at 7:32 a.m.

### 3.0 Railroad Equipment - Summary

#### 3.1 Train Consist Configurations<sup>30</sup>

The two trains involved in this accident, consisting of NS train 192P005, which was moving northbound on the mainline track at the time of the accident, and NS train P22005, which had been left standing<sup>31</sup> (in the industrial track) and unoccupied at the time of the accident, were configured as described in Exhibit 3.

Additional information detail on the train consist description is provided in the Mechanical Group - Factual Report for this investigation.

#### 3.2 Locomotives

The trains involved in this accident were powered by diesel-electric locomotive units, with all of the locomotive units operating at the leading end of the train consists, and all locomotives were operating with their operating cabs positioned at the leading ends<sup>32</sup> of the train<sup>33</sup>. Additional information detail on these locomotive units is as further described in this report (below).

Additional detail information on the locomotive equipment (summarized below) is provided in the Mechanical Group - Factual Report for this investigation.

##### 3.2.1 NS Train 192P005

The two locomotives of NS train 192P005 were arranged according to the configuration (in train Consist sequence) as provided in Exhibit 4.

Summary information for the leading locomotive of this train Consist, which was the only occupied locomotive of this train, is provided in Exhibit 5.

##### 3.2.2 NS Train P22005

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<sup>27</sup> the reporting NOAA [weather] station is about 19 miles southwest of Aiken, SC, which was the station identified to be nearest to the accident site with recorded data available (via Internet).

<sup>28</sup> the accident reportedly occurred at about 02:39 hrs; review of the NOAA [weather] data tabulation indicated the data recorded at 01:53 hrs was very close to the data recorded at 02:53 hrs.

<sup>29</sup> Source: U.S. Naval Observatory / Astronomical Applications Dep't. Internet >>  
[http://aa.usno.navy.mil/data/docs/RS\\_OneDay.html](http://aa.usno.navy.mil/data/docs/RS_OneDay.html)

<sup>30</sup> Source: Mechanical Group - Factual Report for this investigation

<sup>31</sup> a commonly used expression might describe this train as being “parked” at that location, although NS prefers that the term “left standing” (or a version thereof) be used to describe the condition of the train.

<sup>32</sup> note – forward and aft directional references cited in this report are relative to the normal [forward] direction of travel of the specific equipment being described.

<sup>33</sup> i.e. the locomotive was operating with its short-hood (cowl) in the forward position.

The locomotive of NS train P22005, which was the only locomotive of this train consist and was unoccupied at the time of the accident, was arranged according to the configuration (in train consist sequence) as provided in Exhibit 6.

Summary information for the locomotive of this train is provided in Exhibit 7.

### 3.3 Railcars Involved in the Collision

#### 3.3.1 Railcars of NS Train P22005

NS train P22005 contained two railcars, both of which were empty. A brief summary description of the railcars of this train is provided in Exhibit 8.

#### 3.3.2 Derailed Hazmat Content Railcars of NS Train 192P005

Railcars in this train that were transporting cargo classified as a hazardous substance, which were involved in the derailment and wreckage pileup, that are significant to the Survival Factors investigation, are summarized below.

##### a. Non-pressurized Tank Car

A non-pressurized tank car, identified as GATX 58326, transporting liquid NaOH, which was located as the 8<sup>th</sup> railcar behind the two locomotives of this train consist, was severely dented and part of the (encapsulating) thermal insulation jacket detached from the tank, but the railcar did not release its product during the derailment.

##### b. Breached Pressurized Tank Car

A pressurized tank car, identified as UTLX 900270, transporting liquid Cl<sub>2</sub>, which was located as the 9<sup>th</sup> railcar behind the two locomotives of this train consist, was breached as a result of the collision and derailment, which subsequently released a substantial portion of its cargo. The liquid Cl<sub>2</sub>, which is toxic by inhalation<sup>34</sup>, became a vapor upon release from the railcar. At atmospheric pressure (upon release from a railcar), liquid Cl<sub>2</sub> becomes a low-lying, 'relatively heavy', vapor cloud. The released Cl<sub>2</sub> gas then engulfed the area proximate to the wreckage pileup in a concentrated Cl<sub>2</sub> vapor cloud, as further described in this report (see § 7.0, et seq.).

##### c. Other Railroad Cars Transporting Hazmat Content

Three railroad freight cars, which were transporting Hazmat cargo, which were located as the 6<sup>th</sup>, 7<sup>th</sup> and 16<sup>th</sup> railcars, respectively, behind the two locomotives of this train consist, were involved in the derailment and wreckage pileup, but did not release their cargo content.

A brief summary of the [above described] derailed railcars in this train is provided in Exhibit 9.

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<sup>34</sup> Ref MSDS for Chlorine: "... toxic by inhalation " and "... [Cl<sub>2</sub> vapors] are much heavier than air, and tend to settle in low [lying] areas". See the Hazardous Materials Group Factual Report for addition MSDS information.

Additional information detail on specific aspects of the Cl<sub>2</sub> gas release, and information on the other [above described] Hazmat content railcars is provided in the Hazardous Materials Group - Factual Report, and mechanical inspection information on same is provided in the Mechanical Group - Factual Report for this investigation.

#### 4.0 Examination of the Accident Site

The local emergency responders (fire / rescue, police and related emergency response agencies), railroad officials, and Hazmat mitigation contractors reported to the investigation they had been at the scene since the onset of the emergency response, and remained there until the hazardous gas release was mitigated. Local responding authorities indicated that their access to the site for search and rescue, response assessment, fire suppression, or re-railing operations had been precluded for a period of time because of the continuing Cl<sub>2</sub> gas release.

The observations of a (pre-recovery, and post-recovery) site inspection are summarized as follows.

##### 4.1 Pre-Recovery / Accident Site Configuration

Because of the continuing Cl<sub>2</sub> gas release, access by the Survival Factors Working Group to the accident site was precluded for a period of time until the gas release had been mitigated. A cursory inspection of the north section of the accident site, proximate to where the locomotives (both trains) came to rest, was conducted by the Survival Factors Working Group Chairperson about 4.5 days post-event (see § 5.1). Emergency response authorities indicated that further site inspection would need to be postponed until the scene was sufficiently stabilized.

Until a further site inspection could be conducted, information on key elements of the accident site and wreckage pileup was attained from other sources (principally emergency response authorities) at the scene and subsequent, which is summarized as follows.

##### 4.1.1 Railroad Trackage Right-of-Way

Examination of the trackage right-of-way proximate to the collision and derailment site, and adjacent soil areas, indicated it had been substantially disturbed as a result of the equipment recovery efforts. The investigation was unable to identify derailment ground contact markings and/or striations on the trackage right-of-way, such to support a meaningful reconstruction of the event.

##### 4.1.2 Identified Approximate Point of Collision

The accident occurred on the “Avondale Mills / Gregg Industry plant” industrial track, between the Canal Street and the Hickman Street grade crossings<sup>35</sup>. No evidentiary artifacts were

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<sup>35</sup> as further described in this report; see also § 2.2

identified along the track or right-of-way in that area to be consistent with evidence suggesting a likely approximate point of collision<sup>36</sup>.

The point of collision would have been the pre-impact location of the leading end (front) of the [standing] locomotive of NS train P22005, the exact location of which was not *definitively* identified by the investigation. An *approximate* pre-impact location of the [standing] locomotive was identified, however, as further described (below).

Information provided by the crew<sup>37</sup> of Train P22005 indicated that they had placed the [front of the] train “about five railcar lengths” to the north of the industrial track turnout<sup>38</sup>. The distance of the industrial track<sup>39</sup>, between the Canal Street and the Hickman Street pavement edges, was found to be about 328 ft<sup>40</sup>. Train P22005 was found to have a total length<sup>41</sup> of about 172 ft.

In consideration of the [standing train] crew testimony, the known distance of the industrial track [between Canal Street and Hickman Street pavement edges; 328 ft], the known length of the standing train [172 ft], and other documentation examined in the investigation<sup>42</sup>, allowing a 50 ft clearance aft of the train<sup>43</sup> (to the Hickman Street pavement edge<sup>44</sup>), the location datum of the front end of the standing train locomotive was estimated by the investigation<sup>45</sup> to be approximately 106 ft north of the Canal Street pavement edge, which also is about 222 ft south of the Hickman Street pavement edge<sup>46</sup>.

As a further landmark reference for the location of the standing train, based upon the estimated distance between the front end of the standing train locomotive and the Canal Street pavement edge [106 ft], and the measured distance between the switch-stand<sup>47</sup> of the industrial track turnout and the Canal Street pavement edge (which the investigation identified<sup>48</sup> to be about 236

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<sup>36</sup> by the time NTSB staff was granted access to this location (four days post-event, due to the on-going Cl<sub>2</sub> [toxic] gas release which precluded site access), the track and right-of-way had been substantially disturbed by the environmental remediation and equipment recovery contractors.

<sup>37</sup> ref. crew interview testimony cited in the Operations Group Factual Report

<sup>38</sup> the “five railcar length” dimension is recognized as being somewhat subjective, as a specific relative landmark of the turnout was not cited (e.g. the switch-points / switch-stand, frog, clearance point, etc.)

<sup>39</sup> as measured along the track [alignment centerline] datum

<sup>40</sup> as further described in this report; see also § 2.2

<sup>41</sup> ref.: locomotive length, 59.2 ft [see Exhibit 7] + total length of the two railcars, 112.3 ft [see Exhibit 8] = 171.5 ft

<sup>42</sup> track distance dimensional measurements as identified in the Track Group Factual Report, and aerial photographs provided to the investigation.

<sup>43</sup> the 50 ft dimension is recognized as being somewhat subjective, although it is also considered somewhat reasonable in view of observed current railcar-placement practice (such to allow for line-of-sight visibility at the grade-crossing by roadway motorist).

<sup>44</sup> where blockage of this roadway by a train likely would have impeded motor vehicle traffic, which also likely would have been witnessed and possibly prompted complaints (which was not noted in the investigation as being reported to local authorities or the railroad).

<sup>45</sup> through simple arithmetic calculation

<sup>46</sup> the location identification cited in this report is subject to a reasonable distance tolerance, to allow for the lack of evidence to support a more definitive location identification.

<sup>47</sup> as a basic description, a switch-stand is the mechanical device incorporated within a turnout, and typically located adjacent to the switch points, that contains the mechanism that controls the movement of the switch points from a position of normal alignment to alignment toward the direction of the turnout. (ref. Track Cyclopedia, 9<sup>th</sup> Ed., Simmons Boardman Publishing Co., Omaha, NE, 1978)

<sup>48</sup> ref – the track distance measurement for this dimension (Track Group Factual Report)

ft), the location datum of the front end of the standing locomotive was estimated by the investigation to be about 342 ft to the north of the switch-stand of the industrial track turnout. This 342 ft dimension reference is also consistent with the testimony of the crew of the standing train.

#### 4.1.3 Wreckage Distribution of the Derailed Railroad Equipment

Wreckage and debris of the derailed railroad equipment came to rest proximate to the industrial track turnout (switch), and also extended in a northerly direction along the industrial track for more than 500 ft. Detailed documentation of the wreckage distribution could not be performed by the Survival Factors Working Group prior to its removal (from its original orientation) because access to the site was precluded by the continuing potential of a hazardous gas release and wreckage cleanup efforts. For a wreckage distribution determination, the Survival Factors Working Group instead relied upon aerial photographs<sup>49</sup>, as supplied by various sources, to document the scene. NS representatives also provided a site sketch to the investigation, although a comparison with aerial photographs indicates that the sketch is not an accurate portrayal of the wreckage distribution<sup>50</sup>.

#### 4.1.4 Locomotive Relative Positions

The distance separating Locomotive 6653 and Locomotive 4622 was measured to be about 72 ft. Additional locomotive location information was identified (as further described in this report; see § 5.1).

### 4.2 Post-Recovery / Accident Site Examination

A post-recovery examination of the accident site was not conducted by the Survival Factors Working Group personnel due to a site-access prohibition resulting from mitigation of the hazardous gas release that had not been completed by the time the Survival Factors Working Group had completed its on-scene activities<sup>51</sup>.

## 5.0 Examination of the Railroad Equipment

The observations of a (pre-recovery, and post-recovery) equipment examination are summarized as follows.

### 5.1 Pre-Recovery / Equipment Examination

As occurred in the pre-recovery site inspection effort, because of the continuing Cl<sub>2</sub> gas release, access by the Survival Factors Working Group to the railroad equipment was precluded for a

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<sup>49</sup> Survival Factors Working Group photographs are available in a separate Factual Report (Addendum).

<sup>50</sup> It should be noted that the purpose of the site sketch, which was a 'freehand' effort (performed at the scene under somewhat adverse conditions), was to provide a general orientation of the wreckage pileup for on-scene utilization / reference, which was not intended to be a fully accurate portrayal of the wreckage configuration.

<sup>51</sup> Safety Board staff does not have the luxury of time to remain on-scene indefinitely in order to complete examination efforts that can only be performed when mitigation of the hazardous gas release is complete and the site is safe to inhabit.

period of time until the hazardous gas release had been mitigated to the extent that allowed a reasonably safe inspection. Upon mitigation of the gas release, a cursory pre-recovery examination of select pieces of railroad equipment was conducted (to the extent possible<sup>52, 53</sup>) by the Survival Factors Working Group personnel about 4.5 days post-event. Attempts at mitigation of the hazardous gas release had abated at that time (with the leak having been successfully stemmed), and preparations were underway for equipment recovery and site cleanup. The observations of that examination are summarized as follows.

#### 5.1.1 NS Locomotive # 6653

Exterior photo-documentation was performed, and (select) exterior approximate dimensional measurements were recorded. Significant observations in the inspection are summarized as follows.

##### a. Exterior

- Locomotive unit was derailed, resting upright, and positioned somewhat longitudinally aligned with the track.
- Locomotive unit was resting approximately in a level orientation in the longitudinal horizontal axis, and listing approximately 12° to the right (i.e. leaning to the east) in the transverse horizontal axis.
- Front end of the unit was located an estimated 77 ft south of the Hickman Street pavement edge (as measured along the industrial track), and was resting about 4 ft to the east of the track [alignment centerline] datum.
- Obvious severe impact damage sustained to the front end of the unit, with the front coupler, pilot plate structure and stepwell elements were severely mangled, with the various components bent and displaced in an upward and aft direction by about 2 ft.
- Obvious severe impact damage sustained to the front carbody cowl [short hood], which was displaced in an aft direction by about 2 ft.
- Neither truck assembly was separated from the under-frame.
- Aft end pilot plate structure – no visible damage apparent.
- Except for the front impact damage (as described), the balance of the carbody of this unit did not exhibit substantial visible collision damage.
- There was no visible evidence of a Diesel fuel spill beneath the fuel tank.
- No visible evidence apparent of fire damage to the unit.
- No visible evidentiary artifacts of personal trauma were apparent on the outside of the unit.

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<sup>52</sup> The on-going threat of an unanticipated hazardous gas release from the nearby wreckage pileup required that the equipment examination be conducted by Safety Board staff that was protected by (i.e. fully contained within) Level C personal protective equipment, which somewhat impeded an efficient and thorough examination process.

<sup>53</sup> As access to the site was not permitted by Hazmat mitigation authorities until nearly 4:00 pm, with sunset approaching, sufficient time was not available for the Survival Factors Working Group to conduct an inspection of the locomotive cabs, which was deferred, in anticipation to be performed during a post-recovery examination.



- NS locomotive 6593 was coupled to the rear of this locomotive unit.

b. Operator's Cab Interior

An examination of the operator's cab was not conducted<sup>54</sup>. Several general observations could be made based upon an exterior visual observation (from ground level):

- the cab compartment appeared to be relatively intact and did not lose overall structural integrity or sustain significant loss of survival space.
- the cab windows were not broken.

5.1.2 NS Locomotive # 6593

Exterior photo-documentation was performed. Significant observations in the inspection are summarized as follows.

a. Exterior

- Locomotive unit was derailed, resting upright, and positioned with the aft end skewed from alignment with the track by about 15 ft, such that the longitudinal axis of the unit resting at an acute angle relative to the track.
- Locomotive unit was resting approximately in a level orientation in both the longitudinal horizontal and the transverse horizontal axis.
- Front end of the unit was located an estimated 148 ft south of the Hickman Street pavement edge (as measured along the industrial track), and was resting very close to the track [alignment centerline] datum.
- Neither truck assembly was separated from the under-frame.
- Raking / impact damage at the aft end / right side of the frame structure, including a segment of missing handrail.
- The aft end / right corner pilot plate structure and stepwell elements were severely bent / displaced in an aft direction.
- Impact damage visibly apparent to the aft end / left corner pilot plate structure.
- Carbody panel separations, in several places, by several inches, was visibly apparent.
- Except for the aft end pilot plate and frame structure damage and carbody panel separations (as described), the balance of the carbody of this unit did not exhibit substantial visible collision damage.
- Visible evidence apparent of a Diesel fuel spill beneath the fuel tank
- No visible evidence apparent of fire damage to the unit.
- No visible evidentiary artifacts of personal trauma were apparent on the outside of the unit.

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<sup>54</sup> as noted in this report; see § 4.1.

- NS locomotive 6653 was coupled to the leading end of this locomotive unit.

An examination of the operator's cab was not conducted<sup>55</sup>. Several general observations could be made based upon an exterior visual observation (from ground level):

- the cab compartment appeared to be relatively intact and did not lose overall structural integrity or sustain significant loss of survival space.
- the cab windows were not broken.

#### 5.1.3 NS Locomotive # 4622

Exterior photo-documentation was performed, and (select) exterior approximate dimensional measurements were recorded. Significant observations in the inspection are summarized as follows.

##### a. Exterior

- Locomotive unit was derailed, resting upright, and positioned somewhat longitudinally aligned with the track.
- Locomotive unit was resting approximately in a level orientation in both the longitudinal horizontal and the transverse horizontal axis.
- Front end of the unit was located an estimated 5 ft south of the Hickman Street pavement edge (as measured along the industrial track), and was resting about 3 ft to the east of the track [alignment centerline] datum.
- Obvious severe impact damage sustained to the front end of the unit, with the front coupler, pilot plate structure and stepwell elements were severely mangled, with the various components bent and displaced in an upward and aft direction by about 5 ft.
- Obvious severe impact damage sustained to the front carbody cowl [short hood], which was displaced in an aft direction by about 2 ft.
- Right side-sill was buckled downward an estimated several inches, proximate to the area above the fuel tank.
- Left side-sill was buckled (similar to, but not as pronounced as, the right side).
- Front truck assembly was separated the under-frame.
- Aft truck assembly was not separated the under-frame.
- Aft end pilot plate structure – no visible damage apparent.
- Except for the front impact damage and buckling of the side-sills (as described), the balance of the carbody of this unit did not exhibit substantial visible collision damage.
- Visible evidence apparent of a Diesel fuel spill beneath the fuel tank
- No visible evidence apparent of fire damage to the unit.

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<sup>55</sup> as noted in this report; see § 4.1.

- No visible evidentiary artifacts of personal trauma were apparent on the outside of the unit.
- A railcar [PPGX 12119] was coupled to the rear of this locomotive unit.

#### b. Operator's Cab Interior

An examination of the operator's cab was not conducted<sup>56</sup>. Several general observations could be made based upon an exterior visual observation (from ground level):

- the cab compartment appeared to be relatively intact and did not lose overall structural integrity or sustain significant loss of survival space.
- one window on the left side of the cab was shattered.

#### 5.1.4 Railcars in Train Consist P22005

##### PPGX 12119 - Covered Hopper

General observations of the inspection included:

- this railcar was empty at the time of the collision.
- this railcar was not derailed, and was coupled to the adjacent locomotive [NS 4622].
- the railcar that was coupled to the rear of this railcar [WITX 4760] was found uncoupled and resting about 81 ft to the north.
- the carbody of this railcar did not exhibit substantial visible collision damage.

##### WITX 4760 - Covered Hopper

General observations of the inspection included:

- this railcar was empty at the time of the collision.
- this railcar was found uncoupled from the adjacent railcar [PPGX 12119], derailed, and resting about 81 ft to the north on the industrial track.
- the leading truck assembly of this railcar separated from the carbody, and was found resting on the ground immediately adjacent to the front [south] coupler of this railcar.
- the aft truck assembly of this railcar separated from the carbody and was found resting wedged against the underside discharge door beneath the center of the carbody.
- the leading [south] end of this railcar was resting on the ground.
- the aft end of this railcar had overridden, and was wedged against and resting upon the leading end-sill of a tank car (that had been previously placed at a location further west of Train P22005 on the industrial track), which sustained some minor buckling damage.

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<sup>56</sup> as noted in this report; see § 4.1.

## 5.2 Post-Recovery / Equipment Examination

A post-recovery examination of the railroad equipment<sup>57</sup> was not conducted by the Survival Factors Working Group personnel due to mitigation of the hazardous gas release that had not been completed by the time the Survival Factors Working Group had completed its on-scene activities<sup>58</sup>. Further, an opportunity was not made available to the Survival Factors Working Group Chairperson to conduct a post-recovery examination of the locomotives upon removal to a [post-recovery] temporary storage site<sup>59</sup>.

## 5.3 Relevant Train Velocity Information

### 5.3.1 NS train 192P005<sup>60</sup>

A copy of the information data detail (in graphical form), for the reported time interval of 02:38:50 to 02:39:30, for both the lead locomotive [NS # 6653] and the trailing locomotive [NS # 6593] of NS train 192P005, as identified in the Event Recorder Group - Study Report for this investigation, is provided in Exhibit 10.

Additional detail information on the locomotive velocity is provided in the Event Recorder Group - Study Report for this investigation.

### 5.3.2 NS train P22005

As the locomotive of this [standing] train was stationary, its velocity was 0.

## 6.0 Emergency Response Agencies

### 6.1 Jurisdiction

The accident occurred within the community of Graniteville, SC, and was in the emergency response jurisdiction of that locale, which is an unincorporated community within Aiken County. The aftermath of the accident (i.e. the release of a hazardous gas, and subsequent evacuations) affected peripheral areas of communities adjacent to Graniteville.

#### 6.1.1 Population Approximations

Principals of local emergency response agencies identified an estimated population of 5,400 individuals resided within an area encompassing a one-mile radius of the accident site, which

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<sup>57</sup> of principal interest to Safety Board staff in this investigation were the two lead locomotives of both train Consists involved.

<sup>58</sup> Safety Board staff does not have the luxury of time to remain on-scene indefinitely in order to complete examination efforts that can only be performed when mitigation of the hazardous gas release is complete and the site is safe to inhabit.

<sup>59</sup> authorization for the Survival Factors Working Group Chairperson to conduct a post-recovery equipment examination was requested of NTSB/RPH management, but was not forthcoming in time to be included in this report.

<sup>60</sup> Ref. Event Recorder Group - Study Report for this investigation.

includes peripheral areas of adjacent communities<sup>61</sup>. The Graniteville community itself had a 1990 population estimate of about 1,158 persons<sup>62</sup>. The fire district of the local responding fire / rescue agency (GVWFD) has an approximate population of 22,000, which includes communities adjacent to Graniteville that were not directly involved in the incident<sup>63</sup>. The reported population of the area encompassing the USPS Zip Code [29829] that includes the community of Graniteville, as well as surrounding areas, is 7,009 persons, which is an area encompassing about 34.73 square miles<sup>64</sup>. Aiken County has a U.S. Census reported population of 142,552 persons, and encompasses an area of about 1,073 square miles<sup>65</sup>.

## 6.2 Principal Responding Fire / Rescue Agency

The Graniteville, Vacluse, and Warrenton Volunteer Fire Department (GVWFD) is the principal emergency services agency responsible for responding to fire suppression, emergency rescue, and (an initial response to) Hazmat incidents within the Graniteville district of Aiken County, and was the initial fire / rescue agency that responded to the scene in this incident (as further described in this report; see § 7.2.1).

### 6.2.1 Summary Background<sup>66</sup>

The GVWFD is a volunteer fire department operation, which was organized in 1972, and consists of about 45 active (fully-trained / qualified) members and 1 cadet member (in-training)<sup>67</sup>. Prior to the accident, GVWFD maintained seven engines, one ladder, two service trucks, and two first responder / rescue vehicles, and one medical unit in their firefighting motor vehicle equipment roster, which operated out of three fire stations. The Headquarters of the GVWFD, which is their primary fire station, is located at 200 Main Street in Graniteville, which is about 700 ft to the south of the identified approximate point of collision.

The GVWFD is under the command of the Chief of the Fire Department, who is supported by an Assistant Chief, several command officers, and additional operational firefighting and EMT / paramedic personnel. The GVWFD is alerted to calls by Aiken County 911 System dispatchers, and the GVWFD has a parallel 'in-house' backup dispatch capability. The GVWFD also works closely with the Office of Aiken County Emergency Services, and its Emergency Management Division, relative to emergency preparedness Plans, training and drill exercises, and mass casualty incident command protocols.

Many of the GVWFD firefighting personnel are EMT / Paramedic qualified, and medical response support (for most ambulance service activities) is also provided by GVWFD EMT /

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<sup>61</sup> source: Aiken County Emergency Management Agency, Aiken County Sheriff's Office, and others

<sup>62</sup> source: [http://en.wikipedia.org/wiki/Graniteville,\\_South\\_Carolina](http://en.wikipedia.org/wiki/Graniteville,_South_Carolina)

<sup>63</sup> source: GVWFD [Party to the Investigation representative]

<sup>64</sup> 2000 U.S. Census data Internet: [http://factfinder.census.gov/servlet/GCTTable?\\_bm=y&-geo\\_id=85000US298&-\\_box\\_head\\_nbr=GCT-PH1&-ds\\_name=DEC\\_2000\\_SF1\\_U&-\\_lang=en&-format=ZI-1&-\\_sse=on](http://factfinder.census.gov/servlet/GCTTable?_bm=y&-geo_id=85000US298&-_box_head_nbr=GCT-PH1&-ds_name=DEC_2000_SF1_U&-_lang=en&-format=ZI-1&-_sse=on) (note - U.S. Census data doesn't cite a population district for the community of Graniteville)

<sup>65</sup> 2000 U.S. Census data Internet: <http://quickfacts.census.gov/qfd/states/45/45003.html>

<sup>66</sup> Source - information obtained in on-scene interviews, and: Internet: <http://www.gvwfire.com/> (and also for further information).

<sup>67</sup> January 2005 data

Paramedic personnel, who respond simultaneous to (most) ambulance dispatch runs. Training for GVWFD firefighter service personnel was identified as being in accordance with applicable OSHA requirements<sup>68</sup>, and all non-probationary GVWFD firefighter service personnel are certified to a Firefighter II level<sup>69</sup> or higher training level (for their duty assignment). Principals of the GVWFD represented to Safety Board staff that their organization, as a principally rural-based volunteer firefighting institution, adheres to, or are in compliance with, all NFPA technical performance and operational Guides, Standards and Recommended Practices that may be applicable to their organization. Also, the GVWFD has earned [for their Emergency Services jurisdiction] a Class 4 rating by the Insurance Service Office.

Historically, the GVWFD responds to about 500 requests for emergency services support annually (inclusive of fire calls [all varieties], EMS first responder, mutual aid response, false alarms, etc.)<sup>70</sup>.

### 6.2.2 GVWFD Preparedness / Response Execution Plan

The GVWFD does not maintain a formal / documented Preparedness / Response Execution Plan, per se, but instead utilizes and conforms to the formal / documented Operations Plan as developed and promulgated by the Aiken County Emergency Services Division (see § 6.3.2).

### 6.2.3 Actions Consequential to the Accident

The GVWFD reported to the investigation that two [pumper truck] engines, one medical unit [vehicle], and one service truck, all having been parked in their Station # 1 for the duration of the Cl<sub>2</sub> gas release, were lost as a result of Cl<sub>2</sub> contamination. The GVWFD also indicated that efforts were in progress to replace the lost equipment [vehicles], and that they secured temporary replacement accommodations for the loss of use of their Headquarters fire station (as further described in this report).

## 6.3 Jurisdictional Emergency Management Agency

Aiken County Emergency Management is a Division of Aiken County Emergency Services<sup>71</sup>, and was the jurisdictional emergency management agency in this incident, which also responded personnel and resources to support the incident. Emergency Management has the responsibility of compiling and maintaining several documented emergency preparedness and response – operations and action plans (as further described in this report; see § 6.3.2), and is a resource available to provide logistics and technical resources support in the event of a civil emergency or mass casualty incident.

### 6.3.1 Emergency Operations Center

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<sup>68</sup> Occupational Safety and Health Administration (an agency of the U.S. Department of Labor), pursuant to 49 CFR 1910.120

<sup>69</sup> NFPA 1001: Standard for Fire Fighter Professional Qualifications; identifies the minimum job performance requirements for ... career and volunteer fire fighters [National Fire Protection Association, Quincy, MA 02269]

<sup>70</sup> 2004 data [source <http://www.gvwfire.com>]

<sup>71</sup> Aiken County Emergency Services is a Department of the Aiken County Government; see [Internet] <http://www.aikencountysc.gov/DspDept.cfm?qDeptID=ESD>

As a resource available for use by Aiken County Emergency Management and supporting agencies and organizations during civil emergencies, Aiken County Emergency Services maintains an Emergency Operations Center (EOC), which is a 'non-dedicated working space' located at the Aiken County Council Building, in the City of Aiken.

### 6.3.2 Emergency Preparedness / Response Operations Plan

The Emergency Management Division has compiled and maintains a formal / documented Preparedness Plan entitled "Aiken County Emergency Operations Plan (Revised January 2004)". The Operations Plan is produced by the Emergency Management Division of Aiken County in coordination with the South Carolina Emergency Management Division, and is promulgated pursuant to the requirements stipulated under South Carolina State Emergency Management Standards 58-101, and the LEPC (as further described in this report; see § 6.3.3). The Operations Plan (available as a printed document or on a CD<sup>72</sup>) is periodically updated, and is distributed to all of the emergency response / emergency services agencies in Aiken County. A copy of select pages of the Operations Plan, presented to briefly describe the informational content therein, is provided in Exhibit 11.

### 6.3.3 Role of the Local Emergency Planning Committee<sup>73</sup>

As a general description, the Local Emergency Planning Committee (LEPC) is a committee appointed by a State Emergency Response Commission, as required by SARA Title III, which is specifically responsible for formulating a comprehensive emergency plan for its region, and is the coordinating point for both planning and training activities at the local level. Participants of an LEPC include, for example, elected and state officials, fire police departments, emergency management, public health, and private industries, and industry personnel (of those private industries that maintain a Hazmat presence), among other participatory organizations. In summary, its specific responsibilities include:

- Develop, and periodically test and exercise a Hazardous Materials Action Plan.
- Conduct a hazards analysis of Hazmat facilities and transportation corridors.
- Receive and manage Hazmat facility reporting information.
- Coordinate community Right-to-Know aspects of SARA III.

## 6.4 Principal Responding Jurisdictional Emergency Medical Service Provider<sup>74</sup>

Primary emergency medical service (EMS) response support is provided by Aiken County Emergency Medical Services, which is also a Division of the Emergency Services Department.

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<sup>72</sup> a full copy of the document was made available to the NTSB [as file documentation]; a review of the narrative content by NTSB staff noted the factual observation that the subject matter contents were somewhat comprehensive in depth and degree of elaboration (as compared to the overall spectrum of Preparedness Plans having been reviewed over the previous approximate decade of investigations conducted).

<sup>73</sup> ref. Noll, G. G., Hildebrand, M. S., Yvorra, J. G., Hazardous Materials - Managing the Incident 2<sup>nd</sup> Ed., Fire Protection Publications, Oklahoma State University. 1995, pgs 12, 520

<sup>74</sup> Source - information obtained in on-scene interviews, and: Internet:  
<http://www.aikencountysc.gov/DspSvc.cfm?qSvcID=40> (and also for further information).

Aiken County Emergency Medical Services is a ‘professionally paid’ organization, which operates eight ambulances or response vehicles out of eight substations, and responds annually to over 12,000 emergency calls and requests for emergency medical services. Medical response support to Aiken County Emergency Medical Services (for most ambulance service activities) is also provided by GVWFD EMT / Paramedic personnel, who (usually) respond simultaneous to the dispatched ambulance. Aiken County also has a number of commercial ambulance service operators that are also potentially available to provide back-up response support to Aiken County Emergency Medical Services.

#### 6.5 Principal Responding Jurisdictional Agency for Hazardous Material Incidents<sup>75</sup>

Response to hazardous material incidents (i.e. intervention in chemical, biological, and radiological releases) in Aiken County is provided by the Aiken County Hazmat Team, which is also a Division of the Emergency Services Department. The Aiken County Hazmat Team is a voluntary organization comprised of about 35 technical personnel (all voluntary), as well as paid / professional staff members. The Aiken County Hazmat Team operates one [technical support] response vehicle (Unit “HM-1”), and utilizes a preparedness plan entitled the “Aiken County Hazmat Team Emergency Operating Plan”. The Hazmat Team maintains continued technical training for its personnel [in compliance with 29CFR1910.120 (q)], and responds only to Hazmat incidents, which is usually in conjunction with the local responding fire department agency

#### 6.6 Principal Responding Jurisdictional Police Agency<sup>76</sup>

The Aiken County Sheriff’s Office (ACSO) is the principal emergency services agency responsible for responding to law enforcement, public emergency (other than medical or fire / Hazmat), or security related incidents within Aiken County, and was the initial police agency that responded to the scene in this incident.

#### 6.7 Emergency Response - Dispatch Services

Primary Dispatch services for Aiken County emergency response resources (911 Emergency Call Center and police / fire / ambulance Dispatch radio) are provided by the ACSO – Public Safety Communications Center.

##### 6.7.1 Recording Capability - 911 Calls, Police / Fire / Ambulance Dispatch Radio

ACSO – Public Safety Communications Center maintains a recording capability of both their 911 Emergency Call Center telephone calls, and their police / fire / ambulance Dispatch radio channels.

##### 6.7.2 ‘Time-stamp’ Agreement with ‘UTC’ Time Standard<sup>77</sup>

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<sup>75</sup> Source - information obtained in on-scene interviews, and: Internet: <http://www.hazmatteam.com> and <http://www.aikencountysc.gov/DspSvc.cfm?qSvcID=70> (and also for further information).

<sup>76</sup> Source - information obtained in on-scene interviews, and: Internet: <http://www.aikencountysheriff.org> (and also for further information).



The ACSO - Public Safety Communications Center system clock, which is utilized as a source for the ‘time-stamp’ function of the emergency response [Dispatch radio] communications and 9-1-1 Emergency Communications Call Center - call data archive system, was identified to registered a time reading that was consistent with the Coordinated Universal Time standard (UTC)<sup>78</sup>. The fax machine at that location was showing a ‘time-stamp’ reading that was about 4 minutes above the UTC.

### 6.7.3 Reverse 911 Emergency Notification System

#### a. Background / Basic Description<sup>79</sup>

As a basic description, a Reverse 911 Emergency Notification System is an automated telephone dialing system that can be programmed with [a sizable quantity of] telephone numbers of the constituent population (within a specified jurisdiction), that when activated, dials the pre-programmed telephone numbers in the database, and upon answering by the telephone customer (lifting of the handset / receiver), delivers a prerecorded audio message. A Reverse 911 Emergency Notification System, the technology of which is principally associated with the telephone mass-marketing (“telemarketing”) industry, can be programmed with a specific message for delivery to the telephone customers in its database (such as ‘shelter in place’ or ‘evacuation’ instructions), and can also be activated upon relatively short notice and implemented with relatively rapid dispatch. For this reason, a Reverse 911 Emergency Notification System can be an efficient and effective means of disseminating exigent life-saving / time-critical information to a large and widely dispersed constituent population, particularly during the overnight hours, at which time the vast majority of the population is likely to be asleep (in their residences), and not otherwise accessing local mass-media communication outlets (i.e. watching television or listening to a radio) to be informed of critical information.

#### b. Aiken County’s Reverse 911 Emergency Notification System<sup>80</sup>

Aiken County has a Reverse 911 Emergency Notification System as a resource that can be activated during a civil emergency to alert the public of important information, the operation of which is performed by the ACSO - Public Safety Communications Center (i.e. the police, ambulance and fire/rescue Dispatch office). Prior to the accident, Aiken County [emergency preparedness] protocol provided for activation of the Reverse 911 System upon authorization by Aiken County Emergency Services personnel, with the delivery of a prerecorded audio message then executed by the ACSO - Public Safety Communications [Dispatch] Center. Also, activation of the Reverse 911 System required that a computer-based ‘Operations Station’ be manually setup by Aiken County Emergency Services staff, the equipment of which is located in the EOC,

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<sup>77</sup> Time validation was by comparison of the agency’s system clock against the UTC [ref. Internet website <http://www.boulder.nist.gov/timefreq/>] as performed by the Survival Factors Group Chair during a visit to the 9-1-1 Emergency Communications Call Center on 10 Jan. 2005.

<sup>78</sup> as provided by National Institute of Standards and Technology [<http://www.boulder.nist.gov/timefreq/>] or the U.S. Naval Observatory [<http://tycho.usno.navy.mil/>]

<sup>79</sup> source – a synopsis of introductory / background information provided by several manufacturers of this equipment

<sup>80</sup> source – information obtained in on-scene interviews, and ‘After Action Report’ documentation received from GVWFD, Aiken County [Emergency Management], and ACSO, as further described in this report.

which also typically required about one hour to setup. Further, the Reverse 911 System telephone number database had not been updated for about five years prior to the accident, and also did not include non-published (“unlisted”) telephone numbers. Additional information on this facet of the investigation is further provided in the report (see § 7.5).

## 6.8 Jurisdictional Death Investigation Agency

The Aiken County Coroner’s Office is responsible for investigating the cause and the manner of deaths, and for conducting autopsy and related forensic investigation services for the County. The Aiken County Coroner’s Office utilizes the services of a technical contractor, as needed<sup>81, 82</sup>.

## 6.9 State-Level Emergency Management Agency<sup>83</sup>

The South Carolina Emergency Management Division (SCEMD), an agency of the SC State government, is the state-level emergency management agency that is responsible for:

- developing mitigation, preparedness, response, and recovery plans and procedures, and
- maintaining a comprehensive, risk-based, multi-hazard emergency management and training program, and
- coordinating federal, state, and local resources for mitigation, preparedness, response and recovery operations.

The agency maintains the State Emergency Operations Center, which is activated upon notification by local authorities of an emergency situation that might require Emergency Operations support. The agency also utilizes a mobile Emergency Management / Incident Command Center (vehicle), which is available for response dispatch to local sites as a technical support accommodation. The SCEMD has developed, and promulgates, the South Carolina Emergency Operations Plan (SCEOP), which is a comprehensive, all-hazard plan, developed for use by the SC state government departments and agencies to help ensure a coordinated and effective response to natural, technological, or man made disasters that may occur in South Carolina<sup>84</sup>.

## 7.0 Emergency Response

An *event chronology* (“Timeline”) is constructed in an investigation to identify and address potential issues involving the initial notification to the local emergency response authorities, as well as to examine the execution of the emergency response effort (e.g. search and rescue / fire suppression / hazardous materials remediation). Also, if appropriate, the Timeline can serve as a mechanism to foster discussion on potential amelioration efforts (if any) that might help remedy issue(s) identified, to help avoid future re-occurrences. In support of this, the principal

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<sup>81</sup> The Aiken County Coroner’s Office does not having ‘in-house’ capability of conducting certain autopsy and related death investigation services.

<sup>82</sup> the technical contractor utilized for autopsy services of the decedents in this accident is identified as Newberry Pathology Associates, located in Newberry, SC. (for further information, see <http://www.newberrypathology.com/>).

<sup>83</sup> Source - Internet: <http://www.scmd.org> (and also for further information, which includes a Link to 14 Situation Reports issued by SCEMD on the Graniteville incident).

<sup>84</sup> Source - Internet: <http://www.scmd.org/library/sceop.htm> (and also for further information).

responding emergency services agencies were requested to provide incident response data and communications information (relevant to this event). Safety Board staff also conducted individual debriefing interviews with key personnel of the emergency services agencies. The following is a brief summary of the information obtained.

## 7.1 Notification to Local Emergency Response Authorities<sup>85</sup>

The investigation identified that the collision and derailment likely occurred at about 2:39:06 am on January 6, 2005.

The initial notification to local emergency response authorities was a 911 telephone call placed at 2:39:43 am to the Aiken County 911 Emergency Call Center by a female employee of the ‘Data Processing’ office of the ‘Hickman Mill’ (in Graniteville). The location of the caller was a single story office building located on Hickman Street, near the intersection of Main Street, which is about 200 ft south of the identified approximate point of collision and immediately adjacent to the wreckage pileup.

After identifying herself, the 911 caller reported “... I think there’s been a train wreck ... at Graniteville ... at Hickman Mills”. She said that she was at that location by herself, and upon her going [outside] to the end of the building, she could “... see smoke”, but couldn’t discern specifically what was involved. She further indicated the accident [site] was at the Hickman Street railroad grade crossing. Near the end of the call (which totaled about 48 seconds), the caller appeared to become increasingly agitated, with her then saying “... I smell smoke” (which suggested to the 911 Operator that smoke was in the building), which followed with her exclaiming, “I got to get out of here”, wherein (before the 911 Operator was able to ask for more information detail) the call abruptly ended.

The initial 911 call was followed by about a dozen additional 911 calls from the area within the next 10 minutes, with callers indicating there had been a train wreck (proximate to where the initial 911 caller described), and there was a low-lying yellow haze emanating from the accident site, which was described as smelling like bleach. In the approximate hour following the initial 911 call, over 100 additional 911 calls were received, which further totaled to 200 calls being received by 6:00 am. Commencing about 2:40 am, calls were also being received on the non-emergency telephone lines of the Aiken County 911 Emergency Call Center, which totaled 80 calls within one hour, which further totaled 200 calls being received by 5:40 am.

## 7.2 Execution of the Emergency Response<sup>86</sup>

Activities of the principal jurisdictional emergency services agencies and support organizations that responded to the accident are summarized as follows.

### 7.2.1 GVWFD – Fire / Rescue<sup>87</sup>

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<sup>85</sup> Source – a CD containing the recorded voice calls placed to Aiken County 911 in the incident; supplied by ACSO – Public Safety Communications Center

<sup>86</sup> Source – a CD containing the Dispatch Desk radio [voice] traffic of the incident; supplied by ACSO – Public Safety Communications Center, and as sourced for the individual responding emergency services agencies.

A copy of the GVWFD Timeline document, which provides information detail on the GVWFD activities during their response to this accident, and a copy of NS 192P005 Train Consist documentation (as received from NS, via the Bath Fire Department), is provided in Exhibit 12.

### 7.2.2 Aiken County Sheriff's Office<sup>88</sup>

Responsive to the initial 911 call (placed at 2:39:43) to the 911 Aiken County Emergency Call Center, several ACSO [patrol officer] Units were dispatched to the scene at 2:41:01 am. An initially responding officer arrived proximate to the accident site at about 2:42 am, who was followed by additional responding officers. Upon encountering respiratory difficulties in approaching the scene (due to what was subsequently determined to be a Cl<sub>2</sub> gas release that occurred during the collision and derailment), the Officers immediately withdrew to a safe distance, awaiting further instruction. Several of the responding Officers experienced respiratory distress, resulting in their transport to a local medical facility for treatment.

The ACSO later establish, and provided substantial evacuation (door-to-door canvas) support for a mandatory evacuation of an area bounded within a one-mile radius containment zone proximate to the accident, as further described in this report (see § 7.2.1, § 7.6.1, and § 7.6.2). A substantial Mutual Aid response from a number of area law enforcement agencies was received for the mandatory evacuation effort, which included implementation of perimeter approach road blockades at key roadway intersections. The door-to-door canvas effort utilized an evacuation grid system (superimposed upon a map of the accident site area), as a tool employed by the law enforcement personnel performing the evacuation, to efficiently implement a house-to-house search effort (as further described in this report; see § 7.2.1, § 7.6.1, and § 7.6.2).

The ACSO also provided security personnel (Officers) for site access control to a 300-meter radius zone that was established proximate to the Cl<sub>2</sub> vapor cloud release epicenter location (which was also informally referred to as the “hot zone”), into which access was restricted by personnel unless appropriate PPE (Level A, B or C, as determined by the Cl<sub>2</sub> discharge concentration levels measured) was utilized, as further described in this report (see § 7.6.1).

A copy of the ACSO Timeline document<sup>89</sup>, which provides additional information detail, is provided in Exhibit 13.

The ACSO [Public Information Officer<sup>90</sup>] published a series of periodic<sup>91</sup> “Fact Sheet” documents, describing information detail on the ongoing ACSO activities, copies of which are available from the agency<sup>92</sup>.

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<sup>87</sup> Source – documentation prepared by, and received from the GVWFD (ref emails from the Party to the Investigation, dated 29 Aug 05 and 13 Sep 05)

<sup>88</sup> Source – a number of CD's containing the Dispatch Desk radio [voice] traffic of the incident; supplied by ACSO – Public Safety Communications Center (ref documentation package [containing the CDs] received from ACSO staff [Communications Supervisor] on 20 Jan 05)

<sup>89</sup> Source – prepared by, and received from the ACSO (ref email from ACSO staff, dated 21 Jul 05).

<sup>90</sup> Source – ACSO Public Information Officer (<http://www.aikencountysheriff.org/index.php?pagenum=56>)

<sup>91</sup> commencing on 06 Jan, and concluding on 06 Jan 2005; several updates were released daily

<sup>92</sup> Source, and available from: <http://www.aikencountysheriff.org/index.php?pagenum=27>

### 7.2.3 NS Railway Company<sup>93</sup>

A copy of the NS Railway Timeline submitted document, which provides information on the NS Railway activities responsive to this accident, is provided in Exhibit 14. Included in this Exhibit is also [NS submitted] supplementary documentation that further describes NS Railway activities responsive to the accident<sup>94</sup>.

Additional supplementary documentation, submitted to the investigation by the NS, describing specific ancillary elements and information detail of the emergency response to the accident by the NS Railway, are provided in a separate Addendum Survival Factors Factual Report<sup>95, 96</sup>.

## 7.3 Incident Command

### 7.3.1 Organization

The request for, and arrival of Mutual Aid<sup>97</sup> resources from multiple jurisdictions prompted the establishment of an Incident Command System to manage the event, which evolved to form a Unified Command System.

### 7.3.2 Tactical Plan Objectives Summary

Principals of Incident Command reported to the investigation that the objectives of their tactical plan consisted of (in summary):

- execute an exigent ‘Search and Rescue’ effort, utilizing appropriately protected and equipped ‘Entry Teams’ (composed principally of GVWFD and Mutual Aid personnel, as supported by appropriate technical resources), of individuals who were in imminent peril, being located in the immediate path of the Cl<sub>2</sub> gas release plume,
- evacuate / shelter-in-place (which ever was most practical) residents proximate to the derailment site (i.e. within a one-mile radius buffer zone),
- utilize the Aiken County Reverse 911 emergency notification system to instruct residents to ‘shelter in place’ until they can be rescued,
- implement a mandatory evacuation of an area bounded by a one-mile radius of the Cl<sub>2</sub> gas release location; ACSO Officers (and mutual aid law enforcement resources) provided security personnel for site access control,

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<sup>93</sup> Source – documentation prepared by, and received from the NS Railway (ref document package received 26 Sept. 2005 from the NS Party to the Investigation representative, with the NS Emergency Response Timeline as amended by received documentation [printed copy and identical email content] dated 08 Sep. 2005).

<sup>94</sup> Ref. an NS document submission, dated 20 Sept. 2005.

<sup>95</sup> see subsequently compiled Survival Factors Factual Report Addendum # 2 for information on NS [railroad operations] service radio and NS telephone transcripts, NS train consist documentation, etc.

<sup>96</sup> see subsequently compiled Survival Factors Factual Report Addendum # 3 for information on NS TRANSCAER program (activity history), and select pages from the NS Emergency Action Plan for the Piedmont Division.

<sup>97</sup> Aiken County - Emergency Management maintains a formal / documented Mutual Aid Agreement with the constituent municipal / jurisdictional emergency response agencies / organizations in the Aiken County region.

- relocate the displaced / evacuated individuals (situated within the one-mile radius evacuation zone) to local emergency shelters (organized by the Red Cross), unless the individuals are able to organize / utilize their own relocation resources,
- establish a 300-meter radius containment zone proximate to the Cl<sub>2</sub> vapor cloud release epicenter location (which was also informally referred to as the “hot zone”), into which access was restricted by personnel unless appropriate PPE (Level A, B or C, as determined by the Cl<sub>2</sub> discharge concentration levels measured); ACSO Officers (and mutual aid law enforcement resources) provided security personnel for site access control,
- perform an assessment of the Cl<sub>2</sub> gas release and then engage in ‘release mitigation’ efforts to the extent possible (utilizing appropriate technical support / resources).

### 7.3.3 Execution of Tactical Plan Objectives

As reported by principals of Incident Command, considerations of, and potential impediments to the successful execution of the above tactical plan included (in summary, in no particular order):

- during the initial emergency services response, unless responding to a critical search and rescue request, proceeding in darkness for any non-lifesaving activities would be inefficient and potentially dangerous (i.e. unless an exigent [critically urgent / lifesaving] activity, most search and rescue activities were deferred until daylight),
- initially, Incident Command could not make an immediate determination as to exactly what specific railcars were involved and what cargo (contained therein) was to be of immediate concern,
- emergency services agencies needed to await arrival of appropriate technical support and specialized Hazmat release and mitigation equipment,
- some of the various responding emergency services agencies were operating on different radio frequencies, which sometimes impeded efficient inter-agency communication,
- continued discharge of Cl<sub>2</sub> gas precluded close site-access unless responding personnel had donned appropriate PPE (Level A or B, as determined by the Cl<sub>2</sub> discharge concentration levels measured),
- low-level helicopter access (early-on) for visual reconnaissance was ill-advised until the Cl<sub>2</sub> gas plume reduced or stabilized, given the vulnerabilities of the equipment (e.g. potential of air starvation of the engines, potential of pilot / crew incapacitation, prospect of spreading the Cl<sub>2</sub> gas plume by the rotor wash, effects of Cl<sub>2</sub> gas on the engine, electronics, etc.),
- the large number of evacuees (identified to be about 5,400) resulted in some rescue and decontamination logistical difficulties,
- execution difficulties were experienced in the deployment of the Reverse 911 emergency notification system.

Several of the above consideration points were subsequently addressed by the constituent principals of Incident Command, as further described in this report (see § 9.0).

### 7.3.4 Facility Logistics

To facilitate the Incident Command process, separate staging areas were established for (what was informally known as) ‘Forward Command’, which was located relatively close to the wreckage pileup (on Route 1 at the Honda Automobile dealership parking lot), and also an ‘Incident Command’ site, which was located a safe distance (upwind) from the wreckage site (on Route 1 at the “old K-Mart” parking lot).

Many of the responding emergency services support agencies and organizations utilized (self-contained / customized) ‘incident command vehicles’, which were located at the ‘Incident Command’ site. A vacant retail store at the ‘Incident Command’ site was also utilized (commencing on the fourth day) by the responding support agencies and organizations personnel, which afforded an indoor venue for participants in which administrative work and meetings could be accommodated with better efficiency than was provided outdoors or in the individual support vehicles. Commissary support services (e.g. meals, sanitation, land-line communications, etc.) were also provided at the ‘Incident Command’ site by responding support agencies and organizations. Parking space for a number of news media communication vehicles [satellite trucks] was also made available, which also facilitated periodic briefings by the various responding emergency services agencies.

## 7.4 Air Quality Monitoring

An integral element of the emergency response and evacuation process was the monitoring of air quality for the area proximate to the Cl<sub>2</sub> vapor cloud release site, with the information disseminated to Incident Command [staff], such to allow informed decisions to be made which supported the execution of the emergency response to the incident. Air quality monitoring was performed by the responding jurisdictional agency for hazardous material incidents (Aiken County Hazmat Team), as also supported by the various responding air quality and environmental monitoring technical resource agencies<sup>98</sup>.

Additional detail information on the air quality monitoring effort, as performed by the U.S. EPA, is provided in the Hazardous Materials Group - Factual Report (see – Appendix G, therein).

## 7.5 Activation of Reverse 911 Emergency Notification System<sup>99</sup>

The investigation identified that a request was placed by the GVWFD to Dispatch at about 2:49 am to activate the Aiken County Reverse 911 System, and deliver a message to the telephone customers [in the database] located proximate to the accident site, indicating (to the effect) to ‘shelter in place’, with the request reiterated at about 2:57 am<sup>100</sup>. The investigation further identified that the Reverse 911 System was not activated in response to these activation requests

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<sup>98</sup> e.g. US-EPA, SC-DHEC, etc.

<sup>99</sup> source – information obtained in on-scene interviews, from Aiken County Emergency Services management, and from ‘After Action Report’ documentation received from GVWFD, Aiken County [Emergency Management], and ACSO, as further described in this report.

<sup>100</sup> source – Timeline document received from the GVWFD Party to the Investigation representative.

until about 4:20 am<sup>101</sup>, because activation authorization was not immediately forthcoming from Aiken County Emergency Services<sup>102</sup>. A second Reverse 911 System message was dispatched after 6:00 am. Additional information on this facet of the investigation is further provided in the report (see § 9.2.1).

## 7.6 Civil Restrictions and Declarations, and Commercial Closures<sup>103</sup>

### 7.6.1 Mandatory Evacuation / Site Access Restrictions

A voluntary evacuation of the area immediately proximate to the Cl<sub>2</sub> vapor cloud release site commenced, somewhat spontaneously, almost immediately subsequent to the accident, as aided by the initially responding fire department and police resources (GVWFD and ASCO). A mandatory evacuation, for an area bounded within a one-mile radius containment ('buffer') zone proximate to the accident site, was implemented by the ACSO later that morning [January 6], which was executed by GVWFD, ASCO, and supporting Mutual Aid fire/rescue and police resources, and completed by about 4:30 pm that day<sup>104</sup>.

On the second day of the emergency response [January 7], consideration was given by Incident Command to enlarge the containment zone dimension from a one-mile to a three-mile radius, as a 'backup strategy', should such a measure be needed should problems be encountered, for example, during the Hazmat product offloading process. Implementation of a larger containment zone (evacuation area) would have affected a substantially larger number of residences and businesses proximate to the Cl<sub>2</sub> vapor cloud release site<sup>105</sup>. However, as this measure was not needed, the 'buffer' zone enlargement was not implemented.

The mandatory evacuation was suspended commencing on January 14, when the Hazmat release mitigation efforts had substantially concluded.

A 300-meter radius 'restricted access' containment zone, proximate to the Cl<sub>2</sub> vapor cloud release location, was also established on the first day utilizing ACSO Officers (and mutual aid law enforcement resources) to provide security personnel for site access control, into which access was restricted by personnel unless appropriate PPE (Level A, B or C, as determined by the Cl<sub>2</sub> discharge concentration levels measured) was utilized.

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<sup>101</sup> the Reverse 911 message issued was to 'shelter-in-place'

<sup>102</sup> Aiken County Emergency Services management identified that the reason the activation authorization was not immediately forthcoming was due to the one-hour or so time required by Aiken County Emergency Services staff to setup the computer 'Operations Station' at the EOC, in order to proceed with the Reverse 911 activation process.

<sup>103</sup> source – information obtained in on-scene interviews, Fact Sheets issued by the ACSO on the Graniteville incident (see Internet: <http://www.aikencountysheriff.org/index.php?pagenum=27>.), and Situation Reports issued by SCEMD on the Graniteville incident (see Internet: <http://www.scemd.org>.)

<sup>104</sup> It was reported that a small number of individuals (estimated to be 12) who refused to comply with the evacuation, in which the individuals remained domiciled within their residences (essentially prescribing to a 'shelter in place' protocol) for a period of time, in which personnel of the ASCO and fire department agencies made periodic contact to help assure the continued 'well being' of these individuals.

<sup>105</sup> which, as noted by Incident Command, potentially could affect a population [estimate] of 17,000 persons, as well as several 'nursing homes', local commercial districts, a major local hospital, and a large state University campus.



A map, issued by the DHEC, identifies (as an exemplar) the 300-meter radius buffer zone ‘PPE required’ boundary limits implemented, a copy of which is provided in Exhibit 15.

Another map was prepared by Incident Command, which identifies the one-mile radius mandatory evacuation boundary limits implemented. This map shows the evacuation grid system that was employed by the law enforcement personnel during the evacuation process, a photo-image of which is to be provided in a separate Addendum to the Survival Factors Factual Report.

A nighttime (6:00 pm – 7:00 am) curfew was implemented commencing on the first day [January 6] for a two-mile radius of the accident site, which was reduced on January 8 to a one-mile radius of the accident site, which was suspended commencing on January 14, when the Hazmat release mitigation efforts had substantially concluded.

#### 7.6.2 Emergency Highway Traffic Management

Commencing almost immediately subsequent to the incident, the ACSO implemented, as supported by a substantial Mutual Aid response from a number of area law enforcement agencies, roadway blockades (Highway “Traffic Control Points”) at strategic intersections outside the one-mile radius buffer zone proximate to the accident site, restricting access to all except authorized personnel (e.g. emergency responders, law enforcement, authorized Hazmat mitigation contractor and/or railroad personnel, authorized local / state / federal officials, etc).

#### 7.6.3 Flight Restrictions

On the first day of the incident, the South Carolina State Law Enforcement Division (SLED) requested that the FAA<sup>106</sup> establish a temporary flight restriction (TFR) zone for an area bounded within a five-mile radius of the accident site, up to an altitude of 3,000 ft.

#### 7.6.4 Manufacturing / Retail Facility Closures

Commencing with the initial Cl<sub>2</sub> vapor cloud release, and responsive to the evacuation of the affected area, the Graniteville facilities of the Avondale Mills operations (i.e. all of the Graniteville production facilities, including the steam plant) ceased operations for the duration of the incident. Several other affiliated Avondale Mills facilities in Warrendale also ceased operations for a period of time during of the incident.

Commencing with the initial Cl<sub>2</sub> vapor cloud release, and responsive to the evacuation of the affected area, retail (the small commercial retail district on Trolleyline Road, north of the accident site), government (a USPS Post Office), and community service (several local school) facilities in Graniteville ceased operations for the duration of the incident.

#### 7.6.5 State of Emergency

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<sup>106</sup> Federal Aviation Administration

At noon on the first day of the incident [January 6], the Governor of South Carolina issued an Executive Order declaring a state of emergency in Aiken County, which remained in effect for the duration of the incident.

### 7.7 Responding Emergency Services and Supporting Resources

An on-scene (initial) count in the investigation identified approximately 100 responding emergency services agencies and organizations (local and mutual aid), technical support, and governmental agencies, which involved participation by [what is estimate to be] over 500 individuals of these agencies and organizations.

A list of principal responding emergency services agencies and supporting organizations, and governmental agencies that responded to this accident is provided in Exhibit 16<sup>107</sup>.

A more comprehensive list of [what is believed to be] all of the responding emergency services agencies and supporting organizations, and governmental agencies that responded to the accident, was compiled by the ASCO, which is available through the ASCO Internet website<sup>108</sup>.

### 7.8 Dimensional Distances of Cl<sub>2</sub> Vapor Cloud Travel

The distance the Cl<sub>2</sub> vapor cloud traveled (drifted with the wind), as measured relative to the approximate point of release, was identified by the investigation to have a generally defined radius of at least 1,000 feet<sup>109</sup>. Specific dimensional distances that the Cl<sub>2</sub> vapor cloud traveled, as measured relative to the approximate point of release, were identified by the investigation to be at least approximately:

- 2,500 ft in a northerly direction<sup>110</sup>
- 1,000 ft in an easterly direction<sup>111</sup>
- 900 ft in a southerly direction<sup>112</sup>
- 1,000 ft in a westerly direction<sup>113</sup>

Additional information detail on specific aspects of the concentrated Cl<sub>2</sub> vapor cloud travel is provided in the Hazardous Materials Group - Factual Report.

## 8.0 Medical and Pathological Summary<sup>114, 115</sup>

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<sup>107</sup> although it is recognized that all of the responding emergency services agencies and supporting organizations, and responding governmental agencies, made a significant contribution to the emergency response / hazmat mitigation / investigation effort, due to space limitations in this report, only the principal emergency services agencies and other organizations are cited in this report.

<sup>108</sup> <http://www.aikencountysheriff.org/index.php?pagenum=27>

<sup>109</sup> this, as a general observation, is based upon descriptions provided by the various responding emergency services personal who (as witnesses) traveled proximate to the gas release site.

<sup>110</sup> as evident by fatalities that had occurred a distance estimated to be about 2,500 ft north of the release location.

<sup>111</sup> as described by the various responding emergency services personal who traveled proximate to the release site.

<sup>112</sup> as evident by a fatality that had occurred a distance estimated to be about 900 ft south of the release location.

<sup>113</sup> as evident by fatalities that had occurred a distance estimated to be about 1,000 ft west of the release location.

As a result of the accident, a total of nine fatalities were reported, and a total of approximately 554 individuals (civilians, railroad crew, and emergency responders, inclusive) were reported to have been transported to local medical facilities (for examination / treatment), which is further described as follows<sup>116</sup>.

## 8.1 Civilian Casualties

### 8.1.1 Civilians Transported to Local Medical Facilities

Medical transport statistics provided to the investigation<sup>117</sup> identified that approximately 554 civilian individuals were transported to local medical facilities due to respiratory distress or related ailments that were likely associated with exposure to the chlorine release or the aftermath of the accident<sup>118</sup>. Of this count, 75 persons were identified to have been admitted to medical facilities for continued treatment.

A summary tabulation of the civilian casualties reported to have been transported to local medical facilities, as described above, is provided in Exhibit 17.

### 8.1.2 Civilian Fatalities<sup>119</sup>

A total of eight civilians were reported to have received fatal injuries in this accident<sup>120</sup>. Of the eight civilian fatalities, six individuals were employees of the Avondale Mills plant facility operations located to the west and to the north of the accident site, one individual was a truck driver at one of the Avondale Mills plant facility operations located to the west of the accident site, and one individual was a civilian located in a residence to the south of the accident site.

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<sup>114</sup> information sources: the Principal Responding Jurisdictional Emergency Medical Service Provider (see § 6.4), or the Jurisdictional Death Investigation Agency (see § 6.8), as appropriate to the category (i.e. medical transport casualties vs. fatalities), or as further described in this report.

<sup>115</sup> Medical, pathological, and related documentation received in the investigation from medical facilities (contacted in the investigation), and the jurisdictional death investigation agency (Aiken County Coroner's Office) is not included in this report due to confidentiality considerations.

<sup>116</sup> Due to the large-volume content of the casualty report documentation (ambulance run reports, medical / pathology records, etc.) collected in the Survival Factors investigation for review, this Survival Factors report provides only the gross number counts of casualty transports, as tabulated and supplied to the investigation by the Principal Responding Jurisdictional Emergency Medical Service Provider (see § 6.4) which is deemed sufficient for purposes of this Investigation, and does not provide a detailed accounting of the casualty categories, which may be made available in a separate Addendum Factual Report.

<sup>117</sup> Source – Aiken County Emergency Services / EMS Coordinator

<sup>118</sup> this tabulation count may include some emergency responder casualties (see § 8.3)

<sup>119</sup> Source – Aiken County / Office of the Coroner, Investigation Reports; Case [numbers] 2005\_000013, 2005\_000014, 2005\_000015, 2005\_000016, 2005\_0017, 2005\_000018, 2005\_000019, 2005\_000027.

<sup>120</sup> One additional civilian resident of Graniteville (a male, age 51) was reported in the media to have died on 19 April 2005, allegedly as a result of exposure to Cl<sub>2</sub> gas in the accident. The Aiken County Coroner's Investigation Report [Case Number 2005 000428] of this decedent indicated that, pursuant to the final autopsy report, the Manner of Death was "natural due to respiratory failure due to a massive bilateral pulmonary thromboemboli". Irrespective of the media attribution or the Coroner's Investigation report (summarized above), due to the 49 CFR 830.2 criteria followed in NTSB investigations (wherein a fatal injury is defined as any injury which results in death within 30 days of the incident), this person is not considered to have expired as a result of the accident.

Locations of the civilian fatalities are as described in an illustration as provided in Exhibit 18.

As identified in the illustration (Exhibit 18), the fatalities occurred to the north, west, and south of the Cl<sub>2</sub> gas release location, and no fatalities occurred to the east of the Cl<sub>2</sub> gas release location.

In summary, the Coroner's Investigation Reports for the eight deceased civilians all indicated that the Probable Cause and Mechanism of Death was "asphyxia" that occurred at an interval of "minutes", with secondary / contributing factors also cited, which included "exposure to chlorine gas" that occurred at an interval of "minutes".

## 8.2 Railroad Crewmember Casualties

The two NS train crewmembers involved (operating NS train 192P005) were transported to a local hospital for treatment.

The train conductor was treated and subsequently released.

The locomotive engineer died at 6:30 am from injuries arising as a result of exposure to Cl<sub>2</sub> [gas]. In summary, the Coroner's Investigation Report<sup>121</sup> [for the locomotive engineer] indicated that the Probable Cause and Mechanism of Death was "lactic acidosis" that occurred at an interval of "minutes", with secondary / contributing factors also cited, which included "Exposure to Chlorine Gas" that occurred at an interval of "hours".

## 8.3 Emergency Responder Casualties<sup>122</sup>

### 8.3.1 GVWFD

The investigation identified seven GVWFD firefighters experienced respiratory difficulty, which occurred during the onset of the emergency response effort. All were treated at a local medical facility and released shortly thereafter, with the exception of one firefighter who was admitted and remained in a local medical facility for several days, and was subsequently released.

### 8.3.2 ACSO

Two Officers of the ACSO experienced respiratory distress (during the initial response to the scene), which resulted in their transport to a local medical facility for treatment, whereupon they were released shortly thereafter.

## 8.4 Technical Support Personnel Casualties

### 8.4.1 NS Railway<sup>123</sup>

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<sup>121</sup> Source – Aiken County / Office of the Coroner, Investigation Report; Case 2005\_000020.

<sup>122</sup> Source – GVWFD Party representative

<sup>123</sup> Source – NS Party representative, on 19 Aug. 2005

None reported.

#### 8.4.2 Other Organizations

None reported.

#### 8.5 Medical Facilities Utilized

A total of seven medical facilities were reported to have been utilized<sup>124</sup> in this accident, a list of which is provided in Exhibit 17.

#### 9.0 Actions Implemented Subsequent to the Accident

Solicitations were placed by the investigation with the Party to the Investigation representatives in the Survival Factors Working Group<sup>125</sup>, principals of emergency services agencies of Aiken County, and to the other responding (mutual aid) emergency services agencies involved in the accident response, to provide an opportunity for information feedback to the investigation as to specific / documented measures, relative to the Survival Factors investigation, that have been initiated or employed subsequent to the event by these organizations, such to take advantage of 'lessons-learned' in the incident and help disseminate useful information for the benefit of the professional emergency response / emergency services community. The responses received are as follows.

##### 9.1 Parties to the Investigation

###### 9.1.1 Graniteville, Vaucluse, and Warrenville Volunteer Fire Department

- The GVWFD produced a PowerPoint<sup>®</sup> presentation entitled "Graniteville, SC Train Derailment", which presented an overview of the emergency response effort to this event as executed by the GVWFD, and other agencies, which was presented, as an initiative effort, to the IAFC in February 2005<sup>126, 127</sup>. Several additional presentation venues were also subsequently reported.
- The GVWFD produced an "After Action Report" on their emergency response effort, a copy of which is provided in Exhibit 19<sup>128</sup>.

###### 9.1.2 Aiken County Sheriff's Office<sup>129</sup>

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<sup>124</sup> i.e. individuals were transported to this accredited medical facility, as identified by appropriate [ambulance transport / med. record] documentation

<sup>125</sup> ref emails to Party rep's dated 26 July 2005, and 19 Aug. 2005

<sup>126</sup> source: mailed correspondence (containing a CD of the PowerPoint<sup>®</sup> presentation) received 27 May 2005 from the Party representative.

<sup>127</sup> ref IAFC [Hazardous Materials Committee] conference [Reston, VA]; publication "2005 Hazardous Materials Team Leaders Roundtable - Final Report" (available: [http://www.iafc.org/downloads/hazmat\\_roundtable.pdf](http://www.iafc.org/downloads/hazmat_roundtable.pdf))

<sup>128</sup> ref email received 06 July 2005 from the GVWFD Party representative

<sup>129</sup> ref email received 07 Jul 2005 from the ACSO Public Information Officer; report is also available: <http://www.aikencountysheriff.org/index.php?pagenum=27>

The ACSO published an “After Action Report”, a copy of which is provided in Exhibit 20.

#### 9.1.3 NS Railway<sup>130</sup>

The response from this Party is as follows.

“The Norfolk Southern has been an active supporter the TRANSCAER program for many years. The events in Graniteville reconfirmed the value of the TRANSCAER program to our company and we have continued to provide free training to local emergency responders. Attached you will find the TRANSCAER training performed, so far, by Norfolk Southern in 2005”.

A copy of the NS document submission, “TRANSCAER training performed, so far, by Norfolk Southern in 2005”, is provided in Exhibit 21.

#### 9.1.4 FRA<sup>131</sup>

Although produced not necessarily for purposes of disseminating information relevant to ‘lessons learned’ in the accident, the FRA issued a “Locomotive Crashworthiness Data Collection Form” [factual report] document, which contains detailed damage data as obtained from the locomotives involved in the accident. This document is, in itself, potentially beneficial to overall locomotive crashworthiness investigations, a copy of which is provided in Exhibit 22.

### 9.2 Other Responding Emergency Services Agencies<sup>132</sup>

#### 9.2.1 Aiken County Emergency Services<sup>133</sup>

Responsive to the delayed activation of the Aiken County Reverse 911 Emergency Notification System in this incident, Aiken County Emergency Services, in recognition that a shortcoming [in the Reverse 911 activation protocol] needed remedy, has amended the Reverse 911 System activation protocol, such that Reverse 911 activation can now be through direction from the Dispatch Supervisor or upon authorization by the Incident Commander (as further described in the ‘After Action Reports’ received; see § 9.1.1, 9.1.2, and 9.2.2 of this report)<sup>134</sup>. Also, the Reverse 911 System can be activated independently and immediately by the [police, ambulance, fire / rescue] Dispatch office using computer equipment at that location, rather than having to wait for an ‘Operations Station’ [computer] to be setup at the EOC by Aiken County Emergency Services personnel.

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<sup>130</sup> ref email received 02 Sep 2005 from the NS Party representative

<sup>131</sup> ref a CD [received in March 2005] from the FRA Party representative containing the referenced document.

<sup>132</sup> such agencies cited here did not participate as a formal *Party to the Investigation* participant, but did contribute this information for the benefit of the professional emergency response / emergency services community.

<sup>133</sup> source – information obtained in on-scene interviews, Aiken County Emergency Services management, and ‘After Action Report’ documentation received from GVWFD, Aiken County Government (via Emergency Services Department), and ACSO, as further described in this report.

<sup>134</sup> implementation of this revised Reverse 911 System activation protocol also eliminates the earlier activation protocol requirement of having to access the EOC in order to proceed with the Reverse 911 System activation process.

Aiken County Emergency Services has also updated the Aiken County Reverse 911 System telephone customer [phone number] database, as noted in the ‘After Action Report’ (see § 9.2.2). Preparations are also underway by Aiken County Emergency Services to potentially reduce the quantity of Aiken County telephone customers that are not included in the Aiken County Reverse 911 System database (due to having non-published telephone numbers), by undertaking an initiative with the local telephone company to include non-published Aiken County telephone customers in the Reverse 911 System database.

#### 9.2.2 Aiken County Government<sup>135</sup>

The Aiken County Government<sup>136</sup> produced an “After Action Report”, which also reflects the emergency response effort of the Emergency Services Department of Aiken County, and its constituent Divisions (see § 6.3, et seq.), a copy of which is provided in Exhibit 23.

#### 9.2.3 Aiken County Hazmat Team<sup>137</sup>

The Aiken County Hazmat Team<sup>138</sup> produced a DVD entitled “Graniteville Train Wreck”, which was produced for courtesy distribution<sup>139</sup> to, and for the benefit of, the professional emergency response / emergency services community, to help disseminate useful information gained by the experience of this agency during their response to this incident<sup>140</sup>.

#### 9.2.4 Savannah River Fire Department<sup>141</sup>

The Savannah River Fire Department, which provided Mutual Aid support to the response effort, produced a PowerPoint® presentation describing the basic facts of the event and the response effort, a copy of which is provided in Exhibit 24.

-- End of this Report Section --

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<sup>135</sup> ref email received 19 Aug. 2005 from management of Emergency Services Department

<sup>136</sup> as further described in this report; see also § 2.1.3

<sup>137</sup> ref a DVD received 30 Aug. 2005 from the producer of the DVD (who is also a principal of this agency).

<sup>138</sup> as further described in this report; see also § 6.5

<sup>139</sup> according to the producer, distribution is made available for the cost of shipping

<sup>140</sup> a copy of the DVD is available by contacting the agency (Internet: <http://www.hazmatteam.com>)

<sup>141</sup> source: Internet <http://www.exchangemonitor.com/transport/Bell.pdf>

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