Risk Assessment for a Rail Disaster in Anne Arundel County, Maryland

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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Signed: ________________________________
Abstract

Anne Arundel County, Maryland is in one of the most populace and transportation-saturated regions of the United States. The problem was that a rail disaster risk assessment had not been conducted in Anne Arundel County. The County had never experienced an incident of national, or regional, significance involving rail systems and focus had not been placed on the County’s vulnerability; as a result, the county was unaware of its ability to mitigate a rail disaster effectively. The purpose of this research was to assess Anne Arundel County's vulnerability to a rail disaster by identifying risk factors and comparing the County to “rail safe” communities. The descriptive research method was used to answer the research questions: (1) what are the characteristics of rail traffic in Anne Arundel County? (2) What causes rail disasters and which characteristics described are found in Anne Arundel County? (3) What methodologies exist that could be applied to conducting a risk assessment for a rail disaster in Anne Arundel County? (4) What are the characteristics of a "rail safe" community and how does Anne Arundel County compare? A literature review was completed and methodologies were identified to conduct a risk assessment. A probabilistic model identified the likelihood of a hazardous materials release in a train derailment. GIS mapping quantified life safety and business community impacts. A retrospective 10-year analysis of data compared national, state and local trends in rail incidents. The results of the research effort found that Anne Arundel County is vulnerable for a rail disaster of national significance and that despite its robust “all-hazards” preparedness, is unprepared to effectively mitigate a rail specific disaster. Recommendations included the development of a hazard-specific Emergency Operations Plan, development of a rail-safety working group, and the implementation of a full scale Community Hazards Emergency Response-Capability Assurance Process (CHER-CAP) exercise.
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INTRODUCTION

On February 13, 2000, at approximately 2:37 p.m., a commuter light rail train carrying twenty six people (25 passengers and a train operator) entered the Baltimore Washington International Airport (BWI) train station (located in the geographic boundaries of Anne Arundel County) traveling approximately 15 miles per hour, failed to stop as required, and struck an emergency device designed to prevent the train from entering the airport terminal building (National Transportation Safety Board [NTSB], 2001, p.1). The device worked successfully, and although the train derailed, it did not pierce the structure. However, five individuals sustained serious injuries; 13 sustained minor injuries, eight were not injured. The Maryland Transit Administration (MTA) estimated the cost of the incident was $924,000 (NTSB, 2001, p. 5-6).

Within six months, an identical event occurred in the same location. On August 15, 2000, at approximately 7:14 a.m., a light rail train struck an arresting device, resulting in minor injuries to 17 people. The MTA estimated the cost of this incident at $935,000 (NTSB, 2001, p. 17-18). This event occurred on a parallel track to the first track, which was out of service due to the collision on February 13. Fire departments from BWI Fire-Rescue, Anne Arundel County, and Baltimore County were involved in both incidents and operated effectively with all patients transported in under 45 minutes. Although serious (neither incident resulted in critical injuries or fatalities) the economic impact was localized and relatively small.

Rail traffic in Anne Arundel County is not limited to a light rail system. Additional passenger rail systems, including Amtrak and the Maryland Area Regional Commuter (MARC) service, operate trains that pass through the County. In addition, freight rail carriers Norfolk Southern and CSX operate in and through Anne Arundel County.
The research problem is that a rail disaster risk assessment has not been conducted in Anne Arundel County. The County has never experienced an incident of national significance involving its rail system and focus has not been placed on the County’s vulnerability; as a result, the county is unaware of its ability to mitigate a rail disaster effectively. The impact of this failure to conduct such an assessment places lives, the environment, and the economy in jeopardy. The purpose of this research effort is to assess Anne Arundel County's vulnerability to a rail disaster by identifying risk factors and comparing the County to “rail safe” communities similarly situated to itself. The descriptive research method will be used to answer the following questions: (1) What are the characteristics of rail traffic in Anne Arundel County? (2) What causes rail disasters and which characteristics described are found in Anne Arundel County? (3) What methodologies exist that could be applied to conducting a risk assessment for a rail disaster in Anne Arundel County? (4) What are the characteristics of a "rail safe" community and how does Anne Arundel County compare?

**BACKGROUND AND SIGNIFICANCE**

Anne Arundel County, Maryland is among the 200 most populace counties of the more than 3100 in the United States. According to the 2010 census, an estimated 537,656 people live in Anne Arundel County which has a geographic land mass of 514 square miles (http://2010.census.gov/2010census/data.index.php). Located on the western edge of the Chesapeake Bay, Anne Arundel County is home to the State’s Capital, Annapolis, as well as several extremely significant historic and geo-strategically sensitive sites including the United States Naval Academy, Fort George G. Meade and the National Security Agency.

In addition to its geographic significance located between Baltimore, Maryland and the District of Columbia, the County is traversed by several major limited access highways with
significant commercial and commuter traffic. These include Interstate 295 (a major North-South corridor between Washington D.C. and Baltimore) and Interstate 695 (a beltway loop around Baltimore). The Chesapeake Bay Bridge linking the Western and Eastern Shores of Maryland is located in the County. There is also a major fuel depot, with intersecting freight rail lines and a marine terminus, located in the extreme northeastern section of the County; a facility that crosses the geographic border between the County and Baltimore City. This facility stores millions of gallons of petro-chemicals and is an ethanol mixing facility.

The economic base of the County includes over 14,500 businesses employing more than 230,000 individuals. More than 300 businesses employ more than 100 people each. The top governmental employers include Fort George G. Meade (55,365); BWI Thurgood Marshall Airport (9,717); and the State of Maryland (9,424). The top private employers include Northrup Grumman (7,000); Southwest Airlines (3,200); and Booz Allen Hamilton (2,200) (http://www.aaedc.org/top_employers.html). The unemployment rate (July 2012) in the County was 6.6% (http://www.bls.gov/ro3/mdlau.htm). In 2012, the median household income in the County was $87,355 (http://www.aaedc.org/major_stats.html).

The County operates under a Charter form of government in which a legislative branch, known as the County Council, enacts laws and passes budgets presented by the County Executive who leads the executive branch. The County Executive and County Council are elected in a representative democratic system (http://www.aacounty.org/majortopics/government.cfm). Major departments, including the Fire Department and Office of Emergency Management, fall under the office of the County Executive.

The Anne Arundel County Fire Department (AACOFD) is a combination career-volunteer all-hazards metropolitan organization. Operating in 31 fire stations divided into three Battalions,
the Department provides essential emergency and non-emergency services including fire protection; Emergency Medical Services with both Advanced Life Support (ALS) and Basic Life Support (BLS) transport services; and Technical Rescue response including hazardous materials mitigation, confined space and collapse rescue, swift water and dive rescue, marine operations, high angle and rope rescue. According to the Department’s communications center supervisor, in 2011, the Department responded to slightly over 72,000 calls for service (R. Hallock, personal communication, Summer, 2012).

The Department staffs 28 engines, three Quints, seven ladder trucks, 21 ALS and 11 BLS ambulances, and one technical rescue squad with 148 on-duty personnel daily who work a 24 on / 72 hr off schedule. The department is comprised of 748 career uniformed personnel, 37 civilians and approximately 500 certified volunteers who are qualified to ride apparatus. All uniformed personnel (career and volunteer) are required to meet applicable National Fire Protection Association (NFPA) standards consistent with their rank in the Department. All personnel, career and volunteer, fall under the authority of the Fire Chief who is appointed by the County Executive. The Department’s approved operating budget for FY13 was $97,823,700 (Anne Arundel County Office of Budget, 2012, p. 277).

Anne Arundel County’s development and growth is deeply tied to the history of railroading in Maryland. In 1887, a short line railroad, originally known as the Annapolis and Baltimore Short Line Railroad (later known as the B&A Railroad) came into existence with passenger rail service between the largest city in Maryland (Baltimore) and the State Capital. The railroad remained in operation until 1950, a span of over 60 years during which time several important communities within the County including Linthicum, Glen Burnie, Severna Park and Arnold were created and flourished (http://www.aacounty.org/RecParks/parks/trails/bandatrailhistory.cfm). This type of
short run railroad was the pre-cursor to the present day Light Rail system. According to the MTA website, light rail ridership totals over eight million passengers annually, translating into an average daily ridership of slightly over 28 thousand passengers (http://www.mta.maryland.gov/about-mta). The Light Rail system has two major terminus points in Anne Arundel County: BWI Airport (the site of two serious crashes) and Cromwell Station/Glen Burnie with parking for 795 cars (second only to the station in Timonium, Baltimore County) (http://www.mta.maryland.gov/about-mta).

In 1868, the Baltimore and Potomac Railroad, connecting Baltimore and Washington D.C., was established and operated on the route that is now occupied by AMTRAK and the MARC train systems, traversing through Odenton, a heavily populated segment of western Anne Arundel County (http://www.aacounty.org/PlanZone/SAP/Resources/sap_crof_hist.pdf). The MARC train system operates three commuter rail lines including its busiest, the Camden Line, between Baltimore and Washington, D.C. In March 2012, the line saw the greatest increase in ridership with a 7.9% increase compared to 2011(http://www.mta.maryland.gov/mta-sets-new-ridership-record).

Concurrently, AMTRAK operates rail service through Anne Arundel County and, according to its fact sheet, BWI Thurgood Marshall Airport was the 17th busiest station in its nationwide system with over 662,000 passengers embarking and disembarking in 2011(AMTRAK, 2011, p. 1). Additionally, AMTRAK operates both its high speed rail service, known as the ACELA train, and several Northeast Corridor trains, all of which pass through Anne Arundel County and the BWI station. Of the seven major long distance trains traveling in and through Maryland, five pass through BWI (AMTRAK, 2011).

CSX and Norfolk Southern similarly use the rail lines located in Anne Arundel County to move millions of pounds of freight and chemicals on a daily basis. This challenge in compounded
by several key elements: 1) freight traffic and rail traffic share rail space; 2) there are at-grade rail crossings in the County on both the Light Rail system and CSX lines; 3) the commercial and freight rail lines are substantially concealed from public view and emergency responder access.

In order to understand the potential significance of the problem as stated in the introduction, it is appropriate to identify other recent rail disasters in the United States and their impact on local communities. It is reasonable to expect that such impacts, felt elsewhere, could similarly be experienced in Anne Arundel County based upon the volume and diversity of rail traffic that communicates through the County on a daily basis.

At 2:39 am on January 6, 2005, a freight train derailed in Graniteville, SC sending 60 tons of liquefied chlorine gas into the community. 5,400 people had to be evacuated and were prohibited from returning to their homes for approximately two weeks. 554 people were treated at hospitals; 75 were admitted as result of exposure; and nine people died of exposure to the toxic chemical (Dunning & Oswalt, 2007).

On January 16, 2007, at approximately 8:45 a.m., near Sheperdsville, KY, a CSX freight train traveling at approximately 47 miles per hour (mph) derailed 26 of its 80 cars, including three carrying hazardous materials, which caught fire and burned. 500 people were evacuated and the total property damage was estimated at $22.4 million (National Transportation Safety Board [NTSB], 2012).

In Chatsworth, California, a suburb of Los Angeles, 25 people lost their lives on September 12, 2008, when a Southern California Metrolink passenger train collided head-on with a freight train at approximately 4:22 p.m. 102 people were injured in the collision; damages estimates were reported to be in excess of $12 million dollars (National Transportation Safety Board [NTSB], 2010). The incident required the response of over 1000 emergency services personnel and required
the extensive use of a unified command system, which according to the NTSB was observed as, 
“considering the challenges of the recovery operations, the emergency response to the accident was 
timely, well coordinated, and effectively managed” (NTSB, 2010).

On January 4, 1987, an AMTRAK passenger train, the Colonial, crashed into the rear of a 
series of CONRAIL locomotives that had failed to follow a signal warning to stop prior to 
proceeding into the path of the passenger rail train. 16 people died and 175 were injured in what, at 
the time was the worst passenger rail incident in AMTRAK’s history. The incident took place in 
Chase, Maryland (National Transportation Safety board [NTSB], 1988). Chase, Maryland is 
located less than 40 miles from Anne Arundel County and units from the County Fire Department 
assisted at the scene.

On February 16, 1996, MARC passenger train 286 collided with AMTRAK passenger train 
29 (bound for Chicago from Washington DC) in a densely populated section of Montgomery 
County, Maryland. Eleven people were killed, over 50 were injured and the direct cost of the 
incident to the two rail agencies exceeded $7.5 million. The crash occurred at approximately 5:41 
pm and resulted in a catastrophic fire in the lead passenger rail car of the MARC train, where all 
eleven people perished (National Transportation Safety Board [NTSB], 1997, p. vii).

Although an incident similar to the examples provided herein has not occurred in Anne 
Arundel County to date, the conditions permitting an occurrence exist. To that extent, conducting 
this research effort is not only critical to fulfilling the County’s responsibility for emergency 
preparedness, it is also supported by the United States Fire Administration’s goals and objectives. 
Strategic goal #1 states, “Reduce risk at the local level through prevention and mitigation. Every 
disaster or emergency is local and personal, and being prepared is both an individual and collective 
responsibility. Prevention has to be a part of the public consciousness: automatically applied,
regularly practiced, and always respected. The USFA intends to be a national model and advocate for local, State, and national activities that develop, promote, enforce, and reward awareness, preparedness, and prevention” (Federal Emergency Management Agency [FEMA], 2010, p. 14). In order to reduce risk, it must be quantified through an assessment of probability and impact. This research effort is undertaken to identify a methodology to assess the risk within Anne Arundel County. Although probability may be reduced through national initiatives, the impact is perhaps most directly mitigated at the local level.

Additionally, Goal #3 states, “Improve the fire and emergency services’ capability for response to and recovery from all hazards. Every Federally-declared disaster began as a local response. Whenever there is a disaster—every response begins with a call to the local 9-1-1- center. When the local community has a well-trained, prepared, and coordinated local response to an all-hazards incident it usually remains a local response. When an incident escalates to a State or national response, it is the ability of the Federal, State and local responders to deliver a coordinated response to stop the loss of life and property” (FEMA, 2010, p. 14). Although Anne Arundel County has a long standing history of preparedness, including the creation and deployment of a federally recognized all-hazards type III Incident Management Team (IMT), the County remains challenged to ensure that its personnel are prepared to mitigate a hazard specific incident involving a rail disaster.

Finally, goal #4 states, “Improve the fire and emergency services’ professional status. As training and education standards evolve and demand greater academic rigor, the NFA in conjunction with our State, local, and tribal partners, will promote a nationally-accepted competency-based system of professional development” (FEMA, 2010, p. 14). Research, especially
research that is applied to a specific jurisdiction, elevates the professional standing of the personnel responsible for leadership within that community.

**LITERATURE REVIEW**

There can be little doubt that hindsight provides us the clearest view of events. Unfortunately, such clarity comes at a tremendous cost, usually in lives lost or catastrophic economic losses. The goal in such retrospective analyses should always be to first: prevent similar occurrences where possible; and second, to mitigate their impact. Federal agencies in the United States, including the National Transportation Safety Board with a mandate to investigate major transportation incidents, have, through investigations, engineered significant risk and vulnerability out of the rail industry in the United States. In order to understand the issues at hand it is important to review writings on the subject of risk assessment.

One of the primary challenges for modernized society is the juxtaposition of population growth and infrastructure to support such growth. When population density increases, as in the metropolitan Baltimore-Washington corridor, the demands upon the infrastructure also increase. Smith and Petley (2009) have identified that urbanization and infrastructure often co-exist in a paradoxically dangerous relationship where disasters have the increased potential to cause widespread harm. They continued by indicating that future disasters are likely to be more significant due to the concentration of people in urban and suburban areas (Petley & Smith, 2009, p. 9).

When discussing risk assessment, it is important to understand that there is a difference between risk and hazard. Although used interchangeably, they are not the same. Petley and Smith (2009) continue their discussion by defining *hazard* as a potential threat to humans and their welfare. *Risk* relates to the probability of a hazard occurring and its associated impact or loss
(whether in terms of lives or economic cost or both) (Petley & Smith, 2009, p. 13). A comparative example illustrates this point. Two communities, one urban and one rural, have the same rail lines traversing their geographic area. Although the hazard is identical (potential for a rail disaster) the risk is significantly different based on population density. The community with a denser population is, by default, absorbing a higher level of risk in permitting the same rail traffic to exist within their community.

Wisner, Blaikie, Cannon and Davis (2006) concur: “Disasters are a complex mix of natural hazards and human action …and are a brake on economic and human development on a national level when roads, bridges and other infrastructure are affected” (Wisner, Blaikie, Cannon, & Davis, 2004, p. 5). They continue by defining vulnerability as, “the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist, and recover from the impact of a … disaster” (Wisner et al., 2004, p. 11).

In 1996, FEMA produced a guide to jurisdictions in the development of Emergency Operations Plans (EOP) designed to assist local entities with assessing risks and developing response plans for identified risks (Federal Emergency Management Agency [FEMA], 1996). Such broad umbrella-type documents not only represent a crucial component of effective preparedness, they are in fact required under the Stafford Act in order for a jurisdiction to be eligible for reimbursement under a presidential declaration of disaster (FEMA, 1996). FEMA’s model EOP provides emergency management officials and emergency response leaders with a framework to develop action plans relating to directions and control, communications, warning procedures, emergency public information, evacuation, mass care, health and medical, and resource management. Such areas would be critical during an event of certain magnitude and encompass
significant man-made and/or natural disasters. Examples include, hurricane, flood, earthquake, terrorism, pandemic, and hazardous materials release (FEMA, 1996).

Anne Arundel County has such a plan. Developed in 2010, the Emergency Operations Plan (EOP) follows the national model established by FEMA, and addresses the basic components of emergency management including 16 Emergency Service Functions (ESF’s). The document is, however, silent on incident specific events beyond those identified in the FEMA planning guide and does not contain a section for rail disasters (Anne Arundel County Office of Emergency Management [AACO OEM], 2010). The County has conducted vulnerability assessments, developed and applied computer modeling, and performed table-top and full scale exercises for such expected disasters as a hurricane with widespread flooding, a commercial air disaster, and a significant hazardous materials release but has not completed an assessment of the impact related to a rail specific incident.

In its 1997 investigative report of the fatal train crash in Montgomery County, Maryland, the NTSB included in its list of recommendations to the Montgomery County Office of Emergency Management a specific recommendation to “develop comprehensive procedures for responding to railroad passenger train accidents and include these procedures in your disaster plan” (NTSB, 1997, p. 77). This was a result of its findings in the same report that the Montgomery County Emergency Management (MCEMA) disaster plan provided no guidance for a rail specific incident. It also found that there was no pre-planned relationship with either CSX or MARC and that offers of assistance during the incident mitigation phase were either delayed in reaching the incident commander or ignored when they did (NTSB, 1997). It was further described that at one point during the emergency response, a CSX locomotive was positioned close to the scene in a preparatory move to assist in the withdrawal of cars that had not been derailed as a result of the
collision. Upon being informed of an approaching train, the incident commander ordered an immediate evacuation of all personnel from the scene under the mistaken believe that the train was an approaching hazard (NTSB, 1997). Although not quantified, it is not unreasonable to postulate that any delay in controlling the fire, extricating victims, and providing emergency care hampered the rescue effort. Anne Arundel County’s EOP is similarly lacking in rail specific procedures. This places the County at a similar level of risk as was experienced nearly 15 years in the past.

The National Fire Protection Association (NFPA) is a nationally recognized standard-creating organization addressing a wide array of issues pertinent to fire and emergency services organizations. “The mission of the international nonprofit NFPA, established in 1896, is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training, and education” (http://www.nfpa.org). A review of its standards found a partially applicable standard relating to the current research effort. NFPA 1250, Recommended Practice in Fire and Emergency Services Organization Risk Management, provides guidance to organizations in the identification, prevention, mitigation and management of risk (National Fire Protection Association [NFPA], 2010). In it, several definitions are provided. Section 3.3.11 defines hazard as “a condition, situation, attitude or action that creates or increases expected loss frequency or severity” (NFPA, 2010, p. 5). Section 3.3.21 defines risk as, “a measure of the probability and severity of adverse effects that result from an exposure to a hazard” (NFPA, 2010, p. 5) and continues by defining risk assessment as, “an assessment of the likelihood, vulnerability, and magnitude of incidents that could result from an exposure to hazards” (NFPA, 2010, p. 5). There are, however, several significant limitations associated with the standard including its primary focus on hazards and risk internal to an organization compared to external incidents that the organization might be asked to handle. The researcher was unable to find an
NFPA standard directly on point to the research effort. That is not to indicate that the standard is
without application; rather that, like its FEMA counterpart, there is a tendency towards
recommending practices in global rather than incident specific terms.

By contrast, the Federal Railroad Administration, an agency in the United States
Department of Transportation, does provide at least one example of a specific strategy for assessing
rail risk management. In its 2009 white paper entitled High Speed Passenger Rail Safety Strategy,
a series of specific areas are identified relating to prevention and mitigation (Federal Railroad
Administration [FRA], 2009). Although focused on high speed rail (HSR), the paper
systematically lists safety related issues and addresses them through a step-by-step approach to the
general subject of HSR. Under prevention, such topics as vehicle / track interaction, positive train
control, grade crossing safety, maintenance-of-way safety management, right-of-way safety, and
real time system monitoring are addressed. Under mitigation strategies, structural standards, cab
car forward design, fuel tank integrity, emergency management, and system safety programs are
discussed (FRA, 2009).

Under the emergency management section, applicable federal regulations(49 CFR Part 239)
promulgated after significant loss of life incidents specify that rail agencies must develop and
manage policies and procedures for the efficient management of a rail accident (FRA, 2009, p. 18).
The intent is to require agencies that operate rail systems have specific mechanisms in place to
address the risks associated with a rail disaster. Unfortunately, those regulations do not appear to
compel or mandate rail agencies to routinely communicate with response jurisdictions through
which their tracks and trains travel. On the surface, this appears to result in rail agencies being
compelled to develop response plans from an agency level without incorporating the plans or
actions of the agencies through which their rail lines operate. This has the potential to result in
parallel but completely disconnected disaster plans. Although the argument could be made that jurisdictions and for-profit rail entities have competing goals and objectives, what cannot be argued is that both will be directly affected by, and involved in, a rail disaster.

The Passenger Rail Investment and Improvement Act (PRIIA) of 2008 required the development of state rail plans in every state that intends to, or receives, federal monies associated with rail traffic. It also compels the creation of a “state rail transportation authority” to establish policies and regulate freight and passenger rail traffic and oversee the application of federal funds transmitted to the state (Federal Railroad Administration [FRA], 2012). The document provides states with guidance concerning the development of a plan and suggests inclusion of the following sections (FRA, 2012, p. 11):

Executive Summary
1. The Role of Rail in Statewide Transportation (Overview)
2. The State’s Existing Rail System
3. Trends and Forecasts
4. Rail Service Needs and Opportunities
5. Proposed Passenger Rail Improvements and Investments
6. Proposed Freight Rail Improvements and Investments
7. The State’s Long-Range Rail Service and Investment Program
8. Coordination and Review

The researcher was unable to find a state rail plan for the state of Maryland. Reference is made of the intent to develop a state rail plan in the 2009 Maryland Transportation Plan, however there is no indication that the plan or the governing agency responsible for rail traffic has been established / identified (Maryland Department of Transportation [MDOT], 2009). Although not required by federal law, there was also no evidence of a rail plan at the County level and, as discussed earlier, no rail specific response plan exists in the OEM.
The AACOFD does have a rail specific response procedure for incidents involving the Light Rail system (APPENDIX A). This procedure specifies responsibilities of responders as well as required actions and train specific issues that are encountered. This procedure has been tested under training and actual incidents. Unfortunately, the AACOFD does not have a written procedure for managing an incident on either the commercial passenger or commercial freight rail lines that exist within the County.

PROCEDURES

The research effort began as a component of the National Fire Academy’s Executive Analysis of Community Risk Reduction (EACRR) course with pre-course material. The researcher was introduced to the United States Census website, http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml, upon which questions relating to demographic information specific to Anne Arundel County were answered. Once the research effort was undertaken, and the geographic areas of the County were identified, the researcher was able to return to the website and make determinations relating to population, commercial and residential properties, and special hazards.

From March 19, 2012 through March 30, 2012, the researcher attended the National Fire Academy’s resident program, Executive Analysis of Community Risk Reduction. During that period of time, the researcher spent extensive time at the Learning Resource Center. The researcher reviewed Applied Research Projects of previous EFO program participants on subjects similar to the topic being studied. Bibliographies were reviewed for pertinent reference materials as well as content to gain an understanding of research challenges that the researcher had not considered. It was during this time that the researcher drafted a problem statement, purpose statement, research questions, and selected a research methodology.
On March 27, 2012, the researcher attended a writing seminar with Dr. Burt Clark of the National Fire Academy. During the seminar, Dr. Clark provided additional insight into the expectations of program managers and conducted a detailed review of each segment of the Applied Research Paper (ARP). In follow up, the researcher met with Dr. Clark and reviewed the APR proposal. Recommendations were received and revisions were completed. The researcher strongly recommends that researchers undertaking a similar project contact Dr. Clark for guidance relative to the ARP.

Prior to completing the two week program, the researcher was provided with the name and contact information of his evaluator. Thereafter, the researcher submitted the ARP proposal which became the basis for the current research. Comments were received with an approval to proceed.

Upon returning to Anne Arundel County, the researcher subsequently contacted the Anne Arundel County Office of Emergency Management for three primary reasons: 1) obtain a copy of the County’s EOP; 2) obtain contact information for rail systems operating in and through Anne Arundel County; and 3) to ascertain whether a rail risk assessment had ever been undertaken in the County. As a result of the information received, the researcher undertook to obtain information relating to the background / significance and literature review components of the ARP.

A significant volume of time was spent searching for information via the internet. Key word searches were conducted using the search engine, Google Scholar, as well as generic search engines. Searches included words “vulnerability”, “rail disaster”, “risk assessment”, “risk management”, “rail safety”, and “rail hazard management”. Published articles were purchased and downloaded. Materials referenced in bibliographies of similar research efforts were also evaluated, and where applicable, incorporated in the research effort.
The researcher contacted the Fire Department’s Global Information Systems (GIS) specialist to assist in conducting an analysis of rail lines and their relationship to various entities in the County. Maps were produced that identified all rail lines in or near the geographic borders of Anne Arundel County. A map evaluating population density within one mile of the rail lines was developed and a map evaluating commercial businesses within one mile of the rail lines was similarly developed. The one mile standard was selected based upon the United States Department of Transportation Emergency Response Guidebook (ERG) which identifies Ammonia (UN1005) as one of the six most commonly transported Toxic Inhalation Gases transported in rail traffic (United States Department of Transportation [USDOT], 2012, p. 352). On page 188 of the same document, initial evacuation zones for a rail car involved in fire carrying Ammonia indicates that isolation and evacuation zones of one mile in all directions is indicated (USDOT, 2012, p. 188). Ammonia is a commonly used chemical that is classified as a corrosive gas with flammable properties, which according to the Centers for Disease Control is commonly found in Maryland, and is both produced in and transported through the State (Ammonia Properties, n.d., p. 119). The results of the mapping projects are identified in the next section and referenced in the appendices. It should be noted that Anne Arundel County possesses a commercially-available robust GIS mapping program: MapOptix. This program is user-friendly and has the capacity to overlay a wide array of information on research efforts. This researcher recommends the development of a relationship with local or state GIS representatives to obtain information pertinent to similar research efforts.

The researcher undertook to contact representatives from AMTRAK and CSX, the major passenger and freight rail carriers conducting business through the County. Initial efforts were significant in that the Office of Emergency Management did not have current contact information for individuals still working for the companies. On December 10, 2012 the researcher interviewed
Brian McDonough from AMTRAK. The researcher also contacted Michel Austin, a hazardous materials specialist with CSX.

In order to answer question one, what are the characteristics of rail traffic in Anne Arundel County, the researcher used mapping data obtained from GIS data mining and information gathered from representatives of the major rail lines in the County. The researcher also undertook a series of field observations of the County to assess the characteristics of rail traffic. These observations were conducted over a series of several weeks in September 2012 focused on identifying access points along rail corridors. The researcher traveled along rail corridors by road vehicle and noted access points, confirmed commercial properties identified in GIS mapping, and assessed rail traffic frequency for both commercial and passenger rail lines.

In answering question two, what causes rail disasters and which characteristics described are found in Anne Arundel County, the researcher evaluated data from the Federal Railway Administration (FRA) and then compared and contrasted common themes in rail disasters with characteristics found in the County. The researcher used a web-based accident prediction model available from the FRA, identified as the Web Accident Prediction System (WBAPS). The program can be found at http://safetydata.fra.dot.gov/webaps/. The program is available to any researcher and provided extremely accurate empirical data to form the basis for predicting the likelihood of an incident on a rail line in the County. The modeling program is specific for public highway-rail intersections but it should be noted that the WBAPS program is not intended to define intersections as dangerous; rather that certain data can be used to assist planners and emergency management officials with assessments supported by a science-based modeling program (Federal Railroad Administration [FRA], 2012, p. 1). The results of the modeling effort are summarized in the next section and the complete report is found in Appendix B.
In answering question three, *what methodologies exist that could be applied to conducting a risk assessment for a rail disaster in Anne Arundel County*, the researcher evaluated other research efforts attempting to answer similar research questions. The researcher also assessed risk assessment models available through the Federal Highway Administration (FHA), USFA, and the FRA. Several methodologies were identified including an extensive list of resources available to implement a risk reduction program.

Finally, in answering question four, *what are the characteristics of a "rail safe" community and how does Anne Arundel County compare*, the researcher identified “rail-safe” communities including defining characteristics and sought to compare those characteristics with those in Anne Arundel County. The researcher identified characteristics through the National Highway Traffic Safety Administration and the American Public Transportation Association.

**RESULTS**

The characteristics of rail traffic through Anne Arundel County reveal a dichotomy of preparedness and vulnerability. Appendix C, obtained from the GIS mapping effort, revealed 2000 commercial buildings located within one mile of a commercial or passenger rail line (Pyle, 2012). This assessment identified occupancies of national and international significance including the National Security Agency complex, located adjacent to Fort George G. Meade. A freight rail incident involving hazardous materials along the western boundary of the County would impact these facilities with un-quantified but intuitively serious consequences. Such an event would call into question the Continuity of Operations (COOP) plan for the NSA which is beyond the scope of this research effort.

Separately, in the extreme northeast section of the County, CSX freight rail traffic travels immediately over the Chesapeake Bay, posing a significant environmental risk in the event of a
catastrophic infrastructure failure of bridges carrying freight traffic. Additionally, a release in that area could originate in Baltimore City (adjacent to the County) and extend into the County. The area is densely populated. Overall, 127,801 people occupy over 58,000 housing units within one mile of a rail line across the County as shown in Appendix D (Pyle, 2012).

The researcher identified several risk assessment tools that could be applied in Anne Arundel County. The WBAPS program identified the 15 highest probability incident locations between a train and a highway vehicle and ranked them in order from highest to lowest probability. The highest probability intersection received a value of 0.040963 likelihood of a collision within a given year. The lowest probability intersection received a value of 0.000095 likelihood of a collision within a given year. The total combined likelihood value of all 15 locations was 0.100596. In context, the highest risk intersection in Anne Arundel County ranks 23rd statewide with only three intersections appearing in the top 100 locations (FRA, 2012). Between 2007 and 2012 there had been zero at grade crossing incidents reported to the FRA (FRA, 2012).

The researcher identified that no comprehensive commodity assessment had been accomplished in the County. In 2006, a draft proposal was put forth to conduct a comprehensive review of freight passing through the County, however the effort was abandoned for lack of funding (M. O’Connell, personal communication, winter, 2012). The researcher also identified that neither the County nor the Fire Department had evaluated freight or heavy rail lines for pre-planned access points.

Several models were found to assess risk. As discussed earlier, risk is a product of likelihood of an event multiplied by the consequences of an event. The impact of an event was found to be amplified or diminished as a function of the vulnerability or susceptibility to the event itself. For example, a hazardous materials release in the middle of a remote desert area has the
potential to result in a significant environmental impact. By contrast, the same event in a heavily populated area carries the same environmental impact but also has the added impact on lives, infrastructure, and the economy. These factors signal a vulnerability to the impact of an event. Figure 1 shows an example of a model available from the Federal Highway Administration that, for the purposes of this research effort, appeared to be applicable as a valid model for assessing risk.

![Risk Assessment Model](image)

**Figure 3.** Federal Highway Administration Risk Assessment Model (Federal Highway Administration [FHA], 2012, p. 1)

Inserting information into the table based on past experience, an assessment emerged for different types of rail disasters. For example, a rail disaster involving a Light Rail train, as experienced in Anne Arundel County in 2000, would fall into the Moderate category. The likelihood is at least likely or highly likely based on past experience and the volume of train movement through the County on a daily basis. The impact however, or consequence, is smaller
when compared with heavy rail or freight train derailment. As a result the researcher did not categorize the impact as High.

By contrast, a disaster involving heavy passenger rail (AMTRAK or MARC) or freight (CSX or Norfolk Southern), particularly hazardous materials posed an extreme risk from an impact perspective, despite the notably rare likelihood of the event. Without the ability to substantially reduce the impact, the risk model revealed a risk assessment rating of High. This determination was based on assessing previously noted rail disasters identified in the research effort. Two key points: First, the model referenced in this research effort was found in an article discussing the impact of climate change on transportation and infrastructure which is, at best tangentially applicable to this research effort. Having said that, the researcher found the model itself valid in illustrating the concept of risk modeling and applied it to the research effort. Second, the researcher used his own judgment when reaching conclusions concerning impact of a rail disaster involving light rail vs. heavy rail or freight traffic.

The federal government has similarly recognized the importance of conducting risk assessments and limiting, where possible, the transportation of hazardous materials through heavily populated areas. As provided by the FRA, “Importantly, Congress specifically endorsed this approach to rail hazmat routing in Section 1551 of the Implementing Recommendations of the 9/11 Commission Act of 2007 [Public Law 110-432]. The law requires railroads to perform the safety and security risk analyses and then to make an appropriate route selection. Further, moving these types of hazmat shipments over rail routes selected in this manner enhances safety and security for people living both in big cities and small towns”(Federal Railroad Administration [FRA], 2008, p. 1). The complete Fact Sheet, including the list of assessment dimensions, is found in Appendix E.
The Government Accounting Office (GAO) in a report addressing the economic impact of train disasters, attributed the leading causes of train disasters as human factors, track defects, and equipment problems (Government Accounting Office [GAO], 2010). Within human factors, subcategories included: unsafe acts of individuals, such as employee errors including fatigue, inadequate supervision, training and staffing (GAO, 2010).

A ten-year analysis of train accidents/incidents by the FRA between 2003 and 2012 nationally revealed a total of 118,179 which resulted in a corresponding 7,433 fatalities and 81,133 non-fatal injuries. The report classified 23,168 train accidents with human factor causes responsible for 8,750; track causes: 7,771; and motive power/equipment causes at 2,838. Additionally, miscellaneous causes accounted for 3,324. Separately, highway-rail incidents accounted for 22,888 incidents. In terms of economic impact, 507 incidents each exceeded $1 million in damages (Federal Railroad Administration [FRA], 2012).

Table 1 shows the 10-year statistics for railroads operating nationally. These systems also operate in Anne Arundel County. These statistics, when combined with the statistics above, reveal the common causes and railroads most commonly involved in incidents (FRA, 2012).

<table>
<thead>
<tr>
<th>Ranking (Nationally among 648)</th>
<th>Railroad</th>
<th>Incidents</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>AMTRAK</td>
<td>17,307</td>
<td>12.29</td>
</tr>
<tr>
<td>4</td>
<td>CSX</td>
<td>15,548</td>
<td>11.04</td>
</tr>
<tr>
<td>5</td>
<td>Norfolk Southern</td>
<td>13,007</td>
<td>9.23</td>
</tr>
<tr>
<td>29</td>
<td>MARC</td>
<td>254</td>
<td>0.18</td>
</tr>
</tbody>
</table>

A parallel analysis for Maryland revealed the following information: for the same 10-year reporting period, there were a total of 1,328 incidents/accidents resulting in 97 fatalities and 897
non-fatal injuries. A total of 273 train accidents were reported with associated causes listed as:

human factors caused (79); track caused (91); motive power/equipment caused (55); and
miscellaneous caused (42). Separately, highway-rail incidents accounted for 160 incidents. In
terms of economic impact, four (4) incidents each exceeded $1 million in damages (FRA, 2012).

Table 2 shows the breakdown for railroads operating in Maryland. These railroad systems
also operate in Anne Arundel County.

Table 2

<table>
<thead>
<tr>
<th>Ranking (Of 12)</th>
<th>Railroad</th>
<th>Incidents</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CSX</td>
<td>652</td>
<td>43.96</td>
</tr>
<tr>
<td>2</td>
<td>AMTRAK</td>
<td>482</td>
<td>32.50</td>
</tr>
<tr>
<td>3</td>
<td>MARC</td>
<td>156</td>
<td>10.52</td>
</tr>
<tr>
<td>4</td>
<td>Norfolk Southern</td>
<td>87</td>
<td>5.87</td>
</tr>
</tbody>
</table>

A parallel analysis for Anne Arundel County revealed the following information: for the
same 10-year reporting period: there were a total of 44 incidents/accidents resulting in two (2)
fatalities and 23 non-fatal injuries. A total of zero (0) train accidents were reported with associated
causes (FRA, 2012). It is noted that the Maryland Transportation Authority, which operates the
Light Rail system is excluded from the report and that the two incidents previously reported in this
research effort occurred in 2000.

Table 3 shows the breakdown for railroads with incidents occurring in Anne Arundel
County.
The results in this section reflect that national cause and effect of rail incidents are similarly found in Maryland and in Anne Arundel County on a scalar basis. Anne Arundel’s experience with rail incidents reflects, to a significantly lesser degree the challenges faced across the Country.

A retrospective analysis of accidents occurring during the transport of hazardous substances by road and by rail between 1900 and 2004 revealed an increasing frequency of such accidents. Although more than half (63%) occurred on roadways, the balance occurred on railroads (Oggero, Darbra, Munoz, Planas, & Casal, 2006). Figure 2 shows the most common resulting events from an accident with probability for future events.

Table 3

10-Year Reportable Incidents Occurring in Anne Arundel County

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Railroad</th>
<th>Incidents</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AMTRAK</td>
<td>26</td>
<td>56.52</td>
</tr>
<tr>
<td>2</td>
<td>CSX</td>
<td>10</td>
<td>21.74</td>
</tr>
<tr>
<td>3</td>
<td>MARC</td>
<td>9</td>
<td>19.57</td>
</tr>
</tbody>
</table>
In reviewing figure 2, attention should be directed to the fact that of the 1573 events included in the study, over 1200 involved the release of a hazardous chemical. This is important in predicting future events in the population-dense area of Anne Arundel County.

The National Highway Traffic Safety Administration (NHTSA) identified several activities directly related to rail traffic that they observed define a “safe community” (NHTSA best practices, n.d., p. 1). Examples included:

- Crossing safety and trespass prevention programs
- Partnership with local and railroad law enforcement officers
- Inventory of crossings and signal devices
- Systematic coordination in maintenance of railroad signs, markings, signals and equipment
- Priority list for upgrading railroad grade crossings

For Anne Arundel County, the researcher relied on the statistical data available from the FRA in assessing public rail-highway crossings. The results appeared to support a finding that Anne Arundel County was a rail-safe community from the limited perspective of public rail-highway crossings.

By contrast, the County has not maintained a partnership with local railroad officials. Sporadic efforts over a series of years resulted in an analysis that points of contact were not maintained due to turnover of personnel both in the Office of Emergency Management (the county agency responsible for maintaining such records) and the rail agencies themselves. Although not intentional, the confluence of preparing the County for an “all-hazards” event coupled with limited staffing compounded in turnover, has led to the breakdown of accurate information available to planners and researchers. As a result, Anne Arundel County would not be considered a “rail safe community” in terms of maintaining relationships with partner organizations.

DISCUSSION

Anne Arundel County is a major metropolitan jurisdiction that is vulnerable to the hazards associated with rail traffic that traverse the County. Although significant efforts have been put forth by the County in preparation to mitigate incidents upon their occurrence, little to nothing has been done in planning for a major heavy rail vs. freight rail or hazardous materials release from a rail incident.

The challenges are multiple: The researcher, through field observation, identified no more than two at-grade intersections at any point for the heavy passenger rail lines. In fact, the majority of the heavy rail lines are not readily accessible from paved public roads. Those that are, are often
found at the end of a cul-de-sac with extremely limited access which poses an additional challenge for emergency responders. Without the benefit of pre-planning, the tendency is for first arriving emergency vehicles to park as close to the incident as possible, thereby impeding the flow of more urgently needed equipment, including ambulances, to transport injured persons away from the scene. Such challenges have been elsewhere documented including the crash of a Boeing 707 in 1990 in the community of Cove Neck, New York. “Access to the crash site created a bottleneck on a single, narrow blacktopped residential road. Considerable congestion resulted as agencies tried to enter the road to assist as other agencies tried to exit to transport survivors to local hospitals (National Transportation Safety Board [NTSB], 1990, p. 73). Empirically, it would appear that the ability to control a scene of such magnitude is predicated more on the actions of the initial incident commander than any other factor. Without the benefit of training in the management of a rail-specific incident coupled with an awareness of community infrastructure characteristics, such results as experienced in New York could reasonably be expected to occur in Anne Arundel County.

The researcher was startled to learn that field personnel in the AMTRAK system had not been trained to any level of competency in the National Incident Management System (NIMS) (B. McDonough, personal communication, winter, 2012). When consideration is given that AMTRAK is a quasi-federal agency (a privately owned corporation, owned by the US Government) is seems incomprehensible that the personnel who work for the company and would presumably respond to an inter-agency incident are not prepared to insert themselves into a nationally-mandated model for incident management. Such failures have been previously identified as complicating already challenging events, causing needless delays in mitigation, risking lives, property and furthering the economic impact of an event.
From a straight cost-benefit analysis impacting quality of life, one researcher stated that the Baltimore region, of which Anne Arundel County is included, was identified as one of the most disastrous regions based on a “Rail Livability Score”: a series of thirteen categories upon which rail system assessments were made (O’Toole, 2004, p. 20).

**RECOMMENDATIONS**

Anne Arundel County has been assertive in embracing emerging strategies that better prepare its citizens and emergency responders to function in an all-hazards environment. The EOP developed by the Office of Emergency Management addresses major components that have the potential to impact the lives and property of citizens living in, and traveling through, the County. The County has been subject to hurricanes, floods, tornadoes, and other significant natural disasters as well as man-made incidents. In each of those cases, the AACOFD, as a component of a system-wide commitment of resources, has been extremely effective at limiting the loss of life of individuals living in and traveling through the County. Community risk-reduction efforts have yielded measurable results. The fire department routinely exercises the national incident management system on type IV and V incidents to ensure its capacity in managing larger scale emergencies.

The fire department, in cooperation with OEM, should now undertake to marshal its considerable resources in ensuring the county’s preparedness for a significant rail incident. The mission of the Anne Arundel County Fire Department is to “provide essential emergency and non-emergency services and integrated all-hazard emergency management to the citizens of Anne Arundel County. We are committed to eliminating threats to life, safety and property through education, prevention and safe, effective response and recovery activity to fire, medical, environmental, natural or technological emergencies. We will achieve our mission through
leadership, teamwork, professionalism and a commitment to the community we serve (Anne Arundel County Fire Department [AACOFD], n.d., p. 2). Having concluded that the County is at risk for a rail disaster, coupled with a lack of hazard-specific planning, the following recommendations are made:

1. Upon return from the NFA, the ARP should be shared with members of the command staff including the Fire Chief, Deputy Chief of Operations, Director of Emergency Management, and Deputy Chief of Planning. The goal will be to enlist support and authorization for additional action.

2. With approval, the GIS Section of the Fire Department should be directed to conduct a detailed analysis of current rail routes in the County, identifying access points for emergency responders. Within 90 days, Department maps should be updated to include access points for emergency responders. Special attention should be applied to providing mile posts and corresponding geographic street addresses.

3. The Department should open a line of communication with representatives from each of the major rail companies, freight and passenger, operating in and through the County. As experts in the rail industry, they are in a unique position to ensure that the Department’s intent to improve its preparedness for a rail disaster. A cooperative relationship with frequent information sharing will yield measurable improvement in emergency and non-emergency operations affecting rail systems.

4. The Department should undertake to develop a hazard specific Emergency Operations Plan (EOP) for a rail disaster. Given the explosive growth of the
western part of the County, coupled with expected increases in rail traffic over
the next 40 years, the known risks associated with rail hazards will increase. A
hazard-specific EOP will permit the Fire Department to meet its mission.
Stakeholders should be identified and a task group formed to ensure that all
aspects of risk including education, engineering, and evaluation are addressed.

5. The Office of Emergency Management should build into its three to five year
plan a full scale Community Hazards Emergency Response-Capability Assurance
Process (CHER-CAP) exercise to test the EOP. This will require coordination
with FEMA Region III as well as surrounding jurisdictions.
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APPENDIX A

LIGHT RAIL SYSTEM
EFFECTIVE DATE: 8/1/96

The Light Rail System extends out of Baltimore City and into Anne Arundel County through the Linthicum - Ferndale Corridor.

I. General Overview

A. Each light rail car consists of two halves which actually appear to be two cars connected in the middle by a flexible coupling. Each car has an "A" end and a "B" end, the "A" end having the pantograph mounted on its roof and always facing south into Anne Arundel County.

B. Facing the "A" end and counting clockwise, doors are numbered 1 thru 8 beginning with the left front door and ending with the right front door. Doors 1 & 5 are emergency access doors with the manual release handles located under the skirting panels.

C. Roof access must NEVER be attempted until the catenary has been de-energized, the battery breakers thrown open and a 5-minute waiting period for capacitors to drain has been established. The battery box is located on the exterior left side of the "A" end behind marked panels.

D. All power substations, roads and crossings are designated by chain marker numbers. The marker locations and numbers significant to this OPM are as follows:

<table>
<thead>
<tr>
<th>Location</th>
<th>Box</th>
<th>Map Coord.</th>
<th>Marker #</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 Block W. Patapsco Ave.</td>
<td>Balto. City</td>
<td></td>
<td>255</td>
</tr>
<tr>
<td>End of Henson Ave.</td>
<td>31-3</td>
<td>2G5</td>
<td>288</td>
</tr>
<tr>
<td>Power substation @ Hawthorne Ave.</td>
<td>32-10</td>
<td>2C8</td>
<td>350</td>
</tr>
<tr>
<td>Broadview Blvd. @ the border of Box Areas 32-9 &amp; 34-6</td>
<td>34-6</td>
<td>2F9</td>
<td>380</td>
</tr>
<tr>
<td>Power substation @ Rt. 648 &amp; Eugenia Ave.</td>
<td>34-4</td>
<td>2H11</td>
<td>430</td>
</tr>
<tr>
<td>Power substation @ Cromwell Station</td>
<td>34-5</td>
<td>7J1</td>
<td>485</td>
</tr>
</tbody>
</table>
II. Box Area Designations

A. The Light Rail Line will be divided into Special Boxes, divided at the power substations as follows:

Special Box 32-90 - The area between the AACo/Balto.City line & chain marker 288.

Special Box 32-91 - The area between chain markers 288 & 350.

Special Box 32-92 - The area between chain markers 350 & 380.

Special Box 34-90 - The area between chain markers 380 & 430.

Special Box 34-91 - The area between chain markers 430 & 485.

III. Response Procedures

A. Responses will generally fall into 3 categories

1. Incidents around, but not directly involving, the Light Rail System. The response shall consist of 2 engine companies.

2. Medical boxes. The response shall consist of 1 engine Company and 1 EMS unit.

3. Rescue boxes. The response shall consist of 3 engine companies, 1 truck/squad company, 1 ALS & 1 BLS unit, 1 Battalion Officer and the Duty EMS Officer.

4. Fire involving a car/s. The response shall consist of 4 engine companies, 1 truck/squad company, 1 EMS unit and 1 Battalion Officer.

B. Operations - Fire/Rescue

1. With the exception of the 2nd & 3rd due engine companies, all units shall respond to the vicinity of the incident location and stage as required.
2. The 2nd due engine company shall respond to the power substation immediately north of the incident location, and the 3rd due engine company shall respond to the power substation immediately south of the incident location. The duties of the 2nd & 3rd due engine companies shall be to de-energize the catenary wire upon orders from COMMAND, and deny entry to all persons, including Light Rail personnel, until otherwise directed by COMMAND. Power is de-energized by Knox Box key entry and pushing the large, red mushroom shaped kill switch to the left of the entry door.

3. Should the incident be located near enough to a power substation to indicate that a power overlap is possible, COMMAND shall request an additional unit to respond to the next power substation.

IV. Safety Considerations

A. Fire Alarm shall notify Light Rail Control of any situation requiring a Fire Department dispatch.

B. COMMAND shall have Fire Alarm advise Light Rail Control if trains need to be stopped or of any other requirements.

C. Serious caution should be taken to avoid contact with the overhead catenary wires and remotely controlled switching areas. These wires conduct approximately 750 volts. They can be deadly!

D. No operations shall commence until COMMAND has assured that the overhead pantograph has been fully lowered. This can be done by the Light Rail operator using the control console (page LR-5) or manually. Wheels on the car/s in which personnel are operating shall be chocked to prevent unanticipated movement.
Annual WBAPS 2012
WEB ACCIDENT PREDICTION SYSTEM

Accident Prediction Report for Public at-Grade Highway-Rail Crossings

Including:

Disclaimer/Abbreviation Key
Accident Prediction List

Provided by:

Federal Railroad Administration
Office of Safety Analysis
Highway-Rail Crossing Safety & Trespass Prevention

Data Contained in this Report:
STATE: MD
COUNTY: ANNE ARUNDEL

Date Prepared: 9/30/2012
WBAPS generates reports listing public highway-rail intersections for a State, County, City or railroad ranked by predicted collisions per year. These reports include brief lists of the Inventory record and the collisions over the last 10 years along with a list of contacts for further information. These data were produced by the Federal Railroad Administration's Web Accident Prediction System (WBAPS).

WBAPS is a computer model which provides the user an analytical tool, which combined with other site-specific information, can assist in determining where scarce highway-rail grade crossing resources can best be directed. This computer model does not rank crossings in terms of most to least dangerous. Use of WBAPS data in this manner is incorrect and misleading.

WBAPS provides the same reports as PCAPS, which is FRA's PC Accident Prediction System. PCAPS was originally developed as a tool to alert law enforcement and local officials of the important need to improve safety at public highway-rail intersections within their jurisdictions. It has since become an indispensable information resource which is helping the FRA, States, railroads, Operation Lifesaver and others, to raise the awareness of the potential dangers at public highway-rail intersections. The PCAPS/WBAPS output enables State and local highway and law enforcement agencies identify public highway-rail crossing locations which may require additional or specialized attention. It is also a tool which can be used by state highway authorities and railroads to nominate particular crossings which may require physical safety improvements or enhancements.

The WBAPS accident prediction formula is based upon two independent factors (variables) which includes: (1) basic data about a crossing's physical and operating characteristics; and (2) five years of accident history data at the crossing. These data are obtained from the FRA's Inventory and accident/incident files which are subject to keypunch and submission errors. Although every attempt is made to find and correct errors, there is still a possibility that some errors still exist. Erroneous, inaccurate and non-current data will alter WBAPS accident prediction values. While approximately 100,000 Inventory file changes and updates are voluntarily provided annually by States and railroads and processed by FRA into the National Inventory File, data records for specific crossings may not be completely current. Only the intended users (States and railroads) are really knowledgeable as to how current the inventory data is for a particular State, railroad, or location.

It is important to understand the type of information produced by WBAPS and the limitations on the application of the output data. WBAPS does not state that specific crossings are the most dangerous. Rather, the WBAPS data provides an indication that conditions are such that one crossing may possibly be more hazardous than another based on the specific data that is in the program. It is only one of many tools which can be used to assist individual States, railroads and local highway authorities in determining where and how to initially focus attention for improving safety at public highway-rail intersections. WBAPS is designed to nominate crossings for further evaluation based only upon the physical and operating characteristics of specific crossings as voluntarily reported and updated by States and railroads and five years of accident history data.

PCAPS and WBAPS software are not designed to single out specific crossings without considering the many other factors which may influence accident rates or probabilities. State highway planners may or may not use PCAPS/WBAPS accident prediction model. Some States utilize their own formula or model which may include other geographic and site-specific factors. At best, PCAPS and WBAPS software and data nominate crossings for further on-the-ground review by knowledgeable highway traffic engineers and specialists. The output information is not the end or final product and the WBAPS data should not be used for non-intended purposes.

It should also be noted that there are certain characteristics or factors which are not, nor can be, included in the WBAPS database. These include sight-distance, highway congestion, bus or hazardous material traffic, local topography, and passenger exposure (train or vehicle), etc. Be aware that PCAPS/WBAPS is only one model and that other accident prediction models which may be used by States may yield different, but just as valid, results for ranking crossings for safety improvements.

Finally, it should be noted that this database is not the sole indicator of the condition of a specific public highway-rail intersection. The WBAPS output must be considered as a supplement to the information needed to undertake specific actions aimed at enhancing highway-rail crossing safety at locations across the U.S. The authority and jurisdiction to appropriate resources towards the safety improvement or elimination of specific crossings lies with the individual States.
### Abbreviation Key

The lists produced are only for public at-grade highway-rail intersections for the entity listed at the top of the page. The parameters shown are those used in the collision prediction calculation.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RANK</td>
<td>Crossings are listed in order and ranked with the highest collision prediction value first.</td>
</tr>
<tr>
<td>PRED COLLs</td>
<td>The accident prediction value is the probability that a collision between a train and a highway vehicle will occur at the crossing in a year.</td>
</tr>
<tr>
<td>CROSSING</td>
<td>The unique sight specific identifying DOTIAAR Crossing Inventory Number.</td>
</tr>
<tr>
<td>RR</td>
<td>The alphabetic abbreviation for the railroad name.</td>
</tr>
<tr>
<td>CITY</td>
<td>The city in (or near) which the crossing is located.</td>
</tr>
<tr>
<td>ROAD</td>
<td>The name of the road, street, or highway (if provided) where the crossing is located.</td>
</tr>
<tr>
<td>NUM OF COLLISIONS</td>
<td>The number of accidents reported to FRA in each of the years indicated. Note: Most recent year is partial year (data is not for the complete calendar year) unless Accidents per Year is &quot;AS OF DECEMBER 31&quot;.</td>
</tr>
<tr>
<td>DATE CHG</td>
<td>The date of the latest change of the warning device category at the crossing which impacts the collision prediction calculation, e.g., a change from crossbucks to flashing lights, or flashing lights to gates. The accident prediction calculation utilizes three different formulas, on each for (1) passive devices, (2) flashing lights only, and (3) flashing lights with gates. When a date is shown, the collision history prior to the indicated year-month is not included in calculating the accident prediction value.</td>
</tr>
<tr>
<td>WD</td>
<td>The type of warning device shown on the current Inventory record for the crossing where: FC = Four Quad Gates; GT = All Other Gates; FL = Flashing lights; HS = Wigwags, Highway Signals, Bells, or Other Activated; SP = Special Protection (e.g., a flagman); SS = Stop Signs; XB = Crossbucks; OS = Other Signs or Signals; NO = No Signs or Signals.</td>
</tr>
<tr>
<td>TOT TRNS</td>
<td>Number of total trains per day.</td>
</tr>
<tr>
<td>TOT TRKS</td>
<td>Total number of railroad tracks between the warning devices at the crossing.</td>
</tr>
<tr>
<td>TTBL SPD</td>
<td>The maximum timetable (allowable) speed for trains through the crossing.</td>
</tr>
<tr>
<td>HWY PVD</td>
<td>Is the highway paved on both sides of the crossing?</td>
</tr>
<tr>
<td>HWY LNS</td>
<td>The number of highway traffic lanes crossing the tracks at the crossing.</td>
</tr>
<tr>
<td>AADT</td>
<td>The Average Annual Daily Traffic count for highway vehicles using the crossing.</td>
</tr>
<tr>
<td>RANK</td>
<td>PRED COLL.</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
</tr>
<tr>
<td>1</td>
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</tbody>
</table>

TTL: 0.100596
APPENDIX D
Appendix E

**Federal Railroad Administration**

**Rail Hazmat Routing Rule**

**Fact Sheet**

**Background**

The primary safety and security concern related to the transportation of hazardous materials by rail is preventing a potentially lethal spill or release from occurring in close proximity to heavily populated areas, events or venues with large numbers of people in attendance, iconic buildings and landmarks or environmentally sensitive areas. A catastrophic event of this nature could be the result of an accident or a deliberate act.

The U.S. Department of Transportation’s Pipeline and Hazardous Materials Safety Administration (PHMSA) working in close consultation with the Federal Railroad Administration (FRA) has issued regulations requiring railroads that transport certain hazmat commodities perform a comprehensive safety and security risk analysis in order to determine and select routes which pose the least overall risk. These analyses must include a minimum of 27 specific risk factors including input provided by state and local governments.

Importantly, Congress specifically endorsed this approach to rail hazmat routing in Section 1551 of the Implementing Recommendations of the 9/11 Commission Act of 2007 [Public Law 110-432]. The law requires railroads to perform the safety and security risk analyses and then to make an appropriate route selection. Further, moving these types of hazmat shipments over rail routes selected in this manner enhances safety and security for people living both in big cities and small towns.

In June 2008, the PHMSA Interim Final Rule (IFR) on rail hazmat routing became effective at which time railroads began implementing its various provisions, and FRA began related compliance oversight and enforcement activities. In December 2008, the PHMSA Final Rule became effective which clarified certain provisions of the IFR.

**Type of Hazardous Materials Covered**

Under the rail hazmat routing rule, security-sensitive hazardous materials are defined as:

- Bulk shipments of Poison Inhalation Hazard (PIH) materials, such as chlorine and anhydrous ammonia, which are known or presumed on the basis of tests to be toxic to humans and pose a hazard to health in the event of a release during transportation;

- More than 5,000 pounds in a single carload of Division 1.1, 1.2, or 1.3 explosive materials which pose a hazard of mass explosion, fragment projection, or a fire hazard with or without a minor blast or fragment projection hazard; and

- Certain high-level radioactive material shipments.
Role of FRA

The FRA is responsible for enforcing federal rail safety and hazardous materials laws, rules and regulations. The agency performs routine inspections, audits, and investigations of hazmat releases that result from train accidents as well as hazmat releases from non-accident events. Violations of federal regulations may result in enforcement actions including fines being levied against a railroad, individuals or companies which offer hazmat for rail transportation.

• FRA Will Review and Inspect Railroad Risk Analyses and Route Selection

FRA is incorporating review and inspection of railroad risk analyses and route selections into its regular oversight program. However, it is not pre-approving railroad selected routes in advance. FRA inspectors may offer recommendations to modify or improve the risk analyses or to use a different route if the selection documentation or underlying analysis is found to be deficient. If an inspector’s recommendations are not implemented, FRA can compel a railroad to make changes and/or assess a civil penalty.

• FRA Can Require a Railroad to Use an Alternate Route

If FRA determines that the route chosen by a railroad is not the safest and most secure practicable route available, FRA can require the use of an alternative route until such time as the identified deficiencies are corrected by the railroad. FRA will consult with PHMSA, the Transportation Security Administration, and the Surface Transportation Board before ordering the use of an alternate route.

Key Provisions of the Rail Hazmat Routing Rule

• Railroads to Implement Initial Route Selection by September 1, 2009 or by March 31, 2010

If a railroad elects to use six-months of data (from July to December 2008) for its risk analyses it must implement its initial route selection by September 1, 2009. If a railroad chooses to perform the risk analyses based upon 12-month data (from January to December 2008) it must provide FRA advance notification of that decision and implement its initial route selection by March 31, 2010. Full year data analyses will enable railroads to take into account seasonal variations in the movement of hazardous materials covered by the rule.

• Railroads Must Perform Safety and Security Risk Analyses Every Year

Beginning in 2010, railroads are required to conduct risk analyses annually to assess the safety and security risks along the current route utilized to transport the specified shipments, and must also assess the risks on practicable alternative routes over which they have authority to operate. These analyses must include a comprehensive review of all operational changes, infrastructure modifications, traffic adjustments, changes in the nature of potential high-consequence targets along or in close proximity to the route, or other changes affecting the movement of the relevant hazmat shipments. This systematic process will ensure that modifications and changes are taken into account.
in risk analyses during the same calendar year that they occur. In addition, a railroad is expected to consider changes that may reasonably be anticipated to occur in the upcoming year.

• **Railroads Must Consider at Least 27 Risk Factors in Safety and Security Risk Analyses**

Railroad risk analyses must consider at least 27 factors that may affect the possibility of a catastrophic release along a specific route, including the volume of the commodity transported; the total distance traversed; track attributes; population density; the environmental characteristics of the area surrounding the route; and any prior history of incidents or risk mitigation measures for the route, among others (see below for full list). Railroads must then use the results of the risk analyses to select the route with the fewest overall safety and security risks.

Also, the U.S. Department of Homeland Security provided funding to the Railroad Research Foundation, a non-profit arm of the Association of American Railroads, to develop a sophisticated statistical routing model that railroads may use to conduct risk analyses in order to comply with the rule. Railroads may choose other routing models for use in preparing their risk analyses.

• **Railroads Must Analyze and Assess Practicable Alternate Routes**

In addition to the current route utilized for hazardous materials movements, a railroad is required to analyze the safety and security risks of practicable alternative routes over which it has authority to operate. Railroads must also consider the use of interchange agreements (allowing railroads to exchange railcars at a specific junction point) when determining practicable alternative routes and the potential economic effect of using an alternative route.

• **Railroads Must Seek Information from State and Local Officials**

Each railroad’s designated point of contact for hazmat routing issues is required to seek information from state and local officials regarding potential security risks to high-consequence targets along or in close proximity to those routes. Railroads have existing relationships with state and regional fusion centers (organized to share security and first responder information and intelligence) to coordinate routine law enforcement involvement and should use these centers as a focal point for the exchange of information regarding rail hazmat routing. Information or data collected for this purpose will become part of the risk analysis for the current and practicable alternate routes.

• **Railroads Must Address En Route Storage and Delays in Transit**

Railroad security plans must include: (1) a procedure for consulting with offerors and consignees to minimize the time that a hazmat shipment is stored incidental to its movement from origin to destination; (2) measures to limit access to such shipments during temporary storage and delays in transit; (3) measures to mitigate risk to population centers during temporary storage incidental to transportation; (4) measures to be taken in the event of an escalating threat level during temporary storage incidental to transportation; and (5) a procedure for notifying the consignee in the event of transportation delays.
• Railroads Must Enhance Pre-Trip Inspections of Rail Hazmat Cars

To minimize the possibility that an unauthorized individual could tamper with rail cars containing hazardous materials to precipitate an incident during transportation, such as detonation or release using an improvised explosive device (IED), railroads are required to include as part of their routine pre-trip inspections of placarded hazardous material rail cars an inspection for signs of tampering with the rail car, including its seals and closures, and an inspection for any item that does not belong, is suspicious, or may be an IED.
**Rail Risk Analysis Factors**

The following is a list of evaluative criteria that at a minimum must be considered by railroads when performing the safety and security risk analyses:

1. Volume of hazardous material transported;
2. Rail traffic density;
3. Trip length for route;
4. Presence and characteristics of railroad facilities;
5. Track type, class, and maintenance schedule;
6. Track grade and curvature;
7. Presence or absence of signals and train control systems along the route (“dark” versus signaled territory);
8. Presence or absence of wayside hazard detectors;
9. Number and types of grade crossings;
10. Single versus double track territory;
11. Frequency and location of track turnouts;
12. Proximity to iconic targets;
13. Environmentally-sensitive or significant areas;
14. Population density along the route;
15. Venues along the route (stations, events, places of congregation);
16. Emergency response capability along the route;
17. Areas of high consequence along the route, including high consequence targets as defined in § 172.820(c);
18. Presence of passenger traffic along route (shared track);
19. Speed of train operations;
20. Proximity to en-route storage or repair facilities;
21. Known threats, including any non-public threat scenarios provided by the Department of Homeland Security or the Department of Transportation for carrier use in the development of the route assessment;
22. Measures in place to address apparent safety and security risks;
23. Availability of practicable alternative routes;
24. Past incidents;
25. Overall times in transit;
26. Training and skill level of crews; and
27. Impact on rail network traffic and congestion.

For additional information, please contact

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