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Chemical Facility Vulnerability Assessment Project

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Abstract

Sandia National Laboratories, under the direction of the Office of Science and Technology, National Institute of Justice, is conducting the Chemical Facility Vulnerability Assessment (CFVA) project. The primary objective of this project is to develop, test and validate a vulnerability assessment methodology (VAM) for determining the security of chemical facilities (VAM-CF^{SM}) against terrorist or criminal attacks. The project also included a report to the Department of Justice for Congress that in addition to describing the VAM-CF^{SM} also addressed general observations related to security practices, threats and risks at chemical facilities and chemical transport.

In the development of the VAM-CF^{SM} Sandia leveraged the experience gained from the use and development of VAs in other areas and the input from the chemical industry and Federal agencies. The VAM-CF^{SM} is a systematic, risk-based approach where risk is a function of the severity of consequences of an undesired event, the likelihood of adversary attack, and the likelihood of adversary success in causing the undesired event. For the purpose of the VAM-CF^{SM} analyses **Risk** is a function **S**, $\mathbf{L_A}$, and $\mathbf{L_{AS}}$, where **S** is the severity of consequence of an event, $\mathbf{L_A}$ is the likelihood of adversary attack and $\mathbf{L_{AS}}$ likelihood of adversary success in causing a catastrophic event. The VAM-CF^{SM} consists of 13 basic steps. It involves an initial screening step, which helps to identify and prioritize facilities for further analysis. Other steps help to determine the components of the risk equation and ultimately the risk. The VAM-CF^{SM} process involves looking at the covered chemicals and processes at a chemical facility. It helps chemical facilities to focus their attention on the most critical areas. The VAM-CF^{SM} is not a quantitative analysis but, rather, compares relative security risks. If the risks are deemed unacceptable, recommendations can be developed for measures to reduce the risks. This paper will briefly discuss the CFVA project and VAM-CF^{SM} process.

Background

The Chemical Facility Vulnerability Assessment (CFVA) Project was undertaken by Sandia National Laboratories (SNL) under the direction of the Department of Justice's National Institute of Justice (NIJ). The purpose of this effort was to advise the Attorney General of the United States as to a practical method by which the safety and security of chemical facilities within the United States might be assessed. The report provides the Attorney General with a model assessment tool (VAM-CF^{SM}) which can be used to identify and assess the threats, risks, and vulnerabilities of particular chemical facilities, as well as explains the process by which the assessment methodology was developed, validated, and tested. Additionally the report provides the Attorney General with general observations regarding the overall risks, threats, and vulnerabilities that may exist at chemical facilities based on several limited site visits to chemical facilities made during the methodology development process. The report also discusses potential remedies that might be adopted to address these risks, threats, and vulnerabilities, as well as advises the Attorney General on the issues surrounding the public disclosure of the specific information that will result from the assessment of any given chemical facility. Observations for the report were collected through visits to chemical facilities within the United States prior to and after the September 11, 2001 terrorist attacks on the United States.

During the development, testing, and validation of the VAM-CF^{SM}, SNL staff:

- Collected and reviewed extensive information relevant to the threats, risks, and vulnerabilities associated with chemical facilities, including current security practices in the chemical industry.
- Conducted extensive outreach with the field including meetings and discussions with a range of industry, government, and public citizen representatives, as well as private individuals, all of whose observations were considered in developing the methodology and preparing the report.
- Created an Internet web site to describe the development effort and solicit comments.
- Visited eleven chemical facilities.

Overview of the VAM-CF^{SM} Process

In the development of the VAM-CF^{SM} considerable effort was expended to leverage existing requirements such as the facility risk management plans and off-site consequence analysis (RMPs and OCAs), as well as, process safety management (PSM). A useful VAM-CF^{SM} must provide CFs with a means to readily judge the adequacy of their current security systems and practices, and a means to identify potential remedies that can be incorporated into the facility's operations to counter identifiable risks, threats, and vulnerabilities. The following figure illustrates areas leveraged by the VAM.

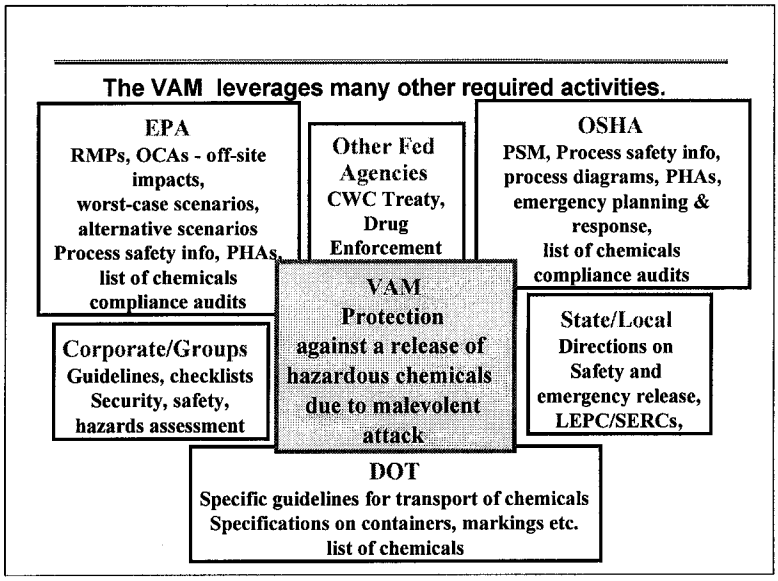

Figure 1, Interactions with Other Activities.

The structure of the VAM-CF[SM] provides for considerable flexibility in the consideration of different CFs, potential undesired events, and possible adversary threats. The worksheets within the VAM-CF[SM] workbook have been tailored to support the VA for an undesirable event of a release of covered chemicals with off-site consequences caused by either an outsider adversary (e.g. terrorist) or an insider adversary. If a different undesired event were selected (e.g. loss of production, theft) then some different criteria and worksheets would be needed to support that assessment.

In developing the CFVA methodology SNL focused primarily on physical security at chemical facilities with a secondary emphasis on security issues associated with the transportation of hazardous chemicals and electronic access to chemical facility control systems. The VAM-CF[SM] methodology was envisioned to be a tool intended to provide a systematic, risk-based approach to assessing security at chemical facilities based upon potential threats and vulnerabilities, the probability of a successful attack occurring, and the severity of consequences resulting from a successful attack. The VAM-CF[SM] incorporates appropriate safety and emergency response measures that could prevent or mitigate the consequences of a successful attack, and is designed to be usable by chemical facility personnel to provide meaningful vulnerability information so that additional protection measures, if appropriate, may be taken.

The objective of the VA methodology is to provide a security assessment tool with the following characteristics:

- Systematic, risk-based approach where risk is a function of:
  - Threat (type and likelihood of an attack).
  - Severity of consequences of a successful attack.
  - Likelihood of an adversary causing a successful attack.
- Incorporate appropriate safety and emergency response measures that could mitigate the consequences of a successful attack.

- Readily useable by chemical facilities.
- Provide meaningful vulnerability information so additional protection measures can be implemented which effectively reduce risk.

From the outset it was also recognized that for a chemical facility' security system to offer a high probability of defeating an attack, three elements must be present and working properly. These are:

- DETECTION. The ability to detect and identify when an attack occurs. Adversaries must be detected in time to prevent them from accomplishing their goal.
- DELAY. Adversaries must be delayed long enough for a mechanism or response force to intercept them before they accomplish their goal.
- RESPONSE. The response mechanism or force must be able to neutralize the adversaries and preserve the integrity of the facility.

Even so, simply including these elements in a security system does not guarantee the effectiveness of the system if the system is poorly designed, or the technologies, personnel, or procedures in the elements do not perform adequately. While numerous safety systems do exist at CFs that are designed to mitigate the effects of an uncontrolled release (e.g., neutralizing spray systems), the effectiveness of such systems needs to be analyzed for their security effectiveness, with special consideration given the possibility of an attacker attempting to defeat such systems.

The VAM-CF^{SM} is comprised of thirteen steps. These are:

1. Screening. This is a determination of which chemical facilities need or desire a vulnerability assessment. To determine whether a chemical facility requires a VA two principal questions must be answered. One is whether loss of the facility would result in a significant national impact. The other is whether a compromise of the facility would result in unacceptable losses in terms of injury and/or death to adjacent populations. If the answer to either is "yes", a VA should be undertaken.
2. Vulnerability assessment project definition. Once a determination is made to undertake a VA, the project should be defined, a team assembled, and the necessary steps taken to proceed with the assessment.
3. Characterization of facility. This entails defining the type, nature, physical parameters and boundaries, operational practices, security systems, and physical characteristics of the facility.
4. Derivation of consequence severity levels. This entails identifying potential incidents and the severity of resulting consequences.
5. Threat assessment. Involves the identification and characteristics of potential threats to the facility.
6. Identification of priority cases for analyses. This involves an analysis of the likelihood of various attack scenarios against the facility.
7. Preparation for analyses. This entails a compilation of all relevant materials relative to the physical plant, operations, and security systems of a facility.

8. Site survey. Physical examination of the facility.
9. System effectiveness analyses. This entails an analysis of existing on-site security systems.
10. Risk analysis. This involves an analysis of risks based on the facility's characteristics, potential threats, potential consequences, and existing security systems.
11. Recommendations for reduction of vulnerabilities. Based on the analysis of risks, this step provides an analysis of actual vulnerabilities.
12. Consideration of impacts. This involves consideration of possible upgrades and their costs and impact of facility operations/schedule, safety/health and other factors.
13. Final report preparation. Summary of the findings from the VA.

Worksheets have been developed for each of the above steps. The current version of the VAM-CF[SM] is a paper-based system but efforts are currently underway to automate the VAM. The following figure summarizes the VAM-CF[SM] risk analysis approach.

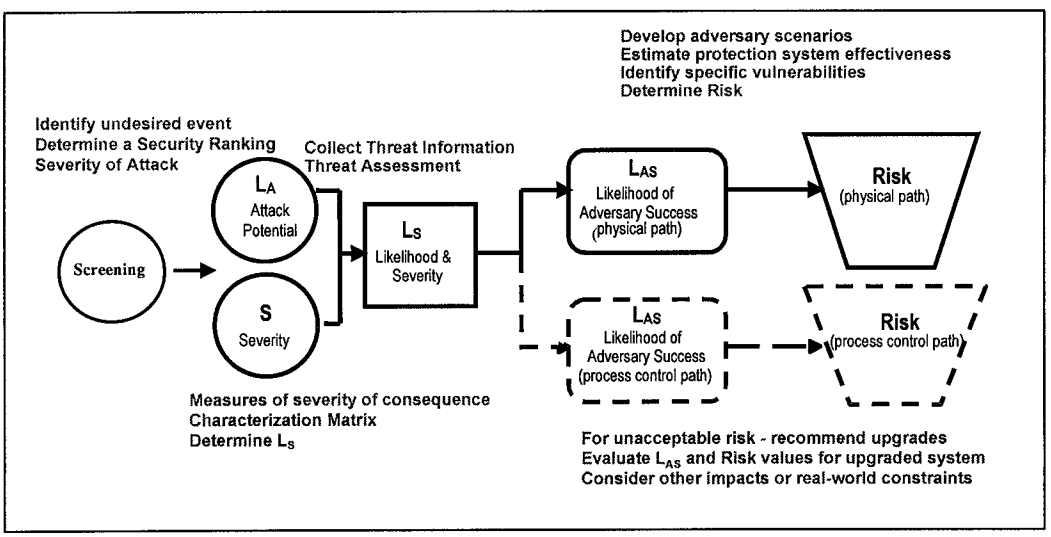

Figure 2. Risk Analysis/VAM-CF[SM] process

Capabilities/Advantages of the VAM-CF[SM] Process

The benefits expected from the use of a chemical facility VA methodology include the following:

- Systematic procedure to help make consistent risk-based analyses
- Having a standardized methodology that will allow for comparison of security risks across a number of chemical facilities and help identify priority chemical facilities and priority operating units within chemical facilities for security upgrades.
- Leverages other requirements (e.g. PSM, RMP) placed on CFs
- Identify and prioritize security vulnerabilities at chemical facilities and the attack scenarios associated with those vulnerabilities so appropriate recommendations can be developed to address those vulnerabilities. Otherwise, security upgrades may be undertaken which do not effectively address the vulnerabilities.

- Provides the capability to address different undesired events and threats
- Provide a mechanism to make the best use of security funding and other resources at chemical facilities to address priority vulnerabilities.
- Provides ability to screen and focus on critical areas and a framework to identify and prioritize security vulnerabilities
- Identify chemical facilities where the consequences of an attack would potentially outweigh the consequences of a accidental release of a hazardous chemical.
- Provides a methodology to help increase protection against the consequences of malevolent attacks on CFs and to make the best use of security funding and other resources
- Having a methodology that strongly encourages, if not requires, expanded interactions between local law enforcement and emergency response agencies and chemical facilities to evaluate and understand security at chemical facilities.
- Having a process that encourages the development of new and innovative solutions to security vulnerabilities at chemical facilities may readily lead to the collection and dissemination of such solutions within the chemical industry.
- Increasing confidence in neighboring communities that chemical facilities have appropriate security.
- Provides a continuous approach to evaluating risk
- Ultimately, improving protection against the consequences of attacks on chemical facilities.

Summary

Although the VAM-CF^{SM} is currently only a paper-based system and is continuing to be developed, it provides the chemical industry with an easy, usable and effective method for assessing the risk against potential malevolent threats. The systematic approach provides for the ability to focus on the most critical areas first and to be able to trace and justify decisions. If vulnerabilities and weaknesses are identified, the process of developing enhancements and countermeasures to either prevent and/or mitigate the consequences of an undesired event can be initiated. The VAM-CF^{SM} is closely linked to other existing hazard and safety analysis and thus helps to provide for an overall protection strategy that makes CFs more safe and secure. The development of a VAM-CF^{SM} and other VA methodologies are an important step toward appropriate improvements in CF and chemical industry security against terrorist and criminal acts.

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