Office of Environment, Safety and Health

Limited Scope Accident Investigation

April 7, 2005 South Gate Active Vehicle Barrier Incident at the DOE Germantown Complex Germantown, Maryland

June 2005

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Figures and Tables

Release Authorization

On April 14, 2005, I appointed a Limited Scope Accident Investigation Board to investigate the April 7, 2005, Active Vehicle Barrier accident that occurred at the South Gate of the DOE Germantown Complex and a subsequent incident on June 8, 2005 at the North Gate. The Board's responsibilities have been completed with respect to this investigation. The analyses and the identification of the contributing causes, the root cause and the Judgments of Need resulting from this investigation were performed in accordance with DOE Order 225.1A, *Accident Investigations.*

I accept the report of the Accident Investigation Board and authorize release of this report for general distribution.

John Spitaleri Shaw
Assistant Secretary for
Environment, Safety and Health
U.S. Department of Energy

07-27-05
Date

This report is an independent product of the Limited Scope Accident Investigation Board appointed by John Spitaleri Shaw, Assistant Secretary, Environment, Safety and Health, U.S. Department of Energy.

The Board was appointed to perform a Limited Scope Accident Investigation of this accident and to prepare an investigation report in accordance with DOE Order 225.1A, *Accident Investigations.*

The discussion of facts as determined by the Board and the views expressed in the report do not assume, and are not intended to establish, the existence of any duty at law on the part of the U.S. Government, its employees or agents, contractors, their employees or agents, or subcontractors at any tier, or any other party.

This report neither determines nor implies liability.

Acronyms

AVB	Active Vehicle Barrier (System)
DOE	Department of Energy
IST	Integrated Security Technologies, Incorporated
NBI	Nasatka Barrier, Incorporated
SO	DOE Headquarters Office of Security Operations
South Gate Project	South Vehicle Entrance Vehicle Barrier Installation Project
WWS	World Wide Security/Wackenhut

The Accident

On the morning of April 7, 2005, a Department of Energy (DOE) contractor employee driving a commercial van approached the DOE Germantown South Gate. The driver was transporting mail between the Germantown, Maryland U.S. Post Office and the DOE Germantown Facility. A Protective Force Officer examined the driver's badge for DOE verification, waved him forward, and pushed the down button for barrier #3. As the driver proceeded forward to pass over the barrier, the vehicle impacted the barrier. The van became stuck at the barrier location, a gate arm came to rest on top of the hood of the van, and barrier #3 was in a partially raised position. The driver, who was wearing his seatbelt, sustained a superficial cut to his forehead from hitting the steering wheel. The van sustained significant damage to the front suspension and was not drivable. The driver was examined by Montgomery County Fire and rescue and refused transport to the hospital. Later the driver visited his physician and was advised to take leave for the rest of the day.

After the accident, tests were conducted at the South Gate for all four active vehicle barriers. The tests concluded that no South Gate safety loops were functional. Nasatka Barrier, Incorporated (NBI) inspected the barriers to determine how the barrier might have raised without receiving a signal from the South Gate House control box and why the safety loop had not prevented the barrier from raising. NBI determined that the safety loops had not been wired to the safety switch inside the control box and that some micro switches were not positioned to allow the safety loops to stop the barrier in place if activated.

On April 14, 2005, the Assistant Secretary for Environment, Safety and Health appointed a Limited Scope Accident Investigation Board to investigate this accident in accordance with DOE Order 225.1A, *Accident Investigations*.

Background

Following the events of September 11, 2001, security upgrades were implemented at the DOE Germantown, Maryland facility. These security upgrades included the installation of guard stations and vehicle barriers at the two entrances to the facility.

On August 15, 2003, Johnson Controls – as prime contractor for security upgrade activities at the DOE Germantown site – delegated project management for the South Vehicle Entrance Vehicle Barrier Installation Project (South Gate Project) to Integrated Security Technologies, Incorporated (IST). On March 23, 2004, the proposal for installation of the active vehicle barrier system at the South Gate of the DOE Germantown facility was finalized.

The purpose of this task was to enhance the security of the South vehicle entrance roadway. The work included installation of hydraulically controlled, surface mounted vehicle barriers. The barriers were controlled from the adjacent guard post. The proposed barriers were similar in nature and construction to existing barriers at the North Gate of the facility and were manufactured by NBI.

Four organizations had the primary roles and responsibilities for execution of the South Gate Project and installation of the AVB system. The Office of Security Operations (SO) managed security activities at DOE

Headquarters and, hence, has overall responsibility for the effectiveness of the AVB project and its operation. IST was responsible for day-to-day management and coordination of the project design, installation, testing, continuous operation, and peripheral maintenance activities. NBI was the barrier manufacturer, installation contractor, and responsible for barrier maintenance. World Wide Security/Wackenhut (WWS) provided protective force services and, in doing so, operated the barrier system.

NBI, in a disclaimer documented in the scope of work, stated that all barrier systems should be carefully planned with safety as a paramount concern and that the system was designed to control vehicle traffic. As the manufacturer was not a traffic safety-engineering firm, NBI recommended that the system be reviewed with respect to these considerations before installation. A traffic safety study was not performed. Following installation of the AVB systems at the DOE Germantown facility, 12 incidents involving vehicles and AVBs were documented. Of these, two incidents involving unintended barrier activation at the South Gate have occurred since July 2004 and prior to this event.

Analysis and Conclusions

The root cause of the accident is that SO and IST did not ensure that principles associated with quality and Integrated Safety Management were adequately incorporated into the design, installation, operation, and maintenance of the South Gate Project. Similarly, the Board determined that SO allowed an unstructured approach to the design, installation, operation, and maintenance of the AVB system. This lead the Board to conclude that the accident was preventable.

Underpinning this, are a series of conditions that contributed to the circumstances surrounding the events of April 7, 2005. These conditions are as follows:

- SO and IST did not establish a formal process for conducting oversight of project activities. They did not establish clear safety objectives that would have been integrated with pre-existing security objectives and requirements, and they did not ensure development of an overall project plan and related quality and safety plan documentation. As a result, there was not a basis on which to conduct performance monitoring.

- IST did not demonstrate effective project management. IST did not develop a project management plan, quality assurance plan, and safety plan to guide project activities. Safety and site plan reviews were not conducted during the design and installation phases. As project manager, IST did not ensure that a critical element of the project – execution of a traffic safety study – was performed.

- SO did not require the establishment of – and IST and NBI did not initiate development of – a set of acceptance and testing requirements for the AVB system. Such requirements would have established clear performance conditions under which SO would have accepted the system as complete and fully functional.

- WWS did not provide formal training and procedures for protective force personnel to operate the South Gate AVB system. Both officers present at the South Gate the day of the accident received a single hour of training on operating the barrier device. The only procedure available for active vehicle barrier operations, Procedure 137, was written for operations of barriers at

the North Gate. Formal training on procedures specific to the South Gate AVB system would have ensured that protective force personnel would have understood how to operate the South Gate AVB system safely.

- SO did not adequately establish effective processes for monitoring and assessing IST, NBI, and WWS performance; providing feedback; and holding these organizations accountable for correction of deficiencies and performance of the South Gate AVB system. The 12 reported incidents – since October 2003 – involving vehicles and the AVB system at the DOE Germantown facility have not been systematically analyzed and trended, nor were lessons learned captured and communicated to prevent recurrence.

Table ES-1 summarizes the Board's conclusions and Judgments of Need.

Table ES-1. Conclusions and Judgments of Need

Conclusion	Judgment of Need
The Board concludes that critical safety roles and responsibilities, which would have ensured safe and effective design, installation, operation, and maintenance of the AVB system, were not properly assigned or executed.	SO needs to develop and implement a formal process to review and modify (as necessary) design, installation, operation, and maintenance documents to ensure that critical safety roles and responsibilities are identified, assigned, and executed for all projects under SO purview.
The Board concludes that several safety expectations were not identified and incorporated into the South Gate Project.	SO needs to develop and implement a formal process to ensure that essential safety requirements are identified and are incorporated into contractor documents for implementation, according to SO safety expectations. IST and other contractors need to formally institutionalize a process for identifying, capturing, evaluating, and translating essential safety requirements into SO project activities.
The Board concludes that the AVB master control panel layout at the South Gate was inadequate for repetitive and routine operations and needs improvement to preclude accidental operation of the AVB.	
The Board concludes that quality assurance processes for testing and acceptance of the operation of safety loop #2 were lacking.	IST and other contractors need to formally develop and implement procedures for testing and acceptance of project deliverables and any associated modifications. SO needs to develop and implement formal procedures for acceptance or receipt of any project deliverables.
The Board concludes that maintenance procedures and the quality assurance process were less than adequate.	
The Board concludes that hazard controls associated with AVB design and operation were not effectively identified, integrated, or implemented.	IST and other contractors need to develop and implement a formal process to define roles and responsibilities for evaluation of hazards, identification and implementation of hazard controls, and the incorporation of any modifications associated with SO projects. SO needs to develop a formal process to ensure that IST and other contractors have established
The Board concludes that requirements for a hazard analysis were not identified and notably a traffic safety study was not conducted as the basis for establishing traffic safety risks and associated controls.	

Conclusion	Judgment of Need
The Board concludes that responsibility to conduct a traffic safety study to identify effective vehicle safety controls was not defined for the project. As a result, there is no basis for safety measures at the South Gate of the DOE Germantown complex.	roles and responsibilities for effective hazard evaluation and identification and implementation of hazard controls for SO projects.
The Board concludes that preventive maintenance activities conducted by an NBI representative at barrier #3 at the South Gate failed to identify that safety loop #2 was not operating and that the dual in-line package switch was misaligned for safety loop #1.	IST/NBI need to modify their existing procedures and checklists to ensure that all safety loops associated with the AVB system are operating and that the dual in-line package switches are aligned to provide for safe operations. NBI needs to develop and implement formal procedures for maintenance activities to ensure that safety loops and associated dual in-line package switches are properly aligned after each maintenance activity.
The Board concludes that IST failed to develop documents for project management, quality assurance, and safety as part of the planning for design, construction and installation of the AVB at the South Gate of the Germantown complex and that a critical safety management element, the traffic safety study, was never performed by any organization with responsibility for the South Gate Project.	SO needs to develop and implement a formal process to ensure that contractors performing work for SO incorporate design requirements into project management, quality assurance, and safety plans prior to project initiation. IST and other contractors performing work for SO need to formally develop project management, quality assurance, and safety plans – incorporating design requirements – prior to project initiation. SO needs to develop and implement a formal process to monitor the effectiveness of contractor implementation of these requirements.
The Board concludes that operating procedures and Post Orders were less than adequate to ensure vehicle safety at the South Gate of the DOE Germantown complex.	SO needs to conduct an evaluation of the adequacy of existing procedures for AVB systems whose operation is the responsibility of SO and develop implementation plans for correcting identified AVB procedures. SO and pertinent contractors need to develop and implement AVB procedures and Post Orders for the safe operation of AVB systems. WWS needs to develop and implement a formal process to train personnel on the enhanced AVB system procedures and all Post Orders for all protective force personnel assigned to AVB systems at DOE Headquarters. SO needs to develop and implement a formal mechanism for ensuring that the enhanced procedures, Post Orders, and training activities for
The Board concludes that the training provided to protective force personnel on duty the day of the accident was inadequate to ensure that they knew how to safely operate the AVB for vehicle access.	
The Board concludes that there is a need for a procedure to address operations at the South Gate and to ensure safe vehicle access.	
The Board concludes that work conducted on the AVB project to assure system safety was not performed in accordance with formal procedures and was inadequate.	

Conclusion	Judgment of Need
	AVB operation are effectively implemented by all contractors under their control.
The Board concludes that the manufacturer's equipment manual lacks documentation on the operation of the AVB when unplanned actions occur involving the safety loops and signals from the master control panel.	NBI needs to develop procedures for operation of the AVB, which address actions to be taken when unplanned events are encountered involving the safety loops and the signals from the master control panel, and to provide training on those procedures to protective force personnel operating AVB systems at DOE Headquarters. SO needs to develop a formal process to ensure that the enhanced procedures and training activities for safe operation of the AVB system are effectively implemented.
The Board concludes the AVB operated as configured on the day of the accident, but safety controls were ineffective to prevent the accident.	
The Board concludes that formal processes were not in place to analyze notification reports of active vehicle barrier incidents, to identify causal factors, and to communicate the results of these analyses to SO for management attention, corrective action, and recurrence prevention.	SO needs to develop and implement a formal lessons learned program to analyze incidents, identify causal factors (including root causes), and communicate the results to DOE and/or contractor line management for corrective action, validation, and verification.
The Board concludes that the Office of Security Operations did not have a formal process to hold contractors and subcontractors accountable for effective performance of the AVB system by establishing clear safety objectives, ensuring mechanisms for the safe conduct of work, and developing and implementing formal processes to monitor performance.	SO needs to develop and implement a formal process for systematically conducting surveillances, inspections, or assessments of all pertinent contractor and subcontractor activities to evaluate the performance of project management, quality assurance, and safety systems, and identify necessary corrective actions.

1.0 Introduction

1.1 Background

On April 7, 2005, at approximately 10:15 am, an incoming van operated by a Department of Energy (DOE) subcontractor collided with vehicle barrier #3 at the South Gate of the DOE's Germantown, Maryland complex. The driver of the van sustained a minor laceration to his forehead. Emergency Medical Services personnel were immediately summoned and arrived on scene, examined the driver, and determined that no emergency treatment was necessary.

On April 14, 2005, the Assistant Secretary for Environment, Safety and Health appointed a Limited Scope Accident Investigation Board to investigate this accident in accordance with DOE Order 225.1A, *Accident Investigations*. A copy of the appointment memorandum appears in Appendix A.

1.2 Facility Description

The Department of Energy Germantown facility was dedicated by President Eisenhower in 1957. The 618,852 square-foot complex is situated on approximately 98.6 acres in Montgomery County, Maryland. The complex includes office space, an auditorium, heating and refrigeration plant, radio building, equipment sheds and garages. The main office building includes a cafeteria, various data centers, warehouse and a computer center.

Following the events of September 11, 2001, a number of security upgrades were implemented at the Germantown complex including the installation of guard stations and active vehicle barriers (AVBs) at the two entrances. One of these barriers (barrier #3), located at the South entrance to the DOE Germantown complex, is the focus of this investigation (see Figure 1-1).

1.3 Purpose, Scope and Methodology

The Board began its investigation on April 14, 2005, completed its investigation activities on May 11, 2005, and submitted its final report to the Assistant Secretary for Environment, Safety and Health on May 12, 2005. The scope of the Board's investigation was to review and analyze the circumstances surrounding the accident and to determine its cause. The Board also evaluated the adequacy of project management, security operations, and safety management systems as they relate to the accident.

The purposes of this investigation were to determine the causes of the accident including deficiencies, if any, in security and safety management systems, to assist DOE in understanding lessons learned, and, in doing so, to reduce the potential for recurrence.

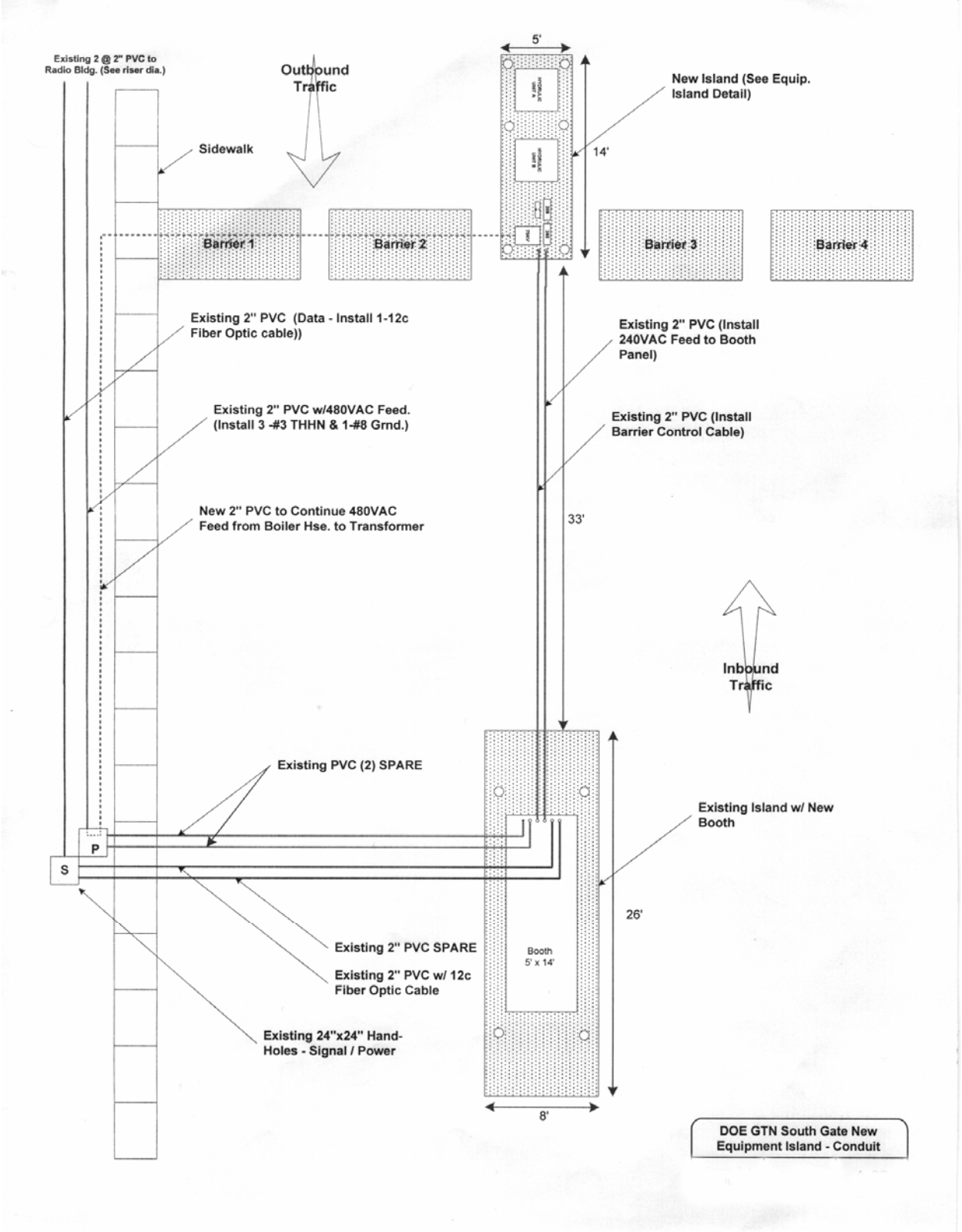


Figure 1-1. Schematic of South Gate Active Vehicle Barrier System

The Board conducted its investigation using the following methodology:

- Facts relevant to the accident were gathered though interviews, document and evidence reviews, and examination of physical evidence.

- Event and causal factor charting, along with barrier analysis and change analysis techniques, were used to analyze the facts and identify the cause(s) of the accident (see Figure 1-2).

- Based on the analysis of information gathered, Judgments of Need for corrective actions to prevent reoccurrence were developed.

Accident Investigation Terminology

A **causal factor** is an event or condition in the accident sequence that contributes to the unwanted result. There are three types of causal factors: **direct cause(s),** which is the immediate event(s) or condition(s) that caused the accident; **root causes(s),** which is the causal factor that, if corrected, would prevent recurrence of the accident; and the **contributing causal factors,** which are the causal factors that collectively with the other causes increase the likelihood of an accident, but which did not cause the accident.

Event and causal factors analysis includes charting, which depicts the logical sequence of events and conditions (causal factors that allowed the accident to occur), and the use of deductive reasoning to determine the events or conditions that contributed to the accident.

Barrier analysis review the hazards, the targets (people or objects) of the hazards, and the controls or barriers that management systems put in place to separate the hazards from the targets. Barriers may be physical or administrative.

Change analysis is a systematic approach that examines planned or unplanned changes in a system that caused the undesirable results related to the accident.

Figure 1-2. Accident Investigation Terminology

2.0 The Accident

2.1 Background and Accident Description

2.1.1 Accident Overview

On the morning of April 7, 2005, a DOE contractor employee driving a commercial van approached the DOE Germantown South Gate. The driver was transporting mail between the Germantown, Maryland U.S. Post Office and the DOE Germantown Facility. A Protective Force Officer examined the driver's badge for DOE verification, waved him forward, and pushed the down button for barrier #3. As the driver proceeded forward to pass over the barrier, the vehicle impacted the barrier. The van became stuck at the barrier location, a gate arm came to rest on top of the hood of the van, and barrier #3 was in a partially raised position. The driver, who was wearing his seatbelt, sustained a superficial cut to his forehead from hitting the steering wheel. The van sustained significant damage to the front suspension and was not drivable. The driver was examined by Montgomery County Fire and rescue and refused transport to the hospital. Later the driver visited his physician and was advised to take leave for the rest of the day.

After the accident, tests were conducted at the South Gate for all four active vehicle barriers. The tests concluded that no South Gate safety loops were functional. Nasatka Barrier, Incorporated (NBI) inspected the barriers to determine how the barrier might have raised without receiving a signal from the South Gate House control box and why the safety loop had not prevented the barrier from raising. NBI determined that the safety loops had not been wired to the safety switch inside the control box and that some micro switches were not positioned to allow the safety loops to stop the barrier in place if activated. Figure 2-1 shows the position of the barrier and the vehicle immediately following the accident.

2.1.2 Background

Per Task Order 03-113 of Contract 223-99-9753, DOE obligated funds to Johnson Controls – who was serving as prime contractor for security upgrades at the DOE Germantown site – to install vehicle barriers at the South Gate of the DOE Germantown facility. On August 15, 2003, Johnson Controls delegated project management for the South Vehicle Entrance Vehicle Barrier Installation Project (South Gate Project) for DOE Headquarters (Germantown) to Integrated Security Technologies, Incorporated (IST). On March 23, 2004, Johnson Controls accepted the DOE Proposal to install the barrier system.

The purpose of this task was to enhance the security of the South vehicle entrance roadway. The work included installation of hydraulically controlled, surface mounted active vehicle barriers (AVBs). The barriers were controlled from the adjacent guard post. The proposed barriers were similar in nature and construction to existing barriers at the North Gate of the facility and were manufactured by NBI. The barriers were installed in the road surface utilizing a small concrete pad and conduits. Automatic gate arms were installed across all lanes and operate in conjunction with the barriers. These arms act to control the movement of vehicles until the barriers are fully recessed (i.e., down position).

NBI, in a disclaimer documented in the scope of work, had stated that all barrier systems should be carefully planned with safety as a paramount concern and that the system was

designed to control vehicle traffic. As the manufacturer was not a traffic safety-engineering firm, it recommended that the system be reviewed with respect to these considerations before installation. A traffic safety study was not performed.

Overall, 12 vehicle and AVB incidents (including this accident) have been documented with these barriers at the DOE Germantown facility. There have been two similar occurrences since July 2004 involving unintended barrier activation at the South Gate:

- On September 1, 2004 (at 10:00 am) as a driver proceeded ahead after a badge verification, the vehicle barrier arm began to lower and the barrier started to rise causing the driver's vehicle to strike the barrier. There was no personal injury; however, the car sustained damage to the hood and left front quarter panel

.

- On October 1, 2004 (about 9:00 am) a driver approached the inbound barrier #3 and proceeded ahead after badge verification. The vehicle barrier arm started to lower and the barrier started to rise, causing the driver's vehicle to strike the barrier. The accident did not cause any injury to the driver, but the barrier did damage the frame underneath the car.

Figure 2-1. Positioning of the Vehicle Immediately Following the Accident

2.1.3 Accident Description

On April 7, 2005, around 10:15 am a commercial van driven by a contractor employee was granted access by the guard at the South entrance to the DOE Germantown facility after badge verification. As the driver proceeded, the vehicle impacted the AVB and the vehicle barrier arm came down striking the windshield of the van. As a result of the impact, the driver hit his head on the steering wheel, causing a slight cut on his forehead. The van sustained front end damage. An IST technician responded to the accident and found that the "up" or "closed" indicator light for the barrier #3 was illuminated on the control box inside the guard booth. The removal of the van from the barrier required a hydraulic jack.

After the accident, the barrier was placed in down or open position. The controls were not manipulated (to avoid returning the barrier to the up or closed position), and the barriers were secured until NBI personnel arrived on property to conduct a series of tests. Prior to the arrival of NBI, the magnetic safety devices (or safety loops) located adjacent to the barriers were tested by SO personnel. The safety loops were imbedded in the roadway and were intended to stop the barrier(s) in place when the presence of metal was detected. The testing indicated that the safety loops were not functioning for barrier #3 at the South Gate.

During inspection of the barrier, the NBI technician discovered that some of the safety devices had not been wired to the safety switch and were unattached in the control box. He also determined that some micro switches inside the control box were in the wrong position. Upon completing his repairs, the technician declared all systems at the South Gate were functional.

The specific events leading to the accident are detailed below:

Date/Time	*Event Description*
September 13, 2003	Task Order 03-113 of Contract #223-99-9753 obligated funds for Johnson Controls to install security upgrades at DOE Germantown South Gate Administration
March 23, 2004	Johnson Controls accepted the DOE proposal to install the barrier
May 2004	South Vehicle Entrance Vehicle Barrier Installation Project completed
September 1, 2004	Vehicle struck South Gate barrier as it is being elevated
October 1, 2004	Vehicle struck South Gate barrier as it is being elevated
October 2004	Safety loop #2 installed at the South Gate barriers
October 2004	Maintenance contract signed with NBI for barrier maintenance
April 7, 2005	
06:30 am	Guards #1 and #2 arrived at the South Gate
10:13 am	Van approached South Gate guard station
10:14 am	Van stopped at the entrance of South Gate guard station
10:15 am	Vehicle struck South Gate barrier #3
10:28 am	Central Alarm Station called the Montgomery Count Fire Department
10:33 am	Central Alarm Station contacted Federal Protective Services
10:36 am	Fire Department and Rescue Squad arrived
02:00 pm	Federal Protective Services arrived to take report
03:10 pm	NBI technician reported at the scene
04:30 pm	The technician placed the barrier back in service

2.1.4 Active Vehicle Barrier System Evaluation

Background

Four NBI security barriers were installed at the South Gate guard post, on the perimeter of the DOE Germantown facility, adjacent to Middlebrook Road on May 17, 2004. The location of the guard post and barriers installed on the day of the accident is illustrated in Figure 1-1. The guard booth was constructed downhill from the barriers and closer to Middlebrook Road. The four NBI security barriers were installed 33-feet uphill from the guard booth, towards the Germantown building. Barriers #1 and #2 controlled outbound traffic from the DOE Germantown complex and barriers #3 and #4 controlled inbound traffic. The initial configuration included a safety loop that was constructed 81 inches in front of each barrier. The safety loops stopped the barrier(s) in place when the presence of metal was detected. Additionally, drop arms were installed at each barrier and two amber and red signals, for incoming and out going traffic, were constructed. Electronic beams were not considered in the conceptual design of the South Gate Project.

In October 2004, a second safety loop was constructed adjacent to the first safety loop at each barrier in response to the vehicle-AVB incident of September 1, 2004. The location of each set of safety loops was not determined by a qualified traffic safety professional. The incident occurred at barrier #3.

Operation and Control

The barriers are activated when a guard pushes buttons on the master pane. This sends electrical commands from the master control panel in the guard booth to a control box on an island located between barrier #2 and barrier #3. The electrical commands actuate a hydraulic system, which opens and closes each AVB. A description of barrier operations at the North Gate is provided in Germantown Vehicle Barrier Operations Procedure (Procedure 137). The procedure states that four operating possibilities exist:

(1) The barrier is fully open (down).
(2) The barrier is fully closed (secure).
(3) The barrier is between fully open and fully closed and moving toward the closed position.
(4) The barrier is between fully open and fully closed and moving toward the open position.

A description of operator input and system response is provided in Table 2-1. The Board performed evaluations and reviews of the design, construction, operation, and maintenance of barrier #3 at the Germantown South Gate in order to understand the purpose and function of systems operated on the day of the accident and to evaluate the effects of these systems on AVB functionality. The Board conducted evaluations of AVB maintenance practices and AVB operations and, in conjunction with the guard force, performed AVB system operability tests.

During the investigation the Board also conducted reviews of:

- Contract specifications and deliverables;
- Equipment and design drawings;
- System schematics;
- Quality assurance provisions;
- NBI's owners manual;
- AVB maintenance history; and
- Related events involving AVBs.

Results of the Board's evaluation of the AVB system are summarized in Table 2-2.

Table 2-1. Operator Input and System Response

(1) The barrier is fully open (down):	
Operator Input	**System Response**
A. Emergency Close	Barrier goes to secure position in approximately one second. An alarm sounds continuously, until manual (key) reset of the system.
B. Close	Barrier goes to the fully secure position in standard operating time.
C. Open	No action.
(2) The barrier is fully closed (secure).	
Operator Input	**System Response**
A. Emergency Close	Alarm sounds continuously, until manual (key) reset of the system.
B. Close	No action.
C. Open	Barrier goes to the fully open position in standard operating time.
(3) The barrier is between fully open and fully closed and moving toward the closed position.	
Operator Input	**System Response**
A. Emergency Close	Barrier goes to secure position in approximately one second. An alarm sounds continuously, until manual (key) reset of the system.
B. Close	Barrier continues toward the fully secure position in standard operating time.
C. Open	Barrier immediately reverses direction of travel and returns to the fully open position in standard operating time (slightly faster due to reduced travel).
(4) The barrier is between fully open and fully closed and moving toward the open position.	
Operator Input	**System Response**
A. Emergency Close	Barrier immediately reverses direction of travel and returns to the fully secure position in approximately one second. An alarm sounds continuously, until manual (key) reset of the system.
B. Close	Barrier immediately reverses direction of travel and goes to the fully secure position in standard operating time (slightly faster due to reduced travel).
C. Open	Barrier goes to the fully open position in standard operating time.

Table 2-2. Summary of Board's Evaluation of the AVB System

Fact	Analysis	Conclusions
The responsibility to perform a traffic safety study was not defined in project documentation.	Neither IST nor NBI was responsible for traffic safety. As a consequence, a traffic safety study was not performed, safety loop locations were not specified on drawings, and they were too close to barrier #3 to ensure vehicle safety – since the system can take 6 seconds to fully open.	Responsibility to conduct a traffic safety study to identify effective vehicle safety controls was not defined for the project. As a result, there was no basis for safety measures at the South Gate of the DOE Germantown complex.
The master control panel design was inadequate for routine, highly repetitive operations.	Push button switches that control AVBs for vehicles entering and exiting the DOE Germantown facility through the South Gate were: • Visually identical; • Aligned in a straight row on the same master control panel; • In close proximity to each other; and • Not labeled to correspond to the AVB that they operated.	The AVB master control panel layout was inadequate for repetitive and routine operations and needs improvement to preclude accidental operation of the AVB at the South Gate.
Safety loop #2 was not connected after it was installed in October 2004.	No documentation of acceptance tests, deviations or waivers existed to demonstrate safety loop #2 operated as intended.	Quality assurance processes for testing and acceptance of the operation of safety loop #2 were lacking.
The manufacturer's equipment manual did not describe how the AVB would respond when a vehicle travels over a safety loop after an open or close command is initiated at the master control panel.	Security personnel were not provided with training or operating instructions for the unplanned modes of operations in the Germantown Vehicle Barrier Operations Procedure (Procedure 137) and the Protective Force Order for the South Gate Entrance. The system as installed will stop the AVB in place whether the open or secure command was initiated at the master control panel and will not return to the open position automatically if a signal is initiated from the safety loops.	The manufacturer's equipment manual lacked documentation on the operation of AVB when unplanned actions occurred involving the safety loops and signals from the master control panel.
Operating procedures and Post Orders did not provide sequential instructions for operating the AVB safely for vehicle access.	Operating procedures and Post Orders did not provide step-by-step instructions for operating the barrier and directing the driver to proceed through the AVB. A safe procedural sequence would be to push the open button (Green) and wait for the barrier to fully open before directing the driver to proceed though the opened barrier. This approach would eliminate the risk of collision during the 4 to 6 seconds needed to safely open the AVB to vehicles. The security officers did not have operating instructions specific to the South Gate barriers. Germantown Vehicle Barrier Operations Procedure (Procedure 137) was written for the North Gate only. The South Gate had a different barrier system configuration. No remote controls existed and the master control unit was different. Additionally, the procedure did not have instructions to test safety loops for operability at the beginning of a shift.	Operating procedures and Post Orders were less than adequate to ensure vehicle safety at the South Gate of the DOE Germantown complex.
The safety equipment was not included in the maintenance checklist and the checklist was not properly used.	The Monthly Visual Inspection Checklist used for preventive maintenance did not contain a check for the safety loops (the maintenance contractor is in the process of remedying this problem). The maintenance worker was observed not using the checklist during work package performance. The checklist was filled out after the work was completed. As a result, the accuracy of checklist results was unreliable. The normally open/normally closed microprocessor mini-switch for the safety loops was found improperly set following the accident. Because of the error, a safety signal was not sent until the van left the loop, resulting in inadequate time to avoid a collision.	Maintenance procedures and the quality assurance process were less than adequate.

Fact	Analysis	Conclusions
NBI AVB preventive maintenance requirements were not adequate to test safety loops at the South Gate.	Preventive maintenance actions for AVB are documented in Section VI of NBI's equipment manual for Model NMSB VII-d. In the electrical systems section of the manual, there was a reference to "Verify the loops are working correctly"; however, there was no procedure or instruction to implement this requirement.	Preventive maintenance activities conducted by an NBI representative at barrier #3 at the South Gate failed to identify that safety loop #2 was not operating and that the dual in-line package switch was misaligned for safety loop #1.

The Board concludes the AVB operated as configured on the day of the accident, but safety controls were ineffective to prevent the accident.

2.2 Emergency Response and Medical Treatment

Immediately following the accident, both officers manning the guard station went to the aid of the driver. The driver stated that he was injured and requested medical care. The local Montgomery County Fire and Rescue was contacted and responded to the accident scene. Emergency medical personnel conducted an examination at the scene and determined that no immediate emergency treatment was necessary. The medical personnel advised the driver to visit his personal physician for further examination. He was taken to his company physician for further examination. The physician advised the driver to rest for the remainder of the day and to refrain from driving.

2.3 Investigative Readiness and Accident Scene Protection

Initial investigative activities related to this accident began as the injured driver was taken from the accident scene and were managed by the DOE Protective Force. The DOE Protective Force personnel arrived at the scene and collected first-person written statements from persons involved directly or indirectly with the accident. Protective force conducted a preliminary interview with the guards manning the South Gate at the time of accident and the results were documented. The South Gate protective force personnel were instructed to secure barrier #3 until NBI personnel arrived to conduct tests on the barrier. Prior to the arrival of NBI, the safety loops located at the South Gate were evaluated by SO and IST and it was determined that safety loop #2 was not functional.

2.4 Accident Reconstruction

After arrival at the scene, NBI personnel inspected the barrier system to determine why all the safety loops were not working. The NBI technician, in the presence of the Facility Security Manager, determined that safety loop #2 for the South Gate barriers had not been wired to the safety switch inside the control box. The technician also determined that some of the micro-switches were in the "hold" position, which could cause the safety loop to malfunction. The technician made the necessary repairs and indicated that safety loop #2 at the South Gate was fully operational. The protective force was directed to develop test procedures for performing daily checks of the safety loops and to incorporate these procedures into the appropriate Post Orders.

3.0 Accident Facts and Analysis

This section addresses the facts related to the accident, along with the Board's analysis. When analyzing the facts, the Board considered the core functions and guiding principles of Integrated Safety Management, which comprise the fundamental DOE safety and health policies that should be incorporated in all phases of the work, from work planning through execution and feedback. The discussion below addresses core functions, aspects of the guiding principles, and other topics of clear relevance and importance to the circumstances surrounding the accident. Table 3-1 at the end of this section highlights significant weaknesses in Integrated Safety Management as determined by the Board.

3.1 Physical Hazards, Controls and Related Factors

3.1.1 Define the Scope of Work

Effective work execution begins with the preparation of a well-defined scope of work that translates the mission and requirements into terms that those who are to accomplish the work can clearly understand. The scope of work must provide sufficient detail to support hazard analysis and implementation of controls at the task level. To fulfill its responsibilities, line management must determine the work to be performed and be accountable for understanding it through every phase of the work cycle. This process applies to the South Gate Project.

Task Order 03-113 of Contract 223-99-97 Obligated $665,795 for Johnson Controls to install security upgrades to the DOE Germantown South Gate on September 13, 2003. As one of the elements of this task order, Johnson Controls was to provide all labor, materials, equipment and supervision necessary to install the AVB for $297,820. The period of performance for the Task Order was not to exceed 52 weeks from the date of award. On March 23, 2004, Johnson Controls accepted DOE's proposal to install the AVB and notified DOE Germantown Security Operations management that the DOE onsite Security Maintenance contractor, IST, would be utilized to coordinate and in some cases perform the work in the proposal.

The scope of work described in the document – *South Vehicle Entrance Vehicle Barrier Installation Project, undated* – outlines project goals and guidelines that address construction, location of the AVB, equipment to be installed, and specifications. The scope of work also documents the operational aspects of the AVB. (A description of the operator input and the system response are discussed in Section 2.1.4). A disclaimer in the Scope of Work stated:

> "All barriers should be planned with safety as the paramount concern. The product is designed to control traffic. NBI is not a traffic safety-engineering firm and recommends that a system be reviewed before installation. It is recommended that all forms of safety be used where possible, examples are proper lighting, written warning signs, traffic lights, gate arms and auditable alarms."

During interviews with personnel from SO, NBI, and IST, IST was acknowledged as the construction project manager responsible for executing the scope of work for design, construction and post construction project phases for the South Gate Project.

On DOE projects, responsibilities of personnel assigned construction project management duties projects include:

- Ensuring accurate and timely project documentation is maintained over the construction project life cycle;

- Ensuring construction projects are completed in accordance with DOE Orders, Federal, state, local, and industry standards; and

- Ensuring compliance with environment, safety and health; quality assurance; and Occupational Safety and Health Act requirements.

As a result, the Board expected that similar roles, functions, and associated processes should have been established and implemented by IST. The Board requested and did not receive the following project documentation: project execution plan, project management plan, responsibility matrix, quality assurance plan, project safety plan, traffic safety study, and AVB testing and acceptance plan based on defined acceptance criteria.

The Board concludes that IST failed to develop documents for project management, quality assurance, and safety as part of the planning for design, construction and installation of the AVB at the South Gate of the Germantown complex and that a critical safety management element, the traffic safety study, was never performed by any organization with responsibility for the South Gate Project.

3.1.2 Hazards Analysis

The objective of hazards analysis is to develop a clear understanding of the task-specific hazards that may affect the worker, the public, and the environment. Each level of hazard analysis is the foundation for a more detailed analysis. For example, a construction project hazards analysis is the basis for an activity-level or task-level hazard analysis. Hazard identification and analysis must occur at any phase of the work cycle to which it applies including construction, system and equipment installation, and system operation and maintenance.

Development of the AVB system involved (1) a variety of design, construction, engineering, testing, operations, and maintenance activities; and accordingly (2) a range of hazards and site conditions. Hazards associated with the AVB process included energized systems, industrial safety, construction safety, security, and traffic safety. Although many of the hazards were effectively identified during the course of the South Gate Project, several key hazards were not effectively accounted for in the design, installation, operation, and maintenance of the AVB system. These include the following:

- The Board requested and did not receive a project safety plan that would have included procedures for conducting job hazards analyses. As a result, the Board had no documented information on which to judge the adequacy of the overall hazards analysis process for the South Gate Project.

- IST did not ensure that a traffic safety study was performed, and that traffic safety was adequately managed.

- There were no specific worker safety requirements contained in the NBI maintenance contract.

- SO, IST, and NBI did not take into account the consequences of (1) potential accidents during initial installation and (2)

subsequent modifications to the AVB system at the South Gate.

The Board concludes that requirements for a hazard analysis were not identified, and notably a traffic safety study was not conducted as the basis for establishing traffic safety risks and associated controls.

3.1.3 Develop and Implement Controls

The objective of developing and implementing controls is to identify and provide the full range of hazard protection (i.e., engineering, administrative, and personnel protective equipment) consistent with the nature of the hazards to be encountered during task performance. The development and implementation of controls assumes that the contractor has adequately and completely identified the hazards associated with the defined scope of work.

The Board evaluated several aspects of the hazard control process for the AVB project. These included design, system operation, and system maintenance. Requirements management and training, as elements of the hazard control process, are discussed in Section 3.1.6. Hazard controls activities, which in the view of the Board were not effective, include the following:

- Safety reviews were not performed at the design and installation phases of the project.

- Traffic safety requirements were not evaluated and translated into appropriate operating controls.

- Safety loops, which were intended to stop the barrier(s) in place when the presence of metal is detected, were not functional at the time of installation. Safety switches were misaligned and, therefore, in the wrong position to ensure that the barrier would remain open when activated.

- The operator's control panel was inadequately designed for routine, highly repetitive operation. The control buttons were extremely close to each other and are essentially identical.

- No procedure existed for operating the South Gate AVB.

- The manufacturer's equipment manual did not describe how the barrier would respond when a vehicle travels over a safety loop after an open or close command is initiated.

The Board concludes that hazard controls associated with AVB design and operation were not effectively identified, integrated, or implemented.

3.1.4 Perform Work within Controls

Hazard controls must be properly implemented and personnel performing work must be fully apprised of the hazards and associated controls before work can safely commence. Authorization to commence work must be explicit and the associated limits under which work is to be performed should be specific. Any deviations to the authorized scope of work are to be analyzed and appropriate modifications to existing controls implemented prior to executing the scope change.

Implementation of the AVB system involved (1) a wide variety of design, construction, engineering, testing, operations, and maintenance activities; (2) a range of hazards and site conditions; and (3) a number of Federal and contractor organizations. The Board reviewed documentation associated with essentially all aspects of the project and

observed barrier operations and maintenance activities. Although many project activities were conducted within appropriate controls, several notable examples exist where aspects of work were executed without full consideration of the hazards or risks.

- Installation of the barrier system(s) at the North Gate and South Gates was not conducted in a consistent manner in terms of such critical aspects as the distance between the barriers and the respective guard stations.

- The routine, wherein officers waved a vehicle forward, then punched the button to open the barrier, worked acceptably given the distance between control console and barrier at the North Gate. This sequence was far more prone to failure at the South Gate which had less than half the travel distance.

- The second set of safety loops for barrier #3 was not initially connected, and was installed without being tested by IST or SO for functionality. The control box, where the connection should have been made, was apparently not examined.

- The safety equipment was not included in the NBI maintenance checklist and the checklist was not properly used. The Monthly Visual Inspection Checklist used for preventive maintenance did not contain a check for the magnetic safety loops.

The Board concludes that work conducted on the AVB project to assure system safety was not performed in accordance with formal procedures and was inadequate.

3.1.5 Feedback and Improvement

Feedback and improvement processes are essential to understanding safety and operational performance, analyzing trends, identifying essential improvement initiatives, preventing recurrence of events, communicating lessons learned, and – in general – promoting enhanced performance. For these processes to be most effective, workers should be clearly involved in identifying performance vulnerabilities as well as opportunities for improvement.

The Board evaluated the mechanisms in place to collect, report, and analyze active barrier incidents and to communicate results to SO for action. Security incidents occurring at the DOE Germantown complex are documented in Notification Reports completed by WWS (the prime contractor for protective force services). Notification reports contained information on the circumstances surrounding an incident, logistical and chronological information, and witness statements when appropriate. Once the notification report was completed, WWS provides these reports to SO management for storage in a database. No formal process existed to evaluate the incident, identify causal factors (including root causes), and analyze trends for management attention, action, and prevention of recurrence.

Since October 2003, there have been 12 reported incidents involving vehicles and AVBs at the DOE Germantown complex. These events are listed below:

- 10/22/03 – Vehicle drove over partially open North Gate barrier #1. Barriers #1, #2 and #4 were found to have bending damage.
- 12/05/03 – Damage to right front tire, North Gate barrier #4.

- 01/05/04 – Vehicle struck North Gate barrier #4 (inspection lane) as it was being elevated to the closed (secure) position. Driver error: Driver tried to enter the Germantown complex through the inspection lane, as the barrier was raised following a vehicle inspection.
- 01/14/04 - Vehicle struck North Gate barrier #2 as it was being elevated to the closed (secure) position. Driver error: Driver made a late lane change from barrier #1 (closed position) to barrier #2, which was fully open at the time.
- 01/30/04 - Vehicle struck North Gate barrier #2 as it was being elevated to the closed (secure) position. Driver error: Driver made a late lane change from barrier #1 (closed position) to barrier #2, which was fully open at the time.
- 04/20/04 - Vehicle struck North Gate barrier #4 before it was fully lowered to the open position. Driver error: Driver assumed barrier would lower automatically.
- 09/01/04 - Vehicle struck South Gate barrier as it was being elevated to the closed (secure) position.
- 09/23/04 - Driver lost control of his Montgomery County School bus and struck North Gate Barrier #3, causing damage to the right side rear wheel.
- 10/01/04 - Vehicle struck South Gate barrier #3 as it was being elevated to the closed (secure) position.
- 03/16/05 - Vehicle struck North Gate barrier #1 as it was being elevated to the closed (secure) position.
- **04/07/05 (event for this investigation) – Vehicle struck South Gate barrier #3.**
- (Post incident) 04/22/05 - Vehicle struck North Gate barrier #2 as it was being elevated to the closed (secure) position.

WWS provided SO management with incident notification reports for all active vehicle barrier incidents at DOE Germantown complex since October 2003. The Board searched the Occurrence Reporting and Processing System to determine whether the 12 incident reports involving vehicles and AVBs at the DOE Germantown Complex were entered into the system; none of the incident reports were contained in the Occurrence Reporting and Processing database.

The Board concludes that formal processes were not in place to analyze notification reports of active vehicle barrier incidents, to identify causal factors, and to communicate the results of these analyses to SO for management attention, corrective action, and recurrence prevention.

3.1.6 Integrated Safety Management

Integrated Safety Management establishes the overall framework and specific guidance for ensuring that the protection of workers, the public, and the environment are fully and effectively incorporated into all work and operational activities. Key aspects of Integrated Safety Management, beyond those explicitly associated with the core functions and relevant to the circumstances surrounding the accident, are discussed in this section. A table at the end of the section summarizes key implementation weaknesses associated with aspects of Integrated Safety Management that are relevant to the conditions and circumstances surrounding the accident.

Line Management Accountability

Line management accountability for worker, public, and environmental protection is fundamental to the successful implementation of Integrated Safety Management. Line accountability involves establishing clear priority for worker, public, and environmental protection; ensuring understanding of roles and responsibilities in achieving safety and

environmental objectives; allocating sufficient resources; ensuring appropriate mechanisms exist for safe conduct of work activities; and rigorously monitoring performance and promoting enhanced performance.

Ultimately, the DOE Office of Security Operations had overall accountability for ensuring the safety and effective design, installation, operation, and maintenance of the AVB system. To achieve this objective, SO engaged the services of IST to manage and coordinate the South Gate Project and NBI to install, test, and maintain the AVB system.

Interviews conducted during the investigation demonstrated that SO was actively involved in the initial planning activities for the South Gate Project, since the Office would ultimately be responsible for the operation of the AVB. The Board requested, but did not receive, reports documenting any SO surveillances and assessments for the South Gate Project; such surveillances would have provided SO with information on the achievement of quality and safety objectives, as well as the effectiveness of the project management contractor (IST).

SO did not develop an Integrated Safety Management System description. In addition, SO did not ensure that the following critical elements were being implemented (either by SO or by the two contractor organizations) as part of the AVB system:

- Establishment of clear safety objectives and integration with pre-existing security objectives and requirements;

- Development of an overall project plan, quality assurance plan, and safety plan to guide execution of activities, achievement of objectives, and monitoring of performance;

- Effective development of operating procedures and training of protective force personnel;

- Proper conduct of routine AVB maintenance; and

- Rigorous review and implementation of corrective actions based on documented incident reports.

The Board concludes that the Office of Security Operations did not have a formal process to hold contractors and subcontractors accountable for effective performance of the AVB system by establishing clear safety objectives, ensuring mechanisms for the safe conduct of work, and developing and implementing formal processes to monitor performance.

On August 8, 2003, a letter from IST to Johnson Controls acknowledged IST as the construction project manager for the South Gate Project. IST is a company that primarily specializes in electronic security, closed circuit television surveillance, and associated peripheral systems. IST had minimal experience with installation of the AVB system. The South Gate Project required design, installation, operation and associated change control processes for the AVB systems and coordination of several organizations to ensure the project was designed, executed, and transitioned to SO for use by protective force personnel at the Germantown complex.

However, the absence of strong line accountability for the AVB system was also evident at the project management level. As the organization responsible for ensuring day-to-day achievement of project objectives and effective design, installation, operation, and maintenance of the AVB system, IST did not

ensure implementation of the following critical elements:

- Conducting safety and site plan reviews during the design and installation phases;
- Executing a traffic safety study;
- Developing clear inspection and testing procedures to assure safe system functionality;
- Establishing a change control procedure;
- Incorporating engineering controls to ensure safe operations of the AVB (e.g., safety loops); and
- Properly conducting of routine maintenance on peripheral systems associated with the AVB.

Collectively, this lack of effective line accountability led to an unstructured approach to the design, installation, operation, maintenance, and change control processes for the AVB system and impacted the quality, safety, and overall system effectiveness.

The Board concludes that IST failed to develop documents for project management, quality assurance, and safety as part of the planning for design, construction and installation of the AVB at the South Gate of the Germantown complex and that a critical safety management element, the traffic safety study, was never performed by any organization with responsibility for the South Gate Project.

Roles and Responsibilities

Clarity of roles and responsibilities establishes the framework for ensuring that each element of the Department, prime contractor, and any subordinate contractor organization clearly understand and readily accept their safety management function and recognize how their role supports the overall mission of worker, public, and environmental protection.

Four organizations had the primary roles and responsibilities for execution of the South Gate Project (see Figure 3-1). The Office of Security Operations had overall responsibility for the effectiveness of the project and system operation. IST was responsible for day-to-day management of the project design, installation, testing, and maintenance activities. NBI was the barrier manufacturer and installation contractor. WWS provided protective force services and in doing so operated the AVB system.

In executing these responsibilities there are a number of examples of specific and critical activities neither being assigned nor executed, hence impacting the overall effectiveness of the AVB system, these include:

- Responsibilities for safety and design reviews of the AVB system were not assigned or executed. During the design and installation phases, no safety reviews were performed either by IST or NBI to ensure that worker and public safety considerations were appropriately and adequately considered in conjunction with the critical security requirements.
- Responsibilities for conducting a traffic safety study were not assigned or executed. NBI did not have expertise in traffic safety studies and issued a disclaimer to that affect and recommended conducting such a study. However, as the project manager for the overall effort, IST did not ensure that this vital study was performed prior to AVB design and installation.

- Responsibilities for conducting inspection and testing of the AVB system were not assigned or executed. SO did not require the establishment of – and IST/NBI did not support development of – a set of acceptance and testing requirements for the AVB system. Such requirements would have established clear performance conditions under which SO would have accepted the system as complete and fully functional.

- Responsibilities for ensuring delivery of effective training were not provided. Protective force personnel were not provided sufficient training on the operation of the South Gate AVB system.

- Responsibilities for rigorously monitoring safety performance were not executed. Both SO and IST had management and oversight responsibilities (in a tiered fashion) for the AVB project. Neither organization implemented these responsibilities to ensure that safety was integrated into the South Gate Project.

The Board concludes that critical safety roles and responsibilities, which would have ensured safe and effective design, installation, operation, and maintenance of the AVB system, were not properly assigned or executed.

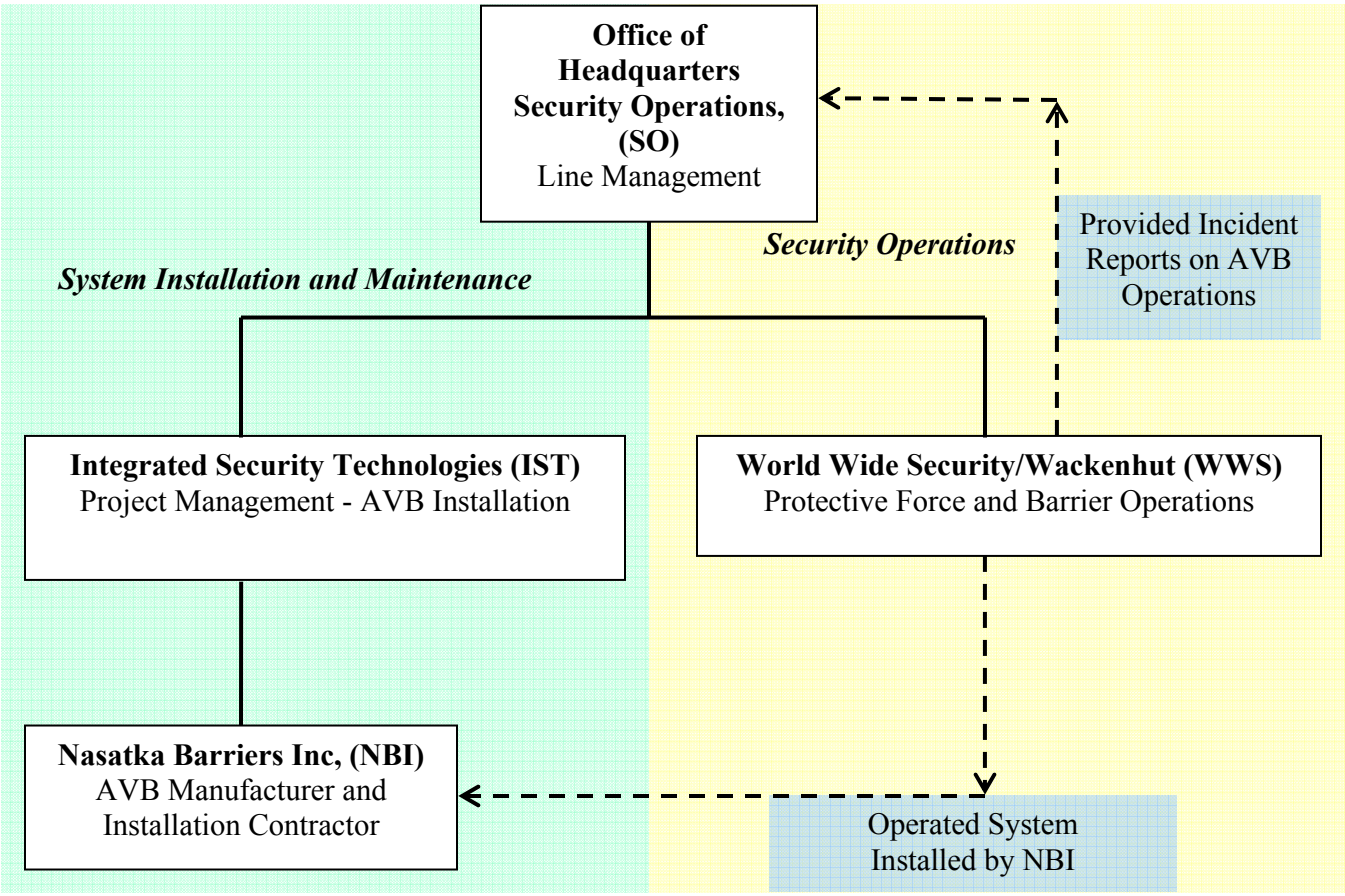


Figure 3-1. Organizations with Responsibilities Associated with the South Gate Project

Requirements Management

Effective requirements management mandates that DOE Orders, regulations, or expectations governing conduct of the project or work activity be systematically identified. Establishing clear expectations and requirements ensures that all hazards have been properly and thoroughly considered; that appropriate controls have been developed; and that implementation of the identified hazard controls will enable protection of the worker, the public, and the environment.

A systematic review of all requirements relevant to the AVB system design, installation, operation, and maintenance was not performed by any of the involved organizations. During the course of the investigation, examples of critical requirements not directly incorporated into the design, installation, and operations processes of the AVB system include:

- Expectations associated with inspection and acceptance of the AVB system were not established.

- Clear performance conditions under which SO would have accepted the system as complete and fully functional did not exist.

- Expectations associated with worker and public safety related to operation of the AVB system were not established in that clear objectives, performance measures, or expectations for the AVB system relative to protection of worker and public safety performance did not exist.

- Expectations associated with safety reviews of the AVB system design and installation concepts did not exist.

The Board concludes that several safety expectations were not identified and incorporated into the South Gate Project.

Training

Training of personnel is vital to assure that they understand and recognize specific job and task hazards, are knowledgeable of the appropriate controls being applied, and are aware of the actions to be taken in a situation where unexpected conditions occur.
During interviews with protective force personnel, the following was determined: (1) the procedure that governs barrier operations was not specific to the conditions at the South Gate and does not direct officers to ensure the barrier is down before waving a car forward, and (2) the routine on the day of the accident involved officers waving the car forward, then depressing the button to open the barrier.

Both officers present at the South Gate on the day of the accident received one hour of training on operating the AVB at the Forrestal Building (on February 4, 2004), conducted without the aid of a lesson plan. In addition, upon installation of the second set of safety loops at the South Gate, no training was provided by NBI to protective force personnel. The only procedure available for active vehicle barrier operations, Procedure 137, was written for operations of barriers at the North Gate; the configuration of the North Gate and South Gate AVB systems were different. There was no procedure applicable to the South Gate available for reference. Further, the South Gate Post Orders did not address barrier operations.

The Board concludes that the training provided to protective force personnel on

duty the day of the accident was inadequate to ensure that they knew how to safely operate the AVB for vehicle access.

The Board concludes that there is a need for a procedure to address operations at the South Gate and to ensure safe vehicle access.

Table 3-1. Implementation Deficiencies Associated with Guiding Principles and Core Functions of Integrated Safety Management

Guiding Principle 1: Line Management is Directly Responsible for the Protection of the Public, the Workers, and the Environment

- SO did not develop an Integrated Safety Management System description.
- SO did not establish and communicate, through contracts and other mechanisms, expectations for Integrated Safety Management and environment, safety and health performance for IST and NBI.
- SO did not adequately ensure that the Integrated Safety Management guiding principles and core functions have been fully institutionalized into procedures, training and other controls for the South Gate Project.
- IST did not effectively include safety process elements into the design, installation, and continuous operation of the AVB system.
- SO, IST, and NBI did not effectively include safety process elements into the maintenance of AVB system at the South Gate of the facility.

Guiding Principle 2: Clear and Unambiguous Lines of Authority and Responsibility for Ensuring Safety Shall Be Established and Maintained at All Organizational Levels within the Department and its Contractors

- Responsibilities for safety and design reviews of the AVB system were not assigned or executed.
- Responsibilities for conduct of a traffic safety study were not assigned or executed.
- Roles, responsibilities, authorities and interfaces related to work for the South Gate Project were not clearly defined and not implemented between SO, IST, and NBI.
- IST and NBI were not held accountable for safety associated with installation and operation of the AVB system. Responsibilities for conduct of inspection and testing of the AVB system were not assigned or executed.

Guiding Principle 3: Personnel Shall Possess the Experience, Knowledge, Skills, and Abilities That Are Necessary to Discharge Their Responsibilities

- SO and IST did not have systems in place to assure that personnel were knowledgeable of safety and health requirements and hazards associated with the design, installation, operations of the AVB system.
- Training was conducted on the barrier system at the North Gate, and on a procedure that is specific to the conditions at the North Gate (Procedure 137).
- SO has not adequately established and implemented an effective process for monitoring and assuring the continuing quality of training associated with AVB system. Protective Force Officers interviewed stated they had never read or been provided a copy of Procedure 137, and training on operation of the second set of safety loops was not provided.

Guiding Principle 4: Resources Shall Be Effectively Allocated to Address Safety, Programmatic, and Operational Considerations. Protecting the Public, the Workers, and the Environment Shall Be a Priority Whenever Operations Are Planned and Performed

- SO and IST did not adequately demonstrate a commitment to assure that Integrated Safety Management and safety and health receive sufficient priority and resources for the South Gate Project .(i.e., the resource and priority associated with worker and public safety for operation of the AVB system was not effectively considered and/or balanced with the overriding security objectives).
- SO and IST did not have formal processes for the development of scope, schedule, and cost to design, install, perform, and operate AVB systems. A well defined work planning and control process was not in established (nor documented) that embraces the core functions of Integrated Safety Management.
- Safety reviews of the AVB system design and operation were not performed.

Table 3-1. Implementation Deficiencies Associated with Guiding Principles and Core Functions of Integrated Safety Management
Guiding Principle 5: Before Work Is Performed, the Associated Hazards Shall Be Evaluated and an Agreed Upon Set of Safety Standards Shall Be Established That, if Properly Implemented, Will Provide Adequate Assurance That the Public, the Workers, and the Environment Are Protected from Adverse Consequences • Prior to initiation of work, SO and IST did not identify, analyze hazards (traffic safety) associated with the AVB system so that the appropriate administrative and engineering controls could have been implemented. • IST did not have disciplined, documented, methodical management approach in design, installing, functioning and continuous operation of the AVB system. • SO has not adequately established effective management controls and processes to assure the involvement of the appropriate safety and health support professionals; quality assurance personnel; and operators in the hazards analysis processes. • Requirements related to design, installation, function, and continuous operation of the AVB system were not based on site specific hazards and risk analyses. • SO did not effectively communicate the safety requirements associated with design, installation, testing and continuous operation of the AVB system to IST and NBI. • SO did not have management systems and controls in place to assure that when significant modifications were done to AVB system after initial installation, the impact of the modifications on requirements and operating conditions was analyzed.
Guiding Principle 6: Administrative and Engineering Controls to Prevent and Mitigate Hazards Shall Be Tailored to the Work Being Performed and Associated Hazards • IST did not develop adequate site specific hazard controls associated with design, installation, testing and continuous operation of the AVB system at the South Gate. • Safety loops designed to ensure driver and vehicle safety in the event of a malfunction of the AVB system were not operational.
Guiding Principle 7: The Conditions and Requirements To Be Satisfied for Operations To Be Initiated and Conducted Shall Be Clearly Established and Agreed Upon • AVB systems at the North Gate and South Gate were not conducted in a consistent manner in terms of such critical aspects as the distance between the barriers and the respective guard stations. • SO has not confirmed the adequacy of maintenance testing and operational procedures required for safe operations of the AVB system at the South Gate. • SO and IST did not ensure that adequate controls were in place to prevent accidents in the event of failure of operations of the AVB system at the South Gate of the facility. The routine, wherein officers wave a vehicle forward, then punch the button to open the barrier, works acceptably given the distance between control console and barrier at the North Gate. This sequence is far more prone to failure at the South Gate which has less than half the travel distance. • SO and IST has not formally established and agreed upon conditions and requirements that must be satisfied for operations of the AVB systems after initial installation and after the modification. No final approved drawings were made available to the Board. • The safety equipment was not included in the maintenance checklist and the checklist was not properly used. The Monthly Visual Inspection Checklist used for preventive maintenance did not contain a check for the safety loops. • Safety loop #2 for barrier #3 had not been connected and was installed without being tested by SO, IST, or NBI for functionality. In addition, the control box where the connection was made was not examined by the NBI during monthly preventive maintenance check. • An NBI worker was observed not using the checklist during work package performance. The checklist was filled out after work completion. As a result, the accuracy of the checklist result was unreliable.
Core Function 1: Define the Scope of Work • SO did not establish safety, quality, and related performance expectations for executing the documented scope of work for the South Gate Project. • SO did not establish an acceptance test plan for installation of the barrier system, and, therefore, did not have a

Table 3-1. Implementation Deficiencies Associated with Guiding Principles and Core Functions of Integrated Safety Management
mechanism for ensuring the quality and operability of the equipment and systems installed. • The Project Manager (IST) did not develop a Project Management Plan and other key documentation to guide overall installation and testing of the barrier system prior to full operation.
Core Function 2: Analyze the Hazards • IST did not ensure that a traffic safety study was performed, and that traffic safety was integrated into the South Gate Project. • Specific worker safety requirements were not contained in the maintenance contract. • SO, IST, NBI did not take into account the consequences of (1) potential of accidents during initial installation and (2) subsequent modifications to the AVB system at the South Gate.
Core Function 3: Develop and Implement Controls • SO and IST did not evaluate physical and engineering hazard controls for functional and operational effectiveness of the AVB system at the South Gate. • SO and IST did not have formal administrative controls or technical procedures for South Gate AVB system. • The manufacturer's equipment manual does not describe how the barrier would respond when a vehicle travels over a safety loop after an open or close command is initiated at the master control panel. • SO and IST did not have formal review, approval, and configuration control process in place for the AVB system for the South Gate of the facility. • Safety loops #1 and #2, which are intended to stop the barrier(s) in place when the presence of metal is detected, were not functional at South Gate barrier #3. • The operator's control panel is inadequately designed for routine, highly repetitive operation.
Core Function 4: Perform Work Safely • SO and IST did not have formal work plan associated with initial installation and subsequent modifications of the AVB system at the South Gate of the facility.
Core Function 5: Feedback and Improvement • SO did not adequately establish effective, performance-based processes for monitoring and assessing IST/NBI performance (Integrated Safety Management and environment, safety and health), providing feedback, and holding these organizations responsible for correction of deficiencies and effective performance of the AVB system at the South Gate. • Since October 2003, there have been 12 reported incidents involving vehicles and AVBs at the DOE Germantown complex. These incidents were not systematically analyzed and trended, nor were lessons learned captured and communicated to prevent recurrence. WWS provided SO management with incident notification reports for all active vehicle barrier incidents at DOE Germantown complex since October 2003. None of the incident reports were contained in the Occurrence Reporting and Processing System database. • There is no formal mechanism in place to evaluate the incident and identify causal factors, including root causes, for management attention, action, and prevention of recurrence.

3.2 Barrier Analysis

Barrier analysis is based on the premise that hazards are associated with all tasks. A barrier is any means used to control, prevent, or impede a hazard from reaching a target, thereby reducing the severity of the resultant accident or adverse consequence. A hazard is the potential for an unwanted condition to result in an accident or other adverse consequence. A target is a person or object that a hazard may damage, injure, or fatally harm. Barrier analysis determines how a hazard overcomes the barriers, comes into contact with a target (e.g., from the barriers or controls not being in place, not being used properly, or failing), and leads to an accident or adverse consequence. The results of the barrier analysis are used to support the development of causal factors. Appendix B, Table B-1, contains the barrier analysis.

3.3 Change Analysis

Change is anything that disturbs the "balance" of a system from operating as planned. Change is often the source of deviations in system operations. Change can be planned, anticipated, and desired, or it can be unintentional and unwanted. Change analysis examines the planned or unplanned disturbances or deviations that caused the undesired results or outcomes related to the accident. This process analyzes the difference between what is normal (or "ideal") and what actually occurred. The results of the change analysis are used to support the development of causal factors. Appendix C, Table C-1, contains the change analysis.

3.4 Events and Causal Factors Analysis

An events and causal factors analysis was performed in accordance with the DOE Workbook *Conducting Accident Investigations*. The events and causal factors analysis requires deductive reasoning to determine those events and/or conditions that contributed to the accident. Causal factors are the events or conditions that produced or contributed to the accident, and they consist of direct, contributing, and root causes. The direct cause is the immediate event(s) or condition(s) that caused the accident. The contributing causes are the events or conditions that, collectively with the other causes, increased the likelihood of the accident, but which did not solely cause the accident. Root causes are the events or conditions that, if corrected, would prevent recurrence of this and similar accidents. *The direct cause of the accident was the collision of the van with the active vehicle barrier.* The causal factors are identified in Table 3-2. A summary of the Board's causal factors analysis is presented in Appendix D, Table D-1, Events and Causal Factors Chart.

Table 3-2. Causal Factor Analysis

Root Cause	Discussion
SO and IST did not ensure that principles associated with quality and Integrated Safety Management were adequately incorporated into the design, installation, operation, and maintenance of the South Gate Project.	SO did not monitor the implementation of Integrated Safety Management on the South Gate Project to ensure that the following critical elements were being implemented as part of the South Gate AVB Project: • Establishing clear safety objectives in conjunction with pre-existing security objectives and requirements; • Developing an overall project plan, quality assurance plan, and safety plan to guide execution of activities, achievement of objectives, and monitoring of performance; • Effectively developing of operating procedures and training of protective force personnel; • Properly conducting routine barrier maintenance; and • Rigorously reviewing and implementing corrective actions based on documented incident reports. • NBI did not establish a formal process to ensure the conduct of periodic barrier maintenance. IST did not ensure implementation of the following critical elements: • Conducting safety and site plan reviews during the design and installation phases; • Executing a traffic safety study; • Developing clear inspection and testing procedure to assure safe system functionality; • Establishing a change control procedure; • Incorporating engineering controls to ensure safe operations of the AVB (e.g., safety loops); and • Properly conducting routine maintenance on peripheral systems associated with the AVB.
Contributing Cause	**Discussion**
SO allowed an unstructured approach to design installation, operation and maintenance and change control for the AVB system.	SO and IST oversight was inadequate. • NBI disclaimed responsibility for conducting a traffic safety study for the South Gate Project. IST took no action to resolve this issue. • SO allowed the project to continue without the traffic safety study. • Failure to ensure that comprehensive and appropriate requirements are fully implemented represents a fundamental flaw in the safety management program of IST and fails to meet the DOE safety management principle requiring that controls be established and implemented to mitigate hazards and assure safety. • SO did not ensure or nor did it have formal processes in place to monitor whether IST was performing effectively as the project manager for the South Gate Project. • SO did not develop or implement a formal feedback process, which would have established roles and responsibilities between all concerned entities for the South Gate Project. • As a result of no formal feedback process, SO failed to ensure that effective operating procedures were established or that protective force personnel would operate the South Gate to assure the safety of those personnel entering and exiting the complex.

Contributing Cause	Discussion
	IST lacked a project management plan with the requirements for design, installation, operation, and associated change control processes for the AVB system. • IST did not demonstrate the appropriate level of project management skills for the South Gate Project. IST did not develop and implement a written project management plan describing, as a minimum, roles and responsibilities for quality assurance and safety, safety objectives, and project schedules. • IST's lack of project management expertise was evidenced by – inadequate records of formal status meetings held between SO, IST, and NBI; the absence of any approved site-specific drawings; and the absence of any schedules for SO testing and acceptance of the fully installed and operational system. • Traffic safety engineering reviews – intended to address the concerns of proper lighting, written warning signs, traffic lights, electronic beams, gate arms, audible alarms, and safe vehicle access – were not performed.
	No formal training was provided to safely operate the South Gate AVB system. • NBI provided on-the-job training at the South Gate to a limited number of SO, IST, and WWS staff members. • WWS did not have a formal site-specific training procedure and implementation plan for training of protective force personnel. The training provided was conducted without lessons plans and attendance was poorly documented. • No procedure was developed for operation of the South Gate AVB.
	No formal mechanisms existed for feedback and improvement. • The Office of Security Operations did not perform any formal quality or safety surveillances, inspections or assessments, which would have identified weaknesses in IST project management and in the achievement of quality and safety objectives. • The South Gate AVB project activities were not consistently performed within controls or by using formal, documented, and accepted procedures or guidelines. • Formal processes were not in place to analyze notification reports of AVB incidents, to identify causal factors, and to communicate the results of these analyses to SO for management attention, corrective action, and recurrence prevention.

4.0 Judgments of Need

Judgments of Need are managerial controls and safety measures believed necessary to prevent or minimize the probability of a recurrence of the same or similar accident. They flow from the causal factors and are directed at guiding managers in developing corrective actions. The Executive Summary identifies the Board's Judgments of Need. The conclusions and Judgments of Need are provided in Table 4-1.

Table 4-1. Conclusions and Judgments of Need

Conclusion	Judgment of Need
The Board concludes that critical safety roles and responsibilities, which would have ensured safe and effective design, installation, operation, and maintenance of the AVB system, were not properly assigned or executed.	SO needs to develop and implement a formal process to review and modify (as necessary) design, installation, operation, and maintenance documents to ensure that critical safety roles and responsibilities are identified, assigned, and executed for all projects under SO purview.
The Board concludes that several safety expectations were not identified and incorporated into the South Gate Project.	SO needs to develop and implement a formal process to ensure that essential safety requirements are identified and are incorporated into contractor documents for implementation, according to SO safety expectations. IST and other contractors need to formally institutionalize a process for identifying, capturing, evaluating, and translating essential safety requirements into SO project activities.
The Board concludes that the AVB master control panel layout at the South Gate was inadequate for repetitive and routine operations and needs improvement to preclude accidental operation of the AVB.	
The Board concludes that quality assurance processes for testing and acceptance of the operation of safety loop #2 were lacking.	IST and other contractors need to formally develop and implement procedures for testing and acceptance of project deliverables and any associated modifications. SO needs to develop and implement formal procedures for acceptance or receipt of any project deliverables.
The Board concludes that maintenance procedures and the quality assurance process were less than adequate.	
The Board concludes that hazard controls associated with AVB design and operation were not effectively identified, integrated, or implemented.	IST and other contractors need to develop and implement a formal process to define roles and responsibilities for evaluation of hazards, identification and implementation of hazard controls, and the incorporation of any modifications associated with SO projects. SO needs to develop a formal process to ensure that IST and other contractors have established roles and responsibilities for effective hazard evaluation and identification and implementation of hazard controls for SO projects.
The Board concludes that requirements for a hazard analysis were not identified and notably a traffic safety study was not conducted as the basis for establishing traffic safety risks and associated controls.	
The Board concludes that responsibility to conduct a traffic safety study to identify effective vehicle safety controls was not defined for the project. As a result, there is no basis for safety measures at the South Gate of the DOE Germantown complex.	

Conclusion	Judgment of Need
The Board concludes that preventive maintenance activities conducted by an NBI representative at barrier #3 at the South Gate failed to identify that safety loop #2 was not operating and that the dual in-line package switch was misaligned for safety loop #1.	IST/NBI need to modify their existing procedures and checklists to ensure that all safety loops associated with the AVB system are operating and that the dual in-line package switches are aligned to provide for safe operations. NBI needs to develop and implement formal procedures for maintenance activities to ensure that safety loops and associated dual in-line package switches are properly aligned after each maintenance activity.
The Board concludes that IST failed to develop documents for project management, quality assurance, and safety as part of the planning for design, construction and installation of the AVB at the South Gate of the Germantown complex and that a critical safety management element, the traffic safety study, was never performed by any organization with responsibility for the South Gate Project.	SO needs to develop and implement a formal process to ensure that contractors performing work for SO incorporate design requirements into project management, quality assurance, and safety plans prior to project initiation. IST and other contractors performing work for SO need to formally develop project management, quality assurance, and safety plans – incorporating design requirements – prior to project initiation. SO needs to develop and implement a formal process to monitor the effectiveness of contractor implementation of these requirements.
The Board concludes that operating procedures and Post Orders were less than adequate to ensure vehicle safety at the South Gate of the DOE Germantown complex.	SO needs to conduct an evaluation of the adequacy of existing procedures for AVB systems whose operation is the responsibility of SO and develop implementation plans for correcting identified AVB procedures. SO and pertinent contractors need to develop and implement AVB procedures and Post Orders for the safe operation of AVB systems. WWS needs to develop and implement a formal process to train personnel on the enhanced AVB system procedures and all Post Orders for all protective force personnel assigned to AVB systems at DOE Headquarters. SO needs to develop and implement a formal mechanism for ensuring that the enhanced procedures, Post Orders and training activities for AVB operation are effectively implemented by all contractors under their control.
The Board concludes that the training provided to protective force personnel on duty the day of the accident was inadequate to ensure that they knew how to safely operate the AVB for vehicle access.	
The Board concludes that there is a need for a procedure to address operations at the South Gate and to ensure safe vehicle access.	
The Board concludes that work conducted on the AVB project to assure system safety was not performed in accordance with formal procedures and was inadequate.	

Conclusion	Judgment of Need
The Board concludes that the manufacturer's equipment manual lacks documentation on the operation of the AVB when unplanned actions occur involving the safety loops and signals from the master control panel.	NBI needs to develop procedures for operation of the AVB, which address actions to be taken when unplanned events are encountered involving the safety loops and the signals from the master control panel and to provide training on those procedures to protective force personnel operating AVB systems at DOE Headquarters. SO needs to develop a formal process to ensure that the enhanced procedures and training activities for safe operation of the AVB system are effectively implemented.
The Board concludes the AVB operated as configured on the day of the accident, but safety controls were ineffective to prevent the accident.	
The Board concludes that formal processes were not in place to analyze notification reports of active vehicle barrier incidents, to identify causal factors, and to communicate the results of these analyses to SO for management attention, corrective action, and recurrence prevention.	SO needs to develop and implement a formal lessons learned program to analyze incidents, identify causal factors (including root causes), and communicate the results to DOE and/or contractor line management for corrective action, validation, and verification.
The Board concludes that the Office of Security Operations did not have a formal process to hold contractors and subcontractors accountable for effective performance of the AVB system by establishing clear safety objectives, ensuring mechanisms for the safe conduct of work, and developing and implementing formal processes to monitor performance.	SO needs to develop and implement a formal process for systematically conducting surveillances, inspections, or assessments of all pertinent contractor and subcontractor activities to evaluate the performance of project management, quality assurance, and safety systems, and identify necessary corrective actions.

5.0 Board Signatures

Robert Crowley
DOE Accident Investigation Board Chairperson
U.S. Department of Energy
Office of Environment, Safety and Health

Vincent Brooks
DOE Accident Investigation Board Member
U.S. Department of Energy
Office of Management, Budget and Evaluation

Prakash Kunjeer
DOE Accident Investigation Board Member
U.S. Department of Energy
Office of Environment, Safety and Health

6.0 Board Members, Advisors, and Staff

Board Members

Chairperson	Robert Crowley, DOE Office of Environment, Safety and Health*
Member	Vincent Brooks, DOE Office of Management, Budget and Evaluation
Member	Prakash Kunjeer, DOE Office of Environment, Safety and Health*

Advisors

Advisor	Ray Won, DOE Office of Environmental Management*
Advisor	Ross Kelly, Protection Strategies, Inc.
Advisor	Marcia Taylor, Parallax, Inc.*

Consultants

Consultant	Andrea Lucido, Parallax, Inc.
Consultant	Robert McCallum, McCallum-Turner, Inc.

* DOE Trained Accident Investigator

Appendix A – Appointment of Accident Investigation Board and Addendum

Department of Energy
Washington, DC 20585

April 14, 2005

MEMORANDUM To: Robert A. Crowley, Office of Facility Operations Support, EH-24

FROM: John Spitaleri Shaw
Assistant Secretary for
Environment, Safety and Health

SUBJECT: Limited Scope Accident Investigation – April 7,2005 Security System Actuation Resulting in Property Damage and Personal Injury, DOE-Germantown Office Complex – Germantown, MD

You are hereby appointed Chairperson of the Investigation Board to investigate the subject incident that occurred at the Department of Energy's (DOE) main Germantown office complex on April 7,2005. You are to perform a Limited Scope investigation of the incident and prepare an investigation report.. The report shall conform to requirements detailed in the DOE Order 225.1A, *Accident Investigation,* and DOE *G* 225.1A-1, *Implementation Guide for Use with DOE 225.1A, Accident Investigations.* The Board will be composed of members, advisors and other personnel as you may deem necessary.

The Board's investigation will primarily focus on the activation of the security barrier and gate at the South Entrance to the main Germantown office complex that resulted in damage to a vehicle and personal injuries to the vehicle's occupant, and the adequacy of the physical security systems and controls that were in place at the time of the incident. The Board will identify all relevant facts; analyze the facts to determine the direct, contributing, and root causes of the incident; develop conclusions; and determine judgments of need that, when implemented, should prevent the recurrence of the incident. The scope of the investigation will also include an analysis of applicable of lessons learned from similar accidents within the Department, and the formal reporting of incidents and occurrences by DOE Headquarters elements.

The Board will provide my office with periodic reports on the status of the investigation. These periodic reports should not include any findings or arrive at any premature conclusions until an analysis of all the causal factors have been completed. Discussions of the investigation and copies of the draft report will be controlled until I accept and authorize release of the final report.

The final investigation report should be provided to my office by May 13,2005.

cc:
C. Sell, DS
B. Carnes, DS
S. Grant, ME-1
G. Podonsky, SP-1
M. Combs, SO-1
R. Shearer, EH-1
R. Hardwick, EH-2
W. Cooper, EH-24
Accident Investigation File, EH-24

Department of Energy
Washington, DC 20585

April 19, 2005

MEMORANDUM TO: John Spitaleri Shaw
Assistant Secretary for
Environment, Safety and Health

FROM: Robert A. Crowley, P.E., Safety Engineer
Office of Facility Safety Support

SUBJECT: Limited Scope Accident Investigation of the
Germantown South Vehicle Barrier Accident
on April 7, 2005

The Board has convened in Germantown to begin an accident investigation into the incident that occurred at the South Germantown active vehicle barrier on April 7, 2005.

I will chair the Board and the members will include:

- Vince Brooks, Safety Specialist, HQ, Safety, Health and Security Group ME-43
- Prakash Kunjeer, Mechanical Engineering, Office of Facility Safety Support, EH-24

In accordance with DOE Order 225.1A, ***"Accident Investigations"***, the Board will identify the relevant facts; analy the facts to determine the cause of the accident; develop conclusions; and determine Judgments of Need to prevent similar accidents in the future. I anticipate having the investigation and subsequent report completed by May 13, 2005. I will provide you with periodic reports on the status of the investigation.

cc: R. Shearer, EH-1
R. Hardwick, EH-2
W. Cooper, EH-24
V. Brooks, ME-43
P. Kunjeer, EH-24
R. Won, EM-3
B. Stone, *SO-30*
M. Zimmerman, SO-30.1

Appendix B – Barrier Analysis

Table B-1. Barrier Analysis

Hazard: Active Vehicle Barrier (AVB)		**Target:** Van
Barriers	**How Did It Perform?**	**How Did Barrier Performance Contribute to The Accident?**
Safety Loop #1	Failed	Safety switches were misaligned (in the wrong position) to ensure that the barrier would stop in place.
Safety Loop #2	Failed	The loop was not connected; thereby providing no assurance that safety loop #2 was functional.
Red and Amber Signal Light	Inadequate	The location of light was not easily visible to the driver and, therefore, would not see the warning signals. The driver could not see to stop.
Drop Arm	Inadequate	The drop arm obstructed the signal in "up" position.
Master Control Panel	Inadequate	Switches for entering and exiting the facility were identical, positioned next to each other, and not labeled.
Maintenance	Failed	System checks were not thoroughly performed. Safety loops were not identified as being inactive.
Training	Inadequate	Training did not ensure the knowledge necessary to operate the AVB safely.
Lessons Learned	Failed	There was no communication of lessons or information learned from previous incidents; hence, opportunities were missed to prevent future occurrences related to AVBs
Procedure 137	Failed (none in place) Inadequate	Procedure 137 for barrier operations was written for the North Gate and not the South Gate.
Electronic Beam	Absent (nonexistent)	Lack of an electronic beam provided no assurance that the barrier would stop in place.
Safety Study	Never performed	Traffic safety engineering concerns such as proper lighting, written warning sign, traffic lights, gate arm and audible alarms were never identified.
Communication Between Guards and Driver	Adequate for security, but out of sequence for safety	Had the guard conducted an access sequence that ensured the barrier was completely open before the van was waived to enter into the facility, the accident would not have occurred.
Acceptance and Testing	Not performed	Acceptance and testing was not conducted; hence, potential AVB failures were not identified.
Integrated Safety Management System	Inadequate	SO and IST did not ensure that principles associated with Integrated Safety Management were adequately incorporated into the design, installation, operation, and maintenance of the South Gate Project.

Appendix C – Change Analysis

Table C-1. Change Analysis

Change Analysis Worksheet			
Accident Situation	**Prior, Ideal, or Accident-Free Situation**	**Difference**	**Evaluation of Effect**
IST Project Management process was not formal.	Formal Project Management System (i.e., DOE 413.1) was established and implemented.	IST did not have project management requirements established for execution of the AVB design construction and operation and, therefore, was inadequate.	The IST project management process for the AVB Project at the South Gate lacked requirements in the areas of: • Documentation of final design; • Documentation of meetings, planning and scheduling; • Roles and responsibilities matrix; • Project execution; • Quality Assurance plan; • Safety plan; • Acceptance and Testing; and • Change control process for modifications.
SO-20 (now SO-30) was responsible for, but did not monitor, the performance of the AVB project.	Line managers monitor the performance of construction projects.	System were not in place to monitor actual performance of the AVB project.	If a system had been in place to monitor the performance of the AVB project from start to acceptance and operation, then deficiencies in design and operation would have been identified and corrected, including the lack of a traffic safety study and testing of the AVB system.
Construction design drawing was not site-specific.	Design drawing is site-specific.	Appropriate placement of safety loop #1 would have eliminated the need for a second safety loop.	Proper placement of safety loop #1, consistent with an approved design based on a traffic safety study, would have eliminated the need for a second safety loop, and would have identified an optimum location for safety loop #1.
Configuration of the South Gate barrier system was not similar to North Gate barrier system.	Both South Gate and North Gate barriers systems are identical.	Instrumentation and controls, configuration, training, and operation would be consistent.	Uniform design would have provided one procedure for both gates. • Training would have been consistent. • No deviations would have existed between the North Gate barrier and South Gate barrier with respect to controls, equipment and operation. • Consistent maintenance would have been performed for all barrier gates.
No lessons were learned from previous AVB events, nor were these events analyzed.	Analysis, trending, lessons learned, and reporting (i.e., Occurrence Reporting Processing System) are formal and institutionalized to identify causes and lessons learned.	There was no process to report incidents outside of SO and analyze data to prevent recurrence of AVB incidents.	The lack of a lessons learned mechanism precluded other DOE elements (Office of Environment, Safety and Health, Office of Management, Budget and Evaluation) to provide insights that might help mitigate recurrence of the AVB incidents. Both IST and SO lacked processes to collect, analyze, and trend data and report outcomes to SO for corrective actions of causal factors.
No procedures existed for	Formal procedures are developed for the	The guards did not understand roles and	Formal procedures for South Gate access would have provided step-by-step actions for guards to

Change Analysis Worksheet			
Accident Situation	**Prior, Ideal, or Accident-Free Situation**	**Difference**	**Evaluation of Effect**
South Gate barrier operations.	South Gate and implemented.	responsibilities relative to safe vehicle access at the South Gate and implement them routinely.	instruct drivers how to proceed through the AVB safely.
Inadequate training was provided for guards on AVB operations at South Gate.	Adequate training is provided for guards on AVB operations at the South Gate.	Training of guards did not ensure that roles and responsibilities were established and understood, lesson plans were developed, and on-the-job training was adequate to operate the AVB at the South Gate.	• The guards' roles and responsibilities for AVB operation were not defined, understood or implemented. • On-the-job training was not evaluated to ensure adequacy. • On-the-job training was not documented in a training plan or in records. • Lesson plans were not developed and implemented specific to South Gate.
Documentation of acceptance and testing for the installation of safety loop #2 did not exist.	Documentation of acceptance and testing for the installation of safety loop #2 is recorded.	Records did not exist demonstrating that acceptance testing was completed and that verified that safety loop #2 functioned as intended.	The lack of records on acceptance testing on safety loop #2 did not provide assurance that: • Test plans were developed • Roles and responsibilities were assigned • Acceptance criteria were developed to meet AVB operation needs • Barrier operations met safety requirements, which required the safety loops to function properly.
No change control process existed to support the addition of a second safety loop.	Change control process exists and fully supports the addition of a second safety loop.	A formal change control process was not used to control barrier installation and any modifications.	Since no formal change control process existed, there was no assurance that evaluation and testing was planned or implemented to ensure that the second loop was installed to perform its intended function.
No formal oversight process existed to monitor the construction and operation of South Gate AVB system.	A formal mechanism exists to document the oversight of construction and operation of South Gate AVB system.	No formal process for conducting oversight existed to ensure that South Gate AVB was designed, constructed and installed to operate safely.	The lack of formal processes for conducting oversight precluded SO from be knowledgeable of the status of the AVB system at the South Gate during design, construction and operation.

Appendix D – Events and Causal Factor Analysis

Table D-1. Events and Causal Factors Chart

CAUSAL FACTORS IDENTIFIED ON THE EVENTS AND CAUSAL FACTORS CHART

A — Safety was not considered in the design of the system

B — IST oversight was inadequate

C — Both IST and SO lack processes to collect, analyze, trend data and report outcomes to SO for corrective actions to prevent recurrence

D — No formal training to operate South Gate AVB safely for:
- Worldwide/Wackenhut
- IST
- SO
- Nasatka

E — No safety review performed

F — No acceptance testing performed to assure AVB system functionality

G — SO and IST did not ensure that controls were in place to ensure safe operation for AVB

H — SO lacked oversight for preventive maintenance contract

I — No procedure for safe operations of the South Gate barrier at the time of the accident

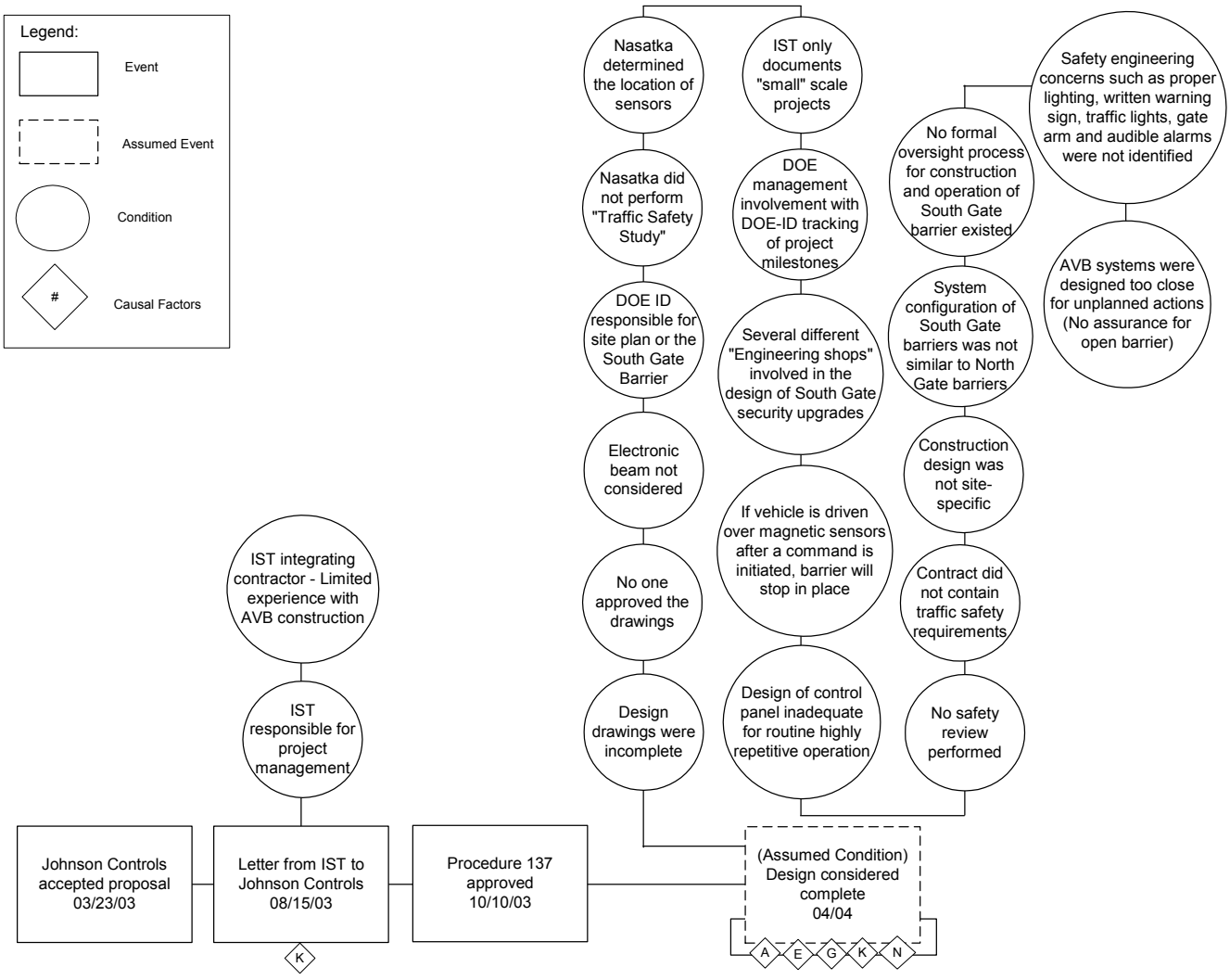
J — Nasatka had no formal acceptance testing procedure to perform safe system functionality

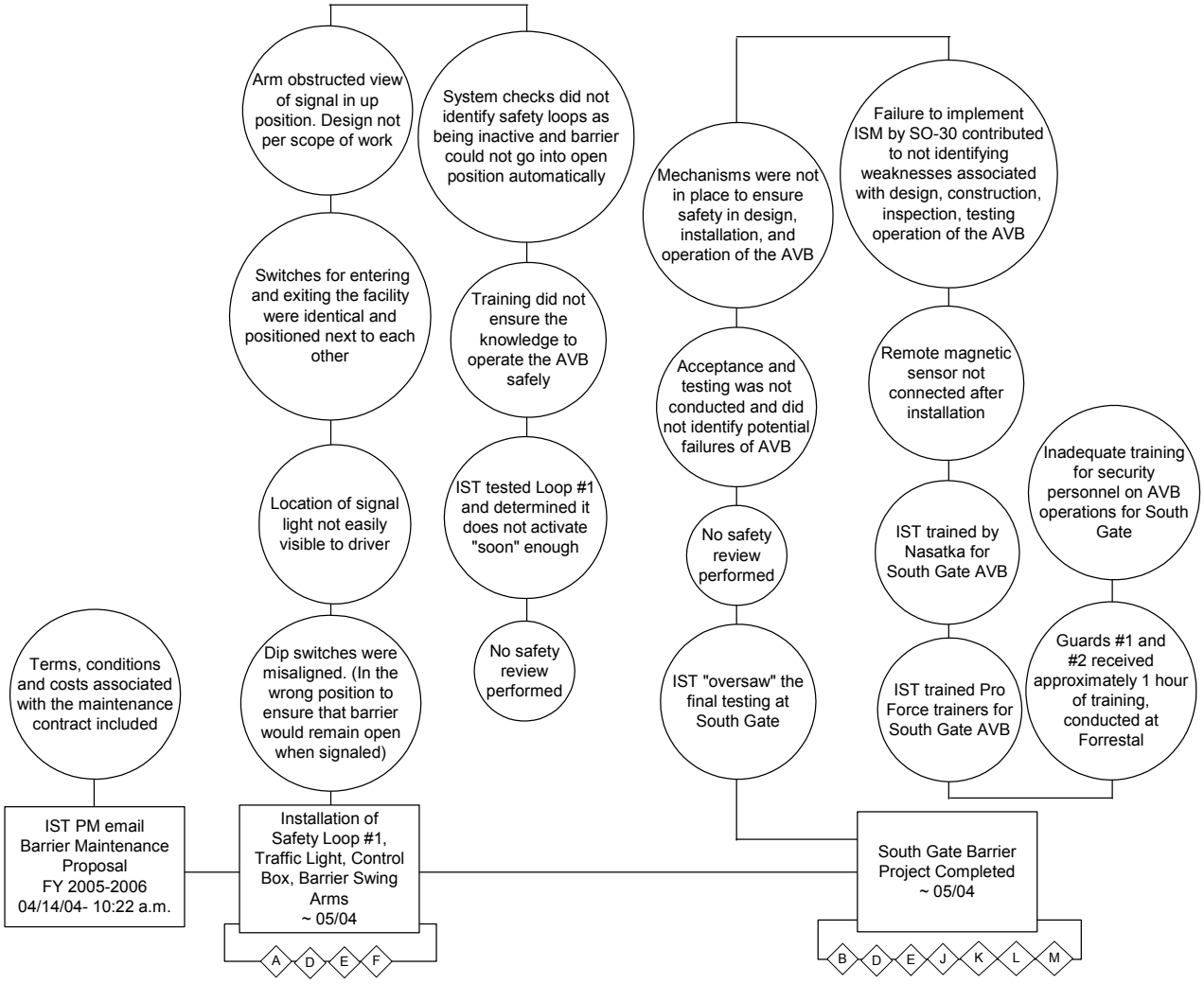
K — IST lack a project management plan with the requirements for design, installation, operation and associated change control processes systems

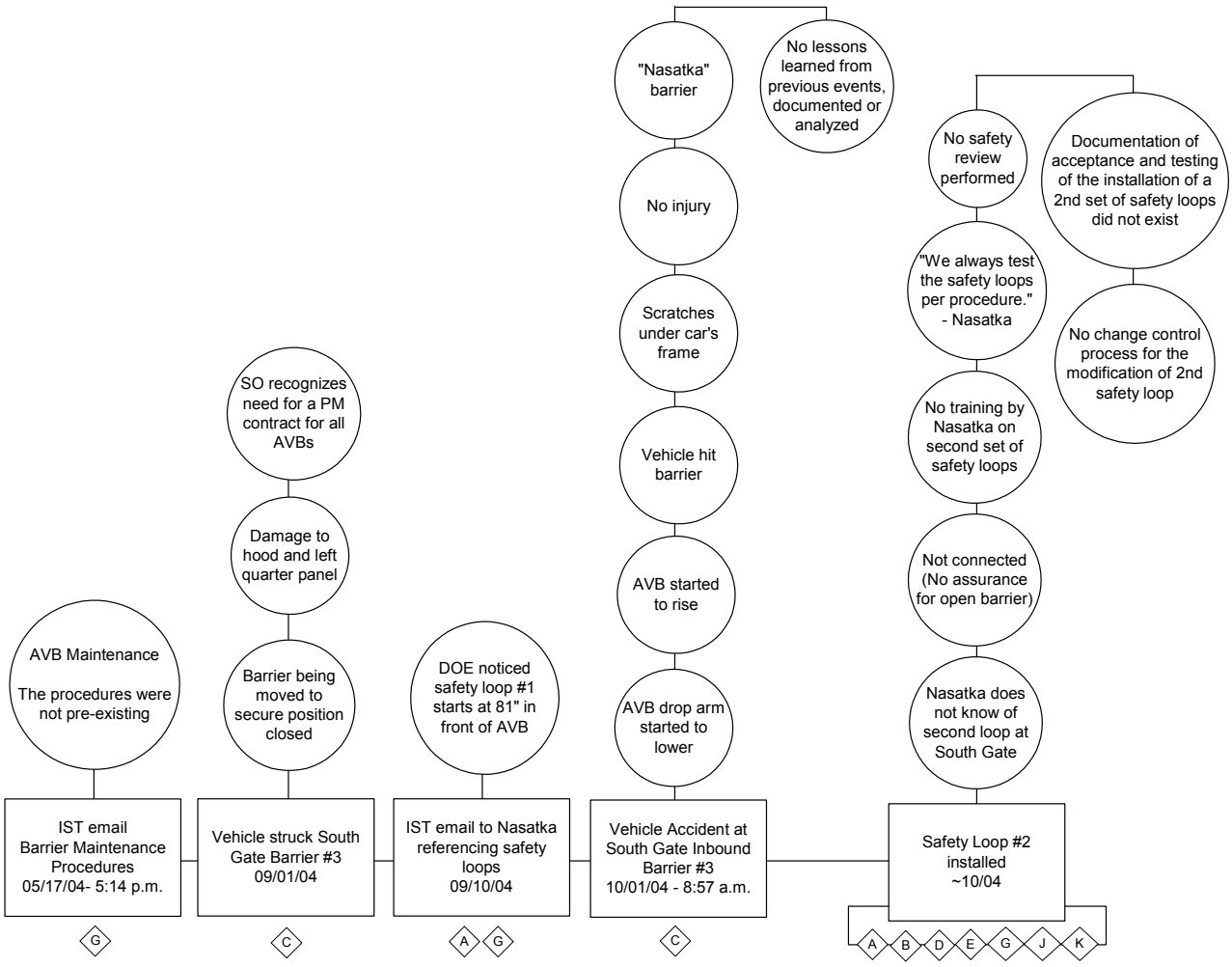
L — Responsibilities for acceptance testing not defined

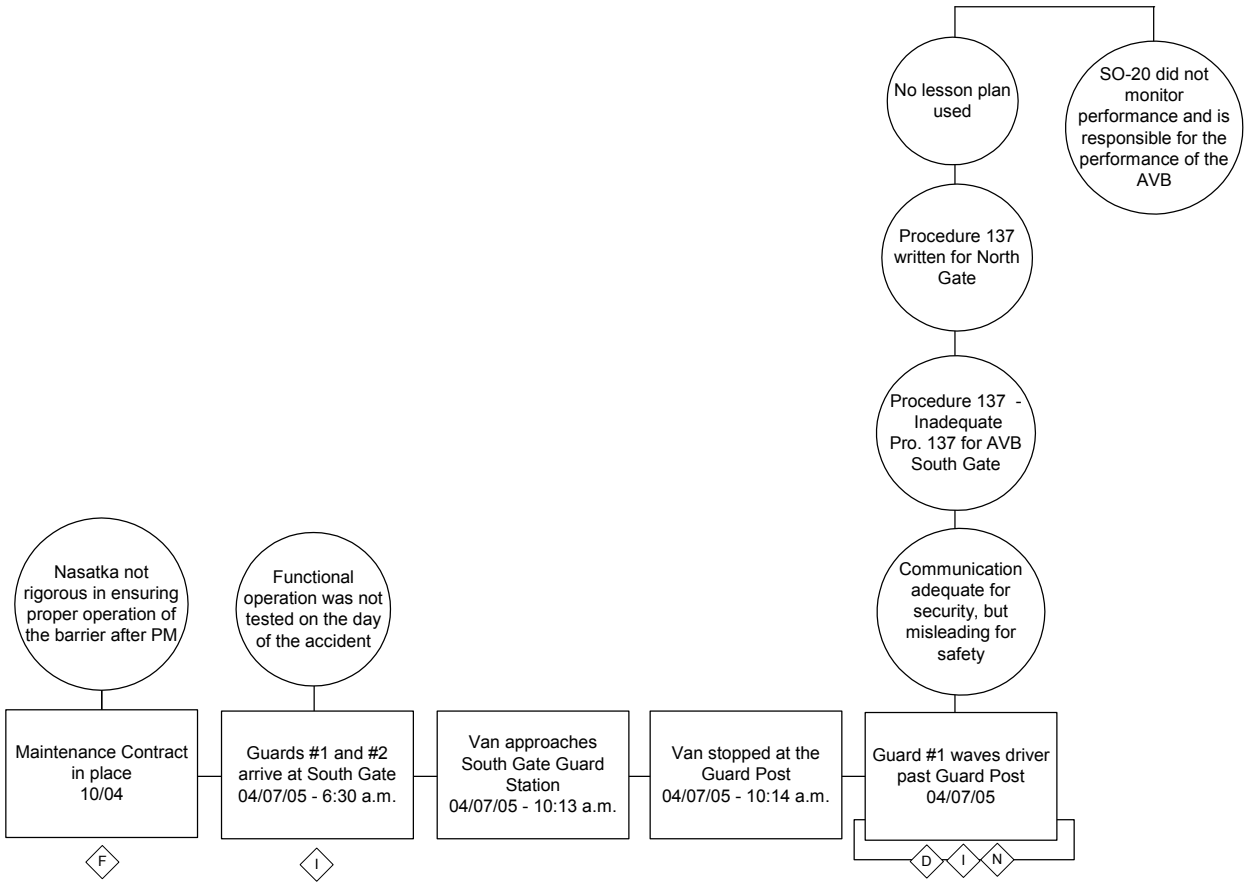
M — Failure to implement ISM by SO-30 contributed to not identifying weaknesses associated with design, construction, inspection, testing operation of the AVB

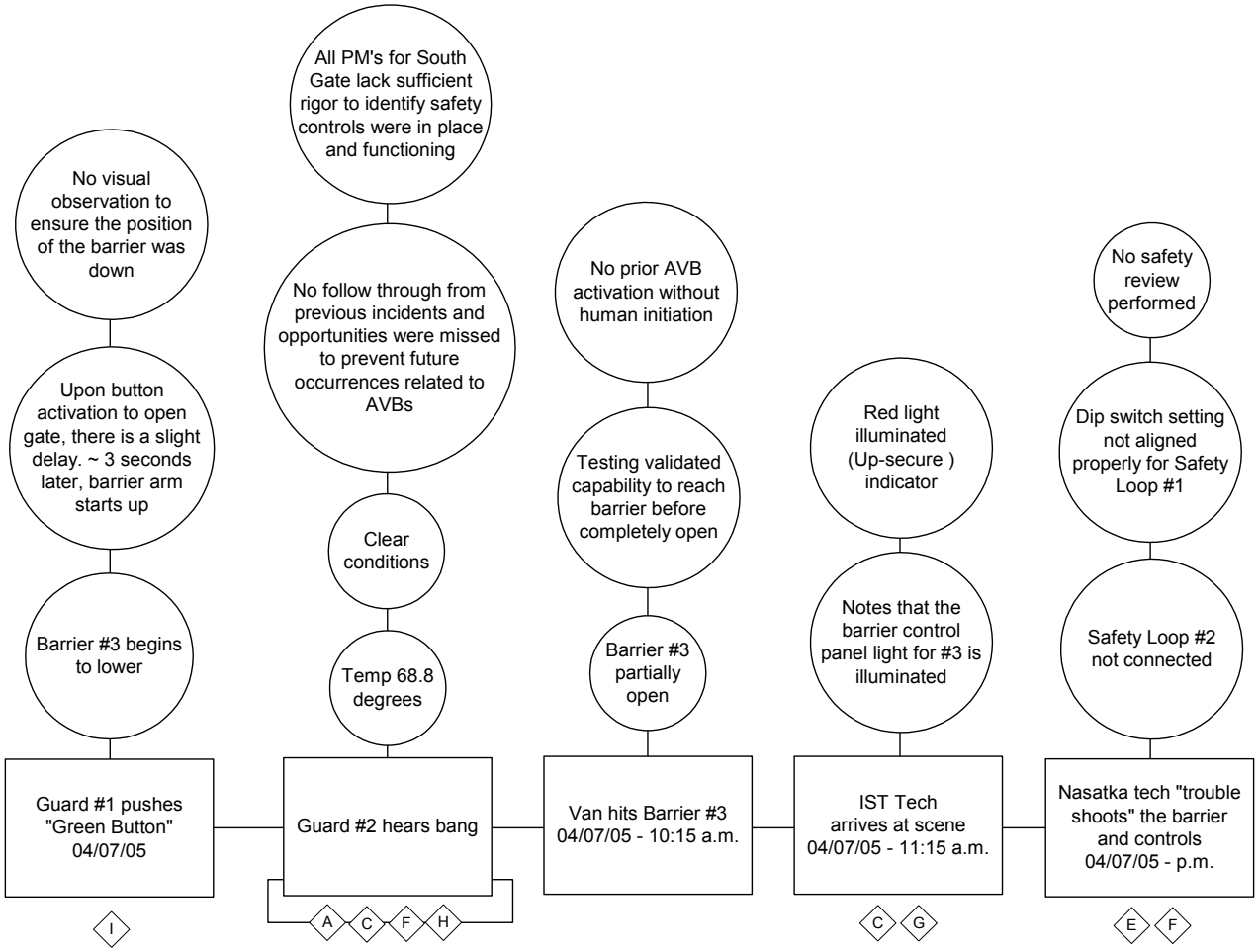
N — SO allowed an unstructured approach to design installation, operation and associated maintenance and change control for the AVB sy


Legend:
Event
Assumed Event
Condition
#
Causal Factors
Nasatka determined the location of sensors
IST only documents "small" scale projects
Safety engineering concerns such as proper lighting, written warning sign, traffic lights, gate arm and audible alarms were not identified
No formal oversight process for construction and operation of South Gate barrier existed
Nasatka did not perform "Traffic Safety Study"
DOE management involvement with DOE-ID tracking of project milestones
AVB systems were designed too close for unplanned actions (No assurance for open barrier)
System configuration of South Gate barriers was not similar to North Gate barriers
DOE ID responsible for site plan or the South Gate Barrier
Several different "Engineering shops" involved in the design of South Gate security upgrades
Construction design was not site-specific
Electronic beam not considered
If vehicle is driven over magnetic sensors after a command is initiated, barrier will stop in place
Contract did not contain traffic safety requirements
IST integrating contractor - Limited experience with AVB construction
No one approved the drawings
Design drawings were incomplete
Design of control panel inadequate for routine highly repetitive operation
No safety review performed
IST responsible for project management
Johnson Controls accepted proposal 03/23/03
Letter from IST to Johnson Controls 08/15/03
Procedure 137 approved 10/10/03
(Assumed Condition) Design considered complete 04/04
K
A
E
G
K
N


Arm obstructed view of signal in up position. Design not per scope of work
System checks did not identify safety loops as being inactive and barrier could not go into open position automatically
Mechanisms were not in place to ensure safety in design, installation, and operation of the AVB
Failure to implement ISM by SO-30 contributed to not identifying weaknesses associated with design, construction, inspection, testing operation of the AVB
Switches for entering and exiting the facility were identical and positioned next to each other
Training did not ensure the knowledge to operate the AVB safely
Acceptance and testing was not conducted and did not identify potential failures of AVB
Remote magnetic sensor not connected after installation
Location of signal light not easily visible to driver
IST tested Loop #1 and determined it does not activate "soon" enough
No safety review performed
IST trained by Nasatka for South Gate AVB
Inadequate training for security personnel on AVB operations for South Gate
Terms, conditions and costs associated with the maintenance contract included
Dip switches were misaligned. (In the wrong position to ensure that barrier would remain open when signaled)
No safety review performed
IST "oversaw" the final testing at South Gate
IST trained Pro Force trainers for South Gate AVB
Guards #1 and #2 received approximately 1 hour of training, conducted at Forrestal
IST PM email Barrier Maintenance Proposal FY 2005-2006 04/14/04- 10:22 a.m.
Installation of Safety Loop #1, Traffic Light, Control Box, Barrier Swing Arms ~ 05/04
A
D
E
F
South Gate Barrier Project Completed ~ 05/04
B
D
E
J
K
L
M


AVB Maintenance
The procedures were not pre-existing
IST email
Barrier Maintenance Procedures
05/17/04- 5:14 p.m.
G
SO recognizes need for a PM contract for all AVBs
Damage to hood and left quarter panel
Barrier being moved to secure position closed
Vehicle struck South Gate Barrier #3
09/01/04
C
DOE noticed safety loop #1 starts at 81" in front of AVB
IST email to Nasatka referencing safety loops
09/10/04
A
G
"Nasatka" barrier
No injury
Scratches under car's frame
Vehicle hit barrier
AVB started to rise
AVB drop arm started to lower
Vehicle Accident at South Gate Inbound Barrier #3
10/01/04 - 8:57 a.m.
C
No lessons learned from previous events, documented or analyzed
No safety review performed
"We always test the safety loops per procedure." - Nasatka
No training by Nasatka on second set of safety loops
Not connected (No assurance for open barrier)
Nasatka does not know of second loop at South Gate
Documentation of acceptance and testing of the installation of a 2nd set of safety loops did not exist
No change control process for the modification of 2nd safety loop
Safety Loop #2 installed
~10/04
A
B
D
E
G
J
K


No lesson plan used
SO-20 did not monitor performance and is responsible for the performance of the AVB
Procedure 137 written for North Gate
Procedure 137 - Inadequate Pro. 137 for AVB South Gate
Communication adequate for security, but misleading for safety
Nasatka not rigorous in ensuring proper operation of the barrier after PM
Functional operation was not tested on the day of the accident
Maintenance Contract in place 10/04
Guards #1 and #2 arrive at South Gate 04/07/05 - 6:30 a.m.
Van approaches South Gate Guard Station 04/07/05 - 10:13 a.m.
Van stopped at the Guard Post 04/07/05 - 10:14 a.m.
Guard #1 waves driver past Guard Post 04/07/05
F
I
D
I
N


No visual observation to ensure the position of the barrier was down
Upon button activation to open gate, there is a slight delay. ~ 3 seconds later, barrier arm starts up
Barrier #3 begins to lower
Guard #1 pushes "Green Button" 04/07/05
I
All PM's for South Gate lack sufficient rigor to identify safety controls were in place and functioning
No follow through from previous incidents and opportunities were missed to prevent future occurrences related to AVBs
Clear conditions
Temp 68.8 degrees
Guard #2 hears bang
A C F H
No prior AVB activation without human initiation
Testing validated capability to reach barrier before completely open
Barrier #3 partially open
Van hits Barrier #3 04/07/05 - 10:15 a.m.
Red light illuminated (Up-secure) indicator
Notes that the barrier control panel light for #3 is illuminated
IST Tech arrives at scene 04/07/05 - 11:15 a.m.
C G
No safety review performed
Dip switch setting not aligned properly for Safety Loop #1
Safety Loop #2 not connected
Nasatka tech "trouble shoots" the barrier and controls 04/07/05 - p.m.
E F

Appendix E – Active Vehicle Barrier Incident on June 8, 2005 at the North Gate of the DOE Germantown Complex

Active Vehicle Barrier Incident on June 8, 2005 at the North Gate of the DOE Germantown Complex

Accident Description

At approximately 9:52 am on Thursday June 8, 2005, an incoming vehicle approached the DOE Germantown North Gate. The vehicle had two occupants; the driver was wearing his seat belt and a child was restrained in a child safety seat located in the back seat of the vehicle. After inspecting the driver's badge just outside the North Gate Guardhouse, a Protective Force Officer directed the driver to proceed into the DOE Germantown facility. As the vehicle approached active vehicle barrier # 2, the Protective Force Officer pressed the "up button." The vehicle impacted active vehicle barrier # 2 as the barrier was approximately half way between its secure and open positions. Both vehicle air bags deployed and the driver sustained an injury to his wrist and chin. The child was not visibly injured. Both the driver and the child were transported to a local hospital for an examination and ultimately released. The vehicle sustained damage to the front bumper cover, the lower valance area, and the cooling system rendering it not drivable.

After the incident, active vehicle barrier #2 was inspected. A piece of the bumper cover wedged beneath the barrier's steel plate, preventing the barrier from retracting to the full "down" position. Once the bumper cover was removed, an inspection was conducted, which determined the active vehicle barrier did not sustain any physical damage. Functional tests of the controls and safety loops to confirm the controls and safety loops were functioning properly was conducted prior to the incident and verified by closed circuit television footage. Additionally closed circuit television footage from camera #48, located directly across from the barriers, showed the barrier beginning to rise just before the vehicle reached the safety loops, and the upward motion of barrier #2 stopped when the loops detected the vehicle.

The active vehicle barriers and controls were inspected by the technicians from IST, and subsequently by NBI. No malfunctions or unexplained circumstances were found during these inspections and after the piece of bumper cover was removed from beneath the barrier plate, the active vehicle barrier was returned to normal operations. A witness statement taken shortly after the incident documented the fact that the Protective Force Officer, who directed the driver to proceed into the Germantown facility, thought that barrier #2 was in the "up" position, and he intended to lower barrier #2 to the open position for the driver to enter the Germantown facility. However barrier #2 was already in the "down" position from a previous vehicle entry, and the Officer mistakenly pressed the "up button" causing barrier #2 to move toward the "up" position.

Date/Time	Event Description
April 22, 2002	IST submits proposal for North Gate Installation
January 2003	North Gate Active Vehicle Barriers are installed
June 8, 2005	
09:50 am	Vehicle Approaches North Gate Guard House
09:51 am	Vehicle Stops at the North Gate Guard House
09:52 am	Vehicle Strikes North Gate Active Vehicle Barrier #2
09:59 am	Emergency Personnel Attend to Occupants and Transport to Hospital
10:45 am	Federal Protective Force Officer Arrives to Investigate
12:30 pm	Damaged Vehicle is Towed from the Scene

The Board concludes that the Active Vehicle Barrier operated as installed on the day of the incident and the lack of attentiveness by the Officer in the North Gate Guard House directly contributed to the incident.

Emergency Response and Medical Treatment

Immediately after the incident, Protective Force Officers in the North Gate Guard House and North Gate inspection booth went to the aid of the vehicle's occupants. Montgomery County Fire and Rescue was contacted and responded to the scene. Emergency medical personnel conducted an examination at the scene and then transported the driver and the passenger to the local hospital. After a precautionary examination, both occupants were released.

Analysis

The Protective Force Officers at the North Gate of the DOE Germantown facility on the day of the incident received training on Protective Force Procedure 137 for operating the Active Vehicle Barriers at the North Gate. The Protective Force Officer, who directed the driver to proceed into the DOE Germantown facility, stated that he thought that barrier #2 was in the "up" position, and he intended to lower it for the driver to proceed. However, the barrier was already down from a previous vehicle entry and the Officer mistakenly pressed the "up button" raising the active vehicle barrier. Although this incident was a direct result of the officer's mistake, the following factors identified by the Board contributed to incident: (1) Protective Force Procedure 137 that governs operation of the active vehicle barrier at the North Gate of the DOE Germantown facility was not implemented so that the barrier was down during periods of "high activity", (2) Protective Force Procedure 137 does not require Protective Force Officers to verify the active vehicle barrier is down before allowing a vehicle to proceed into the Germantown facility, and (3) the operating routine at the time of the incident involved one officer performing duties normally assigned to two Protective Force Officers including inspecting the badges, granting vehicle access, and operating the active vehicle barrier while a second officer was on break.

An events and causal factor analysis was performed for the incident at the North Gate of the DOE Germantown Complex. This analytical process requires deductive reasoning to determine those events or conditions that produced or contributed to

the incident. The events and causal factors analysis for the incident at the North Gate of the DOE Germantown Complex were compared to the events and causal factor analysis for the incident at the South Gate of the DOE Germantown Complex to identify similar causes of each incident.

The incident at the North Gate of the DOE Germantown Facility was preventable. Preventing recurrence of accidents involving active vehicle barriers can only be achieved by effectively implementing corrective actions that address systemic causes of both incidents including the root cause and all contributing causes.

Similar Causal Factors for Both Active Barrier Incidents:

Root Cause

SO and IST did not ensure that principles associated with quality and ISM were adequately incorporated unto the design, installation, operations, and maintenance of all active vehicle barriers at the Germantown Facility.

Discussion:

SO did not monitor ISM implementation to ensure that the following critical elements were being executed:

- Establishing clear safety objectives in conjunction with security objectives and requirements for operation of the active vehicle barrier,
- Effectively developing operating procedures, and
- Rigorously reviewing and implementing corrective actions based on documented incident reports.

IST did not ensure implementation of the following critical elements:

- Executing a traffic safety study,
- Establishing a change control procedure, and
- Incorporating engineering controls to safe operations of the active vehicle barrier.

Contributing Cause

SO and IST allowed an unstructured approach to design, installation, operation and maintenance, and change control for the AVB system.

Discussion:

- IST took no action for conducting a traffic safety study for the Germantown facility.
- SO allowed active vehicle barrier operation to continue without a traffic safety study.
- SO did not ensure nor did it have formal processes to monitor whether IST/Protective Force were effectively performing active vehicle barrier operations at the Germantown facility.
- SO failed to ensure that effective operating procedures were established and implemented by Protective Force personnel operating active vehicle barriers at the Germantown facility
- Formal processes were not in place to analyze notification reports of active vehicle barriers incidents, to identify causal factors, and to communicate the results of these analyses to SO for management attention, corrective action, and recurrence prevention.

Similar Conclusions for Both Active Barrier Incidents:

The Board concludes that critical safety roles and responsibilities, which would have ensured safe and effective design, installation, and operation of the active vehicle barrier system, were not properly assigned or executed.

The Board concludes that requirements for a hazard analysis were not identified and notably a traffic safety study was not conducted as the basis for establishing traffic safety risks and associated controls.

The Board concludes that operating procedures and Post Orders were less than adequate to ensure vehicle safety.

The Board concludes that although the active vehicle barriers operated as configured on the day of accident, administrative safety controls were ineffective to prevent the accident.