Appendix A

USPS Environment, Facilities, and Mail Flow

This appendix summarizes the some of the more salient and applicable characteristics of the USPS operations that must be considered when selecting appropriate counterterrorism initiatives.

A.1 U.S. Postal Service Facilities and Customer Service Points of Contact

The Postal Service is a vast enterprise with unmatched mail processing volumes and worldwide distribution of assets. The bulk of these assets are located domestically in and around postal facilities located throughout the United States. Of these assets, the most visible are those through which the public acquires products and services. Figure A-1 provides an overview of the most apparent Postal assets from the perspective of the Postal Service customer.

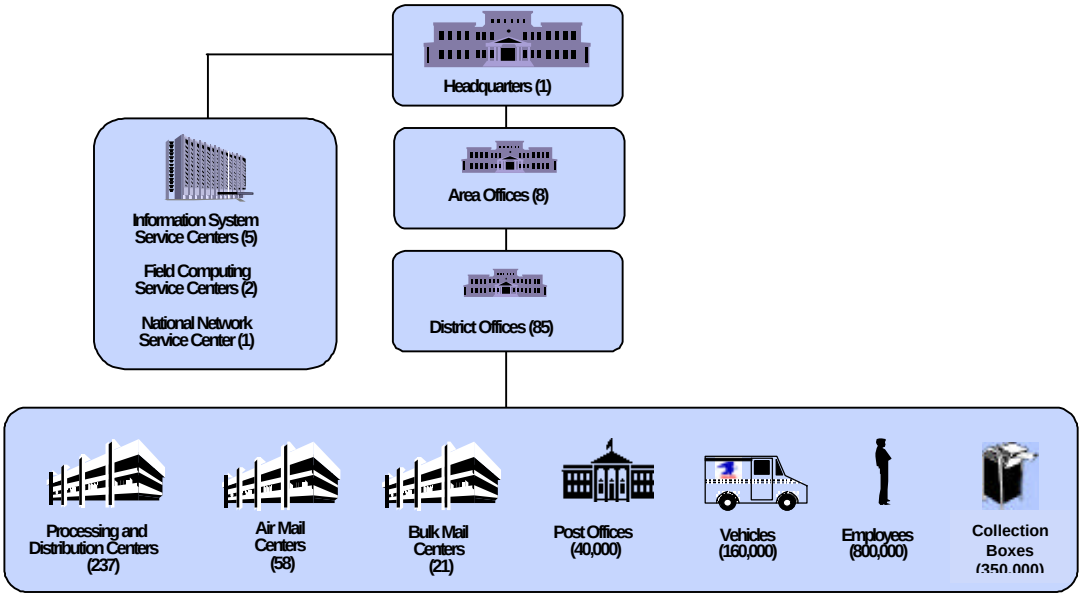

Figure A-1. USPS Customer Service and Administrative Assets

Not evident in Figure A-1 are the millions of bags, boxes, trays, hampers, rolling stock, and various over-the-road and aircraft containers that are in constant service throughout the postal operations.

Types of Mail

The Postal Service provides an array of services for a wide variety of mail items. Standard mail types are letters, flats, and parcels. These items may be introduced into the mail stream in many ways. Postal Service processes and procedures provide some degree of linking of some mail types to their point of origin and receiver. These include registered, express, certified, insured, postage due and COD mail, any item going through customs, and several other types. Of greater concern in the face of terrorist threats is the mail that is anonymously introduced into the mail stream. Anonymous mail may be collected from

mailboxes and collection boxes, as well from thousands of drop points at customer sites, mail facilities, and other locations across the country.

Mail Operations

The USPS mail processing operation is a complex and diversified system, requiring the coordinated effort of mail processing plants and delivery units across the country. While much of this processing is labor intensive, with a large work force distributed across the country, much of the processing required to sort the mail for distribution has been automated by a series of high volume machines. Table A-1 provides a listing of some of the more commonly used equipment that processes the anonymous mail within USPS Processing and Distribution Centers (P&DCs).

Table A-1. Mail Processing Equipment

Equipment	Estimated Quantity in Operation
Dual Pass Rough Cull Systems “Barney” (DPRC)	280
Advanced Facer Canceller System (AFCS)	910
Multi-Line Optical Character Reader (MLOCR)	875
Letter Mail Labeling Machine (LMLM)	360
Mail Processor Bar Code Sorter (MPBCS)	800
Delivery Bar Code Sorter (DBCS)	4300
Carrier Sequence Bar Code Sorter (CSBCS)r	3730
Flat Sorting Machine (FSM)	470
Small Parcel and Bundle Sorter (SPBS)	350
Tray Management System (TMS)	30

Figure A-2 provides a logical view of the mail handling process showing collection, sorting, and distribution, as well as interaction between delivery units and processing plants and interaction between the processing plants. Figure A-3 provides a more concrete view of these processes, illustrating some of the equipment used to perform the processes.

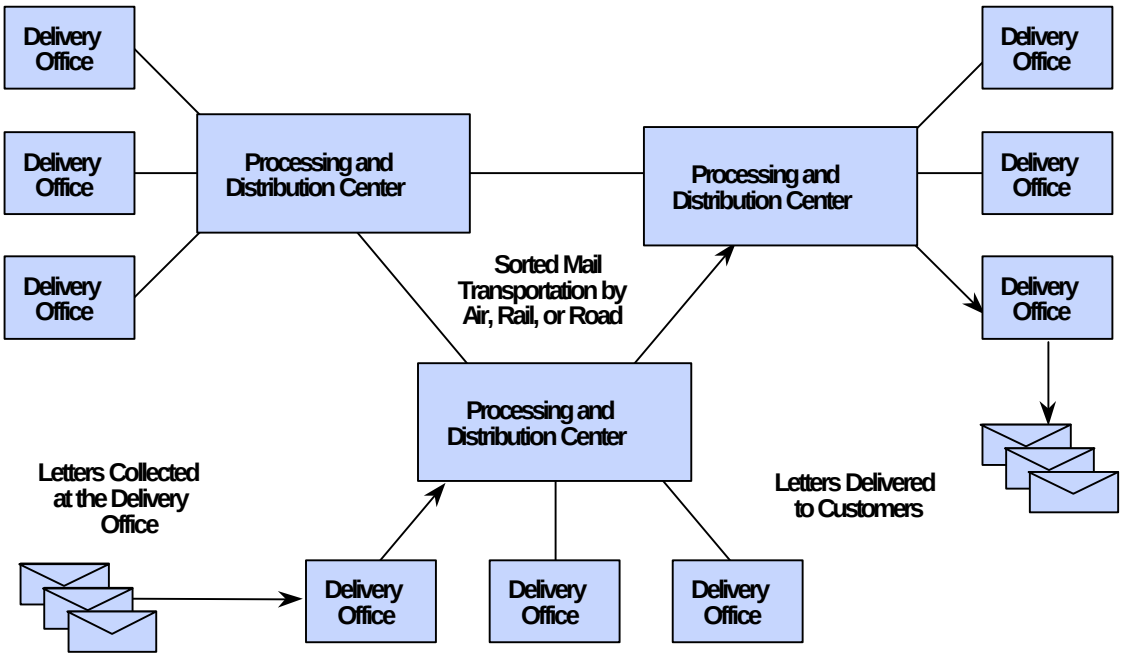

Figure A-2. Mail Flow Block Diagram

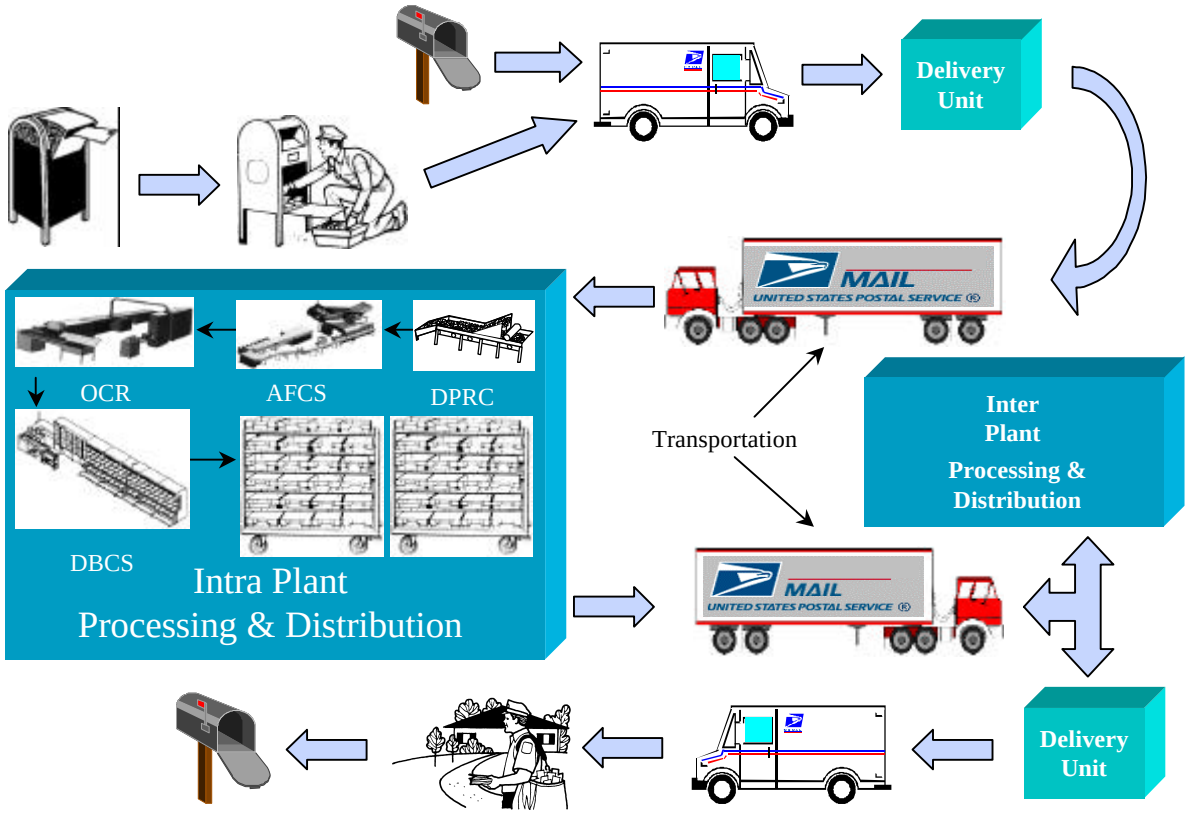

Figure A-3. Mail Handling Overview

Embedded within these operations are the Plant-to-Plant Interactions. Figure A-4 depicts these shipments.

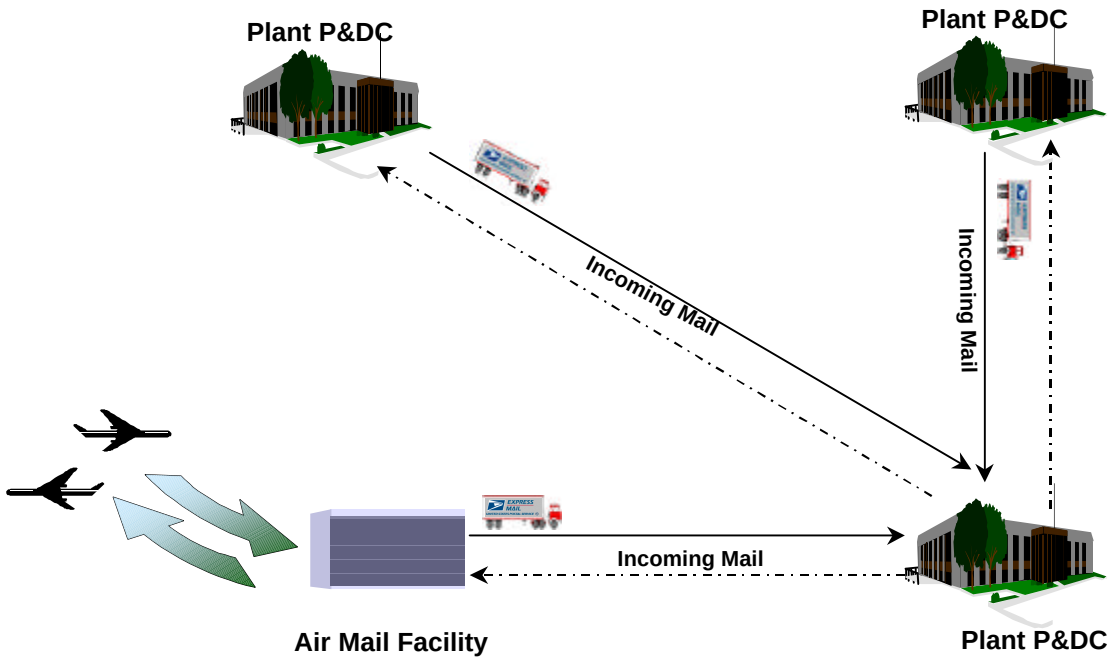

Figure A-4. Plant-to Plant Interaction

This mail handling can be divided into three distinct operations, collection, sorting, and distribution, although the physical processes for collection and distribution within the delivery units are routinely preformed by the same work force and vehicles, often simultaneously in the performance of street operations.

Appendix B

Prevention

B.1 Entry Point Control–Collection Box

This appendix summarizes information that the USPS will need to have as part of its entry point control efforts to minimize the possibility that Postal Service employees will be exposed to biohazardous substances that have been introduced into Postal Service collection boxes.

The Postal Service has about 350,000 collection boxes that are available to the public and that are used to introduce mail into the Postal Service mail flow. The Postal Service has limited means to protect the mail deposited in collection boxes that, generally, are not guarded and are not under surveillance. Multiple technologies could be used to enforce entry point control at the collection boxes.

The Postal Service needs to minimize entry point vulnerabilities by developing technologies to monitor mail that enters the system through collection boxes. The technologies under consideration require that a mail containment technology be used inside each collection box. In addition to providing a single-use bag for containing the mail, and possible hazardous agents, this technology could provide the Postal Service with the capability to detect contaminants and to decontaminate the mail while it is isolated in a container.

This proposed collection box with a containment feature has not been built or evaluated and is not available for near-term implementation. The Postal Service has issued a solicitation to invite submission of additional technologies for collection boxes.

B.1.1 Containment Capable Collection Box

Technical Description

The Postal Service is interested in evaluated collection boxes that have been designed to contain mail in a separate box or containment bag while it is in the collection box and after it has been removed from the collection box. Suggested technologies from firms with knowledge of how the Postal Service uses collection boxes include the use of polyethylene bags inside each collection box and the use of coded information on the bags to trace mail back to its originating collection box. Mail dropped into the collection box slot would be contained/isolated in the bag. These bags would include barcodes that could be used to track mail in the bag to the collection box from which the bag was removed.

The Postal Service has identified required functional capabilities that the containment collection boxes must provide. Containment capable collection boxes must be designed to include the following functionality:

- Hold mail that is deposited in the collection box and isolate that mail from the box. This isolates both the mail and any hazardous materials that may be introduced into the box.
- Isolates mail that has been removed from the box until it reaches a delivery unit or processing point. This protects the collector and protects against cross-contamination during transport.
- Adaptable to collection mail at retail units (e.g., lobby drops). When the Postal Service has identified a technology that it plans to use, it will insure that the technology is adaptable for other uses.

Possible additional functionality that may be used if practical includes:

- Applying a unique code that can be used to track mail back to a collection box. This supports investigative efforts and should enhance deterrence.

- Isolating mail while it is being tested to prevent cross-contamination in the delivery or processing unit.

When these new collection boxes become available, the Postal Service expects to conduct extensive testing in multiple environments to ensure that the new box designs are compatible with Postal Service processes and with the climatic conditions to which the boxes are exposed.

Availability/Development Status

This technology requires that containment capable collection boxes be custom designed for the Postal Service. The Postal Service is aware that firms who are knowledgeable of Postal Service requirements are developing design concepts for containment collection boxes. The Postal Service plans to work with vendors in the development of acceptable designs. The lead-time for the design and development of candidate collection boxes is unknown. Therefore, availability of these boxes is unknown.

Product/Procedure-Specific Information

Since these containment capable collection boxes are not currently available, there is no reliable product specific information about them. During the design, the Postal Service will need to ensure that vendors address issues such as reliability, maintenance, production quality controls, durability in severe weather environments, resistance to unauthorized access, etc.

Effectiveness

Documentation of the effectiveness of the proposed technology is not available at this stage in development. Measuring the effectiveness for this type of prevention will be a multi-phase effort. The USPS will need to determine the effectiveness of the containment technology (including leakage when mail is deposited into the collection box, leakage in the collection box, and leakage when the carrier removes the mail from the collection box).

Environmental Issues

Not known. Would not be a significant factor since the materials and functionality will be similar to today’s collection boxes.

Costs

The Postal Service has developed some initial projected costs for these redesigned collection boxes. Initial projected cost for acquisition of boxes is projected to be $352 million. This includes costs for modifications to lobby drop slots.

The Postal Service will have to extend the cost to cover testing and installation as well as initial maintenance costs.

The projected life cycle cost must include the cost of supplies, maintenance, storage, and distribution and is currently unknown.

Operational

Operational issues and costs will be design specific and are not currently available to the Postal Service. The Postal Service will work with vendors to ensure that potential operational issues are addressed early in the design process. The Postal Service plans to identify the impacts of operational issues such as:

- Issues with installing and maintaining the boxes.
- Operational procedures for handling the bags and the boxes, including space availability in vehicles for bags or tubs that must be kept intact during transportation.
- Tracking collection bags and maintaining accountability.
- Physical issues including footprint, noise, etc. when the boxes are installed in retail units.
- Training requirements and training issues.

Viability in the USPS Environment

The Postal Service will establish criteria for ensuring that containment capable collection boxes are viable in all Postal Service environments. The Postal Service will also provide its requirements to vendors to ensure that the collection boxes satisfy Postal's primary objectives:

- Protect Postal Service employees

- Be compatible with the environments in which collection boxes are currently installed (indoor and outdoor, unprotected from the elements, no external power source, tamper resistant, etc.)

The Postal Service will ensure that collection box designs must be compliant with Postal Service requirements to be considered viable candidates.

B.1.2 Biohazard Detection Strips

Technical Description

Biological indicator strips technologies may be able to detect the presence of specific biohazards in mail received from collection boxes. The biological indicator strip provides unattended monitoring and instant readout and is a candidate for unattended monitoring in the collection box.

The biological indicator strips are sensitive to pathogens and generally display a color reaction if the presence of specific pathogens is detected. They are not specific for pathogens, but give a positive result with some benign bacteria that have surface chemistry in common with pathogenic bacteria.

Availability/Development Status

The biological indicator strips are beginning to be commercially available. The availability of sufficient quantities of strips to implement this technology at all collection boxes could be a major issue.

Product/Procedure-Specific Information

Specific information on the biological indicator strips is contained in Appendix C.

Effectiveness

Detection strip technology was conceptualized with the food industry in mind. However, the Postal Service will require documentation of strip sensitivity in various environments and to specific pathogens. Sensitivity issues may require the Postal Service to develop the capacity to concentrate spores that could be in a collection bag or tub. The Postal Service will determine if equipment must be implemented to extract air from the collection bags or tubs and produce a spore rich medium (a candidate would be a commercially available air sampler).

Biological indicator strips are susceptible to false positives because of a lack of specificity. False negatives are mainly a function of the sensitivity of the technology. The biological indicator strip can be used to determine the possible presence of biological hazards but would be used in conjunction with more reliable technologies for confirmation of the presence of a biohazard.

Environmental Issues

Environmental issues have not been documented for the use of detection strips. Disposal of used strips are issues that the Postal Service will address when it reviews this technology.

Costs

The biological indicator strips discussed in Appendix C cost about $1.00 per strip. The Postal Service will add overhead cost associated with using the strips when it establishes this technology as a viable candidate.

Operational

If documentation of the sensitivity and usefulness of these strips in a collection box environment is available, they will be prototyped in a working collection box to assess operational issue.

Viability in the USPS Environment

This technology will have to be tested further to evaluate its utility in collection boxes.

B.1.3 Collection Box Decontamination System

Technical Description

Another option under consideration is to test a decontamination system located in collection boxes that consists of polyethylene bags in which the mail would be collected. After the mail is in the collection bags, the bags would be sealed and chlorine dioxide would be generated in the bag. This proprietary technology has not been tested or validated by the Postal Service. Chlorine dioxide exists as a gas at room temperature. An available technology for generating chlorine dioxide is from the reaction between sodium chlorite and hydrochloric acid. Additional information on chlorine dioxide is in Appendix E.

As documented in Appendix E, chlorine dioxide is widely used as a bleaching agent, a disinfectant for liquids (water), a sterilant, and as a disinfectant for contaminated buildings.

Availability/Development Status

Cylinders of chlorine dioxide and also the products and processes required to make chlorine dioxide, are widely available. Chlorine dioxide is used for decontamination in a variety of environments. Appendix E includes documentation of these availability issues in Postal Service production environments. Appendix E does not address availability for collection box mail decontamination. As stated above, the polyethylene bag-based technology for using chlorine dioxide is a proprietary technology.

Product/Procedure-Specific Information

The product/procedure issues identified in Appendix E are relevant to the use of chlorine dioxide for collection box mail decontamination. The use of chlorine dioxide in collection bags significantly increases the risk that Postal Service employees could be exposed to the chlorine dioxide gas or to chlorine gas that is generated when chlorine dioxide breaks down. If the Postal Service determines that testing and analysis of this technology is appropriate, procedures for protecting employees will be addressed.

Effectiveness

The known effectiveness of chlorine dioxide is documented in Appendix E. The effectiveness of chlorine dioxide when used to decontaminate mail in a sealed bag is not known. The Postal Service will test the effectiveness of this technology once it is determined that this technology is appropriate in the collection box environment.

Environmental Issues

Appendix E documents that there are OSHA rules on maximum levels of worker exposure to chlorine dioxide gas and EPA rules on the release of chlorine dioxide gas into the environment. The Postal Service may determine that chlorine dioxide, in collection bags, is a viable technology. The Postal Service will then determine if generating the gas in a bag in the collection box is adequately safe or if the bags should be returned to a delivery or processing unit and the gas introduced into the bag in the delivery or processing unit.

The Postal Service will work with vendors to determine procedures for venting gas from the collection bag. Procedures will also be developed for ensuring that mail from a decontaminated collection bag is free of chlorine dioxide gas before it is added to the mail stream for processing.

Costs

The costs to implement this collection bag technology are both direct and indirect. The direct cost covers the acquisition of bags, with decontaminant capability, $61 million annually. This does not include additional costs if the collection boxes must be codified or replaced to support this technology. Other direct costs items include (1) costs to develop and implement procedures to vent gas from bags; (2) costs to implement environmental monitoring capabilities; (3) costs to process decontaminated mail to eliminate chlorine dioxide residue, and (4) costs to dispose of bags, and possibly captured gas if there are EPA restrictions.

Indirect costs include (1) impacts on mail processing volume; (2) increased labor costs; (3) possible liability costs; (4) on-going testing and certification costs; (5) cleanup including schedule and unscheduled costs, and (6) possible costs due to public awareness issues tied to the use of potentially lethal gas in a Postal Facility or in a collection box.

Operational

The Postal Service’s evaluation of this technology will include analysis of operational considerations and constraints imposed by the use of chlorine dioxide in collection boxes or possibly in mail-processing plants. The risk of employee exposure will impose requirements that mail from decontaminated collection bags be processed in an environment that protects the employees from possibly exposure to chlorine dioxide. The Postal Service will evaluate and respond to operational issues including the following:

- Chlorine dioxide leaves a residue that is potentially harmful to employees. In areas where decontaminated mail is processed, the Postal System will develop procedures to monitor and eliminate residue. This effort will become a necessary, an integral part, of site operations.

- An incident in which the chlorine dioxide gas escapes into the general work areas could result in the closing of the site until the gas has been dissipated and the residue eliminated.

- The Postal Service will develop hazardous material training requirements for employees so that the employees and the customers are protected from potential exposure to the chlorine dioxide gas.

- Maintenance operations will be modified to include special procedure for areas in which decontaminated mail is processed.

- The Postal Service will evaluate the operational reliability of the technology to generate, and dissipate, the gas in the collection bags.

- The chlorine dioxide decontaminates the surface of the mailpieces. The Postal Service will need to investigate further risk of contamination from leakage during mail processing operations.

Viability in the USPS Environment

The viability of the chlorine dioxide treatment of collection bags is questionable until the Postal Service is able to test the collection bag with the integrated chlorine dioxide capability.

If the Postal Service decides to proceed with testing, it will evaluate the efficacy of using the decontamination capability provided with the collection bags by testing multiple variations of content, amount, climatic conditions, etc. This testing will be completed early in the evaluation phase for this technology. This testing will determine if the decontamination process is effective in an operational environment.

The Postal Service will have to determine if the impacts of facility changes required to use chlorine dioxide/ collection bag technology outweigh the benefits derived from using this technology.

The overall viability of this technology is critically dependent on the results of Postal Service testing.

B.2 Entry Point Control–Retail Security Initiative

This section summarizes information that the USPS will need to have as part of its entry point control efforts to minimize the possibility that Postal Service employees and customers will be exposed to biohazardous substances introduced through retail units.

The Postal Service currently has video systems in retail postal units that could be used as part of the Retail Security Initiative to enhance the security of the mail-processing environment. The Retail Security Initiative will record retail transactions so that items purchased during these transactions can be correlated with items in the mail stream, if that correlation is required as part of a biohazard or other security investigation. The correlation of retail items with retail purchases and the recording of retail transactions provides the Postal Service with tools to trace retail customers who could have introduced biohazardous materials into the mail system. Having this capability will substantially reduce the level of anonymity that currently exists when customer bring mail to Postal Service retail units.

A significant issue that must be resolved as part of implementing the Retail Security Initiative is the development of a technology for encoding retail products so that the Postal Service can maintain records of when and where Postal Service retail items are sold. The Postal Service has developed an approach for encoding some classes of mail using modifications to the existing POS ONE application. This approach is can provide both schedule and financial benefits to the Postal System since it is built on existing technology. This Postal System strategy is currently the most feasible candidate for implementing a retail security initiative.

B.2.1 Positive Product Tracking System

Technical Description

The Postal Service proposes to develop a positive product tracking capability for retail security. The capability will be built by leveraging existing capabilities of the POS ONE system. POS ONE components will be modified or replaced as required to implement new functionality. The Postal Service will also integrate with the Robbery Burglary Retail (RBR) and Criminal Investigation Systems (CIS).

Development of this positive product tracking capability will result in integrated video and retail systems that will record, store, and transmit information that can be used to correlate retail transaction information with video information.

Existing capabilities are currently used to provide a video record of a retail unit's sales activities. Existing systems use both custom components and commercially available components.

The positive product tracking capability will record retail activity within a retail unit. It will simultaneously encode mail with a unique identifier and record unique information along with the video. This provides the capability to match a product sale with an image of a customer. The recorded information can be stored locally or remotely and can be transmitted to other Postal Service sites.

The specific information that will be encoded for each retail item has not been determined. That encoded information will be recorded and stored as part of the Retail Security Initiative. For example, if the retail unit sells 100 stamps and 250 stamped envelopes, unique identifiers will be associated with those stamps and envelopes and also correlated with the video.

The Postal Service will develop additional documentation of how current technologies will be modified and developed for both near-term and mid-term capabilities.

Availability/Development Status

The POS ONE systems and the video units are already operational in Postal Service retail units. The Postal Service has developed a strategy and schedule for developing and installing the positive product tracking capability. The Postal Service proposes that this capability will be phased in over a 2-year period.

The Postal Service will need to determine the modifications that will need to be made to the POS ONE printers (PVI or IBIP systems) or if those systems will need to be replaced. The Postal Service will also work with vendors to determine estimated costs and time constraints for acquiring systems that can provide the following capabilities:

- Encode unique identification data on retail merchandise.
- Read encoded data during a retail transaction.

- Record encoded data with adequate information to correlate a retail transaction with a video image.

Product/Procedure-Specific Information

Video recording systems are currently installed in some Postal Service retail stores to capture and store customer images. The POS ONE system is also currently in use. The only issue relevant to these products and procedures are the impact of expanding the amount of information being recorded and stored and adding a new data source to the recorded video images.

The Postal Service will not identify near-term and long-term maintenance issues (USPS, vendor, third-party) until the equipment and network configurations required for the positive product tracking capability have been determined.

As part of its evaluation efforts, the Postal Service will address privacy and public relations factors that will develop when customers become aware of the expanded capabilities of the positive product tracking capability system.

The Postal Service will use established models to evaluate the impacts from long-term storage of the collected video/retail data. The retention of video images will have to be addressed for total costs, long-term costs, facility impacts, and privacy issues.

Effectiveness

The POS ONE and video systems are currently in use and have provided uneventful operations. The implementation of the positive product tracking capability may stress some components of the existing systems and could require new and modified components. The effectiveness of the modifications, and the impact of the modifications on existing capabilities will be determined prior to full system development. Additionally, prior to system development the Postal Service will address the following issues.

- Communications capacity requirements
- Long-term storage requirements
- Production impacts of uniquely encoding retail merchandise

Environmental Issues

There are no known environmental issues. Postal Service employees and customers will have no direct interfaces with the positive product tracking capability other than those that already exist as part of POS ONE.

Costs

The Postal Service has developed initial projected costs of about $250 million to acquire equipment for 15,000 retail units.

The Postal Service has documented projected development cost for three sequential time-periods.

Short Term - $13 million
Mid-Term - $33.5 million
Long Term - Over $70 million

The Postal Service will also evaluate life-cycle costs as part of the development effort.

The components covered under the proposed $250 million will be identified so that actual costs can be accurately projected. For example, there may be additional initial and life cycle costs that must be addressed in addition to the cost for video expansion (new printing systems may be required). Some system related activities/items that may result in additional costs include:

- Costs to provide adequate storage for collected retail unit data (video images, retail information, etc.).
- Costs to support additional communication capabilities and capacities.

Public awareness of this proposed technology could prove to be a significant negative factor. The Postal Service will have to acknowledge that Retail Security technologies are implemented in public areas of retail units and that images are being associated with transactions and are being retained. This could have a negative impact on the perceived role of the USPS.

Operational

The implementation of the positive product tracking capability will significantly impact storage requirements/technology. Expected costs to develop an operational system include both capital and maintenance costs if the printers have to be replaced. Replacement equipment will also impact current maintenance procedures. There could be facility communications capacity issues that impact operational capabilities. The Postal Service will evaluate operational issues as part of the system design effort.

Postal Service operations training requirements will be dependent on the technology chosen for encoded retail merchandise. The encoding technology will drive the selection of equipment required to read the encoded information. The selection of equipment will drive the required training. The selection of equipment will also impact maintenance procedures and maintenance requirements.

As part of its design effort, the Postal Service will evaluate the impact of modification and upgrades on POS ONE reliability and will provide a design that maintains or improves existing performance metrics.

Viability in the USPS Environment

The viability of the proposed positive product tracking capability will be determined by the hardware, software, and technical architecture design. The impact of the positive product tracking design on POS ONE viability will also be evaluated.

The Postal Service plans to leverage the POS ONE technology to satisfy its Retail Security Initiative requirements. Primary technology unknowns that could affect the viability of the positive product tracking capability are storage capacity, network capacity, and the equipment required to encode data on retail merchandise.

The Postal Service has developed a preliminary schedule for implementing the positive product tracking capability. The schedule provides an ambitious effort that will provide the Postal Service with prevention capabilities with minimal impacts on existing systems. Developing detail designs, and the efficacy of those designs, are critical to determining if the Postal Service schedule can be achieved or how it must be modified. The Postal Service can best achieve its projected development schedule by initiating an immediate evaluation of existing and planned systems.

B.2.2 Security Process for Commercial Mailers

Description

The potential for receiving mail that has been contaminated with a biohazardous substance will be reduced when mail has been prepared for submission to the Postal Service in environments that are protected by standard security procedures. The Postal Service receives large quantities of mail from commercial mailers. The Postal Service proposes to enhance entry point control security by establishing cooperative security efforts between the USPS and its commercial mailers. An objective of these cooperative efforts is to minimize the potential for receiving hazardous mail from commercial mailers by having the mailers commit to meeting minimum security standards developed by the USPS and mailer representatives. After the USPS has verified that a larger mailer has met these security standards, the USPS will assume that all mail received from that commercial mailer was "safe" when it arrived at a Postal Service facility. Mail received from a commercial mailer who has complied with security standards will not be scheduled to receive any special handling for the detection and neutralization of biohazardous contaminants. Mail received from commercial mailers that have not complied with security standards will be treated the same as anonymous mail. Anonymous mail will be considered "safe" after it has been processed through USPS detection, neutralization, or other procedures.

The effort to develop, implement, and monitor security standards will not be time limited. The USPS will maintain resources that will be available to develop and monitor the use of security standards for larger mailers. After security standards have been developed, the Postal Service will work with commercial mailers to evaluate if they have complied with security standards established by the Postal Service working with mailer representatives. The Postal Service will continue to monitor the commercial mailers to ensure that compliance with security standards is maintained.

This prevention effort is procedural and is not a named technology. The Postal Service will develop Security Standards in coordination with representatives from commercial mailers.

Technical Description

This Postal Service initiative will provide an operational/business environment in which larger mailers will implement security practices at their sites to protect mail before it is delivered to the Postal Service. This initiative will be used to accomplish the following activities:

- Establish organization to develop, implement, and monitor security efforts by larger mailers.
- Meet with commercial mailer representatives to develop security standards for mailer facilities.
- Document how commercial mailers can satisfy security standards.
- Establish criteria for evaluating commercial mailer compliance.
- Develop schedules for initiating commercial mailer compliance activities.
- Work with field representatives to develop procedures for receiving and segregating "safe" mail from commercial mailers.
- Establish evaluation and compliance criteria for monitoring the status of commercial mailers security standards implementations.
- Develop incentive options for achieving wide-spread compliance by commerical mailers.

As a result of developing and implementing this initiative with commercial mailers, the Postal Service expects to reduce that volume of mail that must be evaluated using detection technologies before it can be introduced into the mail processing system.

This initiative will be successful if the Postal Service can involve commercial mailers so that they are willing to comply with Postal Service security standards and the Postal Service develops the mean to monitor commercial mailer compliance activities.

Availability/Development Status

The requirements for establishing this threat prevention initiative are not currently available and the security standards the Postal Service will supply to commercial mailers have not been developed. Postal Service commercial mailer security standards will be developed as part this threat prevention initiative. Postal Inspection Service representatives will work with representatives from commercial mailers to develop security standards that will provide a level of security that meets Postal Service requirements.

The Postal Service will develop in-plant procedures for segregating “safe” mail (from commercial mailers who are compliant with security standards) from mail that is not rated as “safe.” Mail processing flows will be developed to reflect this segregation of the mail. In-plant equipment configurations will also reflect this segregation of the mail since filtering and sanitization technologies will not be required for mail received from compliant commercial mailers.

The Postal Service will also develop long-term plans to provide on-going support and over-sight for commercial mailers. This will require increased staffing and long-term planning for the allocation of resources over widely dispersed areas.

The time required to develop and implement security standards for commercial mailers has not been determined. Security standards must be developed with representatives from the commercial mailers. Some larger mailers may need security standards that are mailer-unique. Resource requirements and schedules for security standard development are unknowns that must be determined.

Product/Procedure-Specific Information

The development and use of security standards for external organizations is not a new concept. It has been used for classified efforts for decades. Additionally, the concept of having one company monitor another company’s facility operations is widely accepted since many manufacturing companies mandate facility requirements (e.g., cleanliness standards for the production of scientific instruments, etc) for their suppliers. An obstacle the Postal Service must overcome is that in most instances the organization that is acquiring products or services, the customer, identifies the requirements it will impose on its vendors and the vendors comply to get the business. The Postal Service faces a more challenging environment since it is the vendor and wants its customers to meet certain standards. The Postal Services will have to determine what leverage is appropriate to ensure that its customers, commercial mailers, will comply with Postal security standards.

The Postal Service must develop in-plant procedures to automatically route mail from compliant mailers. The in-plant procedures could initially include the use of equipment that has not been modified to provide prevention, containment, and neutralization capabilities. The Postal Service will develop the following processing requirements:

- Accept and segregate mail from compliant mailers (mail is classified as “safe mail”).
- All “safe” mail containers received from commercial mailers will be identified and documented so that the Postal Service can track if contaminated mail is received from a “safe” mail source.
- Introduce “safe mail” into the processing flow on equipment that is segregated from contact with mail that is either anonymous or from non-compliant mailers (affects load-balancing at the plants) includes containers.
- Process mail in segregated mail streams.
- Establish procedures for integration of mail streams after “unsafe” mail has been either cleared or neutralized.

Long-term maintenance issues are administrative, personnel resources, and the capacity to process segregated mail streams. The Postal Service will need to provide personnel resources to monitor existing mailers and to assist new customers in becoming compliant with security standards. The Postal Service needs to establish and maintain administrative procedures to document the processing of “safe” mail in Postal Service facilities.

The concept of establishing controls for external company facilities is not new. It has been used extensive by government agencies and commercial organizations. However, the concept has not been applied to the Postal Service or to mail processing operations.

The Postal Service will address staffing, processing, and resource issues as part of the initiative development effort. The Postal Service is identifying and resolving long-term issues as part of its development efforts. Long-term issues that will be resolved by the Postal Service include:

- Providing on-going support to commercial mailers.
- Providing support to mailers to help them implement security standards that are compliant with Postal Service requirements.
- Maintenance of sufficient staff to monitor compliance.
- Maintenance of in-plant capabilities for processing “safe” mail in a segregated mail stream.
- Maintaining levels of service to larger mailers who are compliant with Postal Service security standards.

Effectiveness

A primary issue that the Postal Service will address before initiating this effort with commercial mailers is evaluating the impact of this effort on mail processing operations at affected Postal Service sites. The segregation of “safe mail” could require that processing plans be changed since some equipment will not be available to process mail that was not classified as “safe.” The Postal Service will monitor the impact of segregating “safe” mail on the overall operations at each plant.

Environmental Issues

There are no direct environmental impacts created under this threat prevention initiative. Processing of “safe” mail will be the equivalent of the procedures in general use throughout the Postal Service. The procedures used to process “anonymous” mail are new. These procedures

will have no direct environmental impact. There will be indirect impacts based on the technologies selected to detect and neutralize contaminated mail.

Costs

The initial costs for the development and implementation of security standards for commercial mailers is not known.

The life cycle costs will be dependent on the number of commercial mailers who agree to participate in this initiative. There could be additional costs if the Postal Service determines that it must provide commercial mailers with financial or performance incentives to encourage participation in this initiative.

Initial projections indicate that the Postal Service will need to increase the security resources available to its field divisions. These staff resources will be used to maintain a program of monitoring and re-evaluating the security compliance efforts of participating commercial mailers.

The Postal Service estimates that security support for the field could be achieved with the addition of 90 new postal inspectors who will be added to the security teams in Postal Service field divisions.

Operational

The operational costs associated with this prevention initiative are mainly the personnel costs required to monitor larger mailer compliance with the Postal Service security standards.

There could be operational cost impacts in the plants that are triggered by the requirement to maintain segregated mail flows for “safe” mail and anonymous mail that has not been cleared or sanitized.

There will be training requirements for the staff who monitor commercial mailer compliance. There could also be additional training required to maintained segregated mail flows within the plants.

Viability in the USPS Environment

This prevention initiative is a viable alternative that can be implemented with minimal cost to the Postal Service. It can be implemented in the near-term since the development efforts (developing compliance criteria) can be done internally and does not require that new contract be competed for prospective vendors.

When implemented this initiative will significantly reduce the volume of mail that must be processed by detection and neutralization technologies.

The Postal Service will pursue very near-term evaluation of the requirements for this initiative and of the impacts on the Postal Service and its customers. The Postal Service can quickly initiate efforts to develop security standards and to recruit potential candidates from its commercial mailer customers.

B.2.3 Acceptance Procedures/Technology

The function of a Postal Service facility is to receive mail from external locations and to send mail to external locations. This is accomplished by the continual arrival and departure of Postal Service and third party vehicles. This continual traffic exposes the Postal Service to the possibility that third parties could use vehicle traffic to attack Postal Service facilities and the employees at those facilities.

The Postal Service will develop regulations and procedures to increase the level of security at access points and thus minimize the level of risk from vehicles and individuals using those access points. The Postal Service will use procedures and technologies to control access to Postal Service facilities.

Technical Description

The Postal Service will enhance security at its 400 P&DC, P&DF, AMC, and BMC facilities. A security initiative will be developed and implemented to establish upgraded controls on all individuals and vehicles that use truck entrances to access or leave these Postal Service facilities. This enhanced security will include new and expanded electronic systems and extensive staffing upgrades at all affected entrances.

This security initiative will require significant investments in electronic and mechanical systems at affected entrances.

- The Postal Service will install access control devices at entrances to physically block traffic movement through those entrances.
- The Postal Service will install cameras and video monitors at entrances to monitor and record vehicles and individuals who pass though a controlled entrance.
- The Postal Service will install badge and card readers at entrances. These readers will control access to individuals who have been pre-authorized and have been issued badges or encoded cards.
- The Postal Service will provide intercom and/or video communications between controlled entrances and security staff.
- The Postal Service will install enhanced lighting to assist security staff in monitoring entrance traffic.

The security initiative also requires increased levels of staffing and training operations to ensure security personnel are available to staff entrances and that staff are cognizant of security requirements and how security devices operate.

The expanded equipment that is installed at controlled entrances will impose an additional maintenance burden on facility staff. The security initiative will respond to the increased maintenance requirements by providing increased staffing and increased training for maintenance staff resources.

The Postal Service has access to Government and commercial organizations that routinely provide extensive security support at entrances to their facilities. The Postal Service will develop its security initiative by leveraging the experience and knowledge these organizations will share with the Postal Service.

This enhanced security initiative is critical to providing a layer of prevention against potential terrorist attacks. The Postal Service is vulnerable to the introduction of bioterror components via the entry of unauthorized or unknown individuals or vehicle traffic to Postal Service facilities. This security initiative will significantly reduce the vulnerability level at postal facilities.

Availability/Development Status

The Postal Service is proposing to implement its security initiative using commercially available equipment and technologies. The Postal Service expects to benefit by using production ready technologies, minimizing test and evaluation requirements.

The significant number of facilities that the Postal Service plans to upgrade could impact the availability of some equipment. As part of its security initiative the Postal Service will evaluate lead-time requirements for security components. It will have the flexibility of configuring its security systems to accommodate possible acquisition impediments.

Product/Procedure-Specific Information

The products that will be used to implement the Postal Service's security initiative will be determined as part of the initiative development effort. Product and procedure specific information will be developed as the security component are identified and included in security architecture that will be developed for each facility.

The Postal Service will use security components that are currently in use and proven. This approach will provide the Postal Service with up-front knowledge of performance and maintenance issues that will be critical to 24/7 security coverage at postal facilities.

Effectiveness

As stated above, the Postal Service intends to leverage the experience and knowledge of other Government and commercial organizations when developing its security initiative. The Postal Service expects to have performance metrics available before it commits to any production level technology. These performance metrics will enable the Postal Service to maximize the effectiveness of its security configurations at each facility.

The Postal Service plans to use security components that have been implemented at by other organization and have a documented level of operational success.

Environmental Issues

Security components generally have minimal impacts on the environments in which they are installed. The Postal Service will use security components that are compatible with the environmental parameters of the facilities in which they will be installed.

The Postal Service will address issues that are unique to each facility. Extensive placement of high-intensity lights could be incompatible with a nearby residential community. Some electronic equipment could affect nearby homes or business. These issues will be identified and resolved for each facility.

Costs

The Postal Service has developed initial cost estimates to implement its security initiative. The Postal Service estimates that the cost to upgrade existing systems, install new systems, and provide maintenance support for these new and upgraded systems at the identified facilities will be $64 million.

The Postal Service estimates that the yearly cost to fully staff the controlled entrances at the identified facilities is $70 million.

The cost for the installation and maintenance of the Postal Service's comprehensive security initiative is $134 million.

Operational

Operational issues identified as part of the security initiatives will, generally, be facility and/or security system unique. Facility configurations impact security operations. Equipment capabilities and configurations impact security operations.

Operations requirements and issues will be developed as integral parts of the security initiative.

Viability in the USPS Environment

The Postal Service has not documented any facility or site conditions that will preclude the implementation of required security capabilities at the 400 identified sites.

Sites unique conditions may be identified that require equipment or procedural modifications at a facility. These will be fully documented during the development of the security initiative.

Appendix C

Protection and Health Risk Reduction

This appendix summarizes the evaluation of technologies for the protection of employees and customers by the reduction of human health risk. The primary initial focus of human health risk reduction is in the mail processing facilities. It is here where the processing of mail containing biohazardous materials will likely release airborne contaminants such as anthrax spores, resulting in an immediate risk to postal employees. The strategy of Health Risk Reduction addresses the potential for this immediate risk by evaluating technologies to protect human health in the following three areas:

- To prevent the release of biohazardous airborne materials such as anthrax spores from mail processing machines. The technology being evaluated in this area is the installation of custom-designed permanent vacuum filtration systems on each type of mail-processing equipment.

- To capture or kill infectious bioagents that may enter the heating, ventilating and air-conditioning (HVAC) system of a postal facility. Technologies being evaluated in this area include installation of high efficiency filtration, as well as the use of higher technology methods such as ultraviolet light, ultrasonics, or biological agents.

- To prevent routine cleaning procedures from dispersing respirable bioagents in airborne form. The technology being evaluated in this area is to replace blowing and dry sweeping methods with vacuum cleaners equipped with high efficiency particulate air (HEPA) filters for the routine cleaning of facilities and equipment.

C.1. Permanent Vacuum Filtration Systems on Processing Equipment

Technical Description

The potential risk to USPS employees of exposure to airborne hazards released by mail processing equipment will be reduced by the addition of an air-cleaning system, to existing letter mail processing equipment. This system, which will be custom designed for each type of equipment, will automatically and continuously vacuum letter mail processing equipment ensuring that minimal dust escapes from the equipment. The air from inside of these machines will be filtered using HEPA filters before it is discharged back into the mail processing environment. The continuous flow of air into the equipment and the discharge of air through the HEPA filters will reduce the release of airborne hazards from processing equipment into the facility by several orders of magnitude.

Availability/Development Status

This technology requires the custom design and fitting of ventilation/filtration equipment onto existing machines and the uniform system wide deployment in a narrow time frame. Experience with and intricate knowledge of mail processing equipment, and the acquisition of expert knowledge of air movement, filtration, and behavior of biohazards will enable the USPS to apply this technology.

Prototype systems are being put in place for evaluation. A schedule for the field testing of prototypes and nationwide deployment of technology is shown in Table C-1. As seen in this table, a prototype air-cleaning system for the Delivery Bar Code Sorter (DBCS) was installed in January in the Dulles VA P&DC for field evaluation. A prototype air-cleaning system for the Advanced Facer Canceler System (AFCS) will be installed in mid March in the Dulles VA P&DC for field evaluation.

Table C-1. Air-Cleaning System Field Testing and Deployment Schedule

Equipment	Field Test	Deploy
AFSM 100	Mar-02	FY 03-04
DBCS	Jan-02	FY 03-04
AFCS	Mar-02	FY 03-04
DPRC	Mar-02	FY 03-04
Loose Mail System (010)	May-02	FY 03-04

Product/Procedure-Specific Information

The basic use of a permanently installed continuously operating vacuum system on mail processing equipment is not a new idea for the USPS. Previous USPS research efforts were aimed solely at the collection of nuisance dust to improve maintenance on our machines. The technology proposed here is a combination of this previous research and response to the finding of biohazards in the mail stream. The HEPA filtering technology proposed here, as the final filtering stage to remove the smaller particles that constitute airborne biohazards is the same as that used to protect human health in facilities that handle highly infectious organisms, including anthrax.

Machines with a relatively closed mail pathway are seen as better candidates for the initial prototyping of vacuum systems than more open machines. These machines are also more unitized and standard, such as the AFCS, Automated Flats Sorting Machine (AFSM 100), and the DBCS, which facilitates widespread deployment of a uniform modification.

In addition, acquisition is in progress to design and fabricate modifications to the conveyor systems that transport collection mail from the entry point to the initial processing systems. These conveyor systems are not enclosed and vary in architecture according to plant size and floor layout. The absence of existing hoods and shrouds over these systems will require mechanical designs and changes to enclose these systems so that particulates and contaminants released from these systems can be extracted, entrained on filters and removed from the environment.

Effectiveness

USPS has developed strategies to take permanent vacuum systems beyond previous efforts aimed at nuisance dusts. The new proposals have vacuum intake at many more points than previously considered. The discharge of the vacuum system is now far more effectively filtered. Systems in prototyping utilize multi stage vacuum filtration, to initially filter out the larger particles to prevent their plugging of the finer filters. The final filtration stage is a HEPA rated filter. HEPA filtration is 99.97 percent efficient at 0.3 micron particle size. Biohazardous particles typically fall into the range of 1 to 10 microns. Thus this HEPA filtration stage will significantly reduce the amount of particles that exhaust from the vacuum system, and into the ambient air of postal facilities.

HEPA filtering technology is the state-of-the-art technology for removal of particulate biohazards and other particles in the micron size range. It is used in countless facilities around the world for bio-safety facilities, electronic clean room assembly, isolation wards, surgical theaters, bioengineering, pharmaceutical processing, and any application where maximum state-of-the-art reduction or removal of sub micron particulate material is required.

The primary advantage of the proposed system is that airborne particles that may be released from mail upon entering the machines will be captured at a high efficiency by the filtration vacuum system. This will reduce operator exposure to airborne particles. Removal of particles from the machine prevents them from contaminating the ambient air, the equipment, and other mailpieces.

A second exposure is also substantially reduced with the permanent vacuum system. This exposure may occur when maintenance personnel routinely clean the accumulated dust and debris in the machine on a daily basis. The former process of blowing out the dust with compressed air has been banned since October 2001. That process allowed the dust to become airborne. The current process is to hand vacuum the internal workings of the machines. A permanent vacuum system, installed as part of the machine, reduces or eliminates the need for that task, and the associated exposure of maintenance personnel.

A limitation of the vacuum filtration system is that it has no effect on any particles that remain inside the letter envelope. In addition, while 99.97 percent of the particles released from a mailpiece will likely be captured, some small percentage (0.03%) of particles could theoretically pass through the filter and be released into the facility. While this does not afford absolute protection, it reduces human exposure, cross contamination, and facility contamination by several orders of magnitude, accomplishing a significant reduction in human health risk.

Performance data on the specific custom systems installed on mail-processing machines could be generated by introducing spores from harmless anthrax surrogates into the system and monitoring the egress of live spores from the system. Another performance issue will be the potential for plugging of the HEPA filter by the large amount of paper dust generated in the mail-processing system. A multi-stage filtration system is used to protect the HEPA filters from this possibility. It will be important to evaluate the effectiveness of the multi-stage filters in the prototypes deployed.

Environmental Issues

Since the purpose of this technology is to provide a cleaner working environment and to reduce human health risk by removing airborne contaminants from the facility, it is an environmentally friendly insertion. Reducing the concentration of airborne contaminants will likely improve the assessed impact of the facility on the surrounding environment.

The disposal of filters from the technology must be accomplished in a way that prevents the release into the environment of virulent organisms potentially trapped on the filters. Identification of filters as biohazardous could be accomplished by the use of detection technology to detect the presence of hazardous organisms in the machines. Filters that were present during such a detection will be treated in a non-routine way to assure the containment and destruction of any trapped infectious organism. The USPS is working with National Institute of Occupational Safety and Health, NIOSH, to establish requirements and to evaluate prototype systems.

Costs

Unit Cost: The estimated unit cost of the custom retrofitting of machines presently in use is approximately $50,000 per machine for DBCS, and AFCS; $200,000 for loose mail systems or 010 operations; and $85,000 for AFSM 100 machines.

In addition, logistical and contingency costs per machine are estimated at $15,000 for AFSM 100, DBCS, and AFCS machines, and $20,000 for loose mail systems machines.

Table C-2 summarizes the total costs of applying this technology throughout the Postal System.

Table C-2. Total Costs to Apply Technology Throughout Postal System

Equipment	Quantity	Cost each (000)	Logistics/Contingency (000)	Sum (000)
AFSM 100	560	$85	$15	$56,000
DBCS	5200	$50	$15	$338,000
AFCS	1100	$50	$15	$71,500
Loose Mail/010	292	$200	$20	$58,400
CSBCS	3732	$20		$74,600
			Total Cost:	$598,500

Prototype Development is estimated at $280,000 for AFCS, $250,000 for DBCS, and $500,000 to $750,000 for the Loose Mail Systems.

Initial deployment of the filtration vacuum systems will be to equip all of the 1100 AFCS machines, 560 AFCS100 machines and approximately 1800 of the outgoing DBCS machines for a total equipment cost of $211 million. The DBCS machines sending mail out to other facilities will be chosen for this initial deployment. Additionally the installation of shrouding and filtration in 292 facilities will require an estimated initial outlay of about $60 million. The total initial cost estimated for deployment of retrofitted vacuum filtration systems is thus $271 million. This does not include logistical and contingency costs.

This initial deployment leaves 3400 DBCS machines to be retrofitted in the future at an estimated equipment cost of $170 million.

Operational

Operational demands of this system are increased energy consumption, decreased machine accessibility, increased heat load on HVAC equipment, costs of servicing the vacuum equipment, and loss of floor space. Design efforts will aim to mitigate each of these impacts.

Maintenance of these systems will involve the changing out of filters at appropriate intervals to assure that plugged filters will not compromise the airflow. This can be done during normal down time of the machines and would not have a significant operational impact. Filters that were present during detection of a hazardous organism will be treated in a non-routine way to assure the containment and destruction of any trapped infectious organism.

Viability in the USPS Environment

Initially, the DBCS, AFCS, and AFSM 100 will be retrofitted with the prototype filtration vacuum systems. It is expected that the lessons learned during the prototyping of these systems will allow an efficient adaptation to other letter mail-processing systems, such as MultiLine Optical Character Readers, Mail Processing BarCode Sorter and Carrier Sequence BarCode Sorter, should those prove to be appropriate for retrofit.

C.2 Filtration Systems in HVAC

Technical Description

The possibility exists that airborne anthrax spores can be trapped and possibly killed in the HVAC systems in postal buildings. Ordinary HVAC systems contain air filtration systems to prevent heating and cooling coils from becoming clogged with airborne dust and dirt. Anthrax spores are small enough to pass through most filters used in ordinary

systems. It may be possible to upgrade the efficiency of filter media to capture anthrax. Another possibility is the use of high-tech methods such as ultraviolet light, ultrasonics, or biological agents to kill anthrax spores traveling through the ducts.

Availability/Development Status

The Postal Service is conducting a feasibility study to investigate improved filtration and high tech methods. This investigation will include:

- Evaluating five "typical" facilities of various sizes.
- Funding for consultation with other government agencies.
- Evaluation of filtering and decontamination devices.

Product/Procedure-Specific Information

Technology areas under investigation are:

- Enhanced filtration
- Ultraviolet light
- Ultrasound
- Antimicrobial agents

Effectiveness

A study is under way to evaluate the potential effectiveness of the potential modifications in the HVAC in the postal environment.

Some of the anticipated advantages of improved filtration are:

- May provide a positive method of capturing anthrax spores that enter the HVAC system.
- Much of the infrastructure (i.e. ducts and fans) is in place.

Some of the anticipated advantages of the higher tech methods are:

- Possible lower cost than improved filtration.
- May be used in some combination with filtration to kill anthrax spores.

Some of the anticipated technical issues are:

- These methods have not been successfully demonstrated on the scale of a large Postal facility.

- Because HVAC systems are not designed to circulate all of the air in a building, anthrax spores may not enter the high tech system before being inhaled by employees.

- HVAC systems are designed to heat and cool a building and are not designed to move ALL the air through the filtration system on a regular basis. Anthrax spores could remain airborne for hours or even days before being entrained into the return duct.

- Since high efficiency filters have a greater pressure drop, duct and fan modifications will probably have to be made to each building at significant dollar and energy costs.

- Since all buildings are different, the modifications for each building will have to be engineered separately.

Environmental Issues

No environmental issues have been identified. The environmental impacts of the technologies being considered will vary. Enhanced filtering will be environmentally friendly, although the appropriate disposal of filters will need to be defined.

Costs

Cost estimates will be developed after this study is completed.

Operational

Operational considerations will be presented as a result of the study in progress.

Viability in the USPS Environment

The possibility that airborne anthrax spores can be trapped and possibly killed in the heating, ventilating and air-conditioning (HVAC) systems in postal buildings is being specifically evaluated in a feasibility study, as indicated above. From this study, viable alternatives, if any, will be selected for prototyping by the end of FY-02.

C.3 HEPA Cleaning Systems

Technical Description

The cleaning procedure of blowing out mail processing machines with compressed air was discontinued in October of 2001. The use of vacuum cleaners is now the method of choice for routine cleaning of equipment and surfaces. Consultation with Postal Service Certified Industrial Hygienists (CIH) and CIHs from the Logistics Management Institute (LMI) confirmed that conventionally filtered vacuums might allow the small anthrax spores to pass through a conventional vacuum cleaner's filter and be aerosolized. Fortunately, high efficiency particulate air (HEPA) filtered vacuums are commercially available and will be most efficient at capturing any spores that might enter the vacuum cleaner as a result of cleaning mail processing equipment or building surfaces.

Availability/Development Status

The decision was made to procure HEPA vacuums at the Headquarters level because:

- Potential vendors are more responsive in production, quality, and price to large national buys than to requests from many Postal entities.
- Logistic issues, specifically spare parts and consumable items, could better be handled under larger contracts.

The decision to procure nationally does not prevent offices from buying additional HEPA vacuums with local funds, if desired.

- Because of the urgency of the need, Purchasing contracted for over 9,000 vacuums that were already on the shelf or could be produced very quickly. These were in the field by mid to late January.
- Vacuums that have to be manufactured will be deployed by the end of March 2002.

The process for choosing the appropriate make and model was as follows:

- Engineering developed an initial specification for HEPA vacuums that will define Postal requirements.
- A cross-functional team from Engineering, Purchasing, and LMI began reviewing HEPA vacuums from major manufacturers.
- The specifications were further refined and expanded.
- The team wrote detailed specifications for each acceptable model that included part numbers and quantities for accessories, consumable items, and repair parts.
- LMI and Engineering continued to review additional HEPA vacuum equipment.

By the end of March when this program is complete, approximately 9050 facilities, which are 5,000 square feet in area and larger, will receive at least one HEPA vacuum. Facilities over 25,000 square feet will receive approximately one vacuum per 20,000 square feet. Approximately 16,000 HEPA vacuums will be purchased at a total cost of approximately $12.6 million.

The 5,000-square foot limit for facilities receiving vacuums was established because offices smaller than this do not have mechanized equipment that will likely cause the mail to expel anthrax spores. There are approximately 25,000 of these smaller offices. The total cost to provide each of these offices with a HEPA vacuum will exceed $20 million and will not significantly increase employee protection.

Product/Procedure-Specific Information

HEPA vacuum cleaners are available in a wide variety of prices and applications. The process for choosing the appropriate make and model for postal needs is outlined under Availability/Development status above.

Effectiveness

The primary advantage of using HEPA vacuums instead of dry sweeping and cleaning with compressed air is their ability to trap anthrax spores. Additional advantages include:

- Less airborne dirt in the facility resulting in fewer employee complaints.
- Significantly less dust settling on the floors and other surfaces that has to be removed again.
- Reduced energy consumption and noise compared to compressed air cleaning.

Disadvantages of HEPA vacuums include:

- Possible less efficient mail processing equipment cleaning, which may result in degraded performance.
- A perceived increase in the time and labor required to clean equipment.
- Additional cost for consumables (filters etc.) and maintenance.

Environmental Issues

No environmental issues in the use of HEPA vacuum cleaners have been identified.

Costs

15,020 HEPA vacuums will be purchased at a total cost of $12.6 million.

Operational

Dry sweeping and cleaning with compressed air, which until recently were standard practices in the Postal Service, have been banned to prevent aerosolizing anthrax spores. Only vacuuming and wet methods can be used.

Potential operational impacts of the use of HEPA vacuums include:

- Possible less efficient mail processing equipment cleaning, which may result in degraded performance.
- A perceived increase in the time and labor required to clean equipment.
- Additional cost for consumables (filters etc.) and maintenance.

Viability in the USPS Environment

This technology has been implemented. Effectiveness and impact will be monitored.

Appendix D

Detection

D.1 Introduction

Following the Postal Service's first notification that letters containing anthrax had been sent through the mail, the Postal Service formed a task force that has been actively pursuing acquisition of biohazard detection and identification systems. The following four-step plan was constructed to guide the task force: (1) perform a technology scan to determine any existing systems deployed and available; (2) assess feasibility of technology in postal environment; (3) contract and conduct testing; and (4) choose and recommend most appropriate technology(ies).

D.2 Factors that Determine the Ability to Detect Contamination

Given a scenario in which a contaminant is placed into a mailpiece that subsequently enters the mail stream, a variety of factors may affect the ability to detect the contaminant. These factors include the following:

- Quantity of contaminant in the mailpiece
- Type of contaminant (species of organism, etc.)
- Physical form of contaminant
- Integrity/porosity of mailpiece
- Handling of mailpiece
- How sampling/detection is conducted (active, passive)
- Where in the process sampling/detection is conducted
- When/how frequently sampling/detection is conducted
- How sampling/detection is performed (specific vs non-specific, sensitive vs non-sensitive)

It must be recognized that no detection technology will work 100 percent of the time, and that the specifics of any scenario could result in even a highly effective technology failing to detect a contaminated piece of mail. The challenge will be to engineer into the mail processing system an appropriate set of detection technologies that offer a maximum probability of detection contamination when it occurs, within the constraints imposed by the system itself and the limited funds available.

D.3 Screening Process

Under the auspices of the President's Office of Science and Technology Policies (OSTP), the Postal Service has been aided in evaluating technology by several agencies. The OSTP immediately formed a subgroup, which includes leading scientists in biohazard detection, to aid the Postal Service. The group has met on multiple occasions to discuss different technologies and their feasibility in the postal environment. Also, the Joint Program Office for Biological Defense, a Department of Defense agency, has been extremely helpful in evaluating which military technologies could potentially be applicable for our use.

The overall screening process of technologies has in large part been done using the experts from the agencies listed above. A short list was put together of the best potential military technologies from all the technologies the Joint Program Office for Biological Defense has evaluated. However, the Postal Service has received hundreds of calls regarding other technologies from research laboratories, universities, and firms that have products being used in hospital pharmacies and food processing. The following criteria were used to determine whether these technologies could have potential: (1) Is the product currently available?; (2) Could it be

produced in the quantity the Postal Service needs, and in the short time frame required (looking for technology that can be rolled out in the next year)?; (3) Are any data available on sensitivity level and false positive rates?; and (4) What range of threats would it be capable of detecting (microorganisms, toxins, chemical, etc.)? Most of the technologies being solicited were still in research and development and not deployable in the near future. Applications evaluated included several premature usages of mass spectrometry or flow cytometry, new concepts using ultraviolet or laser technology, systems using microchips, a technology that used X-rays to look inside letters, and a myriad of other potential applications. The systems listed above were either not ready, or would not work in our environment.

D.4 Technology Under Consideration

The state of biodetection technology is rapidly developing and the Postal Service will continue to look for new technologies that can identify biological hazards. At this point in time, the Postal Service has identified the following products as having significant potential:

- Biological indicator strip (provides a visual indication of the presence of biological agents in envelopes or other postal containers)
- Air particulate monitoring technologies for use in major processing and distribution centers
  - Particle counter
  - Particulate shape analyzer
  - Laser discriminator
- Biohazard signature testing (either as a confirmation to air particulate monitoring, or for periodic sampling and analysis of airborne particulates)
  - Immunoassay test strip
  - Integrated air sampling/sample prep/polymerase chain reaction assay system
- Air particle concentrator interfaced to a mass spectrometer, for use in major processing and distribution centers. A possible alternative to particulate monitoring and confirmation testing

Below is a detailed description of each of these categories of technology.

D.4.1 Biological Indicator Strip

Technical Description

The Biological Indicator Strip is a strip of paper impregnated with indicator reagent(s) that react with compounds found in the bio-threat to produce a color change. The strip being considered has reagents that will react with two compounds found in bacteria of the genus *Bacillus* and several others. The technology was originally conceived for bacterial testing in the food industry. Its potential application as part of the United States Postal Service (USPS) approach to biohazard threats is for bacterial testing of surfaces or other samples at almost any point in the mail processing system. Its simplicity and low cost make it possible to be deployed at collection boxes.

The anthrax spore has one major chemical signature that is detected by the Indicator Strips. This major chemical signature is dipicolinic acid, which is found in bacterial spores. Bacteria are grouped into two basic types—either Gram positive or Gram negative—as a function of the cell wall chemistry. A Gram positive stain can produce bacterial spores. Bacterial spores are a highly specialized, dormant form of the organism that forms when conditions are unfavorable to growth. Spores are resistant to relatively high degrees of heat, chemicals, and radiation, and have a unique compound–dipicolinic acid—that reacts with a reagent on the Indicator Strip to produce a color change.

A positive test result on the test would indicate the possibility of anthrax contamination. However, this test is not specific for anthrax, and confirmation testing will be needed following a positive result. Other kinds of *Bacillus* spores are widely and commonly found in the environment, and could also give a positive reaction if present in sufficient quantities. While one would not expect that the mail would contain high levels of bacteria, the practicality of this technology in the USPS environment remains to be demonstrated.

Availability/Development Status

A test strip is available off-the-shelf that has three independent visual tests. These are a dipicolinic acid spore test (as described above), a gram-negative organism test (based on presence of the biomarker Lipid A in cells), and a vegetative cell test (based on a pH change from cell growth). The technology is probably not readily applicable to such threat agents as toxins and viruses. The lead-time for large quantities is not known, nor is the availability prototypes of indicator strips of other kinds, that could be used for other bioterrorism agents.

Product/Procedure-Specific Information

The technology was conceived for use in food production in industrial settings. The manufacturer is proposing incorporation of the strips into the USPS mailing environment. The item is disposable, so there are no maintenance issues. Its shelf life is not known.

Effectiveness

There is a concern over the sensitivity level of these strips. If a large quantity of spores is needed to obtain a positive test result, the potential applicability of the technology could be much more limited. Detection of airborne spores may require an aerosol collector front end. The strips are not specific for anthrax and will give a positive result with some relatively common and benign bacteria of the *Bacillus* family. A positive result on this test will require confirmation by a more specific and reliable test using PCR or a laboratory-based immunoassay.

The device is FDA listed as a class 1 microbiology-testing device. The availability of data on performance, utilization in current applications, and limitations on its use are not known.

Environmental Issues

Not a significant factor. Use of this technology will have small but significant facility impacts (primarily storage and personnel). Positive test strips will have to be disposed of properly, but this will be done in the context of remediation of contaminated mail or facilities.

Costs

The indicator strips are estimated to cost less than $1 per test. Overhead for their use is expected to be minimal, as the items are disposable, but allowance must be made for the logistics of stocking and distributing strips to points of use, and for recording test results.

Operational

Several kinds of operational impacts will be expected to result from use of the indicator strips. In some situations the use of indicator strips may require interruption of processing operations. Some specialized uses of the strips may require swipe or air sampling to be performed, for which training will be needed. Also, if deployed routinely in collection boxes or personnel monitoring badges, mail carriers and other affected personnel will have to learn how to use the devices properly and what actions would be taken upon obtaining a positive test result. If the indicator

strips are deployed to “integrate” over time (i.e., collect biohazardous agent cumulatively and give a color change after some threshold value is exceeded), they will have to be changed out on a fixed schedule. Being disposable, there are not expected to be any maintenance issues.

Viability in the USPS Environment

If it performs as expected, the indicator strip can help the USPS rapidly identify the possibility of contamination with certain biohazards wherever it may occur in the mail processing system. In particular, the relatively low cost of the indicator strip may allow for monitoring at the earliest point in the process--the mailbox—and/or on personnel identification badges. Its value to USPS will ultimately depend on its sensitivity. A relatively low sensitivity test will only give a positive result when a large amount of contamination is present. In addition, the lack of specificity of this technology could give an unacceptable number of false positives.

The indicator strips are expected to be compatible with testing in USPS environments without restriction. To qualify this technology for USPS applications, the following information gathering steps need to be taken: (1) determine the availability of indicator strips in quantities required by USPS; (2) determine what kinds of test strips have been developed, what kinds of biohazards are covered by them, and what the lead time would be for developing additional kinds of test strips; (3) determine the sensitivity of the test strips; and (4) perform testing to determine the likelihood of false positives within the postal processing environment.

D.4.2 Particle Counter

Technical Description

A particle counter continuously compares the size distribution of particulates present in the air stream at a given point in time with that observed over the preceding few seconds. If a biohazardous particulate is introduced in the mail stream, a reading of the profile of both size and amount of particulate will be recognized as outside of a normal profile. Typically used in laboratories and industrial settings, it could be inserted into the mail processing system at points where mechanical forces are likely to cause release of substantial amounts of spores from a piece of mail.

Particle counters work by continuously sampling air at a given location, sorting particles into separate streams by size range, and counting the particles in each stream. Typically the device focuses a laser beam on a collimated stream of particles and detects attenuation of the beam by individual particles. It compares readings at a given point in time with a previously established baseline.

Availability/Development Status

Particle counters are widely available as commercial-off-the-shelf items. The lead-time for a large quantity such as will be required by USPS is not known.

Product/Procedure-Specific Information

Particle counters are typically used in labs and industrial settings where airborne particles pose a risk to human health and/or product quality. They are precision instruments that require periodic maintenance and calibration, although the exact frequency is not known.

Effectiveness

This technology, or variants of it, has been certified and performance measures are available. Continuous operation of particle counters is required in some industrial settings by occupational safety and health regulations.

A major concern about the effectiveness of this technology is that the postal processing environment has a very high background level of particulates. There has been no determination that a particle counter/sizer can effectively identify bacterial spores or other kinds of bioterrorism threats against this high background of particulates. Further testing, and improvements, in the postal environment will be required to demonstrate this capability. Another consideration that especially applies to the particle counter is that dry bacterial spore preparations, even of the type used in the anthrax letters, have a wide range of particle sizes, suggesting that particle size distribution is not a very good criterion to identify the presence of biological contamination.

Environmental Issues

No environmental, safety or health constraints would be expected to be associated with the use of a particle counter. Maintenance personnel may need to use caution or personal protective gear if encountering accumulated dust within the device.

Costs

Capital costs are approximately $5,000 per unit for a representative device. Up to 2000 units could be needed to cover the major processing and distribution centers. Life cycle (operation and maintenance) costs are not known, but may be significant. Other types of costs are expected to be insignificant.

Operational

The most likely place of deployment will be in major processing and distribution centers, and the most likely equipment that will be fitted with a particle counter will be the Advanced Facing and Canceling Systems (AFCS), since the AFCS is one of the first points in the mail processing flow for mechanical disturbance of mailpieces.

Operation and maintenance of this equipment will require nominal but significant training and expertise. Requirements for maintenance are not known, but the device may require frequent cleaning.

Viability in the USPS Environment

The technology may be able to satisfy USPS requirements for ongoing monitoring of airborne particulates released from mailpieces during automated handling and sorting operations. It will be placed at the earliest points in the mail handling process where mechanical forces are likely to cause release of substantial amounts of spores from a piece of mail. This is a fairly low technology solution to the problem of identifying anomalous particles, and may not be sufficiently sensitive to identify the presence of microorganisms at useful levels in the context of the high particulate background.

Additional testing of the technology is needed. Critical to the usefulness of the technology is that it be demonstrated to be able to positively identify a release of bacterial spores at potentially hazardous levels in the postal processing environment. Testing in an operational setting demonstrated there was difficulty with high background particle loading and the ability to detect the release of small amounts of surrogate agent spores under these conditions.

D.4.3 Particulate Shape Analyzer

Technical Description

The particulate shape analyzer is a device that counts and images airborne particles. It measures the shape and size of every particle in the 2–20 micron range from an air stream continuously collected from a specific location. The resulting profile is then compared to established profiles of shape/size combinations for a match with other biohazardous agents. If a biohazardous particulate is introduced in the mail stream, a reading of the profile of both size and amount of particulate will be recognized as outside of a normal profile. Typically used in laboratories and industrial settings, it has primarily found applications in Europe. It could be inserted into the mail processing system at points where mechanical forces are likely to cause release of substantial amounts of spores from a piece of mail.

Particles in a continuously sampled stream of air are collimated and deposited on a moving surface that passes through a strobe-illuminated microscope. Images of individual particles are captured, stored, and analyzed using image analysis software and statistical functions.

Availability/Development Status

Particulate shape analyzers are commercial off the shelf items from a small number of vendors. The lead-time for a large quantity such as will be required by USPS is not known.

Product/Procedure-Specific Information

This device is designed primarily for use in industrial applications for quality control of particulate products. Such devices may have been evaluated for military/industrial uses to monitor for the presence of, and tentatively identify, airborne pathogens. They are precision instruments that require periodic maintenance and calibration, although the exact frequency is not known.

Effectiveness

This technology has been developed to the stage of commercial equipment with well-defined performance specifications. A major concern about the effectiveness of this technology is that the postal processing environment has a very high background level of particulates. It has not been proven that a particle shape analyzer can effectively identify bacterial spores or other kinds of bioterrorism threats against this high background level of particulates. Our assessment of the technology suggests that it difficulty in this environment. There are no known constraints on the use of the device.

Environmental Issues

No environmental, safety or health constraints will be expected to be associated with the use of a particle counter. Maintenance personnel may need to use caution or personal protective gear if encountering accumulated dust within the device.

Costs

Capital costs are approximately $50,000 per unit for a representative device. Up to 2000 units could be needed to cover the major processing and distribution centers. Life cycle (operation and maintenance) costs are not known, but may be significant. Consumables may be required for the operation and maintenance of the device. Other types of costs are expected to be insignificant.

Operational

Use of this technology will not require significant retrofitting of postal processing equipment. The most likely place of deployment will be in major processing and distribution centers, and the most likely equipment that will be fitted with a particle counter will be the (AFCS, which is the one of the first opportunities for mechanical disturbance of mailpieces at the centers.

Operation and maintenance of this equipment will require nominal but significant training and expertise. Requirements for maintenance are not known, but the device may require frequent cleaning.

Viability in the USPS Environment

This technology will have to be further modified to satisfy USPS requirements for ongoing monitoring of airborne particulates released from mailpieces during automated handling and sorting operations. It will be placed at the earliest points in the mail handling process where mechanical forces are likely to cause release of substantial amounts of spores from a piece of mail. However, it appears that this technology is not sufficiently selective to reliably identify the presence of microorganisms at useful levels in the context of a high particulate background.

Additional modification of the technology is needed. Critical to the usefulness of the technology is that it be demonstrated to be able to positively identify a release of bacterial spores at potentially hazardous levels in the postal processing environment.

D.4.4 Laser Discriminator

Technical Description

The laser discriminator is a device that counts and optically characterizes airborne particles. It measures the ratio of scattering to fluorescence of particles in an air stream continuously collected from a specific location. The resulting profile is then compared to established optical profiles for a match with other kinds of particles, including biohazardous agents. The resulting profile is then compared to established profiles for a match with other biohazardous agents. If a biohazardous particulate is introduced in the mail stream, a reading of the profile will be recognized as outside of a normal profile. There are several variants of this device under pilot production that are currently undergoing evaluation for possible military applications. This kind of device could be inserted into the mail processing system at points where mechanical forces are likely to cause release of substantial amounts of spores from a piece of mail.

In one variant of this technology, a stream of air containing particles is passed through a flow cell illuminated by a laser beam. Using sophisticated optics, light emitted at right angles from the incident beam is captured, separated into fluorescence and scattering signals, and quantified using photomultiplier tubes.

Availability/Development Status

Laser discriminator technology is a continuously emerging technology. Several developers currently have variant products available. The lead-time for the large quantity of devices that will be required by the Postal Service will depend on the developer. Improvements in laser and optics technology could significantly improve the performance of laser discriminators, but this will require additional development before achieving a deployable device.

Product/Procedure-Specific Information

The device is designed for military/industrial use to monitor for the presence of, and tentatively identify, airborne pathogens. It is a precision instrument that is likely to require periodic maintenance and calibration, although the exact frequency is not known. There are reports of degradation of performance over time due to deposits of particulate matter on the optics.

Effectiveness

A major concern about the effectiveness of this technology is that the postal processing environment has a very high background level of particulates. There is no current proof that a laser discriminator can effectively identify bacterial spores or other kinds of bioterrorism threats against this high background level of particulates. It has been demonstrated to be effective in distinguishing bacterial spores from non-biological particles such as road dust. However, the technology has been assessed as having difficulty with a high particulate level background. There are no known controls or constraints on the use of the device.

Environmental Issues

No environmental, safety or health constraints would be expected to be associated with the use of a particle counter. Maintenance personnel may need to use caution or personal protective gear if encountering accumulated dust within the device. The device uses a laser in an enclosure. Precautions and/or safety controls will be applied to reduce the likelihood of eye damage to equipment users or service personnel.

Costs

Capital costs are approximately $50,000 per unit for a representative device. Up to 2000 units could be needed to cover the major processing and distribution centers. Life cycle (operation and maintenance) costs are not known, but may be significant. Other types of costs are expected to be insignificant.

Operational

The most likely place of deployment will be in major processing and distribution centers, and the most likely equipment that will be fitted with a particle counter will be the AFCS, which is the one of the first opportunities for mechanical disturbance of mailpieces at the centers.

Operation and maintenance of this equipment will require nominal training and expertise. Requirements for maintenance are not known, but the device may require frequent cleaning.

Viability in the USPS Environment

With additional development, this technology may be able to satisfy USPS requirements for ongoing monitoring of airborne particulates released from mailpieces during automated handling and sorting operations. It will be placed at the earliest points in the mail handling process where mechanical forces are likely to cause release of substantial amounts of spores from a piece of mail. This technology may not be sufficiently selective to reliably identify the presence of microorganisms at useful levels in the context of the high particulate background.

Additional testing of the technology is needed. Critical to the usefulness of the technology is its demonstrated ability to positively identify a release of bacterial spores at potentially hazardous levels in the postal processing environment.

D.4.5 Immunoassay Test Strip (Lateral Flow Immunochromatographic Assay)

Technical Description

The immunoassay test strip is a small (matchbook-sized), self-contained, one-time-use test for the presence of a specific pathogenic agent. A sample (a single drop of a liquid solution or suspension) is introduced into a port, the test is allowed to develop, and the result is read visually or optionally using an automated strip reader. The test strips have been used in environmental testing for the presence of pathogenic agents. They have been used in testing anthrax-contaminated areas following the discovery of contaminated mail.

Immunoassay test strips were initially considered by USPS as a possible confirmation test to follow a positive trigger with the air particle monitoring technology. The strip contains reagents to conduct a sandwich immunoassay for the target analyte. The analyte reacts with an antibody-coated silver particle, and is carried along a porous strip by the carrier liquid containing the sample. A second antibody reaction immobilizes the analyte-bearing silver particles at a specific location on the strip, at which (if analyte is present) they become visible as a dark band. A second, control reaction is also carried out, to verify proper functioning of the strip.

Availability/Development Status

Immunoassay test strips are currently in production. Also available as off the shelf items are a benchtop device for automated aerosol capture into a liquid sample for introduction into a test strip, and a benchtop device for automated test strip readout.

Immunoassay strips are commercially available in variants from several vendors. Six to ten tests for different pathogenic organisms of terrorist concern are currently available from one vendor. The specificity of the tests is highly dependent on the antibodies selected, and that some antibodies may not be species specific. Any selected test strips will be evaluated against organisms present in the background. If additional assays were required, substantial lead-time could be required to produce antibodies and develop the tests.

An alternative and somewhat less mature variant of this technology uses upconverting phosphors in place of silver particles and can combine several tests into a single strip, each with a specific color readout. In addition, there are commercially available, disposable, integrated sample preparation and analysis cartridges that employ DNA amplification and lateral flow assays to identify organisms.

Product/Procedure-Specific Information

Immunoassay test strips are recommended for testing of environmental liquid and swab samples. The items are disposable and designed for one time use only. Their long-term storage potential is not known but the item is believed to have a reasonable shelf life. A built-in control assay helps identify malfunctioning test strips and provides greater confidence in a negative result. In spite of this, the uniformity of the items is not known and will need to be determined and documented.

When an immunoassay test strip, or any other technology, is used to test manually collected samples, the precise strategy for how and where to collect samples becomes an overriding factor. A negative test result for an improperly collected sample may prove unreliable even when the underlying detection technology is working properly.

Maintenance is a potential issue with the air sampler and strip reader devices, and could be a significant factor in terms of material and labor costs.

Effectiveness

The device produces a test result within 15 minutes following application of a sample. There is concern about the level of sensitivity for most applications. The specificity of the antibodies in the test are an issue—not all tests that are nominally for a given organism are equally specific, and one would compare vendors carefully on this issue.

The immunoassay test strips are not a certified technology and are specifically stated as not qualified for use in clinical testing. The extent of its use in various applications is unknown, but the devices are generally known as useful for environmental testing and have seen considerable use. Variants of this technology are under development.

The combination of an air sampler, sample applicator, test strip, and readout device has been advertised as an integrated solution for testing for airborne particles of biohazardous agents. The effectiveness and reliability of this combination of devices is still a concern because of the underlying sensitivity of the strip.

Environmental Issues

There are no known environmental or occupational constraints on the use of the test strips.

There are no added personnel risks above those caused by the presence of contaminants being tested for. If contamination is found, used strips may require handling as a biohazard.

Costs

As expendibles, the strips currently cost about $20 per test, a value that could be considerably lower in high volume. The strips are one-time-use, disposable items. Benchtop sampling and readout devices are each available in the range of several thousand dollars as a capital outlay.

If the strips are used as confirmation tests in conjunction with an air particulate monitoring technology, and that technology is effective in alarming only when independent tests show that bacterial spores are present, then the usage rate will be relatively low. If on the other hand, they are used for primary testing, then their usage rate will be much higher and the overall cost will increase accordingly.

Operational

Implementation in a postal processing environment should be straightforward. The sampler and reader devices require a square foot or so of space and a low level of line power. The sampler device may have to be interfaced with air monitoring systems if used, or directly to mail processing equipment.

Training is required for proper collection and preparation of samples and their application to the strips, and for proper operation and maintenance of the sampler and reader devices.

Viability in the USPS Environment

This technology is not believed to have high potential value to USPS efforts to secure its facilities and personnel against contamination by infective agents. The application of confirmation testing of airborne particulates on process lines at major mail processing and distribution centers requires reliability not demonstrated by these strips. It will be associated with anonymous mail process lines involving physical stresses on mailpieces that could result in release of pathogenic organisms. It could also be used in other parts of the mail processing system as a test of possible contamination, but sensitivity is a big issue.

D.4.6 Integrated Air Sampling/Sample Preparation/Polymerase Chain Reaction (PCR) Assay System

Technical Description

PCR is a technology for detecting small quantities of DNA with a particular genetic sequence. Typically, tests are designed to be specific for a given species or strain of an organism. Tests for a pathogen usually focus on the genes responsible for its pathogenicity. If the target DNA sequence is present in any of the DNA in the sample, the reaction produces multiple copies of the target sequence. These multiple copies can then be detected directly or indirectly to give a positive test result. If no target sequence is present, no copies are made, and a negative test result is obtained.

PCR is broadly used in the biological sciences for organism identification. It has been used for clinical, forensic, and environmental testing for the presence of, and specific identification of, pathogenic agents, human DNA, interspecies relationships, etc. In the context of USPS requirements, it is envisioned as a primary or confirmation test that will be used to monitor airborne particles released during automated mail processing and to detect biohazardous agents that may be present. It could be used for direct sampling and analysis of these particles, or as a follow-up to a positive trigger with the air monitoring technology. It could also be used as a confirmation test following a positive test with biological indicator strips.

The sample is mixed with test reagents, either manually or automatically in a cartridge. A precision instrument subjects the mixture to a precise series of heating and cooling cycles. Each cycle causes each copy of the test sequence that is present in the sample tube to form a replica of itself. These replicas in turn are also replicated; giving a chain reaction that quickly builds up a large quantity of the replication product. Each replication step is accompanied by generation of a highly fluorescent dye molecule, which is detected optically.

Availability/Development Status

PCR is a mature technology that has a wide variety of experimental and commercial variants. Benchtop thermocyclers are available in some variety of designs, some of which employ an integrated microfluidic cartridge that automates most of the sample processing steps. Handheld thermocyclers are also becoming available. Variants also exist in which the PCR reaction is carried out at a constant temperature.

Thermocycling instruments, some with optical readout and data management capabilities, are available from multiple vendors. Reagents for many tests are commercially available, or can be made to order by specialty companies from specifications for previously developed tests. Development of new tests can be challenging, but adequate tests exist for most pathogenic agents of concern for bioterrorism.

The specific technology under consideration is an integrated air sampling/sample preparation/PCR technology using disposable microfluidic cartridges. It is designed to automate the sample collection, preparation, analysis, and readout processes into a single seamless process. Two commercial variants of this system are available, but both are relatively new.

New assays if required may involve a substantial development effort. Selection of sequences for effective primers and probes for a new PCR test is not straightforward and considerable testing is required to design optimal reagents and validate the new test, however, a wide range of tests are currently available.

Product/Procedure-Specific Information

PCR is used for testing of clinical, forensic, and environmental samples of all kinds. USPS envisions it for use in testing airborne particles released as mail is handled by automated processing equipment.

Maintenance requirements for the specific devices under consideration are not known. Thermocycling instruments do require periodic maintenance, but it is not expected to be a major cost or labor factor. The air sampling device may also require maintenance.

Uniform performance is assured by calibrating each analytical run. Each run includes a number of standards (spikes and blanks), and a standard curve is generated for each run. This helps assure reproducibility.

Effectiveness

PCR generally is an extremely sensitive assay method and can routinely detect as few as 50 copies (organisms) per sample within 15-30 minutes. Its theoretical detection limit is one copy of DNA per sample. Consequently it is viewed widely as the “gold standard” of detection methods.

Problems with this kind of assay may arise if certain contaminants are present that inhibit the DNA polymerase used in the reaction. Such contaminants are frequently found in environmental samples, but methods are being developed to filter and clean inhibitors to reduce risk.

PCR has been certified for clinical testing. PCR evidence of genetic relationships is frequently used, and accepted, as evidence in court cases. Performance measures are generally widely available for both instruments and for complete assays. Performance measures are typically required as part of the development process for a new assay.

PCR technology is well known and widely used at present. An important factor is sample throughput, which varies from one instrument to the next as a function of the number of readout ports on the device and the ability of the instrument to independently thermocycle individual samples. In the latter case, one could analyze for multiple analytes at the same time (using separate cartridges following different thermal cycling programs). One can also use multiplex assays, which enable more than one analyte to be tested for in a single reaction tube or cartridge. There is a potential for cost savings over separate individual assays, but multiplex assays are usually not as sensitive.

Environmental Issues

There are no known environmental or occupational constraints on the use of the PCR cartridges.

There are no added personnel risks above those caused by the presence of contaminants being tested for. If contamination is found, used cartridges may require handling as a biohazard.

Costs

The cost per assay, labor and materials will run in the $10s to $100s range, depending on assay format, use of cartridges, etc., with costs expected to be lower in high volume. Research grade benchtop thermocycling devices are in the range of $50,000 - $100,000 in capital outlay, portable and handheld versions are less costly. Up to 2000 thermocyclers could then be required. For situations involving possible contamination at other facilities, samples could be transported to the nearest major processing and distribution center for analysis.

If not used in association with triggering devices, each of the PCR instruments will need an integrated air sampling device at a cost of about $3000 each.

Life cycle costs for these devices are not known, but could be significant. Improvements to technology may outpace instrument longevity.

If the PCR cartridges are used as confirmation tests in conjunction with an air particulate monitoring technology, and that technology is effective in alarming only when independent tests show that bacterial spores are present, then the usage rate will be relatively low. If on the other hand, they are used for primary testing, recurring costs will be relatively expensive.

Operational

Operational impacts may vary depending on how PCR testing is used. When used as a confirmation test for an air monitoring system, their use can help establish the reliability of that system as well as help determine the course of action following a trigger on the air monitoring device. Also, following a determination of contamination, PCR tests may be used as part of the process of verifying successful decontamination (e.g. via surface sampling).

Implementation in a postal processing environment should be straightforward. The sampler and thermocycler devices require several square feet of space and a low level of line power. The sampler device may be interfaced with air monitoring systems if used, or directly to mail processing equipment.

Viability in the USPS Environment

This technology is believed to have high potential value to USPS efforts to secure its facilities and personnel against contamination by infective agents. It is expected to be used in primary or confirmation testing of airborne particulates on process lines at major mail processing and distribution centers. It will be associated with anonymous mail process lines involving physical stresses on mailpieces that could result in release of pathogenic organisms. It also can be used in other parts of the mail processing system as a test of possible contamination.

The technology is fairly well understood. However, low levels of analyte, the possible presence of inhibitors and other interferents with the assay, and integration with the process are negative factors but these are being overcome. It is much more sensitive than the immunoassay test strips. It is more flexible than the test strips (new assays can be added relatively easily) but more costly per test.

D.4.7 Air Particle Concentrator/Mass Spectrometer

MALDI-TOF-MS (matrix assisted laser desorption ionization-time of flight-mass spectroscopy) is one variant that has been studied extensively relative to the BW agent detection problem.

Technical Description

Mass spectrometry is an analytical method that identifies chemical species by their mass to charge ratio. Under some circumstances, it can be an accurate means of identifying specific bacteria. A mass spectrometer works by producing charged particles (ions) from the substances to be analyzed, and then uses electric and magnetic fields to separate and quantify the ions by their mass to charge ratio. The instrument can interpret the masses and relative abundances of the ions generated from a complex (e.g., biological) sample to obtain information on the composition of the sample.

Mass spectroscopy is a mature technology that has been used widely throughout the scientific community for decades as a means to identify chemical unknowns and verify proposed chemical composition and structure for new substances. It has been used widely by the military for chemical warfare agent detection in battlefield settings, and by law enforcement in forensic applications such as detection of explosives residues. It could be deployed at the US Postal Service as an integrated alternative to the combination of an air monitoring technology and a confirmation testing technology. Two unique solutions were presented to the Postal Service that attempts to automate the whole process and allow for continuous monitoring of the air. These systems use an air concentrator to collect a sample of the aerosolized particles and then present the sample for ionization and mass spectrometry.

The mass spectrometer uses specially developed technology such as matrix-assisted laser desorption to convert high molecular weight cellular components into ionized particles with high efficiency. It uses a combination of electric and optionally magnetic fields to separate particles in a vacuum by their mass to charge ratio. Particles are detected on a cathode and measured as a current flow. The mass spectrum is a plot of ion abundance as a function of mass. Software then can be used to try to match the mass spectrum of a sample against a library of mass spectra of known substances, to make positive identification. This problem becomes more difficult if one is analyzing a more complex mixture, such as a living organism, and requires more sophisticated pattern recognition approaches. A variant of this technology, known as ion mobility spectroscopy, uses rate of diffusion through a low pressure inert gas as a means to separate ions.

Availability/Development Status

Research mass spectrometers are widely available commercially. The integrated air sampler-biological mass spectrometers being considered for USPS deployment are in pilot production and have limited availability. There will be a long lead-time expected for acquisition of a large number of devices (as will be needed for deployment in major processing and distribution centers).

Product/Procedure-Specific Information

Mass spectrometers of various types are used in research environments for chemical identification. The technology has found limited but increasing use in microbiology for bacterial identification and cytology, largely due to new technologies for producing ions from high molecular weight solid materials. However, most biological applications of mass spectroscopy do not allow for real-time, continuous monitoring. These devices still require biochemists to perform manual sample preparation and analysis.

The maintenance overhead for the devices under consideration is not known, but maintenance is probably a significant factor. Mass spectrometers can be high maintenance instruments that require frequent calibration. However, sophisticated control systems may partially automate calibration. Factors related to long term utilization and storage, and quality control are not known for the prototype under consideration, but are probably not significant.

Effectiveness

Mass spectroscopy is a highly sensitive technique requiring very small amounts of analyte—for bacteria, hundreds of cells are sufficient for analysis. The promise of this technology rests on the observation that each species has its own set of chemical constituents (“biomarkers”) that allows it to be distinguished from others. The relative proportion of these biomarkers can be viewed as a fingerprint for the organism. A limitation of this approach is that the relative proportion of these substances may vary depending on the conditions under which the bacteria are grown or to which they are subsequently exposed.

Overall, it is a much bigger challenge to identify bacterial species from their mass spectra than to identify pure chemical substances by mass spectroscopy. It will require the development of an extensive reference library of mass spectra of both pathogenic and non-pathogenic bacteria, including those considered likely agents of bioterrorism, and possibly as grown under a variety of conditions. This is a potentially costly and data intensive undertaking. Furthermore, it is a big leap to go from analyzing a homogeneous sample of bacterial cells of a single type, to the complex mixture of particles that one will encounter in a mail-processing environment.

Mass spectrometers have been tested and certified for military and forensic applications, especially in identification of trace levels of chemical substances, and its application to biological macromolecules such as proteins and DNA fragments has become nearly routine. The particular hardware under consideration and its expected application within the postal system is quite new and few specific data if any are available on its ability to meet USPS requirements.

Environmental Issues

A particle concentrator/mass spectrometer will require maintenance on a regular basis, but the risks posed to maintenance personnel are not expected to be significant. The device will require space and power, but at levels far below those required by the processing and sorting equipment, and probably can be accommodated within the constraints of the existing infrastructure, although the equipment will have to be retrofitted.

Costs

The devices under consideration are expected to come in with initial capital costs of about $150,000 each (approximately 1128 units could be needed to cover the major P&DCs). There will be nominal ongoing costs for consumables used during the operation of the device, and materials used for periodic maintenance. There will be potentially significant labor costs for maintaining the devices in working order. No other kinds of costs are expected to be significant.

Operational

The operational considerations for implementing this technology in the USPS are nominal. The devices will require space and power, but on a scale much smaller than the machines to which they will be interfaced/retrofitted. Operation, and to a greater extent maintenance, will require substantial training. Maintenance requirements are not known but may be significant.

Viability in the USPS Environment

The technology may be able to satisfy USPS requirements for ongoing monitoring of airborne particulates released from mailpieces during automated handling and sorting operations. A critical issue here is whether it can function effectively given the high level of particulates expected in this environment. The technology is in prototype/pilot stage and may be available in a timeframe acceptable to USPS, but if so it will be only in limited quantities. In the near term it may have to be supplemented with a combination of airborne particulate monitoring and confirmation testing.

Additional testing of the technology is needed. Critical to the usefulness of the technology is that it be demonstrated to be able to positively identify and distinguish closely related bacterial species independently of their growth conditions and environmental history. Also it is critical that it be shown to work in a postal facility in the presence of the typical load of particulates found there.

Appendix E

Intervention

This appendix summarizes the evaluation of technologies for intervention of contamination before contaminated mail enters the system. The mode of intervention that is being evaluated and applied is the bulk sterilization (killing of all live organisms present) of mail prior to its entry into processing.

The sterilization technologies evaluated fall into two basic categories, irradiation and chemical. One additional physical method, high-pressure sterilization, is evaluated.

Irradiation technologies include:

- Electron Beam
- X-rays
- Gamma Rays
- Ultraviolet (UV) light
- Microwave

The first three of these technologies are evaluated together under "ionizing radiation" because of their logistic similarity.

Chemical technologies include:

- Chlorine Dioxide
- Ethylene Oxide
- Methyl Bromide
- Ozone

These technologies are also evaluated for decontamination of facilities in Appendix E.

E.1 Ionizing Radiation–Electron Beam, X-ray, Gamma Ray

Companies that provide this equipment and/or services include Titan/Surebeam, Ion Beam Associates, Rad Source Technologies, Inc., MDS Nordion, Steris Corp., NUTEK Corp., and duoTEK, Inc.

Technical Description

Ionizing radiation relies on the deposition and absorption of energy at the molecular level. The absorbed energy breaks chemical bonds, destroying essential chemical structures and resulting in reactive ions and free radicals, which cause additional damage. Damage to deoxyribonucleic acid (DNA) and cellular proteins required for a cell to survive and reproduce results in the death of cells, including infectious organisms.

There are three technologies for producing ionizing radiation that are currently considered for use in mail sanitization via irradiation. These are: Electron Beam (e-beam), X-ray, and Gamma ray (-ray).

An e-beam is a beam of electrons driven by a high accelerating voltage, similar to the beam of electrons generated in a television picture tube. The accelerating voltage determines the energy "content" of the driven electrons. At sufficiently high energies, these electrons sterilize biological materials by reacting with the DNA and proteins of

cells. The result is a biological particle that has lost the ability to reproduce and is thus non-infectious. Because the beam of electrons loses some of its energy as it interacts with the material it is sent through, there is a finite "thickness" of material that can be treated to effect sterilization.

X-rays are high-energy electromagnetic radiation. X-ray photons are generated by bombarding electron-dense materials with high-energy electrons. These X-ray photons can be focused and directed with mirrors and they contain energy that can interact with biological materials. In sufficient quantity, X-rays can disrupt nucleic acids of cells, leading to cell death. As noted, X-rays can also damage proteins by generating reactive free radicals. Because of their higher energy content, X-rays can penetrate materials more easily than e-beam electrons.

Gamma ray systems are functionally similar to X-rays and e-beams but are the most energetic portion (shortest wavelength) of the electromagnetic spectrum. They are generated by the decay of radioactive sources such as cobalt 60 or cesium 137. Gamma rays are even more powerful and have an even higher penetration capability than X-rays.

All three irradiation technologies are currently used to sterilize medical equipment and for food "pasteurization."

Irradiation technology is of potential use to the United States Postal Service (USPS) because it provides the capability to penetrate sealed envelopes in a relatively non-destructive manner, allowing for the sterilization of both the contents and the wrapper or envelope of an item of mail.

Availability/Development Status

Of the three-irradiation technologies available, only e-beam is immediately available with a capacity to handle the Postal Service needs. While both X-ray and gamma ray technologies have demonstrated the capability to destroy *B. anthracis*, neither is immediately available on the scale required by the USPS.

USPS identified two CONUS sources of e-beam accelerators. The use of e-beam technology was implemented in October 2001. Contracts have been awarded for off-site e-beam sterilization of mail from the Brentwood and Trenton facilities and incoming government mail for Zip Codes 202-205.

USPS purchased eight e-beam systems to install in the Washington, DC and Trenton, NJ areas. Preliminary plans call for four systems to be installed and ready for use in the Washington, DC area. The irradiation facility layout and design is near completion; the appropriate approval and permitting process will be followed. In turn, public notification will be a critical component of our plans to move forward. The site for the other four systems is still being worked.

Product/Procedure-Specific Information

All three irradiation technologies are currently used to sterilize medical equipment and for food "pasteurization."

The e-beam process has been in use for high throughput uses such as the sterilization of foods on a factory-scale, and has been adapted to process mail. It does not need a radioactive source to generate the high-energy electrons, but does require significant electrical supply and sufficient shielding while the beam is on. The process can be semi-automated. Costs of the process depend on whether mail can be sorted sufficiently to ensure that only items of sufficient risk to merit sterilization are treated in this

manner. Other cost drivers include capital cost of equipment, capital costs of facilities (the shielding of the units requires a foundation that can withstand ~45,000 lbs per sq. ft.), and energy costs.

Since irradiation technologies have never been used in applications similar to USPS requirements, current knowledge gaps include maintenance issues and performance issues.

Effectiveness

All three technologies have demonstrated the capability to effectively destroy *B. anthracis*. However, due to the amount of energy transferred to the mail by any of the irradiation processes described, all three technologies could damage certain types of mail, including film, electronic equipment, and live samples such as seeds.

All three technologies will affect mail service and make the handling of mail more difficult and time consuming. Gamma ray technologies, in addition, require specialized handling procedures for the radioactive source.

E-beam has been shown to be effective in the eradication of biohazards. In order to assure immediate effectiveness, energy levels on the high end were used.

The downside of high energy input is the greater likelihood of unacceptable damage to the mail. Because physical changes occur in irradiated material, mail processed in this manner may have different organoleptic properties after processing than before–paper is embrittled, plastics yellowed and hardened. As operational experience is gained in the real time application of this technology, the energy levels can be fine-tuned to continue to achieve complete threat eradication while minimizing the possibility of effects on certain mail items.

Performance evaluation designed to identify the lowest range of energy that will assure adequate killing of the relatively resistant anthrax spores with the minimum of damage to the mail will be important if e-beam technology is to be more widely and uniformly applied to mail processing.

Another issue in the effectiveness of irradiation technologies is the possibility of materials within the mail that are opaque to radiation. Such materials could shield portions of the mail from the radiation and allow biohazards to survive the treatment. This issue is being resolved by irradiating from multiple directions or by turning the mail as it passed through the irradiation chamber.

Environmental Issues

All three technologies have been successfully permitted for other applications. A knowledge gap exists as to the specific environmental regulations with which the USPS will have to comply. However, it is highly likely that the manufacturers of the technologies will have experience in this area and will help the USPS comply with relevant regulations.

There may be constraints on the use of irradiation technology due to public concerns as to the effect of irradiation on mail and its contents.

Costs

For implementing e-beam processing in Postal Service facilities, the following estimates have been developed:

Purchase of 8 e-beam systems for servicing of two centers–$40.2M
Service contracts–$2.5 M/month for servicing of 8 e-beam systems
Equipping of all Processing and Distribution Centers Solution (350 Sites)–$2.25B

Equipping of Centralized locations (100 Sites)–$750M to $1B

All three technologies are expected to be expensive and have recurring costs. Utility costs are expected to he high with all three technologies. X-ray technology will provide the highest utility costs due to the fact that X-ray producing equipment has only 5-8 percent of the power efficiency of e-beam technology.

Gamma ray technology may present recurring costs related to the radioactive fuel sources. Fuel may be limited, especially in quantities large enough to meet USPS requirements.

Operational

A large and heavy footprint requires that the equipment be located outside of existing buildings, in structures designed and built to house the equipment. Location of the intervention equipment outside of the existing facilities is consistent with the intent of intervention technology to kill biohazards before they enter the processing facility.

The power requirements for irradiation technologies are likely to be high when compared to other technologies.

Irradiation technology as used for intervention will likely impact USPS operations. It will require a new step in the mail processing system, which could result in an increase in mail delivery times. A knowledge gap exists as to exactly how much of an impact the use of these technologies will have on service although a knowledge base is building as the technology is being used currently for some mail processing.

A knowledge gap exists on operational considerations such as noise and vibration levels and other considerations that may affect worker health and safety. Some of this information may be available from vendors, but much will have to be developed by the Postal Service as it continues its use of the e-beam process.

E-beam and X-ray technologies may present worker safety issues which are readily resolved by appropriate shielding and safety interlocks are employed. The equipment is self-contained and requires little or no operator intervention during normal operation. Gamma ray technology may present additional safety hazards to workers due to the presence of highly radioactive sources. While the sources will be shielded during use, workers could be exposed during maintenance activities.

Neither X-ray nor gamma ray technologies have been demonstrated for high throughput applications. Gamma ray technology has significant safety and security issues related to the handling of radioactive materials. Introducing cobalt 60 or cesium 137 into USPS facilities will create additional safety and terrorism risks since these materials are highly radioactive and large quantities are required for USPS uses.

A knowledge gap exists as to the training requirements for irradiation technologies. However, they process is likely to be significantly automated and it is unlikely that much training will be required. Vendors should be able to address this gap.

A knowledge gap exists as to reliability, maintenance, and performance data for the technologies. As stated above, performance evaluation designed to identify the lowest range of energy that will assure adequate killing of the relatively resistant anthrax spores with the minimum of damage to the mail will be important if e-beam technology is to be more widely and uniformly applied to mail processing.

Viability in the USPS Environment

All three technologies have demonstrated effectiveness in meeting USPS objectives for an intervention technology. Irradiation technology can be placed in-line as an initial step in mail processing. As stated above, the technology will require housing separate from existing facilities.

Only e-beam technology is currently developed to the point where it is immediately available. Titan and IBA have been awarded contracts for off-site e-beam sterilization of mail from the Brentwood and Trenton facilities.

The USPS has purchased eight Titan e-beam systems to install in Washington, DC and Trenton, NJ. Preliminary plans call for four systems to be installed and ready to use in Washington, DC by Summer to Fall 2002. Long-term plans for irradiation technology are on hold, pending the development of USPS requirements.

A knowledge gap exists as to how the technologies will be further evaluated. Appropriately designed performance evaluation will be critical to the effective application of this technology.

E.2 Ultraviolet Light (UV Irradiation)

Technical Description

That portion of the electromagnetic spectrum that ranges from about 210 to 328 nm is called ultraviolet light or ultraviolet radiation. The region between 240-280 nm has maximum bactericidal effect. Many companies provide germicidal lamps for use in water treatment and food processing plants, in air disinfection systems, and in biological safety cabinets. UV radiation is non-ionizing radiation that kills microorganisms by disrupting the organism's ability to reproduce.

The primary target site for UV radiation is DNA. Several types of damage result from UV exposure but the most important of these are DNA strand breaks and the formation of photoproducts such as thymine dimers. Damage to DNA results in cell death.

Availability/Development Status

UV sterilization equipment is in widespread use and could be made available for use by the Postal Service with little delay.

Product/Procedure-Specific Information

A variety of equipment for the generation of UV light is available.

Effectiveness

Since UV light does not penetrate light opaque materials, it will only be effective on directly exposed surfaces. The difficulty with using UV will be in "setting up" the mail to be treated–eliminating shadows, treating both sides of a flat or envelope and all sides of parcels.
UV radiation is currently used for surface disinfection and sterilization and to treat air in specific environments.

UV radiation has been used as a germicide for a long term in specific environmental settings. A specific use (exposure times, ergs applied, etc.) in a Postal Service environment will require validation before it was assumed to be useful.

Because of its low penetrating power, UV is used primarily to disinfect surfaces. Susceptibility to UV radiation varies widely—some microbes are easily killed by UV radiation while others

(including some viruses) are very resistant to its effects. Further, because it doesn't penetrate, microbes protected in "shadowed" areas are unaffected by it.

Environmental Issues

There are no obvious especially difficult environment issues associated with the use of UV radiation in a postal facility. Certain precautions will be required–individuals cannot be exposed directly, disposal of the old lamps might require a special facility due to their mercury content (but old lamps may be recyclable).

Costs

The costs of implementing UV sterilization as a service-wide process could vary from the cost of installing UV lamps at strategic places to construction of specific exposure chambers, depending on the mode of use.

Operational

There are several operational considerations to be made when considering UV sterilization in a commercial environment, including the avoidance of human exposure to UV. While expensive because of the quartz glass requirements, the mercury vapor lamps only gradually lose their germicidal power over time. The numbers of them that will be required in a postal processing environment might lead to disposal issues when the useful life is over. There should not be any issues associated with quality of the lamps because this is a well-established industrial process. Maintenance of the lamp tubes may be an operational issue. In the dusty environment of mail processing, the collection of dust on the lamp surface may block the emission of the light.

There will be minimal training requirements for application and use of UV systems. Health and safety training issues will include protection against undue human exposure. The reliability of UV for surface disinfection is well documented, but the use of the technology in the Postal Service will require some validation studies to ensure efficacy if it is decided that the technology has specific application.

Viability in the USPS Environment

Because of its limitations to surface applications, UV radiation will not be effective as a large scale intervention technology. It may have limited applications in concert with other technologies.

E.3 Microwave Irradiation

Microwave radiation is that portion of the electromagnetic spectrum with a frequency range of 3 kHz to 300 GHz.

Technical Description

Microwave radiation is a subset of radio frequency radiation but is commonly treated as a separate spectral region. Microwave radiation is non-ionizing due to its relatively low energy. The energy from microwaves is transferred to water molecules in biological materials. As microwave energy is absorbed by water, it increases the temperature of the water phase and can transfer heat to the surrounding materials. Thus the primary effect of microwave radiation on biological materials results from thermal changes. Applications of microwave technology are communications, plastic welding, glue curing and heating or cooking foods.

Availability/Development Status

Microwave generators are COTS technology. Existing microwave chambers could be adapted to process mail with minimal difficulty, although there is no equipment certified for this use. Lead-time for this type of conversion could likely be 4-6 months.

Product/Procedure-Specific Information

Microwave radiation is now used for a variety of large-scale industrial processes that use heating as part of the process. The technology is robust and relatively low maintenance.

Effectiveness

Microwave equipment is usually certified to meet leakage and power licensing requirements. Because it is very difficult to control the thermal effects induced in biological materials when they are microwaved, hot spots and cold spots are common. This dramatically reduces the effectiveness of microwave irradiation as a disinfection or sterilization tool. Further, because many of the biological agents of interest to the Postal Service will not have high moisture content, the effectiveness of microwave exposure could not be relied upon for uniform intervention.

Environmental Issues

Microwave radiation usage carries a number of environmental issues. There will be a variety of licensing and registration issues associated with the use of microwave frequency radiation in Postal Service facilities, at both the state and federal level. In some states (NJ, for instance), usage fees are applied for microwave sealers, heaters and industrial ovens and these may also apply to Postal Service applications.

There are concerns about non-thermal health effects in humans. Any application of microwave radiation processes in Postal Facilities will be closely regulated and require monitoring to ensure no leakage occurs.

Costs

The costs associated with microwave irradiation of mail will include capital costs for equipment, handling equipment, and energy expenses. Comparative costs can be derived from equipment used for medical waste processing. A unit that can process 400 lbs per hour costs about $500,000. A unit that can process 900 lbs per hour costs $600,000. Energy consumption is about 0.1 kWh per pound treated.

Operational

The operational impact of the use of microwave radiation for intervention applications in a Postal Service application will likely impact USPS operations. It will require a new step in the mail processing system, which could result in an increase in mail delivery times. A knowledge gap exists as to exactly how much of an impact the use of intervention technologies will have on service.

Long-term exposure to low-level microwave radiation has been investigated as a source of adverse health effects, but an association between microwave exposure and adverse health effects has not been unequivocally demonstrated.

The energy requirements for this technology will be significant.

Viability in the USPS Environment

It is doubtful that microwave radiation technology will be useful as a method to sterilize the mail because of the lack or precision in the heating process–i.e., hot spots, cold spots, edge overheating and so forth. This problem will be exacerbated by the heterogeneous nature of the mail and its low water content. Finally, the water content of anthrax spores may be so low that microwave radiation could not inactivate them without very long exposure times to high microwave energy levels.

E.4 Gas Plasmas–

Technical Description

Gas plasmas are the fourth state of matter, other than solids, liquids, or gases. Plasmas are atoms that have been stripped of their outer electrons and thus are very reactive. They are commonly found in very high temperature environments. However, they can be generated at atmospheric pressure and at low temperatures by corona discharge devices. Plasmas generated this way are very short lived because they react so quickly with matter in their surroundings. Because they are very destructive, it is unlikely that they are viable as a sterilization technology. A relatively new commercial process under development is hydrogen peroxide plasmas. These are used to sterilize medical devices and equipment, but there are severe material constraints. These plasmas are incompatible with paper.

Availability/Development Status

Plasma generators are commercially available but the technology is limited to surface decontamination rather than mail sterilization.

Product/Procedure-Specific Information

Plasmas are high temperature, reactive materials. They have application in hazardous waste disposal and decontamination of surfaces by plasma etching. Because plasma have a reactive temperature in excess of 3000°F, they are not useful for Postal Service intervention applications.

Effectiveness

Because the technology uses high temperature plasmas and is destructive, it is not useful to the Postal Service as an intervention technology. It is accepted as a hazardous waste treatment technology by the EPA's Superfund Innovative Technology Evaluation (SITE) program and could be used as a decontamination technology for catastrophic events at postal facilities.

Environmental Issues

Gases produced by the thermal process may be subject to federal and state air emission regulations, depending on the materials destroyed by the process. The residue (the process reduces material volume by up to 90 percent) may require disposal as a hazardous waste, again depending on the types of material treated.

Costs

A small unit with a capacity of 1000 lbs per day will cost about $800,000. Energy recovery is possible to recoup some operating costs. The process generates gases that may require treatment, depending on the content of the pyrolyzed material.

Operational

Operational considerations are not discussed because of the unsuitability of the process for use in the Postal Service system as an intervention technology.

Viability in the USPS Environment

Because of the destructive potential, high temperature plasmas are not viable for intervention in the USPS environment.

E.5 Ultra High Pressure Sterilization

Ultra High Pressure (UHP) Sterilization is a process under development by Flow International and others to effect sterilization of food stuffs by using ultrahigh pressure (~100,000 psi) with or without slight temperature elevation.

Technical Description

Application of pressure approaching 100,000 psi in specially constructed vessels inactivates biological particles directly, apparently by physical changes in protein and nucleic acid structure induced by the pressurization/depressurization cycles. It may be less effective against spores than against vegetative cells unless the vessel is also heated during the processing. Relatively short cycle times less than 30 minutes) are possible with relatively large volume (>200 liters). Minimal damage to foodstuffs is claimed, so it is likely that typical mail items will also be undamaged by the process. However, items containing air (Styrofoam packing peanuts, air cushions, etc.) will be crushed by this treatment.

Availability/Development Status

The technology is not currently commercially available for application but is under development for use in the food industry. It has been demonstrated effective on both liquid and solid foods. Flow International is reported to be developing high volume, low cost vessels for the technology. The lead-time for application in a Postal Service environment is likely to be several years.

Product/Procedure-Specific Information

Currently used in development processing, UHP sterilization is reported to be non-destructive of the products upon which it is used. Depending on the mail item, this technology could be applicable to inactivate most biological agents. Regulatory issues are also an open question, other than those of occupational health and safety.

Effectiveness

This is a newly emerging technology and thus any claims for successful application in Postal Service facilities will require empirical validation of the technology. UHP has not been approved or certified for use in the food industry and should be considered a technology under development. It is under study both in the US and internationally and Flow International is developing large volume vessels for application in the food industry.

Environmental Issues

Because this technology is new, the environmental issues associated with its application in the Postal Service systems are not known at this time. There will be certain health and safety implications of using vessels pressurized to 100,000 psi that will have to be addressed and approved by OSHA, NIOSH and state regulatory agencies.

Costs

Costs for pressure treated food is estimated to be $0.03 to 0.046 per pound, based on a new plant equipped with five Flow 215-liter batch-type vessels, 330 day per year production, 90 percent production efficiency, and an 80 percent vessel loading rate. The maintenance costs are estimated to be $0.008/pound and capital costs are $0.02/pound. Utility costs are location dependent. It is expected that the costs will be similar for mail applications.

Operational

Because this technology is a long-term application, all operational considerations have not been completely analyzed.

Viability in the USPS Environment

Because of the developmental nature of this technology, the relative utility of this process in a Postal Service environment cannot be estimated at this time. If it is shown to be effective on all agents of interest to the Postal Service but non-destructive on mail items, it may be of use as an intervention technology in conjunction with specific mail handling processes. This technology may have long-term potential for application in the Postal Service.

Sterilization by Chemical Gas Phase Methods

The Postal Service has identified chlorine dioxide, ethylene oxide, methyl bromide, and ozone as candidate technologies for intervention by chemical sterilization.

E.6 Chlorine Dioxide

Technical Description

Chlorine dioxide is a gas at room temperature that can be generated from a reaction of sodium chlorite with hydrochloric acid. Chlorine dioxide is an oxidizer and reacts with a wide range of materials. It is widely used to bleach paper pulp during manufacture, and is becoming more widely used as a disinfectant for water treatment. It has recently been used as a surface sterilant for certain processed foods. Proprietary delivery methods include capturing a generation system in polymer bags and allowing the chlorine dioxide to slowly release into the bag, sterilizing its contents. Chlorine dioxide has been used as a surface sterilant in several industries and was recently used as a spatial disinfectant of a large office building that had been contaminated with *B. anthracis* spores. The physiological mode of action of chlorine dioxide in bacteria is disruption of proteins and interference with protein synthesis. It inactivates the outer protein structures of viruses.

Availability/Development Status

Chlorine dioxide as a decontaminating agent is a mature technology and is currently available in small to large-scale applications. Use of chlorine dioxide as a sterilant at the scale need by the Postal Service is a more complicated matter. Several development issues will have to be addressed before it could be used at Postal Service facilities, including developing new reaction vessels or adapting current vessels for use with the gas. Even though the gas is short-lived, care will have to be taken to render any residual harmless before the treatment vessels could be opened. Because of its reactivity, the residual could be entrained in a wastewater stream and disposed of as liquid waste. Chlorine dioxide will need to be generated onsite for large-scale applications or could be supplied in bulk cylinders by vendors for relatively small-scale applications. According to Charles Haas's testimony to the Committee on Science of the US House of representatives, the generating system used does affect the purity of the chlorine dioxide gas. This should not be the case for gas purchased in cylinders.

Product/Procedure-Specific Information

Industrial uses of chlorine dioxide include microbial control of food processing, food-equipment sanitization and wastewater and drinking water treatment. It has also been used in air duct sanitization, food processing, and to sanitize and disinfect hospitals. The need for Postal Service mail sterilization by chlorine dioxide or other gas will be a specialty requirement best handled by

approved vendors familiar with the hazards of the gas. Sterilization of mail using ClO_2 will require large quantities of the gas so long-term utilization will be an issue. An additional issue is the fact that chlorine dioxide is reactive and can break down to more reactive chlorine gas.

Effectiveness

The Food and Drug Administration (FDA) has approved the use of chlorine dioxide as a disinfectant for use in the food service industry and as a surface sterilant for processed foods. The Environmental Protection Agency (EPA) has approved its use for a water disinfectant but its use as a mail sterilant is novel and will require study before regulatory approval would be granted. The EPA has published tables of microorganism inactivation by chlorine dioxide as affected by exposure time, temperature, concentration and pH of the water being treated. Applying such performance indicators to bulk mail sterilization would be the first step in evaluating chlorine dioxide for gas-phase intervention. It seems unlikely that a gas phase would dependably penetrate all types of sealed mail to effectively and uniformly sterilize the contents of the mail.

Environmental Issues

OSHA sets maximum allowable levels of chlorine dioxide exposure by workers while the EPA and state regulatory agencies would regulate air release of the gas. Potential short-term environmental effects are likely if gas escapes containment when used in facility. Another issue that may affect whether the gas can be used effectively for mail sterilization is the need for relatively high humidity levels to maximize the gas's efficiency as a sterilant. High humidity levels may damage the mail being processed. The gas is an irritant to eyes, lungs and skin and concentrations in excess of 5 ppm are considered immediately dangerous to life and health.

Costs

A breakout of actual costs associated with the chlorine dioxide decontamination of the mail at the Brentwood and Trenton Postal facilities are not yet available. Only aggregate costs of the facility decontamination and processing of mail for subsequent irradiation are available. See the appendix on decontamination for this information.

Operational

The treatment of bulk mail by a gas phase sterilant will have several operational impacts the foremost of which will be the addition of a new step in the process. Protection of workers and assurance of adequate degassing of mail will likely complicate mail processing and increase time required. It will require training of workers and monitoring of successful off-gassing.

Viability in the USPS Environment

Gas phase sterilization does not appear to be a viable technology for intervention, because of unproven effectiveness, the need for monitoring of off-gassing, and the potential health concerns.

E.7 Ethylene Oxide

Technical Description

Ethylene oxide is a sterilant gas that can be used in bulk delivery sterilizers (similar to autoclaves) or in specialized packages using premeasured volumes of ethylene oxide. It is widely used to sterilize medical equipment and heat-labile materials and has been used successfully as a sterilant in the medical industry for years. Widely used as a fumigant for

delicate or rare objects and books. The physiological mode of action of ethylene oxide in bacteria and viruses is by alkylation of proteins, disrupting protein function and inactivating cells and viruses.

Availability/Development Status

Ethylene oxide as a sterilant is a mature technology that is currently available through a variety of vendors from small to large scale. Large-scale application such as facility sterilization will be problematic because of the off-gassing requirements after the sterilization process. Significant permits and emissions requirement would affect the implementation of the technology. A long lead-time would be needed before this technology could be implemented at Postal Service facilities.

Product/Procedure-Specific Information

Industrial uses of ethylene oxide include sterilization of hospital equipment and supplies, especially items that cannot be subjected to heat and/or pressure, such as fiber-optic scopes. Gas purity will not be an issue as it will be the responsibility of the vendor.

Effectiveness

While certified for use in medical device sterilization applications by the FDA, use as a mail sterilant would be a new application subject to evaluation for the specific requirements. It seems unlikely that a gas phase could dependably penetrate all types of sealed mail to effectively and uniformly sterilize the contents of the mail.

Environmental Issues

Bulk use ethylene oxide will trigger air quality permit requirements, including Clean Air Act requirements. Further, because of the flammability and potential carcinogenicity of the compound, there may be even more severe regulatory constraints on its use. It is an irritant to the eyes, lungs, and skin. There may be reproductive issues with women exposed to very low levels of the compound.

Costs

This is a data gap. The costs associated with all aspects of the use of ethylene oxide will be high considering the quantities required for bulk sterilization.

Operational

The treatment of bulk mail by a gas phase sterilant will have several operational impacts the foremost of which will be the addition of a new step in the process. Protection of workers and assurance of adequate degassing of mail will likely complicate mail processing and increase time required. It will require training of workers and monitoring of successful out-gassing.

Viability in the USPS Environment

Gas phase sterilization does not appear to be a viable technology for intervention, because of unproven effectiveness, the need for monitoring of off-gassing, and the potential health concerns.

E.8 Methyl Bromide

Technical Description

Methyl bromide is a colorless, gaseous, toxic pesticide primarily used for soil fumigation, post-harvest protection, and quarantine treatments. It is also used to control insects, nematodes, weeds, and pathogens in more than 100 crops, in forest and ornamental nurseries, and in wood products. Annually, 6 percent of the methyl bromide employed in the U.S. is used to fumigate warehouses, food processing plants, museums, antiques, and transport vehicles. When fumigating large buildings for insect control, building airways are sealed to prevent the fumigant from escaping. Methyl bromide is an effective fumigant for eukaryotic cells, and has not been used against bacteria.

Availability/Development Status

Methyl bromide is an EPA registered pesticide that has been proven effective in fumigating large buildings, including those in urban settings such as flourmills infested by insects. However, it has been identified as an ozone-depleting chemical and as such will be phased out of use in the United States by 2006. This severely limits its applicability as a potential sterilant for use by the Postal Service even if it were to prove effective against bacteria and viruses.

Product/Procedure-Specific Information

Methyl bromide is primarily used for soil fumigation, post-harvest protection, and quarantine treatments, and to control insects, nematodes, weeds, and pathogens in more than 100 crops, in forest and ornamental nurseries, and in wood products. Because of its toxicity, storage of the quantities needed by the Postal Service will create a hazard at these postal facilities.

Effectiveness

There are no documented cases of methyl bromide's efficacy in eradicating anthrax. In a case where methyl bromide was used to decontaminate harvesting equipment of karnalbunt (a fungal disease of wheat), only 90 percent of the fungal spores were eliminated. The efficacy of methyl bromide depended on the life cycle of the spores. Methyl bromide was most effective on germinating spores. Its effectiveness as a nematocide is well documented, however.

Environmental Issues

Methyl bromide vapors are toxic; inhalation causes dizziness, headache, nausea, vomiting, abdominal pain, mental confusion, tremors, convulsions, pulmonary edema, and coma. Death from respiratory or circulatory collapse may occur. Human exposure to this compound is clearly not acceptable. In addition, it has been identified as an ozone-depleting chemical and as such will be phased out of use in the U.S. by 2006.

Costs

Methyl bromide is widely available and at a low cost now. As the date approaches for its phase out and discontinuance, it is expected that costs will increase.

Operational

The treatment of bulk mail by a gas phase sterilant will have several operational impacts the foremost of which will be the addition of a new step in the process. Protection of workers and assurance of adequate degassing of mail will likely complicate mail processing and increase time required. It will require training of workers and monitoring of successful out-gassing. Routine treatment of mail with methyl bromide would require heroic measures to avoid any possibility of human exposure.

Viability in the USPS Environment

Gas phase sterilization does not appear to be a viable technology for intervention, because of unproven effectiveness, the need for monitoring of off-gassing, and the potential health concerns. The phaseout of methyl bromide as an allowable chemical precludes its further consideration.

E.9 Ozone

Technical Description

Ozone, O_3, is a strong, naturally occurring oxidizing agent with a long history of safe use in disinfection of municipal water, process water, bottled drinking water, and swimming pools. More recent applications include treatment of wastewater, water theme parks, and home spas. Ozone is formed by high energy-induced splitting of the O_2 (oxygen) molecule. Singlet oxygen rapidly combines with available O_2 to form the reactive O_3 form. In nature, ozone is formed by UV irradiation and lightning discharges; commercial generators use high electrical voltage to form ozone.

Studies on the sporicidal action of ozone indicate that spores of *Bacillus* spp. are more susceptible to ozone than to hydrogen peroxide, and at 10,000-fold lower concentration (Int J Food Microbiol 2001, 71[2-3]:131-8). The outer spore coat layers were found by electron microscopy to be the probable site of action of ozone.

According to EPA, ozone has been extensively used for water purification, but ozone chemistry in water is not the same as ozone chemistry in air. High concentrations of ozone in air, when people are not present, are sometimes used to help decontaminate an unoccupied space from certain chemical or biological contaminants or odors (e.g., fire restoration). However, little is known about the chemical by-products left behind by these processes. Vendors claim ozone kills mold spores; however there does not appear to be definitive information about its efficacy against anthrax.

Availability/Development Status

There are numerous vendors of ozone generator.

Product/Procedure-Specific Information

Ozone is used to disinfect municipal water, bottled drinking water, swimming pool water, cooling towers, hospital water systems and equipment, and aquarium water. OSHA limits exposure to ozone to 0.1 ppm for continuous exposure during an 8 hr time period and 0.3 ppm for a 15-minute time period. At 1 ppm ozone is irritating to the eyes and throat. Unstable in water, ozone decomposes to oxygen with a half-life of about 20 minutes. Thus, maintaining effective concentrations may be difficult.

Effectiveness

Ozone is an effective disinfectant of water and may be an effective gaseous sterilant. Ozone has 1.5 times the oxidizing potential of chlorine and 3,000 times the potential of hypochlorous acid. Antimicrobial action times are about 4-5 times less than chlorine. There are a number of scientific reports that indicate sporicidal activity of ozone. However, the effect of ozone on *Bacillus* spores varies depending upon the strain. Ozone could harm or destroy components of mail processing equipment, due to its properties as a strong oxidant.

Environmental Issues

Exposure to high concentrations of ozone may cause severe irritation of the respiratory tract and eyes. Ozone is a benchmark of air pollution in urban areas. Exposure standards are set at about 0.1 ppm. EPA approval would presumably be required for use.

Costs

Operating costs are estimated to be around $1,000 per lb. of O_3 but it is not clear what the usage rates will be, thus no firm estimate can be provided at this time.

Operational

The treatment of bulk mail by a gas phase sterilant will have several operational impacts the foremost of which will be the addition of a new step in the process. Protection of workers and assurance of adequate degassing of mail will likely complicate mail processing and increase time required. It will require training of workers and monitoring of successful out-gassing.

Viability in the USPS Environment

Gas phase sterilization does not appear to be a viable technology for intervention, because of unproven effectiveness, the need for monitoring of off-gassing, and the potential health concerns.

Appendix F

Decontamination

Decontamination of facilities and mail involves the inactivation of bioagents after they have been discovered or identified in the mail or in a facility. Decontamination of mail involves the sterilization of selected items of mail, which have been identified as being contaminated. It is essentially the same process as intervention, the sterilization of bulk mail, except that it will be applied selectively to mail that is pre-identified as contaminated. The above evaluation of technologies for intervention in Appendix E is thus equally applicable to decontamination of mail and will not be repeated here. This appendix, therefore, summarizes the evaluation of technologies for decontamination of facilities after contamination has been detected within the facility.

Of the two types of sanitization technologies evaluated in Appendix E, irradiation was found to be most applicable to intervention, because of its ability to penetrate bulk mail in a focused exposure scenario. Similarly, irradiation will be the most effective for decontamination of mail.

For decontamination of facilities, the converse would seem true. Namely, gas phase sanitization is the most viable and irradiation technologies are not conceptually viable for facility treatment. This is because contamination of facilities occurs by the migration of contaminants from the source to accessible surfaces, so that the contamination is exposed on surfaces. Irradiation is low viability because it is not feasible to irradiate an entire facility and all surfaces available to the diffusion of airborne contaminants. In contrast, gas phase treatment allows the sterilant to occupy a facility and to reach all available surfaces.

Because of the low conceptual viability of irradiating facilities, the irradiating technologies will not be evaluated further for decontamination of facilities. This appendix will evaluate chemical gas phase technologies for the decontamination of facilities.

F.1 Chlorine Dioxide

Technical Description

Chlorine dioxide is a gas at room temperature that can be generated from a reaction of sodium chlorite with hydrochloric acid. Chlorine dioxide is an oxidizer and reacts with a wide range of materials. It is widely used to bleach paper pulp during manufacture, and is becoming more widely used as a disinfectant for water treatment. It has recently been used as a surface sterilant for certain processed foods. Proprietary delivery methods include capturing a generation system in polymer bags and allowing the chlorine dioxide to slowly release into the bag, sterilizing its contents. Chlorine dioxide has been used as a surface sterilant in several industries and was recently used as a spatial disinfectant of a large office building that had been contaminated with *Bacillus anthracis* spores. The physiological mode of action of chlorine dioxide in bacteria is disruption of proteins and interference with protein synthesis. It inactivates the outer protein structures of viruses.

Availability/Development Status

Chlorine Dioxide as a decontaminating agent is a mature technology and is currently available in small- to large-scale applications. Use of chlorine dioxide as a sterilant at the scale need by the Postal Service is a more complicated matter. Several development issues will have to be addressed before it could be used at Postal Service facilities, including developing new reaction vessels or adapting current vessels for use with the gas. Even though the gas is short-lived, care will have to be taken to render any residual harmless before the treated facilities could be accessed. Because of its reactivity, the residual could be entrained in a wastewater stream and

disposed of as liquid waste. Chlorine dioxide could be generated onsite for specific applications or could be supplied in bulk cylinders by vendors, depending on usage. According to Charles Haas's testimony to the Committee on Science of the US House of representatives, the generating system used does affect the purity of the chlorine dioxide gas. This would not be the case for gas purchased in cylinders.

Product/Procedure-Specific Information

Industrial uses of chlorine dioxide include microbial control of food processing, food-equipment sanitization and wastewater and drinking water treatment. It has also been used in air duct sanitization, food processing, and to sanitize and disinfect hospitals. The need for Postal Service facility sterilization by chlorine dioxide or other gas will be a specialty requirement best handled by approved vendors familiar with the hazards of the gas. Sterilization of mail using chlorine dioxide will require large quantities of the gas so long-term utilization will be an issue. An additional issue is the fact that chlorine dioxide is reactive and can break down to more reactive chlorine gas.

Effectiveness

The Food and Drug Administration (FDA) has approved the use of chlorine dioxide as a disinfectant for use in the food service industry and as a surface sterilant for processed foods. The Environmental Protection Agency (EPA) has approved its use for a water. The decontamination of the Senate office building with chlorine dioxide was apparently successful, and decontamination of Trenton and Brentwood facilities by this same technology is in progress. Further evaluation of the lessons learned from these scenarios is an important part of the future use of chlorine dioxide in facility decontamination.

Environmental Issues

OSHA sets maximum allowable levels of chlorine dioxide exposure by workers while the EPA and state regulatory agencies will regulate air release of the gas. Potential short-term environmental effects are likely if gas escapes containment when used in facility. The gas is an irritant to eyes, lungs and skin and concentrations in excess of 5 ppm are considered immediately dangerous to life and health. Adequate degassing of facilities must be assured before they can be re-entered.

Costs

As of the date of this report, the additional cost for decontaminating the Brentwood and Trenton facilities is estimated to be $80 million. This is a total cost, including building and other infrastructure preparation, gassing and testing, and also preparing contaminated mail for shipment to irradiation facilities.

Operational

A major operational impact of the decontamination of facilities by gas phase sterilants is the requisite shutdown of the facility. The facility cannot be reopened until the decontamination of the bioagent and the successful degassing of the chlorine dioxide have been shown to be complete. Additional operational issues may become obvious from the experience with this decontamination technology at the Trenton and Brentwood facilities and at the Hart Senate Office Building. Careful documentation and evaluation of the experience in decontaminating these facilities will provide valuable insight into the operational impact of this technology.

Since chlorine dioxide has been used in decontamination of the Hart Senate Office Building, and will be used for decontamination of Postal facilities at Trenton and Brentwood, there is both precedent and real time data to learn from in the future application of this technology to facility decontamination.

F.2 Ethylene Oxide

Technical Description

Ethylene oxide is a sterilant gas that can be used in bulk delivery sterilizers (similar to autoclaves) or in specialized packages using premeasured volumes of ethylene oxide. It is widely used to sterilize medical equipment and heat-labile materials and has been used successfully as a sterilant in the medical industry for years. It is also widely used as a fumigant for delicate or rare objects and books. The physiological mode of action of ethylene oxide in bacteria and viruses is by alkylation of proteins, disrupting protein function and inactivating cells and viruses.

Availability/Development Status

Ethylene oxide as a sterilant is a mature technology that is currently available through a variety of vendors from small to large scale. Large-scale application such as facility sterilization will be problematic because of the off-gassing requirements after the sterilization process. Significant permits and emissions requirement will affect the implementation of the technology. A long lead-time will be needed before this technology can be implemented at Postal Service facilities.

Product/Procedure-Specific Information

Industrial uses of ethylene oxide include sterilization of hospital equipment and supplies, especially items that cannot be subjected to heat and/or pressure, such as fiber-optic scopes. Gas purity will not be an issue as it will be the responsibility of the vendor.

Effectiveness

While certified for use in medical device sterilization applications by the FDA, use as a facility decontaminant will be a new application subject to evaluation for the specific requirements.

Environmental Issues

Bulk use ethylene oxide will trigger air quality permit requirements, including Clean Air Act requirements. Further, because of the flammability and potential carcinogenicity of the compound, there may be even more severe regulatory constraints on its use. It is an irritant to the eyes, lungs, and skin. There may be reproductive issues with women exposed to very low levels of the compound.

Costs

This is a data gap. The costs associated with all aspects of the use of ethylene oxide will be high considering the quantities required for bulk sterilization.

Operational

A major operational impact of the decontamination of facilities by gas phase sterilants is the requisite shutdown of the facility. The facility cannot be reopened until the decontamination of

the bioagent and the successful degassing of the ethylene oxide have been shown to be complete.

Viability in the USPS Environment

There is now a precedent for the gas-phase decontamination of facilities because chlorine dioxide has been used in decontamination of the Hart Senate Office Building and will be used for decontamination of postal facilities at Trenton and Brentwood. Ethylene oxide seems less viable than chlorine dioxide at this point however, simply because of the precedent for chlorine dioxide.

F.3 Methyl Bromide

Technical Description

Methyl bromide is a colorless, gaseous, toxic pesticide primarily used for soil fumigation, post-harvest protection, and quarantine treatments. It is also used to control insects, nematodes, weeds, and pathogens in more than 100 crops, in forest and ornamental nurseries, and in wood products. Annually, six percent of the methyl bromide employed in the U.S. is used to fumigate warehouses, food processing plants, museums, antiques, and transport vehicles. When fumigating large buildings for insect control, building airways are sealed to prevent the fumigant from escaping. Methyl bromide is an effective fumigant for eukaryotic cells, and has not been used against bacteria.

Availability/Development Status

Methyl bromide is an EPA registered pesticide that has been proven effective in fumigating large buildings, including those in urban settings such as flourmills infested by insects. However, it has been identified as an ozone-depleting chemical and as such will be phased out of use in the United States by 2006. This severely limits its applicability as a potential sterilant for use by the Postal Service even if it were to prove effective against bacteria and viruses.

Product/Procedure-Specific Information

Methyl bromide is primarily used for soil fumigation, post-harvest protection, and quarantine treatments, and to control insects, nematodes, weeds, and pathogens in more than 100 crops, in forest and ornamental nurseries, and in wood products. Because of its toxicity, storage of the quantities needed by the Postal Service will create a hazard at these postal facilities.

Effectiveness

There are no documented cases of methyl bromide’s efficacy in eradicating anthrax. In a case where methyl bromide was used to decontaminate harvesting equipment of karnalbunt (a fungal disease of wheat), only 90 percent of the fungal spores were eliminated. The efficacy of methyl bromide depended on the life cycle of the spores. Methyl bromide was most effective on germinating spores. Its effectiveness as a nematocide is well documented, however.

Environmental Issues

Methyl bromide vapors are toxic; inhalation causes dizziness, headache, nausea, vomiting, abdominal pain, mental confusion, tremors, convulsions, pulmonary edema, and coma. Death from respiratory or circulatory collapse may occur. Human exposure to this compound is clearly not acceptable. In addition, it has been identified as an ozone-depleting chemical and as such will be phased out of use in the United States by 2006.

Costs

Methyl bromide is widely available and at a low cost now. As the date approaches for its phase out and discontinuance, it is expected that costs will increase.

Operational

A major operational impact of the decontamination of facilities by gas phase sterilants is the requisite shutdown of the facility. The facility could not be reopened until the decontamination of the bioagent was shown be complete, and the successful degassing of the methyl bromide is shown to be complete.

Viability in the USPS Environment

Methyl bromide has been widely used for decontamination of buildings. However, its lack of demonstrated effectiveness against bacteria and its status as an ozone-depleter and scheduled phaseout preclude its viability for further consideration for decontamination of postal facilities.

F.4 Ozone

Technical Description

Ozone, O_3, is a strong, naturally occurring oxidizing agent with a long history of safe use in disinfection of municipal water, process water, bottled drinking water, and swimming pools. More recent applications include treatment of wastewater, water theme parks, and home spas. Ozone is formed by high energy-induced splitting of the O_2 (oxygen) molecule. Singlet oxygen rapidly combines with available O_2 to form the reactive O_3 form. In nature, ozone is formed by UV irradiation and lightning discharges; commercial generators use high electrical voltage to form ozone.

Studies on the sporicidal action of ozone indicate that spores of *Bacillus* spp. are more susceptible to ozone than to hydrogen peroxide, and at 10,000-fold lower concentration (Int J Food Microbiol 2001, 71[2-3]:131-8). The outer spore coat layers were found by electron microscopy to be the probable site of action of ozone.

According to EPA, ozone has been extensively used for water purification, but ozone chemistry in water is not the same as ozone chemistry in air. High concentrations of ozone in air, when people are not present, are sometimes used to help decontaminate an unoccupied space from certain chemical or biological contaminants or odors (e.g., fire restoration). However, little is known about the chemical by-products left behind by these processes. Vendors claim ozone kills mold spores; however there does not appear to be definitive information about its efficacy against anthrax.

Availability/Development Status

There are numerous vendors of ozone generator.

Product/Procedure-Specific Information

Ozone is used to disinfect municipal water, bottled drinking water, swimming pool water, cooling towers, hospital water systems and equipment, and aquarium water. OSHA limits exposure to ozone to 0.1 ppm for continuous exposure during an 8 hour time period and 0.3 ppm for a 15-minute time period. At 1 ppm ozone is irritating to the eyes and throat. Unstable in water, ozone decomposes to oxygen with a half-life of about 20 minutes. Thus, maintaining effective concentrations may be difficult.

Effectiveness

Ozone is an effective disinfectant of water and may be an effective gaseous sterilant. Ozone has 1.5 times the oxidizing potential of chlorine and 3,000 times the potential of hypochlorous acid. Antimicrobial action times are about 4-5 times less than chlorine. There are a number of scientific reports that indicate sporicidal activity of ozone. However, the effect of ozone on *Bacillus* spores varies depending upon the strain. Ozone could harm or destroy components of the mail, due to its properties as a strong oxidant.

Environmental Issues

Exposure to high concentrations of ozone may cause severe irritation of the respiratory tract and eyes. Ozone is a benchmark of air pollution in urban areas. Exposure standards are set at about 0.1 ppm. EPA approval will presumably be required for use.

Costs

Operating costs are estimated to be around $1,000 per lb. of O_3 but it is not clear what the usage rates will be, thus no firm estimate can be provided at this time.

Operational

A major operational impact of the decontamination of facilities by gas phase sterilants is the requisite shutdown of the facility. The facility could not be reopened until the decontamination of the bioagent was shown be complete, and the successful degassing of the ozone is shown to be complete.

Viability in the USPS Environment

Facility decontamination with Ozone does not appear viable at this point because of the lack of demonstration of effectiveness against anthrax spores and possible damage to mail equipment due to its strong oxidizing properties.

F.5 Paraformaldehyde

Technical Description

Paraformaldehyde or polymerized formaldehyde, is obtained by concentrating formaldehyde solution. Paraformaldehyde powder when depolymerized by heat produces formaldehyde gas. After treatment, the gas is rapidly dissipated by aeration.

As a fumigant, paraformaldehyde permeates space and kills all viable microbial forms of life. Past uses of paraformaldehyde include sterilizing surfaces and detoxification. It is known to eliminate *Bacillus anthracis* and other infectious agents and toxins. Paraformaldehyde is used internationally in hospitals, biomedical, veterinary, pharmaceutical, research organizations, and universities. Formaldehyde gas is widely used in the poultry industry.

Availability/Development Status

Paraformaldehyde is widely used as a disinfectant. For sterilization, formaldehyde gas exposure for 16 hours at a concentration of 1.0 mg/liter at 40 to 60 percent relative humidity, ambient temperature, is recommended. Information about the effectiveness of formaldehyde is available in fact sheets were developed by Timothy P. Gouger (U.S. Army Corp of Engineers) and Manuel S. Barbeito (Industrial Health and Safety Directorate, U.S. Army, Ft. Detrick, MD).

Product/Procedure-Specific Information

Formaldehyde gas is used for disinfecting sickrooms, clothing, linen, and sickroom utensils. It is also used as a fumigant. It is used internationally in hospitals, biomedical, veterinary, pharmaceutical, research organizations, and universities.

Effectiveness

Paraformaldehyde has been proven effective in eliminating infectious pathogens and poses no significant health risks when properly used. In an experiment performed by Taylor, Barbetto, and Gremillon, formaldehyde gas treatment was completely successful in sterilizing facilities, materials, and equipment of several organisms, including *C. botulinum*, in a lab environment. There seemed to be no problems of repolymerization or other residual when the concentration and humidity were controlled. Mechanical, electronic, and optical equipment showed no visible operational effects as a result of treatment.

Environmental Issues

There are toxicity issues with regard to human exposure. Due to the carcinogenic and toxic nature of paraformaldehyde, the facility must have a specially designed ventilation system. The US EPA classifies formaldehyde as a group B1, probable human carcinogen of medium carcinogenic hazard. Breathing in contaminated air can be extremely irritating to the eyes, skin and mucus membranes of the upper respiratory tract and can cause nausea and vomiting. Pulmonary edema, allergic respiratory and skin reactions have also been reported.

Costs

Cost information has not yet been developed for this item.

Operational

In addition to the operational impact of shutting down the facility for decontamination by paraformaldehyde, the carcinogenic and toxic nature of paraformaldehyde requires that facilities using this method of disinfection must have specially designed ventilation systems and are subject to air monitoring requirements.

Viability in the USPS Environment

Paraformaldehyde fumigation as a means of facility decontamination is not viable for USPS because of its status as a carcinogen.

Appendix G

Investigation

Following the October 2001 incidents in which anthrax spores were sent through the mail, the Postal Service initiated multiple investigations. The Postal Service is evaluating technologies and procedures to provide both near-term and intermediate-term enhancements to improve our investigative capabilities. This appendix summarizes the technologies and initiatives that are being considered or are in development.

G.1 Image Capture and Analysis

Technical Description

The Postal Service plans to review both technologies and procedures to improve our investigative capabilities in the areas listed below.

- Increase the information available to support post-incident investigations of mail-based attacks.
- Guard against future attacks by identifying suspect letter mail using established criteria.

The Postal Service has technologies in place that can be used as baselines for developing and implementing capabilities to improve our investigative capability. Current mail processing systems include the optical character reader (OCR) processes that are used to capture an image from a piece of mail, analyze the image, and determine the delivery point for that piece of mail. All images are then discarded after the delivery point analysis of the piece of mail has been completed. While Facing Identification Mark (FIM) mail in the collection mail stream is not imaged (20 to 30 percent of collection mail), the remainder of the collection mail does have its image captured and saved.

The Postal Service is reviewing enhancements to its existing systems so that collected images will be saved in on-line databases. The Postal Service is also evaluating plans to develop enhancements that can provide more analysis of the content of the mail images.

To develop these enhancements, the Postal Service is putting together a three-phase plan for implementing the capabilities to scan, capture, save, and analyze mail images that have been read as part of the Postal Service's mail processing system.

In Phase I of the effort, the Postal Service plans to evaluate technologies to provide the following capabilities:

- Scan all letter mail images as an integral part of mail processing on each of the AFCS, MLOCR, and DIOSS processing/recognition systems utilizing the current MLOCR type camera.
- **Save all scanned images to on-line databases.**
- **View and retrieve selected images based on ZIP Code or ID Tag over secure Postal Service computers and the Postal Service data network.**

Develop software to manage the databases, and to delete images that are more than 30 days old.

Phase II of the initiative adds an evaluation of technologies and procedures for real-time/on-line analyses of scanned mail images. The Postal Service will establish criteria to determine if a mailpiece should be categorized as "suspect" mail. During real-time/on-line analyses, mailpieces

that satisfy the established criteria for "suspect" mail will be segregated from the normal mail flow and diverted into separate bins for subsequent security analysis.

Phase III of the initiative includes implementation of on-line analysis of the handwriting on mailpieces. The Postal Service will expand the list of "suspect" mail criteria by including automated handwriting analysis software to evaluate all mailpieces with visible handwriting. Mailpieces that satisfy the handwriting analysis criteria would be diverted to separate bins for subsequent evaluation.

Availability/Development Status

The availability of a Phase I system will be driven by the prototype testing results, performance issues, and the reliability of the image analysis processing. A prototype of the Phase I system has been installed in Monmouth, NJ. Postal Service organizations, including the Inspection Service, Engineering, and operations support staff are involved in its evaluation. Technical and performance improvements resulting from the operational evaluation of the prototype and laboratory testing, where required, will be incorporated into the system as part of the production process.

The Postal Service will develop schedules for testing, evaluation, deployment, and installation of systems based on the operation and testing of the prototype system(s). In production, the Postal Service estimates that the equipment could be deployed to 350 sites at a rate of about 40 systems per week.

Phases II and III of the initiative will require additional development and testing to determine if Postal Service criteria can be met. Criteria include performance goals, reliability, impacts on production processing, false selections (errors), compatibility with existing systems, and alternative technologies.

The Postal Service projects that system development for Phases II and III will take 6 to 12 months. The estimate to deploy is 8 to 12 months.

Product/Procedure-Specific Information

The Postal Service has a prototype system installed. Product specific information will be developed based on final equipment configurations.

For Phase I, procedure specific information will be developed to minimize impacts on production systems. For Phase II and Phase III, procedure specific information will be application specific since processing flows will be interrupted.

Effectiveness

The Postal Service estimates the proposed systems will provide the capability to capture approximately 70 to 80 percent of the collection or anonymous mail.

Environmental Issues

There are no known environmental issues for this system. The systems are electronic with few mechanical components. With these systems, the Postal Service could potentially identify hazardous mail and provide an excellent investigative tool.

Costs

The Postal Service developed the following initial cost estimates based on deployment to 350 sites for each phase of this initiative. These estimates do not include facility costs or indirect personnel costs, which will be developed during the pilot tests.

Phase 1 - $57,150/site - $20 million for program
Phase II – $160,000/site - $56 million program
Phase III - $160,000/site - $56 million program

Operational

The development of these systems will have impacts on the following components at the 350 projected sites:

- Servers (Phases I, II, III)
- Storage capacity (Phases I, II, III)
- Facility space (Phases II, III)
- Staff requirements (possibly Phases II, III)
- Production volume (possibly Phases II, III)
- Communications channels/capacities (Phases I, II, III)

Viability in the USPS Environment

The Postal Service believes the system is viable, and the impact on mail processing systems will be minimal.

G.2 Wide Field of View (WFOV) Camera

Technical Description

The Postal Service currently uses Wide Area Bar Code Readers (WABCR) to read POSTNET and PLANET bar codes on the following machines:

- **MLOCR/DIOSS**
- **DBCS**
- **CSBCS**

The current WABCR cameras do not have the capability to capture the full mailpiece image and are not viable for reading IBI codes. The Postal Service believes that to implement an effective image-scanning technology, 100 percent of the full mailpiece image of the address side of the mailpiece must be captured. Fortunately, the Postal Service recently awarded a contract to purchase replacement Wide Field of View (WFOV) cameras. These WFOV cameras will replace the bar code readers on letter mail processing equipment and are being considered for mailpiece tracking.

These cameras will be used to capture complete images for the Postal Service's bar code recognition processes.

The WFOV cameras produce high-resolution images and can be used to process IBI codes in addition to POSTNET and PLANET codes. The WFOV camera technology provides the following image characteristics:

- High-resolution gray scale image, 256 pixels per inch suitable for OCR
- Binary image available
- Full mail piece height (6.25 inches) image capture

- Currently processes POSTNET/PLANET, IBI (PDF417, DataMatrix)
- Other bar code processors can be added

Availability/Development Status

A contract was awarded in December 2001 for the production of WFOV advanced camera systems for nationwide deployment in Postal Service facilities. Initial production testing and evaluation of these camera systems is planned for May 2002.

Product/Procedure-Specific Information

The technical features of the camera systems are identified above. The WFOV camera system provides the capability to capture additional data (IBI codes) as a mailpiece is processed to aid with the mailpiece tracking.

Effectiveness

The WFOV camera systems provide the Postal Service with new capabilities for identifying specific mailpieces and for mailpiece tracking in a revenue protection environment. While it is a new technology, the system is an upgrade, so its effectiveness is estimated to be high.

Environmental Issues

There are no direct environmental issues. The WFOV camera systems are electronic (no film involved).

Costs

Low risk as this program is already funded by the Postal Service.

Operational

Low risk as the operational impacts were reviewed and addressed prior to the production contract award.

Viability in the USPS Environment

Initial testing and evaluation of the candidate systems indicate that the WFOV camera systems are compatible with existing Postal Service operational bar code reading capabilities. In addition, the technology is a viable tool that can be used as an investigative tool.

G.3 MailPiece Tracking

Technical Description

The Postal Service currently uses mail-tracking technologies that provide the capability to uniquely identify collection mailpieces that are deposited in the postal mail stream by the general public. This technology uses one or more bar codes and the POSTNET code, which consist of the destination ZIP Code. When a piece of letter mail enters the automated mail handling system at a postal processing facility, a unique identification barcode (ID tag) is physically applied to the mailpiece. The ID tag is a unique identifier used to correlate a scanned image analysis result with the physical mailpiece. The ID tag is also used by a mail tracking system to trace the path of each mailpiece as it moves through subsequent automated mail processing systems.

Mailings that originate with businesses (large mailers) are drop shipped to Bulk Mail Entry Units. While these mailings have less anonymity than pieces arriving from the collection mail stream, drop shipped mailpieces do not receive an ID tag. Mailers, working with the Postal Service, can apply a second bar code, the PLANET bar code, to enable tracking. The PLANET code together with the POSTNET and other information presented at the time the mailpiece enters the Bulk Mail Entry Unit can provide the unique tracking of mailpieces.

These mail tracking capabilities can be further enhanced with additional information available with the implementation of the new WFOV cameras. Bar code systems that receive the WFOV cameras will be capable of reading mailer applied two-dimensional bar codes. The two-dimensional bar code provides the Postal Service with additional information that could be used to identify and track mailpieces that contain the mailer applied two-dimensional bar code. This additional information provides the basis for developing a refined tracking strategy for mail that originates with large business mailers.

To collect and use the additional information available from the WFOV cameras, software modifications are needed within the camera and bar code sorting systems. In addition, the existing network capacity and data storage/processing systems will need to be increased to accommodate the increase in data. This enhanced tracking strategy, when combined with a concurrent initiative to support the implementation of security standards at mailer facilities, can provide the Postal Service with increased levels of confidence that the mail stream is safer for both the Postal Service's customers and employees.

Availability/Development Status

The Postal Service has projected the following schedule for the enhanced mailpiece tracking initiative:

- WFOV camera and bar code sorting system modifications – FY 2002 - 2003
- Increased network capacity – FY 2002 - 2003
- Increased data storage/processing systems – FY 2002 - 2003

Product/Procedure-Specific Information

This initiative is based on maximizing the existing capabilities of the WFOV camera systems. Specific network and data storage issues are being studied. The Postal Service plans to model techniques to determine specific impacts on bar code sorting equipment, networks and data storage systems.

Effectiveness

This initiative is an enhancement to the current letter mail tracking system for collection mailpieces, which was initially developed for tracking mailer applied PLANET codes. Enhanced capabilities will provide the Postal Service with additional information on bulk mailings that contain the mailer applied two-dimensional bar code.

The enhanced mail tracking capabilities will require the cooperation of large mailers in applying the two-dimensional bar code. This cooperation combined with the system and network enhancements can provide the Postal Service with a passive mailpiece tracking of bar coded letters and will enhance the use of data as an investigative tool.

Environmental issues

No environmental risks are imposed on the current mail processing systems. This initiative requires the addition of equipment to production areas and existing server rooms.

Costs

The Postal Service has determined that this initiative can be achieved with the following estimated levels of spending:

- WFOV camera and bar code sorting system modifications - $4 million
- Network enhancements - $180 million
- Computing, storage and processing - $30 million

Operational

The Postal Service has undertaken the following near term efforts to support this initiative:

- The USPS Engineering Group has developed and deployed a basic data gathering system for tracking ID tag and PLANET coded mailpieces.

- The development and deployment of a more robust system that supports customer products such as CONFIRM and guarantees the availability of trace information is currently under way.

The resources needed to support this development effort will be identified during the initial pilot testing.

Viability in the USPS Environment

This initiative consists of enhancing existing capabilities. Initial evaluations of proposed enhancements indicate there will be no substantial impacts on existing technologies and procedures.

G.4 Positive Product Tracking

Technical Description

The positive product tracking Retail Security Program initiative provides the capability to uniquely identify and track retail mail and mail products at USPS retail outlets. The video image capture system links to the POS 1 retail system to capture customer images along with unique identification information for both the mail item and the customer.

The program will:

- Ensure all mail and Postal mail products are uniquely identified,
- Capture unique product identifiers and retail transaction information,
- Correlate transaction records with security camera images of Postal Service customers,
- Reduce or eliminate anonymity associated with retail mail transactions, and
- Enhance the reporting of suspicious activity mandated by federal anti money laundering laws.

This initiative, the positive product tracking System, provides the Postal Service with both enhanced investigative capabilities and with enhanced prevention capabilities (described in Appendix B).

Appendix H

Impact of Removing Collection Boxes

The Postal Service performed research on the effect of removing street collection boxes. The overall conclusion is that removing the collection boxes would create a major problem, reducing the convenience of our service for consumers and small businesses. This would damage our basic franchise with these customers; encourage them to use competitive services such as electronic bill paying and Federal Express and UPS for expedited packages.

It also would damage the perception that we are a universal service, providing convenient, safe, and secure service. It would force many customers to change their normal, daily behaviors. It would increase customers' perceptions that we do not put customers first and increase dissatisfaction with our service.

We also will be creating major problems for our commercial customers as they have built our services into their business processes. This is especially important for the financial service industry for which the basic First-Class Mail service, including the current mail collection service, is a fundamental element of the billing/payment/banking process.

As it often stated, the core processes important to our customers is the fact that we provide the "first and last mile" of the hard copy communication system. If this is fundamentally changed, our customers will have make their own fundamental changes in their processes and in their own customer relationships.

CONVENIENCE: A CORNERSTONE OF THE POSTAL BRAND

KEY LEARNINGS

1. Convenience is a key driver of customers' satisfaction and their perception of the quality of service.

2. Easy access by consumers to deposit mail is a core element of the paper check/financial payment infrastructure and a day delay in the delivery of payments represents a loss of over $1 billion in lost interest income to commercial customers.

3. Easy access for the deposit of packages is a critical feature in businesses' evaluation of the competitiveness of package services.

4. Consumers use their own home mailbox and on-street collection boxes as their normal ways to deposit mail. Depositing mail in these boxes is part of the normal behaviors for many of our consumers, similar to such basic activities as reading the newspaper or watching TV.

5. Customers will use alternative services when faced with hard to use services. And competitors will take advantage of service gaps on our part to promote their services.

6. The collection box is an icon of the basic values which the Postal Service represents: security, safety, and tradition. It represents the universal service promise of the Postal Service through its physical presence throughout the community.

CONCLUSION

The Postal Service would severely risk its franchise with consumers and small businesses if it eliminated its on-street collection service. It would force customers to change their normal mailing behavior, increase the difficulties in using our services, and adversely affect their ability to use mail to manage their normal responsibilities.

We can expect that removing on-street collection service will lead more customers to adopt electronic bill paying and use Federal Express and UPS for their expedited package shipments, especially as both Federal Express and UPS will continue to provide on-street acceptance.

The Postal Service would put at risk its basic role in providing Americans a convenient, safe, and secure way to communicate and conduct basic transactions.

We also will be creating major problems for our commercial customers as they have built our services into their business processes. This is especially important for the financial service industry for which the basic First-Class Mail service, including the current mail collection service, is a fundamental element of the billing/payment/banking process.

As it often stated, the core processes important to our customers is the fact that we provide the "first and last mile" of the hard copy communication system. If this is fundamentally changed, our customers will have make their own fundamental changes in their processes and in their own customer relationships.

ANALYSIS

The U.S. Postal Service provides American consumers and business customers with universal service through convenient access - our franchise is built on it. Our consumers depend upon the convenience and ease of use provided through a variety of channels - from obtaining stamps online or at a supermarket 24/7 to being able to mail a letter any time whether at the corner mail

box or in front of the local post office. Business customers have a similar need for convenient access, including the more consumer-oriented access along with the commercial oriented access at our larger mailing plants.

Much of our convenient access is transparent and taken for granted. There are the anecdotes about consumers not being able to mail their bills because of the limits placed on mail service in the Washington DC area as a result of the anthrax crisis and the impact this has had on both the consumers and the companies expecting to receive the payments in the mail.

As a result of the anthrax tainted letters having been sent through the mail in the fall of 2001, several ideas have been voiced by various stakeholders with the intent of preventing a further incident through enhanced security. Some of the ideas involve placing more stringent requirements on postal customers' basic mailing options, which in the end, will add burden to the customers and reduce the ease-of-use Americans have come to expect of the mail service.

This paper provides an assessment of the importance which consumers and small businesses place on having convenient access to the Postal Service and convenient service by the Postal Service. This paper is based on a review of a number of market research studies conducted in the past few years.

Convenience of Access

Convenience is provided to customers in a variety of ways. We offer a large number of postal products and services to meet their various needs for speed of service for different types of mailing materials. We deliver to every address in the U.S. and provide many places at which to deposit mail. We have almost 40,000 post offices. We have over 350,000 street collection boxes. We stop at over 110 million homes and businesses six days a week, providing customers not only universal delivery but also a convenient way to deposit mail.

We also offer wide convenience to help customers purchase stamps. In addition to the counters at the post offices, we have over 32,000 vending machines. Further, stamps are available through grocery stores and rural letter carriers.

Retail Access

In 1998, in a market research study[1] to assess the quality of our retail services with consumers and small businesses, we learned that access is a fundamental driver of the value which customers place on the service provided by the Postal Service. This research showed clearly that our customers find our retail access to be inconvenient. Customers also indicated that they perceive that the Postal Service is insensitive "to the time required to receive service." It was concluded that, if customers perceive that service is inconvenient, inconsistent, and unreliable, "it is as if the gatekeeper has closed the gateway and is urging customers to go elsewhere for service."

In a recent study consumers demonstrated strong concerns over a large-scale reduction in retail access. In a quantitative survey, 48 percent of the consumers said that they would be strongly against closing post offices nationwide while 68 percent said they would be strongly against closing the post offices near them.[2] In the qualitative portion of this research study,[3] consumers indicated that they would be willing to allow the Postal Service to be flexible in the placing of its retail post offices. They would be willing to have selected local post offices closed as long as there would be post offices in reasonable and convenient locations and as long as these post

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[1] *The USPS Competitive Value Proposition,* January 1998
[2] *Customers' Attitudes Towards Postal Service Reform & Transformation,* January 2002 Ibid
[3] Ibid

offices would be staffed to absorb the increased customer traffic and reduce already unpleasant waiting times and long lines.

In a 1999 research study in which we studied customers' attitudes and experiences with the new Automated Postal Center, customers rated the Postal Service as convenient. Around 60 percent of the customers rated the Postal Service highly convenient (5.6 on a 6-point scale).[4] A study in 1997 on Convenience and Quality of Service in Post Offices indicated that the reason consumers evaluate the post office as better on convenience than other retailers primarily is because of fast, efficient service and secondarily on having more convenient locations.[5] In terms of convenience, the majority of consumers said the post office is better or the same as their local supermarket, fast food restaurant, bank or mailing store, with one-fourth to one-third rating the post office as much better.[6]

As part of the proposals to increase security in the mail, it has been suggested that our vending equipment should accept only credit or debit cards but not cash. Our research indicates that this would seriously reduce the use of the vending equipment and therefore create more inconvenience for our customers. In a 1997 research study on customer acceptance and use of vending machines, only half (51 percent) of the consumers expressed a willingness to use Postal vending equipment that accepted only credit or debit cards. Our ongoing research indicates that those who would be discouraged from using the vending equipment would migrate to our postal counters, increasing lines and wait time for customers.[7]

It is important to recognize that the quality of retail access affects the purchase behavior of many customers. In a 1999 study of the consumers' experiences with the hours of post office service, many experienced situations in which they were not able to conduct their business due to inconvenient hours of operations. A third of the consumers in the past six months had visited a post office which was closed when they visited the post office and of these customers 19 percent went to an alternative place, i.e., a Fed Ex Center (40 percent), another place to purchase stamps (49 percent), and collection boxes (7 percent).[8]

Collection/Mail Deposit Access

Along with the need to provide retail access to purchase stamps and conduct transactions, consumers and small businesses also consider the access provided by collection boxes to be a fundamental aspect of their relationship with the Postal Service. In September 2001, in a qualitative study of the customers use and perceptions of collection boxes, it was clear that almost all consumers and small businesses use collection boxes regularly to deposit letters, post cards or small packages.[9] Some small businesses are very dependent on the collection box while only a few would prefer to go to the Post Office to deposit mail or use carrier pick up.

This research showed that the collection box is more than a piece of equipment. It is perceived as a direct and very convenient link with the Postal Service and, in many ways, represents the brand of the Postal Service in their communities. Both consumers and small businesses said that these collection boxes are important to them because they are so dependable, convenient, are there 24 hours, have no lines, and save the customers time and money.

In addition the collection box offers customers a sense of security and ultimately reduces stress. Customers said that by using the collection boxes, "I don't have to go to the post office, I can

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[4] *Automated Postal Center Baseline Results,* August 3, 1999
[5] *Consumer Opinion Survey Post Office Evaluation,* September 4, 1997
[6] *Consumer Opinion Survey Post Office Evaluation,* September 4, 1997
[7] *Consumer Opinion Survey Post Office Evaluation, September* 5, 1997
[8] *Customer Perceptions of Post Office Convenience of Hours,* April/May 1999

[9] *Brand Icon Collection Box Research, September 2001*
drop mail on my time schedule, I can get rid of a chore." By using a collection box, customers indicate that they are less stressed and feel more secured and safe.

On a deeper level, the collection box is a representative icon of the Postal Service. To many customers it portrays the positive image they have about the Postal Service as a long-standing institution of the country and our government.

In assessing the impact of removing collection boxes, it is important to understand how critical this access is for consumers. In a 1998 survey of consumers on their bill paying practices, they mailed 34 percent through their own mail receptacle at home, 10 percent through collection boxes, 7 percent at work, 21 percent at post offices.[10]

In the spring of 2001, as part of the study on Five-Day Delivery, we studied customers' reactions to a variety of concepts to reduce costs.[11] Similar to the study cited above, most consumers and small businesses do not use the post office to deposit their mail. Only 20 percent of consumers and 30 percent of small businesses use the post office to deposit their mail. Thus, removing street collection from both home mailboxes and collection boxes would require a major change in mailing behavior for customers.

Also, when asked about their preference to cutting service on Saturdays as a way to reduce costs, more consumers and small businesses would support cutting retail counter service over discontinuing mail pick up from collection boxes and at post offices. Only 27 percent of consumers and 10 percent of small businesses would prefer to discontinue mail pick up from collection boxes and at post offices while 37 percent of consumers and 21 percent of small businesses would prefer to close counter service at post offices.[12]

In addition, 38 percent of consumers felt it would be highly inconvenient to discontinue mail pick up from collection boxes and at post offices while 44 percent of consumers did not think it would be inconvenient to do so. Thus, the customers are very much split on their reaction to this type of change in service.

Reduction in the acceptance of mail through mail collection boxes and pick-up from a home or place of business would create an inconvenience for customers, reducing their use of the mails to communicate and conduct business.

Currently customers are unhappy about the operations at a number of post offices because of long lines and long transaction times.[13] Forcing customers who want to mail letters, cards, bills, and other items that could otherwise be conveniently dropped into a collection box to have to go to a post office would aggravate the situation in our retail environment by overloading the system, driving down the quality of service provided. "They (the post offices) have a line going around the building.... " (A consumer in Charlotte, NC). then why would it benefit us to stand in line for 45 minutes to use Priority Mail?" (A small business, Charlotte, NC).

A consumer in San Francisco said, "sometimes I don't take it to the Post Office even if it is $2 cheaper because you've seen the... lines at the post office. They are a mile long." (A consumer in San Francisco) A small business customer said, "I would go FedEx everytime, the FedEx box is outside. I don't have to go inside the post office and wait in line." (A small business, Ft. Lauderdale, FL).

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[10] *Origin and Destination Remittance Mail Volume,* 1998
[11] *Five Day Delivery Study,* May 2001
[12] *Five Day Delivery Study,* May 2001
[13] *FedEx Retail Agreement Study,* Spring/Summer 2001

Recently the Federal Reserve Bank of Chicago reported that over 80 percent of the 15 to 17 billion consumer bills issued annually are paid by check.[14] This represents a bill paying practice for a large portion of the population, of which a high percent of the payments are deposited in the consumers' own home mailboxes and collection boxes. In assessing the opportunity to convert these check payments to electronic payments, the Fed identified three key attributes which electronic payment systems must meet:

1. A new, electronic system must be more convenient than the current paper/mail system and "consumers do not view the traditional payment methods as overly burdensome..."
2. This new system must reduce consumers' costs.
3. This new system must provide consumers more control over the timing of the payments.

Obviously, removing collection boxes and requiring consumers to go to post offices to mail payments would be a major basis to allow the electronic payment systems to promote their services as more convenient than the paper/mail payment system as well as requiring less time to complete and send the payments (and time is money for many). This could produce an increase in the diversion of mail to electronic payments.

In the Five-Day Delivery research,[15] personal interviews with large banks indicated that any delay in the mailing of the payments by the consumers would have major financial impact. It is estimated that a one-day delay in the delivery of the payments to commercial organizations would be worth at least a billion dollars in lost interest on the float. Given that almost half of the payments by consumers are mailed in their own home mail box or collection boxes, the financial service industry would be very concerned that requiring them to go to post offices to mail payments would lead to delayed payments and thus lost income.

In very recent focus groups covering issues and opportunities on the Transformation of the Postal Service, consumers strongly rejected the concept of removal of all boxes. They are willing to allow the Postal Service to have flexibility in the placement of these boxes, but they would oppose removing all of them. They immediately saw they would lose the convenience they need and depend upon. Small businesses had very similar reactions as consumers while larger ones with service provided in office buildings would be opposed if their "building collection" service was eliminated.[16]

In addition to the serious negative impact removing collection boxes would have for our customers, limiting the collection service and the use of the letter carriers in offering pick-up service for businesses would seriously reduce the competitive value for our package services.

In a 1998 CVA Attribute Survey, the availability of collection boxes for Expedited Packages was rated as being very important, especially for small businesses (with a score of 7.55 out of a score of 10 for all businesses and a score of 7.63 for small businesses, as seen in Table 1 below). It is important to note that this feature was rated nearly as important as other features such as rates, on-call pick-up service, and payment methods.[17]

This is also important as businesses have rated our pick-up service as a service feature inferior to major competitive services. Table 2 below exhibits the results of the 2000 Expedited and Package Market Supplemental CVA survey. In the study, Priority Mail was rated lower than UPS, FedEx and Airborne on both the pick-up features.[18] However, as it relates to the availability

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[14] *Electronic Bill Presentment and Payment - Is it just a click away?,* Federal Reserve Bank of Chicago
[15] *Five Day Delivery Study,* May 2001.
[16] *Customers' Attitudes Towards Postal Service Reform & Transformation,* January 2002.
[17] *CVA Attribute Survey,* 1998.
[18] *Customer Value Analysis Supplemental Add-On Survey, 2000.*

Table 1
IMPORTANCE OF 2- AND 3-DAY SERVICE FEATURES
(Ratings on a scale of 1 -10, with 10 = Extremely Important and 1 =Not At All Important)

	Employment Size			
Service Feature	**Total**	**1-19**	**20-99**	**100+**
On-Time Delivery	9.67	9.56	9.72	9.74
Service Reliability	9.47	9.40	9.42	9.60
Scheduled Pick-Up Service	9.25	9.05	9.34	9.38
Track & Trace	9.16	8.90	9.31	9.27
Geographic Coverage	9.07	9.04	9.10	9.07
Customer Service	9.00	8.82	9.13	9.06
Rates/Price of Service	8.86	8.72	8.91	8.94
On-Call Pick-Up Service	8.58	8.44	8.61	8.68
Choice of Payment Method	7.89	7.84	7.71	8.16
Late Acceptance at Drop Off Locations	7.61	7.65	7.56	7.62
Convenient Drop Off Locations	7.56	7.59	7.77	7.29
Availability of Drop Boxes	7.55	7.63	7.54	7.49

Source: CVA Attribute Survey, September 1998.

of collection boxes, Priority Mail was rated very good on this feature in comparison to the competitors, with a score of 8.11 out of the full score of 10, as seen in Table 2 below). This Priority Mail rating was only slightly trailing behind that of FedEx, but was ahead of both UPS and Airborne. This partially explains why a large amount of Priority Mail volume is from the small business sector (51 percent business origin Priority Mail is from small businesses).

Table 2
CUSTOMER PERCEPTION RATINGS OF 2- AND 3-DAY SERVICE CARRIERS
(Ratings on a scale of 1 -10, with 10 = Excellent and 1 =Very Poor)

Service Feature	**Priority Mail**	**FedEx**	**UPS**	**Airborne**
On-time Delivery	7.47	8.79	8.35	7.81
Service Reliability	7.67	8.80	8.45	7.74
Scheduled Pick-up Service	7.92	8.69	8.78	8.32
Track & Trace	6.52	8.90	8.65	7.89
Geographic coverage	8.61	8.85	8.83	8.34
Customer Service	7.36	8.51	8.23	7.73
Price of Service	7.93	7.41	7.75	7.56
On-Call Pick-Up Service	7.60	8.62	8.38	7.90
Retail Counter Convenience	7.94	8.19	7.86	7.39
Availability of Drop Boxes	8.11	8.26	7.77	7.26

Source: Customer Value Analysis Supplemental Add-On Survey, November 2000.