A surge in federal funding combined with a perceived heightened vulnerability at the local level since September 11, 2001, is pushing personal protective technology acquisitions into new territory for many communities. Decisions regarding how personal protection technologies are identified, acquired, and used in the field vary significantly among agencies, many study participants noted. Numerous issues and concerns were raised that have implications for PPT research and development needs. This chapter addresses issues surrounding the procurement; certification; and storage, transportation, and maintenance (collectively referred to here as “logistics”) of personal protective technologies.

THE ACQUISITIONS PROCESS

Our discussions with participants uncovered some key areas of the acquisitions process that are in need of improvement: risk assessment and identification and evaluation of personal protective technology options.

Risk Assessment

Police don’t have enough chemical protection. We don’t even know what protection we need. We need information.

—Law enforcement representative

PPE is ordered according to tradition and personal preferences and is not linked to performance standards. Risk assessments are not done as part of the procurement process.

—Fire service supplier

In their discussions with RAND, participants indicated that few emergency response agencies have the resources or capabilities to conduct formal risk assessments to guide decisionmaking for PPT identification, assessment, acquisi-
tion, and deployment. In the fire service, for example, several participants claimed that protective technology acquisitions were based largely on tradition, style preferences, and inertia. Missing from the process, they noted, was an assessment of the risks that firefighters face, the protection they need, and the performance requirements for that protection. In the realm of terrorism response, the perceived threats driving PPT acquisitions are poorly characterized, and the protocols and training for PPT use are often not well developed or implemented.

An example of the uncertainties in risk assessment is the push to acquire chemical protection for terrorism response without having good models of the threat or plans for how the protection would be used. According to one participant from a major metropolitan police force, terrorism is “the biggest issue in law enforcement today. We are trying to determine what that means for us.”

**Personal Protective Technology Identification and Evaluation**

Numerous participants described identifying and evaluating protective technologies as areas of the acquisition process that needed improvement. Strong loyalties and tradition, especially within the fire service, motivated agencies to stick with the suppliers they had historically used. The municipal acquisitions process can exacerbate this situation by requiring additional justification for purchasing new or different technologies. Systematic methods for evaluating technology options are not well established.

> People are buying stuff because they think, “That’s the way it’s supposed to look.”

> —Law enforcement representative

When asked how they assess PPT performance before making an acquisition, most participants relied on information provided by suppliers or vendors. Yet, several participants were concerned that vendors’ product claims were not properly justified. One fire department leader questioned the appropriateness of marketing literature that shows firefighters standing amidst flames: “In my opinion,” he said, “it’s gone too far.”

As a result, vendor information often is backed up by personal references. This informal system of performance verification is maintained via e-mail, telephone, or encounters at conferences and meetings. Two participants noted, however, that such informal information was not always reliable because many individuals in the emergency response community are wedded to certain manufacturers and practices and are therefore biased in their opinions. In addition, while “most departments are open with their information,” a fire service
representative said, some are reluctant to report bad experiences. “It’s kept on the hush-hush,” he said. “People don’t want to point the finger.” One participant said that when he started digging into SCBA recall data, he discovered problems that were not reported by the professional media. “Nobody’s got a perfect system out there, regardless of what they say.”

Most agencies reported having review committees and conducting in-house studies and pilot trials of protective equipment, principally to check ergonomics, comfort, and the general receptiveness of the rank and file. Except for a few very large departments, most municipal agencies do not have bench-test facilities, trained analytic personnel, or funding to carry out rigorous performance assessments. Larger agencies might also hire a consultant to assist them with their PPT identification and evaluation process. Uncertainty about PPT performance was cited by two participants as a significant impediment to the diffusion of new technologies. “They want research to the nth degree,” said one participant of municipal purchasing managers’ need for thorough justification of a change in equipment.

[When acquiring new technology] it’s very typical for a department to get five different models and try them all to decide which is best. They reinvent the wheel—why should every department have to go through this?

—Fire service representative

One issue further complicating the acquisitions process is that the effectiveness of much PPT equipment remains uncertain. Among the most critical examples of PPT equipment with uncertain effectiveness is environmental hazard monitoring technologies. In talking about the surge in spending on such equipment post–September 11, one participant who is knowledgeable about fire service technology development and standards said flatly, “These guys are going out and buying stuff, and they are buying junk.” During the anthrax episodes in fall 2001, officials in one state banned the use of “smart-ticket” technology for testing suspected anthrax samples because of reliability problems, calling instead for all samples to be sent to a state laboratory for traditional culture tests.

Even technologies that are subject to rigorous standards, such as firefighter turnouts, are not regulated or monitored beyond the initial testing phase. If a defect or other problem is discovered after the technology is fielded, no regulatory or oversight agent is charged with notification or recall authority. Consequently, information about inferior performance or even catastrophic failure has not always been shared with the community. Similarly, no organization reviews PPT manufacturers’ advertising and performance claims in the way that the U.S. Food and Drug Administration reviews claims about the efficacy of drugs and medical devices.
There’s lots of junk on the market. We want a *Consumer Reports* system to rate PPT.

—Law enforcement representative

In response to these problems, many participants strongly advocated implementing objective, third-party assessments—akin to assessments by the Consumers Union and its publication *Consumer Reports*—to help guide them in their PPT evaluations and decisionmaking. To this point, the National Institute of Justice (NIJ), in conjunction with the National Institute of Standards and Technology, the InterAgency Board for Equipment Standardization and InterOperability, the U.S. Army Soldier and Biological Chemical Command, and the Technical Support Working Group, has compiled a resource guide for comparing PPT used for chemical warfare agents, toxic industrial materials, and biological agents (National Institute of Justice, 2002). This guide, one of a series of NIJ resource guides on technologies for emergency responders, offers data on duration of protection, dexterity and mobility, launderability, and use and reuse characteristics for commercially available equipment.

The NIJ guide largely comprises a detailed market survey, but it represents an important first step toward performance evaluation, given that many RAND participants indicated a need for additional information to help guide PPT acquisitions. Over the longer term (several years), the National Institute of Justice plans to subject selected protective equipment for law enforcement to laboratory testing and evaluation according to protocols to be established by the National Institute for Standards and Technology. This measure should greatly simplify the evaluation process and help address responders’ questions about suppliers’ claims concerning PPT performance.¹

**STANDARDS AND CERTIFICATION**

The NFPA, NIJ, and NIOSH standards and certification play an important role in guiding PPT acquisitions, particularly in fire protection. Despite the emphasis on high-quality standards for firefighting and other protective garments, existing standards were seen as inadequate in the areas of ergonomics and sizing. Currently, turnout clothing is designed, tested, and certified according to standards that call for testing only swatches of fabric or testing garments in a static standing position. However, firefighting entails exposures to the entire body

¹Performance evaluation of commercially available PPT is within NPPTL’s mandate, although such evaluations are restricted to technologies for which NPPTL does not develop standards or certify equipment.
and is extremely dynamic. It involves tasks such as pulling down ceilings, wielding an axe, crouching, and crawling, one participant pointed out. Addressing such concerns will require improved clothing design. One participant suggested adopting designs from sportswear manufacturers that would improve the functionality of compression and expansion areas of a garment. In addition, new testing and certification procedures will be required to adequately address problems with exposure and ergonomics.

Consistency of sizing is also a problem, especially for women, who are being sized for garments as if they are small men. “We throw an sack of potatoes on someone. If you had a more custom fit suit, it’s likely to be worn more,” one representative noted. An inadequate range of glove and boot sizes and designs was a particular area of concern for several participants. “Picking the right kind of boot for 1,000 people and then stocking enough [of them] is a logistical nightmare,” a participant said. One fire service representative went so far as to suggest the adoption of a national standard firefighting uniform, as has been done by the U.S. military and U.S. Forest Service and by national fire services in the United Kingdom, France, and Japan. Such a standard, it was argued, would reduce the vagaries of the acquisitions process and serve to push down prices. “Every city has to design its own gear,” said one participant. “Everybody and their mother has a different interpretation of what’s appropriate.”

Compared with the fire service, the emergency medical and law enforcement services have less-well-developed PPT standards and certification programs. While NIJ compiles information for a number of law enforcement technologies, it gives limited attention to biological, chemical, or respiratory protection. The absence of national bodies (analogous to NFPA) focused primarily on personal protection guidelines and standards, or even a common view of what is appropriate in these areas, contributes to the great variability in strategies for levels of personal protective equipment used. “It’s so fragmented,” said one EMS community member of the situation. Given the lack of guidance from within the profession, decisionmakers in those services turn to outside organizations, such as the North Atlantic Treaty Organization (NATO), the Occupational Safety and Health Administration (OSHA), private industries for industrial (e.g., hospital-based) safety models, or NFPA, for guidance.

Standards and certification also remain lacking for major classes of fire protection such as environmental hazard monitors and other electronic devices. NFPA has recognized this deficiency as an important issue and has recently organized a committee to address it.²

²The NFPA Committee on Electronic Safety Equipment for Fire and Emergency Services is responsible for documents on the design, performance, testing, certification, selection, care, and maintenance of electronic safety equipment used by fire and emergency services personnel.
LOGISTICS

Emergency responder organizations are acquiring more PPT—increasing the supplies of gear they already have on hand and acquiring new technologies—often with the assistance of federal and state funding. This creates a new set of questions: How do you store and maintain all this new equipment? How do you transport it? How do you outfit responders so they can operate with all this gear?

Storage, Transportation, and Outfitting

You have to gain weight to get everything on your belt.
We are getting more and more equipment every day. Sometimes too much.
—Law enforcement representatives

Many participants pointed out that personal protective equipment must be readily available when it is needed, otherwise emergency responders are unlikely to use it. “If you don’t put PPE on before you leave the barn, you won’t use it,” said one participant. Yet, as emergency responders have acquired more PPT, they have become increasingly loaded down with gear. Firefighters spoke of the desire for extra pockets, hooks, and belts to handle specialized gear. While enhanced protection was seen as being desirable, many fire and police representatives also raised concerns about their reduced effectiveness from being excessively encumbered. To this point, one department had substantially improved compliance in emergency medical response by issuing fanny packs containing an ensemble of protective gear.

Vehicles, too, are becoming increasingly crowded: Fire apparatuses are becoming increasingly full of equipment, EMS vehicles have very limited storage space, and police patrol cars typically carry cones, flares, first-aid equipment, and crowd-control gear. “We are getting to where we need a trailer on the back of the car,” said one senior law enforcement representative. Police officers mentioned that gear stored in squad cars gets knocked around and damaged and exposed to the elements, and because patrol cars often are pooled, personal protective equipment frequently gets lost. One large metro police department that participated in the RAND discussions is issuing all patrol officers Level-C hazmat gear and air-purifying respirators. “How quickly will this stuff deteriorate in a trunk that is 140 to 160 degrees?” asked one officer. Several other departments voiced similar concerns. “Gloves, gowns, and masks are supposed to be in the [squad] car,” said a representative of another major metro police force, but they often disappear. Respirator face pieces frequently get
cracked or contaminated with food. One solution being used to reduce the storage space requirements and enhance the preservation of PPT is shrink-wrapping of gear.

Where are you going to park all of this stuff?
—Fire service leader

Many communities have purchased dedicated disaster response vehicles and trailers, and many have created supplemental caches, but these solutions raise questions about how rapidly the equipment will be fielded and who will have access to it. In the case of a serious chemical event, stockpiled equipment is of no good if it is not out in the field, argued an emergency planner. When an event happens, EMS personnel typically use only what is on their vehicles, said one participant. This was a key argument supporting why one EMS service was equipping each of its first-response trucks with a large duffel bag filled with PPT for use in case of a WMD-type scenario. “You need to have it right now. Space is a hot commodity, but we are putting up with it,” said a representative of the service. In addition to acquiring equipment caches and vehicles, agencies need environmentally controlled garages and warehouses to house and maintain them—expensive capital expenditures for most municipalities. Moreover, facility costs usually are not reimbursable under state and federal PPT assistance programs.

**Maintenance and Reliability**

As emergency services acquire more gear, their maintenance and reliability costs are increasing. Having more gear in the field means more gear will break or wear out over time. Many municipal services reported buying Level-B haz-mat suits for first responders, but one group of firefighters questioned whether those suits would be serviceable after being used and then folded up and stored. A police department representative questioned the effectiveness of escape hoods and air bottles that had been stored in patrol cars for six or seven years, noting that many were overdue for testing. Another large police department listed equipment care as a real concern, noting that respiratory and chemical gear may sit in a trunk for days after being used. More-sophisticated gear, such as environmental monitoring equipment, also requires complex and expensive testing, calibration, and repair, capabilities that few departments have in house.
The cost of spare parts, such as replacement batteries to power the increasing number of electronic devices, was cited as being significant by both a fire department and a police department. Even for small-cost items, a lack of authorized funding for spare parts and repair is causing problems. For example, one police representative noted that face shields lose screws from getting knocked around in patrol cars, but no funds are available to replace them. “We don’t have money for that,” he said. Advanced medications require periodic replacement. Along those lines, a big-city medical strike team was having problems managing its pharmaceuticals inventory, leading to questions about the efficacy of the stocks on hand. One person in the team noted, “As a first responder, I would like to know that the drugs are available.”

The pace of PPT turnover is being accelerated because of management concerns about liability for equipment failures in the field and a new NFPA standard (1851) specifying procedures for PPT care, inspection, maintenance, and replacement. Training and retaining maintenance personnel can be very expensive. One participant noted that firefighters are capable of performing daily maintenance of respirators, but specialists are required to perform periodic equipment overhauls and advanced maintenance when, for example, there is a high-temperature exposure. A small-town police official said he wished his city had a “czar” to tell his department which safety equipment needed testing and maintenance.

Increasing emphasis on maintenance and reliability led several participants to call for simpler ways to inspect gear and more obvious ways to identify existing or imminent failures. An example commonly cited by numerous fire departments was the desire for easy inspection of the moisture barrier in turnouts, a concern driven by recent incidents of serious burns being caused by undetected decomposition of moisture barriers. Similarly, several manufacturers as well as fire and police departments felt that passive integrity monitors would be a valuable addition to protective equipment. Participants pointed out the utility of equipping aluminum ladders with temperature-sensitive tags that change color as conditions change to warn of potential heat damage. They felt that analogous systems would be very useful as alarms to warn the wearer of failure or expiration of components, such as turnouts, chemical-protective clothing, helmets, and respirator cartridges.

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3. A police official noted that replacement batteries for flashlights cost his department $78 apiece. A fire official complained that replacement batteries certified as intrinsically safe for the radios used in his department cost twice as much as the noncertified variety.
Care, inspection, maintenance, repair, and replacement of PPT typically are classified as operations or overhead expenses, where they compete for funding with numerous other priorities. Explicit funding of such critical tasks usually is difficult for agencies to justify to elected officials and taxpayers. Moreover, many participants wondered whether financial resources will be available for restocking PPT several years down the road after the post-9/11 concern with homeland security recedes. One participant noted that the U.S. Drug Enforcement Agency had cut back on funding for personal protection equipment and training even while operations involving drug laboratories remained a serious problem. “It’s killing us,” the participant said. “There is no money for sustainability. If you don’t build in sustainability, you are actually hurting us,” said another responder.

Given these pressures, many participants noted that PPT replacement decisions seemed to be arbitrary and not necessarily reflective of the true performance capabilities of personal protection equipment. Several participants expressed their suspicion that manufacturer-recommended service intervals and shelf lives were shorter than necessary, reflecting an interest on the part of manufacturers to reduce liability and increase sales. One police department representative cited a case in which ostensibly the same respirator cartridge was assigned a shelf life for military use that was considerably longer than that for municipal use. Rescue ropes, according to NFPA guidelines, must be cut up and discarded after a single use or after five years in storage. A fire service representative noted that inspection requirements were motivating his department to discard bunker gear before the end of the gear’s service life to avoid having to go through required inspection protocols. One very large police department reported doing periodic inspecting and testing of respirator cartridges and returning to service those batches that passed inspection. Most municipal agencies, however, do not have such capabilities or resources.
As discussed earlier in this report, the workload that emergency responders carry and the risks they encounter are changing. The number of structural fire responses is decreasing while the number of medical calls is increasing. Responders are concerned about the increasing risk of communicable diseases. Counterterrorism protection is dictating many departments’ priorities.

At the same time, the ability to assess and manage these risks is also improving as the quality of available information improves and preparation of rank-and-file emergency response workers also improves. As one technical expert noted, “There is more of an assessment function happening now compared to the past. People know more now about hazards and that there are different levels of hazards, so a fixed single standard is not reasonable.” In response, many organizations as well as individual responders are seeking more-varied levels of protection and greater flexibility (a “menu-driven” approach) in choosing among personal protection technology options for discrete hazards. Tasks with the potential for greater use of risk-specific or “tailored” PPT that were mentioned in the discussions include fire attack, ventilation, overhaul, medical emergencies, automobile accidents, urban search and rescue and technical rescue, WMD events and public decontamination, and wildland fires.

The standard-issue protection in the fire service is “universal” protection, or a single ensemble designed to protect against all anticipated hazards. Consequently, a firefighter’s protection options are maximum protection or no protection. Nonetheless, many responders said they modify their equipment and ensembles for some tasks because they felt that the maximal protection offered by their standard-issue gear was too burdensome. Because of these limited options, many responders reported being underprotected in some situations. Commenting on this point, one firefighter stated flatly that “PPE protects against death, but not disability.” A common example of underprotection that was cited is firefighters deciding to eschew SCBAs during the overhaul phase of a structural fire response. Municipal fire services (especially in the West and Southwest) are engaged in an increasing number of wildland fire events of increasing intensity as more homes and businesses are built “in the trees.”

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4 The intensity of wildland fires has increased due to the build-up of fuel caused by decades of fire suppression and, more recently, public resistance to controlled burning and thinning.
mid-size municipal department reported taking a hybrid approach to its wildland fire ensemble: mixing National Forest Service–style wildland shirts and goggles with standard structural firefighting bunker pants. Because of the high cost of equipping the entire fire department with a set of leather wildland boots, firefighters were given the option of buying and using their own. Tailoring and modifying personal protection equipment and practices are especially prevalent in the emergency medical and special operations fields, where PPT standards are less developed and greater emphasis is placed on individual responder decisionmaking.

Moving away from uniform, maximal PPT was recommended by many participants. One fire service leader recommended three clothing ensembles and a three-tiered system of respiratory protection:

- **Hot Zone:** SCBA
- **Warm Zone:** Powered APR with face piece or hood (no fit test required) to provide protection from extended exposures
- **Support Zone:** APR (fit testing required).

In addition to having tailored gear, one fire service representative recommended having interchangeable ensemble components. It would be better, the representative said, “if you could layer or mix and match” components. To this point, one manufacturer recommended a modular protection approach that was being developed in London. The proposed system starts with a station uniform and, by adding components, builds to discreet protection levels that are appropriate for emergency medical response, technical rescue, or structural firefighting.

Many individuals who participated in the RAND discussions expressly rejected the desire for risk-specific PPT in favor of universal PPT. Universal PPT, currently the standard practice in the fire service, assures a uniform and high level of protection. Proponents of universal PPT also warned that more options for protection translated to more opportunities for mistakes. A single option reduces the risk that a responder would not be familiar with its use, and it relieves responders from the need to make complex PPT decisions in what are often stressful and time-constrained environments.

Another argument proffered in opposition to tailored PPT is that hazard information often is not specific enough to select the appropriate PPT. “If you don’t have information, you don’t have the option of what PPE to use,” said one participant. Further, responders often do not have a specific task assignment until they arrive at the scene, at which point, it was argued, there is no time to select and don specific PPT. Finally, increasing the number of PPT options will result
in an increase in the amount of gear that a department must acquire, store, maintain, transport, and provide training on, which was seen as adding to an already heavy logistic burden on departments. For many departments, the decision to issue only one set of gear is strictly determined by funding constraints. However, despite opposing a tailored approach, proponents of universal PPT routinely confessed to a certain ambivalence over the situation. As expressed by one representative from a large fire department, “The problem is that there is not enough information to be sure [that alternate protection is appropriate]. Still, the present options are too limited.”

**MUTUAL AID AND INTEROPERABILITY**

The recent terrorist attacks on the United States severely taxed the capabilities of local emergency response organizations. Responders present at those events noted the importance of mutual aid and raised the need for greater PPT interoperability and standardization—especially in the case of respirators (Jackson et al., 2002). Planning for mutual aid and pooling equipment are ways that local agencies can share the preparedness burdens, complement each others’ capabilities, and lower their equipment and logistics costs. Interoperability and standardization would facilitate the sharing of equipment in the field and would facilitate the use of supplementary equipment delivered to a major event site (e.g., delivered from federal caches) by assuring compatibility with existing gear and requiring less training and fitting in the field.

> The last thing that people are standardizing is personal gear.

—Fire service leader

Despite the potential advantages of interoperable protective equipment, the organizations with which we spoke rarely coordinate their acquisitions with other services within their community or with neighboring jurisdictions to facilitate equipment sharing in a mutual-aid situation. With neighboring departments making acquisitions independent of one another, little attention is paid to their complementary strengths, sometimes resulting in unnecessary redundancy in capabilities. The local police, fire, and EMS agencies “are all buying the same stuff,” said one emergency management specialist. Meanwhile, agencies may suffer critical gaps elsewhere, noted an EMS representative.

This situation does not appear to reflect any purposeful efforts to avoid interoperability. On the contrary, when asked, most departments acknowledged that equipment compatibility and interoperability would be beneficial. Rather, the lack of PPT coordination in the emergency responder community stems from a
number of formidable impediments. Major barriers to PPT coordination and interoperability that were cited in the discussions include the following:

- Communities’ PPT purchasing cycles rarely coincide with each other and “use-it-or-lose-it” funding mechanisms deter long-term planning and coordination.
- Neighboring communities often have different purchasing power—for example, metropolitan centers may have greater buying power than small satellite communities.
- Changing of technologies often entails a major initial expense because new personal protective equipment, as well as ancillary support equipment and services, ideally must be changed throughout the entire department at the same time.
- Agencies’ well-established vendor relationships and traditions favor certain PPT practices or manufacturers that often are incompatible with the practices or equipment of neighboring organizations.
- Logistical and bureaucratic questions, such as who pays, who receives, and who stores equipment, thwart cooperation.
- There is reluctance on the part of emergency response agencies to rely on an outside agency for particular capabilities.

These barriers to PPT coordination may be compounded by the small proportion of large mutual-aid events within the spectrum of emergency responder activities. Consequently, priorities for protecting emergency responders are focused on more-common events and protection needs.

A few exceptions to this situation were mentioned in the discussions. One municipal EMS service reported purchasing the same respirators as the local fire service: Many of the EMS personnel had been trained on SCBAs in the fire service before coming to the EMS service, and the EMS service relied on the fire service to manage its respirator maintenance needs. A fire/medical service covering a large territory reported sharing technical rescue and hazmat gear with neighboring jurisdictions “so that when you get on the scene there are no surprises.” Fire departments in three neighboring cities of comparable size and economic means share responsibility for hazmat, light rescue and air utility, and USAR. Despite this cooperative effort, the agencies do not coordinate their equipment acquisitions except for those related to communications.

In general, however, coordination to enable mutual aid did not include PPT. As one participant explained, “In terms of emergency management, yes; in terms of training, yes; but in terms of PPT, we’re not there.” Several agencies did report using the same vendors as other jurisdictions in their area, but this situa-
tion occurred only because state regulations enabled them to obtain favorable prices by purchasing under the same contract.

In addition to the obstacles at the user end, several impediments to interoperability and standardization exist on the PPT supply side. First, manufacturers drive much of the PPT research and development in the emergency response field, and they have a strong financial interest in proprietary designs as a means of differentiating themselves in a crowded market and earning a return on their investment. This is particularly true given that the strict certification standards leave little room for various manufacturers to distinguish their products. When a department has made a substantial investment in a piece of proprietary technology that is functionally incompatible with competing options, it becomes difficult for that department to choose options from other suppliers, thus making that department less able to coordinate PPT acquisitions and use with neighboring jurisdictions. Many suppliers also are reluctant to promote interoperability because they wish to avoid any liability for systems over which they do not have complete design control. As one participant summed up, “The fire service is very dependent on manufacturers and manufacturers’ interpretation of what is important.”