B. Hand-held scanners for personnel

1. The name of the game: Policies and procedures

Battery-operated, hand-held metal detection devices are a very viable technology for use by schools, and most detectors on the market work quite well (exhibit 3.9). By moving the wand of a hand-held metal detector around and close to a scannee's body, the operator can fairly accurately locate sources of metal (or more accurately, sources of conductive materials) that may be on, or even in, a person's body. When a suspect area is located, the hand-held device will generally give off an annoying squeal. These devices do not have the ability to discriminate between an actual weapon and some piece of benign metal. The responsibility of the operator of the device is to judge whether the squeal he or she heard is truly suspect, then to investigate and determine the cause of it. A very common use of hand-held metal detectors is in airports, where these devices allow the security staff to more accurately locate the source of an alarm on a scannee's body, after a scannee has already walked through a portal system and caused an alarm.

Although most hand-held metal detection devices on the market work well, the hand-held metal detector is only as good as the operator using it. Some vendors and users of hand-held metal detectors say that there are only three things that need to be considered for their successful use: procedures, procedures, and procedures. A disinterested or unmotivated operator can negate much of the benefit that could be derived from a school's metal detection program. While it is not difficult to learn to use a hand-held metal detector correctly, school administrators should not underestimate the value of annual training for their operators, as well as training for staff who may be called upon to serve as backup or supplemental operators. A complete training course, including practice time, should take no more than an hour. However, on-the-job practice is definitely key in allowing the school to achieve the throughput that will be required to process students quickly.

Policies and logistics for use are also very important. Though hand-held metal detectors are affordable, it would be unusual for a school of any size to screen all students and employees each morning using only hand-held detectors. Manpower would be far and away the major cost of such an endeavor. Using a throughput rate of about two students per minute, a school would need one operator for a full hour for every 120 students. This assumes the students' arrival rate is evenly spread across 1 hour, which is not very likely.

If a school is attempting to do a complete screening of students each morning, the hand-held metal detector will more likely be used as a supplement to portal metal detectors. As in airports procedures, the hand-held detectors allow the security staff to more accurately locate the source of an alarm on a student's body, after a student has already walked through a portal system and caused an alarm.

Most schools that desire to establish some type of weapon detection effort (but less than a full-scale, every-morning, every-person effort) will set up a policy to allow random spot checks on students or complete student population scanning as deemed necessary. It is very difficult to do truly random checks with any hope of locating weapons. There is almost always a small but distinct group of kids that a school is most concerned about possibly carrying a weapon. These high-risk students are going to object if you search them more than once, and they would quickly compensate for this anyway, by forcing another student to carry their weapon

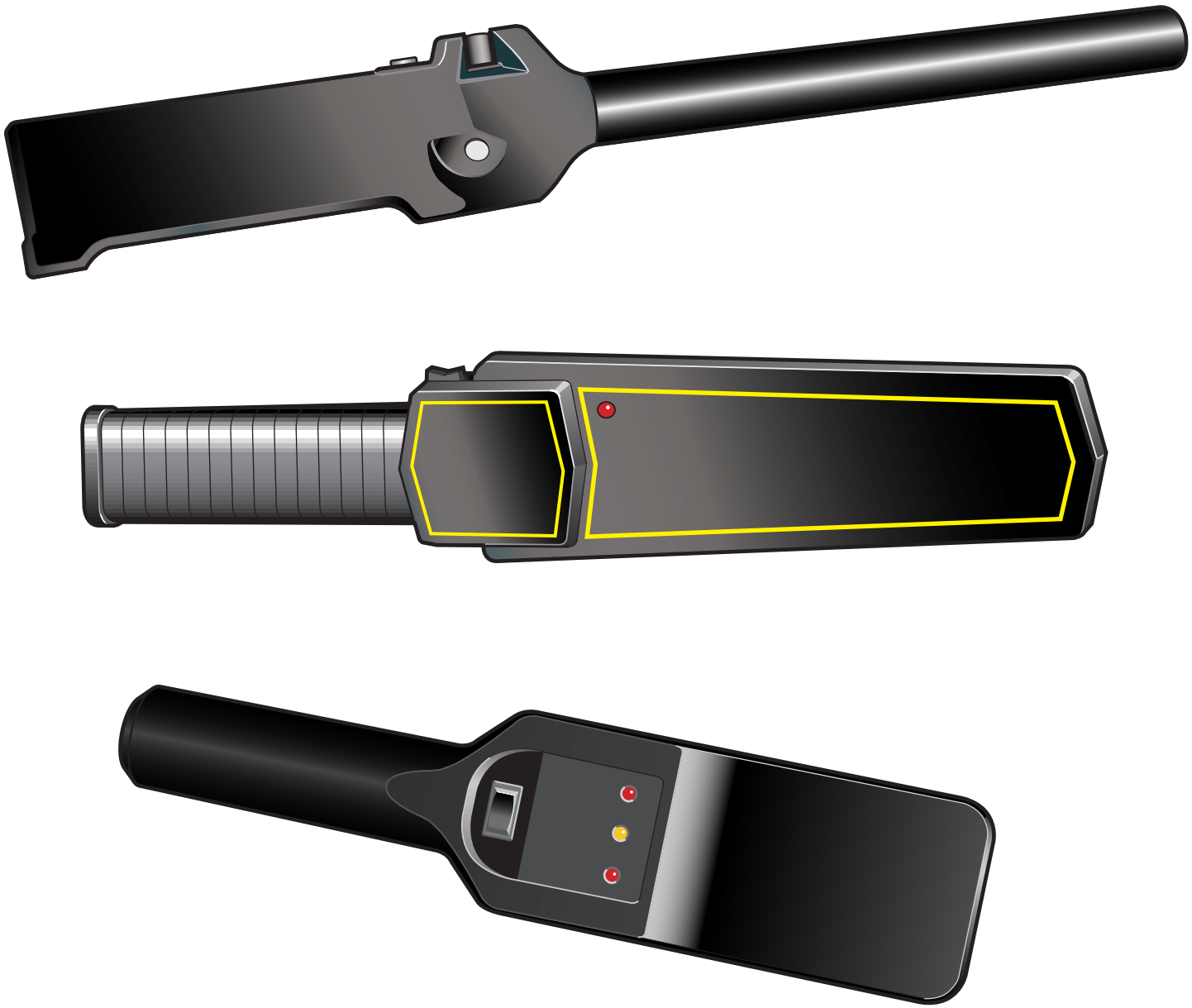

Exhibit 3.9. Examples of hand-held metal detectors.

onto the campus for them. One of the more successful approaches being used is for a school administration to choose an entire classroom at a time and scan every person (including the teacher) in the room.

Complete student population scanning with only the use of hand-held detectors can be undertaken when a school feels that major weapon issues are evolving suddenly and quickly, i.e., a member of the school staff has received information from a reliable source. The school administration and staff need to realize the great amount of time this will take and be prepared to handle the discipline of the crowd of waiting students.

One approach that may help some schools is to establish a policy that allows the school to do a weapon detection scan of any student who arrives at school late in the morning. This may provide the school with a lot of leverage. There could be some excellent deterrence created if students knew they would definitely be scanned when they are running late, if only to convince them to not be late.

It would also be beneficial for information regarding the potential use of metal detectors at school events to be printed on all tickets for games, dances, and so forth.

A school should seriously consider having both a male and a female operator of hand-held detectors in order to perform scans on students of both genders.

2. Space requirements

The use of hand-held metal detectors requires only slightly more space than that already occupied by the operator and the scannee. Unlike portal metal detectors, hand-held metal detectors are not nearly so sensitive to their surroundings; their sensitive zone is usually within just a few inches of the device's paddle. Metal walls, elevators, fluorescent lights, and plumbing that can affect portals do not usually have any affect on hand-held devices. The school must provide enough space for the students who are waiting to be scanned and about a 6- by 6-foot area for the actual scanning process. It is also necessary to have a table or other stable structure for students to place their purses and bookbags on and for them to lean on when they lift their shoes to be scanned. (See the sections about procedures for the operator and instructions for the scannee.)

It is not recommended that this scanning process take place in a private room or area. To avoid possible misconduct, accusations of misconduct, or a confrontation with a student who does end up actually having a weapon, all of the weapon detection program functions should be performed in view of everybody else. The exception is the unusual circumstance wherein a person is suspected of hiding some type of contraband in a private area of their body.

3. Throughput

In an environment where scannees are unfamiliar with the routine of hand-held metal detector use, such as at a courthouse, accurately scanning an individual may take as much as a couple of minutes to do well, especially when there are multiple alarm sources on one person, i.e., belt buckle, pocket knife, and steel shanks in boots. However, in a school environment, after the program has become routine, and where the students are generally cooperative and anxious to get through the metal detection system quickly, it should take no more than about 30 seconds to scan an individual with a hand-held detector. Assuming there are no difficult or

ambivalent students, most schools can plan to hand scan two students per minute per operator.

A good routine for any school weapon detection program involves training the student, staff, and parent populations. If the program requirements are repeated in presentations, in classrooms, and in writing, it will take much less time to settle into a routine. Instructional posters located at the scanning equipment should include diagrams of how a scannee should stand. For a complete, full-scale metal detection program to be held every morning for every member of the school, about 1–2 weeks will be needed for students to acclimate themselves by coming a few minutes earlier and wearing clothing and accessories that are less suspect. The first week of any metal-detection program will be chaotic.

4. Hardware costs and manpower costs

Most hand-held metal detectors on the market range from about $20 to about $350. Schools should plan to spend between $150 and $200 for detectors that have desirable features, including a long detection paddle (to reduce the amount of passes necessary across a person's body), a warning light or beep when the batteries are beginning to run low, and an audible feedback alarm that squeals louder or changes pitch for larger suspicious items and softer for less suspicious items (such as a zipper). Even the least expensive detectors will work, but more time may be required to perform a complete scan, and the procedures for the scan may be more intrusive. These smaller detectors are convenient if a school administrator or security person wishes to carry a smaller detector on their belt at all times.

Hand-held metal detectors run on either a 9-volt battery or on a rechargeable NiCad battery. A new or freshly recharged battery will last for approximately 1 hour of constant scanning. The rechargeable units may require that the battery be recharged by itself. Other hand-held detectors have a jack or plug built into them so it is unnecessary to remove the battery to recharge. (It is suggested that, for hand-held detectors that are used very infrequently, such as once a month, batteries should be removed when the unit is not in use.) A staff member should be assigned the responsibility for recharging batteries each night and/or making certain that new batteries are always available.

Obviously, manpower costs drive the use of hand-held metal detectors. As mentioned in the section on throughput, a trained operator can scan approximately two people per minute. For each operator and all back-up operators, a thorough training course along with some practice time should take no more than an hour at the beginning of each school year. A school should not forget to formally train security personnel who are hired after the start of the school year. (Some metal detector vendors provide an instructional videotape that can be useful, but the tape should not be used as the only source of initial training and practice.)

5. Procedures for the operator

While it is not difficult to learn to use a hand-held metal detector correctly, school administrators should not underestimate the value of annual training for their operators, as well as training for staff who may be called upon to serve as backup or supplemental operators. However, on-the-job practice is important in allowing the school to achieve the type of throughput that will be required in order to process students quickly.

Every school will want to tailor its own set of operator procedures to take into consideration its students' and community needs. Some generic procedures:

- The detector should be passed over the scannee's body at a distance of no more than 3 to 4 inches. Avoid touching the body or clothing with the detector. However, for some baggier clothing, such as pants or jackets, it may be necessary to hold the detector against or more into the fabric while scanning in order to stay within 3 to 4 inches of all body surfaces.
- Most hand-held metal detectors should be set at their highest sensitivity. An exception to this is if there is significant interference from metal reinforcing in a floor or other nearby material that could cause constant alarms unless the detector's sensitivity is turned down.
- The body scan should be performed each time in the same pattern so that the operator always knows what parts of the body still need scanning. A sample routine, illustrated in exhibit 3.10, follows:
  1. Ask the scannee to place all carried items, plus any caps or headgear on a table (procedures for manual search of baggage are not covered in this text). The scannee should stand with his or her feet about 18 inches apart, facing away from the table and about 2 feet in front of it. Footprints outlined on the floor or drawn on a mat can greatly help position the scannee properly. Ask the scannee to hold his or her arms out to the sides, parallel to the floor.
  2. Quickly run the hand-held detector across some piece of conductive material on your own body, such as a belt buckle. The ensuing squeal of the detector will assure you that the scanner is still operating properly.
  3. Start at the top of one shoulder of the scannee. With the paddle of the detector held horizontally and parallel to the front of the body, sweep down one side of the front of the torso, down the leg to the ankle, then move to the other ankle and sweep back up the front of this opposite leg and torso, ending with the opposite shoulder. (If a particular detector's detection paddle is less than half the width of the average body, or if a particular body is wider than twice the width of the detection paddle, the pattern will have to be modified to achieve adequate coverage.)
  4. Sweep the detector paddle over the outside top of the arm from the top of the shoulder to the bottom of the wrist, then up the inside of the arm to the armpit. Sweep down that side of the body to the ankle, then up the inside of that leg and down the inside of the opposite leg, then back up the other leg from the ankle to the underarm. Repeat the sweep of the inside and outside of this arm. Note that it would be particularly important to avoid touching the paddle up against the scannee's body when scanning up and down between the legs.
  5. Ask the scannee to turn around. (Arms can be put down now.) The pattern used to scan the front of the body should now be repeated over the back of the body.
  6. Ask the scannee to grab the edge of the table for support, then to lift one foot up in back of him- or herself. Scan across the bottom of the shoe. Repeat for the other foot. The operator should expect to hear a short squeal from the detector when scanning the bottom of shoes or boots with steel shanks or steel toes. Both shoes should cause equivalent squeals.
  7. For the head area, start at the top of the forehead and scan around the top of the head down to the back of the neck.
- Given that the type of hand-held detector being used is the kind that provides different volumes of feedback, i.e., a soft squeal versus a much louder squeal, the operator will be able to distinguish between the detection of a smaller innocuous item or material, such as a zipper, and the detection of a larger, more suspicious item. It is important to be attuned to

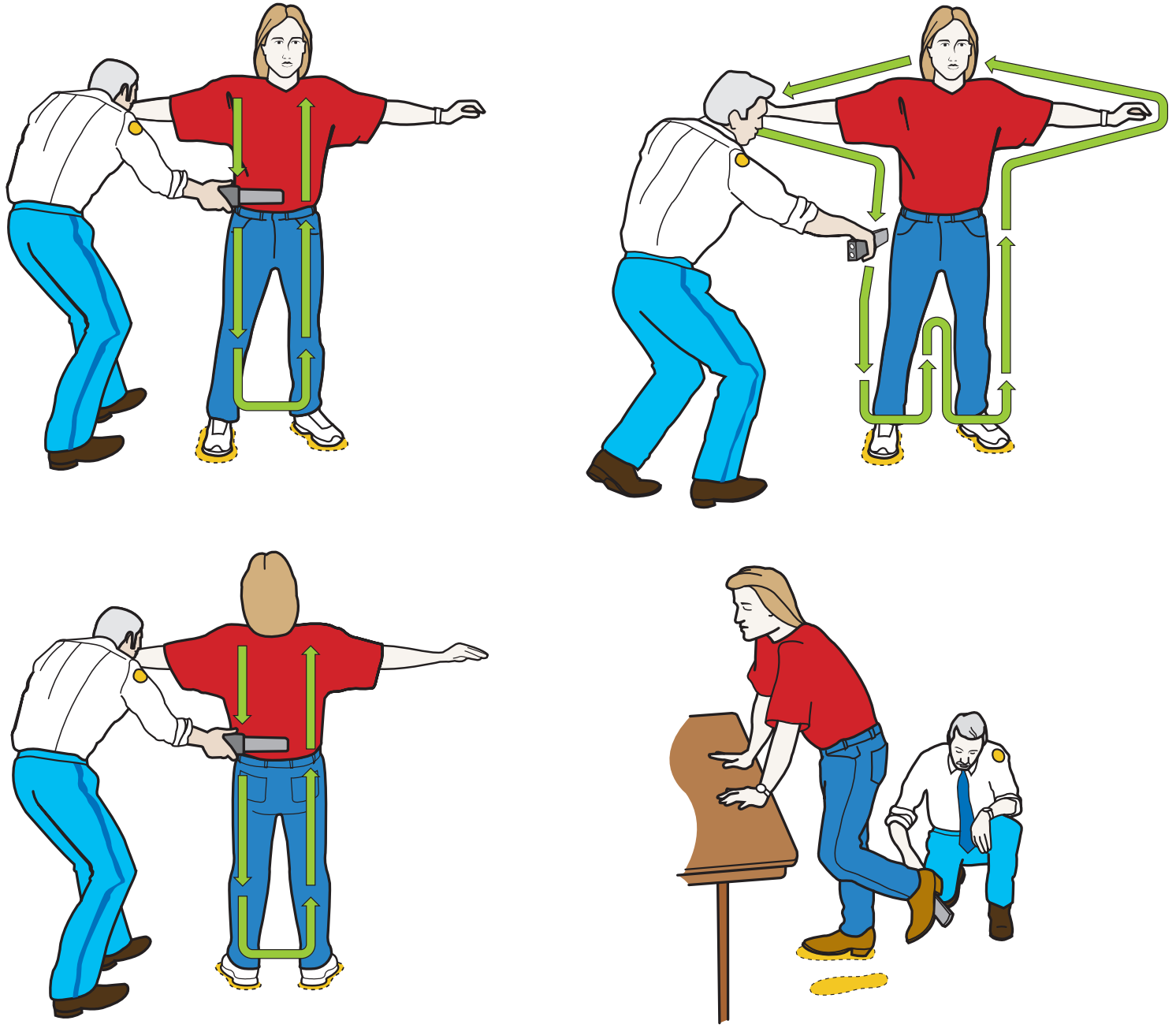

Exhibit 3.10. This is an example of procedures for using a hand-held metal detector that has at least a 10-inch zone of detection.

these different volumes to recognize when further investigation is required for a particular scannee.

- When the detector identifies a suspicious item and there is no visible source for the alarm (clothing is shielding the source object), ask the person to show you what they have in that area. For example, for an alarm along the arm or wrist, have the scannee pull up his or her shirt sleeve. Using your detector, duplicate the squeal you heard before, but now over the visible item.
- Do not let the scannee influence you as to what is actually causing an alarm (exhibit 3.11). For instance, if the detector denotes the presence of a suspicious item under a shirt sleeve, do not fail to completely investigate the source of the alarm even though the scannee assures you that it is just his or her watch.
- If the person you are about to scan caused an alarm when walking through a portal metal detector, and your job is to try to locate the source of that alarm on his or her body, do not stop the complete scanning process just because you come across one alarm-causing item. Continue the scan even though you find one or more items in the process.
- The lower abdominal area is particularly difficult to scan because this area is private in nature and because of the metal items usually found in this area: belt buckles, metal buttons or snaps, and metal zippers. When doing the initial front body scan, if an alarm occurs in this area, there are two possible ways to further investigate:
  a. Ask the scannee to undo any belt he or she might have on and have him or her pull the belt ends away from the middle of the body. Now scan the zipper area; the feedback volume from your hand-held metal detector should tell you if it is now only sensing a zipper and/or a metal snap, or if a more suspicious item is present and further investigation is needed.
  b. A second approach that some schools use is that, if the lower abdominal area is causing an alarm on the hand-held detector, ask the scannee to bend the front of his or her front waistband forward, to ascertain that no weapon is hidden behind it. Facilities need to be available for situations where further investigation can be accomplished privately, but only in the presence of two or more school employees who are the same gender as the scannee.

6. Instructions for the scannee

Education is important in enabling your scanning program to operate smoothly. Before the initiation of a weapon detection program, presentations and handouts should describe to the students, employees, and parents the items or materials that will make it more difficult to get through the scanning process quickly. If your school is also using x-ray technology for purses, bookbags, and so forth, consider asking students to put all alarm-causing items into their bags before they enter the scanning process.

For visitors and first-time scannees, it is very helpful (and will save time) to give them an idea of the process they are about to go through. Particularly helpful are posted instructions that are simple and quick to read, with diagrams showing what is expected of the scannee. An example of such instructions follows:

> Welcome to our school. For the safety of our students, employees, and visitors, our policies require that EVERY person be scanned and his or her carried items searched to prevent weapons from entering our school.

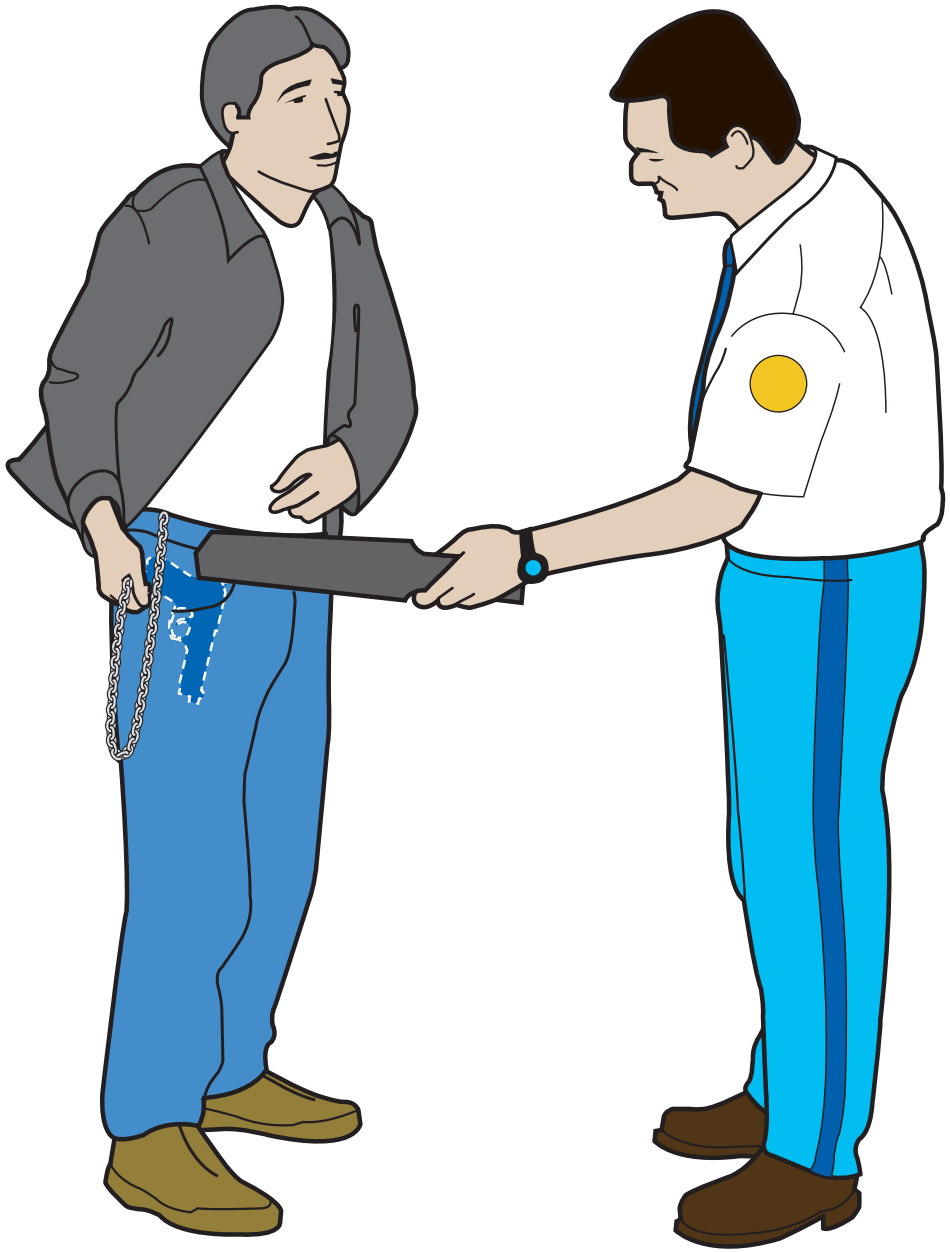

Exhibit 3.11. Here, the scannee is attempting to influence the operator by claiming that the chain is causing the alarm, when, in actuality, there is a hidden weapon.

When it is your turn, please stand first on the footprints on the floor. Extend your arms out to your sides, parallel to the floor.

If requested by the security personnel, please open your belt and extend both belt ends away from the front of the body.

To scan shoes, please grab the edge of the table and hold each foot, one at a time, out in back of you.

7. Maintenance and expected lifespan

If not accidentally or intentionally abused, most good hand-held metal detectors will require no maintenance. Extended maintenance contracts are usually not required beyond the initial warranty period. The only in-house maintenance that will be required is to provide for the recharging of batteries each night and/or making certain that new batteries are always available.

Most good hand-held metal detectors should have a useful lifespan of about 5 years, much more if used infrequently and possibly less if in constant use.

8. Working with the vendor

If a school is required to go out on bid for one or more hand-held metal detectors, it is recommended that the contract require the following optimal features:

- A variable pitch of alarms that provides more information to the operator using it, i.e., a softer squeal for an innocuous item, like a zipper, and a louder squeal for a bigger, more suspicious item.
- A detector paddle or zone that is at least 10 inches long.
- A signal that indicates the battery is beginning to run low, as opposed to an abrupt termination of operation.

C. X-ray baggage scanners

1. Safety concerns

X-ray equipment is available for the detection of weapons within baggage or other carried items. For single-energy units appropriate for school applications, a vacuum tube emits x-rays on and through these items. These x-rays come from inside the top of the unit and scan downward as baggage is automatically moved through the equipment. Sensors collect the magnitude of the signals that make it through scanned items, with low Z-number material allowing more energy through and material with high Z-numbers allowing less energy through. (A “Z number” is the atomic number of a particular element; a low Z in x-ray terms is any atomic number less than 26. A high Z in x-ray terms is any atomic number equal to or greater than 26.) The resulting images are transferred to a TV monitor, where an operator must carefully examine each image for evidence of firearms or knives.

The safety aspect of x-ray equipment for baggage inspection has improved greatly over the past two decades. This application of x-rays previously used a large cone of energy in order to make an image of an entire piece of baggage at one time. Today’s x-ray machines for baggage use a much lower energy pencil-thin beam of radiation that generally scans back-and-forth across a piece of baggage as the baggage moves beneath it. More sensitive sensors can now adequately capture an image with these lower dosage x-rays.

Infrared (IR) beams installed within the equipment can accurately start and stop the x-ray beam source so that the x-rays are not operational when there is not a piece of baggage located in imaging position. Add to these improvements the excellent shielding built into x-ray detectors, and it is easy to understand what has made modern baggage detectors quite safe and of negligible health risk to either the operator of the equipment or to the general public. Indeed, the radiation exposure to operators from baggage scanners has been shown to be only a few microrems per hour, which is equivalent to standing in the sunlight for a few minutes. Even smoking a cigarette gives a person a larger dose of radiation. About the only potential health risk from an x-ray baggage machine would be to someone attempting to ride the conveyor belt through the equipment, which would still result in substantially less radiation exposure than would be gained from a medical x-ray.

There have been concerns raised about the safety of exposing food to baggage x-ray machines. The U.S. Food and Drug Administration (FDA) has approved much higher doses of radiation for normal food preservation methods than any food items would receive going through x-ray baggage equipment. Most scientists feel that the FDA is quite conservative in the limits it has established.

Over the past 10–15 years, x-ray detectors have become quite safe for camera film because of lower dose x rays. This would include the x-ray equipment most schools would normally consider purchasing today but not, perhaps, an older piece of equipment that has been donated for the school's use. One modern exception to this is the much more sophisticated $1million x-ray machines that are used on some airline flights to examine checked baggage. This equipment is used to search checked baggage for explosives, and it may well damage camera film.

2. Setup and space requirements

A typical x-ray baggage scanner will have a footprint about 4 by 4 feet in size. This does not include any type of conveyor belt to automatically move items into and out of the x-ray imaging area. The smallest conveyor belt that would probably be useful for a school application is 8 feet in length, which would add about 2 feet on either side of the detector itself. Conveyors can come in almost any size; typical conveyors for airports are a total of 10–12 feet in length.

Smaller desktop x-ray units are available but are used primarily for screening letters and mailed parcels.

Unlike portal metal detectors used for personnel, x-ray baggage scanners are not sensitive to their surroundings. Virtually no clearance is needed around the equipment except for space for on operator to sit or stand at the controls, which are located to the side of the unit.

A school should have the factory or vendor install, set up, and calibrate the x-ray detector. After installation, moving the equipment to a different onsite location is generally not a problem. While the equipment should not be abused, it is not overly delicate.

3. Throughput

The expected throughput of an x-ray baggage scanner will depend on two things: the efficiency of the operator and the amount of clutter in a typical bag at this particular school. Clutter can also affect the speed

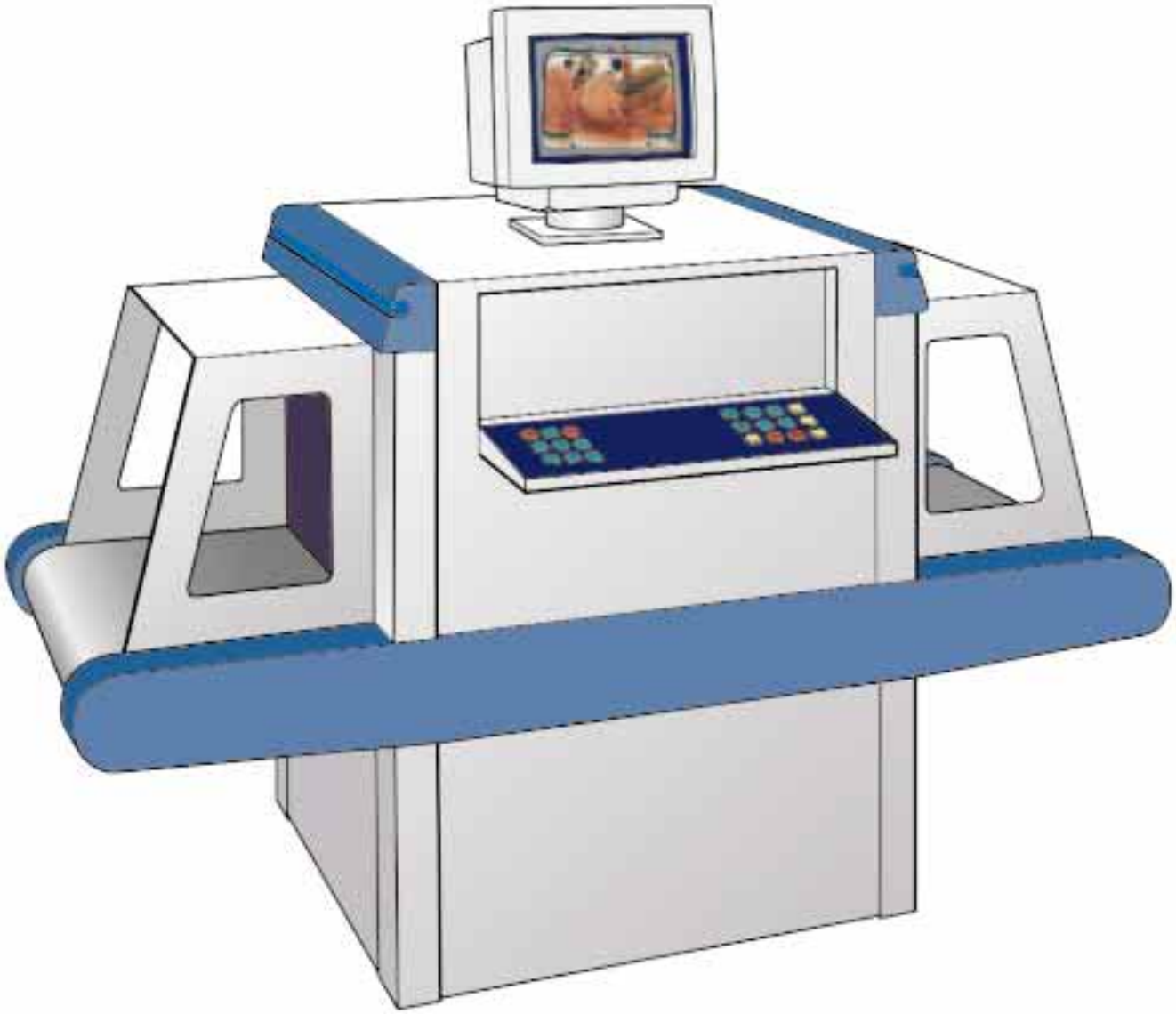

Exhibit 3.12. An illustration of an x-ray baggage detector.

of the operator. Carried purses and bookbags that contain many high Z-material items, such as metal rulers, screwdrivers or other tools, metal aspirin tins, foil-wrapped items, and so forth, can significantly slow down an operator who is examining each piece of baggage. Fortunately (or unfortunately), in most schools where the security equipment operators become familiar with the individual students and the kinds of things they usually carry, the speed of an operator will increase.

Generally, between 10 and 20 items per minute can be examined using an x-ray baggage scanner. As many as 30 items per minute can be effectively scanned if most of the items are benign, i.e., contain no obvious metal items larger than a coin or button, none of which are touching in the image. Dense clutter within a bag will necessitate that bag being pulled off the conveyor to be manually searched.

4. Hardware costs and manpower costs

X-ray detectors for baggage are not cheap. Most appropriate for schools is a single-energy unit (one radiation source) costing about $30,000. There are much more expensive models on the market, ranging from $250,000 to $1 million, but these are used in applications concerned more with the detection of explosives. The detection of drugs is also possible, but the sophisticated equipment needed is too expensive for most schools. Schools will generally use a black-and-white monitor with the x-ray machine. Some models add the convenience of a color monitor, which may not add any valuable information to be used in decision making by the operator. Again, costs limit most schools to black-and-white monitors.

The conveyor belt needed to feed items into and out of the x-ray detector will generally be priced as part of the total system cost.

The manpower cost for operating this equipment is very high. For low-volume applications, in which baggage comes through slower than one bag per minute, one full-time operator will be sufficient to help with the placement of bags on the conveyor belt, operate the controls, view the monitor, make a judgment regarding each bag, and perform any needed manual searches. However, it is generally recommended that one operator work at the monitor of an x-ray machine no more than 2 hours at a time and preferably no longer than one-half hour at a time, trading tasks with another security person.

Most high-volume facilities, including airports and schools, will have two operators assigned to each x-ray detector. In this way, the operators can switch off the task of watching the monitor and of performing manual baggage searches as required. Airports will normally give these operators a break every 2 hours because of the intensity of the work, but most schools will not be engaged with intensive baggage scanning for more than 2 hours.

For schools, it is not the length of time an operator has to work that is of concern; rather, the issue is the number of operators needed during a relatively short period of time and the number of x-ray units required to maintain an adequate throughput during the morning rush. While it is probably a simple matter to hire one security aide to work 8 hours a day, it is much more difficult to find eight security aides to work 1 hour a day. (Eight or more security personnel would normally be required to support the equipment and

processes in a complete weapon-detection program at a school with 2,000 students.) For this reason, it is not unusual for a school administration to use fellow administrators, teachers, and other employees to supplement the security personnel running the equipment each schoolday morning. Employees may be pleased to earn the extra money, but the administration must be certain that all receive adequate training.

Who will run the equipment the other 7 hours of the schoolday? This can be expensive and a somewhat low payback effort. An approach implemented by some schools is to enforce a policy that the school doors are basically locked one-half hour after school begins in the morning. Although this is a rather harsh stance, it may be necessary in a school where resources are limited but the threat of weapons is quite high.

Vendors will normally provide initial training at no additional expense. A 4-hour course will adequately introduce a new operator to the overall use and safety information of an x-ray detector, but practice and experience is equally important. Interesting training aids are currently available from some vendors. Prepared images of baggage going through the x-ray scanner can be played back on the TV monitor for operator practice. Another feature on some equipment will randomly superimpose the image of a suspicious (but fictitious) item over the actual images being captured during the normal work time. These phantom images may help operators to stay aware so that they are not lulled into complacency by the routine absence (hopefully) of any weapons coming into a facility.

5. Procedures for the operator

The actual operation of an x-ray baggage scanner is straightforward. Vendors will provide recommended procedures for operating their specific equipment, and each school will probably tailor this for its own environment. However, as with the radiologist who examines medical x-rays, the challenging part of operating x-ray equipment for weapon detection is knowing what to look for. The untrained or disinterested operator can negate any possible benefit that could be gained in a weapon detection program.

The TV monitor that displays the black-and-white x-ray images of baggage it is scanning can usually be used in the positive or negative, i.e., solid objects can be displayed as light or dark objects. There are two types of color systems on the market. There are colorized single-energy (one radiation source) systems in which the color is arbitrarily assigned based on the level of energy transmitted. The second type is a dual-energy (two radiation sources) system that assigns color based on the effective Z-number of the material. The first type is inexpensive but adds no useful information to the display. The second type adds useful information but would normally be cost-prohibitive for most schools (exhibit 3.13).

Some general guidelines for the operator of an x-ray detector are:

- The different models of x-ray detectors utilize various techniques and angles for transmitting the radiation and receiving it on its sensors. Your vendor will inform you as to the best orientation for items being scanned by your equipment. For example, for an x-ray detector that uses a fan-shaped beam emanating from the top of the equipment's interior in a downward direction, the vendor will give instructions similar to:
  Do not put a bag down on a conveyer belt such that

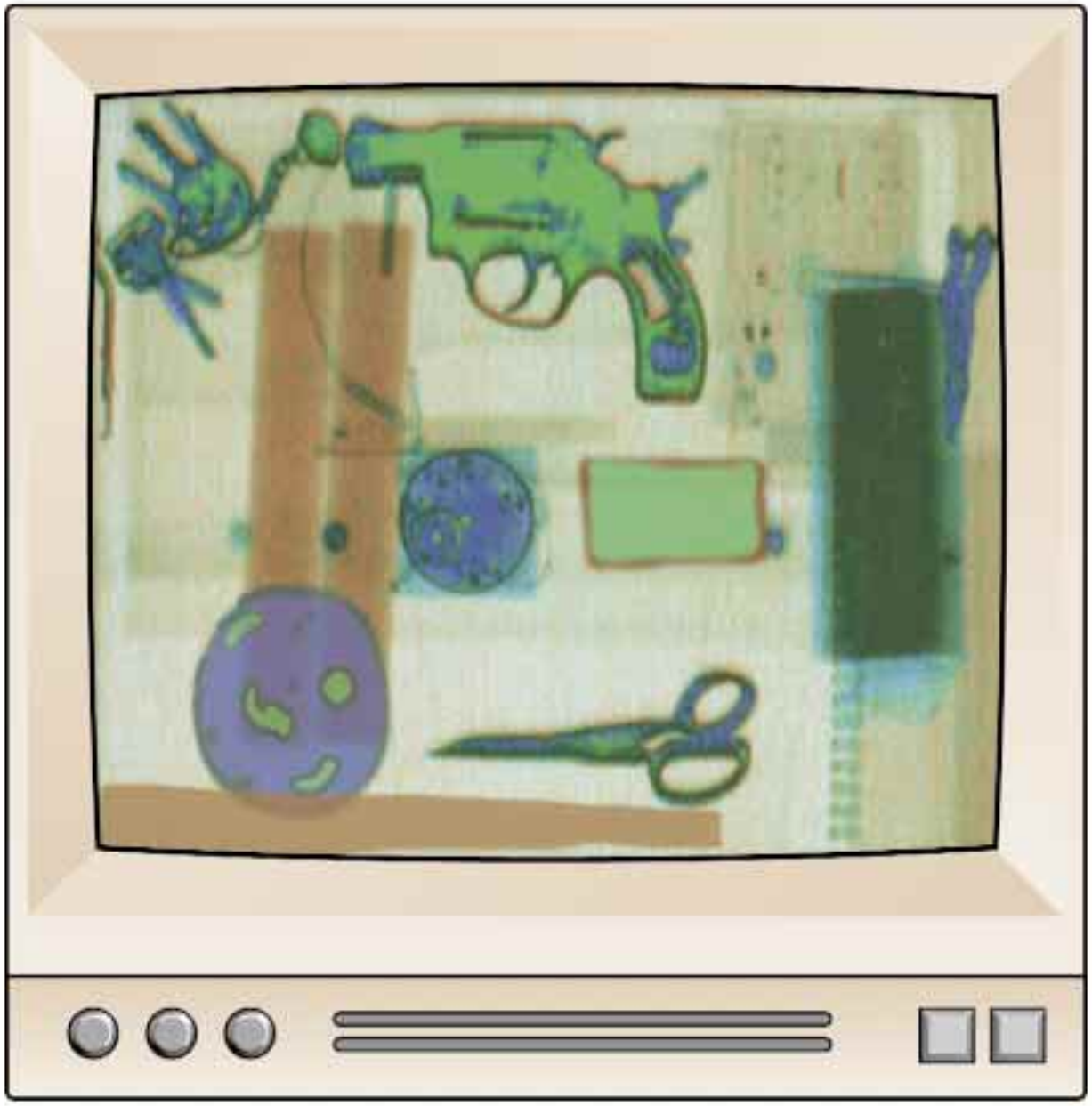

Exhibit 3.13. An example of a dual-energy x-ray machine that assigns color based on the effective z-number of the material. This is an informative system but normally too expensive for schools.

the images captured will be of the narrowest perspective of the bag. Lay the bag down on its widest side to allow the x rays to penetrate the least amount of material. Be careful that no part of the bag is outside the zone of detection, which is generally defined by the width of the conveyor belt that is used.

- What you are looking for is a solid dark object (if display is set this way) that could be a weapon, part of a weapon, or hiding a weapon. A best case scenario (for the operator) is a revolver that is lying on its side so that its shape is obvious. The same is true for a knife of substantial size if it is lying on its flat side. What becomes difficult, and where most operator training and judgment come into play, is when a weapon is in a different orientation so that it is viewed from the top, bottom, or back of the weapon. A revolver will generally still have a revolver shape that reveals its cartridge. An automatic weapon viewed from the top, however, will produce an image that is an innocuous rectangle 4 inches or more in length. (Keep in mind that there are some weapons available today such that the length is less than 3 inches.) An automatic or semiautomatic weapon viewed from the back is an even smaller rectangle. And, unfortunately, a knife can be very difficult to detect if it is made of any material other than metal.
- Clutter occurs where several dark items are grouped together in an x-ray image, such that the actual size and shape of each item cannot be reasonably determined. More often than not, clutter is the cause of manual searches in weapon detection programs.
- Surprisingly, band instruments can usually be put through an x-ray machine successfully; the normal thinness of the metal of most instruments will allow the x-ray detector to see within and behind the instrument for any hidden weapon. The school should screen all of the different types of instruments beforehand to determine if any of the instruments (or their cases) will be a problem for the x-ray detector.
- When in doubt about an object in a bag, investigate!

6. Instructions for the scannee

Hopefully, as students grow accustomed to what items in their bags and purses trigger an alert to the operator of the x-ray equipment, they will tend not to bring these items to school with them. This may not be the case for disruptive students, who may go out of their way to slow down the system. School administrators may want to consider having some type of consequences in place if this behavior continues.

Educating students and parents in advance about what to expect from the x-ray process and which of the items they carry will result in bag searches can help speed up the process at the beginning of a scanning program. However, do *not* share with the students information regarding the system's weaknesses and what makes it difficult to recognize weapons hidden inside bags. This information should remain restricted to appropriate school and law enforcement personnel responsible for security.

A simple set of instructions located at the x-ray detector can remind students quickly of what is expected of them. An example of such a sign is:

> Place all large jewelry, watches, belts with metal buckles, large keyrings, loose change, and other detector-sensitive items in your backpack or purse. (This first sentence is for a school that also has portal metal detectors.)

> Lay all books, notebooks, purses, bags, lunches, backpacks, briefcases, hats, coats, jackets, and electronic devices on their widest side on the conveyor belt. (Adjust according to whatever orientation is best for your equipment.)
>
> Do not stack items; place them on the conveyor belt separately. It is easy to reduce the chance of security personnel going through your things manually—DO NOT CARRY A LOT OF JUNK IN THEM!

There should be a sign on the other side of the x-ray detector:

> Please immediately check for all of your personal valuables and possessions. The school is not responsible for your things. If you have irreplaceable items, please do not bring them to school.

7. Acceptance testing and performance testing

The American Society for Testing Material (ASTM) has defined a test procedure that most schools will want to use as part of the initial acceptance test and also incorporate into their regular performance testing. This test uses a 10-step wedge of milled aluminum (exhibit 3.14). Across the bottom of the step wedge are several wavy wires of different gauges. The x-ray detector is performing well if, when this step wedge is sent through the detector, 10 different shades of gray are clearly distinguishable and a certain number of the wires are also seen. (A very good x-ray detector will see even the smallest gauge of wire behind the thickest step of the step wedge.) This step wedge will be available through your vendor, who will likely employ the same tool for its own testing purposes.

Schools should initially run this test to accept the equipment and on a regular basis, such as once a month, for validating that the system is still performing well. Any significant decrease in the number of wavy wires that are visible may indicate that the unit needs repair.

8. Maintenance and expected lifespan

Most companies offer extended warranties or maintenance contracts for x-ray baggage scanners. Service contracts are generally more expensive than what you can expect to spend over the life of the equipment for repair. However, depending on the fiscal arrangements at each facility, some schools may want to establish a service contract up front, when they have the funding available. (Schools can never be certain what their budget will be in subsequent years, and coming up with $5,000 for a repair bill 3 years from now may not be possible.) In the absence of such a contract, schools should contact the factory when repair is needed.

Most x-ray baggage scanners will have a life of 10 years or more. Technology advancements are more likely than failure to render them less useful. Over the course of this time, there is a reasonable chance that a facility will need to replace the vacuum tube that is the source of the x rays.

There is little regular maintenance required for this equipment. The largest moving part, the conveyor belt, often is self-oiling, and the facility may only need to add oil to a reservoir occasionally. Individual vendors

Exhibit 3.14. This 10-step wedge is used for x-ray baggage scanner acceptance testing and regular performance testing.

may recommend certain procedures be run periodically (once a month or so) to test for radiation leakage, even though the chance of such leakage in modern x-ray detectors is small. Heavy damage, malicious acts, or purposely holding the shielding flaps aside while the machine is in operation would normally be required to allow radiation leakage.

9. Working with the vendor

There are several excellent products on the market that would be appropriate for use by schools. A school security person or administrator should take the time to visit one of the national trade shows where most of this equipment is on display. Seeing the equipment and talking with vendors can often help a facility gain a better understanding of the products that they are considering using. Such a visit allows schools to identify the vendors they would like to seriously consider.

Because of the high cost of this equipment, schools may want to invite at least two different vendors to visit their campuses and demonstrate their equipment. This is not a trivial expense for a vendor and should not be done unless a particular product is actually under consideration. When equipment is available for testing on campus, the security personnel can become familiar with the operation of the equipment and what options might be appropriate for their school's needs. If at all possible, a school should involve the people who are going to run the equipment in the decisionmaking process.

Given that all the available x-ray baggage scanners are priced similarly, operate easily, offer substantial training up front, and have good quality monitor images, schools will be most concerned about service. If a service contract is being purchased, it may be possible to include language in the RFQ requiring the chosen vendor to provide service and repair within 3–5 work days or to substitute a backup system within 48 hours. This may be easy to incorporate within a large city but impossible in more rural locations. If a particular school district is planning on purchasing several units for multiple schools, the district may be able to negotiate an excellent price that will include one backup unit that will be stored by the vendor for use when needed. This backup unit may be a used product that is in good working order and easy to bring in quickly and set up during a crisis.