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PROCEEDINGS OF THE U.S. NUCLEAR REGULATORY COMMISSION

Security Training Symposium

"Meeting the Challenge-Firearms & Explosives Recognition and Detection"

Held at
Hyatt Regency Bethesda
Bethesda, Maryland
November 28-30, 1989

Sponsored by
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

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ABSTRACT

These conference proceedings have been prepared in support of the U.S. Nuclear Regulatory Commission's Security Training Symposium on "Meeting the Challenge—Firearms and Explosives Recognition and Detection," November 28 through 30, 1989, in Bethesda, Maryland. This document contains the edited transcripts of the guest speakers. It also contains some of the speakers' formal papers that were distributed and some of the slides that were shown at the symposium (Appendix A).

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Kenneth C. Rogers, Commissioner, U.S. Nuclear Regulatory Commission

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PROCEEDINGS – DAY ONE

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Welcoming Remarks

Mr. Burnett:

Good morning and welcome to Bethesda, Maryland. As Priscilla just said, my name is Bob Burnett for those that do not know me. I am the Director of the Division of Safeguards and Transportation. I am here this morning, however, in my capacity as Chairman of this Security Training Symposium. I would like to emphasize right off the bat, first and foremost, the Nuclear Regulatory Commission (NRC) is truly delighted at the enthusiastic response that we have received from licensees and other Federal agencies in support of this, our first Security Training Symposium.

The idea for conducting this symposium originated several months ago. As many of you know, my division is responsible for the protection and transport of commercial nuclear materials. The bombing of the Pan American Flight 103—and I am sorry to say possibly another one that happened yesterday—got my division thinking pretty hard about the job that we are doing in the detection of explosives, contraband, and firearms, and the difficult job of keeping them out of the nuclear environment.

I guess also, that particular incident brought, at least to my division, the harsh realization and heightened awareness of the damage that could be done by relatively small amounts of high explosives. Of course, it underscores the importance of security, which caused us to reflect on how we are protecting our nuclear facilities against the threat and introduction of contraband, high explosives, and weapons.

As a regulatory agency, the NRC has had in place for many years requirements for the conduct of explosives and firearms searches. The specific methods, however, were left to and selected by our licensees, subject to NRC licensing and inspection. Because of our ongoing threat assessment activities and contacts with other Federal agencies, my staff and I maintain an awareness of current developments from both the terrorism and counter-terrorism perspectives in the area of firearms and explosives recognition and detection.

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I strongly encourage all attendees to take maximum advantage of the forum through active participation. This symposium can only be considered truly successful if such participation takes place and the information and knowledge gained here is reflected back in your own security systems. A successful symposium can lead to future NRC symposiums of this type on other pertinent topics.

Each one of us here today is well aware of the challenge facing us in providing adequate security at nuclear sites. Day-to-day problems are often compounded by the fact that even the experts do not always agree. You will probably see overlap and possibly even disagreement among the speakers. But disagreement can be a positive motivating factor if it leads to new ideas and better ways to do things.

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Thank you, Mr. Burnett. I would now like to introduce Mr. Hugh L. Thompson, Jr., who is our Deputy Executive Director for Nuclear Materials Safety, Safeguards and Operational Support.

Hugh Thompson, Jr., Deputy Director for Nuclear Materials Safety, Safeguards and Operational Support provides opening remarks to symposium participants.

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Thank you Priscilla. I guess when I first look out there I wonder, who is minding the store? Who is protecting all those facilities out there that you are responsible for? It is delightful to see such a nice turnout, and I would like to welcome each of you who represent our licensees, the NRC staff members who are here today for their training, the other Federal agencies, as well any of the Chicago Bear fans who are seeking solace here in Bethesda. I certainly want to welcome all of you.

I would like to emphasize three things for this training symposium today. The first is the timeliness of the symposium, both with regard to the firearms and explosives and to the recognition and detection aspects. This is an effort that we have had to bring you, as Bob said earlier, right up to the state-of- the-art on, in those two areas.

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Third is the consideration of human factors in carrying out your responsibilities. As Bob said, the threats both at Lockerbie on the Pan American flight and the alleged bombing of the Colombian flight just reinforce attention on terrorists and the capabilities that they do have. While none of that has really come to the nuclear industry or certainly not to the United States, the nuclear industry does present a highly visible target and we must be ever vigilant.

One way to prepare for this potential threat is to have these types of symposiums. Today, production units are available to detect heretofore undetected plastic explosives, although they are very costly. X-ray devices to distinguish material of different atomic weights also are available. These devices give us, the security staff, for the first time, the potential to keep pace with advances in modern weaponry.

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Commissioner Kenneth C. Rogers delivers the Keynote Address to participants of the symposium.

Keynote Address

Commissioner Rogers:

Good morning ladies and gentlemen. I am sure you have heard that already several times, so it is not a new greeting. I am very pleased to speak with you this morning from my perspective as an NRC Commissioner on the development and maintenance of effective security for commercial nuclear plants and fuel cycle facilities.

I am especially pleased to share this podium with the distinguished speakers who will address you from other Federal agencies, including the Departments of State, Defense, and Treasury, the FBI, Sandia National Laboratories, the NRC itself, and the nuclear industry. In addition, my fellow NRC Commissioner, Commissioner Curtiss, will address you on Thursday morning.

As a former Professor and University President, I am a strong advocate of education. I can assure you that the NRC staff has made every effort to assemble a stellar cast of faculty for this symposium, and I look forward to hearing more from them as time goes by.

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Before 1973 there were no codified physical security requirements at power reactors or fuel facilities possessing strategic quantities of special nuclear material, such as enriched uranium and plutonium. From the mid-1950's to about the mid-1960's, a variety of nuclear safeguards measures were applied piecemeal to the various U.S. defense and commercial facilities. During this period, U.S. defense programs relied primarily on nuclear secrecy and physical protection.

In the Atomic Energy Commission's (AEC's) contractor facilities on the other hand, financial responsibility, material accountability, and criminal penalties constituted the major elements of the safeguards program. In private commercial facilities during this period, only financial responsibilities related to value of nuclear material and criminal penalties for misuse of this material provided the safeguards.

AEC safeguards regulations, up to about 1969, consisted primarily of nuclear material control and accountability requirements. Physical protection requirements were not placed on the private sector. The AEC position began to change in the 1969-to-1970 period, as the number of U.S. airliner hijacking incidents and terrorist attacks escalated internationally.

By 1970, there was a developing consensus that nuclear safeguards regulations should be extended to include physical protection requirements for the growing numbers of commercial nuclear power plants and their associated commercial fuel cycle facilities. Upon creation of the Nuclear Regulatory Commission in 1975, the NRC was charged with protection of the public against nuclear accidents and related criminal acts.

These two areas of concern overlapped to some extent, in that safety measures to prevent or cope with accidents may also prevent or mitigate plant vulnerability to criminal acts. The NRC's safeguards program was designed principally to focus on criminal acts, protection of facilities against theft, diversion, or radiological sabotage.

Thus, an objective of the NRC safeguards program is to ensure that licensed private activities, such as the operation of commercial nuclear power plants and fuel cycle facilities, do not contribute to any significant increase in overall risk of death, injury, or property damage to the public from criminal acts.

Safeguards effectiveness criteria were established, which included provision for protection against serious civil damage and for the accumulation of timely and accurate information on the status of nuclear material in facilities. The acceptability of these safeguards required a realistic accounting of the risks involved and of the burdens on the public in terms of encroachment upon civil liberties and effect on institutional organizations, economic activities, and the environment.

To ensure the appropriateness of the nature and level of safeguards requirements, a design-basis threat was defined, together with provisions for its continuing review and revision as circumstances warranted. The development of safeguards criteria, however, introduced new problems. Since there has been no history of credible threats against the U.S. nuclear industry, how were licensees to demonstrate that the effectiveness criteria could be achieved in practice? Without a safeguards design standard, how were licensees and the NRC to design physical protection systems or judge their adequacy?

The NRC chose to rely on the use of hypothetical threats, the design-basis threats, which would serve as a standard against which safeguard measures would be developed, evaluated, and implemented. It is important to note that from the beginning, certain key concepts have served as the foundation for the design-basis threats.

First, safeguards at nuclear facilities are bounded by an assumption of civil order within this country. Second, safeguards measures for deployment against a small adversary group would also offer some protection against a larger adversary group. Third, public acceptance would be the final arbiter of the degree or level of safeguards that is appropriate. Fourth, the definition of threat in precise terms is judgmental. Thus, the design-basis threats are not intended to be the maximum or worst conceivable threat.

The NRC design-basis threats were originally defined and validated following extensive worldwide study and analysis of adversary characteristics associated with subnational and intranational conventional crime and terrorist actions. These studies included consultations with intelligence community and law enforcement experts on crime and terrorism and examined group size, motivation, weaponry, equipment, and tactics among other adversary characteristics.

In 1979, the NRC articulated separate threat statements for radiological damage and for theft of nuclear material. These threat statements provided licensees and the NRC with practical, performance-oriented standards against which safeguard systems could be designed, evaluated, and implemented. Their use has helped standardize licensee security capabilities across the country.

In addition to their role in the design of safeguards systems, these design-basis threat statements provide the standard against which changes in the threat environment, the world of real threats, can be evaluated and their adequacy determined. The NRC staff performs a number of tasks to detect any significant change in the threat environment and to assure that the threat statements remain reasonable.

The staff maintains close and continuing contact with the intelligence community, including regular interagency meetings of Federal agencies concerned with terrorism. The staff also reviews and evaluates intelligence reports on terrorist activities and incidents on a daily basis and assesses all reported threats against licensees.

Every six months the staff formally documents its analysis of the threat environment and provides this analysis to the Commission. Any significant change in the threat environment that could affect the design-basis threat would result in revised licensee safeguards requirements to meet the new threat level.

To assure that licensee safeguard systems to meet the design-basis threat are effective, the NRC conducts a regulatory effectiveness review, an RER, that includes a week-long site visit at each facility for a hands-on evaluation of safeguards. RERs will be discussed more fully on Thursday. Finally, when the need arises, the NRC works with the Executive Branch of the Federal Government to address policy issues regarding the design-basis threats.

Although security requirements have been defined over the years, entrance searches have always been a key requirement for access to both power reactors and fuel facilities. Fortunately, the early 1970 antihijacking efforts of the Federal Aviation Administration (FAA) resulted in the availability of effective firearms detection systems that could be used at licensed reactor facilities. At first, difficulty was experienced with procurement of acceptable detectors of explosives and incendiary devices. Licensees supplemented equipment searches for a time with random "pat-downs" for site employees and 100 percent pat-downs for visitors.

In the mid-1980's after thorough review, the staff concluded that explosives detectors that were available at that time were more effective than pat-down searches. Subsequently we amended our rules to require the use of detectors for both explosives and firearms.

Most recently, with commercial development and near-term deployment of an estimated 200 to 400 thermal neutron activation explosives detection systems by the FAA and airports throughout the country, it appears that new advancements in technology may make available more effective methods for detecting certain explosives such as plastic. However, these devices are not currently suitable for use at commercial nuclear facilities.

The NRC and the Department of Energy assure that for like kinds and quantities of special nuclear material comparable levels of protection are provided by security forces, whether at NRC-licensed facilities or at DOE facilities, which are exempt from NRC oversight. A final rule to ensure comparability was issued in November of 1988. It called for performance evaluation through tactical response exercises, establishment of tactical response teams, upgrading of guard force weaponry and training, strengthening of entrance search requirements, and upgrading of protected-area barrier systems.

As to important nuclear security issues, I am inclined to agree with the previously stated view that human factors play an important role in nuclear safeguards. Human factors issues can have great impact on security for nuclear facilities and include such considerations as chemical substance abuse or fitness for duty, access authorization, physical fitness, security force vigilance and training, and motivation of individual security force personnel. I will discuss these briefly.

An NRC final rule addressing fitness for duty of personnel who are granted unescorted access at nuclear power plants was issued in June of 1989. It establishes a high standard—possibly among the highest found in any sector of industry—against on-the-job impairment from chemical substance abuse and the potential for unsafe practices and operations in nuclear power plants.

The staff is presently considering whether a similar rule should apply at non-reactor fuel cycle facilities possessing large quantities of highly enriched uranium. Licensee employees affected by such a rule would include those who have direct access to or direct responsibility for transportation or protection of large quantities of highly enriched uranium.

The NRC is developing a proposed rule that would provide for a physical fitness program and establish minimum fitness standards for security personnel at NRC-licensed fuel cycle facilities possessing large quantities of highly enriched uranium.

The basis for safeguards effectiveness against an assault by a determined adversarial group is a composite of many attributes: motivation, size and weaponry of the attack and defensive teams; transportation capability available to each, including capacity and speed; communications ability available to each; robustness of intrusion delay devices such as fences, buildings, and entrances; and most importantly the capability and diversity of intrusion detection devices and equipment.

Small group adversarial engagement modeling and simulated field games have repeatedly shown that early detection of attempts at intrusion, early mobilization and effective deployment of security force personnel, and early communication notification to offsite local law enforcement personnel of an imminent attack are dominant contributors to the success of the security force in a subsequent engagement.

Early intrusion detection requires vigilance by, and effective training of, security personnel. Personal motivation is essential to the maintenance of vigilance and professional ability of security forces. Personal motivation must be an important licensee management objective.

What developments are in store for the future? Only five years ago who would have predicted recent dramatic events in the Soviet Union and Eastern bloc countries that have included unprecedented demands for freedom and expressions of resurgent nationalism by ethnic groups within the Soviet bloc, or who could have foreseen the dramatic rise to power of the drug cartels with their ruthless and violent methods?

The lesson to be drawn from these examples is that we must be prepared to accept change around the world on the national, subnational, or ethnic level for better or worse. Ethnic and ideological conflict often result in the emergence of new groups with new agendas, sometimes including terrorism. It is only prudent that we remain alert and dynamic in our approach to nuclear safeguards. There is a need for greater acknowledgement and recognition of the essential role that the nuclear security community serves.

In the vast majority of cases, it has shown itself to be staffed by professionals eager to perform their assignments to the best of their abilities, despite institutional constraints, and open to new ideas and initiatives. In my view, we must continue efforts to ensure the effectiveness of our nuclear power plant and fuel cycle security forces, both in terms of personnel and in terms of program integration with other security system components.

We should continue to fulfill our concept of excellence in the overall integrated security and safeguards system. I challenge you to reexamine your own security systems, paying particular attention to embedded key assumptions as to likely threats within the framework of the design-basis threat. I also urge you to share the information that you acquire at this symposium with appropriate local and State law enforcement officials to strengthen their interest in and active support of your security program.

I urge you to consider implementing programs to increase security force personal motivation. Personal motivation and individual accountancy result in increased professionalism and vigilance, the vital ingredients in a successful security program. Finally, I wish you a successful symposium and fruitful exchanges with one another and the speakers at the symposium.

Thank you very much for your attention.

[Applause.]

NRC Policy on Explosives Detection

Ms. Dwyer:

Now it is my pleasure to introduce myself. I am next on the agenda, to give a brief overview of the NRC policy on explosives detection.

As most of you know, NRC requirements for explosives searches cover Category (CAT) I fuel cycle facilities and, also, our power reactor facilities. "CAT I" means those facilities that possess formula quantities of strategic special nuclear material.

What these search requirements consist of is a 100-percent search of personnel, except for State, local, and Federal law enforcement personnel and DOE couriers for fuel facilities. All hand-carried packages are searched—a 100-percent search—and delivered packages and materials are also subject to a search for explosives, except those specifically exempted by the Commission in approved plans.

Vehicles, except DOE and emergency vehicles, responding to emergencies are searched before entry into protected areas (PAs). The cab, the engine compartment, undercarriage, and cargo area are searched.

How are these searches conducted? For personnel, we require a search by the use of detection equipment at both the CAT I facilities and the power reactor facilities, with pat downs for cause; that is, if the individual appears suspicious or if there has been equipment failure. Hand-carried packages are also subject to an equipment search.

Specifically, with regard to the performance standards for nuclear power reactor facilities, performance guidelines are outlined under security plan commitments. These commitments for the most part parallel manufacturers' specifications for the explosives detection equipment. Some additional guidance on entry and exit control may be found in Review Guideline 20 and Regulatory Guide 5.7, which the license reviewers use. But for the most part, it is the security plan commitments that outline the performance standards for explosives detection equipment for power reactor facilities.

We recently revised our guidance at CAT I fuel cycle facilities. NUREG-1329* calls for operational testing of explosives detectors each shift or whenever the unit is turned on or off, and we require three out of three trials to be successful. The test sample should consist of one-eighth of a stick of nitrated dynamite, a wrapper from a stick of nitrated dynamite, or two-to-three grams of double-based shotgun or pistol powder. We do performance testing quarterly, and during performance testing the detector has to detect the test sample 30 out of 30 trials.

That is a brief overview of our requirements of explosives detection for fuel cycle facilities and power reactors. That concludes my briefing.

Next on our agenda is Mr. Robert Quigley of the Federal Bureau of Investigation (FBI) Bomb Data Center. Mr. Quigley has been the Chief of the Bomb Data Center since 1983. He has been on the faculty of the FBI Academy, and an adjunct Professor of Management at the University of Virginia. Mr. Quigley will speak to us about domestic terrorism and statistics on the bombing threat. With that, I would like to present Mr. Quigley.

Domestic Terrorism – Statistics on the Bombing Threat

Mr. Quigley:

We are going to cover a lot of ground in the next two hours. I always guarantee people we will get to lunch on time. If you have any questions, there is a possibility of stopping me while I am talking, but I have a bet with a few of my colleagues that once I get this Bronx, New York, accent going, I am going to purposely make sure that there is no possible way they can transcribe anything I say. I think I can win the bet.

As I am rolling along, it might be difficult to ask a question, given the size of the audience. We will be here all day. Later on we will have a question-and-answer session. If you can hold the question – if you do not get my attention – hold the question and catch me later on or catch me at one of the breaks. For all of you in the room, if you are involved with explosives in any way, in the detection of explosives, problems dealing with surreptitious entry with explosives, etcetera, please do not hesitate to give us a call. We are more than happy to talk to you on the phone or meet with you if you have a specific problem.

I do notice that we do not have any address or phone number in the booklets . Our phone number is FBI-BOMB. Only one person ever uses it – my mother calls from New York because she thinks it is very cute. But really, if you ever have a problem, do not hesitate to give us a call. I would like to preface everything with that, because I am not going to cover everything here. We would be more than happy to speak to you and help you out. The threat is real, and it is a threat that can be countered to some degree, but not totally.

[Mr. Quigley's formal paper and selected slides are contained in Appendix A to these proceedings.]

What is a bomb data center? I think you ought to know that. Basically in the FBI, if there is an investigative case dealing with explosives, our Criminal Investigative Division handles it. We have a large division that handles all the ongoing cases. But there are only two groups within the FBI who handle explosives, deal with explosive items. Both these groups are in the FBI Laboratory.

The easiest way to describe the two groups is that one group is forensic in nature – post-blast investigations. Once the bomb goes off it's theirs. This group travels all over the world dealing with bombs. In fact, right now, the group has a few people sitting around wondering if they are going to the sunny climate of Colombia this afternoon. That's one group, and it will be represented later today.

My group [the other group] is basically preblast. Everything we do is before the bomb goes off. We are called a "bomb data center." The FBI Bomb Data Center is the U.S. representative to a network of bomb data centers around the world. Canada, Australia, New Zealand are on board. In Europe there are representatives at these bomb data centers from Great Britain, Germany, France, Switzerland, and Spain. We have other countries that are petitioning for membership in this group. Bomb data centers have been around since about 1975, and more countries are becoming involved, particularly in Asia where bombings had not been a major problem until now. I will show you statistics on this later.

The bomb data centers share technical information on bombings and bomb components. That is one of the reasons why I'm not afraid to stand up at an unclassified conference, because most of the work that I am involved in is technically unclassified. What do I mean by that?

Basically, I can pick up the telephone and I can talk to my counterparts in the United Kingdom, and we can

* NUREG-1329, "Entry/Exit Control at Fuel Fabrication Facilities or Possessing Formula Quantities of Strategic Special Nuclear Material," USNRC, December 1988.

talk on a standard telephone about types of batteries, what kind of explosives are currently being used—technical information. If somebody is overhearing our conversation, it really isn't going to mean anything to them. We do not, in bomb data centers, speak about groups that have conducted the bombing, we do not speak about individuals, or anything of an investigative nature.

This is what makes the bomb data centers really work. It is a very effective tool for most of the countries involved because we share technical information very quickly. It is my job to impart the technical information to some of our investigative people, which just makes for a better package for everybody. I have the rare luxury within the FBI of being able to speak about things without worrying about tripping over investigative items.

The second major thing that the bomb data centers do in most countries is provide all the training for bomb technicians. It is the FBI's responsibility to train all the police bomb squads in the United States. A little later on in my comments I will show you how we do that and how many people have been trained. It's quite a sizeable number. It is a very unique job for the FBI.

This training doesn't fit in anywhere with our normal type caseload or our normal investigative function. We were directed to do it by the U.S. Congress—it's mandated for the FBI. We are proud of the schools and I think it is worth your hearing about later on in our conversation.

Today, most of the agenda is dealing with terrorism. There are a million definitions of terrorism. To be honest with you, none of them really are very good. They are not perfect. There is no perfect definition of terrorism. Every time you try to commit it to writing, you leave some kind of a loophole that, within months, happens to come up, and you start defending your definition. The British definition of terrorism is about two lines. They thought they had very succinctly given a definition of terrorism. Every time a bomb goes off in Northern Ireland, they have trouble fitting that event into their definition. It's an awkward situation.

The U.S. Government's definitions of terrorism also are awkward. Within the law enforcement community we try to operate with the following definition:

> *Terrorism is the unlawful use of force or violence against persons or property through a criminal act designed to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives.*

This is a combination of a few of the U.S. Government definitions that have surfaced over the last few years. The reason I bring this to your attention is to give you an idea of the focus of the FBI and the law enforcement agencies. There is a different focus in the law enforcement community compared to other agencies of the U.S. Government, and probably most notably, the U.S. State Department. It is a bone of contention on occasion. We both try to live with our general goals and objectives, but there is a little split in the road and it does at times adversely affect U.S. efforts in terrorism.

The law enforcement community believes very strongly that terrorism is a criminal act. As you can see, one example here involves a criminal act. There is nothing in the statutes of the U.S. Government or, for that matter, State and local governments that includes terrorism as a crime. Bombings are a crime; kidnappings are a crime; killing is a crime—terrorism is not written down as a crime.

We in law enforcement have taken the focus that we want to "work the crime," that's what we get paid to do. We treat terrorism as a criminal act and we try to specify what act it is. Why do we do that? One of the main reasons is, it is the area we are most comfortable in. For years we have been working criminal acts, so we would like to use the knowledge accumulated from those years and transfer it into our investigation of terrorism.

Most of the definitions dealing with terrorism include a reference about it being a political act. Unfortunately with the term "political act," it makes things subject to all sorts of individual subjective interpretations. Here is the problem that occurs in using the term "political act." A guy from the provisional Irish Republican Army blows up a British dormitory housing troops that parade for the Queen. Seven men are killed. The bomber escapes; the British do an excellent investigation and conclusively prove that he was the individual who was not only at the scene but who made the bomb because they find a fingerprint on a piece of tape.

He is known to have been in New York, Boston, San Francisco—he is found in the United States. Then the extradition process starts. He and his attorneys argue that what he did was a political act. Before we know it, in the United States, instead of the judge ruling on the criminality of the act, the extradition process calls for him to rule on the political motivation. Terrorism starts to become defined by motivation rather than the criminality of the act.

That's where we in the law enforcement community have a real hangup. As far as we are concerned, the individual should be treated in relation to the act in which, according to the evidence, he was involved and any extradition should be based on the act itself. It doesn't become any more clear-cut when you start dealing with Central American countries and other countries around the world.

So, I want you to know what the focus of law enforcement is—for us it's a lot easier to deal with terrorism if we deal with the criminal act. We are looking for the guy who put the bomb on Pan American Flight 103; we are looking for him because he put a bomb on that plane that exploded and killed people. Then, as far as we are concerned, in law enforcement, when he's in court having been charged with that crime, it's up to his attorneys to raise all the motivational problems that led him to do what he did. If they want to talk about his terrible family life and the fact that he was beaten when he was a kid and locked in a closet, fine. The system allows for all of that. It allows for him to speak about his motivation for doing what he did. But let's get him into a courtroom based on an indictment on a criminal charge.

I am going to cover material contained in some of your handouts. You have to realize that all terrorists are involved in trying to undermine public confidence. Certainly, when you get into the nuclear world—what an ideal place to undermine public confidence. Why? Because you do not have to do too much to undermine it. That makes you a target. They know—these people are not dumb. They read about all the civil actions against the nuclear industry, and it occurs to them that it's almost like taking nine supporting pillars in the building and watching seven of them being knocked down by others and then their job is to knock down the other two to bring down the whole building

That's why there is no question that you are a target. There are reasons why you haven't been hit, and hopefully we will get to those. This idea of public confidence is a very, very important idea. By the way, it's an important idea, not only with regard to the terrorism that we are going to be talking about here during this conference, but also with regard to the work we have been doing lately on narcotic or "narco" terrorism, which is the combination of the drug people and the terrorists. This type of activity is going on quite heavily right now in Central America and there certainly have always been examples of it in Europe.

We are very concerned that if terrorism does show up in the United States, it will be narco terrorism. We have been spending so much time looking eastward toward the Middle East and their suicide bombs that we have forgotten that the real problem is south of our border. We have been passing it off as a drug problem, but the evidence is becoming clearer and clearer that there is a combination: the terrorists who provide security for the drug cartels and the drug cartels who are funding the terrorists. This issue is going to get bigger and bigger as time goes on and it poses a real threat.

Public confusion and fear—there is no question that is what terrorists like. They can either kill the target or destroy property. If you are going to put this down in a chronological fashion, you could almost say that the bulk of terrorism in the 1970's right up to around 1983 was more the destruction of property. From 1983 on, very clearly, it has been the killing of people. Statistically, the level of brutality involved with terrorism has been increasing over the last five or six years.

You must understand that mass media attention is the basis for all terrorism. As long as the terrorists can get the media's attention, they can thrive. Once they lose the media's attention, they have serious problems dealing with their cause. This is what drives them to do certain things. Frequently, the newspapers will say that the driving force of the terrorists going after Pan American Flight 103 was to get even—get even for taking down an Iranian jetliner, get even for this, get even for that, get even for the attack on Qhadaffi. Yes, revenge probably does play a part.

But you have to realize that one of the critical elements is to get that media attention. Because of the way the world's news media is set up right now, terrorists can take down a jumbo jet and they have everyone's attention. They have put fear into everyone. I do not care how hard-hearted, everybody is attuned to something like that.

Bombs are the principal tool of terrorists. Within the FBI, I create some problems occasionally because most of the funding in the FBI to be used against terrorist activities goes to a specialized elite unit, the Hostage Rescue Team. The Hostage Rescue Team is the civilian equivalent of the military DELTA or Navy SEALS. It was set up to handle certain emergencies that would be considered civilian in nature.

The government was looking for was a civilian team that could move in and that would create less of a public loss of confidence in government. That's how the Hostage Rescue Team was formed. It's a very good team. They are all very professional, they train all the time. For the FBI, it's a commitment of 50 special agents who are working out all the time, practicing, getting ready for a major hostage situation or a major kidnapping.

The interesting thing to me is that the formation of this team is based on the statistics from the 1970's when hostage taking was a major terrorist activity. That's how terrorists were getting most of their media attention. The thing about the terrorists is, they were also noticing—apparently they do critiques—that the hostage takers were losing almost every one of these hostage situations. After a while, it's kind of hard to get terrorist recruits when they know they are going to be killed. The motivation isn't too strong.

Hostage situations have dramatically declined in the eighties. The establishment of professional police and military teams have contributed to this decline. Some officials have decided that these special teams have scared the terrorists; so let's keep pumping money into the special teams and we will keep frightening the terrorists. Whereas, I am sitting here saying, "No, they are bombing things. We have to start putting more money into bombings, because statistically that's where it is at." Some officials really became peeved when I had a sign put up over my door: "All I need is one more bomb." They said that was very insensitive. It was my feeble plea for some funding because nobody was sending the money our way.

Why are bombs so popular with terrorist groups? Because the terrorists can generally accomplish the bombing with one person. It doesn't require all of the work that a hostage situation requires. To be honest, even an assassination generally takes a little more time to work out.

With a bomb, the terrorists could position it six months ahead of time and read about it in the newspapers later because technology has made th it possible. I have told this to other groups and it's not a classified item. One of the things that helps us in the bombing world is the fact that there is an understood division of labor. There are some spectacular bomb makers around the world. They are the scourge of the earth, but these guys make excellent bombs.

We can build the greatest detectors in the world, and these guys will build a bomb that is better. They are professionals in what they do, and that's all they do, make bombs. They either make them for an organization or they sell them to an organization, either way. Some of them make a very good living from their trade. One of the things that helps us is the fact that the bomb maker, quite frequently does not place the bomb. The guy that places the bomb generally makes some kind of a mistake.

Placement becomes a very critical element in having a successful bombing. I will give you an illustration that I use around the country. There was once an attempt to knock out some major pipelines by a terrorist group. The pipelines, like so many things in the transportation world, are like power grid lines, and they are not really well protected. Pumping stations generally are located out somewhere all by themselves and somebody comes by periodically to check some the dials and maybe put some oil in something. But the station just pumps all the time. The pump station building is surrounded by a nice fence with some barbed wire and the presumption that nobody can get in. They make a good target, they are a pretty soft target.

An attempt was made to hit some of these soft targets. There were six of them—six individuals were given bombs. The bombs had been specially made by a professional who was told about his target. He elected to make a bomb that was a very well-made, homemade "shape charge." The idea being that the explosive charge, the vast majority of the pressure and the power, would go in one direction and it would sever the main pipe. If the six terrorists could sever the pipeline in six separate places, that would take a long time for people to put together again.

They went marching off at night to carry out their assigned terrorist task. Each was carrying a bomb that had been given to them with instructions. The instructions were to break into the buildings and place the bombs approximately two feet from the main pipes. In all these pump station buildings, that required walking about 18 feet into the building and using magnets to place the bomb on another pipe aimed directly at the main pipe. The terrorists were then told that once they had the bombs properly aimed, they should move the toggle switch and a little red light would come on indicating that the bombs were armed. With the timers working, the terrorists could exit the buildings and the bombs would go off one-half hour or an hour later.

There is something about carrying a bomb that makes one feel a little awkward to begin with. But hitting the little switch and waiting for the little red light to go on adds a crucial element. In this case, all six of these individuals successfully broke into the buildings and all six of them elected not to cross the room. Instead, they reached inside the door, slapped the bomb on the wall, and ran after they hit the switch. There wasn't one of the six, as dedicated as they were to Marx and Lenin or whoever. There wasn't one of them willing to walk across the room—they didn't trust the bomb maker. They didn't know who made the bomb. I venture to guess that half of them probably thought that if somebody was really thinking, they would not leave them around as witnesses—would they even see the red light. All of a sudden the uncertainty started to bother them.

The fact that there is this division of labor has been helping us in the bombing world. We are hopeful that it will continue that way. We do not personally think that the bomb makers will, of their own volition, get up and start placing the devices. Again, I am talking about a fairly small group of people, some of whom we have identified and others we still have not identified.

There is a little egomania, by the way, involved in bomb making. Most bomb makers leave a signature in their bomb. Some of them are ridiculous—there were some FALN [Puerto Rican Armed Forces of National Liberation] bomb makers in the United States who insisted on initialing the components of their bomb. That is the height of egotism. They also might have been showing some stupidity—and they had to be stupid if they actually thought the bomb disappears after it blows up. That isn't true. The bomb components are still there. They may be in very small pieces, but they are still there.

There are other people who use certain types of woods; other people only use certain types of explosives or certain types of wire. In many cases, it is because these bomb makers can rely on that particular material. However, they are not stupid; they also know that they are telling us who they are. The more successful they are, the more they want to tell us who they are. They feel very comfortable that we can't get them. Even if we identify them, we could not get into the country in which they reside.

Very few people are needed to accomplish a bombing. There is no need for a complex plan because the technology is available. If they want to put the bomb in a building and set a timer for six months or nine months, they can do it. You can buy many of the components of a bomb at Radio Shack. The technology is there, it just requires a person to have some basic ability with explosives and basic ability with electronics and basic ability to put it all together—in addition to a certain amount of basic courage to sit there at a table and put the final wires together inside an explosive device.

These people know the statistics. It is estimated that half of the bomb makers generally either kill themselves or at a minimum they lose their hands. Sooner or later, they are going to cross the wrong wire. It's an awkward situation. They are not making military ordnance, they are making a bomb by themselves and little errors do creep in.

There is usually time to escape because of the use of long-term timers. The terrorists can either hit a specific target, or they can assassinate a person. They can put a bomb in a newspaper receptacle and have somebody pull it open. Watch the person for a few days, know roughly when he shows up to pick up the paper, and the odds are that the terrorists are going to get him. If they don't get the target, they get an innocent bystander. Therefore, a bomb can be used as an assassination technique or for a general target. Quite frequently those general targets are airplanes, airports, large areas with a lot of public movement.

There are a variety of terrorist bombs. The mobile bomb, thank God, has stayed in the Beirut area basically, in the Middle East. It is an extremely difficult bomb to deal with. Even if you put up the best barricades, a 20,000-pound bomb is still going to do a lot of damage to your building, particularly if your building was built before we worried about these things and before we used barricades. In that case, your building probably has a lot of glass. Twenty thousand pounds of high explosive going off at that barricade will send slivers of glass flying through your building at roughly the rate of speed of a bullet. These slivers of glass are going to rip through people. Most people die of fragmentation not of blast pressure. The mobile bomb is a real threat. The mobile bomb in the Middle East is the car/truck with the suicide driver. A number of drivers have died and the terrorists are having a little trouble finding a new group of drivers now.

Accurate, long-term timers are being used frequently on bombs in Northern Ireland. They also are used in the United Kingdom. Clearly, it was some type of long-term timer that worked on Pan American Flight 103. Western Europe has been having quite a bit of trouble with these timers, and we have been seeing them to quite a large degree in Central and South America. Again, the technology is available and the materials can be easily purchased at places like Radio Shack.

Most of us do not think that a timer can be set to go off nine months or a year later. When we were working with the South Korean security before the Olympics, we were trying to convince them of this. They kept showing us new buildings, and we asked them if they had checked out the buildings as they were building them, to make sure somebody had not secreted a bomb. The initial Korean thinking was, even if a bomb had been hidden, it couldn't go off two years later. We had to show them some of the technology.

The radio-controlled explosive devices are a major problem, particularly in Northern Ireland. They are used quite heavily in the Middle East as well. These devices are high quality. Most of the radio-controlled devices that are used by terrorists employ scramblers so that the terrorists can use the devices in areas that contain a high level of radio frequencies. This way the terrorists can still control their device.

Explosives are available all over the world. All over the world. The United States does try very hard to control our own military plastic explosives, C-4. I think the military does a very good job of controlling it. Most of the instances where C-4 has moved out of military control are generally in drug cases. C-4 is a wonderful bartering chip for drugs.

People trained in using explosives are available; there are a lot of people who came out of the Vietnam War who know how to use explosives. Some have become mercenaries. Recently, as I am sure you all read in the newspapers, down in Colombia you allegedly have former members of the British SAS [Special Air Service], you have former Israeli commandos, you have former Australian commandos; these men were on contract down there to the drug cartels, although they claimed they thought they were working for the Colombian Government. They are being hired as mercenaries and are bringing with them their capability to use explosives, which just adds to the terrorist's arsenal.

How many of the terrorist incidents in the world are bombings? It's 50 percent. Fifty percent of all the incidents in the world are bombings. This has held true for a number of years. There really is nothing to indicate that it is going to change. As a matter of fact, the level of bombings internationally for this year is running quite a bit ahead of 1988. So, we are experiencing an upsurge. A lot of it is happening in Central and South America.

Where are these bombing incidents happening around the world? There are some interesting statistics *(Appendix A, Quigley)*, and they may be applicable to your line of work if you have dealings with some of these countries. Central and South America have consistently been a problem. The reason that we know very little about the problem is that the U.S. news media does not really cover Central and South America. The news people will cover Noriega, they will cover El Salvador when the capitol is under attack, they will cover Colombia when the government takes some solid action against the drug cartel and there's an increase in bombings. They will cover some of these South American countries for a few weeks and then they will back off. The lack of coverage is also true in Africa. It is unfortunate that Americans do not know the extent of terrorism and bombings in these parts of the world.

Many of the bombs in South America are put together in an exceptionally professional manner—the latest in technology. In some cases, the technology that is brought over from Western Europe and the Middle East is used, providing a nice testing ground for some new techniques. It is a very serious problem down there, and they are our closest neighbors.

The rate of bombings in Europe is usually consistent—20 percent of the world's incidents. Of course, most of the bombings that occur in Europe are carried out by groups from outside of Western Europe. They have a constant terrorist problem in Europe. The Middle East is generally down at the 10-percent level. The reason for that is, really, there aren't that many people or countries in the Middle East. Percentage-wise, when you look at the international breakdown on terrorism, the Middle East represents a small component.

One of the unique things though, is that in the Middle East, when a bomb goes off, it quite frequently injures or kills 20 to 50 people. The sizes of the devices in the Middle East are what is frightening. The concept of a 450-pound car bomb going off on a city street is difficult to imagine. It would be a major disaster. That is why we get media coverage of bombings from the Middle East. These bombings are extremely brutal acts.

The region that is bothering us is Asia. Asia is clearly showing an increase in the use of explosives. Countries like Japan, through the years, have always used incendiary devices, but are now using explosives. We are not sure whether it is a criminal element or whether it is tied to terrorism. Clearly, we can show an increase statistically. In 1987 Asia accounted for 12 percent of worldwide bombings. Asia increased to 17 percent in 1988 because of the Sikh terrorism going on in Northern India. The Sikh's make good bombs. The problems in Sri Lanka also have contributed to the increase. These two areas of terrorism have really been boosting Asia's average. There is no question that there is a rise in terrorist activities and bombings going on in Asia.

Africa continues along at a fairly low percentage with many of the bombings in South Africa. Again, the reporting that goes on in Africa is poor.

North America is consistently low in terrorist bombing statistics. Unfortunately, when it comes to funding, this quite frequently hurts us, both at the Federal level and with the bomb squads in the various police agencies. They can't show too much activity and they particularly can't show terrorist activity. So, when the budget comes around, these groups are not considered for equipment or training. The frightening thing to me about this is that, in the law enforcement circles, a bomb squad is more analogous to a fire department than it is to a police department. A bomb squad has to be prepared to respond. You do not have a bombing and then turn around and say, "Listen, read a book about how to respond and let's get out there." No, you need equipment and you need training. If we fail to prepare in response to the threat, we will not be prepared to deal with the actual incident.

What are the targets? This has to be of interest to you on a few levels. The terrorist targets around the world have moved from government and diplomatic facilities to business interests. There is one very simple reason for that, and it's called hardening targets. As soon as you start to harden targets, the terrorist will move to another target. Terrorists need some successful operations to attract media attention. So, if you harden your facilities, making it difficult for them to attack, they are not going to continually try to get through to that target and fail. Failure is not what they want on a TV screen. In fact, they know that most TV stations do not run failures. They only run successes. So, they frequently move to the softer target.

As soon as the U.S. Government, particularly the State Department, started to harden embassies, which were a prime target, statistics show that the attacks on embassies started to decrease and then military installations became the target. At that point, the U.S. military, particularly in Europe, started to harden their facilities. So now the focus has moved to IBM, General Electric, and other business interests. Now people are scampering around trying to figure out how to harden their facilities. If and when they do, it will move to something else. That is a common principle of terrorism; they will generally go for the softer target.

It doesn't mean that the hardened target is off the hook; it does mean that there is less of a threat against it because strategically the terrorists do not want to take on a hardened target. The two places in the world where police and military become primary targets are basically Northern Ireland, where the military is the target, and Spain, where the Basque separatists, another terrorist group, generally try to go after police personnel.

When a terrorist group booby traps a device, it means they are hoping that the police agency will try to disarm the device—not dispose of it, not disrupt it. In the bomb world, to dispose of a device or to disrupt it means that the police or whoever are generally using remote techniques. They are not putting themselves at risk, or they are limiting the risk to themselves by doing something to the device to destroy it. When the police disarm a bomb, frequently that entails actually getting into the device and cutting off its power source or whatever.

If the terrorist knows that police procedures consist of hand entry into explosive devices, the terrorist tends to use a booby trap in the device. Why? He says to himself, "Wait a second, if I put the device in a bank in Madrid, I am going to get coverage on that. But, if I booby trap a device, I am going to get more coverage because I am going to get coverage on the fact that I killed two or three police officers at the same time that I blew up the bank." Same bomb does both things. A bomb doesn't differentiate.

I recommend to all officials responsible for security that they use the expertise of private security consultants as well as the official U.S. Government statistics and information. They often do a better job of monitoring Reuters [the news service] and all these other news gathering groups that really come out with what is going on in the world. Frequently, government agencies do not want to spend money on something like that or commit staffing to sit there and read the ticker. The private groups do because that's their life blood. They are expensive, there is no question about it. The private groups cost money.

In my position, I match the private information up against U.S. Government statistics, whether they be from the State Department or the law enforcement side of the house. I can tell you this much, as far as I am concerned, statistics from the private groups are every bit as good as ours and they are generally more timely—they are quicker than we are.

The Rand Corporation is used very heavily by the U.S. Government and perhaps your agency has used them as well. Rand has always been very competent in putting together statistics, particularly in forecasts. In their forecast for the 1990's into the early 2000's, they maintain that principal targets will include transportation, telecommunications, computer networks, and power grids. All are considered highly vulnerable—usually as soft targets.

Basically Rand says that there is no question that terrorism will continue. It will go a little more slowly than in the 1980's. All the statistics are pointing out that there is a greater willingness to kill. There are more people being killed in terrorism now; I will get to some of the reasons for that. Better concealed state sponsorship. The Libyan raid, no matter which side of the argument you want to be on as to whether it was worthwhile or not, it did send out a signal to most of the countries that would support terrorism financially or otherwise that they better conceal it. There is evidence that the raid has made terrorist supporters more cautious.

Increased standoff tactics are a problem that everyone in security has to worry about right now. There is a movement of military quality weapons going into terrorist hands. This is very well documented and it's also been made public. The thing that kind of confuses us at this point is, why those devices are not being used more often. The fact that the terrorists are not using these devices is to our benefit. They are out there, so these standoff tactics have taken terrorism into a military warfare sense. What are we expecting? We are expecting bigger bombs. There are some interesting statistics. Believe it or not, back in 1984 there was a paper written that said that psychologically if you kill more than roughly 450 people, your impact on the public will be less. It said that the way the human mind operates, when a large number of people die—500 and above—the human mind, to protect itself from all the horror and the fear that comes from large scale death, makes something an act of God, like a flood, like a hurricane or an earthquake.

What we are finding is, based on that paper, that the terrorists have concluded that the number of people on a 747 is probably the ideal number. I mean, that really rivets peoples attention. It is something very physical, and since we all travel, we can all relate very heavily to it. So, it's not an act of God. The bigger bombs are clearly...the reason I got into that is, remember about an airplane, the airplane becomes a bomb once there's a bomb on it. That's a very unique thing about an airplane, and it may very well be a unique thing about some of your facilities and the terrorist knows that. The terrorist knows that it isn't the pound of explosives that he puts on that plane that really makes the difference. The fact is that the plane is in an environment of 30,000 to 35,000 feet and is pressurized, and the plane becomes a bomb. Their small explosive device really becomes the initiator of a larger bomb—the airplane. Be aware! They think this way, and that may be the way that they look at some of your locations.

Will terrorism continue? Yes. No question about it. State sponsorship, there is a lot of talk about this. A lot of people like to look at the Soviet Union and blame them for it and everything else. But, it's pretty hard to put your finger on any particular state. Let's face it, just about any country in the world, if it serves some of their needs, will give either explicit or implicit support to terrorist or revolutionary groups.

The social, economic, religious problems are always going to exist, and that's why terrorism will probably always exist. Access to weapons and technology has become great. Will it escalate? Yes, it will and very quickly. When you go back over the statistics of terrorism, back in the early days of terrorism, particularly the PLO [Palestinian Liberation Organization] terrorism, all its public statements said that it would only use enough violence to get attention. The PLO held to that in the sixties and early seventies.

We could literally track a level of control—they could have done worse things. By the way, I am not excusing anything they did. But from the level of brutality, there was some kind of a control over it. From 1983 on, you can't see that level of control. Many of the groups have gone just absolutely wild in developing the most brutal techniques they can. There is a self-fulfilling prophecy with all terrorism. Again, it gets back to the fact that to get attention you have to demonstrate a greater violence.

About the interaction of terrorist groups, I can tell you this much, there are very strong indications that certain groups do have dealings with each other at certain times. There really isn't much information that indicates that the groups go off to some retreat and work together refining their skills. Rather, one terrorist group reads the newspapers or watches television and copies the technique because it was successful.

To be honest with you, after Lockerbie one of the most frightening things for any of us in the explosives community, was sitting there and watching people on McNeil/Lehrer, on Dan Rather, on all the morning shows, talking about what they thought the device was, how it was made. I remember one security consultant sitting there saying, "And here's how I would have made it, which would have been better than theirs." They were literally telling people how to make bombs on TV!

[Video tape of bombing scene in Asia, not included.]

The bomb itself was largely a fragmentation bomb. However, many of the people died because they were buried in debris. One of the things the video tape shows is this: When the bomb exploded, many of the people in the area were security personnel. Yet, they had no idea what to do, no idea. For those of you involved in the security world, it is your job to try to train people. There should be some kind of a plan of operation to deal with a major catastrophe like the one you just saw. Instead, what we saw were people responding to someone moaning and literally stepping on the bodies, some still alive. We saw other individuals trying to aid the person who was moaning. They just didn't have any idea of what to do. Similarly, there were no medical facilities set up there, nobody in attendance. A lot of people bled to death because there was no rapid medical response.

[Photographs of bombing events are not included.]

These are airline crashes. By the way, people are still working on the one that happened yesterday. The last I heard, the Colombian Government said they still had not found any evidence of a bomb, although all the eyewitnesses said the plane blew up and was cut in half. So, the odds of it being a bomb are very high. Right now we are still working on that.

I am going to go through some of these photographs very quickly, just to give you an idea of a bombing. That is the U.S. Embassy in Beirut, and that's after a 2000-pound bomb exploded in the lobby. This photo shows Marine Corps Headquarters in Beirut in 1983. I had been there about nine months before the bombing. This photo was taken after the bomb went off. The large smoke cloud is the Marine Corps barracks, the smaller one is the bombing of the French military headquarters. Basically, that was the building after it was all over, after a 20,000-pound bomb had exploded.

The crater was huge and no semblance of the building remained.

This is another famous bombing, the Brighton bombing in England. It was a very cleverly placed device, and again, aimed at killing members of the Thatcher government. It had been secreted in the floor of the hotel room with a timer going, and the bomb sat there while people checked in and out of that room for a number of months. That bomb was just sitting there ticking, waiting for the Thatcher government to hold their annual meeting.

What are the statistics in the United States? The United States has about 1000 bombings a year. Compared to a lot of our foreign counterparts, this is a large amount. The British, the Germans, they just do not have the level of violent criminal activity that we do in the United States. If they have 30 or 40 actual bombings in a year they consider that unusual. However, they may have the equivalent number of terrorist bombings or more terrorist bombings.

Here, it is just the opposite—very few terrorist bombings. We haven't had one really in two years, except some in Puerto Rico. It gets into a question whether it is terrorist or not, but at the present time we just haven't had any terrorist activities.

Anywhere between 60 and 75 percent of the bombs that explode in any given year in the United States are pipe bombs. Interestingly enough, this is not common overseas. Again, when our British and German counterparts come over here, they are absolutely amazed that the pipe bomb is the bomb of choice in the United States.

In most cases, this is probably as crude a device as it comes, but that's what makes it so dangerous. I mean, a pipe bomb is an extremely lethal device, extremely lethal. When it goes off, it's the steel or the fragmentation that is going to kill you. When the bomb makers start adding clocks and power sources, they can make a very interesting device that poses a real problem to any member of a bomb squad.

High explosives are used in the United States in about 10 percent of all the explosive devices. In South America or in Europe, high explosives will be up around 50 to 60 percent. There is a uniqueness here in the United States in that most of the bombs are made with black powder. Basically it is the accessibility of powder. You can buy it almost anywhere and there's no great problem getting it. As a matter of fact, it's not a particular problem to get certain explosives in the United States. Plastic military explosives (C-4) are the most difficult explosives to get in the United States. When you look at targets in the United States, again, they are different than the targets in the international terrorist world in that most of them are residential property. That's because most of the bombings in the United States are criminal in nature.

They are either drug related, organized crime related, or acts of vengeance. Frequently, boy against girl, lover against lover, ex-lover whatever. That's why the residential target shows up pretty heavily, 34 percent. For your purposes, in the area of utilities, we do not have much activity, two percent. Some of your locations would fall into the utility category.

But then when you look at damage that comes from a bombing, utilities are up here at almost 50 percent. I guess basically what we are saying is, not too much activity against places similar to yours, but when one is successful, it causes major, major physical damage and perhaps the potential for large-scale death and injury.

This [photograph] is the largest bomb to go off in the United States. Some of you may remember it—it was 10 years ago in Harvey's Casino at Lake Tahoe. That's the bomb. I like to show it to people, only because you all have this vision in your mind of what a bomb is. Unfortunately, that is not the standard device we envision. Devices can be made any way the bomb maker wants, and that's what makes it so difficult to find them. They are not always of the TV variety—sticks of dynamite with a watch and blasting cap.

This device has roughly 850 pounds of explosive in it. It is two metal cabinets, a small one on the top containing most of the firing mechanism. The bottom one contains the high explosive. Many individuals from the U.S. Government, local police, and the military were out there to look at the device. It was an extortion device. Again, for those who are responsible for security, see how easy it is to breech security. When these guys showed up at one or two in the morning at Harvey's Casino and told the guard force that they were unloading a computer, the guard force helped them unload the computer.

The guard force helped them roll this through the casino onto an elevator, up into the administrative offices, at which point the three guys involved said: "You can leave us alone now, we will set up the computer." Translated: we will now set up the bomb, thank you for all your help. The motive was extortion, he wanted $1 million. He gave us "X" amount of time to come up with the money, and conducted a dialogue with the law enforcement authorities.

The X-rays did not properly show us that he had some sticks of dynamite wrapped in tape in the top box. They were there. Certainly in the aftermath everybody looked at it and said, "Oh God, there's the dynamite." The technique that was employed was to separate the top box from the lower box and if we could do it fast enough, beat the circuits and all, at least the large portion would not blow up and only the initiating elements would blow up. Unfortunately, the unseen dynamite was lit during the neutralization process and the rest is history—a large explosion.

For those of you in the room who deal with security, since we had time and the building was completely evacuated and all...one of things that really did cushion the amount of damage was to open the windows. Try to plug that into any plan you have. You might be caught up in the idea that it could be a security problem and maybe it is, but it will cut down on the amount of damage. The more you can release the pressure if that bomb goes off, the better off you are going to be.

Basically, to anybody who does not know about explosives, we say this: "Do not touch it, do not move it, do not wet it, do not open it, do not do anything with it." The best thing that you can do in your plan is to have people who are familiar with an area so they can spot something that is unusual. Once something is found, the next part of the plan is to notify competent people to come in.

We can tell you who we think is competent on the basis of training. However, I can tell you this, of all the people we train, some are much more competent than others. You want to bring in competent people to professionally deal with the explosive device, and you want to be sure that from your standpoint you have evacuated the area. If there is ever going to be litigation, it will be directed at the security personnel who have not evacuated the area. Evacuate to the extent that you think is possible and necessary.

I saw a very high ranking member of the New York City Police Department once argue with the commander of the New York Police Department's bomb squad who—in a high-rise building right off Park Avenue, 70 some odd stories tall, the device was located on the 44th floor—ordered an evacuation of two floors above and two floors below. This senior officer said, "my God man, you are talking 30,000 people." The commander said to him, "you better move quickly because if something goes off, the odds are that some of those people are going to die."

It seems like a crazy thing to have to do, but in today's world of civil litigation, if you are a security chief and you do not evacuate, not only does your job disintegrate but you can look forward to maybe four or five years in court.

What I am saying to you is this, you may not be able to stop a bomb going off but you have to fulfill the basic requirements of the security world. One of those requirements is to evacuate people as far as possible. You are going to be under tremendous pressure. We see it all the time, especially with planes. A threat is known, and we insist that people be off the plane before any search occurs. But the airline that has the flight keeps saying, "come on, you are screwing things up." Or a police chief says, "you are holding up traffic." In your case, you may have to shut down an installation for a while. You are a lot better off being safe than sorry, I can guarantee you that.

One of the devices that was found in Germany in 1988 was a basic Toshiba radio. It will give you a rough idea of the capability that we are dealing with nowadays. This device was found by the German police during a concerted group of arrests and searches last October. When they opened up the radio, the first thing they noticed was a white package. The white package was cloaked in a Toshiba wrapping, but the white package was an explosive charge. The charge in this case was a little under a pound.

The bomb technician peeled each layer to get into this package because he didn't know what kind of electrical or electronic component would be inside there. In other words, he was concerned about a possible booby trap or the fact that he could inadvertently set it off. Once he got in there, he found a plastic explosive. It was orange in color, probably Semtex plastic explosive, and the wires and the blasting cap were hidden under a little cutout Toshiba marking. The bomb makers also had cut the Toshiba marking out and pasted it on top of the timer. The bomb makers did everything they could to make the insides look like a Toshiba radio with the thought that if somebody opens it up, the odds are that they are not going to bother looking at anything that has the Toshiba logo on it.

The antenna was the arming switch and the radio contained an atmospheric pressure switch. The switch was set so that at a certain atmospheric point it would open up—when the plane hit a certain pressure—and it would start the timer. The timer would be geared for "X" number of minutes or hours, whatever the terrorists wanted, and then the device would go off. I guess what I'm saying is that with the level of sophistication used to make something like this, if the radio was in somebody's luggage, without a good intelligence report telling you what to look for, that thing would be almost impossible to find.

In April 1989, the German police found out that in the places they had searched they had missed a few devices. That is one of the tendencies that all of us have. We find something and we think we have scored, and we stop searching. Again, for those of you in security, always remember if you find one device, do not stop looking; there could be a second device somewhere else. Just do not let up because you found one—that seems to be what happened here.

Anyway, the German police went back in April and they found two larger devices in rather large living room stereo cabinets. They brought these devices back to their headquarters and for some unknown reason they were taking the devices apart downstairs in the basement parking area of the building. I say unknown reason, because the West German bomb squads have absolutely excellent equipment. They have robotic alarms and all sorts of things to use to really bring in the safety aspect when they are dealing with an explosive device. For some reason they decided to do this down in the basement.

The bomb technicians managed to disarm the first device, but the second device had been made in a slightly different way. They fell into a trap, a trap that could happen to many technicians if they aren't careful. That is, having taken apart one cabinet, the second cabinet looked very much like the first one, and they made the assumption that the second cabinet was put together the same way as the first. It was not. It blew up and killed one bomb technician immediately and the other fellow, although he has been on life support since April, his hope of survival is very slim.

You are up against very clever people. Look at this photo of a piece of luggage. If any of you are familiar with explosive detonating cord, detonating cord looks like a piece of rope. What the terrorist did was to take the detonating cord, and in a circular fashion inside a piece of luggage, he actually just weaved it around so it had an interesting pattern. He then sprayed gray paint to match the gray of the Samsonite luggage. I can guarantee you, an inspector would open up the suitcase and consider the detonating cord to be part of the luggage. The blasting cap is sitting up in the top of the suitcase.

The only thing that you can do to deal with the threats that are out there is to be prepared. The only way you can do that is to be organized—you have to have a plan. By the way, having conferences like this is a very important element of it. It really is. Some of you might be sitting there saying you are conferenced to death. But in the materials you've received there is a lot of good information. Training is very critical. As soon as the budget cuts occur in all agencies, the first thing we cut down on is training. Unfortunately, the negative effect of training reductions are not observable in the year it is cut, it happens two or three years later when people can't handle a crisis situation.

Technical equipment, in dealing with this kind of a technical threat, is an absolute necessity. It is very expensive and really does require some farsighted leadership and people who are willing to expend money and take a little heat in anticipation of something happening down the road. It's very easy for a manager, after a bomb goes off, to start running around and buy all sorts of safety equipment. The person who does it ahead of time generally takes some heat because a lot of people can't see the same threat that he sees. This is what makes a security manager's job so difficult.

Sharing of information, which we are doing today, is very important and coordination is critical. I am going to end my talk with telling you about bomb squads. The FBI trains all the civilian bomb technicians in the United States. Our school is located at the Redstone Arsenal in Alabama—Huntsville, Alabama. The school has been in existence since 1971. Congress put us in charge of it in 1981.

There have been over 4000 graduates of the school. There are probably right now, 700 to 800 trained police and fire bomb technicians in the United States. We are running classes constantly at the Hazardous Devices School. We lose bomb technicians in the United States through attrition, retirement, promotion, and even death or injury. We do not train anybody who is not a volunteer. They are all volunteers, and by in large, they are pretty good.

The difference between the police or public safety bomb technician that we train and the military EOD [explosives ordnance disposal] personnel is just a difference in the focus of the training. Military EOD personnel receive at least a year of training and many of them more than that, but the bulk of it is focused on military munitions. They are trained in how to deal with all sorts of U.S. and foreign military munitions. It is a critical part of their job.

They are also trained to deal with improvised explosive devices (IEDs), but unfortunately it's a minimal part of the training. There are some moves in the Army right now to try to increase the level of proficiency in dealing with IEDs. The police or fire personnel who deal with a bomb generally only deal with the improvised device. The thing about an improvised explosive device is that an individual made that device. He didn't make it by following instructions from any kind of a book; he doesn't write down how he made it.

All the techniques and all the training that we give these bomb technicians is on how to try to unravel the mysteries of how the bomb works and how to use high technology to safely disrupt the device. We are proud of the people who graduate from our school. I feel very awkward about the school, because there is no Federal agency that has the responsibility to render safe a bomb. In the FBI, those of us who do this training, we do not normally respond to a device.

I had a group in once from South America, and they were at FBI headquarters, and we were talking through an interpreter. It was November a few years ago, and by their questions to me it was clear that these people were trained in explosives. They understood explosives. One of the things that they said led me to ask them how many police bomb technicians died in bombings. The interpreter said, "Mr. Quigley, they lost 58." I said, "58 people, that's a lot. When did the terrorists first start using bombs?" I was figuring that we were talking 10 years or whatever. I looked at her and she actually had tears running down her cheeks. She said, "No, it was this year." She said, "they lost 58 men since January." These are not people killed in a bombing, these are people killed trying to disrupt a bomb. It puts it into a certain perspective. Explosive devices are very dangerous.

During the next few days, you are going to hear some of the state-of-the-art techniques used in trying to detect a device. From the standpoint of the bomb technicians who have to respond to the device, we do have state-of-the-art technology, but we frequently feel inferior to the guy making the device. You have to recognize that you are dealing with some professional people. Many people do not like to use the word professional when they talk about terrorists.

Unfortunately, many terrorists are highly skilled at what they do. It's a fulltime job, they do it 24 hours a day. So, it takes everything that you can do to try to prevent or deter them. You have a formidable task, and this is the place to talk about it. Sound security is primarily based on the effective exchange of information.

Afternoon Session

Mr. Burnett:

Our next speaker is the second representative from the FBI Bomb Data Center. Mr. Rick Redman joined the FBI in 1969. Since joining the bomb data center in 1984, Mr. Redman has specialized in aviation security and physical security. He is the author, editor of the FBI's book on Bombs, Airport Security. He will speak to us this afternoon on the topic of non-nuclear explosions—types and effects of explosives.

Non-Nuclear Explosions—Types and Effects of Explosives

Mr. Redman:

I am not quite sure whether I was invited to speak directly after such a fine luncheon because I would be able to keep you awake or, quite the opposite, I would give you a nice rest from your lunch and a nice relaxed nap. We will soon see.

You have seen this morning some good video tapes of what happens during a bombing, resulting damage, et cetera. Now I would like to talk a bit about why that damage occurs. What actually happens in explosions and with explosives.

The first time I talked to people from a similar community to yours was out at a seminar in Las Vegas last year for the Department of Energy. Before that, I was a little apprehensive that talking about basic phenomena or effects of explosions and explosives was too elementary for people of that ilk. I was told, and I am told the same with this group, that generally speaking, you are security people first and not bomb experts.

Therefore, I am going to get into some of the actual basic phenomena of explosions from the basic level. I think it is important. I think it sets the stage and builds a foundation for you for the rest of the portion on explosives during this seminar. I hope you will find that to be true.

Security's response to an explosive threat must be to prevent entry of explosive devices through site hardening and screening, to contain and isolate the threat once penetration occurs, to evacuate the facility of the people once penetration occurs, and to conduct a systematic search of the premises to locate the device if its location is unknown. To do this, you must have a good security plan. Planning is all important—be proactive.

You must have your procedures in place before an explosive threat happens, otherwise it is too late. I do want to impart to you though, that once a bomb or a suspect package is identified and isolated, then only people who are trained bomb technicians should handle these bombs. We have too many people out there in security fields and the public safety fields that are not explosives-trained people who make that attempt with dire circumstances.

[Mr. Redman's slides are not included, but the FBI paper, "Introduction to Explosives," has been included in Appendix A.]

I would like to talk about the effects of explosives to the human body. There is some good news and some bad news. The bad new is, obviously, what explosive power can do to the human body. The human body is like a speck of dust standing against an explosive force. That is the bad news.

The good news is that, in the particular case that I am relating to you, from a law enforcement officer's standpoint, this was a good bomber. This fellow was a bomber before this happened. He was in one of the lettuce boycotts out in California and was attempting to place a bomb inside of one of the grocery stores. He was climbing through the vents of the grocery store making an illegal entry into the building. The device functioned and the sides of the vent caused a tamping effect, which kept the explosive force entirely on his body—this can happen. You might be able to discern little pieces of lettuce there, very symbolic of the nature of what his cause was, to boycott lettuce.

The next incident is one of tragic circumstance. This is a case in which a law enforcement officer attempted to handle an explosive device. What Mr. Quigley alluded to this morning, only when somebody else's life is in imminent danger should a person not trained in explosives attempt to handle a bomb, only under those circumstances. When you do not have to deal with it, leave it to the experts. All that was left after the explosion was part of the officer's uniform. Those are the tragic results of an explosion.

What are these forces that we are talking about? I am going to read this first one to you, a definition of an explosion. An explosion may be broadly defined as the sudden and rapid escape of gasses from a confined space accompanied by high temperatures, violent shock, and loud noise. The generation and violent escape of gasses are the primary criteria of an explosion and are present in each of the three basic types of explosions.

This next hour is going to be like going back to school. But, the good news is that you do not have to take notes. The FBI paper, "Introduction to Explosives," the modified version, has all of this information in it for you to peruse at your convenience. So, it is in there. Almost everything that is on these slides will be narrated in that handout *[Appendix A, Redman]* that I mentioned.

One type of explosion is the mechanical explosion, which may be, as the example in the paper, an over pressurization of a steam boiler. We are not going to deal much with that today because you do not get too many terrorists standing outside your facility's walls stoking up a fire with wood or coal in a boiler of some type trying to get your place to blow up—at least not that I know of. It hasn't happened. It could happen. One way that it may happen, which may have occurred to you already, is through sabotage, through your internal heating system, or the nuclear system that you have in there. That does happen. You can have a mechanical type of explosion through a heating system; that is, a build up, somebody over-pressurizing your boilers, et cetera. But it is not too likely.

Chemical explosions are the second type. When I talk about chemical explosions and I talk about commercial and military explosives, are those chemical explosions? Yes, they are.

The third type of explosion is the one which most of you people are engaged in, the industry, nuclear. I am not going to talk about that today. Far be it for me to pretend to be an expert on nuclear explosions. I will only cover it in passing as being one of the three types of explosions that do occur.

We all know that there are two ways of creating nuclear explosions; either with the splitting of the nucleus of atoms or joining them together, fission and fusion. Something that you may not know, but when you think of it in these terms that will help you to envision what is happening in an explosive process. In all chemical explosions, the changes that are occurring either result in combustion or burning. If you think of it in those terms, it will greatly enable you to think in terms of what is happening during that process.

That is the difference between thinking about the burning of a log and what we refer to in the explosives community as detonations of an explosive. It is the rate of that combustion process, the rate of it, from a very low, slow, comparatively, to an almost instantaneous. To have combustion at all times though, you need something to feed it, a supporter of that combustion. What is that? It's oxygen.

In ordinary combustion, which is slow, that's burning something. In an explosion, it is a rapid combustion. Visualize your automobile engine. The process that is taking place in the engine when the fuel along with the air containing the oxygen mixture is being compressed, raising the ignition temperature until explosions occur in the engine releasing the power.

Detonation, I referred to that before in reference to explosives, instantaneous combustion, that's the way to visualize it, to understand it. Is it truly instantaneous? No. Actually, in time elements, it is not instantaneous, but it is so rapid and so quick that it is phrased as a detonation when you are referring to explosives.

Detonating explosives, what is happening when that happens? The explosive is converted from a solid into a rapidly expanding mass of gasses, producing three primary and several secondary effects. Your three primary effects are the blast pressure, which is the most powerful and destructive. Blast pressure is the main thing that is going to damage your facilities, damage your personnel, as far as the power and destructiveness from that force. But not far behind is fragmentation, and then you have incendiary or thermal effects.

Figure 1 in the paper provides an illustration of what the effect is. On the right side of that half circle a wall is simulated. You have your detonation point right in the center. That is where your explosives are on a surface shot. Right at that same point the incendiary or thermal effect is occurring. That is the heat, that flame that occurs at that point. You have your blast pressure effect and a shock front which is leading, it is compressing the atmosphere, pushing outward. Everything in that path, as it expands from the explosive point itself is flying out and becoming fragmentation.

If you are not already respectful of explosive force, read the facts about speed, about exertion of force. You have approximately 700 tons per square inch of pressure on the atmosphere surrounding the point of detonation and expanding, pushing outward. The velocity is up to 13,000 miles an hour as that shock front is moving away. Anything in that path is susceptible to the effects of that explosion. Can your buildings withstand it? Are there ways to get around minimizing, deflecting, et cetera, your sites? It can be done.

The positive pressure phase is when at the instant of detonation these pressures that I just talked about are moving away with that shock front pushing everything away from the seat of the explosion, the site of the explosion. The negative pressure phase...What happens when you have anything rush away like that in air? A vacuum is created. The vacuum sucks everything back in right behind the outward expanding force of the explosion. It has nowhere near the power and force of the outgoing blast, but still has a very strong velocity.

To help you visualize the effects of what I am talking about *[see Figures 3–5, Redman, Appendix A]*, we have a wall on the right, a tree, a table, and a chair. To the left is a simulated drawing of a bunch of dynamite already lit and burning. During that positive-pressure phase that I mentioned, everything is moving outward at speeds of up to 13,000 miles per hour, 700-pounds-per-square-inch compression of the surrounding atmosphere, everything is flying away.

See that the bricks on the wall start to fly also in the direction away from the seat of the explosion. Very quickly, in the elements of time, the negative pressure phase starts. Now, everything is going back to the site of the explosion, being sucked back. You see portions of that wall beginning to fall back toward the seat of the explosion.

Why are conditions after the explosion important? You need to understand this in order to help at a bombing crime scene. Being the security people at the target facility, you are going to be there before the public safety bomb technicians arrive. Evidence is all around there. You are going to have mass confusion if you have deaths and people injured, and you are going to want to help them first. That is understandable, it is primary to get help to those people—maintain and save lives if you can.

Tempering that though, if you are able, is to also think about evidence. You want to be able to isolate that crime scene, hold it and secure it until your bomb crime scene investigators arrive. With the positive and negative pressure phases that I talked about, you have a lot of the components of that bomb, and other evidence as well, that are going to remain very close to that detonation point. A lot of the components are going to be sucked right back into the crater itself, the explosive crater.

Whenever there is an accident on the highway, you have gawkers and all the traffic slows up. Everybody is always interested in seeing what is going on. If you have such people trampling through the bomb scene, walking around and picking up evidence and component parts—pieces of clock in their shoe soles—or kicking these pieces away, they are going to be destroying a great deal of evidence. Part of your plan, I suggest, once the tragic circumstance of a bombing occurs, will be to protect the crime scene to the best of your ability for the experts who will be coming in there afterwards.

A lot of people, if they do not understand or haven't gone through explosives training, will come on a crime scene, and they will wonder about it. They will say, "where did that blast come from? Did we have two blasts? How come pieces of the wall are lying down over here and how come some of the other pieces are on the other side?" These people will think that an explosion only pushes debris away. It doesn't make sense to them that fragments are moved back toward the crater. But now, hopefully, you understand why that happens, and you can see, if you do have an explosive attack at your facility, why it is important to protect that scene for the experts.

Secondary blast pressure effects. Remember we talked about the three primary effects of an explosion; the blast pressure, and the fragmentation effect, the thermal one. Now we have the secondary blast effects. Why is it important that I address these? I think it's important because you can deal with these effects—the reflection, focusing, and shielding of the pressure wave.

When that explosive positive pressure wave is going out, if there is a barrier in its path that is strong enough to withstand breaking away—disintegrating and being blown as fragmentation down range—if the barrier stands, you have an actual hole in that positive pressure wave. The force of the pressure wave will split to go around the barrier. Why is that important? It is important, particularly in the design of your sites. Do your sites have good bomb site planning? Do you have barriers put up to deflect this primary pressure wave up and away from the critical points of your facility where your glass structures are? It can be done. Today, with computers—this thing called CAD, computer-aided design—these formulations can be worked out. Unfortunately in the security field, we've all known for a long time that generally speaking they will build the facilities first and then they will ask someone to design the security system for it, the control points and everything. The best way is to get in on the ground floor, before construction occurs—to be able to get the security experts in there on explosives to help design that facility to withstand explosive effects.

Besides the good point about reflection, being able to build barriers and deflective shielding, masonry, et cetera, there is a bad point to it. You have to understand where you want to locate the crucial, critical elements of a facility, including the people. If there are long walls, long hallways, long passageways, you have to be cognizant of the fact that those walls, hallways, and passageways cannot only allow explosive force, as we have talked about, to do its destructive damage, but it can enhance it.

How many of you play handball? If you do, you probably know that the ball coming off the surface on the sides of your handball court seems to leave at a faster speed than it enters. The same thing happens with explosive power reflection, it extends the force of the explosive power.

It is important to understand that element in the design capacities of your sites, or where you are going to place your guard at the end of a long hallway. It is important to realize what the possibilities or probabilities are going to be if an explosive is put in the front part of a long passageway.

We've talked about reflection, focusing and shielding of that positive pressure. It also is important to understand your earth and water shock effects. The same thing occurs with that explosive when it is buried in the ground or placed under water—these forces are still present. A terrorist, or disgruntled employee attacking your facility, can bury explosives at your site at locations where you have susceptibility to critical structural points.

The ground does not compress like gasses or air does, but the same positive pressure wave does occur. Natural phenomena can crack foundations and crack fuel storage tanks, et cetera, and the same things can be done by a person who knows how to bury explosives in the ground. Water does not compress at all. A bomber can get up to three times the distance of shock effects with a water explosive shot. It travels further. That's why UDT people, underwater demolition team people in the military, are so endangered from underwater explosions. The shock wave travels about three times as fast and far under water.

Structural fires are also secondary blast effects. These are the fires—not the actual thermal incendiary effect itself—but those fires that come from the other effects of destruction such as electrical cables shorting or fuel lines rupturing in the facility and being set ablaze by the thermal nuclear effect.

I will talk a little bit about explosives. It is incumbent upon you as security managers to have a training program in effect for your security personnel, the people who are out there actually on the front line day in and day out, controlling, screening, et cetera. You need a training program. You are the managers and people that are responsible to make the programs and the training available. I am not going to go into what I would give your front line people, what types of courses, but I will give a brief overview of what explosives look like and what should be known about the explosives.

If you are going to set up a training program, it has to be detailed. Actually have inert explosive packages brought in; take the trainees out on a demolition range to see some of the things that I am talking about so that they have an understanding that will enable them to recognize and identify and control entry of explosives.

Let's talk a little bit about explosives. One thing you have to realize about explosives...I am going to say this right off the bat. Even though I say there is a critical need to recognize discernible explosives, that is not the whole ball game. Today, explosives can be so well disguised, hidden, or shielded in packages that it causes a great problem for people in the security field.

Fortunately, in most of the bombings around the world and in this country, the bomb maker does not use all the available technology. It is out there. It is relatively simple to use. Every day, every week, or every month, you can read in your local newspapers about some generally intelligent student in your community getting killed or getting arrested for making explosive devices simply because of an interest in explosives. These people are not terrorists, they are not connected with organized crime, but it is simple enough to be able to construct explosives and to be able to construct IEDs, which is a term we use in the explosives community for improvised explosive devices. IEDs will be talked about in the next speaking segment by Agent Higgins.

It is easy to construct IEDs. Who out here doesn't have a Radio Shack store in their community? I am not here derogating Radio Shack. I am just saying that readily available electrical component parts are out there, whether it is a hardware store, Radio Shack, or what have you—grocery stores sell some of it. It is all out there, easy to get, easy to construct.

Yet with all this availability, the terrorist is not taking full advantage. The most prevalent bomb made around the world today is a pipe bomb. Primitive in its lack of sophistication, and yet, still deadly. More public safety bomb technicians are injured or killed by pipe bombs around the world than any other IED. If terrorists ever start using the available technology—sophisticated timers, barometric pressure switches, which are used some places—this country and your job will become a nightmare. The technology is out there. It is frightening and sobering to think about it, but that knowledge is out there.

Let's get to low explosives. What are pipe bombs generally made of? Quigley talked to you this morning about that one down in South America, in Colombia. That didn't have the typical low explosive in it, the black powder or the smokeless powder. It had a high explosive charge in it. Most of the explosives in your pipe bombs are low explosives.

Low explosives are said to burn rather than detonate or explode. Remember, we talked about that combustion process, the difference between detonation and the burning, ordinary and slow combustion. Low explosives can generally be initiated by flame, shock, friction, and they do not require a blasting cap, which is a blasting initiator. It's these low explosives that are generally used in pipe bombs.

Low explosives are designed to give a pushing, heaving effect. If a person wants to move a boulder from a road, that person will use low explosives to have muscle pushing that object out of the way. That is what low explosives are legitimately designed to do.

I would go into a great deal more of the show and tell if you were the actual people that had to recognize this stuff, but this gives you an idea of what I am talking about. Black rifle powder can be bought in any gun store, its easily obtainable. "Bulls-eye" powder, "Red Dot," are different brands of black powders and smokeless powders. Flash powder is used a great deal in the manufacture of fireworks, its very volatile, very sensitive.

We read every year around the Fourth of July about some legal or illegal fireworks factory completely disappearing off the face of the earth, numbers of people killed. Flash powder is usually one of the things causing the problem, it initiates the explosion and sets off the other explosives.

Match heads can be used. A person simply collects enough matches, breaks the heads off, and has a great explosive. Children will use match heads to stuff into fire extinguishers. Why into a fire extinguisher? By placing a low explosive into some type of containment, such as a cylinder, the person can intensify the blast effects from the low explosive. A high order effect can be obtained this way, rather than a low order effect that otherwise would occur from an uncontained low explosive.

In the explosives community, a *high order* as opposed to a *low order* is simply the explosive detonating at its design velocity. If you are out on a demolition range, dealing with high explosives, C-4, et cetera, you can sometimes have a low order effect. The explosive did not detonate at the speed it was designed to. Therefore, instead of being consumed the explosive was torn apart and thrown around.

High explosives are designed to shatter and destroy. Military explosives are high explosives. The nature of war is destruction. Generally speaking, when you speak of the difference between low order and high order, the accepted cutoff is 3300 feet per second in your detonating wave velocity. Anything below 3300 feet is considered a low explosive and anything above 3300 feet is a high explosive. HMX, an explosive compound, goes all the way up to 29,900 feet per second.

Generally, these explosives have to be initiated by a blasting cap or a booster of some type. There is a thing called an explosive train, the steps to actually getting explosives to detonate. With low explosives, remember I talked about heat, friction, flame, shock, their being sensitive to those elements, you do not need a blasting cap. High explosives, secondary explosives, which I will get into, need something strong enough to be able to cause and initiate that explosive detonating wave.

Blasting caps are designed to do that. Sometimes you need another part in that explosive train, to boost it up even higher. Those are called boosters, but I am getting ahead of myself. The high explosives we are talking about are designed to shatter and destroy, a brisance effect. When you hear that the effect had a lot of brisance, it simply means a very high shattering effect.

A lot of you have probably heard about C–4, and you also have heard a great deal today about Semtex H, the Soviet bloc made equivalent to the C–4, because of the different terrorist events that are occurring around the world, airplane explosions, et cetera. The speed at which the detonating wave travels, the initiating effect is about 26,400 feet per second. In other words, if you laid out a line of detonating cord, which is made up of PETN or RDX, if you laid it out five miles in length, it would take one second from the point of initiation to the end of it.

Phenomenal, the effects and the elements of explosions. These are the things that are causing the destruction that you saw in the films, video tapes, and slides this morning that Mr. Quigley showed. These are the materials that are being used in explosives.

Primary explosives have included such chemical components as lead azide, lead styphnate, and mercury fulminate. Primary explosives are extremely sensitive explosives, which are generally used to initiate your secondary explosives. They are used in blasting caps as the primary charge. They give the oomph that is needed to set off the secondary explosive. The primary explosives could be used to do damage themselves, but what is the problem with a terrorist using these? The problem is that primary explosives are sensitive to heat, shock, friction, and flame, making them very dangerous to handle and use. You don't see these used too much as a main charge.

Secondary explosives are used as the main charges. These are what your people need to be familiar with and to understand as far as screening attempts go. Of course, always remembering the exception I told you about, that today these explosives can be easily disguised, they can be shielded and hidden within innocuous looking devices. Some of these devices can be very hard to recognize either by X-ray machine, explosive detectors, or by the human eye.

These main charges can be categorized in different groups. There is dynamite, and there are different types of dynamite also. Each is designed to perform a specific function. Some of these dynamites have lower detonating velocities, which give them more muscle, a pushing, throwing effect. Other ones have more brisance, which gives a shattering effect. Some of them are easy to work with and some of them are hard to work with. The straight dynamites that have the higher nitroglycerin content, are the more sensitive dynamites to use.

Not too long ago, ammonium nitrate was a very common ingredient in the manufacture of dynamites that were most used in legitimate trade in this country. Today, I can tell you that dynamites are disappearing. They are not being manufactured in the amounts they used to be. There are more sophisticated materials that I will tell you about that are taking the place of dynamites. The terrorist of the past carried several sticks of dynamite wrapped together and put them aboard a plane. Those were easier to see inside an IED—lunch pail, or something like that with a clock. These are becoming less and less used today, making your jobs more and more difficult. This type of dynamite was not easy to disguise or reconfigure; it was harder to hide from security and law enforcement personnel and fairly easy for dogs to detect.

Gelatin dynamites are much safer to use, much easier to handle, and were very popular in more recent days. Once again though, because of the other materials being developed, which I will get to in a second, dynamites are being phased out. IME people, that is, International Manufacture of Explosives representatives, tell me that they do not expect much dynamite to be left around in this country by the year 2000. I am talking about being manufactured, there's always dynamite being left around.

Some of the highly routine regular work that our bomb technicians, State and local law enforcement people, do around this country is recovering old dynamite that has been left in old mines, left in old factories. This unused dynamite is very hard to handle because it has been what is known as sweating. A very crystalline situation, where the nitroglycerin is sweating out of the dynamite and coming out of the bottom of the wrappers. It is very sensitive to heat, shock, and friction and very hard to handle.

The permissible or permitted explosives are those that are designed to be used in mines. In other words, they are designed and manufactured to reduce some of the toxicity of the explosives. These dynamites have certain salts added to them, which retard or quench the flame and heat temperatures, this cooling effect makes these dynamites usable in mines with less hazard to the users.

One thing to remember about dynamite, there are some quick and easy ways to recognize whether you may have dynamite or you may not have dynamite. Note that I didn't say you either have or do not have—I said you may not have or you may have. A lot of bomb makers today will take safety flares, et cetera, and use them as the supposed threat in extortion type cases or hoax devices. They will say that it is dynamite and it's not. With the eye, if you are experienced, you can tell whether your lines and your wraps are crimped at the appropriate places and whether your lines are straight down on your wrapping or not. All of that means something in the actual packaging. That is something that your people are going to have to be taught if you are going to have them out there trying to attempt to identify dynamite or devices being brought into your facility.

Blasting agents—I told you dynamite was disappearing, and one other reason why is because of the advent of new blasting agents. These are chemical compositions or mixtures that are much easier to handle, much less sensitive than the old fashioned dynamite, or any of the different types of dynamites. These blasting agents are being used much more by your commercial blasters, people out there that have legitimate needs. I am talking non-military at this point.

The blasting material, remember, is also a source for the terrorists, or bombers, to get their explosives. Continually throughout this country and the world, blasting sites, legitimate blasting sites, are being broken into and the explosives are being stolen from lockers and bunkers. It is from these sites that a lot of the blasting materials are disappearing. They turn up in different parts of this country, used by different organizations. The radical group, the Weathermen, back in the 1960's and 1970's got a lot of their blasting materials that way.

Bob Quigley talked about the groups having cross-training, cross-familiarization with each other, cross-exchange of information. Sometimes when explosives are stolen, we can make ties between terrorist groups because we find the same stolen explosives showing up within these groups that we thought had nothing to do with each other. They have a commonality of being terrorists, and they have a system where they do pass on information to each other. That does happen. We can trace it, we have traced it.

Blasting agents are much easier to handle and use than dynamites. Water gels or slurries, another name for them, are another common group of explosive that is used. However, cap-sensitive blasting slurries or water gels are not considered blasting agents. You can get a water gel called Tovex, that is cap sensitive. It is just a very subtle thing, the fact that we do not consider it a blasting agent if it is cap sensitive.

Tovex comes in a sausage-type package. If you were to take a crimping tool, with its sharp type of probe, and poke into the Tovex to affix your blasting cap or detonator, the Tovex would be gelatinous, very runny. That's the type of material that is inside of this water gel type of explosive.

Binaries are two inert compounds that are not explosive until mixed. This type of explosive achieved its popularity because of its easy-to-handle properties. Two inert components for traveling purposes, to carry on trucks to transport around, and they are not dangerous as long as they are separated. Only when they are joined together, mixed together, do they become explosive. You can see the advantages of that. A lot less hazardous to your health, whether you are a bomber or legitimate user of explosives. An example of a binary would be Astropak. Simply mix the two component parts of the binary and it becomes explosive—apart, no problem.

Explosive sheets or sheet explosives such as Flex-X or Deta Sheet, are some of the so-called "plastic explosives." We hear a lot about these in the field. If you want to appear chic in media and other circles, you would use the French term "plastique." If I hear someone say "plastique," I say that person doesn't know much about explosives. Nobody other than the French and the so-called people who like to appear knowledgeable use the term "plastique." We just call it plastics.

Plastic explosives are rubber like, malleable, moldable—they can be formed in any shape. That is what makes them so valuable. Instead of fastening those old dynamite sticks to the wall, plastics can be shaped to get more efficiency out of the explosives around pilings, structures, supporting columns, or whatever. Much easier to use; they are relatively insensitive, far less hazardous to personal health.

We, in the community dealing with explosives, still handle all explosives very gingerly, very carefully. We do that for two reasons. One is that, if we handle all explosives that way, we do not make a mistake when we are dealing with more sensitive explosives. The second is that it just makes no sense to bet your life on the chance of having a detonation.

Great quantities of military explosives disappear every year—stolen, sold off, et cetera. A few years ago, two CIA operatives had sold tons of C–4 explosives to Qhadaffi over in Libya. They are both in jail, but those explosives are still out there ready to be used on someone or in someplace.

Like I told you earlier about the brisance in military explosives, the nature of war is to destroy. They are designed to shatter and destroy, they have high rates of detonation, and they are relatively insensitive to shock, heat, and friction. The reason is that these explosives are going to be carried to a combat zone with bullets flying around here and there and hot fragmentation from exploding artillery rounds; a soldier doesn't want to be carrying that demolition charge and have some little thing hit it, causing him to be vaporized. These explosives are manufactured that way on purpose so that they can be taken to a combat zone and be less hazardous in that environment.

TNT is still used; it is very prevalent in the military, very available. It is also commercially available in different forms. Composition C-4 is a plastic explosive; composition C-3 is merely an older plastic explosive, a forerunner to C-4. It doesn't have the temperature range of C-4; it is more restrictive in the hot and cold ranges. The applicability is diminished—C-4 is an improvement.

Deta Sheet, which wraps almost like a sheet, is thin—visualize wallpaper. It comes in rolls and can be as thin as one-sixteenth of an inch. Dupont makes it and calls it a C-1 Deta Sheet. This is important to know because if an explosive can be made in sheets like that, think about it being used as the lining of a suitcase. We have heard a lot about suitcase bombs today.

The C-1 Deta Sheet is very prevalent in the world of terrorism. It is used and suspected in the airplane attacks; it can be brought in the linings of briefcases —it could be brought into your facilities in a briefcase. How are you going to catch that? Your person can't identify it and he can't see it. Do you have dogs to detect it; do you have artificial detectors, TNA [thermal neutron activation] chemoluminescence or whatever? You have to try to detect the vapors from those materials.

If the Deta Sheet is shielded, and it can be shielded to minimize detectors or dogs from being able to discover it, then it will become very easy to use and very much a favorite explosive of the terrorist.

For all intents and purposes, I would simply say that the so-called military dynamite is not a true dynamite. As you can see by the figure in my report *[Redman, Appendix A, to these proceedings]*, military dynamite is 25 percent TNT. It comes in a cardboard container with the two metal ends, like a juice can.

The thing about TNT is, you can flake it and you can cast mold it. I could have your chair, table, or ashtray made out of TNT. Does that present a problem for you in security? The item can be painted, varnished, it will look beautiful. You could compliment the terrorist on the beautiful piece of work he is carrying, but he's carrying your death and the death of your facility. These are the types of things that we have to deal with that are out there and very easily done.

The hole in the center of these different sized TNT containers is called a blasting cap well. You can prime it with a blasting cap that fits right in that hole. It is a harder material, not soft and putty like, like your C-4 plastic materials. They make a well right in it, where the blasting cap can be inserted inside. That's Flex-X. That's a plastic type of explosive. It is a lot thicker than Deta Sheets, the thinner Deta Sheets that I mentioned to you.

Explosives can be improvised and made out of various commonplace items that can be obtained in your grocery stores, hardware stores, et cetera. You can make a homemade bomb from ingredients like match heads. Terrorists make an excellent main charge explosive out of fertilizer, ammonium nitrate mixed with diesel fuel with a booster for detonation. It causes a tremendous explosion.

This type of bomb exploded outside the Physics Building at the University of Wisconsin, back in 1971 if I remember correctly. It killed a graduate student working in the building and did tremendous damage to the building—an improvised bomb by using fertilizer that is sold right in your fertilizer stores.

Before I end this talk on explosives, I want to show you a very interesting video tape. It is about a terrorist who was actually captured in this country not long ago, a couple of years ago. The reason I think this is important is because, if you think that terrorists aren't already here in this country, you are wrong. The FBI and other intelligence communities have tracked many, many different people through this country.

This video tape shows an example in which the person was actually caught and brought to justice. It has happened in other places. You may have read about an incident in Maine a couple of years ago also, Middle East types coming across the Canadian border with explosives. It never was determined what their target was.

The film I am going to show you emphasizes that in the security field as in the law enforcement field, recognition and understanding of explosions or explosives or IEDs is vital. A trooper from the New Jersey State Patrol used his knowledge to the fullest to capture this individual. The trooper happened to get suspicious of the individual's activity. A good quality for a security person to have.

The trooper was motivated and alert enough to check out the individual, and when he saw things in the car that further peaked his suspicions it turned out he was correct.

[Video tape played.]

I think you found that film interesting and entertaining. The individual in the film is representative of the individuals that we are dealing with today, the terrorists. They come in all different shapes and forms. The one thing they have in common is dedication. I hope my talk about explosions and explosives has given you a good foundation and understanding for the rest of this seminar.

I thank you very much for allowing me here to speak to you, and have a good rest of the day.

[Applause.]

Mr. Burnett:

Our next speaker is Mr. Wallace Higgins. Mr. Higgins is presently a Special Agent Examiner in the Explosives Unit at the Laboratory Division of the FBI. He will speak to us today on IEDs, improvised explosive devices.

Improvised Explosive Devices

Mr. Higgins:

Good afternoon. I am going to talk to you about improvised explosive devices. It is going to be for one hour, and we might retitle this presentation "bomb building 101." I am going to try to tell you what goes into a bomb. The information that I give you is not going to be complete for several reasons: for one thing, I don't want to help 300 new bomb makers. So, it's sanitized. Don't take the information that I give you and try to build a bomb with it because you will hurt yourself.

I usually give this presentation to police officers who are bomb investigators or bomb technicians. When my supervisor asked me to give it to the NRC, I said, "why does the NRC want to know how to build bombs; they already have enough problems on their hands."

[Laughter.]

I got to thinking about it, and, as Mr. Quigley pointed out, most of the bombings in South America are aimed at power grids and you are definitely involved in that aspect, the nuclear reactors that produce electricity. You do have secure sites. I went to several of them when I was in SWAT [special weapons assault team] training at one time, and I have been inside your reactor facilities and have seen the security. It is impressive.

Your people do have clearances; background investigations are conducted and that's impressive. However, in a real-life situation, we have people in the military, we have people in law enforcement, and we have people in the intelligence community who compromise themselves to foreign governments. Why can't it happen to you? Even in a maximum security prison that has some of the best security available, a prisoner can be sitting in his cell and still get drugs or bomb-making components. Why can't it happen to you?

That's why we are going to educate you a little bit today on what it takes to build a bomb. Then, if you see these components, or you see a bomb that has been put together, you will recognize them and be able to take the appropriate action. In time of national crisis you are going to be a big target. You are going to be a hard target. The damage is already going to be done; the person will have been compromised a long time ago. He will already have the components in place at your site, he will probably already have the blasting cap and explosive hidden somewhere inside the facility. All he will have to do is put it together. That's real life. That can happen.

It takes some expertise to put a bomb together. Some of the things that I am going to show you today are very basic technical things that any person can do if he has a little education. We are not going to talk about the domestic type of bombing, where the motivation is revenge. We are going to talk about terrorist bombings, terrorist bombers, or bomb makers, who are supported by other governments.

Before a bomber starts executing his plan, he's going to determine what it is he wants to do. Does he want to destroy property, cause havoc, does he want to kill people, or does he want to do both? If a bomber is interested in a nuclear site, what he will probably do is not aim at blowing the reactor but at blowing something that will release radiation into the atmosphere. The general public and the news media will take care of the rest.

A terrorist will look at your target and see how soft or hard it is. We use those terms, "soft" for a target that has easy access and "hard" for a target that is difficult to access. If a terrorist has infiltrated the work place of a target, it is an easy target because the infiltrator is in and out every day. If he doesn't work there, it's a hard target. So, depending from what aspect the terrorist is looking at the target depends on how he is going to perceive it.

It's the same thing with people. If a person goes around without guards, uses the same route every day, that person is an easy target. If the person has protective equipment around him, wears a bullet-proof vest, or has a bullet-proof car, that person is a hard target. We are looking at hard and soft targets.

Any terrorist, or anybody, attempting to assault a place or person is going to have to have some kind of training. The terrorist might have some prior military experience that gives him some basic demolitions training; he may have gotten it from the commercial sector working as a blaster; or, he could be a dyed-in-the-wool terrorist that didn't know anything about explosives and other terrorists taught him. If you think these terrorist organizations are a bunch of ragtag outfits, you are on the wrong track. We did a raid several years ago down South in the United States, which involved searching a house, a normal house, middle income for that area. There were several bedrooms, and it looked like a normal house until you got to this one room.

The room had a blackboard, conference table, and several chairs in it. No problem, he holds classes, right? Maybe they are reading classes. We opened up his closet and found all kinds of firearms, shotguns, rifles, pistols, thousands of rounds of ammunition, various literature. He had hand grenades, he had explosives, he had blasting caps, he even had a LAW [light anti-armor weapon] rocket. I told you so, that's a clue. How many American SWAT teams have LAW rockets?

These are not ragtag organizations. They have the best equipment. They have bullet-proof vests, they have packs; they have changes of clothes; changes of ID; they have communication systems; they have aircraft for surveillance; they have boats, cars; they have computers, physical training programs, just like the FBI or any law enforcement or any government agency. So, they are not ragtag. When you get to the "druggies," they have their own army and they have the money to back it. They have the money to buy the professionals to teach them how to do the job. So, the knowledge is there.

If a person wants to make a bomb, he can do it through self-education. He can go out to a flea market at one of these gun shows and buy the military manuals that tell you how to do it. He can get commercial manuals and books in the library. And, he can experiment. The technology is there, all it takes is an open mind to look for it.

What does the terrorist need to build a bomb? He needs explosives, and he needs an initiator, a blasting cap; he needs a fusing system, and he needs a container for it. The terrorist can't walk in someplace carrying a bomb in his hands and expect to get by the security guard, so he will put it in some kind of container. If he wants to cause personnel damage, he will put shrapnel in the bomb. That is, bolts, nails, beebees, whatever he can find. He will need the tools to put all this together.

We are going down through each one of these items and talk about them.

[Slides shown. Mr. Higgins' slides are not included because of the sensitive nature of the material.]

As far as explosives, domestically we find that the pipe bomb and the low explosive, is very popular. Why? Because anyone can go in any gun store with cash in hand and buy it. You do not need a driver's license. All you have to do is look like you are over 21, pay your money and walk out with a can that has a lot of power in it. There are States that allow a person to walk in with a driver's license, pay the money, and walk out with a case of dynamite and the blasting caps. Simple as that, it's easy to do.

If anyone is looking for high explosives, he can go and buy them. It's as simple as that: Pay the money, show a driver's license, and get it. He can make it in his own home. Buy the fertilizer, buy the aluminum powder, diesel fuel, and you have a high explosive. All he needs then is one blasting cap. In some cases, he can steal it from the military. That is where you get your best explosives, military explosives. They have a high brisance, or shattering effect.

You don't need an initiator for a low explosive. All you need is a spark. You can use a flashbulb, lightbulb, anything, an element that fires these model rockets. You do not need a blasting cap. For high explosives you need a blasting cap.

There are two types of blasting caps, non-electric and electric. Non-electric uses a fuse system that you light. The powder train burns, just like you see in the movies with John Wayne. The blasting cap goes and sets off the high explosive. That is not very common in improvised bombs. The most common is the electric blasting cap or the exploding bridge wire. You need electricity to set them off.

On an electric fusing system, you need the basic requirements for a dc circuit. You need a power source, you need a conductor, you need a load. That's all you need. To control that circuit you need one other thing, and that is switches. We will get heavily into switches, but let's go into power sources first. What kind of power sources are we going to talk about here? Batteries. Batteries come in all shapes and sizes, big ones, little ones. All you need is a battery that has sufficient power to set off a blasting cap. Some of the smaller ones like the ones that fit in your ear or watch do not have enough power to set off a blasting cap.

So you need something that has enough power in it to set off a blasting cap. A bomber's choice is usually a 9-volt transistor battery. Why, I do not know. Maybe it is just more reliable and always fires. This is a 6-volt battery. It is a flatpack. It is in every roll of film that you buy from Polaroid. It is thin, lightweight, and it has enough power to set a blasting cap off.

Next, you need the conductors. Wire or a printed circuit board, anything that conducts electricity. Wire comes in all shapes, sizes, colors, and gauges. Next you need a load. In this case, it is an electric blasting cap.

This is a military-type blasting cap. It is very powerful, and it will set off any type of explosive that can be set off with an electric blasting cap. My favorite part is when we get to the switches. Switches can be made of anything that anyone could probably think of to use.

We will talk about clocks, clocks that are either mechanical or electrical. How does a bomb maker make a timing device or a switch out of a clock? He takes one wire and hooks it to the base of the clock. Next, he will drill a hole in the face of that clock and insert a screw and attach a wire to it. He will probably take off the hour hand or the minute hand, whichever he wants to operate on. One gives him 12 hours and the other one gives him 1 hour.

I have one here to show you that is wired up, only this one is wired to the bell. When the clapper hits the bell, it goes off. No drilling in this. This is a little electronic egg timer. It makes a beep. It makes a beep that has sufficient current in it so that, if it is amplified just a little bit, it will set a blasting cap off. The bomb maker just has to pull the back off, cut out the beeper, put in a small amplifying circuit, and he can create a timer that will time up to 99 hours.

Another type of switch is a vibration switch. This type of switch is sold in an electronic warehouse store for house wiring so that a person can wire an area in his/her house where an excess type of vibration will set the alarm off. Another type is a mercury switch, which can be bought at Radio Shack or any electronic warehouse, or it can be made.

The mercury switch has a little ball of mercury and two electrodes embedded in the glass container. When the mercury rolls over and makes contact with those two electrodes, the current flows. It can be carried in one position, move it, set it down, and somebody else comes along, moves it, and that will set the bomb off. A mercury switch can be homemade, with a test tube, a plug, two contacts, and some mercury. It is a very simple switch. It is an antidisturbance switch, has no time factor. In other words, it is waiting for somebody to disturb it and it will go off.

A photoelectric switch is another type that can be bought. With a little modification to the circuitry, it can make a bomb go off when the ambient light is disturbed. When the light source changes the ambient light and either gets lighter or it gets darker, the circuitry can be set so that it will set the bomb off. We will go through some of these circuits after you understand what the switches are like, and you will get an idea how the circuitry works.

There are a lot of other electronic components. There are transistors, silicone control rectifiers, which have different functions than electronics, but in bomb making they are basically just switches that control the circuit in a bomb. By combining a resistor and a capacitor, you can make a timing circuit that will detonate a bomb. There are other integrated circuits that can be built. One is the popular 555 circuit. There are several other types of circuits that can be designed to not set off the bomb for years. It can be set at a predestined time in the future and it will function at years, months, minutes later.

There are electrochemical switches, E cells that are nothing but timers. They work under the premise that when an electrode deplates and plates onto the other electrode at a timed sequence, when it is through deplating, a current will either flow or be interrupted and set the bomb off. There also are sound- activated switches. The concept is similar to that used for the "dancing flower" that they have out in the stores right now. That's a sound-activated switch that makes the flower jump around. A bomb can be built so that a normal voice talking over it will set it off.

There are other switches that are proximity switches, and they work off magnetic induction—in other words, if a person walks toward the location of the bomb, that person will change the magnetic field and that will set the bomb off. These are just some of the options that bomb builders have if they use their imagination and they will.

Relays can be used in building bombs. They can hold a circuit open until the battery decays, releasing the contact inside the relay which will fire the bomb.

An altimeter, quite commonly used in aircraft, can be purchased in a good automotive store in the United States or in Europe. An altimeter for a vehicle will cost about $30.00. An altimeter can be modified so that a change in altitude will make it set off a bomb. Where would we use one of these? In an aircraft. That would probably be one of the few places you would use an altimeter switch.

Radio-controlled devices are becoming more and more popular. They are complicated to build, but a reliable system can be built for about $130.00. A person can go to a hobby shop and buy a FUTABA or any other brand device that is used for radio control of model airplanes. With a little ingenuity, a person can build a reliable radio-controlled device. Granted, it doesn't have a long- distance range, only about a quarter of a mile. But a terrorist can be a quarter of a mile away from his target when the bomb goes off. A reliable radio-controlled system can be built.

However, if one is not careful about the way he builds one of these, it can be fatal and unhealthy because, when turned on, the receiver sometimes has a little slap in the servo, a little current goes through. Here's another type of radio control. This one is encoded and decoded. In other words, it operates on a frequency on which there are other radios working. Unless it receives a certain code before the transmission is received, it doesn't work. If it receives that code, the receiver turns on. This device can be tailored to reception in a bomb. Again though, it is tricky because the bomber could be delivering it to a target site and somebody could key a radio on the same frequency and inadvertently set off the bomb. That can be unhealthy.

I have a couple of radio-controlled devices that were confiscated in some raids. These are not sophisticated, they get back to the basics. This is a switch. How does it operate? What is it? It's two tin can lids with nail holes in them and a piece of paper between. What happens if somebody pushes on the tin can lid or steps on it? It completes the circuit. It can be hooked to a bomb.

This is another one that is made with common, ordinary clothespins. Clothespins are not as popular nowadays, but you can still buy them. They can be wired in about five different ways. They can be set for pressure release, pressure, or time—several different ways to wire a clothespin and have it function as a switch. Another favorite of "dopers" who are trying to guard marijuana fields and their drug stash is a simple mouse trap, which can act as a switch. All one has to do is make a contact for the wire to come down on and a contact for it to function against. Current will flow to the bomb.

I have a device that was found on an aircraft; it was found under the seat of an aircraft. It is a sheet explosive, with circuitry that consists of a resistor, an E cell, one transistor, and a blasting cap. Not a very bulky circuit. The device was placed under the seat of an aircraft, a passenger got on that flight and sat down. When they sat down, they made contact with a pressure switch, which caused the current to flow into the E cell, the E cell starts deplating, and when it is through deplating, the current flows through the transistor and fires the blasting cap. The passenger inadvertently sat on a bomb.

I have a diagram of an altimeter switch that was hooked into a fairly complicated circuit with power source and explosive. Altimeter switches are mostly used in aircraft.

Those are some of the basic electrical circuits that you will find. A person who knows nothing about electronics can go to an electronics store or buy a book and learn everything he needs to know to be able to build a dc circuit and adapt it to firing a bomb. My telling you this is not any type of security violation because all the information is out there in simple books for anyone to read.

One thing that a bomb maker has to consider is a container for the bomb. Domestically, the most popular is the pipe. It is easy to buy; it's cheap; it provides a lot of fragmentation. The pipe can be purchased in different sizes to hold as much explosive as the bomb maker wants to put in it. It can be fired in several ways. It can be fired nonelectric or electric. The whole firing circuit can be placed inside the pipe container; the end caps can be screwed down and the bomb placed. Even if it is found, the bomb technician that has to work on it has a big problem. It is not easy to get in that pipe and get the explosives and firing train out.

The reasons why the pipe bomb is probably so popular: it is cheap and provides a lot of fragmentation. About 30 pounds of dynamite can be placed in a common briefcase with a firing circuit. It would be very easy to carry on the streets of Washington, D.C., and nobody would ever question the carrier. Letter bombs can be made with a sheet explosive, a thin explosive, and some type of switch, a power source that is thin. For example, a Polaroid battery and some kind of switch that makes contact when the secretary sticks the letter opener in to open it up. An antidisturbance type of switch would not work in this type of package because of the handling it receives en route. It would need to be a switch that is activated by the individual opening the letter or package.

Containers can come in all shapes and sizes; carry-on baggage or a pocketbook may be used for an aircraft. An umbrella can be a bomb very easily; all the circuitry and explosives can be inside the umbrella. In fact, in one case, it was. It hung in the hallway of a building for several days before somebody discovered it. Fortunately, it didn't go off.

When a bomb maker builds a bomb, there is no manual for it and there is no quality control for it. Terrorist organizations don't have quality control. They try to make the bombs reliable, but it is not 100 percent. Airports have a lot of suitcases, and a suitcase can be a bomb container. We are trying to detect explosives in suitcases. There will be no simple answer for our problem with bombs at the airport. There will be no one simple machine that solves the problems of explosives at airports. It will be a system.

Let me talk about camouflaging the bomb—not only a container for the bomb, but a camouflage for it. A bomb can be built and put inside an electrical component, and that electrical component plays. Who is going to take the back off a radio and look inside it in an airport and hold the rest of the line up?

A car is one of the best containers for a bomb. A car has all kinds of switches in it, all kinds of power in the battery, and that car becomes one of the biggest fragmentation bombs that you will ever see. It has glass and metal in it, and it can travel several hundred miles away before the bomb goes off. You can pack as many pounds of explosives in the car that the springs on that vehicle will hold. If I wanted to get an electrical component on to your site and I worked there, it would be very easy. In fact, the components are probably already there. You probably have electrical components laying around that you have pulled out of old equipment and put in new equipment. The old equipment sitting on the site may contain resistors, capacitors, and probably some integrated circuits that I can use, and there could be all kinds of switches on it.

The electrical components for building a bomb are probably already on your site and legally there. It just takes a little ingenuity to find them. That simplifies the problem. If I am going to build a bomb at your site, all I have to get in to the site is a blasting cap, they are small, and explosives. How many pounds of explosives? That depends on where I am going to put them in your plant. I am going to put them somewhere where they would do the maximum amount of damage and cause the greatest amount of confusion. Also, I might not just plant one.

The explosives can be brought in at a small amount at a time. If people can get drugs and paraphernalia like that into a Federal prison or State prison into maximum security death-row cells, why can't they get explosives to your site? What I want you to do is get you a little paranoid and start thinking about it. I don't want to get you so paranoid that you can't do your job or you mess the system up, but I want to get you thinking a little bit like a bomber. Then you will start looking at the areas in your security that are deficient.

Airports have what they call a sterile concourse. I recently went to an airport with my mom and dad, they were flying and I was not. I wanted to go and get them seats on the aircraft while they waited out with the rest of the family and have a few minutes to visit. I went up to the security station and showed them my badge. They said, "I will have to check you through security and check you out anyway." I said, "That's fine with me, I investigate airplane bombings and anything that you can do to reduce them is fine with me."

I walked through the magnetometer and it beeped. I didn't have a weapon on. I walked around again and took some change out of my pocket and walked through it again. It beeped again. Now, this was getting aggravating because I wanted to get the seats. So, I walked back and took my belt buckle off and walked through holding my pants up. It didn't beep. I was impressed. On the other hand, while I was standing there watching security and talking to my family, a guy came by in a blue uniform pushing a cart in front of him. The cart had a bag on it that said Rubbermaid. He had a broom and a dust pan. What is he? A janitor? He walked right down the side where there is no security into the sterile concourse. People in security standing there at that station didn't give him a second thought. How many bombs could he have had in that wastepaper sack that he had? You have to watch for these simple things. They get by you at times.

Among the tools and accessories needed to build a bomb, a good bomb maker will have a voltmeter, normal screw drivers, wire cutters, pliers, tape, and rubber gloves or some kind of gloves. You probably have voltmeters on your sites to check out circuits. This is an actual kit that a bomb builder had. If you notice, it has a lot of watches in it; it has snap connectors in it. You will see some of the faces of the watches are already drilled, some of them already have screws in them, and some of them already have wires connected to them.

That is a clue. Normal people don't want watches with a face like that. They don't need them.

Here's another bomb builder's kit, a fishing tackle box with the same things, watches, pliers, wire. This guy was a little bit more elaborate. He had solder and a magnifying glass. He even had flashbulbs. Why would he use a flashbulb? To check his circuitry out; he doesn't want that thing going off at the wrong time.

In conclusion, I want to point out to you that all the components that are needed to make a bomb are off-the-shelf items. They can be found in almost any site that has a repair shop that deals with any type of electronic gear. I want to make you aware that even though people have clearances, they have vulnerabilities. I want to make you aware that even though you have the best security in place, don't rely on it. A system is only as good as the people that enforce it.

There are two thoughts that I want to leave with you on bombs. As a former head of a bomb squad in New York said one time: "If you think it is a bomb, it's a bomb. If you suspect it's bomb, it's a bomb. Don't touch it, call somebody." Have a system in place so that you can respond to it without touching it, without being in the area of it. If it goes off, it is going to eat you up. It is not like a firearm where you can accidentally crank a round off, blow a hole in the ceiling, and walk home.

If the bomb goes off, your quality of life has suddenly changed, and it's not going to be very good if you li- Don't mess with it. Tell your people, "don't touch it. - they think it's a bomb, it's a bomb. Don't go up and check it out. Get somebody that is trained to check it out.

I will be here all day. If you have any questions later on, I will be glad to answer them. If you have anything that we can help you with in the Explosive Unit, please give us a call. Thank you very much.

[Applause.]

Mr. Burnett:

Thank you, Mr. Higgins. I know the majority of the people here are either from NRC or are a licensee of NRC. I don't think the first part of the meeting would be complete without giving you all a shot at us. This panel that we have arranged this afternoon is made up of the NRC Inspection and Enforcement Management that I know all you licensees know and love.

I would like to introduce on my far right, Mr. Jim Lieberman from Headquarters. He is the Director of Enforcement. I guess he's the last one to sign off on any enforcement that goes out into the field. Immediately to his left is Mr. Phil McKee, he is representing the NRR [Office of Nuclear Reactor Regulation], which regulates the majority of the sites from which you all come. I will be representing NMSS [Office of Nuclear Material Safety and Safeguards], which regulates all the fuel plants.

I would like to introduce Mr. Philip Stohr from Region II, who will introduce the other regional managers in the enforcement chain.

Generic Regional Inspection Issues

Mr. Stohr:

Thank you, Bob. I am the Director of the Division of Radiation Safety and Safeguards in Region II. The other people that are with me this afternoon are my counterparts from the other regions. There is Mal Knapp from Region I, Chuck Norelius from Region III, Bill Beach from Region IV, and Bob Pate, who is Safeguards Branch Chief from Region V.

It is going to be a little bit of a change of pace from what you have heard in the presentations earlier in the day. Although we could each of us talk for an hour on the material that we have with us, we have agreed to each present a couple of issues taking no more than five or six minutes each. We will be rotating through pretty quickly up here.

We, like you, are here to learn about this area. Bob did ask us to bring with us, if appropriate, some issues, things that we are observing out in the regions that might be of interest to you.

For the most part, the generic regional inspection issues are supposed to give you a heads up, perhaps, on some of the things that we are seeing respectively in our regions. You may be coming across some of these types of situations and the information may be of use to you. I guess we also set the stage, a little warmup, for the question-and-answer period that we are going to get into after this.

Since we are going to rotate through rather quickly, we would prefer that you hold whatever questions you might have for any of us until the end, until we all get through.

I am going to talk about two things. Both of them relate to security program management. The first one I would characterize generally as some management problems. Establishing and maintaining a good effective physical security program is certainly a challenge. We heard Hugh Thompson early this morning talking about the human factors problems; it is a fairly sizable staff and we are working with different shifts. Perhaps there are some pay differential problems as compared to the other staff.

The electronic systems that are being used are becoming increasingly complex. The security staff has to establish teamwork and interface with a technical staff that may not always be sympathetic to or understanding of its problems. They have to work together effectively. I could go on, but I think you recognize the situation even better than I do.

For the most part, I think you are meeting that challenge. I might also say that I think I have seen over the last several years, an increased professionalism in the area of security management, certainly since I started having a management responsibility in this area in the early 1980's. However, I see some indication of a drift back to what I consider to be an inadequate management situation, which existed several years ago at some of our sites. This is not all pervasive by any means, and I want to make sure that I don't exaggerate it in that regard.

Let me expand a little about what I mean. A few years ago we did have significant problems at a few of our facilities. I thought I saw some commonality with regard to the problems that the facilities were having. To start with, there was inadequate management at the program level. This is my perspective that I am sharing with you. I also thought there was inadequate management attention, involvement, oversight, and support at the upper management level, corporate management.

It appeared in some of these cases that less capable managers had been given almost complete responsibility for the program. My perception of the way in which upper management oversight involvement was going was that they would question the program manager as to how things were going. The program manager would say that "things were pretty good" and upper management would say "okay, thanks, let's get on with making some kilowatts."

Licensees found it very difficult to turn these programs around. Typically, there were several aborted attempts until there were some management changes and also some attitude changes on the part of management. However, what I seem to be starting to see in some cases may be an early indication of some initial drift back to the original situation. It seems associated, perhaps, with complacency on the part of some of our good performers, less attention by levels of upper management, and perhaps resting on laurels. Again, you know what Hugh Thompson said about resting on laurels this morning.

We have also seen a turnover of some of our good managers and supervisors. There is now competition out there for these people, and I think that goes with the increased professionalism in a sense. To perhaps a lesser degree, I am also aware of the fact that we have had a relaxation, and I am sure you are also aware, of NRC's enforcement policy. We now look at some of the situations that we have seen in the past and assign them a lower significance level.

Bottom line is, this is meant to be an early warning to you on our part. I will leave you with the thought that I would like you to keep your guard up—no pun intended. Don't relax, keep striving to maintain and improve your program or you may be drifting back and lowering your overall performance.

Second issue is one that I also consider to be a management-related issue and somewhat easier to focus on. If I were to give it a heading, I would probably entitle it "inadequate corrective actions for security events." We have recently found inadequate corrective actions for events that are clearly recorded in safeguards event logs—multiple, repetitious items being logged without effective action being taken to prevent recurrence.

We feel that licensees are doing a good job identifying events—identifying events that should be identified—and recording them—capturing them in that log—but licensees may not be taking overall effective corrective action to prevent recurrence. If used properly, event recording, tracking, and trending can be a good management tool at several levels of management.

Having a tracking system to ensure that the problems that need corrective action are corrected and also, coupled with that, having a system to categorize and trend events to see if related problems continue and if the root problem was really identified the first time around. A tracking system may also be useful in making sure that attention and resources are being applied to the proper problem areas. This can also provide a good tool for program oversight, perhaps at the upper management level.

I should also point out that the enforcement policy provides additional incentive in this area. That is, you don't get violations generally if you identify and adequately correct problems, if it is not a problem that should have been prevented as a result of corrective action taken for a previous similar problem. If problems are just recorded and reported without having effective corrective action taken, you are probably not managing the program adequately and may be setting yourself up for an enforcement problem with your inspection staff.

Mr. Knapp:

I am Mal Knapp, DRSS [Division of Radiation Safety and Safeguards] Director in NRC Region I, which is in the Northeast. There are two issues that I would like to mention. They are brief and very simple. The first is overtime and the second is what I might have called the adversarial perspective. To steal from Wallace Higgins, it is an elaboration of his idea of "think like a bomber."

Both of these issues arise from experience that I have had with violations that we have observed in Region I and in escalated enforcement that we have had to undertake. In looking at violations of course, we do look for root causes. Is a particular violation an isolated incident or is it, in fact, indicative of a root cause that could lead to future incidents?

In that kind of an investigation, I seem to be finding that excessive overtime appears to be associated—perhaps only coincidentally—but it does appear to be associated with a number of the incidents that we find. Sleeping guards or inattentive guards, guards who pass a fence that has been inadvertently unlocked and who fail to notice and report it, improper scrutiny when badging employees coming through, failure to note that perhaps they gave the wrong badge to the wrong employee. That is not to say that we have an extensive problem in Region I.

Like Phil, I would note that most of our licensees do very well. But we do see occasional problems, and it would appear that the fatigue and boredom that can sometimes accompany excessive overtime can lead to incidents and violations. It is also my view that that could lead to excessive staff turnovers, which will exacerbate the other problems that I have mentioned.

The other issue that I would like to talk about is that of taking the perspective of an adversary, perhaps even an inadvertent adversary. Certainly, one of the things you can do is to think like a bomber. You can think like an intruder. One of the changes that has taken place over years of management of nuclear facilities has been what I think is a very sound movement away from a compliance orientation to a performance orientation.

To take this performance orientation a bit further, I think it would be very valuable for people to try to think like an adversary. If you walk the fence, ask yourself how you would try to get in if you were assigned the job of getting through the fence. How would you avoid a detection system? How would you hide from an assessment system? What are the ways that you personally, based on your knowledge of the facility, would use to get in? What are the soft spots and, having identified them, how would you strengthen them?

You could look at the problem not only from that sort of an intrusion but from any other potential soft spot. How about access? Suppose that you were an employee that was using a controlled substance. As little as I would like to recognize it, the fact is that with as many employees as there are in the nuclear industry, we do have that problem no matter how well we screen.

If you were an employee that was trying to get a controlled substance in the plant, how would you go about trying to do it? If you were an employee that had just been suspended and you were disgruntled and wanted to go back and make mischief, is there any way that you could get by the guards? What time would you pick, what guard would you use? How would you do it?

I think that if you take these approaches and challenge your system and encourage the entire security force down to the guards to think this way and to make suggestions, I think you will find, at least in Region I, that the frequency of incidents in a security system would drop dramatically and the frequency of violations would also drop.

Mr. Norelius:

I am Chuck Norelius from Region III in Chicago. There are two issues that I wanted to talk about. One has to do with strikes by security forces and the second has to do with limiting access to those who need it.

I think we all know that an important aspect of any system is the people that are involved. Certainly, in the security arena the security forces that we have are extremely important to making the total security system work properly. We have encountered a couple of instances of strikes this past year, and I think it is just helpful to remind ourselves of what kinds of problems can be caused in such a situation and what can be done to try to alleviate those problems.

Obviously, a strike can result in degrading security protection at a plant. It does several things. First of all, it disrupts normal communications. While there are procedures and there is training, there is also a network of communications that develop when people work together. When you enter into a strike situation that changes. So, your communication systems are disrupted.

Secondly, it introduces stress in individuals. They may have friends that are on opposite sides of the issue, and if things get tense this introduces stress and for those who remain and work it can affect their performance. It can also decrease individual effectiveness of individuals doing a particular job. Because of the loss of certain people, others are pressed into service who do not normally perform that particular function. Even though these people may have been trained, the newness of that activity can decrease the effectiveness of the role that they play in the security arena.

Then there are the general strained relations that exist, not only at the beginning of a strike situation but during that situation, depending on its duration, and after the strike situation is over and people return to work. All these things can degrade security protection.

Well, what can you do to help counter these situations? First of all, obviously, is to plan for various contingencies. I am sure you have strike plans, but sometimes we have found that some licensees think that a strike is not going to happen to them. Maybe they have been a little slow on the initial uptake of saying, "what if it does happen and what if it happens today, what would we do? What if there is a quick action, are we prepared to take action on short notice?" You ought to think in those terms. Usually there is some indication that a strike may happen. Once you have that indication, you ought to start your planning immediately.

Secondly, you should enhance your management oversight during a strike. This becomes difficult because often you have to press some of your management people into service, so you may have to work longer hours. Because of the changes, you need to enhance management oversight. It has been my observation, not only in security but in other areas, that often when there are regulatory problems they have been preceded by some change, either a change in the management structure, a change in the system, a change in the people. It is a time that you have to be especially cautious.

Of course, you have to ensure proper training of those who fill in the gaps. I also believe you have to enhance general communications to ensure that at times of strained relations you have people talking to one another about what they are supposed to be doing and carrying out those actions.

The other thing we would like you to do is inform the NRC early and often. We like to keep in touch with what is going on because we have our regulatory responsibilities as well. This past year in Region III, we had a strike by a single union that affected three sites. One was a fairly short duration, one lasted 57 days, and one has been ongoing and continues since February 6 of this year.

In this case, the early notification to the NRC was good, and what we did was to notify other sites that had the same union to just let them know in case they had not heard that there was a potential of strikes affecting their plants. This also allowed us to prepare our own inspectors, to put them on alert, so that if a strike did develop, we could dispatch them promptly to the site.

In addition, our security Section Chief, Jim Creed, met with the guard contractor managers to see what their plans were. This was extremely helpful to us, because we were concerned they were supplementing some of the sites with guards from other sites. We were concerned that this may detract from the security force at some of the sites that were not on strike as well.

We also maintained frequent, almost daily, contacts with site and corporate offices through the early part of the strike. Of course, then we did inspections early on when the strike was first initiated to ensure minimum staffing and training. During extended periods of the strike, we continued to look at that and at logs to look for trends and events to see if there was any degradation in performance from those strikes. We looked at retraining of people coming back and their effectiveness as they returned to the job.

Those are some things to think about in case you face that situation.

In terms of access control, in the design against threats to plants, there are really two things that you look for. One is the external threat and the other is the internal threat. Of course, we have systems in place to address each of these. For the external, we have armed guards, physical barriers, intrusion detection devices, compensatory measures. To guard against internal threats, we have criminal history checks, psychological testing, and reference investigations to try to define those people who may have a tendency to do something improper within the plant.

NUREG-0525, which is entitled "Safeguards Summary Event List," shows that for the last five years the events that have been reported, there are about 10 times as many events that have resulted from insiders than there have been from outside intrusions. These have not been the type that we have heard about today in terms of bombs and those types of things, but they have been actions inside the plant that could result in adverse safety situations.

In one case there were 62 fuel assemblies that were damaged while they were in storage. In another case, a safety valve was mispositioned and the chain that had secured it in place had been cut. In another, the reactor's chemical system was contaminated and, in another, the packing of a safety-related valve was tampered with.

One way that one might reduce the chance of an insider taking that kind of action is to look and see if you have limited access to people in the plant as much as you can. We have sent out bulletins and information notices in the past that have addressed this subject. I think it is something that I would suggest you take a look at again.

I believe we should approach this by saying you should base your access on the need for a person to go into a particular area and not on convenience of the system. We have identified some situations, for example, where a security access system is based on a four-step level of entry. An individual doing a particular job may only have to go into an area that is classified as a level four, but because of the way the security system is set up and the software related to it, he automatically has access to the other levels as well. That may be unnecessary for the particular job that he has to do.

My suggestion here is—as a way of reducing risk—I would ask that you look at limiting access and limiting the number of insiders and the areas that they have accessibility to.

Mr. Beach:

My name is Bill Beach. I am the DRSS Director in Region IV, which is our office in Arlington, Texas.

In Region IV, I have two issues that I want to address. I have a bet with one of my counterparts up here that I can get through these two issues without talking about violations. If I say violations, I know you hear it, but that's not the message that I am trying to get across.

We have had several licensees who have initiated significant program improvements, improvements to hardware, and also improvements overall in their program as a result of problems that they themselves have identified. When this occurs, however, several regulatory—and for the lack of a better term—conflicts can result. Basically, we in the NRC are telling you we want licensees to improve performance, we want you to look for problems, identify programmatic weaknesses, and then, once they are identified, we expect you to correct them.

Oftentimes, when you attempt a major program upgrade, increased compensatory measures are required because of equipment that is going to be out of service. As Mal said, increased compensatory measures increases the potential for human error. Increased overtime results in sleeping guards and other human behavioral problems. And, for some reason or other, during this time, there is usually an increase in access control problems.

All of these problems reflect negatively on your performance. Besides putting you in the enforcement arena, they also may affect your ratings. Rather than being encouraged by your program upgrade, you may become discouraged. The other problem is a poor performer who attempts a major upgrade and who already has a low rating. The improvements, even though they are initiated, aren't being implemented properly, and this may result in an already low rating going lower.

We want to encourage you to make improvements and to modernize equipment. As long as you are identifying and correcting the problems, we will balance those considerations with the problems that are identified. In short, we expect problems during that time, just like in outages. The main focus that we want to see is that your attitude is to correct your program, make it better, and as long as you identify the problems, we are confident that you are doing what we expect.

A second issue that I want to talk about involves the security operations interface. More aptly, I should say, what appears to be, in a large number of cases, a lack of a security operations interface. The implementation of our security program can be very proscriptive. Please note I said, "can be."

It becomes proscriptive—and again, this is my opinion—when it is viewed as, for a lack of a better term, a separate entity within the licensees total organization. It becomes isolated. There are many things that are different about security than the other organizations such as health physics, engineering, maintenance, and operations. But the security organization still shares in the responsibility for plant safety.

The security organization cannot be mutually exclusive. Sabotage or tampering threats, which aren't addressed by the regulations, would be primarily directed against operations and the equipment that the operations staff operates. The security staff would be expected to at least delay and possibly prevent the effect of a threat or event on nuclear safety. The operations staff is trained and responsible to recognize the safety implications on the equipment and by the equipment that is lost if such an event occurred. You can't have one without the other.

Recently, four inspections were performed in a larger region that reviewed this interface primarily and focused on contingency plans and procedures that were implemented by the security organization. The findings indicated that interface responsibilities were not understood in all cases by either operations or security. Operations staff frequently declined to participate in security contingency plan exercises. The relative safety significance of violations was not understood by security personnel, and the consequences of a threat were not understood by operations personnel. Those results apply to all four inspections equally.

Further complicating the last issue, are the vast differences in approaches that are taken by the physical security programs with regard to vital areas. Some have many individual vital areas with many access control points, which makes access by operations staff very difficult. Other programs minimize vital area access to have easier access by operations but, likewise, they allow easier access by a threat or an event.

The operations staff has to be involved with security in developing the strategy of responses to an event. It is impossible to have one without the other. The last thing is an example that I would like to close with. Recently, I had a conversation with another region about a plant with 100-percent capacity batteries supplying two separate redundant operating trains. A vital area door was lost, leaving vital area access to two of the operating trains. All three operating trains were functional.

Is it a concern that a vital area barrier was lost? Of course it is. But, should a threat exist, you would still have two operating trains of equipment, which meets the design requirements. The unfortunate thing is that this type of situation has a major impact on the enforcement action taken in such an incident. It was over an hour and a half before the fact of the 100-percent battery capacity was brought forth by the licensee. In my mind, it should have been the first thing discussed, because it significantly minimizes the significance of the enforcement action.

Mr. Pate:

I am Bob Pate from Region V, Branch Chief of the Nuclear Materials Safety and Safeguards Branch. I would like to talk to you about the experience that we have had in a couple of areas that might help to improve your security program.

First, I would like to tell you about three separate instances where improper background investigations were being done by contractors. These happened to three different licensees. To identify each of them I will call them number one, number two, and number three.

Through an allegation, licensee number one found that a contractor was providing certifications of background investigations before the investigations were complete. The allegation was true that the certifications had been made and the background investigations weren't complete. The contractor was completing the investigations, but several days later.

The end result was that the contractor's employees had access to the site without the background investigations being complete. As far as I know, there was no evidence to indicate that the contractor was doing it particularly for that reason. In other words, he wasn't motivated to get his people on site, at least that wasn't his only motivation for providing the early notification.

Licensee number two, through an audit of a contractor, found that a lot of the background information records were missing. In fact, most of the contractor's employees had access, but there were no records to indicate that background investigations had been done. There was some information that indicated some of the background records had existed at one time and they had been lost. For other contractor employees, the licensee could not tell whether background investigations had been done at all.

Some of you may be thinking that contractors who are providing certifications for their own employees don't apply to you at all because you have a centralized program. Hold that thought while I tell you about licensee number three.

Licensee number three hired a contractor to do employment verifications and reference checks. Another licensee informed licensee number three that it had also used the same contractor, and that the contractor had provided that licensee with some incorrect information on background screens. So, licensee number three took a fairly large sample of the background checks to review and verify that the records were correct. There were several discrepancies and the records were not correct. In fact, the records had been deliberately falsified by one of the contractor's background screeners. In interest of brevity, I won't get into why the contractor wanted to falsify those records.

It may be a coincidence that there have been three instances of improper background screening in Region V in the past several months—maybe the contractors in Region V are different than the rest of the United States. However, that is probably not true; I suspect that the contractors in Region V are just like the contractors in all the other regions. It might be worthwhile for you to check and see if you have the same problem.

How can you do that? The first thing you could do is verify that your contractors have a QA [quality assurance] program to verify that the records that are provided from background screening are correct. Also, you could have your own QA department do some double checking to make sure those records are correct.

Next, I would like to talk about the safety safeguards interface. In Region V, we used a special inspection to review the safety safeguards interface of the plants in Region V. We used the expertise of Pacific Northwest Laboratory, a five-member committee appointed by the Deputy Director of Operations, to perform this inspection. The team members were experienced in the areas of security, health physics, and reactor operations.

The team observed a regularly scheduled emergency preparedness exercise. They observed what was happening, how the players played out their parts, and they noted any possible conflicts between safety and safeguards. They didn't interfere with the players at that time, they only made notes. Based on their knowledge of the facility's security and operations procedures, the team came back the following week and interviewed the players and covered these areas of possible conflict. They asked the players what kind of changes did they think would have made the exercise go better.

At all sites, the team identified areas where improvements could be made. There was no one area that was consistent across all the sites. I will give you a few examples of the sorts of things that can be found through this type of team inspection. They found at one plant that there was a vital area door that could be eliminated because it was between two electric equipment rooms, both vital areas. They had a common door. That common door was a vital area door. Actually, they were both vital areas and that door could be eliminated.

There were other examples of vital doors inside vital areas, like the shutdown room, which was already inside a vital area and had a vital area door inside that.

There again, it was possible, with proper evaluation, to reduce the number of vital area doors and thereby increase the flexibility of the operators to get around the plant during an emergency.

The team identified one case where doors weren't labeled as well as they could be and there wasn't communications equipment near the doors. In the event that a computer failed or a card reader failed and the security officers had to respond to assist the operators through the door, they could make it much faster if the door was labeled or numbered or a telephone was close by so that the operator could call the security officers and tell them precisely where they were and the officers could respond quickly.

In some cases, it was decided that it would be best to just issue hard keys to select people so that they could get through the doors by using keys rather than electronic passes. In some plants, it was obvious to the team that the players knew that, during an emergency, certain doors would be open so that access would have been easier. Likewise, during an emergency, emergency vehicles would be allowed in to protect the area without being searched.

What wasn't clear was, who had the responsibility or authority to declare when it was an emergency. During one drill, the operations manager declared the emergency. However, the security people decided they had to check with their management to make sure they could do that.

These are the kinds of problems that this kind of team inspection reveals. Some of you may have already used this method. If you have, that's great. If you haven't, I encourage you to do so. I think it may be well worth your while.

Mr. Burnett:

I hope we have raised some controversial issues. I know that the FBI is still with us in the back of the room, and I thank them for staying. I would like to encourage any questions that you might have. Just to start you out, I will share one of the questions that the press had for us at lunch time. They asked, "why are you having this conference?"

The young lady wanted to know if we had sensed an increased threat to the nuclear community. My answer to that was, "no we have not." I think you also detected in the talks by the FBI, particularly Mr. Quigley, that no, we haven't detected increased activities directed toward our facilities. I would solicit any questions that you might have for the FBI or any of the regions. Also in enforcement and for NRR.

Mr. Ernest:

My concern is Region IV. I heard a couple of the regional personnel state that the problem with the access to vital areas was that it was complicated by the fact that you have both the need to access and the vital area concept. Is there any move afoot by NRR to either come up with a solid decision as to which one the NRC is going to go with, or is there still going to be a plant-to-plant decision?

Mr. McKee:

I think now the focus of the Commission is based on some information that we have observed as we have gone out on inspections. We are more focused on, from a generic aspect, if there are any areas that aren't protected.

I don't think we have really distinguished between the vital area concept or compartmentalization, but we are looking more at some specific areas that may need to be protected in the future.

Mr. Burnett:

Any additional questions out there?

[No response.]

Mr. Burnett:

It is obvious that everybody wants to get to their other duties, or the reception. For those that are coming to the reception, I will see you there. For those that are not, I will see you tomorrow morning at 8:00.

PROCEEDINGS – DAY TWO

Ms. Dwyer:

Good morning. Today's discussion will focus on explosives detection technology. Yesterday we heard the basics about explosives and explosions; today we will hear more about technology. I am going to turn this over to Donald Kasun, who will chair the session this morning. Mr. Kasun is the Acting Branch Chief of the Domestic Safeguards and Regional Oversight Branch, Office of Nuclear Material Safety and Safeguards.

Mr. Kasun:

Good morning. Continuing our discussions on explosives is Lt. Commander Edward C. Kittel, the Explosive Ordnance Disposal Program Manager, Department of Defense, who will talk about foreign terrorist explosive devices.

Foreign Terrorist Explosive Devices

Lt. Cmdr. Kittel:

Good morning. I am going to talk today on domestic and foreign terrorist explosive devices, and you are going to be a little bit surprised to see some of the same slides you saw yesterday. Hopefully, by the time my presentation is done, there will be no doubt in your mind what terrorist devices look like.

[Slides shown. Lt. Commander Kittel's slides are not included because of the sensitive nature of the material.]

We are seeing terrorism in the news all the time, all around the world. We are not seeing too much in the United States, as pointed out yesterday. There are very few domestic international-type terrorist incidents, but we have a lot of bombings. We have policemen being killed very frequently, especially in South and Central America. These scenes are becoming pretty common, like Rome Airport. Car bombs are fairly popular. People have a lot of affinity for using car bombs because of the ability to hide the explosive in the car and move it to the target with relative impunity.

Aircraft bombings have caught all of our attention. Most recently, this scene December 21, 1988, at Lockerbie, where there was about a 650-square-mile crime scene or bomb scene in which the Scotch and British investigators have done an outstanding job. We will talk a little bit more about that as we go.

If any of your lives have not been touched by bombs, I think you are kidding yourselves. We have seen these types of covers on *Life* magazine. Most of our news headlines have been focusing, especially since Lockerbie, on the issue of bombing. When we travel, if we don't think about bombs and if we don't think about vulnerability in our daily lives, especially when we travel to high threat areas abroad, we are kidding ourselves. We are all affected by it.

How do people learn how to build bombs? I think we covered that in fairly good detail yesterday. It does not take a rocket scientist to build an improvised explosive device. You can pick up any number of electronics handbooks and figure out how to put together relatively easy circuits. You could also look at military manuals and commercial manuals, such as military explosives and explosive demolition manuals from Army training, other service training manuals, and items like the "Blasters Handbook."

Of course on the left is the more famous book, the *Anarchist Handbook* and *The Poor Man's James Bond*. There's a lot of information on the market. So, it's not difficult for the bomber to figure out how to put these devices together. As was also pointed out by previous speakers, we like good bombers, the ones that blow themselves up.

An improvised explosive device can look like anything. If there is one "takeaway" from this presentation, I would like you to keep that in mind. A lot of the things that I am going to show you today are the conventional, obvious, easy to detect improvised explosive devices, or IEDs. I want you to consider how many ways a device can be built, what types of components can make up these devices, and how they can be very easily disguised to look like other-than-normal Mark One model bombs.

I have a couple of examples. One is an electronic device with a mercury switch inside a pack of cigarettes. You could put a number of ounces of explosives inside a pack of cigarettes that could do a fair amount of damage. We see a number of small devices of this size used by animal rights groups, for example, where they put them in mink coats and other furs in stores, particularly in the U.K. [United Kingdom].

The second example is a self-igniting fire bomb. This one has a wrapper on it that would cause a reaction when broken. The simpler version, of course, has a wick and fuse coming out of it. Any number of types of mechanical timers or electronic alarm clocks also can be used to delay these devices.

Let's go through a little bit of the lineage leading from fireworks used as explosive devices to some of the more technical items. Here is an example of a regular cherry bomb—I guess you would call that fireworks with some fragmentation added to it. This could be thrown or placed. The problem here, of course, is that there is not much of a delay for the bomber to get away. Match heads also are a very simple source of low explosives. When put into some type of a containment vessel—in this case a piece of copper tubing that has been crimped—you have an explosive device.

Where do we get the materials? Everything that you see in this picture can be picked up at many hardware stores, not only in this country but around the world. There are very few, if any, controls on smokeless powder and black powder and, certainly, there is no law against buying pipes and end caps and drills and other equipment. The explosives are out there. They may be low explosives or they may be high explosives, but you can still get a high explosion effect from low explosives, as we pointed out yesterday.

Frequently the bomb maker will try to add extra fragmentation to the device. Here we see a simple pipe bomb with a piece of fuse sticking out of the end, and the bomb maker also has decided to add some nails. Obviously, he is going after a personnel target rather than a building. Here is a pipe bomb that is electrically initiated with black powder exposed to show you the filler. This could be match heads, a smokeless or black powder mixture, or it could be a high explosive inside the pipe bomb. So, we can't get too focused on what is inside the pipe bomb and what the filler is. That is really the problem of the bomb technician. Your problem in security, of course, is detection and preventing these items from getting into your facility.

PVC [polyvinyl chloride] pipes will work just as well as steel or iron pipe. This particular device was recovered by the Puerto Rico police last year, along with another one that had a timer on it. What I have tried to do in this presentation, as much as possible, is show you some actual devices. Some of the items, especially the ones with the pretty backgrounds, are training aids.

If you come across a short piece of pipe with two end caps on it, chances are it may not be something left behind by a plumber. We don't know what is inside it. In this case, it might be just a piece of pipe and two end caps, or it might have an electronic antidisturbance mechanism inside it. From a security standpoint, the most important thing to remember is when you find suspicious items—which is what you and your people will be doing—don't disturb them. Call in the bomb technicians who are trained to handle them.

Here is an example of a pipe with a timer inside it. It could have a mercury tilt switch or it could have any number of other antidisturbance switches inside it. One of the techniques that bomb makers have used with some success, to try and catch the bomb technician or security person off guard, is to take a pipe bomb and put a burned piece of fuse through the end cap. So, when the technician walks up to it, he gets lulled into a false sense of security believing that the fuse has gone out. Low and behold, there is an electronic circuit inside. So, please be careful.

How do the bomb makers disguise devices? How do they try to beat you? They do this by putting the bombs into obvious containers. There are lunch sacks and grocery bags and lunch pails and briefcases all over most of your facilities. The search techniques that are involved in looking for a bomb can get complicated. Please don't expect the EOD [Explosive Ordnance Disposal] people, whether they be military or civilian law enforcement types, to do your searches for you. They don't know what is "normally" in your facility.

You need to have detailed search plans made in advance so you can deal with these inevitabilities as they come. Don't expect the bomb technicians to search. Your job is to locate the items without disturbing them, and then contact the bomb disposal people.

We talked a little bit yesterday about the 20/20 interview with Yu Kikumura, which was pretty interesting. Kikumura is a "failed" terrorist because he's in jail now for 30 years and will hopefully stay there, unless his lawyer, Mr. Kunstler, has his way. One item that wasn't brought up yesterday that I thought was an interesting anecdote was, during his travels around the Mid-Atlantic and Midwest States as far as Missouri, Kikumura stopped at numerous places, stayed at bed and breakfasts and campsites. We believe that he initially tried to manufacture a high explosive device, rather than these fire extinguisher pipe bombs that he wound up with at the I-95 Vince Lombardi rest stop. At one time he went into a drug store. The druggist remembers him having burns all over one side of his body—on his arm and legs. Kikumura went in and bought gauze bandages, ointments, and those sorts of things. What we suspect, based on the items that he had in the car, was that he was trying to make mercury fulminate detonators for a high explosive device. That went badly and he burned himself sufficiently to require first aid.

This is not a rocket scientist terrorist. Kikumura has been arrested three times. This time, at least, there was a conviction. He is a member of the Japanese Red Army with ties to Libya and to Hizb Allah in the Becca Valley. We have every reason to believe that this international terrorist was planning to carry out his attacks either that day or the following day in New York City.

The other incident that was alluded to yesterday was of international terrorists entering the United States in Vermont. Some Middle Eastern gentlemen all dressed in matching running suits came over the Canadian border into Vermont. They didn't quite fit in, in northern Vermont. One of the things that was noted when they were caught was that they looked out of place. They tried to look like they were part of an athletic team, or something, with their matching jogging suits, but they were all chain smoking.

[Laughter.]

A combination of Middle Eastern gentlemen in northern Vermont, in running suits, and chain smoking just didn't fit right. They were picked up pretty quickly.

Anyway, the "Kikumura" devices were evaluated as high explosive devices. They were three Kidd brand fire extinguishers filled with smokeless powder with extra fragmentation ball bearings thrown in. These were definitely destructive devices. Mr. Kikumura also had three marks on the map of potential targets in New York City, including the Marine Corps Recruiting Station.

Let's move from the placed device to thrown devices such as grenades. If we are facing an assault on a facility by a squad-size group, we could expect to encounter, most likely, military ordnance, but possibly improvised grenades as well. As you can see, they can be made out of CO_2 cylinders, film cans if you can find them anymore—I think they are all made of plastic now—and glass bottles with various explosives in them.

We can get a little bit "higher tech" and go with small pipe bombs that can easily be thrown. These would be lethal, no mistake about it. A little bit on military ordnance—a number of older style grenades, as shown on this slide. Probably the most popular grenade used by terrorists across the world today is the Soviet or Warsaw Pact version F-1 grenade.

Grenades come in various shapes and sizes. Some of the more modern grenades have a rounded configuration, the size of baseballs and softballs to make them a little easier to throw. They all function basically the same, with about a 4- to 6-second delay on the firing action once the "spoon" is let go and the firing pin goes forward.

There is another problem that we are seeing—and I think this is serious. I would expect that you would see this more at home than overseas. These are training grenades. They are the type that we teach soldiers and marines to throw while they are in boot camp and various other basic training schools. As you can see, most of these training grenades, if not all of them, have a hole in the bottom. They have a cartridge that emits a bang or a little puff of smoke after the normal 4- to 6-second delay. This adds some realism to the training.

We are finding that terrorists are buying training grenades on the open market. They can be found at military conventions and hobby shops, as collectors' items. The terrorists screw or weld the holes closed in these grenades and fill them usually with a low explosive—or it could be a high explosive—and thus create a functional grenade out of what was previously considered an inert training item. So, don't think that just because a grenade is marked blue—which is how a training ordnance is marked in the United States—it may not be lethal. We are seeing a lot more of those.

Probably the most popular improvised explosive mix is potassium chlorate and sugar, which can be set off by a detonator or blasting cap, or by several different types of acid. As the switch in this device, we have potassium chlorate and sugar with acid inside a condom, which provides for a time delay. This is a fairly popular device. It has been advertised in most of the bomb building manuals like the *Anarchist Cookbook*.

This is an item that can be placed with a delay and secreted into a facility in an ordinary container, in this case, a hairspray can. Again, don't always look for the obvious. We need to look for the less than obvious because the terrorists will think of it. They are going to do surveillance, they are going to look at our security and figure out how to go around it.

I have one slide on detonators, which shows a normal electric detonator, a nonelectric blasting cap, and the same type of nonelectric cap with a piece of time fuse or detonating cord crimped into it. This is your basic firing train, either electric or nonelectric with the fuse.

How do you tell the difference between a detonating cord and time fuse? Detonating cord has a high explosive core, which is normally a white powdery looking substance that detonates at roughly 23,000 feet per second. It can be less, it could be a little more, depending on the type of "det" cord. I responded one time to an incident in California where a woman's husband had died. He had been an old miner and blaster out in the desert in California. She had only gone into his workshop one time when she went to get some clothesline. It turned out that she had used detonating cord as the clothesline, which is a quick way to get your clothes off at the end of a wash day!

The woman had called and asked us to take a look in the shed because she thought there might be some old explosives in there. I saw the roll of det cord and looked at the clothesline and, low and behold, we had a good match. Basically, my ID [identification] was the white powdery substance in the core.

On the other hand, a time fuse usually burns at about 30 or 45 seconds per foot and has a black powder core. So, you can keep that in mind. In hoax devices, people will sometimes use clothesline, which is neither. It may be difficult to tell. Again, rely on your bomb technician's judgment if you are not sure.

Ammonium nitrate and fuel oil (ANFO) is a prepackaged product that was made by Dupont and others. Ammonium nitrate fertilizer is a commercially produced item. ANFO is ammonium nitrate fertilizer prills mixed with diesel fuel. It is a very potent high explosive that is very easily manufactured out of garden-variety ingredients.

If any of us can't recognize a stick of dynamite either before or certainly after this conference, we are in trouble. We are not generally going to see dynamite carried around exposed. This slide shows a bomb with a cigarette delay going into a couple of match sticks. It is a simple delay switch that a bomber may want to use because it gives him a fair amount of delay time to get away. A little bit of extra fragmentation with some chain and a fairly old type of blasting cap, but still effective. You may still see some of that type around.

A little bit on military explosives. TNT [trinitrotoluene] comes in three blocks for military use: quarter pound, half pound, and one pound. It is a yellow straw-colored cast composition. Although it can be powdered and flaked, the most common form of TNT is in a molded hard block. It is not malleable. It is rather difficult to disguise in small containers. But, it is a very potent military explosive.

All military demolition explosives are what we call combat safe. These types of explosives can take small caliber bullet fire and not go off. For people like me who have been known to walk around with military explosives in a back pack and sometimes in my pockets when I am out in the field, I think that's a nice feature.

Now I will show you three slides on plastic explosives to give you a little bit of a comparison. This is the basic U.S. composition C–4 plastic explosive. It is white in color, it is malleable; you can cut it, mold it, roll it, or press it. You can do just about anything to it. It will burn without detonating unless it is confined. This plastic explosive is absolutely the explosive of choice for terrorists.

Last year in the United States, according to the ATF [Bureau of Alcohol, Tobacco and Firearms] statistics that just came out, there were only 9 pounds of C–4 unaccounted for or stolen from military supplies. There are relatively small quantities that we know are stolen. There is C–4 on the international market, besides U.S. sources, and it does show up in bombings around the world.

This is such a popular explosive that there is a fairly lengthy list of other countries that have copied it and are making essentially the same type of C–4 that is produced by the United States. This is a block of Iranian C–4 and it looks pretty much like the U.S. C–4, and it has relatively the same performance characteristics in the range of 26,000 to 27,000 feet per second detonation velocity. It's powerful stuff.

I have had many questions about Semtex since the bombing of Pan Am 103. This is Semtex-H, basically the only Semtex that is on the market. There have been earlier versions, but what we are seeing around the world is Semtex-H. It is recognizable by its brownish orange color. Unlike C–4, which is made of 100-percent RDX [research division formula X, also called cyclonite] explosive with some other plastics and additives, Semtex has a combination of PETN [pentaerythritol tetranitrate] and RDX. It's about the only item that is made today that has both of those in the same explosive.

Deta Sheet, the sheet plastic explosive, which you saw in the presentation yesterday, is made out of PETN. We conclude that we have had a Semtex bomb when forensic investigators find the presence of the byproducts of both PETN and RDX in a post-blast investigation. Generally, you won't get too many forensic chemists to say it was Semtex unless they find a piece of it. They will say that it had PETN and RDX and that is consistent with the formulation of Semtex.

Semtex is only made in Czechoslovakia in a little town called Semtin and it has been widely distributed throughout the Eastern bloc. The Soviets buy it and we know for certain that the Libyans have a lot of it, which they provided to the IRA, which was mentioned yesterday also. If there are any more questions about Semtex, we can take them at the end of the presentation.

This next slide shows a fairly recent arms cache found in El Salvador. You can see quite a mixture of items here. The items in the left-hand corner include improvised hand grenades. No magic, they make them frequently out of items like papier-mâché and any type of material that can be held together to be thrown. We are not seeing a lot of sophisticated ordnance being used by Central and South American terrorists, but the potential is there. These terrorists do not always use items as simple as a little homemade bomb.

They also had 60-millimeter mortars and 81-millimeter mortars and a lot of other pieces of military ordnance in this cache. Those pressure-plate booby traps in the upper right-hand corner are pretty simple pressure switches. They have two pieces of metal separated by a little piece of rubber tire at either end with a wire to each plate buried in the ground. When the soldiers on patrol step on the plate, it makes contact and fires a device that is normally tied to a tree and aimed at the soldiers.

This item actually came from Puerto Rico, but is very similar to an item used today in Central America, which they call a Rampa. Basically it's a satchel or burlap bag filled with explosives with either a lit burning fuse or sometimes a contact switch. This is actually hurled onto the target by a catapult similar to the old medieval catapults. Insurgent groups, such as Shining Path in Peru, have used this device and it has also been seen in El Salvador. It's no great secret how the devices are made, but they can range in size from very small "bomblets" to very large powerful satchels.

People walk around with briefcases as a normal part of their business, but we are pretty good at detecting the obvious, like a briefcase, using either metal detectors or explosive detectors. This is probably not going to be the way explosives are introduced into your facility. It could be, but I would say that we are probably well enough prepared to deal with this.

Here's an interesting one, a cigar tube with a small amount of plastic explosive in its base with a battery and detonator. There are any number of ways the explosion could be initiated, not the least of which is just by unscrewing the cap and making contact. The tube also could have a timer in it.

The next one is a simple fuse device with a burning time fuse hidden in a soda can. We have seen a lot of these in the Latin and Central American countries. This is a basic satchel. Other items include a cigarette pack with an electronic printed circuit board inside. A flashlight also could be used.

As you know, in conflict situations soldiers are always told, "don't pick up souvenirs, don't pick items left behind by the enemy." Well, these situations now exist in our cities, internationally. If you live in Bogota today you can be sure that the word "conflict" is part of your everyday vocabulary. Heaven forbid what it would be like to deal with the urban environment in Beirut, Lebanon, today.

This is a hand grenade, and it's about a 30- or 35-millimeter hand grenade. It nicely fits into that film package. Think about that as you are screening people and they pass their film around the metal detector or X-ray machine because they don't want it to be harmed. This is a military hand grenade that will fit inside a box of film. That's not the most powerful hand grenade in the world, but it is still a hand grenade with a fuse and high explosive.

We have seen devices, I might add, that were hidden in the cameras themselves. That's another thing to think about in your security plan. This device has been in use frequently in South and Central America. In this old slide from the Canal Zone, you see the modern version of the soap-dish bomb, which is extremely popular in Central America. It can have either an electronic timer or mechanical kitchen timer and magnets. It may be placed either underneath a vehicle or actually on top of the vehicle over the driver's head. For example, while the target is driving in traffic, the bomber walks by and places a plastic soap dish with small magnets on the bottom of the vehicle or an explosive device with a timer right over his head.

I didn't have a picture of the rockets themselves, but there are a number of groups—probably Japanese Red Army being the most famous for this tactic—who use improvised rockets that are projected onto their target from cars. In some cases, these have been fired from the back of pickup trucks where they have a clear open shot of the target. In other cases, they have been a lot more devious and have put paper panels in the side of the trunk of the car and painted them to match the car's finish. The rockets would project right through the trunk into the building. Several of our embassies around the world have been hit by these types of improvised rockets. This is a unique concealment technique, with the items actually firing right through the vehicle.

This is one of the most ingenious concealment devices that I have seen. This is an old slide, but I thought I would bring it to your attention. The explosive device was attached around the woman's waist and she was wearing maternity clothes. When she removed the device and placed it on the target, she used an inflatable bladder in place of the device so that she still looked pregnant. Who is going to mess with a pregnant woman? Certainly not me. This was an actual photo of a device used by a Middle Eastern group.

A couple of quick slides on switches. We saw a lot of this yesterday. Here's your basic trip wire pressure-release type switch, where the clothespin has contacts separated by some type of insulator. It could be a trip wire, it could be attached to a door, it could be attached to a package. I think you have the idea on this one.

This other one, the second slide, shows both pressure release and pressure in the same clothespin, where it could function by stepping on it and closing the contact on the right side of the pin or by an alternate means of pulling out the insulator from the left side. It is a combination, fairly low technology item, but extremely effective. Mouse traps are pretty obvious. You can see that when the pin is pulled the spring will flip over and hit the contact on the other side.

Motion-type switches may use springs. For example, all of us have government ballpoint pens, the little black pens with the silver ring around the middle. Open that up, take out the spring, and use the metal ring from the center of it for the other contact, and you have an instant trembler switch. We walk around with the components of a bomb every day.

Rather than mercury, this switch just has a small wire that is free to move within the glass vial and some wire mesh around the side of it. The same idea as a mercury tilt switch or the swing type of trembler switch, just a little bit different twist.

An item like this could be a chemical delay pencil or it could be the type of delay that has a sheer pen inside, where metal fatigue will cause a wire to break, the spring goes forward and makes the circuit. If you see something like this, chances are it is one of those types of delays. Again, in the security business we need to be able to recognize things that are unusual, things that don't fit, things that aren't what they seem to be.

This is a pretty popular little timer out of the Middle East, frequently referred to as an ice cube timer. This timer shows up everywhere, particularly with Middle Eastern groups. The PFLP-GC [Popular Front for the Liberation of Palestinian General Command], for example, used a timer similar to this in the Toshiba radio that was recovered in West Germany last October 26th. I might add that this timer comes with directions. Each one has a number, the time is predetermined, it's a capacitor discharge type of electronic timer. It comes out in kit form. When the bomb maker gets it, he just has to pick the one with the right number for the delay that he wants and follow the directions, hook up the battery, put it into his circuit, and he's ready to go.

Realize also that some of these devices are being provided with instructions to people by very experienced bomb builders. These have been around for a long time. There are at least four—I think we are up to the four and one-half or fifth generation of ice cube timers. This was the first.

This was a timer that got a lot of recognition a number of years ago. Libyan bombers were using this. It was called the decade timer. An electronic timer, which also had instructions telling the bomb maker how to dial in the desired delay time. Not particularly high technology, but certainly a lot higher technology than a clothespin with an insulator between the contacts. Basic electronic store-type circuitry in a manufactured device—all you need to do is add explosives.

There are any number of types of printed circuit boards around. I just threw this one slide in as an example. All the electronic components on this PC board are a lot smaller than that 9-volt battery. E-Cell timers, 555 Chips—I am sure that you have heard of a lot of them. They all serve a purpose, to provide an electronic precision time delay that can range from seconds to hours to days, months, and so on.

Radio control devices have become increasingly popular. This is an actual device that was recovered in the Middle East; it has a radio paging transmitter and receiver. Model airplane radio transmitters are extremely popular. Why is that? When you are planning an assassination, it's a little difficult to figure out exactly when your target is going to be there. If you can give yourself the maximum standoff range, a quarter mile let's say with a 500 milliwatt transmitter, you can stand across the street or down the block safely behind cover, wait for your target to be at a place—basically of your choosing—he goes by, and you push the switch. It's very, very simple technology.

As we look at the higher technology solutions and as we look into the 1990's, we are going to see more tone encoded systems rather than your basic model airplane controllers. In fact, the new model airplane controllers have encoding and encrypting systems on them so that people can fly more than one airplane at the same location. We are seeing the bomb makers get more sophisticated in their technology, but the basics are still the same.

I will be willing to bet that you will see this again before the conference is over. This is the bomb of the century. On 26 October of last year, the West German police arrested 11 PFLP-GC people who were operating in West Germany. This device was in a vehicle outside one of their apartments. This is the actual device, and it was interestingly enough called the Bombeat 453, the model number.

Why a Toshiba radio? It has a lot of room inside of it, probably for no other reason. I know that you have seen these slides, so I won't belabor the point. There was an extra set of penlight batteries in this device in the lower right corner. That might have been a way that this device could have been detected rather than detecting it by the explosive vapors. Maybe an operator on an X-ray machine, if this had gotten to an airport, would say, "I wonder why there's an extra set of AA batteries."

There are the normal C or D cells across the bottom and at one corner another set of batteries. Those are the types of things that should stick out for an operator on an X-ray screening machine; something different. The rest of the device, the detonator and the explosives, were both contained in that white block marked "Toshiba." I would venture to say that most X-ray screeners looking into a bunch of electronics may not pick up a detonator from the other electronic items inside the radio. Some may and some may not, but that's the type of thing you could think about in your training, trying to distinguish detonators from electronic components. We will get into that with future speakers who will talk about detection.

Lower left corner of this slide, under the motor, you can see the back of the altimeter. This is the type altimeter that you can buy in an automotive store, as was mentioned yesterday. The altimeter normally is set up on the dash of a car, so that when you are driving around the Alps or Bavarian countryside you know how high you are. I personally wouldn't need an altimeter in the car, but some people like that kind of thing.

A few slides on letter bombs. Generally speaking, a letter bomb is a little bit bigger than the first class envelope. Why? You need to get some amount of explosives in it, some type of a switch, some type of power source, et cetera. One of the more common ID features, although I wouldn't rely on it, is that the explosives may exude through the paper. You can see that in both of these cases the paper has oily stains on it. That's a good hint. If you see oily stains on an envelope, something may be amiss.

You see in the upper left-hand corner there is a piece of tinfoil sticking out of this one. Again, just another indicator that something is not quite right. Another feature is that sometimes they will be lopsided, a "funny" weight, not your normal package. It doesn't feel right and doesn't look right. Some letter bombs, package parcel bombs, whichever term you want to use, show up at your doorstep without postage on them, no UPS label, no stamps. Good questions to ask are: How did the package get here? What is it doing here? Why is the package left sitting against the building?

"Science of Living," I love this one, a book bomb. Recognition signs, I will let you read through them. A lot of times they will have the wrong title or they will be addressed incorrectly to "His Excellency," "The president of NRC," something like that. That is, something that just doesn't quite fit right. Those are the types of things that your mailroom screeners should be looking for. I am not going to go through the whole list. If you have any questions, we can cover them later.

Car bombings are another method. Five people were killed when a bomb went off outside the Naples USO building. Another occurred at the U.S. Embassy in Beirut. I will cover this next one in a little bit of detail since it involved one of our DOD people. Captain Bill Nordeen, who was the Defense Attache in Athens, Greece, was killed by a fairly healthy sized car bomb, about 50 pounds of ANFO [ammonium nitrate and fuel oil] explosive in the trunk of a car that was set off by a radio-controlled firing device.

Captain Nordeen was about a block away from his residence on a one-way street when the device went off. The perpetrators, a group in Greece called 17 November, a left wing revolutionary organization, did a very nice job on this. They were right on the scene behind an abandoned house with the radio control. They waited for the Defense Attache to drive down the street—which he did about the same time every day.

They had him under surveillance for between 7 and 10 days in his neighborhood before the attack. It was a devastating car bomb. This is what is left of the Ford Granada, a lightly armored vehicle, that Captain Nordeen was driving. The Toyota was the vehicle bomb; it had the ANFO in the trunk. Not only did these guys use a fairly sophisticated radio-controlled device, but they were trying to get the maximum "bang for the buck." They focused the blast out into the street in the direction of Captain Nordeen's car by stacking bags of cement on the curbside of the trunk so that the blast would be directed out into the street.

I might add, 17 November just celebrated their 14th anniversary. They have been blowing people up for 14 years, and they [Greek police] have no suspects and no arrests in any of those cases. They have assassinated an Embassy official, the Chief of the Joint U.S. Military Advisory Group, Captain Nordeen; they tried to bomb a senior DEA [Drug Enforcement Agency] official; they have blown up two Air Force school buses; they shot an Army Master Sergeant courier who luckily survived his attack.

Just one note on physical security: If you are moving about in a high-threat area, remember to vary your times and vary your routes and realize that you are going to be under surveillance before an attack. You can make it more difficult on the bomber if you show good security practices.

It was mentioned yesterday that Secretary of State Shultz was attacked in August of 1988 down in LaPaz. This device was fired by remote control. In this case, it was a command detonation wire running up the hillside. This is right on the edge of the freeway, connecting LaPaz Airport to the downtown area where Secretary Shultz was going to stay. As in many South and Central American bombings, the explosive of choice was dynamite.

A couple of sticks of dynamite were buried in that hillside, just behind that drainage system to provide some cover and deception for the bomber. He ran the wire up the hillside putting it underneath pieces of grass and rock, to a fairly good observation point. Mr. Shultz's car was hit by explosive fragments and debris, as were the two cars following behind his. Fortunately, the device was small enough in size that no one was injured.

This slide does not show a foreign city; this is San Diego last March, a case which remains under investigation and unsolved. The question in many people's minds has been, "Did foreign terrorists come into the United States to seek revenge for the shooting down of the Iranian Air Bus?" Mrs. Rogers is the wife of Captain Will Rogers, III, who was the Commanding Officer of the U.S.S. *Vincennes*, which fired the missiles that shot down the Iranian aircraft. A pipe bomb exploded under her car as shown here.

There has been some speculation that this was not an international terrorist incident. I am not saying that it was or wasn't, but just presenting it as an example of a car bomb with that question mark hanging over the incident: Was this terrorism?

One quick word before I conclude on military antitank rockets. They have been around for a long time. This particular rocket propelled grenade launcher, the RPG-7 with the PG-7 grenade, was preceded by the PG-2, and it is not out of use by any means. There is a PG-18 and a PG-22, new versions, which have been fielded throughout the Soviet and Warsaw Pact countries. These are everywhere. Everybody wants to a have a rocket-propelled grenade.

This is the U.S. version, the 66-millimeter LAW [light anti-armor weapon] rocket, disposable throw-away tube. Fairly light, compact, easy to conceal. Not a bad item, if you are going after a hardened target. It will have a devastating effect on vehicles, armored or not. This is the Soviet copy of the U.S. LAW rocket

This is an old system that is obsolete in the United States today, the Redeye surface-to-air missile. It has been replaced by the Stinger, which I am sure you are all familiar with. Redeye's in their day, were sold through foreign military sales and have shown up in other countries in the hands of terrorists. More often than not though, the Soviet SA-7 Grail missile will be the terrorist's anti-aircraft missile of choice. These are guided missiles, shoulder fired, and we know they are out there. We know that terrorists are using them. Recently the Cyprus police recovered several of them next to the Larnicha Airport. They were in the water in waterproof containers, probably waiting to be picked up and fired at an airplane.

Several days ago El Salvador police announced that they had recovered an arms cache that had a number of SA-7 Grail missiles. They are available. When we look at threats to aircraft, these items have not been used nearly as much as we believe they will be in future years.

That's all I have, subject to questions. I think we may have a couple of minutes. I would prefer, if you do have any questions, that you give them to me now because I am not going to be able to stay for this afternoon's question-and-answer session.

[No response.]

Thank you very much.

Mr. Kasun:

Thank you, Commander Kittel. Our next speaker this morning is Frank J. Conrad from Sandia National Laboratories, who will tell us about the impact of explosives detection.

Frank, if you will go ahead.

The Impact of Explosives Detection

Mr. Conrad:

My topic today is the impact of explosives detection. I hope that you gathered from the lengthy presentations by the FBI yesterday that you are probably in trouble if you expect your people are going to be able to pick these devices out. Did you get that message? One of the things that we are trying to do in explosive detection is to give your people instrumentation that will allow them to do things that they cannot do now.

In most cases, we could give you an explosive device and you would not know that you had it. Did you get that message out of the presentations thus far? What we would like to do is to be able to extend the arm of the guard sufficiently so that he knows that he has a problem and knows what the problem is. My specific job is to develop explosives detectors to detect people carrying explosives into your plants, the DOE facilities, and also airports.

Although my specific area of expertise is vapor detection, you really have two different problems—maybe more than that—of detection; that is, you have to worry about bulk, like your X-ray devices, your TNA [thermal neutron activation] devices, those kinds of things, and vapor. Since I am really interested in vapor, I get to talk about what I like first. You do not get a vote in this.

[Slides shown. Mr. Conrad's slides are contained in Appendix A.]

In vapor detection you find the most pressing issue that has been discovered in ages. Almost everyone, including university professors, are intrigued by the possibilities for publications from this work. This brings up the matter of classification of this information. This information is not classified, but is sensitive, and the only way to get this information is to talk to someone who is actively involved in the work.

One of the things that you have to understand is, we have a big problem. We do not have anything to work with. We have tried to find a way of showing you about vapor pressure. The first thing we are going to do is plot the molecular weight of the individual molecules on the X axis. If you have a bottle and you have a piece of explosive and you put it into the bottle and put the cap on and leave it for a month or two, it will build up to a certain level of concentration and then the action will stop. For every molecule that comes off, one goes back on.

It maintains an equilibrium depending on the temperature and the pressure, mainly the temperature. So, you are only going to have a certain amount of material to work with. What we are going to do is, plot the molecule on the X axis by its molecular weight. One hundred, two hundred, three hundred, four hundred. We want to plot how much we have on the Y axis. One way of plotting that is to plot one part in 10, one part in 100, one part in 1,000, one part per million, one part per billion, and one part per trillion.

I assume that makes just about as much sense to you as it did to me when I started, and that was none. Let's go through it this way: If we take the individual components in nitrated dynamite, such as EGDN [ethylene glycol dinitrate], and we plot its molecular weight versus its concentration, how much do you have to work with? You find you have a lot—64 parts per million. That is 64 times the crud in the atmosphere. That is a lot.

In fact, with the commercial explosive detectors, you can detect the explosive vapor even before the person gets to the check point. That was not always the case, but it is now.

The vapor pressure of EGDN is 64 parts per million. If EGDN is not the explosive, the explosive that you are looking for is NG, nitroglycerin. That's three carbons, three nitrates, where EGDN is only two carbons, two nitrates. That's the same as the antifreeze that you put in your radiator. It's ethylene glycol, but we heated the substance to release the hydroxide and substituted a couple of nitrates in their place.

Nitroglycerin will go down to 185 parts per billion, not as much stuff. DNT [dinitrotoluene], which is the impurity in TNT [trinitrotoluene], has two nitrates but TNT has three nitrates. TNT is the explosive that you are really looking for. When you get to that part, you are down to six parts per billion, which is not much to work with.

The problem gets even worse. Here is ammonium nitrate, $NH_4 NO_3$. We chemists like to do that. That's our jargon that separates us from other people, especially physicists. Ammonium nitrate, which is fertilizer, has given the British a big problem for a long time. They have tried to make the fertilizer so that the terrorists can't use it.

The explosives we are really looking for are RDX [research division formula X] and PETN [pentaerythritol tetranitrate]. You should know by now that RDX is C-4 and the PETN is the detonating cord Deta Sheet. HMX is a high military explosive that we cannot even detect right now. We don't even know its vapor pressure. Although HMX is shown a lot higher on the slide, it is actually lower vapor pressure. HMX has RDX in it. It comes with a compound called PBX 9404 and we can detect that very easily with current instrumentation.

Do you get the idea from this slide that you have a problem? You don't have anything to work with. Those materials on the top only have six parts per trillion—not much. It's like a shot glass of whiskey in Loch Ness, Scotland. It is like one dollar out of our national debt. Not much stuff. This is like one second out of 32,000 years of seconds. Remember, that is all you are ever going to get and things will go downhill from there.

These concentrations are what you people are asking us to detect. Not to detect with the commercial instrumentation that exists, but with the instrumentation that we are developing and helping the commercial people to develop. We can actually detect those molecules at those concentrations easily and tell you what the molecules are. That is where we are going, and we are working on it, but we are not there yet. The problem is tremendous.

Realize one of the basic premises of this is, if you do not have any molecules you can not make a detection. If the person is smart enough to not contaminate the outside of the package, we are not going to detect anything—no molecules. Not much to work with.

In addition, people do not like to wait in long lines to get into the plant, and you don't like it either, you don't want to take too much time. You tell us that you will be really gracious and give us 15 seconds to do all of this. There is the problem; we do not have anything to detect nor any time to detect it.

It does not take a whole lot of explosives to do a whole lot of damage. I would like to show you a video tape on some tests that were run by the Las Vegas Fire Department after a certain incident out in Nevada. The first test shows what two and one-half pounds of explosives does to a car. The next one, I want you to hear for yourselves. I will talk about the test after the video.

When I say we, I want you to know that it is not just Sandia, it is all the people around the world working together. There are a lot of advancements, and we are a lot closer to being able to do the job than we ever have been before. It looks as though this tape may have been blank.

Now that we have had this interlude, let's talk about some peculiar characteristics of these molecules. If you take these molecules and put them in a plastic bag, almost immediately the detectors will detect them because they come right through the bag.

They are sticky. They stick to everything in the world. We have looked at just about every metal, every plastic, even skin. They go through skin just like it's an open window. In fact, you will notice that people who have worked with explosives a lot will stay away from nitrated dynamite because that is what heart patients use to keep their heart going. It is a vascular dilator, it dilates the vessels around the brain and can cause horrible headaches to those people who are sensitive to it.

In addition, these molecules are frangible. That is, if you ionize them, as you normally do in a mass spectrometer, they will break into pieces and will look just like any of the other pieces that are already in the atmosphere 100 million times more concentrated. You need to look at the whole molecule. If you hit them with too much energy, like ionizing them with 70 electron volts (70eV), they are gone, bad news.

Explosive molecules are thermally labile. Because of their stickiness the molecules will stick on a tube [preconcentrator], but then you must heat the tube to release them. If you heat it too high, the molecules are gone. They decompose and look like all the other pieces. The only property that helps is that these molecules are electronegative. They pick up a soft electron, if you can supply it with a low enough energy. There are not many compounds in the world that have this reaction—perhaps hundreds out of eight million organic compounds that we know. So, the detector must be very selective if you want to use that particular property.

There is a device used in commercial explosives detectors called an ECD, an electron capture detector. It is a tube that is about one-half inch in diameter with a radioactive source in it. The source is nickel-63, which emits 66 keV [kiloelectronvolts], which in turn releases the electrons from the gasses. These electrons are the secondary electrons, which lose their energy very quickly and become very soft electrons.

These electrons accumulate around the anode in the center. When the switch on the right-hand side of the device is closed, there is a measurable amount of current. We do it again, and again, and we get the same current, this current is the standing current. Explosives molecules and a few other compounds actually suck up these electrons when they are passed into the detector. In this situation, when we pulse the switch, we get a lower measurable current. This doesn't tell you what the explosive is, but it is used in the commercial explosives detectors as an indication that you have an explosive. It doesn't tell you which one, but it tells you that you do have something that will attack the electrons.

Let's talk about the commercial explosives detectors that are on the market. There are two principal ones, which you are going to hear a lot more about from Dr. Fetterolf when he gives his paper, so I will just talk about them in general and tell you how they work.

Explosives detectors are a very important element in the contraband detection. I think you have now been convinced that it is not easy to detect a bomb even if you thought you knew what a bomb looks like. What you need is something that will help you do that. You have both hand-held and portal [walk through] commercial devices to help.

You must know what you are doing, and you have to be able to use these devices intelligently. With the hand-held device you have a greater probability of getting a sample than you do with a portal because you can get right in the vapor cloud where the molecules are. If you then know how to handle the sample, you have a chance. However, with the portal you must worry about getting the molecules off an individual and detecting them—not easy. Remember, you are going to have six parts per trillion to work with, and that's in a saturated volume. Dilution makes it go downhill from there.

I included detection of vapors from nitrogen-based explosives on purpose. Recently a vapor device and a TNA [thermal neutron activation] device have been heavily advertised because they detect nitrogen itself. We do not necessarily care if it is nitrogen based or not, as long as the molecule has the property of picking up that soft electron.

We have not checked how many of these other explosives molecules we can actually detect, but we at least have the possibility of detecting other than nitrogen-based compounds. You can actually build a peroxide explosive that is effective. There are several other kinds of compounds. For example, ammonium chlorate or potassium chlorate and sugar can be used to build a good device—it works very well.

We have a possibility of working with much more than just the nitrogen-based compounds. One of the technologies we are going to use is the electron capture technology, but since it does not give us any idea of what that compound is, only that something is there, we are going to first pass it through a GC [gas chromatographic] column. I am sure that everybody understands "GC column," right? None? That's reasonable.

If a tube is packed with old cigarette butts or whatever and the explosives molecules are soluble in whatever the tube is packed with, and also soluble in pure gas, a drop containing 100 compounds can be added, and the time that it takes those compounds to get through the column, one at a time, will give an indication of what the compound is. But once the molecules go through the column, you need a specific detector to determine what the molecules are.

You know the amount of time it has taken for each compound to go through the column and you know it is electron capturing—those are the two processes. That is, in effect, the basis of most of the commercial devices. They are using the electron capture technology, but they are using it with a GC column.

Obviously, the detection depends on whether or not you have explosives. If you get an indication that you have an explosive, then you have a problem. What I have heard from my discussions with some of you, is that you really do not have procedures indicating who is going to do what, in case you find explosives. You might want to think about hiring a bomb technician or at least writing procedures on what you are going to do if you find explosives.

If you find explosives, then you have a definite problem; if you don't find any, it doesn't mean that you don't have a problem. It is indeterminate. You are not going to find everything, and you are not home free and clear.

There are two major U.S. manufacturers of commercial explosives detectors. One is Sentex Corporation, model Scanex Jr., and the other is the Ion Track Instruments, Inc. (ITI), model 97. Each company has walk-through and hand-held models.

The Sentex unit operates by pumping the molecules to be checked into the unit. The molecules of explosives stick on a preconcentrator, which collects them from the flow. Then a flow of pure gas is sent over the preconcentrator while the preconcentrator is being heated, which releases the molecules to the GC column. The molecules are separated on the column arriving at the ECD where they are detected. If explosives are present the unit alarms.

The other device that is probably the best seller is the ITI Model 97. This device is a membrane device. The material is attached against the membrane where it disolves into the membrane. It passes through the membrane into the pure argon flow, which flows to a divider and divides into two. One flow immediately goes to an ECD and the other flow, which is retarded slightly, arrives in its timeframe. If the delay is correct, it is called an explosive. If it isn't correct, the instrument indicates a single band on the display to indicate a "caution."

In this next slide you see a hand-held device that has been modified slightly and placed in a portal. The portal will probably have at least one door to cut down the extraneous air flows. The flows will go around the person being screened and out to a preconcentrator. We haven't talked about a preconcentrator yet other than the platinum wire with the coating on it. The preconcentrator is then heated and the material is dumped into a detector.

There are some tests that have been done on the performance characteristics of these devices. A comparison test was done by Dr. Fetterolf, and he will tell you about that. There are some additional tests going on right now at an EOD [explosives ordnance disposal] technical center, where they are running tests to characterize the lower limit of detection (LOD) of these devices and test the ITI Model 97 in different operating scenerios.

The thing that you have to realize is, the commercial devices up to now have all received a bad name. What I want to tell you is that what they do, they do very well, but they don't do everything. We are working on developing instruments that will do the rest of it.

Nuisance alarms can be triggered by nonexplosive vapors. Since I have already described to you an ECD that is very selective, you would not expect many nuisance alarms, and that is true.

In California I heard a fellow talk about a lady who came to work every morning and triggered an alarm every morning. She said, "Why me Lord, why is it always me; why are they picking on me?" The guard indicated that if she would change her perfume she might get through. She did change the perfume and it did work. Musk perfume has a compound very similar to TNT; it is called musk ambrette— this compound was evidently causing the problem.

The probability of detection with these devices is, of course, dependent on whether or not you collect the vapors. That makes sense. I don't think it needs any additional comment.

To test if these detectors are really working—the ITI works in about three seconds—there is no reason that you can't give your guards a sample and just let them test it to their hearts content. If they don't think they are getting a proper detection, let them try the sample with it. It just doesn't make sense to do it any other way. They can do it hourly, daily, or whatever. The thing is, you would like to make sure that it is working.

What kind of a test sample should you use? From the courses that we have given before, we decided that you really did not need a pound of dynamite. A test was run at the FBI—Dean Fetterolf will cover contamination—I will stay out of his territory.

When you are making an installation, some of the obvious things that you should watch for are drafts. Feel the draft in this room. Do you notice one? If you notice a draft, the flow is a lot faster than you think it is. If you place your portal right, it will help you. If you place it wrong, it will kill you. You won't ever see the vapor because it blows right out of the portal. Installation is very important.

Use your head and know that you don't have anything to work with anyway, so you can't afford to give any of it away. Look at your installations, see if the drafts are killing you, see if you are getting the best out of what you have. Obviously, you are going to keep smokers away. I am an ex-smoker, but all the time that I was smoking, I at least knew that it was loaded with all kinds of carcinogens. Bad news. Watch your installation to prevent smoker's smoke blowing into the portal. Remember, you don't have many emplosives molecules to work with so don't confuse the situation with extraneous molecules.

Let's talk about maintenance. I understand from a rumor that I heard yesterday that a number of these commercial units have been sold and they are operating just like a group of instruments that were sold to Sandia National Laboratories. I now have all of those units in my lab because we can't get anybody to change the gas bottle in the field. These units need good ultra pure argon-99.999 (five nines). If you do not have pure gas, the units are not going to work. You have to have good gas and you have to have somebody who is going to be able to replace it.

What we are telling people who ask about maintaining commercial explosives detector devices is that they do not require a whole lot of maintenance, membranes do not have to be changed frequently unless extremely dusty conditions exist—the membranes on the ITI Model 97 will last for months unless you have a lot of dust—and make sure that you have good clean gas.

It is probably best to assign an individual the responsibility of maintaining the device as his special thing. You don't give him an extra $400.00 bonus for taking apart a bomb, but you do give him a few strokes. It is his prime responsibility. If you make him a specialist of some kind, you have a chance of winning. I have seen it work before, especially in the military.

Throughout the country the fire departments are using their people to work in the parks and elsewhere. These people are trained firemen, but they do these other things. Since this is a commercial firm, they can get by with that. Once the fire alarm goes off, everybody throws down what they are doing and goes to the fire. It has been very effective. In effect, you would use this fellow the same way. His principal job is that device. If it doesn't work, it's his problem. He is the expert, he will take care of it. That psychology seems to work.

These detectors have some vulnerabilities. They may not be able to detect explosives with low vapor pressure. They will not detect pure RDX and pure PETN. However, from ATF [Bureau of Alcohol, Tobacco, and Firearms] and FBI statistics, you will find that 30 percent of the explosives that they are not supposed to be able to detect, can be detected because at one time they were close to nitrated dynamite. If they are detected, it is because they will be mistaken for nitrated dynamite at this low sensitivity.

Nitrated dynamite vapor is the worst contaminant that we have seen. It passes right through your skin and can give you a headache. What's more, you will find many people that wear heart patches. That is one of your problems. You can't load a 747 airplane without getting five people who are wearing nitroglycerin heart patches. Therefore, you are going to have a number of people who are going to get caught by the detector, but legally so. So, you are going to have to figure out what to do with them.

Detectors can be sensitive to some non-explosive vapors. I covered that with my story of the lady who wore the musk perfume.

Detectors may not detect explosives in hermetically sealed packages. We guarantee that if it is hermetically sealed—that means no leaks, no molecules—there will be no detection, very simple.

Detectors require special gas. Some of the ITI units that were located in Germany did not work. When they finally figured out that they had to have pure gas—and they were having a horrible time getting it—they could keep them working.

There's a fellow here who doesn't like instruments and I don't think dogs can do the job, so we are both amending our positions to such a point that I will say that canines are an alternative. However, people just don't like to be sniffed by dogs and that can be a problem. During a test using dogs in the South, people became very upset when the dogs began sniffing around to see if they could detect explosives. People just didn't like that sniffing going on.

Your success with dogs very definitely depends on the training. There is a team involved with dogs and handlers. I have seen handlers walk along and get so frustrated at their dogs that they would drag the dogs right off the "bit." I watched this guy drag probably the best nose dog I've ever seen. She was doing her best to sit, to say something was in that suitcase, but he would just drag the dog even though she was trying to sit on that suitcase.

Drug dogs attack the package. You don't want them to do that with explosives, because that could be disastrous.

[Laughter.]

These dogs are made to use an undefensible position to indicate a find, and that is to sit. The second undefensible position is to lie down.

Contamination is a big problem. How do I phrase this. If you have contaminated samples you are in big trouble—people stink. If I had an instrument with me called an IMS [ion mobility spectrometer], it would be going crazy in this room. You exude a compound called pyruvic acid, which is an intermediate in the oxidation of sugar in your body. This instrument detects that very nicely.

What does touching do to a training sample? If you ever touch a training sample, the dog will no longer look for these things hard to smell like the explosives, he is going to smell you. And you know, they are very good at that. You come home at night and the dog knows there is someone there. In addition, he knows it is you. He knows right away it is you and not someone else.

It is very interesting, and if you have ever worked around people who work with dogs, they have more excuses: the dog doesn't feel well today or he must have smelled a female, I could go on. It is infinitely long, okay? That is why a lot of the published literature on the use of dogs shows an almost 100-percent hit rate. If you believe that, I have some Florida swamp land I want to sell you.

We found out very early in the game that these dogs were trained to work for four hours a shift. However, we also found out that on retraining the dog, the handler would allow the dog to find the sample quickly so that he could go and get a beer. Guess how long the dog actually worked the next time it was supposed to work four hours? Five minutes. Most people do not give these dogs credit for the sense they have. They will fake you right out.

If you ever watch a dog go through the field, you will see that he keeps his mouth open, he is breathing through his mouth mostly, there is a very small percentage of odors that he is actually pulling through his nose. I don't care where they are going, they are all doing this. If you got your dog on a leash and you are going down the street, you see the same thing if you pay attention. You will see that the mouth is open. Only occasionally, he puts the tongue to the top of his mouth and does a searching sample.

Once you get to that point though and he smells something, he stops and goes back, and now he closes his mouth totally and really smells the sample. In fact, researchers are now saying that the dog forces a little bit of wet air on the surface of the sample by exhaling, and then he breathes it in. Interesting—if you watch the dogs and the handlers work, the dog never even puts his tongue to the roof of his mouth. What he is doing is, he is faking so that you think he's working.

I have attended a number of tests where the background contamination was so high like in baggage handling areas, where the brake fluid and the motor oil and everything was gagging me, so I know that a dog would have trouble.

Let's spend a minute with bulk detection. The difference between vapor and bulk is in what you use to look for the molecules. I don't know about you, but I don't want to be "neutroned" or "X-rayed." I don't want to be examined with an active probe. That is the difference.

With bulk detection you can use rough techniques. That is exactly what you will find in bulk detection. So what kind of things might we use that could be classified as an active probe. I think in the recent history we have all heard of TNA [thermal neutron activation]. Do you really know how it works, since you are all nuclear people, you probably do, but most people don't. What you are going to do is, throw in a neutron with nitrogen 14; it emits an immediate gamma, 10.83 million electronvolts (MeV).

After it has made nitrogen 15 in a very short timeframe, like ten to the minus five or eight seconds or something like that, it emits this 10.83-MeV prompt gamma ray—

that is what detection is based on. You can look at baggage, boxes, and so forth. Is it the answer to the world's problems, maybe not. Do you think it is a bad idea? You shouldn't. We won't know how good it is until we try it in a real life situation.

Right now, I am working on something at the lab and sooner or later I am going to have to put it in the field. Then we will see whether or not it is really going to fly. That's the same psychology that is being used on the TNA devices

You are familiar with the different kinds of X-rays and, if you are not, you will hear more about that later.

Vapor, of course, is the method being used for personnel because we can't do those other nasty things to people. There are four possibilities. The GC/ECD or commercial devices with some variations. One of these days, maybe they will get my patent through. You can use the IMS device, which we are working on with Dr. Martin Cohen of PCP, Incorporated, in West Palm Beach, Florida, who owns the patents on that technology.

The MS/MS [mass spectrometer/mass spectrometer], a mass spec [mass spectrometer] is being worked on at Oak Ridge National Laboratory in Oak Ridge, Tennessee. Dr. Scott McLuckey and Dr. Gary Glish are developing this technique for DOE. They have invented a new ionizer that can be used with an ion trap mass spec. This ion trap will do both mass spec and mass spec. Does that make sense? Do you know how a mass spec works? Do you care?

[Laughter.]

Let's talk about a mass spec device. If you ionize the sample out here in the air at 760 torr or one atmosphere, and make an ion of it, you need to pass that ion into a vacuum, into a mass spec, where you can actually steal that ion and separate it according to its M/C (mass to change) ratio. You can actually scan all of the masses in microseconds. You can say, "I have a mass 227." You say, "Great, that is the mass of an explosive." But there are two explosives, nitroglycerin and TNT, that both have the mass of 227. Which one do you have? Do you care? Yes. TNT is castable and melts at 80°C. A person can make nice cast statues or nice dishes of it, and you would like to know if this dish is really TNT, which is going to blow up your working area.

You have it separated to a given mass. You know you have mass 227. How do you know if it is TNT or nitroglycerin? In effect, you are going to hold a first mass spec of the combination mass specs at mass 227—in other words, it is transmitting mass 227. Now you throw in a little air behind the first mass spec, which will break the mass 227 into pieces, and scan these pieces with the second mass spec. This will tell you not only that you have mass 227, but that it is built with the right pieces. Remember, you have already separated it from all the other junk in the world. Now you are going to see that your mass 227 breaks apart in the right pieces.

There are four vapor techniques. Another one is the chemiluminescence technique, which is getting a lot of advertising by Thermedics, Incorporated. It is undecided right now just what is going to happen to that.

There are other nuclear techniques that you might use. Of course, there is TNA, but there are other nuclear techniques. Fast neutron activation/scattering. You can actually use a fast neutron, not a thermal neutron, and see how it scatters. There are a number techniques that are being worked on right now that are very interesting—they are still being researched.

You might use the Bremsstrahlang, a German word meaning breaking radiation. This company in Albuquerque is using a gamma N reaction. You literally hit it with a large current of very high energy gamma and literally knock the neutron out of the nucleus, forming nitrogen-13.

I have included this slide just to show you what this equation looks like. I have to convince you that we know a little more about it than what we have told you—not much, but some. In effect, you have a generator giving you neutrons, whether fast or slow, and then a detector for radiation. For years I worked in the field of neutron activation analysis.

Let's look at the characteristics of TNA. Advantages: relatively rapid, non-invasive—since you are not using it on people, you don't have to open their bags either—good reliability, low false positive, low false negative, and specific for nitrogen. That could be both good and bad, but right now those explosives that you are interested in are nitrogen based.

There are disadvantages. You don't really see small amounts. If you are talking about the insider threat, you are talking about small amounts. You are talking about the individual who can bring in a little today, a little tomorrow, a little the next day, until he gets enough to do whatever it is that he desires to do. You do have difficulty with thin sheets. You cannot use it on personnel. It is a little expensive. If you compare that to the cost of an airplane or one of your places of business that would be rather cheap, I think. You may have a radiation hazard. There is a reason the first one weighed 20 tons. They are hoping to cut that down a little.

All you know is, there is something in there that has a lot of nitrogen. It can be orlon sweaters; nylon has high nitrogen. It can be any number of things. Nevertheless, you are not going to know unless you test. Since we didn't have the video tape, I didn't get to show you how two and one-half pounds of explosives literally wipes out a car. But two ounces does tremendous damage.

If you are around "shooters," you will find out they take great delight in giving shows. L.E. Casey at the ATF Academy down in Brunswick, Georgia, puts on an excellent show. He strings up 100 feet of detonating cord between two poles and sets it off at one end and takes odds on how many people will be able to tell which end he started it from. Of course, it is so fast you can't tell. Statistics show that you get an equal number of guesses for both sides. It is quick, absolutely amazing. One of the demonstrations that I always like to use is a couple of big tires. Tape is placed to form an "x" on the bottom tire—this is what the other shot was. You can take two ounces of an explosive and put it on top of that tape, put another tire on top of that, and put gasoline inside of the rim. Now, you get way back and you touch this thing off, the two ounces go off and it throws that top tire out of the field of view. As it goes up and down it burns, so you get all this other action too. That is what the second show was. You get an idea, if two ounces will do that, what will it do to me. That was the other thing that I wanted to bring into this: what could an explosive device do to my place of business?

I would like to take just a minute and ask you if you have any specific questions. Do you have any questions?

Mr. Kasun:

I have a question. Are there any devices available for detecting explosives that are not nitrogen based?

Mr. Conrad:

The IMS and the MS/MS, depending on the way you ionize the sample; yes, it will work for any number of them.

Mr. Kasun:

The no-vapor type of devices.

Mr. Conrad:

Those are the vapor devices.

Mr. Kasun:

Thank you.

Mr. Conrad:

Are there any other questions?

[No response.]

Mr. Conrad:

Thank you.

[Applause.]

Mr. Kasun:

Thank you, Frank.

Our next speaker is Ron Peimer, Special Agent, Munitions Countermeasure Section, Technical Security Division, the U.S. Secret Service. He will be telling us about the use of canines in explosives detection.

Use of Canines in Explosives Detection

Mr. Peimer:

Thank you. The first thing I would like to do is thank the NRC for letting me do this. This is an excellent opportunity for non-government people to get together and have this kind of conference. We in the government think that we sort of own the business of explosives detection and prevention. That is not the case. Clearly, the statistics that you saw yesterday are indicative of that, and you need the information that I hope you are getting from this conference.

I really do welcome this opportunity to talk about the only proven method of explosives detection.

[Laughter.]

In addition, it is the most widely used method. I do have to say it with this caveat: canines cannot do everything. There is a place for machines, and there is a place for canine detection, and there is a place for human intervention. Only when you use all three properly do you have a good system. I will take questions at the end of this session because I have to be back at my office.

We will also have a demonstration at the end of my talk. We are going to bring a canine in and show you exactly how canines work.

I am going to talk about canine explosives detector teams, EDTs. We believe in explosives detection by canines and in the "hand search" by competent EOD [explosives ordnance disposal] people. This is the premier method for detecting explosives. There is nothing better than that. That's the bottom line on that, and there isn't much more that I can say.

What I am going to talk about is the United States Secret Service Canine Program. There are other programs that are good and other ways of doing things. We have a little over 14 years of experience, and we operate the largest single canine explosive detector unit in the United States and possibly the world. There are other units that have more dogs, but they are widely separated. We believe that we have the greatest number of dogs in one location.

The United States Secret Service is generally pro-dog. We believe our dogs work for us and work well. You have to understand the mission of the Secret Service. Very simply, very basically, the mission of the Secret Service is to keep the President and the Vice President alive. That is the bottom line on what we do. In order to do that, we have to ensure an environment free from explosive hazards. That's a fancy way of saying that we make sure that they don't get blown up.

In order to do this, we use canines. You can see by the recent events in Lebanon and Northern Ireland and the Pan American Flight 103 incident that these things do go on, explosive hazards are present, and it is something that we need to be aware of and prepared for. Just today I heard an incident where airport people, during a luggage search, discovered a bomb that was going to be placed on an Avianca airliner in Los Angeles.

We do trust our canines. They are an integral part of what we do. I understand that some of you have nuclear facilities and others of you are from private companies and some of you operate various other plants. What I want to tell you is, if you are thinking of establishing a canine program, you have to understand that you have to put the proper amount of time, effort, and money into the program.

Clearly with canines, as we are going to talk about in a few minutes, if you don't do it right you shouldn't do it. If you don't do it right, you will have a false sense of security. In this business, a false sense of security equates to stupidity. That is the bottom line.

The first thing to understand is that canines, like X-ray or TNA or whatever, are a system. They are a detection system. You have to apply your canines, your explosives detector teams, like a system and use them in the proper method. Like Dirty Harry [the Clint Eastwood movie] says, "You have to know your limitations and you have to know your capabilities." Our dogs have finite limitations and they have finite capabilities.

As you might understand, I cannot tell you what my dogs' finite limitations and capabilities are. I should say, it is not that I can't tell you, it's that I won't tell you. If you were conducting an operation against me and you knew my dogs could do "x" but not "y," I suspect that you would use "y," so we will just talk in general about what dogs can do, how you operate a canine system efficiently, and what are some of the important factors in canine detection.

Our canines, we believe, are capable of detecting all known explosives, commercial, military, and improvised. This includes, I might add, Communist bloc explosives.

I will talk about the dogs, the handlers, the training, and some of the environmental and physical factors that affect canine detection. These are of the basics of explosives detector teams. The first thing is that a team consists of a dog and a handler. It is a tough concept—it is a simple but hard concept for people to understand.

They think that the dog is what is most important, or they think that the handler is the key. In point of fact, both the handler and the dog need to be working for the job to be accomplished. They are equally important, and we understand that if either one is having a bad day you are probably not getting a good search. They are both vital to the operation of the canine system. There is no substitute for a good dog and handler working together as a team, and we will talk more about that later.

The second thing, and this is *very* important, is that canine explosives detector teams do not clear suspicious items. It is not a method that you use to say that there is no explosive in this box or in this case. The reason is that as good as our canines are, on any given day, we don't know whether that dog is working. The handler believes that he knows, but we don't actually know whether the dog is working.

So, we use a redundant system. We use hand search plus canine, we use X-ray plus canine—we use something plus canine. The canines give us a tremendous advantage. They give us tremendous opportunity to locate explosives, but we do not, and you should not, walk a canine around a room and say, "hey, the room is clear, it is okay." I have seen this happen. It is not the method to use. If you are using canines like that, I would urge you to stop and think about some other method besides canines.

The best example that I can give you is this: You wouldn't want a doctor operating on you for cancer or bypass surgery or whatever because of one test. Certainly, it is just as important that you don't say a room is clear and a room is safe on the basis of just one test. If you have a vapor detection machine or if you have a thermal neutron activation machine, do you want to trust that one machine? It is a choice that you have to make, but the choice that we made is to have redundancy in our testing. We believe redundancy is very important. Certainly, it is part of the scientific method.

The team concept, as we use it, involves a single handler, home kenneling, bonding between the dog and handler. Each handler has a dog. He or she, the handler, takes the dog home. He lives with the dog 24 hours. He knows the dog best. The dog is also climatized to a home environment. Many of our handlers have children. Although the dogs are aggressive and they are trained in cross-purposes, the dogs are generally good around people.

The handler has the best opportunity to know his dog the best. As we will talk about in a few minutes, the bonding between the dog and the handler is very important. It gives the handler an opportunity to read the dog the best, and some of the handlers will tell you that the dog is actually working to please him rather than accomplish his task. For whatever purpose, for whatever reason the dog does what he does, whether it is for either of those reasons, or another, the system works better, we believe, when the dog goes home with the handler.

You have to understand that the financial cost of a canine system is very high. Although I can't tell you the exact figures, we spend a lot of money on our canines. We have a large number of canines, and there is a very high financial cost involved. The cost is much higher with home kenneling and single handlers.

Just a word about other agencies. In particular, I will single out the New York Police Department because it is a program that I know. They have a different philosophy. They have multiple handlers and they have central kenneling. That is, they have a few dogs, they have a lot of handlers, and they keep the dogs together in a central kennel.

Their program is very good and it works very well, but we believe that we just simply get a better product with a single handler. I can't give you empirical data; there is no basic research in this area. It is a feeling that we have and it's like one of these things: "if it ain't broke, don't fix it."

How do canines work, how do EDTs work? Very simply, the job of a handler essentially is to take the canine to the odor, or where he perceives the odor of the explosive might be. Canines are vapor detection systems. They are not a nuclear system, and they don't read the labels—although some people think they do—they smell the explosive. We have done some studies, some classified studies on what dogs smell, and I can say that dogs smell explosives.

The handler has to be trained in the proper method of bringing the dog to the explosive. In order to do this inside, for example, we issue our handlers little smoke tubes. They open this tube up and it sends a little stream of non-noxious smoke and they look for where the vapors go. They follow the air trail back to try and get at the vapors.

The dog doesn't know what you want him to do unless you tell him how to do it. The handler is charged with the responsibility of doing a systematic search. When we have a demonstration later, hopefully, the handler will conduct the systematic search and you will see the dog have an opportunity to catch odors in various different locations. The dog is trained to go to the source of the odor.

The handler has to give the dog the opportunity to find the source. He has to give the dog an opportunity to get in the cone of odor so that the dog can do its job.

Dogs only respond to the odors that we teach them to respond to. They don't know, for example, that dynamite is an explosive. They don't know, for example, if the next odor that is presented to them is smokeless powder that it is also an explosive. There is nothing intuitive in the dog's head—at least we don't think there is—that would enable it to recognize something about an odor that indicates that this is something to be worried or concerned about.

In point of fact, the dog is just simply doing this to receive his reward from the handler. We use in virtually all instances, a ball award. You will see the handler throw a red ball to the dog and that's his reward. In other programs they use a food reward, but we feel the ball system works better.

You can train the dog for anything. I am sure that you have seen on TV the pictures of dogs, the narcotic sniffing dogs going after drugs. You may have seen pictures in San Francisco or whatever of the dogs that are trained in search techniques for going after people who are buried and that sort of thing. You can even train them to smell termites. There is a fellow here in the Washington area who has a beagle named Buster, and it's "Buster the termite buster." If you want to buy a house and pay the man quite a considerable amount of money, he claims that Buster will go around your house and sniff out termites. Whether he will or not, I don't know, but that kind of thing is possible.

In any event, dogs can smell essentially what you want them to smell. There are police departments that have used dogs to search for weapons. A dog can be trained to detect the odor of the smokeless powder or the odor of the smokeless powder and metal, whatever it is on the gun. If a policeman has a suspect, he can put the suspect in some position that is not harmful to the policeman and use the dog to search the suspect. Frank mentioned that people don't like being sniffed by dogs. Imagine being sniffed by a dog with your hands over your head and a gun screwed in your ear.

If you have something that you want the dogs to smell, maybe in your nuclear plants you could get the dogs to smell uranium oxide, you thought somebody was taking that out of the plant. You might try it. You probably wouldn't want to take the dog home after he had been sniffing around that stuff, but it is possible to train the dog to do that. If you have some unique aspects of your plants or whatever you are interested in, you need to talk to the people who train canines. They can be trained for a lot of things, it's surprising.

Let's talk about alerts. What do our dogs do when they perceive the odor that we have trained them to perceive? If a dog in its mind recognizes the odor, the dog is trained to sit. This is a passive response. We will talk about why that is important in a little while. In order for the dog to sit to have a full alert, the dog must be sure in its mind that this is the odor that it is trained to smell and that this is what it is.

The second thing that happens is a change in the dog's behavior. It's kind of a nebulous factor. This is what the handlers are trained to read. The dog will exhibit a change in behavior for a variety of reasons. It may not get a strong enough odor off the explosive and its not sure—it might be a strange odor to the dog. It might be the odor of a strange dog. The dog might be having a bad day, or there might be a related chemical compound. There are a number of chemical compounds that are similar to explosives. There is no way to essentially de-train the dog on these chemical compounds, because then you de-train them on explosives.

There are a number of reasons the dogs would not give a full response. This change in behavior would be an activity that the handler would read, and the dog gets excited and starts gulping the air, essentially biting the air. Frank talked about the dog with his mouth open and that sort of thing. Dogs do a lot of things. Each dog essentially does things a little differently. This is where the handler's reading of the dog's action comes in.

Clearly, this ability of the handler to be able to read the dog is what the handler gets paid the big bucks for, in my estimation. They are the operator of a system, they are an operator of a machine. Just like a back hoe operator, a surgeon or whatever, the handlers have to learn to be good at what they are doing.

The handler's reading is the vital part of this detection scenario. If the handler for some reason does not know how to do that, the dog's actions are meaningless. The bonding between the handler, the home kenneling, the climatizing of the dog to its family, the friendship between the dog and the handler is very important. The handler learns his/her dog.

Those of you who have dogs at home know that your dog probably has a bark for going out or a bark for when the kids come home, and the dog acts differently when strangers come in the house, or whatever. It is the extension of this sort of thing that is important for good canine operation.

Let's talk a minute about the handlers themselves. It is very important for us to have professional handlers or for you to have professional handlers. All of our handlers are Uniform Division Secret Service Officers. They have full police powers, they are sworn officers, they carry firearms, they wear uniforms, they have badges, and they do all sorts of things that police people do. We use these officers because we can get the most professional results from them as handlers.

If you want to operate a canine system, it is very important for you to have a professional handler, somebody who does nothing essentially other than handle that dog. For instance, supposing you installed a $150 thousand or a $200 thousand X-ray machine at your facility and then paid somebody $3.50 an hour to watch the items come down the belt of the machine. That person probably sees 360 bags or objects an hour. If you think that you are getting a good detection system out of that, you had better take another look. At that wage, the person is not motivated, is not paid enough, and could care less.

This does go on. That sort of thing does go on and various agencies do allow it. We will not allow it, and that is why the professionalism is important.

We understand and the handlers understand that a leash is a two-way transfer of information. It is more than just a method of holding a dog back and getting the dog to do what you want him to do. Clearly, if the handler is not working, the dog will not be working. If the handler is not interested and just kind of moping around and not doing his job, the dog will sense that. The dogs understand a lot more than we give them credit for.

However, if the handler is not doing his/her job, the dog is not doing its. That's a basic tenet to this, and that's one of the reasons you have to have professional handlers. If you think at your facility that you are going to be able to have a security person be a part-time handler—that you are going to give him a guard uniform and have him check ID for six hours a day and have him operate a canine for the last two hours in the day—it's probably not the best system in the world. It may be better than nothing, but you need to think about that.

Operating a canine system can be expensive because you have to dedicate an employee to that specific job. People in personnel tell me that for 24-hour coverage you have to hire five people on a 365-day basis. That's five positions for the handler, which, in our philosophy, also means five canines. It means five vehicles to take the canines back and forth. It means five vet bills, five food bills, and that sort of thing.

Another point, if a professional handler's canine has a false positive, that is okay. You cannot recriminate your handler for a dog having a false positive. Why do dogs have false positives? There are related chemical compounds that the dog will react to. If you have an indication—even if it is a false positive—you have to respond to it with the EOD team. You may remember, the canines don't clear; they respond with the EOD team and the EOD team clears—then you walk away from it.

We may try to find out why the dog had a false positive, but there is no recrimination against the handler. You can't jump and scream at the handler and tell him that he is an idiot and the dog is a dope, and you cannot downgrade the program. If you do that, it will be counterproductive, as you might suspect. You do not want to have any negative impact on your handler. You want your teams to be aggressive. You want them to do what they have to do.

The thing that you cannot have, however, is a false negative. You can allow 10,000 or 10 million, 100 million, ten to the ninth, whatever you want, false positives, but you cannot allow a single false negative. That means you cannot allow a bomb or any explosives to get in your facility. If you are not running your program like that, if you say okay a few bombs can get in, then you are not doing the right thing.

The handler also needs your trust, which, again, goes back to professionalism. You have to trust your handler and give him the authority to remove his canine on any particular day. The handler has to be able to go to his supervisor and say, "look boss, this dog has a cold, he ain'tworking, he's not doing it today." The boss has to say, "okay, let's go and get canine B because yours isn't working." Or the boss could say, "break your dog and come back in a half hour and try it again." If you force your handler to work with a dog that is not working, it's the same thing as trying to use vapor detection system without your carrier. It just isn't worth the trouble.

If a dog alerts, you have to have enough confidence in your canines to say this is an alert, we need to call an EOD team and check this out. You can't bring a second dog in for a second opinion.

If one dog alerts and one dog doesn't, who do you believe? Do you bring in a third dog and go two out of three, do you go three out of five? You have to have confidence in your dogs. It all goes back to professionalism and spending the money and having the right training for your handlers. There are no second chances with explosive devices.

In our instance, we cannot allow one device near the President or Vice President. The handlers have to be professional. They have to motivate their canines and they have to be interested in what they are doing. You are going to have to pay them more than you think—the handlers I mean—in order to have confidence in the canine system. I don't want to emphasize this expense thing too much, but if you think you are going to go to the corner dog clipping and obedience school and get an explosives detection dog and the right guy to handle it for you, you are greatly mistaken and you shouldn't do it.

Trainers tell me that canines are basically capable of about 120 tasks. The 120 tasks include sit, stay, come, eat, don't eat, take a break here, or whatever. We use about 75 tasks for the dog. So, there is a lot of untapped potential in the dog. We don't stress dogs in the amount of tasks that we ask them to do. We don't ask them to do things that are beyond their capabilities, at least we don't think so.

Cross-training is okay. Our dogs are cross-trained in bomb and patrol work. Patrol work is a fancy name for the kind of work a police dog does. That includes tracking, criminal apprehension, evidence detection, and that sort of thing. You can cross-train a dog in bomb and patrol work. The reason is that these jobs are separate but equal things; they are like apples and oranges. The dogs understand they are doing two different things. The dog understands the bomb work is when it's sniffing, and when it finds a bomb it sits. The dog understands that when it does patrol work, it goes out in the field and bites. These are two things that the dog can understand. You have a passive response and you have an active response. You don't want to mix the responses. That's why you don't want to mix bomb work and drug work with your dogs. You may have drug dogs at your plant. You may periodically use drug dogs to sniff your employee lockers or some sort of thing, but don't cross-train that dog to do bomb work.

The reason is very simple. The alert that canines are taught for narcotics is to be very aggressive and go after the narcotics, to try and dig for them. The same is true of dogs who try and smell people who are trapped in buildings. The alert for canines taught to look for bombs is passive. They sit or they lie down, depending upon their training. Clearly, you would not want a dog digging after a suitcase of explosives. In addition, if you cross-train for bomb and drug work and the dog alerts on a suitcase, you don't know if it is full of C-4 or full of cocaine.

The size of canine depends on its use. We use large dogs. We use German sheperds; we use Belgian Malinois; there are other agencies who use dogs of differing size. The size of the dog has essentially nothing to do with his explosive detection capabilities. There are other agencies who use small dogs. Small dogs are cheaper, for example, beagles or whatever. Labrador retrievers are cheaper to run than the sheperds and other large dogs that we use. We use the large dogs because of the patrol work. Clearly, we do this because there is no such thing as an attack beagle.

The New York City bomb squad, for example, uses Labradors exclusively. They are a single unit. New York City has a separate unit for patrol work, a separate unit for drug work, and a separate unit for explosives detection work. Labradors are excellent dogs. They have very good noses, they are very tractable. We cannot use Labradors because of our cross-training activities.

Let's talk a minute about training. This is really the key to your program. If you don't have good training, you don't have repetitive training, you don't train the dogs well, you don't have a program. Training is the backbone of the canine program. Unfortunately, it is also a black art. There is nobody who can tell you much about canine training other than canine trainers. I am not convinced that even they understand a lot about it other than they do it this way because it works. Again, "if it ain't broke don't fix it." I don't know if training is an art or a science. I do say that you need people who know how to do this. You can't go and read a book and train a dog to sniff out explosives. You could try, but I suspect that the dog would not certify, certainly not by our standards. In any event, our program is 26 weeks initially. The dogs are in a class of five or six dogs—the handler and the dog, I should say, because it is training both of them. The handler learns how to work the dog and the dog learns how to work the handler, and they both learn how to do the task.

In addition, we require our handlers to retrain eight hours a week. That's a lot of time when you think about it. One day a week or one day out of five to be retraining. We do this because we feel it is important. Of the eight hours a week, in theory, the dogs are getting four hours of explosives work and four hours of patrol work. In practicality, it may not work out like this, but it is a goal that we think we need to achieve.

In addition, the handler is required to motivate that canine daily. What that means is, the handler takes a small aid, meaning a small amount of explosive with him every day, and at some point during the day, when he is working, he has to motivate that canine. The handler tests the dog every now and then to make sure the dog is doing what it's supposed to. The dogs get bored; if they get bored, they don't work.

Varying the type and amount of explosives that you train a canine to recognize is very important. This physically means you have to train the dog on more than one explosive. There are some people who believed for a while that there was a common contaminant in all explosives. Explosives do cross contaminate if you store them in a bunker. We did some testing, which I am not at liberty to talk about, but I can tell you the results of that testing indicate to us that you need to train the dog on enough explosives so that you feel confident that it can detect varying amounts and kinds of explosives.

For example, if you train on explosive A and the dog is presented with explosives A plus B, the dog will probably alert on it, but you can't be sure because some dogs will alert on A plus B and some dogs won't. So, you need to train on a variety of different explosives. We believe that any explosive that a terrorist might try and use against us, we certainly have the capability of detecting it.

You need to vary the amounts of explosives. This is physically the weight of your training materials. We train from very small amounts to very large amounts. Going back to operational planning or target analysis, we believe that our target analysis—the thing that would be used against us—varies from very small amounts, from anti-personnel devices like a pipe bomb to a truck bomb filled with thousands and thousands of pounds of explosives. We are sort of unique in that aspect, because we have the President who might be the number-one target in the United States.

The other thing that is important is, you need to vary your locales. You cannot train only in one place. What that means is, you cannot reward your dog essentially in only one place. The dog works for the reward or the dog works to please the handler. For whatever reason the dog works, if you only train the dog and handler at the training facility and never reward the dog when it is working at a different place, the dog will not work effectively.

You also have to vary the circumstances. If you only train the dog when you are wearing blue uniforms and only when the trainer is present—that sort of thing—the dog will not be working correctly.

If you only have the trainer, for example, place the aid, you cannot be sure if the dog is smelling the odor of the trainer on the aid. You need to vary the people who are placing the aid.

I really can't stress this enough. If you have a poor training program, you will have a poor canine detection system. There is nothing really to be said beyond that. I would say one thing about varying the amount of explosives. We use the sledge-hammer approach. We don't know what "cues" a dog, so we want to be sure that the dog is going to be "cuing" on anything that he could possibly encounter.

Because our dogs go so many different places, we use 12 or 14 different locales around the Washington Metropolitan area. We use theaters, bowling alleys, airports, all the kinds of places that the President might go. For those of you who have a physical plant, you would have to train your dog in your physical plant. You would have to take him to the pump room, the visitor center, or wherever.

Operational planning or threat analysis would give you an idea of the amounts of explosives you would have to train for. If I took a pound of explosives and put it in the control room of your nuclear plant, I suspect that your nuclear plant would be shut down for an extended period of time. However, if I took that same pound of explosives outside in your cooling units, or whatever, it may or may not do anything to your cooling units. A threat on your cooling units might be 15 or 20 pounds—I don't know offhand, but I know that you need to know what to train for.

The dog and the handler must be working. If the dog isn't working, it's the handler's job to motivate the dog. If the handler isn't working, the dog probably cannot motivate the handler very well, but they both need to be working.

The chemistry and the physics of the explosives affect alert possibilities. We had a very interesting discussion about vapor pressure with regard to explosives. The point I would like to bring out is that in the high molecular weight, low vapor pressure explosives, the dogs are capable of detecting those explosives. I know there is some discussion about what they are smelling, but my point is, who cares, it works. In any event, dogs can do things that the machines cannot.

Again, the vapor pressure is the key to explosive alerts. The vapor pressure on explosives themselves is relatively low. The explosives are generally fairly high-molecular-weight compounds, they are complex organic compounds, they do a lot of weird things. The molecules stick, they break apart. You can use the buildup of vapors from the explosives to your advantage, and you can do this in your training techniques. You can make this an opportunity.

Time, quantity, and distance are important factors as well. If I put a block of explosives here and the dog came over three seconds later and was smelling around the base of this thing, he probably wouldn't smell it. If he came back a minute or two later there would probably be enough vapors for the dog to detect it. So, time is important.

If I put 1 pound here as opposed to 10 pounds, the dog would have a better chance of smelling the 10 pounds sooner than he would the 1 pound. This is simply because more vapors are coming out. It is not that there's a higher vapor pressure, but there are simply more vapors available.

The closer you can bring the dog to the explosives, the better the chance that the dog can detect the odor. As you might suspect, if the dog tries to smell the explosives from across the room, it will not be very successful unless the explosives have been there a while.

Environmental factors are important—temperature is important. The warmer the explosives the more they release vapor. The humidity, the wind speed, and air currents are important because they affect the biological capability of a dog.

On very hot humid days, the dogs do not do as well as they do on nice dry days in the fall. They are subject to the biological responses that you and I respond to. We cannot use our dogs as long on a 95-degree day in the summer in Washington as we can in the fall. The dogs break down, they get tired, and this is something that the handler needs to be aware of.

The greater the wind speed the further out the explosives odor can travel. It also can dilute the explosives odor—you need to be aware of that.

Air currents are important indoors. We talked about the smoke tubes. It is important to get the dog in the cone of odor.

I put this slide [see Appendix A, Peimer] up because I think there are people in the audience who feel that you can't have a talk like this without lines and diagrams and graphs. In point of fact, I don't know what that line should be. The slide shows a linear relationship between time and detection probability and the distance, of course, would be the inverse. However, the line might be a sine curve, it might be exponential, it might be anything that you can imagine. It might have dips and plateaus. Nobody knows.

Why, with all this trouble, do we use explosives detection teams? I mean, the cost and the dogs—you don't know if they are working or if they aren't working. Very simply, they work better than anything else we have found.

But, dogs work the best. In any comparison with machines that I have been involved with or that I have read about, the dogs come out better. In your handouts, there is a discussion about some detector machines. If you look at the graphs or charts, you will see a lot of negatives for a lot of those machines for a lot of different explosives.

If a canine was acting like that, if that canine had all those false negatives, that dog would either go back for retraining or be retired.

Dogs are simply cost-effective for us. They save time, they save manpower and, believe it or not, they actually do save money. For exam, f the President were coming to this room, we would have to get everybody out of the room and we would search the room for explosive devices. Suppose he were going to stand in front of this podium, well, if all I had was the human asset, the guy could knock on the wood and fool around with it. I understand and you understand, as explosives people, that you could probably layer this thing with sheet explosives and you could have the mythical E-cells in it or whatever, and probably not detect them. However, instead of spending four hours taking the podium apart and paying a carpenter to put it back together, I could use a canine and feel secure. That is the key. The canines give us security and they also assist us in searching large areas in small amounts of time. After this room had been hand-searched, the dog probably could do this room without anybody in it in about 10 or 15 minutes. This is not the case, at least at the present time, with mechanical detectors.

The dogs also have deterrent value. You cannot discount this. If there is a group working an operation against you and they see those big sheperds out in front of your gate sniffing cars and sniffing people, it is a very important deterrent. They think that they have to go to some other length—that they have to try and attack you in some other way. Maybe they won't come into your plant, maybe they will only do something outside. If they do that, you are way ahead of the game.

With the canine explosives detection team, we feel secure—our goal is 100-percent security for the President and the Vice President. We cannot accept, we do not accept the 95 percent acceptance rate that some other agencies allow for machines. We just cannot do it as far as the President and Vice President are concerned.

We have the luxury, however, of time. If the President is coming to this room and I determine it's going to take an hour and a half or whatever to search this room properly before anybody gets in, it is going to take an hour and a half. We do not have the problem of running 10 million bags a year through the airport and that sort of thing. It is a tradeoff between time, between money, and between efficiency.

The last reason we use dogs is because they can go anywhere. They don't require an electric plug and we can use them anywhere. We take them and fly them across the United States, we fly our dogs internationally. We use them in airports, we use them in machine rooms, hotels, we use them anywhere a human can operate essentially. Whatever environment a human being can operate in, the dogs can operate in.

Does anyone have any questions?

[No response.]

I am available at the Secret Service to try and sort of point you in the right direction [1800 G Street, NW., Washington, DC 20223, or call 202-395-6093]. I don't know everything that there is to know about canines. As I said, I am not a handler and I am not a trainer, but I can certainly give you the right information and maybe point you to the right people.

Beyond that, I thank you for your cooperation and support.

[Applause.]

Mr. Kasun:

Thank you, Ron. We also want to thank your staff and Sandokan. Now, we are going to have a lunch break.

AFTERNOON SESSION

Ms. Dwyer:

Our Chairman this afternoon will be George McCorkle, Deputy Director of the Division of Safeguards and Transportation. He is going to chair this session and will introduce the speakers.

Mr. McCorkle:

Thank you, Priscilla.

This afternoon, our scheduled speaker was Dr. Wall from the Federal Aviation Administraton (FAA). Unexpectedly, he is unable to be here. However, we have two very qualified replacements that are going to make presentations describing the FAA's programs for explosives detection for personnel and baggage.

The presenters this afternoon will be Ms. Janelle Derrickson and Mr. Roy Mason, both of the Technical Center of the FAA. Mr. Mason is to speak first. I am told they put their briefings together with very short notice.

Explosives Detection Programs for Personnel and Baggage

Mr. Mason:

Thank you. We represent the FAA Technical Center in Atlantic City, New Jersey. The Technical Center is FAA's prime facility for research and development and test and evaluation of basically anything that is safety related in the aviation industry. There are a number of things that go on there: air traffic control, design and evaluation, radars, lighting, fire safety, and security, which is the area that we are going to talk about.

The aviation security research and development (R&D) program is based at the Technical Center. It has been in existence since 1974. The basic objective is to develop systems and devices to prevent hijacking and sabotage, but obviously, it is considerably more involved than that. That has been the main thrust of the program. We are now getting into other areas, access control and operational issues.

The authorization for this program is the Air Transportation Security Act of 1974. This Act basically came about because of the hijackings in the early 1970's. FAA is the prime agency for explosives detection in the Government. We have interagency agreements, and work closely with a number of other agencies. We have interagency agreements with a number of the Department of Energy laboratories, the Navy, DARPA [Defense Advanced Research Projects Agency], Customs, and some other agencies.

The basic general requirements of the program—and these happen to be broken down basically the way government regulations are broken down—there's Federal Aviation Regulation (FAR) 108, which has to do with the parts that airlines play in security, what airlines have to do, and there's FAR 107, which covers the part that airports have to play. Airlines are basically responsible for the screening of passengers or anything that goes into the airplane. The airports are responsible for physical security, protection of assets, access control, et cetera.

We have some constraints that we have to operate under, of course, as everybody does. As researchers, we don't really have to live under those constraints as much as operational people do, but they are guidelines. Obviously, screening for airlines particularly is not a profitable operation. They do it only because they are regulated in most cases—they have to do it. So, their concern is to do it as cheaply as possible and meet the regulations.

We don't want to inconvenience the public anymore than we have to. Time is a big factor. At airports last year in this country, approximately 1.3 billion people went through the screening points. So, if you increase the time to screen each person by one second, it is a horrendous amount of time.

Right now, the requirement for checking bags that we are operating under—that we are trying to operate under—is six seconds per bag. That is probably not fast enough. If you could spread the number of bags that come to an airport on the day's time evenly over the day, that would suffice. But, air traffic doesn't work that way. Everybody wants to fly early in the morning and late in the afternoon.

From a safety standpoint, we have to worry about harm to passengers or their belongings. Then, when you get into screening people, you get very quickly into an invasion of privacy area.

The program is broken down into three basic areas: explosives detection, concourse security, and airport security. There is obviously overlap. There is a need to detect explosives in the concourse, for instance. Explosives detection basically deals with checked baggage and cargo, things going into the belly of the airplane. You can deal with those differently than you can deal with screening people.

Concourse security is screening people and carry-on baggage. Given the situation with carry-on baggage now, we are fast approaching having the same problems because the carry-on baggage is almost as big as some of the checked baggage now. Airport security is kind of a "none of the above."

There are other things that we get into, the operational issues. One of the things that we have done that is probably the most fun of anything in the project is, we have actually gone out and blown up salvage aircraft and tested some of the theories. For instance, if you are flying along and your dispatcher says you have a bomb in the airplane, what do you do besides bail out? There are procedure studies that were done by the airlines that say for this particular aircraft you put it near a certain door, et cetera, and we have been able to test some of those theories. They work reasonably well.

Again, the requirements that we operate under, along with some of the constraints, are passed on to us by the Office of Civil Aviation Security in Washington. They set the guidelines that we operate under. They determine the amounts and types of explosives that we are looking to detect and control the priorities in the program. We come to them and say we have these number of things to do and we only have money to do some of them, which ones would you rather do. It's that type of a situation.

The explosives detection part of the program is basically broken down into two main areas. One is prototype development, which is more of a short-term effort. The other is new technology R&D, which means we go out and beat the bushes and look for new ways to find explosives.

Back in 1985 when they had the Air India incident, we were called down to Washington and basically asked, "how much money do you need to accelerate your program over the next five years?" Part of the deal was that we would identify the two most promising technologies at that time for screening baggage and screening people and implement and accelerate a prototype program for those two technologies. Those two technologies were the thermal neutron for screening baggage and chemiluminescence for screening people. We will talk about those in more detail.

As it stands right now, vapor is the only technology that has been identified that you can use to screen people for explosives, specifically for explosives. There are some other things that you can do to screen people, just to show that they do have some unidentifiable object. But it is not an explosives detector. We have done a lot of work with vapor and still are continuing to do that.

In the new technology area, there are very high-risk-type projects. We were instructed by the Secretary of Transportation to go out each year with an RFP [request for proposal] that basically says we are looking for new technology in the area of explosives detection and that we would fund some of those, and we have funded some of those. They are typically high risk, not much chance of payoff in most cases, and we have done them all as a two-phase contract. The reason for that is, it cuts down on a lot of the contractual administration problems when we fund it as an initial proof of concept phase with an unfunded optional prototype phase to follow if the proof of concept is okay. That's the way we have been doing it.

We are also heavy participants in the SBIR [small business innovative research] program that the government has. We use that quite a bit to start some of our projects.

Thermal neutron activation was developed particularly for the screening of checked baggage and cargo. On the basis of tests that were done with the airlines and factoring in a little bit of practicality, the machine was built to look for the explosives equivalent to two and one-half pounds of C-4, realizing that, yes, it certainly is possible to take down an airplane with less explosives than that. It is very hard to find on a reliable automated basis, less than that, given the volume of traffic there is.

That is probably going to change by the way. The system has the capability of being combined with an X-ray system. Combined not just physically but through using the computer it correlates the nitrogen image that is generated by the thermal neutron system with an X-ray image to help itself make a decision. If there was not a requirement to find sheet explosives, the thermal neutron system would work virtually 100 percent.

The problem basically is trying to differentiate between sheet explosives in a bag and a bag full of wool sweaters or some other material with a relatively high nitrogen content. The nitrogen is not there in the concentration that it is in explosives in most cases. It is spread out more, but the system can't resolve the difference very easily. The X-ray machine that is being used currently is an Astrophysics System 5, the dual-head machine with which you get an orthogonal view—two orthogonal views of the bag.

At this point, we have found that about half of the false alarms generated by the thermal neutron system alone can be resolved automatically by the computer once the system is coupled with the X-ray image. If there is still a problem, then a person experienced with X-ray screening would normally be used. The screener would be able to look at the X-ray image and combine that with his or her knowledge to determine where the thermal neutron system sees the nitrogen and what type of explosive it thinks is there—whether it is sheet, bulk, or whatever. If the screener cannot say that it is not an explosive, as they are doing now with just standard X-ray, then the airline would call the person the bag belongs to and have the bag opened.

FAA has bought six of the dual-sensor systems. The first one has been installed and is in operation at Trans World Airlines, John F. Kennedy Airport, New York City (TWA/JFK). They are using it to screen interline transfer baggage that is going to be going out on TWA's international flights. The second system has been delivered to Miami International Airport, Florida. It is still in a trailer at the airport, pending the resolution of legal problems that Pan American and FAA are having. The third system is expected to go to England, at Gatwick Airport. There are some possibilities about where systems four through six are going, but it still pretty much undefined. Hopefully one of those will go to a foreign airport.

The dual-sensor system is the basis for FAA's explosives detection system rule that I will talk about more in just a minute. We are still doing R&D work in this area. We are looking now at the possibility of a different type of X-ray system that will be able to resolve more of the false alarms. We are looking into some fairly sophisticated X-ray tomography, similar to the CAT [computerized axial tomography] scanners that are in hospitals, the dual-energy type of systems that you are starting to see in the airports now that have the capability to tell you the difference between metal and organic materials.

There is sort of an inherent problem even with those. Yes, they can tell you the difference between metals and plastics, but they can't tell you the difference between explosives and plastics. Laminar tomography is a simpler form of the CAT scanner that allows you to decouple objects as you move through the bag. The other one that we are looking at is the AS&E [American Science and Engineeing] back-scatter system that is similar to the Astrophysics dual-energy system and provides projection, or metal image as they call it, and a plastic image.

There has been a lot of concern by airports and the public about the fact that these machines contain a radioactive source. There was some testing done of an early prototype system using a laboratory electronic neutron generator. It turned out that the system was not usable for any period of time for airport screening because the life of the tube was very short.

We have had a couple of new systems developed. One is based on the Van de Graaff generator and the other is a radio frequency quadrupole generator. Those are currently being evaluated in the old prototype system. The generators basically have the capability of generating the same neutron flux that californium generates, but they can be turned off.

We are also doing some preliminary work on the possibility of adapting this technology to the carry-on baggage concourse. It is, again, very preliminary. It obviously has a ways to go before it gets there, because it would have to be smaller—there are a number of concerns. In the case of checked baggage, you don't have to be as concerned about activation as with carry-on baggage because the passenger has been separated from the bag. If you are going to give the bag back to the passenger in the concourse, activation of something in the bag becomes a real concern because it's in a public area. It is a much more controversial issue.

We don't see the thermal neutron system as being the answer to our problem. It is a first step. There are a number of false alarms. There are other materials that contain nitrogen. How do you handle those false alarms? You get into problems with any kind of explosives detection system. As you get closer to a real true explosives detection system that has no false alarms, handling that bag is more of a problem because, anytime the alarm does go off the probability of that bag having an explosive in it is higher. Airlines don't like to talk about calling the bomb squad.

As I mentioned before, if the source in the existing system is californium-252—about 150 micrograms, which I think is about 80 millicuries—the system will weigh about 20,000 pounds because of the shielding that is required. It is big. Bigger than a bread box. The Xenis system, which is the combined X-ray, thermal neutron system, is something like 38 feet long, 8 feet high, and about 8 feet wide. The thing costs in the neighborhood of about $750,000 to $1 million.

Currently, the NRC has granted a license to the FAA for this system to be used only in the baggage-type area, the secure side of the airport, and not on the public side. There has been an application for a license to use the system in the public area, and I believe that's under evaluation by the NRC.

As I said, FAA has just passed an explosives detection system rule. The rule itself as it appears in the *Federal Register* is not very specific. It just says that the FAA will require explosives detection systems and it will be a phased approach. That is, within approximately the first year to 18 months the rule will apply to about 40 high-risk airports that will be designated—something like 15 U.S. airports and 25 foreign, I believe.

Of course, now we get into some fairly serious problems when the FAA starts mandating this type of equipment at a foreign airport. So, how this is going to work out remains to be seen. The existing rule would require that approximately 400 of some type of explosives detection system—I stress explosives detection systems and not specifically thermal neutron systems. This is an explosives detection system rule and not a thermal neutron rule.

Basically, it will be handled just as the FAA handles X-ray systems and metal detectors. There will be an approved list. The FAA has performance specifications. Anybody, I guess, that thinks they have a system that can meet the requirements can get a copy of the performance specifications from the Office of Aviation Security in Washington, D.C. It was not published with the rule.

Either the FAA, or somebody contracted by the FAA, will be doing some fairly extensive testing on these systems, using actual explosives and probably actual lost baggage, to find out if they do, in fact, meet the performance specifications and will be on the approved list.

I have about a four-minute video about the thermal neutron system that we will run now.

[Video tape played.]

Janelle Derrickson will now talk about the vapor detection area and some of the other areas that we are pursuing in the new technology. After she is finished, if anybody has questions, we will try to answer them.

Ms. Derrickson:

We also have a vapor prototype that was developed, the chemiluminescence vapor detector. It is called the Secure Scan and was developed by Thermedics. It is a walk-in booth that screens people. Can I have the video now please.

[Video tape shown.]

This was basically a test to see what the background contaminants would be. We screened in excess of 2,000 people and there were no background contaminations. We did not test for explosives. We have a problem with the portal system [Secure Scan] in that it provides insufficient sensitivity and it's a long screening time. We have funded Thermedics to do some sensitivity enhancements to improve the portal system. It is not sufficient for what we call the threat explosives. We are still working on it.

Before that, we used the Egis system to do a baggage screening test, a controlled operational test where we screened baggage for explosives. The results of that test have been classified by the State Department. If you want to know what the data is, you would have to talk to Steve Klein who is here representing the Department of State. We can say that it does not meet the requirement which is 95 percent detection, so we are expending more money to increase the sensitivity. As a result, we are looking at alternate screening portals and detectors.

We have been forced to have a panel review the technologies that are now available for explosives detection; that is, ion mobility, mass spec/mass spec [mass spectrometer/mass spectrometer], ECD [electron capture detector] and chemiluminescence. We realize that the chemiluminescence detection, which is on equal footing with all the other technologies, may not meet our requirements. So, we are trying to investigate other technologies.

One of the problems with sensitivity, we discovered, is that the sensitivity required is between 100 to 10 femtograms. As a result of that, we are trying to find some unit or some detector that can detect those quantities, at least at the detector if not through the entire system. We are coming up with new definitions as far as how much explosives are available. We have been told that at most, on a person, it is only 10 milliliters of saturated vapor. Once you get that, that is all that is available. So, we have to find something sensitive enough to get that amount, if nothing else, because that is all there is.

The other problem with the portal is the screening time. Even though it takes 6 seconds for the analysis, it takes 41 seconds for the complete analysis and that's too long for a screening. Either we are going to have to come up with a way to do batch sampling—six people at a time—and figure out which one of the six people have the explosives, or get something that is faster.

We are working with Ion Track Instruments (ITI) on one of our new technologies for a portal—a walk-through portal with an air curtain. It has polyurethane doors. The person is forced to push the first two doors but the other ones encase the body. So, it pulls all the vapor from the person's body as he walks through.

Under the new technology R&D program, we have to identify promising new detection approaches. We need something that is better, that is cheaper, and more effective. We also have to develop second-generation detectors for the ones that we already have, like improving the Model 95 and improving the Egis system from Thermedics, improving those things that we have so that in the long term—maybe three or five years from now—we will have the sensitivity that we need and there will be a better explosives detection system for vapor.

In October 1989 we sent out a broad agency announcement that allows us to ask the community at large if they have any ideas about explosive detection in vapor, bulk, X-ray, preconcentration, vapor generation, anything at all to submit a paper to us for review. If it looks like a good idea, we can immediately fund it. With the old RFP, it could take a year after a proposal was accepted before we could actually do any funding. We have this in effect for a year, and that's what we hope will help us.

We are trying to create stronger involvement with the international scientific community. In February or March of 1990, we will be having an international symposium. The purpose of that symposium is to have the scientific minds of the world, so to speak, meet with us so that we can explain to them what our problems are, what we are trying to do, and see if they have any ideas or any technologies that we have not investigated, have not tried—we will just talk about them. Maybe we will get something that will work.

The other thing that we are trying to do is get the community at large to understand what it is that we are doing and what these new technologies are. If we could give a broader understanding of the capabilities to the scientific community, perhaps they could help us in our effort to try to find an explosives vapor detector. As Mr. Mason has said, we cannot actively screen people, we can't touch them, we can only do a passive screening. It has to be vapor, and it has to be a portal.

In 1987 the Secretary of the Department of Transportation instructed us to have our aviation security program assessed by the National Academy of Sciences. This is presently being done. One of the things that has come out of that assessment is that it may be necessary to marry many of these technologies into one unit. It may require an ECD for one thing, mass spec/mass spec for another, the IMS [ion mobility spectrometer] system. We may be forced to have a system integrated with all the detectors to find something that will meet our needs. Once the National Academy of Sciences report is out, we will know what we really have to do.

Our successes at this point are the dual-sensor; Xenis; biotechnology, which I will talk about shortly; and the nuclear probes, which are gamma ray probes and part of a classified research effort that we are doing.

Frank Conrad at Sandia National Laboratories is currently evaluating our IMS [ion mobility spectrometer] detectors. He is working with the PCP-100, and ITI has developed an IMS system that may be used for a portal or for baggage screening.

In the biotechnology area, we are using a slow "immunosensor" system. What it is, the beads have antibodies attached to them and they also have labeled explosives—or something that is just like an explosive—that says labeled explosives. These are all attached. If you take a vapor sample of the air, you collect the explosives in water, you get a one milliliter sample, and you inject it through this collector. The explosive displaces the labeled explosive and the labeled explosive goes through the detector and it becomes fluorescent. You get a signal that says, yes, it is an explosive, but it also tells you which one. Labeled explosives are very specific, they can be developed for RDX, TNT, PETN, whichever explosive you are interested in, they have a specific antigen for it.

We are going to test this system in the summer on airplane cabins. It's a five-minute analysis. We will place the detector in the airplane and take an air sample for five minutes. If there are any explosives, it should detect the explosives. This is going to be like a first-run operational test to see how effective it is. It shows a lot of promise so far.

The next thing that we are studying is olfaction. The program was put on hold because the principal investigator has died. We need to establish a baseline. We need to know what the true capabilities of the dogs are, as far as explosives. What are they hitting on? Is it the explosive, or a contaminant. If you keep all explosives in one bunker, that means it could be hitting on whichever one has the strongest vapor pressure. If you separate them, then you find out if the dog is really hitting on pure C-4, if it's hitting on the Semtex, or which explosive it is. We are trying to do an extensive test to find out exactly what the capabilities of the dogs are, and then once we discover that, we will try to improve the performance, if that is possible.

We are doing an optical technique in modulated IR [infrared], in which we target explosives collected on a surface and transport them through a drift tube where they are decomposed into the decomposition products. As you know, each explosive decomposes in a different ratio between hydrogen cyanide, carbon dioxide, and all these other things. We are assuming that if you use lasers that are tuned to cyanide, the carbon dioxides and nitrates will decompose; the ratio will tell us which explosive is present and we will have another detection scheme. We are still investigating it. It is very difficult to find lasers that work. The problem right now is finding the cyanide laser.

ITI technicians did some work for us in sampling. The fronds are the little tubes coming from the top of the detector. They are hot sampling lines made of teflon tubes. The idea is, if we place the suitcase on a conveyor belt and put holes in these tubes that are strategically placed where the cracks in the suitcase are and we "burp" the suitcase [compress the suitcase to force out air], maybe we will get the explosive vapor that is in the suitcase and have a better chance of detecting an explosive.

We are investigating a baggage screening system. The tests are being conducted, and we are using it for RDX.

Inelastic scattering is a fast neutron technique that we are using. Basically, the neutrons with energies greater than 10 MeV [millionelectronvolts] give off a gamma ray. The gamma ray is specific for the element that it impacts, and if the element is a ratio of carbon, oxygen, and nitrogen, we can use this ratio to determine which explosive it is—again, we have another detector.

If NMR [nuclear magnetic resonance] works, we could reduce the false alarm rate down to 0.1 percent. In the past, we constructed a baggage inspection system and we tested it. The explosives were recognized based on relaxation. They have a long T-1 time. The system suffered from a high magnetic field, which means that camera shadows and things would get stuck, the credit cards wouldn't work anymore, things like that. We also found out that you can beat the system by encasing the explosive in aluminum foil.

We have since started a new study. Right now we are starting the relaxation after you turn the magnetic field off, and we get an NMR of the hydrogen and nitrogen, which is a unique signature for each compound and for each explosive. In that way, we can identify an explosive. Also, we are using the NMR for one-sided imaging. If there is a sheet explosive on a lining of a suitcase and we do an NMR of it, we should be able to identify the sheet explosive.

We are also using NMR for bottle screening. Liquid explosives and gasoline have a very low water content. If we check a bottle for the water content and it's not what we expect to find in wine or alcohol or in water, then we might have a liquid explosive. We are investigating this because nitromethane has been used. This is one way to find out if that is what is in the bottle.

NQR [nuclear quadrupole resonance] is a low-level effort that we are using. Basically, the explosive will be identified based on its crystalline structure. We are just using this method to characterize what the explosives look like. This may be another way, because of low penetration, that we can screen the sides of a piece of luggage to find out if there is a sheet explosive in there.

Millimeter wave imaging is an active system. It is an alternative screening process with straight objects. We started out using this method to find plastic guns on people, but we found out that we could also use it to detect plastic explosives. It sweeps the body with millimeter waves and we look at what is reflected back. The human body will absorb most of the waves, but if there is something on the body, it will be reflected. If there is a foreign object, we may be able to identify it as an explosive or whatever. But, it is not a part of the body, so it could be a threat. In its present stage of development, people would still have to remove their leather jackets or heavy coats and take everything out of their pockets. But these are some of the projects that we are working on right now.

Any questions for Roy Mason?

[Laughter.]

Mr. McCorkle:

Are there an questions?

[No response.]

Mr. McCorkle:

Thank you very much, Janelle and Roy. I appreciated your comments. Next on the agenda, it is a pleasure to introduce Dr. Dean Fetterolf from the Federal Bureau of Investigation Laboratory. He has been with the FBI since 1984, and he specializes in mass spectrometry and the detection of narcotics and explosives. His primary subject this afternoon is going to be on the topic of evaluation of commercial explosives detection.

Evaluation of Commercial Explosives Detectors

Dr. Fetterolf:

Good afternoon. I would first like to start out by thanking the NRC and the organizers of this symposium for the opportunity to be here. I must say it has been very well organized and very well run.

What I would like to do first is to have a quiz. I have a question. I want to see a response. How many of your installations out there have bomb detection equipment installed?

[A majority showing of hands.]

Dr. Fetterolf:

Do you have explosives detection equipment installed?

[A majority showing of hands.]

Dr. Fetterolf:

How do you know that you have a bomb detector? Have you ever detected one? Until today and yesterday, the pictures that you have seen for most of you were probably the first time you have seen an actual bomb. You have an explosives detector. If you remember from yesterday, there are four things that you need to make a bomb. First of all, you need the explosive; you need an initiator, a fusing system, and a container.

Terrorists or disgruntled employees are not going to walk into your facility carrying five sticks of dynamite or a quarter pound of Semtex or a block of C-4 and say, "I am going to blow your place up." They are going to conceal that explosive in some fashion. That concealment is going to cause you problems with your existing explosives detection equipment.

[Dr. Fetterolf's paper is included in Appendix A. However, the slides shown during his talk are not.]

I would like to talk about an explosives detector evaluation that we carried out in the FBI Laboratory back in

March of 1988, almost two years ago now. I am with the Forensic Science Research and Training Center, and we are the research and development branch of the FBI Laboratory. One of our functions is research, and that is to investigate new methods of forensic analysis, whether it is drugs, explosives, DNA, any technology that can be used in analysis of forensic evidence and in training. We sponsor training classes that we offer to State and local forensic crime laboratories.

We are located at the FBI Academy in Quantico, Virginia. We are located on the Marine Corps Base, well isolated from everybody in our little college-type campus. Before I talk about the results of the tests, I want to go over a few things, a little bit of positive reinforcement.

There are three main classes of explosives. The nitrated esters, which contain the very volatile explosives, nitroglycerin [NG] and EGDN [ethyleneglycol dinitrate], are the nitrated dynamites. The types of detectors that you have installed at your facility, the types of detectors that you are tested against quarterly and have to get 30 out of 30, are NG and EGDN based.

PETN is a nitrated ester, and you would think it would be very similar in chemical properties. It is, except for one, and that is its vapor pressure, which is many orders of magnitude lower. We will take a look at that again in a little bit. You have the TNT and you have the RDX and HMX types of explosives.

In 1986, TWA Flight 840 was at about 15,000 feet in route from Rome to Athens when a device detonated under a seat and four people were killed when they got sucked out of that eight-foot hole. This is one of the lucky ones. Hiding the explosive under the seat was kind of a common thing to do for a while. You have seen this a number of times now, probably the third or fourth time. The little Toshiba "Bombeat 453." Just the insides.

Even more treacherous, five year old Erin Bower was walking through K Mart with her mother. She reached up on the shelf and grabbed one of these pump-type toothpaste tubes and it detonated. She lost part of her left hand, some injuries to her left eye, and had some shrapnel wounds on her stomach. Just another concealment device, considerably different than anything you have seen so far.

We should not fall into the trap of believing that the only explosives are those six or seven that I had listed on that first slide—things that could be used to cause considerable damage to one of your facilities. There are over 130 publications out there: Kurt Saxon, the *Poor Man's James Bond* now in volume three; and my favorite, *Kitchen Improvised Blasting Caps*. All readily available through a number of publishers and organizations, standard terrorist, standard survivalist-type literature.

All of the explosives that we have talked about so far and all of the equipment that has been mentioned so far are all nitrogen-based detectors. These books will tell you how to make non-nitrogen containing explosives. With $12.8[illegible] and a trip to the hardware store, you can buy some acetone, you can buy some sulfuric acid drain cleaner; you can go to the beauty parlor and get some hydrogen peroxide that is used in bleaching your hair; you mix those together on your kitchen stove at home and you can make an explosive called triacetone triperoxide that contains no nitrogen, has a detonation velocity almost equivalent to PETN, and has been used in various parts of the world.

One of the common things, where we first heard about this was in the Middle East. They would mix up this stuff and pour it into Coke cans and leave the Coke or Pepsi cans or beer cans lying on the streets. Little children would come along—and, what do they do when they see a can—they kick it. This stuff is extremely shock sensitive. It is a primary explosive. If you mix it up at home on your stove, which I don't recommend that you do, when you try to scrape it out of the pan, you have a problem.

I am a chemist, I am not in security. So, I have to look at things from a chemist's standpoint. I am not going to stand up here and give you a lecture in basic chemistry. Just a list some of the properties of explosives and how they affect our ability to be able to detect. A plus sign means that's good for us. It means that it is a property that we can exploit in detecting these types of molecules. A negative sign, or in the case of low vapor pressure, two minus signs, means that we are hurting. These are things that we cannot change—you can't change, I can't change, Congress can't change them by passing legislation—this is it. This is what we have to work with.

High electronegativity is the property that we exploit the most in our detectors. That is because we have those nitro groups that we talk about so much. Frank Conrad this morning mentioned that the explosives are sticky and they have high absorbtivity. They will stick to anything. That is good and it's bad. We use that property to concentrate the molecules to try and take them out of this large room full of air, for example, and concentrate them into a smaller space.

It also means that if there is an explosive in here, it is sticking to everything. It is sticking to the walls, the ceiling, and there's a heck of a lot more surface area in here than there is on the block of explosives. To reach that thing that we call equilibrium, takes a long time.

Thermal instability, by its very nature, means that these types of explosives don't like to be heated up too much. They fall apart and some of them go boom. Then we come to the vapor pressure, which Frank talked about that this morning. What I want to try to stress here in terms of detections and the types of things that you are asking us to try to do for you, one that is not on there is EGDN [ethyleneglycol dinitrate], which is a factor of 100 or so higher in vapor pressure. You are talking about a dynamic range of seven orders of magnitude, almost eight orders of magnitude in vapor pressure.

You want me to be able to detect EGDN or NG. In the same instrument at the same time, you want to be able to detect PETN or RDX. Eight orders of magnitude difference in sensitivity. If I have just a tiny amount of NG or EGDN, that's all I need to make a detection. You have seen this chart earlier, which lists the vapor pressures of the various explosives broken down in terms of their molecular weight. The commercially available detectors are very good for vapor high pressure explosives. They were designed to detect nitrated esters and they do that very well. You will see that as we go through the test results. They do that extremely well. By the time you get to TNT, ammonium nitrate, PETN, RDX, you see that the data from the experiment shows that as the vapor pressure goes down, so does the ability to be able to detect these explosives.

I made a little chart that I call technological maturity. This is looking at the vapor technologies only, not the bulk. You have a range of technologies that you can look at. Olfactory, which are the dogs, the electron capture and IMS hand-held portable detection, chemiluminescence, some ion mobility and two on the bottom. Their range in maturity is what I call infancy to just kind of new.

You could also look at this in terms of funding and dollars and investment. There isn't a whole lot you can do to make a dog better. You can maybe train him a little better, maybe give the handler more money, although we found out that may not be a good idea—maybe buy the dog a better brand of dog food—but overall investing money and trying to improve the performance of a dog is not going to get you very far.

If you look at these technologies that are in their infancy like ion mobility spectrometry, MS/MS, which is being developed at Oakridge National Laboratories, or some of the biotechnology things that we heard Janelle mention and some of the things that we are working on in the FBI Laboratory, a small investment of money might move those from infancy up to an advanced state rather quickly.

To give you some idea in vapor technology, probably the largest sum of money has been invested in the chemiluminescence technology, the combined efforts of Department of State, FAA, and Department of Transportation. If you add up the dollar figures over the last five or six years, you are probably looking on the order of $12 to $15 million, maybe closer to $20 million. It is a very large investment in research and development. R&D doesn't come cheap, and things just don't pop up overnight. It takes many years of research and development to get to the state they are now.

Let me preface what I have to say. Although I am going to mention names of specific instruments, specific manufacturers, I want to make it clear to you, as it was made clear to them when they volunteered to participate in our test, we are not endorsing, recommending, or favoring any detector. I am not going to tell you which is the best. I am going to let you make that decision. Which of these detectors, if any of these detectors, are useful for your particular application.

Our goal was to evaluate these detectors under operational conditions that are of interest to law enforcement and security. We divided the evaluation up into a number of phases. The first was instrument certification, and that involved training and also having the manufacturer certify that his instrument was operating the way it was designed to and that he was happy with the training and that we had trained an operator to his satisfaction.

We looked at packages, briefcases, luggage, some practical search problems, and we will go into those in a little more detail. We evaluated four detectors. Graseby PD-5, which is an ion mobility spectrometer (IMS)-based instrument, and three electron capture instruments: the ITI [Ion Track Instruments] Model 97, the Scintrex EVD-1, and the Sentex Scanex Jr. I have a couple of pictures of those, and will just go through to let you see what we are talking about in terms of size and portability.

This is the ITI Model 97. There is that refillable gas cylinder that was talked about this morning, and the need for argon. This is a briefcase or a small suitcase-sized portable detector. All of the detection parts are out in that end unit.

This is the Scintrex EVD-1. This instrument is manufactured in Canada, used throughout Canada at all of the airports by Transport Canada. It is kind of unique among these instruments because its sampler is mobile. It is portable and can be separated from the instrument. The sample is actually collected on a little quartz tube.

There is an interesting advantage to that. You saw the dog this morning. The dog is what I call a point-source detector, as are all these other detectors. You have to take the dog or the detector to the sample. In other words, when the dog was up here sniffing, the dog didn't know there was an explosive under this table until the dog was here. He didn't walk in the back room and say I think I have an explosive in the room. The dog had to come up here and find it. A detector like this has an advantage that you can walk into a room and, if you have a volatile explosive, one of the nitrated dynamites, in a very short period of time you will be able to say there is something in this room. We will talk about that a little later as well.

This is the Sentex Scanex Jr., small briefcase-sized portable detector. The umbilical cord runs up to the sampling head. One of the main problems with this instrument is the umbilical cord, which is a big long 1-meter piece of teflon tubing. If you remember this morning, explosives stick to anything and they even stick to teflon—that can cause a problem.

All of these electron capture detectors have some kind of chromatographic column for separating the explosives as well as the electron capture detector. Up in that little red box marked microprocessor, there is some kind of intelligence built into the instrument, if you will, that says I have a signal within a given timeframe so I think I have an explosive. However, the real intelligence is still with the operator.

This is the Graseby PD-5, which is an ion mobility spectrometer. The IMS is actually located in that little black head that is attached to an umbilical cord. The only thing that is in that other box is an air filtration system, a power supply board, a microprocessor and a battery. There are no gas cylinders or anything that needs to be recharged. It has an on/off switch.

I don't believe that anyone has talked about how an ion mobility spectrometer works. You have heard that name a couple of times today. An ion mobility spectrometer takes into account that property of high electronegativity. The front part of that is actually an electron capture detector. After the molecules or explosives have captured that electron, they are ionized, and they can now drift under an electric field. You apply a potential gradient to that tube and the molecules will drift. Small ones will drift faster than the big ones. They separate in time. Your microprocessor then gives you that separation in time.

We use a range of explosives, not just nitrated dynamites—Hercules Unigel dynamite is one of the nitrated dynamites, a mixture of NG and EGDN. Hercules Red Dot, a double-base smokeless powder. By definition, double-base smokeless powders contain nitroglycerin, up to 30 and 40 percent by weight nitroglycerin. We also used Atlas 7-D, which is an emulsion and one of the more popular types of commercial explosives. Military TNT, Dupont Deta Sheet which is PETN, and C-4 which is RDX. These explosives were obtained from sterile sources. That means they were never exposed to nitrated dynamite during their storage or during the preparation of the packages or during the test and evaluation. You will see as we go through this that we did a pretty good job of keeping things that way.

We looked at a number of "interferants": wrapped boxes, plastic molded briefcases, and some items of luggage. There are a lot of questions out there about the interference capability. I still hear the questions: Do these things alarm on shoe polish, does dry cleaning solvent cause a problem, how about perfumes? We decided to take a look at a number of these things: mens and womens toiletries, household chemicals, foodstuffs, smoking materials, laboratory chemicals. I am not going to show you all of the data from all of the tests because we would be here for a long time.

Plus signs mean a hit, minus signs mean a negative. Interferants with plus signs aren't good because that means you have a false alarm. You have something there that your detector thinks is an explosive. We have two types of perfumes and a mouthwash that caused a positive response on the one detector, but the other detector did pretty well. As we go through the data, the Scintrex EVD-1 and the Sentex Scanex Jr. had no false alarms on any of the materials that we tested.

None of the detectors alarmed on shoe polish. The ITI Model 97 responded to the Obsession and Coty musk perfumes; these contain a musk ambrette that is structurally very similar to TNT. In fact, there are six musks that are approved for use by the Food and Drug Administration in cosmetics and fragrances. We just recently got a collection of those six and are going to go back and test the responses of the detectors until we find out which of these are causing a problem.

The Skoal Wintergreen smokeless tobacco caused an alarm under the smoking materials. This is snuff, a preparation of tobacco to be placed between cheek and gum—not only does it ca[illegible] cancer of the lips, but it makes the explosives de[illegible]r alarm. The reason for that is quite simple. The wintergreen flavoring that is used contains a chemical called methyl salicylate, which is an electron captured in nature and has the same chromatographic and ion mobility behavior as some of the explosives. The alarm the tobacco caused in the Graseby PD-5 is kind of easy to explain because that same detector is used by the British military in chemical warfare training exercises. They do not want to drop live warfare agents on their soldiers, so they use methyl salicylate bombs. They also use an instrument to detect how well the soldiers have decontaminated their clothes and their vehicles, and a detector like this is used to do that. Actually, it happens to be programmed into the detector.

We looked at pure explosives, pure explosive components, pure RDX, pure PETN. Let me clarify this. This is in close contact or near contact with the detector, shoving the detector down inside of a little vial of the pure explosive component. That is not a bomb. There is no container. You will see that all of the detectors responded to NG without any trouble. In fact, we used nitroglycerin heart tablets because we didn't want to bring any dynamite into the facility.

Ammonium nitrate is the basis for most of the emulsions and water gels and slurry types of explosives that are very popular. Dinitrotoluene is a trace contaminant in military TNT. It is roughly one percent or less, but about three orders of magnitude more volatile than the TNT.

PETN and RDX, the major components of plastic explosives, did not receive a positive response. We did not detect the pure PETN and RDX. Although I have plus signs under the Sentex Scanex Jr., those detections really aren't the instrument responding to PETN and RDX, but are actually a detection of a more volatile explosive that has been previously absorbed onto the surface of the teflon tubing. It is kind of like a parking spot—a memory problem, if you want to look at it that way. When a detector is exposed to a more volatile explosive, some of that compound stays on the walls of the tubing. Then when RDX or PETN is released, some of those molecules, which have a greater affinity for that surface than does NG or EGDN, displace the other. They say, "you are in my parking spot, get out of here." They replace the NG or EGDN and off those go, down in the detector.

We took samples of the test explosives that we would be using in the evaluation and placed them in near contact with the detectors. The detectors readily responded to Hercules Red Dot smokeless powder, a high NG content explosive, no problem. TNT, no problem. Deta Sheet, which is made out of PETN, also tested positive. Actually none of the detectors "hit" on the pure PETN, but they were responding to the Deta Sheet. I will explain that in a second.

None of the detectors hit on pure RDX and none of them hit on C-4. This is pure explosive, right up in front of the detector—no attempts at putting it in a container or concealing it. Why did they hit on Deta Sheet? There is something in the Dupont Deta Sheet that is more volatile than the PETN, and it is behaving like an explosive to these detectors. We are not sure what it is, but there is something there.

There is a problem with relying on that type of contaminant or interferant for detection. What if the manufacturer decides to change this formulation and use something else. The terrorists don't play by the same set of rules. You saw some pictures yesterday and today of homemade sheet explosives that are made out of very pure PETN and natural rubber and not much else, analyzed down to the parts per million and parts per billion and nothing else. Terrorists don't play by the same rules as the commercial manufacturers. Relying on an interferant or relying on a cross contamination as a means of detection could be fatal.

For our packages, we used cardboard boxes, 1 cubic foot each, wrapped with a packaging sealing tape and brown paper. The explosives were just thrown in the boxes, not wrapped in plastic or hermetically sealed. They were just taken out of their wrappers and just thrown in the boxes. One of the things that somebody mentioned earlier was time, time since the device was placed. We call that soak time, which is how long the explosive has been in that container before we got around to sampling it.

Soak time is very important. For most of these explosives, with the exception of the dynamite, all of the other explosives had 18 hours to sit in their cardboard boxes, overnight in a sterile environment. The dynamite was only in the box for two hours. We only had one-quarter of a stick of dynamite in the box and you will find out that was orders of magnitude too much dynamite to have around.

We set out the packages. These were treated as suspicious packages. It's a bomb. We had some manufacturers who wanted to poke holes in the boxes, we had some who wanted to "burp" [compress the box to force out vapor-enriched air] the boxes, we had some who wanted to heat them with heat lamps. I have talked to EOD [explosives ordnance disposal] technicians all over the country, and I have yet to find one of them who will burp a bag or burp a suspicious package. I don't blame them. I don't think I would do it either.

[The actual boxes were not color-coded, but the boxes on the slides were color-coded for visual aid.]

The blue boxes were blank; they had nothing in them. The tan- or brown-colored boxes had interference items chosen from the interferants list in them so that we could see if the detectors would alarm on chewing tobacco or the other items in the boxes as well as explosives. In designing our test, we knew dynamite might be a problem. We started out with a stick of dynamite and then decided that was too much; we better go to a quarter of a stick. We were still leery of that, so we surrounded that little red box there with a D on with blank boxes.

If we started getting alarms on the blank boxes during the test, we knew we were having trouble with dynamite vapor emanating from another package and possibly contaminating the area. It turns out that it really started to happen. In less than an hour, the quarter stick of dynamite in the red box made it impossible for us to get within 10 feet of it with the first detector in that phase of the evaluation. In fact, in less than an hour, using the FVD-1 detector with the hand-held remote sampler, we could not operate in our building. We had a total of a stick of dynamite hidden. We couldn't operate in our building, which is only about 40,000 square feet—taking ceilings and floor space into account, it is roughly one-half million cubic feet. In about an hour, we were able to say there was an explosive in that building. We were also able to say it was dynamite because that is really about the limits: Whatever it was that contained high amounts of ethyleneglycol dinitrate or nitroglycerin.

In an hour, a 15-second air sample was enough to say there was something in the building. The detectors are very sensitive to the nitrated dynamites. All of the detectors found the nitrated dynamite in that cardboard box. In fact, at this point in time, we had some trouble. We had actually ended up taking the dynamite out of the box and remaking the box. The only thing that was left in there was a couple of little pieces and whatever vapor had absorbed into the cardboard. We were trying to prevent problems with contamination.

We kind of had a round-robin thing going where the detectors were at different stages of the evaluation. We ran into some technical difficulties with the Sentex Scanex Jr. We were unable to repair it and the manufacturer voluntarily withdrew the detector from the test.

Dynamite was no problem. One of the detectors, the Model 97, responded to TNT. If you remember, all of the detectors were able to detect the Red Dot smokeless powder in close contact. About one-half to three-quarters of a pound of Red Dot smokeless powder was put into a bag within that box and had 18 hours of soak time. The powder was not packed into a pipe with the ends capped and a blasting cap shoved in to keep any vapors from getting out, it was just dumped in the box. We were unable to find it. If you remember—some positive reinforcement here—the most common device found in the United States is the pipe bomb. For the most part it is packed with double-based smokeless powders. In our evaluation, it was just thrown in a box.

The emulsions, the C-4, the PETN, no dice—we were unable to detect them.

We also learned something else about the detectors. I think the manufacturers learned something about their detectors—they learned how sensitive they were toward dynamite. But we were also running into some other problems. Although chlorinated solvents and other electron-capture-type chemicals don't alarm as explosives, they have a significant effect on the sensitivity of the detectors. They are electron capture in nature and the detectors see those molecules.

There is an automatic zeroing type of circuit built into the detectors—most of them have it. Most of them are automatic and some of them you have to hit a button. What this is telling us is that if we have a nice level background, everything is nice and clean, we have no problems. Auto-zero is kind of nice because it takes care of minor fluctuations in the detector current. If the detector current is down here at the floor and a little bit of explosive molecule comes along, it just gives us a little tiny signal, just above baseline, the detector sees it and we have no problem. But, if there is a contaminant in the background that is absorbing some of those electrons in the detector, the zero in that detector has been elevated. Now, instead of a signal this high to be detected, I need a signal this high plus that much. So my detector's sensitivity has been greatly diminished. Some of the detectors, the ITI Model 97, for instance, has a nice little light that comes on and says something is wrong. It is letting you know that it is operating in an environment in which it may not be operating at maximum sensitivity. If that little light keeps coming on all the time, you know you have a problem.

We had 25 black molded-plastic GSA [General Services Administration] government-issue briefcases. It's kind of hard to get 25 plastic briefcases out of GSA for a test, particularly when you tell them you are going to put explosives in them and they say, "we want them back anyway." I would not use one of these briefcases for carrying my papers around in. They seal so poorly that a credit card would probably fall out of them through the cracks—they leak like sieves. They are not a very tight briefcase, certainly not like a Samsonite or anybody else's real briefcase.

[Laughter.]

So, don't ever order one of these briefcases from GSA; use your own. It's kind of like the GSA-brand magic tape, the sealing tape. We can go through a very elaborate analysis in the laboratory and tell apart the various manufacturers of scotch tape. But it's easy to tell the GSA tape because it doesn't stick.

[Laughter.]

We had 25 molded briefcases into which we just threw the different explosives. We didn't put them in any bag, didn't hermetically seal the briefcase; just threw the explosives in the briefcase and lined these up about 8 to 12 feet apart and went along sampling them. We did a little better on the briefcases with plus signs.

We made a concession at this point. We considered this to be like a briefcase that somebody would be carrying through a secure checkpoint coming into work. It's a pretty good assumption—although I always hate to make assumptions—that it doesn't have an antidisturbance device because somebody is carrying it around. It probably does not have a mercury switch in there to set it off. So, we let them burp it. What do we mean by burp? We let them pop the hinges, press down on the bag and burp it. It didn't make any difference in getting that air out. Only in one case did a detector respond—that means it detected something on the burp, but didn't get it without burping the bag. So, in only one case did it make any difference on these leaky briefcases.

We did a little better there in terms of detection. Again, no C-4, and we had an intermittent result on one of the Dew Sheets.

We were easy on the manufacturers when we tested explosives in luggage. We only had 10 items of luggage, and we only threw one-quarter stick of dynamite in one. By the time of the test, we had taken the dynamite out as well. The instruments all had no trouble detecting the dynamite in a purple soft-sided piece of luggage, a little bit bigger than carry-on bag. We had the zipper partly open and they could sample around the zipper. There was no trouble detecting the TNT. There were clothes and other stuff in the other ones. Not very many false alarms—no false alarms.

Those are things that could be coming into one of your facilities, a briefcase, a package coming through the mail, a suspicious package left. You are walking your security detail late at night and you see something funny sitting there by the garbage can that looks a little bit out of place. We saw a couple of examples, one yesterday of the New Jersey State Trooper—something just wasn't right. He had a gut feeling that something wasn't right. He was right. There was something wrong, and he got our friend Mr. Kikumura.

None of these detectors—and I am going to go on talking about these...I don't think there is any technology out there or will be in the very near future that will totally replace the human factor in looking at some of these things. There are some things that you just can't quantify, and if you are a security guard at a facility and have been there for a number of years, you just know things, little things. You see little things. When something is out of place, you know it right away. It's like, that garbage can doesn't belong here, it belongs over there. Or, this door should not be open, it's supposed to be locked. You just pick up on those things. You are out patrolling a perimeter and you see a blue van drive by, just keep circling around the facility all day long. It's going to trigger something. Sometimes your hunches are pretty good.

What about practical search problems? What if somebody calls up and says I put a bomb in an office or put a bomb in the control room, or put a bomb in a repair vehicle or in a little go cart or some maintenance vehicle that you drive around. What about the mail? We set up some search scenarios involving a telephone booth, a townhouse, automobiles, motel rooms. We made it easy on the detectors. We were interested in the detectors, how well they were able to detect an explosive and not how well the operator knew how to conduct a thorough search.

I think we saw a very good demonstration of thorough searching this morning with the Secret Service dog. That is a skill, that is learned, something you have to practice and train for. If I haven't mentioned it, these devices are tools. You have to train with them. You have to become familiar with them, you have to understand how they work, and you have to be retrained.

The EVD-1, which has been used in the airports in Canada for a number of years, is a tool for the operators to do a search—that is their job. It has gotten to the point now where they say, "We are not getting enough training on this thing, we want more training, we want harder training. We think we can beat our own machine. Test us to see if we can." Those are the kind of things you have to work for.

We carried this out in what is called Hogan's Alley. It is a training complex located at the FBI Academy. It is a multipurpose training facility designed for FBI and DEA [Drug Enforcement Agency] training exercises in practicing the normal things that law enforcement officers do like arresting people and hand cuffing them and chasing them down the streets. It's a village. It actually has working office spaces, it has a little bank that is used in training exercises involving bank robberies. It has a little working deli.

All of the physical plant support people are over there, maintenance, the electrical shop, and the plumbing shop. Those people are all over there. There are bodies around, people around, to make it look like a little village. There is a pawn shop; in the back of the pawn shop there are little slot machines and gambling things.

The Hostage Rescue Team, which you heard mentioned, repels out of helicopters down onto the roof.

We used this complex to set up the scenarios. The first was a post office scenario involving a sheet of PETN, Deta Sheet, with the nice and smelly stuff that the detectors could respond to when you stuck it right in the front end. All we had to do was stick it in a manilla envelope, the container. None of those vapors, which weren't PETN that it was detecting in the first place, could get through that package to be detected.

This is kind of nice. These were what we called directed searches. In order to have everybody have a fair chance, we told everybody where to search. We put little 3x5 cards up there and labeled it so they knew where to search. Everybody searched the same thing and eliminated the "oh well, he didn't know how to search a room." Everybody searched the exact same places. In this bag, double-base smokeless powder, three-quarters of a pound, poured into a brown paper lunch sack, not even put in a pipe, and just stuck on the top of a gym bag that was full of gym clothes and sneakers. We had them sample across the zipper area. Nobody saw it.

We had two automobiles. One was an exterior search where areas on the exterior of the vehicle were searched and the other was an interior search. Here we see an example of searching along a doorway. We had them search along the hood and trunks of vehicles.

A word of caution about new vehicles. The trunks on new vehicles are sealed very, very well. What does that mean about vapors getting out of a trunk if there is something in there giving off vapors? They might not get out. We had a quarter stick of dynamite stuck in the trunk of the vehicle, just sitting there on top of the spare tire, about a foot back from the end of the truck. The operators, with their detectors, walked about the crack of the trunk. This was a Chevy, late 1970 Chevy Impala—I think it was. They had no trouble picking up the dynamite in the trunk, only a quarter stick. It had only been in the trunk for about an hour and it was only about 50, 55 degrees outside that morning. We had them search other areas, and there weren't any positive signs searching under wheel wells and hoods and places where there weren't any explosives, we didn't have any trouble. We didn't get false alarms. We had one on an air sample, but that was done a little bit later in the day. There is a possibility that the explosive vapors could actually penetrate through the back seat into the air space in the vehicle.

We put about one-sixth pound of TNT under the driver seat of a late model Lincoln and had the manufacturers search various areas. We had two out of the three detectors find the explosive under the seat. We had some other alarms at various places. Whether or not these alarms were the result of TNT vapors or DNT vapors emanating through the vehicle or whether they were alarms caused by other things, there is no real way of being sure.

We did some room searches. To impress upon you how sensitive these detectors are toward dynamite, we took a two-by-two-inch piece of dynamite wrapper and put it in a styrofoam coffee cup from 7-Eleven. We put the plastic lid on top of the cup and tore back that little drinking spout that is provided so you don't spill your coffee in the car on the way to work in the morning. We stuck that in a garbage can about halfway down with some potato chip bags, pretzel bags, and empty Coke cans on it. We set the trash can in the corridor and told the operators to search the can. They weren't allowed to disturb anything. They could "sniff" it, but they couldn't rummage around in the can. We also had them search a desk drawer in which we had placed the C-4, but they weren't allowed to open the desk drawer. We already had it opened a little bit and a little note that said sniff here.

By the way, we tried to make two of these rooms have as much a lived-in environment as we could. We sprayed some deodorant around the room, dumped some mouthwash in the sink, we ran the shower, deodorized the toilet. I shaved three times that morning. Things to give the room that odor—like when you come back from breakfast to your hotel room—give it that kind of odor, lived in, used kind of smell—stink.

[Laughter.]

That little tiny piece of dynamite wrapper in the garbage can, no trouble. We had another room in which we hid a piece of dynamite wrapper under a sofa, all the way back against the wall. We had them search under the edge of the sofa and along the cushions and they were able to find the dynamite wrapper. We had one-quarter pound of C-4 in the desk drawer only back a couple of inches—you couldn't see it by looking in, but it was in near contact—and couldn't find it. We told them where it was.

By the way, I didn't mention this. The test was done blind. The manufacturers, the operators, the scorer observers, the referee of the test had no idea what explosives were being used or where they were, so it was blind.

Atlas 7-D emulsion again, indicative of the most common or very common commercial explosive, about a pound tube of that chub, as it is called, was stuck in the top of the desk drawer and nobody saw it, nobody detected it.

I put together a slide that I really didn't like to do. I really didn't want to summarize the result. I did it, and after I did it, I said I like it for a reason. Remember the chart I had of vapor pressures? I had nitroglycerin at the top and went all the way down to PETN and RDX, very volatile to non-volatile. It should go from being easy to detect to being hard to detect. That is our theory. Did the experiment prove that out?

I didn't show you all of the test results. But when we summed it all up, there were seven instances of dynamite times three is 21, we got 19 of them, so we got 90 percent of the dynamite hides. If you remember that chart way back early where TNT was kind of in the middle. TNT is kind of the cut-off range for the commercial detector. We only found one smokeless powder, one Atlas 7-D, and no PETN-based Deta Sheet and no C-4.

Volatile to non-volatile, in some kind of a container of some shape or fashion, no attempts to hide the explosive by molding it into plastic or sealing it, just dumped in the box. Let me ask the question now. How many of you have bomb detectors in your facility?

[A showing of hands.]

I still saw a hand or two. You must have very good guards. I thank you for your attention. I will be happy to answer any questions. I think I have about seven or eight minutes here. I would like to take the questions now. Please don't be shy. If you have the question, somebody else in the audience does too. Don't everybody all run up at once and "gang question" me at the end.

Use the microphones so that everybody can hear you, please.

Participant:

Do you plan to use Semtex in any future evaluations?

Dr. Fetterolf:

It would be nice to be able to use Semtex in the evaluations. There is a problem there. It is difficult to get bomb quantities of Semtex in this country, thank goodness. I have asked for some, but every time that I ask people who might have it the usual answer is, "we don't have that much around right now." I say, "That's good news."

Participant:

Is there any plan to run checks like this against dogs, or dogs versus machines?

Dr. Fetterolf:

Let me answer the question this way. This test took five months to plan, took 18 people from the laboratory to carry out, was four days of evaluation, took nine months to write the report. I spent a year of my life working on this test.

If anyone else would like to carry out such a test, I will be happy to tell you how to do it. I really don't want to have to do another one in the near future. There have been some tests done with dogs in the past. In 1980, I guess was the last test.

Participant:

Do you plan to do any work with portal detectors?

Dr. Fetterolf:

No, I don't, because our colleagues over at FAA have got that under control. That fits right in with their search scenario. We are more involved in the FBI with the law enforcement and security applications of some of these things. Our real, main interest in explosive detectors is not in preblast searches and investigation, although we have some applications there...

How could we use these devices, if we can, in post-blast to...what do you do when you have a crime scene that is spread over hundreds of square miles or hundreds of square kilometers and you have bits and pieces of airplane or whatever scattered all over the place? How do you know what to bring back with you to the laboratory to work on? It is very difficult to ship back 10 or 12 tons of debris to the laboratory and try to do a chemical analysis on it.

It would be nice if we had something that could be used in the field to help us with that process.

Participant:

You said that the Scentex Scanex was giving kind of a false positive on the C-4 because of displacement from the teflon tube. Is that a potential way of detecting that material, by coating a tube with this other material?

Dr. Fetterolf:

That would be a guess. No idea is a bad idea. There is certainly the possibility that something like that could be looked at. It is not something that you could count on reliably. I don't think you could make a reproducible detector that would do that. It would depend on the age, how old that tube is, and how much residue was on there. I don't think you could make a reliable enough detector.

I didn't mention...there are some...I didn't want to leave you with the bleak picture that there is no hope out there. There are some things being worked on. You heard some of the things that FAA is looking at. We at the FBI are looking at ion mobility spectrometry through the assistance of Sandia National Laboratory.

We are also hoping to look at the MS/MS technology down at Oak Ridge National Laboratory. We are funding some work in the bio technology area that is looking very promising. But as I mentioned earlier, technology doesn't come quickly and it doesn't come cheaply. There certainly is not a whole lot of funding out there to investigate new applications. It takes a lot of scrapping and a lot of fighting: "How are you doing friend, we need some help, can you cut us a deal on trying to do a little bit of research for us."

There isn't adequate funding for doing the job the way it should be done. Write your Congressmen and Senators. There are a number of things that Congress is doing. There is a study going on in the Office of Technology Assessment with regard to the state-of-the-art in explosive detection. I am glad to see that. Senator Biden's and Senator Cohen's offices are soliciting ideas for the formation of a civilian analog to DARPA [Defense Advanced Research Projects Agency] for law enforcement and counter terrorism and counter narcotics.

Hopefully in the future, we are going to see some additional funding to do the kind of work that needs to be done. Thank you.

[Applause.]

Mr. McCorkle:

Thank you. I would like to thank Dr. Fetterolf for a very interesting and informative presentation.

The last on our agenda for this afternoon is Mr. Patrick Laird. He is Chairman of the Nuclear Security Subcommittee for Edison Electric Institute [EEI]. I think we have all interfaced with that committee at one time or another. He is also the Corporate Security Director for Commonwealth Edison. He is going to talk to us about the industry perspective on some of the things that have been discussed at this symposium.

So, without further delay, Pat.

An Industry Perspective on Contraband Detection

Mr. Laird:

Thank you, George. Periodically, since I have been in the industry, I have heard that some of the NRC safeguards people have doubts about some of our nuclear security people's ability to respond properly. Well, I think we dispelled that rumor last night with the fire drill here in the hotel. We were the first ones out on the street, and I want you to feel assured that we can handle it.

Most of the discussions we have had so far have been technical in nature. I am going to deviate from that, primarily because I don't have a technical background. I am going to give you a layman's approach to some of the problems and some of the issues that we have encountered at our nuclear power stations. The data for the presentation is not mine alone. I received comments to the inquiries I sent to the approximately 36 utilities that belong to the EEI Security Subcommittee. In order to protect the guilty, we will not identify any manufacturers or nuclear power stations.

[Slides shown. Selected slides from Mr. Laird's presentation are contained in Appendix A to these proceedings.]

To put this in some sense of order, there are programs at the nuclear power stations that generally require proper performance by security officers and certain types of technical equipment. The three areas that I will focus on are firearms detectors or weapons detectors, explosives detectors, and X-ray equipment. In order to put it in a perspective, we will look at what the equipment is supposed to do or can do, and then I will discuss in a little more detail what problems we have encountered from the technical and operational viewpoint, and just a passing comment on what is expected by the industry from the manufacturers.

We have a metal detector that we use in firearms detection. Basically, this detector is designed to identify guns. If it is set at the right sensitivity, it also can pick up other weapons and tools. However, when the sensitivity is set at that level, we have found in the past that the alarm rate is proportionately higher.

Some of the mechanical problems in the responses to my inquiries addressed an issue called cabling and slaving for sites that have multiple units. They all transmit and receive at the same time unless they are in the slave mode. For instance, if you have three machines, one would be designated the master, the other two [slave units] would be the secondary, or two and three units, and the cabling is done through the logic terminal, which would control the master and place the other two in the backup position.

When a lot of the machines were put in place, we had some problems in the industry with steel-toe shoes causing the detectors to alarm. As a correction for that, a shielded plate was installed, which solved that problem but then created the problem of a small caliber weapon coming through the machine without detection. Therefore, the steel plates have been removed.

Nuclear power stations have been, in some circles, described as the home of spurious alarms. We found these alarms can be triggered by radio frequencies from the guards' net (from their portable radios), metal in the ceilings and floors, and some facilities have metal doors or railings within two or three feet of the detectors. I was told by one facility that their fluorescent lights located directly over the metal detector have caused alarms.

Follow the manufacturers' recommendations for maintenance. Operational checks on the equipment should be conducted every shift. Performance checks are conducted every seven days or when a machine is returned to service Calibration tests are supposed to be done every quarter. Another recommendation is to purchase and use an actual weapon for the test-piece device.

We had some operational problems with the firearms detectors such as the rebar in a concrete floor that has caused alarms. A simple correction for that is to build a two- to three-inch platform of wood or plastic. It seems to have worked well. The other solution would be to install a fully shielded metal detector.

Another operational problem that was picked up during one of the RERs [regulatory effectiveness reviews] that will be discussed tomorrow is a weapon kick-through technique. That involves a small caliber weapon being strapped to an ankle, and as you enter the detector with your left foot and the weapon is on your right foot, you quickly bring it through the detector and it will not alarm. There is a state-of-the-art high technology solution for that: You make the people delay in the machine for one second. We found that to resolve the problem. It does not delay the ingress process at all.

Industry would like to see a little more sensitivity to ferrous and nonferrous material and less maintenance with the equipment.

Explosives detectors are designed to identify explosive materials by air flow over a person's body within a given period of time. Two devices are commonly used at nuclear power plants: the walk through or portal and the hand held. Consensus within our industry is the walk-through device is preferred because it is quicker. If you are processing people over an extensive period of time, the walk-through device is more reliable than the guard having to do the search.

There are some mechanical problems associated with explosives detectors. If the gas supply inventories are not checked properly, the equipment could be inoperable. There are two types of gasses recommended: argon and helium. These have been referred to before. There is another problem with contaminated gas. There are two choices on gasses for the equipment. One is the use of a single bottle of gas for each unit and the other one is a series or bank of bottles for the equipment. The problem with the series method is that if one is contaminated, they all could be contaminated.

The calibration for the equipment has been cited as being very time consuming. Make sure your test sample is not defective. The people at the sites working with these samples recommend that you use one sample jar per unit. If you try to use one sample jar for multiple units, the vapor may not be sufficient when you get towards the end of the test.

Some of the required checks on the operational problems, cleaning fluid in the portals—some have nitrates that have caused problems. The portal needs a sterile environment, almost dust free. I received the same information that Frank Conrad did about the perfume alarming, although ours was a little different. Our problem was with a male passing through the detector. It took the guards a considerable period of time to figure out what it was. The explosives detector is very sensitive to fertilizer during the planting season.

Most of these detectors would only detect dynamite-based explosives and not plastic explosives. One station, in terms of maintenance cost, experienced $1,000 per machine per month on maintenance. The maintenance cost was reduced to $200 per machine per month after a "change out." Industry would like the ability to detect commercial explosives including plastics and incendiary devices. Several people suggested that portable equipment to search cargo-laden vehicles should be more reliable than what is available, which would reduce the maintenance.

The final piece of equipment is the X-ray equipment, which is basically designed to detect contraband by displaying an image on the monitor for an observer to determine if further evaluation is needed. The one common mechanical problem that was cited was maintenance costs. Several utilities would spend approximately 15 percent of their initial cost for the machine on annual maintenance of the X-ray equipment.

There are several operational problems that have been corrected or are easily correctable. The RER team identifies a lot of problems. Team members must stay awake at night thinking of ways to beat our systems, such as putting a small caliber weapon in an envelope and carrying it with other envelopes, flinging it through the X-ray machine, thereby beating the X-ray envelope detection. Using a nonskid belt, conveyor belt, should deter that. You also can have the people maintain a minimum distance from the X-ray machine: you can install a plexiglass barrier so they can't fling items through. They would have to set items down or drop them over. Another method is to have all materials enter the X-ray on a plastic tray, in other words, all contents would be on a tray.

Another problem that was identified were the dead spots on the upper left- and right-hand corners of the X-ray machines that have the rays coming from the top to bottom. There are two solutions for that. One is a plexiglass barrier that would prohibit any package from entering the dead area. Another alternative is to acquire a device, which is on the market, that has the X-ray generator ray coming from the bottom upward; it gives you complete coverage of the package conveyor area.

The X-ray machines cannot adequately detect explosives, but there have been several efforts by the manufacturers to try to correct this. Basically, the choices that we have available are the traditional black and white, which defines the shape of an article; the color enhanced system, which defines colors according to their materials; and then the pseudo color, which identifies objects according to density. I said that I wouldn't identify any manufacturers, but some of you may be familiar with some of the examples.

I have one example of a briefcase with obvious contraband items, and I will flash on some of the examples of the alternatives to give you an idea of what the alternatives are. Black and white, in essence, that is what the observer would see in the X-ray. This would be the color system and how it would be defined. That is the pseudo color system. I think if you presented that to—in our case guard forces—to make selections, they may have a difficult time choosing between the color and the pseudo color. Their preference would probably be for either one of those.

This is a chart to identify the items according to the color scheme under the color alternative. One of the problems that has been identified with either the color or pseudo color is a fear that the guards may rely too much on the color to make a decision for them. With the black and white, they have a definition of an object and they have to resolve it.

The industry, of course, would like to be able to identify plastics and to do it more cheaply. But, when we see the cost of the TNA [thermal neutron activation] machine, obviously we are getting a good deal. The big one is $750,000 per machine plus installation, and it still has some limits on what it can in fact detect.

An important aspect of all of our ingress programs and the equipment that is utilized is the role of the security officer. They need to rely on and understand why the machine alarms. For instance, if a person gets an alarm because an individual is wearing a steel-toe shoe, the guard has to make sure that is the cause of the alarm and not make the assumption that the steel-toe shoe was the cause.

There is a software program called false-image projection (FIP) available. It is now used as a training device for the observers on the X-ray equipment. In essence, this software can generate approximately 115 samples of weapons or bombs on the monitor. The training officer can evaluate the performance of the observer or the guard as to whether or not he/she was alert and observed this device on the monitor. When the shift is over, it is a training device to indicate any weaknesses in the system.

The very last comment that I will make is that the security officer is the core of a successful ingress program. We rely on the equipment as a tool, but if that security officer is not alert in doing his/her job, the equipment won't do us much good. I am ready to take any questions if you have any. This was a quick overview of what we face in the industry.

[No response.]

If not, thank you.

[Applause.]

Mr. McCorkle:

If we have no questions, we will close now. It seems that this afternoon the questions came after each presentation. Unless there are any specific questions for our guest lecturers this afternoon, I thank you all. We will see you tomorrow morning bright and early.

PROCEEDINGS – DAY THREE

Mr. Burnett:

Good morning again.

When we first started this, I knew that it was going to be topical and timely, but I really didn't know how much so. The day before we convened we had what probably looks like a bombing of a plane in Colombia, and then last night the bombing of a vehicle carrying a very high official in the banking industry in Germany. I think it all just points to the importance of looking and watching carefully, which is the whole reason for this seminar.

I would like to call your attention to Mr. Robert Bernero, the Director of the Office of Nuclear Material Safety and Safeguards; he will not be addressing us this morning; however, he will be available through lunch. As I have said repeatedly, if you have any questions, these are the right people. Bob will be here to entertain any questions and interact. So please take advantage of the opportunity to meet these high ranking individuals that are setting national policy.

I do have the distinct honor this morning of introducing James R. Curtiss, Commissioner of the Nuclear Regulatory Commission. He has been with us for several years. He is very interested in this subject and I personally look forward to what he will have to say this morning.

Commissioner.

Commissioner James R. Curtiss speaks before the symposium on the topic—The Importance of Security at NRC-Licensed Facilities, A Summary Perspective.

The Importance of Security at NRC-Licensed Facilities

Commissioner Curtiss:

Good morning ladies and gentlemen.

It is a good thing we got started about 15 minutes later this morning. I left the office a little bit late this morning. As you can probably imagine, traffic around here is pretty thick in the morning. So I told the driver that I needed to get here in the worst way possible, and we did.

(Laughter.)

I do want to extend on behalf of the Commission as a whole our most hearty welcome to all of you at this session. We know you have been here for a couple of days and had what I hope is a productive session. Bob and I had an opportunity to talk this morning. He tells me that representatives are here from most of the agencies in town and from all of the 57 sites that we have, together with some representatives from other countries.

We are well pleased as a Commission to see such widespread attendance at this the first conference that has been organized on the security and safeguards issue—an area where perhaps not as much attention is focused, at least on the Commission's agenda or in the public's eye, as should be. We know it is useful and helpful for our purposes and we trust that you will come away from this conference with a feeling that it has been productive and helpful for your purposes as well.

Let me begin with a few remarks. As I say, in the midst of all the matters of which the Commission has jurisdiction, security and safeguards issues are topics that may not often seem to be the subject of much focus at the NRC. The Commission recognizes, however, that safeguards constitute an important part of our mission and are an important component of our ability to ensure that the public health and safety and the common defense and security are adequately protected from the potential risks posed by the operation of nuclear facilities and the processing and handling of nuclear materials.

Our sponsorship of this symposium further recognizes the responsibilities of both the Commission and the commercial nuclear industry to develop, implement, and maintain adequate physical security systems for the protection of public health and safety. The efforts that have taken place here over the past two days and are continuing today are a testament to the Commission's desire to work with the industry to maintain as high a standard as reasonably achievable for the protection of commercial nuclear sites.

In executing our responsibilities, we all recognize that a proper mix of safety and safeguards must be achieved. This is an issue that has been the subject of some considerable discussion within the NRC as well as within the industry over the past several years. Safety issues have at times overshadowed safeguards issues. However, we regard both safety and safeguards as vitally important in protecting the public health and safety. The consequences of an event are, after all, insensitive to whether the event was the result of a safety or a safeguards occurrence.

From a historical perspective, the safety/safeguards issue was studied a number of years ago at power reactors by a committee convened by then Chairman Nunzio Palladino, who was concerned that security measures might adversely affect plant safety. In his memorandum of July 15, 1982, to the NRC staff, Chairman Palladino wrote: "The Commission does not consider that the level of safeguards protection is too great for nuclear power reactors. Rather, the Commission is interested in a reexamination of the safety/safeguards relationship with the objective of determining ways of reducing the impact of safeguards on safety."

Overall, the committee that was tasked by the Palladino memorandum did not identify any clear safety problems associated with security requirements. However, it established that the potential for problems existed to varying degrees among various licensees. For example, a pipe break incident at the Surry Nuclear Power Plant in December of 1986 resulted in a previously unforeseen security access computer failure caused by steam entering a card reader. As a result, the key cards could not be used. The implementation of new regulations subsequent to that event, which require power reactor access authorization systems to accommodate the need for rapid ingress or egress of individuals during emergency situations or situations that could lead to an emergency condition, have resolved that issue.

The interface between the operations and security staffs was also an important issue examined by the committee. One concern in this area was that poor communication or the lack of information could lead to situations in which authorized work activities adversely affect either safety or security. As pointed out by the regional inspection panel on Tuesday of this week, this issue continues to be an area where we strive for improvement. The Commission continues to endorse the cross training of individuals in operations and security so that employees gain a better understanding of the practical problems and difficulties faced in the conduct of site activities. Indeed, the NRC can contribute to the solution of problems in this area by encouraging licensees' operation staff to participate in security conferences of this very sort.

Up to now we have been most fortunate that there have been no significant safeguards events at commercial nuclear sites that have adversely affected public health and safety. While this is directly related to the relatively stable threat environment in this country, it is my personal belief that the lack of significant events is also directly related to the overall caliber of individuals employed in both the private and public sectors of the commercial nuclear security industry. Inspection of the Safeguards Summary Event List published by the Nuclear Regulatory Commission indicates that events relating to equipment tampering, vandalism, bomb hoaxes, and firearms do in fact occur, and accordingly, proper attention must be paid to mitigating any consequences of these events and steps must be taken to minimize their occurrence.

The Commission recognizes, however, that some events may be beyond the control of a licensee. A good example is the Palo Verde incident, which occurred in 1986, where three of the four transmission lines that provided electrical power to the site were sabotaged. The licensee's investigation of this event revealed that the three lines had been shorted out deliberately at remote locations more than 30 miles from the facility. Because of the distances, timing, and actions necessary to short the lines that converge on the site from four different locations, it was believed that more than one

individual was involved. The FBI was notified and assumed jurisdiction over the incident. The location where these actions occurred and the lines involved were not subject to NRC security requirements. Nevertheless, the nuclear security community should be aware of the possibility of such activities and do whatever it can to minimize the susceptibility of nuclear facilities to such actions.

It is also important to emphasize that the safety/safeguards linkage affects safeguards in ways that may not be readily apparent. For example, the development of thermal neutron activation technology, or TNA, which was discussed earlier this week, brought with it to the NRC a need for both a safety licensing and environmental review because of the use of a radioactive californium-252 source as well as a need for a study of the new technology to determine any possible safeguards applications at commercial nuclear power plant sites.

In fact, some of the findings of the environmental assessment conducted as part of a safety licensing review may be of interest to you. On the basis of our staff's assessment, the staff has concluded that the environmental effects of normal explosives detection systems, or EDS operations, when located in the baggage ramp area of an airport, will be extremely small. For all radionuclides the maximum unrestricted area concentrations are calculated to be well below the maximum permissible concentrations specified in NRC regulations.

The environmental assessment thoroughly investigated potential exposure pathways to workers and passengers and concluded that after a minimum one-hour delay time, neutron activation of elements of contents in suitcases does not contribute significantly to natural background radiation exposure.

With regard to radiation doses to workers in operating the EDS system, there are three major pathways for potential EDS exposure. First, exposure during normal operation as a result of attenuated radiation penetrating the shield around the californium source in the immediate vicinity of the EDS and from handling the baggage that has been irradiated. Second, exposure with the source in the safe position during maintenance or to clear baggage jams. Third, exposure during source transfer operations to or from a shipping cask.

A conservative estimate for annual doses to operational workers would be less than 200 millirem from the direct radiation exposure. The estimated total effective dose equivalent rate from various sources of natural background radiation for the continental United States is approximately 300 millirem per year.

Potential radiation doses to passengers were also assessed by the staff. The two major pathways to the public during normal operations are: first, direct radiation exposure of passengers to beta or gamma fields from reclaimed luggage, and second, internal dose to passengers or other members of the public who consume food contained in the reclaimed luggage. The largest remaining exposure is from a 1-kilogram mass of various elements one hour after passing through the EDS or from indium-116 at .019 millirem per hour and europium-152 at .005 millirem per hour, both of which are very unlikely to be found in luggage. Neutron activation of elements in clothing, such as carbon, hydrogen, nitrogen, or oxygen, does not lead to significant amounts of residual activity in suitcases. Activation of the components of typical accessories is also very small.

On September 5, 1989, the Federal Aviation Administration published a final rule that would require each airline carrier, when ordered by the administrator, to use an explosives detection system that the FAA administrator has approved to screen checked baggage on international flights. Thus far the only detection system that the FAA has approved is the TNA Model EDS 3. An estimated 200 to 400 TNA devices will be needed to be licensed in both this country and abroad.

Currently the Commission is evaluating an amendment to FAA's license that would allow the use of those devices on the concourse or ticket level area of international airports. The environmental assessment and licensing review, including publication of the environmental findings in the Federal Register, is expected to be completed by the end of February 1990.

No discussion on the importance of security and safeguards and related activities would be complete without touching upon the NRC's role in international safeguards. U.S. policy that sensitive nuclear materials exported to other countries must be adequately protected against theft or sabotage by subnational groups, including terrorists, was established in 1974. The yardstick used for judging the adequacy of recipient countries' security was a 1972 IAEA, International Atomic Energy Agency, information circular entitled "Recommendations for the Physical Protection of Nuclear Materials," Info. Circ. 225. This document was later revised and published in 1977 by IAEA as Info. Circ. 225, Revision 1. These guidelines were prepared by international physical security experts, including a representative from the NRC and other individuals from the United States brought together by the IAEA.

Confidence that the physical protection afforded to U.S. origin nuclear materials in foreign countries is at an appropriate level is bolstered by our knowledge of how a recipient country has implemented its national requirements. This knowledge is obtained in part through country visits and other technical information exchanges. The country information exchange program conducted by individuals who have expertise in physical protection systems provides an opportunity for a discussion of how these guidelines are implemented at a representative site.

Because the visit is conducted at the invitation of the country involved and national sovereignty therefore plays an important role, it is conducted in the context of an information exchange with emphasis placed on observations of selected elements of the country's physical protection program. The NRC and DOE members of the visiting team work closely together on the planning and execution of the visits, with DOE having the lead in scheduling and arranging them. Since 1974 there have been 81 overseas visits to 41 countries by U.S. teams and there have been approximately 25 visits to the United States by reciprocal representatives of foreign governments.

In 1979 government representatives from 58 countries and one organization, EURATOM [European Atomic Energy Community], drafted the convention on the physical protection of nuclear material, Info. Circ. 274, Revision 1, dated May of 1980, which further increases the awareness of the need to adequately protect nuclear material worldwide. Each country that becomes a party to the convention agrees to ensure that, during international nuclear transport, nuclear materials will be protected at levels set forth in Annex 1 of the convention. These guidelines are based on and are comparable to those specified in Info. Circ. 225, Revision 1. The United States ratified the convention and enacted enabling legislation in 1982 with the convention going into effect February 8, 1987.

Public Law 99-399, the Omnibus Diplomatic Security and Anti-Terrorism Act of 1986, is a law with which most of you should be familiar. It is the enabling legislation that grants commercial power reactor licensees access to Federal Bureau of Investigation criminal history data for the purpose of employee screening.

This legislation also had an impact on international physical security standards by calling for relevant departments and agencies of the U.S. Government to review the adequacy of international physical security safeguards with special attention to protection of material against risks of seizure or other terrorist acts.

As a result of its study, the NRC staff came to the conclusion that although international safeguards are less prescriptive than domestic safeguards, their objectives are comparable to the performance objectives of NRC regulations designed to protect Category I amounts of strategic special nuclear material against risks of seizure by a small subnational group of potential adversaries, including terrorists.

The NRC report to Congress recommended actions to encourage the IAEA to reconvene a group of international experts to review the specific provisions of Info. Circ. 225, Revision 1, and concluded that it would be appropriate for the NRC, in conjunction with DOE, to conduct more timely information exchange visits to foreign recipients of U.S. origin nuclear material and to encourage reciprocal visits from these countries to the United States.

I am pleased to say that as a result, in part, of the U.S. efforts, the IAEA anticipates publication of a revised and strengthened international standard by the end of this year. One major aspect of this revision will be to encourage states to consult and cooperate and to exchange technical information on physical protection techniques and practices. The foreign trip program continues its vigorous schedule.

Let me conclude by saying that this symposium has concentrated on one highly important and visible element of nuclear security, and that is firearms and explosives recognition and detection. We must be vigilant, however, in recognizing that this element is but one component of a well-integrated comprehensive safeguards system. It is the safeguards system as a whole in proper balance with nuclear site safety that forms an important cornerstone of our ability to have adequate protection of the public health and safety and to ensure that the common defense and security are indeed protected.

This concludes my remarks. Before I leave, let me again thank everybody for attending this conference and welcome you and wish you a most productive conference during the remaining sessions today.

Thank you.

(Applause.)

Ms. Dwyer:

Thank you, Commissioner Curtiss.

We will now begin our session on metal detection. I would like to introduce Donald J. Kasun, Acting Chief of the Domestic Safeguards and Regional Oversight Branch of the Division of Safeguards and Transportation. He will present a briefing on the NRC's policy on weapons detection.

NRC Policy on Weapons Detection

Mr. Kasun:

Thank you, Priscilla.

As we did on Tuesday morning for the sessions on explosives, we will begin our briefing on firearms with a brief reminder of current NRC requirements for firearms searches at Category I facilities and power reactors.

The current requirements apply to all persons entering a protected area except law enforcement officers on official duty and DOE couriers transporting special nuclear material.

"All persons" means employees, operators, security personnel, management; it means visitors; it means NRC inspectors; it means NRC Commissioners; it means everybody.

Philosophically, that is a little bit different than the FAA system, which, at least originally, exempted airline employees and airport employees from the search function. They only searched the passengers or strangers or visitors. That may have changed because of an incident several years ago. I would ask the FAA speakers when they come here to describe to us what the current requirements are for searches at the airports. I still don't think they search pilots, for instance, whereas we search everybody.

The exemption there for law enforcement officers and DOE couriers did not always exist. Before the exemption there were some rather nasty confrontations between site guards and DOE couriers bringing SNM [special nuclear material] to the site. The couriers refused to give up their weapons, and they refused to be searched, and the plant guards, who had no discretionary authority not to search them, refused to let them on site.

Also, there were some cases of Bureau special agents coming on site, power reactor sites, for whatever reason. They also refused to be searched and refused to surrender their weapons. We recognized that we had a dumb rule. We changed it by license condition right away and then later on we changed the rule to exempt these categories.

The requirements cover personnel, hand-carried packages, delivered packages and material—except for certain categories of material. For instance, sealed foodstuffs. We don't want those opened. Fresh fuel coming on to the site. We don't want it opened up outside the site. That kind of thing.

The same way with construction materials. Those are exempted from the search although some other requirements apply to those.

All vehicles are required to be searched except for emergency vehicles entering the site. There we did it right. We had that exemption in right from the beginning. There are some other requirements we apply to emergency vehicles, though, for instance, recognizing the driver and escorting the vehicle when it is on site. But emergency vehicles are exempt.

Current regulations do not specifically require entrance searches for vehicles at power reactors for firearms, although they do require searches for any device that can be used for sabotage purposes. Certainly a firearm could be used for sabotage purposes, so it is included in there.

The search techniques that we generally require for personnel are electromagnetic portal devices. We do require equipment searches. Early on we allowed some pat-down searches, but we changed that. We require equipment searches. Hand-held and pat-down searches are for backup only and for alarm resolution when there is an alarm.

Hand-carried packages that are not metallic are subject to X-ray, otherwise direct observation. Our general guidance, if there is a package that is difficult to search and you can't search it with an X-ray system and you can't open it up, is to not let it on site.

Delivered packages to the site are searched either by X-ray or direct observation. Again, certain deliveries are exempted from that requirement.

Vehicles are searched by direct observation of the cab, engine, undercarriage, and the cargo compartment.

Our guidance with regard to testing of the firearms detection equipment at fuel facilities: Operational tests are required of each shift using a .22 caliber Triumph or equivalent held horizontally at the waist with three out of three successes. If the equipment fails to meet the three-out-of-three standard, it has to be taken out of service and some action is required. We are insisting on 100-percent detection in this case, or some action has to be taken.

A performance test is done quarterly. The .22 caliber Triumph or .25 caliber Best or equivalent should be used as test weapons. The equipment should detect 25 out of 28 trials for each weapon in seven different orientations four times each for a total of 48 alarms out of 56 trials. This is the minimum acceptable performance.

X-ray detectors at fuel facilities are subject to operational testing each shift using 24-gauge wire under step 5 of the ASTM [American Society for Testing and Materials Standard] 792–82standard wedge. Performance testing is not necessary if the above is done every shift.

I have some historical results of firearm searches conducted from 1976 to 1988. It does not include 1989.

Forty firearms were detected on personnel, thirty in vehicles. The numbers of firearms found on site, which means they weren't detected, were three on personnel and seven in vehicles. I would say that of all these, only three were intentional. The rest of them were unintentional. By the way, nowadays the drivers carry weapons in their vehicles, and they come up to the site and they forget to take them out or forget to declare them. But of all these only three finds were intentional. This was determined by investigations. The ones that were intentional were not brought on site for purposes of doing damage; they were brought on site to show their buddies that the system didn't work, et cetera.

So as far we know, there is no evidence whatsoever for either theft or sabotage purposes. We certainly miss some. This is the result of about a half a billion searches over a four-year period. Also, we have found out that probably 80 to 90 percent of these firearms were detected in the last three years. I don't know whether that means that more weapons come on site or our detection procedures are better, but most of this has happened recently.

For future direction, we intend to follow the FAA [Federal Aviation Administration] lead. When the FAA comes up with standard weapons and a standard test procedure, we are going to adopt it and at that time change our testing procedures. Also, we intend this year to develop a test device that the NRC inspectors can use as they go around doing their inspection to find out if the units are functioning properly.

That is a short description of some of our requirements. I think now we can go on to the technical discussion.

Ms. Dwyer:

Thank you, Don.

Next on our agenda is Special Agent Charles Demski from the Bureau of Alcohol, Tobacco and Firearms. He is Program Manager of the International Traffic in Arms Program at the Bureau.

The Firearms Threat—Statistics and Description

Mr. Demski:

I am Charles Demski. I am with the Bureau of Alcohol, Tobacco and Firearms, commonly referred to in the government as ATF. That is what I will refer to it as. Since most of you may never have even heard of ATF or know what our mission is, I first want to talk about ATF for a few minutes and then I want to talk about the types of guns that we are seeing today in international trafficking in firearms and the domestic firearms aspect. Then I will open the discussion for some questions.

I have brought along Bob Burrows. He is from our Firearms Technology Branch. He is one of our court experts that testify on firearms. You can come up during the intermission, look at the firearms that we are displaying here, and ask him or myself any technical questions or individual questions that you may have.

As I said, I am with the Bureau of Alcohol, Tobacco and Firearms. It is a bureau within the Treasury Department. We have a very narrow mission within the Treasury Department. We have a regulatory and a law enforcement mission. As such, we are divided into two primary directorates, an Office of Compliance Operations and an Office of Law Enforcement.

The Office of Compliance Operations is responsible for the regulation of the alcohol, tobacco, firearms, and explosives industry. They license each of these businesses as required by regulation; they inspect each of these businesses; they make sure they are in compliance with the law and the regulations; and they issue the regulations. They also are responsible for collection of all of the taxes on alcohol and tobacco.

The Office of Law Enforcement is divided into five divisions with 22 district offices throughout the country and 176 posts of duty. We currently have 1780 special agents assigned to those field offices.

The Firearms Division, of which I am a part, has a Firearms Enforcement Branch that is responsible for the overall monitoring and the creation and implementation of our bureau policy and the administration's policy as to firearms and gun control.

The Firearms Technology Branch, which Bob is part of, is responsible for classification and analysis of new firearms that come on the market and ruling on which firearms can be manufactured in a State, the way they can be manufactured, and the importation of firearms.

We also maintain, within our division, the National Firearms Tracing Center, which offers as a service to all law enforcement agencies anywhere in the world the ability to trace a firearm from the manufacturer to the first purchaser.

We have an Explosives Division that is responsible for the enforcement of the laws assigned to ATF, which are the Explosives Control Act and its corresponding arson statutes. They have an Arson Branch, an Explosives Branch, and a corresponding Explosives Technology Branch, which examines explosives, certifies explosive devices. When an agent in the field gathers evidence from a bomb scene, he sends that up to them. They recreate the bomb, put together a video of it, and prepare to testify in court from it.

As part of that division, ATF initiated in 1980 a National Response Team, which is a team concept for the investigation of major bombings and arson. We have four teams stationed throughout the country that are available to respond on 24-hour notice. We have had 215 incidents that we have responded to this decade. There has only been one related to the nuclear industry. We did respond to a fire at the Browns Ferry Nuclear Power Station in Alabama several years ago.

The team is composed of a team leader, a team supervisor, and 10 agents, all of whom have had extensive fire and explosives training, including a two-year program on cause and origin. We have a forensic chemist assigned to the team and an explosives specialist. Using this team concept, we currently solve 46 percent of the incidents that we investigate.

You may be asking yourself why I am bragging about a 46 percent resolution rate, but when you consider that the national average is only 6 percent, and that includes those who blow themselves up and those who burn themselves up trying to start the fire, that 46 percent does stand out and it proves that concept is a viable investigative method.

Over the past few years ATF has witnessed the evolution of several new trends associated with violent criminal activity and the individuals involved in such activity.

The enormous influx of narcotics being smuggled into the United States has created a highly lucrative market that is often fierce and deadly in competition. Law enforcement is constantly confronted with trends of increasing violence associated with the illicit narcotics trafficking. Hundreds of murders, kidnappings, and assaults have been directly related to the illicit narcotics trafficking, and the trend is clearly on the rise.

Probably the most alarming trend in the violent criminal activity in America is that law enforcement is being outgunned by the criminal element. ATF has observed that violent offenders are utilizing paramilitary weapons because of their concealability and their increased fire power. This increased fire power in the hands of violent offenders and narcotics traffickers poses a significant threat to law enforcement.

When I began my career in 1971, the Gun Control Act of 1968 had just been passed and it was passed in response to the Saturday night special, those little six-shot, cheap revolvers. That was the threat 19 years ago. However, now the threat is the type of weapons that I am going to show you on the slides and the type of weapons that we have displayed up here. The Saturday night special is hardly even manufactured anymore in the United States. There is now increased firepower and concealability.

What I want to do now is show you some of the slides and talk about some of these weapons.

(Mr. Demski's slides are contained in Appendix A.)

All of the weapons are not necessarily being observed in crime in the United States, but they are demonstrative of the type of weapons that are being developed and where the trend is.

The first weapon is an Uzi in the configurations that we see them in the United States. They are primarily semi-automatic. With the replacement of certain parts and the bolt, it becomes a machine gun. The weapon on the top has had the barrel—you can buy barrels that are precut and it just screws into a flange on the front. That is actually illegal. The law states that the weapon must have at least a 16-inch barrel. That is why the original weapon on the bottom looks kind of odd, but it does conform to the law and it has the 16-inch barrel.

The weapon is made in Israel and is imported into the United States by Action Arms in Philadelphia. It has the same qualities as the submachine gun that the Israelis developed and used in their army for a number of years. It is a very well-made weapon and very reliable. It is highly favored by the drug traffickers because of its firepower and because, as you can see, once you cut that barrel down and you fold that stock up, the concealability is there. It can easily be concealed beneath a topcoat or even a sports coat.

They also make a mini version which we classify as a pistol. It is a little bit smaller but has the same firepower.

This is another slide of the same weapon.

As I said, the Uzi can be converted to fire fully automatic. It is a little more difficult than some of the other weapons that are on the market. It does require the replacement of the bolt and some internal parts. We classify a weapon as a machine gun by the frame or receiver of the weapon, but we also classify a weapon as a machine gun if any combination of parts can be used to convert that weapon into a machine gun.

As you can see, at gun shows and in market trade magazines the parts are sold readily and openly. The dealers are not violating the law because they generally don't have all of the parts in any one place that are necessary to convert that firearm to fully automatic. You go to one gun show and buy the bolt and you go someplace else and you buy the parts. Once you have all that, then you are going to have a machine gun, but the individuals that are selling these type things avoid the law by just not selling the complete package.

This weapon is the AKS [the nomenclature used for AK-47 machine gun and similar semiautomatic type weapons]. This is the weapon that has made the news so much in the last few months. We do have one up here. Generically this weapon is just called AKS, which is a fully automatic machine gun. Similar weapons that are being imported into this country are generically called AKS weapons in that they are semiautomatic and are not converted to fire fully automatic.

They come in a number of different models. Generically we just refer to them as AKS weapons, but there are models 56S, M-76S, et cetera, depending upon where the firearm is manufactured. They are currently manufactured in Finland; they are manufactured in Egypt as Maadi; they are manufactured in China as Norenco and Polytech; they are manufactured in Israel as the Galil; and they are manufactured in Hungary. The fully automatic version is manufactured in all the Communist bloc countries, Cuba, and North Korea.

These guns come in a caliber 7.62, .223, and the 7.62 NATO [North Atlantic Treaty Organization]. They accept 20 round, 30 round, and 40 round magazines, and will accept a 75-round drum magazine. So it is a large caliber round; it is a relatively inexpensive weapon. It became very popular in this country and has a tremendous amount of firepower. Obviously this one is not concealable.

This is one of the versions of the AR-15. It is manufactured by Colt Industries. The AR-15 is a semiautomatic version of the M-16. It basically has the same mechanisms and it can be converted with parts kits. It's a .223 caliber, though some of them are manufactured in 9 millimeter. It is very popular among sportsmen and collectors, but unfortunately it is also equally popular among the narcotics traffickers.

In the International Traffic and Arms Program that I am responsible for, we see tremendous amounts of these being seized by the Colombian Government now and during their drug raids.

Some versions come with a collapsible stock, as this one has. Some of them come with a "sportirized" model.

I think Colt stopped manufacturing them.

Is that right, Bob?

Mr. Burrows:

Right.

Mr. Demski:

The patent has run out, so any company can copy them. There are a number of other manufacturers that are copying that particular model.

This is an AR-15 with an attached grenade launcher. This is the AR-15 up close. On the center right is the selector switch

This particular one has a selector switch that will go to all three positions, which makes it able to fire fully automatically. It has had the internal parts changed out.

Those internal parts that I am speaking of can be found at gun shows, flea markets, and in some of the trade magazines from the firearms industry. We run into the same problem that I talked about with the Uzi: If somebody has one piece, it is not necessarily a violation. It takes all of the pieces before we can go out and charge somebody.

Another advertisement for the AR-15 Auto Sear. That is such an integral part that we classify that part alone as the machine gun.

Isn't that correct, Bob?

Mr. Burrows:

Yes.

Mr. Demski:

This is an Ingram. Originally they were manufactured in this country as a semiautomatic version. As it turned out, of all the semiautomatic firearms, this was the most easily converted firearm to fully automatic. Ingram is actually the designer and they have been manufactured under a variety of names. Military Armament Corporation in Powder Springs, Georgia, manufactured it from 1983 to the present. R.P.B. Industries in Atlanta manufactured it from 1978 to 1982. Then the SWD Corporation picked it up and started manufacturing it. Plus they put kits in. The metal was all flattened out and all necessary holes weren't cut out in it, but you could also get the stencil to show you where to cut the holes. Once you cut the holes and folded that metal up you had the frame of a machine gun. All you had to do was acquire the other parts from the market and you had a machine gun. It is generally either .45 caliber or a 9 millimeter. Very high rate of fire, very popular among narcotics traffickers, and as you can see, very concealable.

It also is very well adapted to a silencer. You can get the barrels threaded to fit a silencer, as this particular model has.

This particular model is one from a case that we had down in Florida in which the individual was taking those type of weapons, attaching the silencer, rigging it inside a briefcase, and having a trigger pull attached to the outside of the briefcase to fire the weapon. He was selling several hundred of those.

These are the parts for a Sten gun. It is patterned after the British design of the Sten gun, which was very popular during World War II. There are not a lot of parts. They can be fabricated. We are now seeing that particular weapon being manufactured and sold in this country, oftentimes illegally. It is fully automatic, because it is a machine gun.

Again, you get the Sten parts kits. You can order the parts from the various trade magazines. As long as you don't get them all together you are in good shape. Once you get them all together, then you are in violation of the law.

The H&K is the Heckler and Koch Model 91. It fires a .308 Winchester. This particular weapon is not one that has been seen that often in drug trafficking crimes or in other crimes, but it is a very popular semiautomatic weapon. It is one that was recently banned in the import ban because they were being manufactured outside this country. It is basically a sporting version of the West German service rifle.

This is also an H&K. Again, it is not one that is particularly common in crimes here, but it is illustrative of the variety of the weapons. This particular one is mated at the factory with a silencer. It is not a real thick barrel. The silencer is actually manufactured with the weapon at the factory. It has either a fixed or a collapsible stock. It fires a 9 millimeter round.

This is the Styerof. It is manufactured in Austria and it was imported by Gun South in Birmingham, Alabama. It is one of those that is now banned from importation, at least until the lawsuits are over with, by the new importation ban. It fires a .223 caliber. It has a one-piece molded stock and is gas operated.

This is the KG-9. We have one of these up here also. It is not much bigger than a pistol. It has tremendous firepower. It is relatively cheap as firearms go. The original model of it was called the KG-99, which we had to classify as a machine gun because more often than not that is exactly how it fired. Certain modifications were made to the KG-99 and it was remanufactured and sold as the KG-9. It is very popular along with some similar models, the Tech 9 from Intertech. Very popular among drug traffickers. We see a lot of these picked up in South America that have been trafficked from the United States to Colombia and other drug trafficking countries. It is 9 millimeter.

This particular one is the M-60 machine gun. It is up here on the table too, and we will go over it. They are being destroyed by the military and being cut up and then some very industrious people are actually rewelding the parts back together and converting these things back to fully automatic fire and selling them illegally.

There have been some instances in the narcotics trade where these have shown up. They haven't been real prevalent on the criminal side, but there are increasing amounts of them out on the streets. It became very popular after Rambo carried it in "First Blood." All I can say is, having carried it in here, he's a heck of a lot stronger than I am, because that is a heavy weapon.

By the way, let me explain a few things about the Federal firearms law. These types of weapons, if they are fully automatic, are not necessarily illegal to possess. The law does allow possession of these types of weapons if they are registered with the Federal Government. These are the only types of weapons that have to be registered with the Federal Government.

If you go out and purchase a shotgun or a rifle or a pistol, those are not registered. You fill out a yellow form certifying you are not a prohibited individual. That form stays with the dealer and it is not sent to us unless that dealer goes out of business; then it is stored at an out-of-business records center for tracing purposes only. Any type of weapon such as a machine gun or a sawed-off shotgun—and the law really gets specific after that—mines, rockets, grenades, even if you manufactured a bomb—technically those types of weapons are supposed to be registered with the Federal Government.

That is one of the charges that we use in this type of violation, that the individual didn't have the weapon registered. Of course very few criminals or the people who acquire these illegally are going to go out and register them. So most of these weapons are illegally out there. If someone had one and he did have it legally registered, he can possess it with no interference from the Federal Government. There are some State laws that would prohibit it. New Jersey and some other States.

The law in 1986 prohibited any further manufacture of machine guns for domestic consumption. They can still be manufactured for law enforcement purposes or for sales to the military or overseas. So the law effectively froze at the 1986 level what was out there.

I think in 1986 there was something like about 200,000 weapons in the registry, most of which were machine guns. From the time the law was proposed until it came in effect on May 19th, I think we received another 200,000 applications to register machine guns. Some of those were rejected because we were able to prove they weren't manufactured, that they were only registering numbers and not actual machine guns. But the number is still up somewhere over 300,000 machine guns that are actually legally registered. A person can actually own one of these legally.

The arrows on this particular slide are pointing out the weld points. As I said, there are some enterprising people that collect this old stuff as scrap metal and weld it back together and assemble a working machine gun. Those arrows are pointing out the weld points. As you can see, they do a fairly decent job of welding it and restoring it.

These are pictures of the types of silencers that we are seizing now. The silencer problem is growing. Maybe you have the impression that this is kind of farfetched, James Bond, but actually it is not. There are quite a few seizures now of silencers. In fact, so much so that Congress changed the statute last year with the Drug Control Act. Now if you are found in a drug crime with a machine gun or a silencer the first offense is 20 years; the second offense is life in prison, mandatory, with no possibility of parole. So it has become enough of a problem with the drug traffickers that Congress has identified it and set the penalties that high, life in prison with no parole just for possessing a machine gun or silencer during a drug trafficking crime.

If they are good enough machinists, they can fabricate the tubes themselves, but they can also buy the tubes. It is not a crime to have a hollow piece of tube metal. They can buy the kits with the parts to assemble it. As long as they don't have all those parts together, they don't have the silencer. It is only when all the parts are put together that the person comes in violation of the law.

This is just an illustration of one of the silencers that is being used. To be effective it has to be on a semiautomatic weapon that has a bolt to it. If you see a silencer on a revolver in the movies, it is just for show because it is not going to silence a revolver.

This is just illustrative of how you can acquire the parts or these types of silencer parts kits. This particular silencer here is designed to go on the Ingram models that I showed you earlier.

This is a departure from the firepower side of the firearms to the concealability side. This is wallet gun. It is also illegal if it is not registered. It is in the "any other weapon" category. It is nothing but a two-shot Derringer concealed in a wallet.

This is a small revolver that is concealed in a pager. We call it a pager gun. You carry it just like you would a pager on your belt and you are easily armed.

These have been favorites for quite sometime. Obviously it is a one-shot deal, so it is not anything for firepower. We call them pen guns; this particular one is housed in a tire pressure gauge. It will generally fire a small caliber, a .22 or .25, no more than a .32 caliber round. It is only good for one shot. If you do that right, that's all you need.

This weapon is the Taser that got a lot of notoriety a few years ago. It fires a barb that is connected by an electrical wire back to the main mechanism and a very powerful electrical jolt is sent through the wires to the barb. It stuns the individual and knocks them out for a period of time. This is the same thing, another view of the Taser.

This is the Glock-17. It got a lot of notoriety, probably unjustified, during the era when we talked a lot about plastic guns and their ability not to be detected by any of the metal detectors that are out there. Actually, there really isn't any such thing as a plastic gun.

The frame of this particular gun has a composite material in it, but the slide and the barrel and the internal mechanisms are still steel. It is just as detectable as any other firearm. It fires a 9 millimeter parabellum and it is 17 shot. It is manufactured in Austria and imported by Glock in Smyrna, Georgia. It has been adopted for use by the Austrian armed forces.

The Undetectable Firearms Act, which was passed last year, requires ATF to develop an exemplar that must have in it 3.7 ounces of metal and PH-17 stainless steel. That 3.7 ounces is now the minimum standard by which every firearm must be measured. This one more than exceeds that.

In fact, there is only one weapon that is even close to the minimum, and that is the little Freedoms Arms firearm, which was the one, I believe, in the pager firearm. That is the only one that is even close to the minimum content of metal.

We had to also run studies with the existing metal detectors, and all of them that we tested will detect the

3.7 ounce exemplar. That means that there is really no firearm that can be manufactured now that is not detectable by the metal detectors that you use in your industry and that the airports use.

As the technology is developed on these metal detectors to a greater ability to detect metal and to distinguish from other innocuous objects in your pockets, such as keys and pocket change, then the Secretary of the Treasury can lower that 3.7-ounce minimum content. So conceivably over a 10-year lifespan of the law, 8 years from now we could have an exemplar that may only have two ounces of metal in it, but that can only be done after the technology is in place to detect that weapon.

What I am saying is that any weapon out there right now is detectable by the technology available.

This slide shows you the trend in shotguns. No more of these one-shot ones that you used to shoot birds with when you were kids. The top weapon is a Striker. It was developed in South Africa, and since we did not permit the importation of the weapon, two companies were set up here in the United States to manufacture it. That rotating drum holds up to about 28 rounds of 12 gauge. It fires just like a semiautomatic weapon, but it is firing a 12-gauge shotgun shell each time with a case of number 4 buckshot. I guess that is around 28 pellets per round. It very quickly fires those 28 rounds.

The bottom one is just a Spaas shotgun. A lot of shotguns are going to this paramilitary look, with the collapsible stocks.

I just want to talk for a minute or two about the trend of the firearms or the future of the weaponry. There is a tremendous amount of research being done right now to design the weapon of the future. Much of that is being spurred on by the U.S. Army and its competition to replace the M-16, because that is basically a Vietnam-era weapon. It has been around approaching 30 years and they are looking to replace it.

There are basically two prototype weapons that are being designed now to do that. One fires a dart, or what they call a fleshette. It is nothing more than a thin strip of metal that is just exactly that, a dart, but it is firing that fleshette at over 5000 feet per second. That is much faster than the present day bullet. At that speed it can penetrate almost anything.

Currently both Styer Manlicker, an Austrian company, and AAI, a Maryland (U.S.A.) company, are developing weapons to fire the fleshette. The Styer weapon is 30 inches long with a space-age design similar to the Styer Aug that I showed you. Those darts are only 1-5/8 inches long. The AAI weapon that is being designed in Maryland is basically along the traditional M-16 lines, but it will fire the dart also.

H&K, the German company, is designing a weapon that will fire caseless "ammo." Instead of having these brass shells, which actually slow down the mechanism and the firing mechanism, they developed a caseless ammo in which the propellent is actually the case; the actual bullet is contained in the center of the round and the propellent surrounds the bullet. Then there is a small booster in the base of the bullet. The primer sets that booster off, which pushes the bullet on down the barrel before the main propellent is ignited. Everything is consumed in the actual firing process so there is no need for an extractor and no need for all the mechanism to get that casing out of the gun, which gives it an increased rate of firepower.

Colt is working on a refinement of the M-16, which would fire a duplex bullet. Each cartridge would have two bullets in it. The first bullet would be partially down the rifle barrel before the second bullet went out. So you have one bullet following one bullet to the target. They are going to hit several inches apart, but that would compensate for the error of any soldier or any person aiming that weapon. Two bullets striking the target are more likely to do some damage than just one bullet striking the target.

That basically is where the trend is going in the future, to design not smaller or more concealable weapons such as the plastic weapon, but actually to change the ammunition that we are using.

I am going to open it up now to any questions before we break and take a look at these weapons. Are there any questions that I can address specifically?

Participant:

What is the law on silencers not used in drug trafficking? Can you own a silencer as a citizen?

Mr. Demski:

You can own a silencer. When the law was changed to limit machine guns, it did not include silencers. Silencers can still be manufactured if the applications are filed and the tax is paid and they can still be registered to an individual.

Participant:

You mentioned that there were 300,000 registered weapons or machine guns in the United States.

Mr. Demski:

It is somewhere in that neighborhood. We had around 200,000 and then there were 200,000 more applications, but we bounced a number of those. I don't have the exact figure, but it is somewhere around 300,000.

Participant:

With approximately 300,000 machine guns registered in the United States, how many have been traced back as used in an actual crime?

Mr. Demski:

Of the registered types?

Participant:

Yes.

Mr. Demski:

There are relatively few that are registered that turn up in crimes. When an individual applies to get one registered, he has to submit a photograph, fingerprints, and a criminal record check is done before that application is approved and sent back. Of the actual legally registered ones, very few of those turn up in crimes. The ones that turn up in crimes are the unregistered ones.

Participant:

Of the unregistered ones, what percentage actually are part of the violent crimes being committed?

Mr. Demski:

I would have to research that one for you. I don't have the statistics on that. It would be very difficult to give you that statistic. We trace 60,000 firearms a year for law enforcement officers, but we have no idea what the total number of firearms that are seized in crimes are in this country. ATF seizes about 2000 machine guns a year, I think. DEA [Drug Enforcement Agency] seizes several thousand machine guns a year. What that represents as to the total number of firearms seized in the United States, I don't know, because nobody collects that statistic.

Participant:

Of the weapons that are used in crimes, how many are machine guns?

Mr. Demski:

Again, I don't know how many weapons are actually seized in crimes in this country because there is no central collection for that statistic. We trace on behalf of law enforcement about 60,000 firearms. The total number could be 500,000 actually picked up by the police. I don't know. That is not a statistic that is collected anywhere that I am aware of.

Participant:

Thank you.

Mr. Tobin:

I don't have a question for you, Charles. It is more of a question for the folks in the audience. I'm a regional inspector out of Atlanta. Bill Tobin is my name.

I am wondering if the utilities and any of our licensees are experiencing a problem with getting parts. I am told that with the 1986 importation ban some of the folks who have H&K semiautomatics, for example, are having problems with barrels, magazines, and in some cases, magazines in excess of 15 rounds.

I am sort of priming the pump right now. I am wondering if any of you folks are having that problem. Maybe now is a good time to discuss it. I am told some of you are.

Mr. Demski:

Before they answer your question, there was no 1986 ban on the importation of those weapons. That ban only occurred this year. It was a ban on certain of the H&Ks but not all of the H&Ks. The 1986 ban was on the manufacture of any additional machine guns for the civilian market.

Mr. Tobin:

So there is nobody in the utilities having problems getting parts for any of these weapons?

Participant:

In response to Bill's question, we are also having a problem with the H&K model 93. It is getting more and more difficult to repair and get replacement parts. We have been able to maintain them so far, but in the future I am not sure what we are going to have to do. Replacement parts are getting more difficult and the repair is getting more difficult.

Mr. Demski:

Perhaps Bob might have some solutions for you at the break, since he is in the technology end of it, as to sources for those parts. I can't help you much on that.

(Applause.)

Ms. Dwyer:

Thank you, Mr. Demski.

Now we will break. If you would like to come forward and look at some of these weapons and have some discussion with the people from ATF, please do so.

Ms. Dwyer:

Our next speaker is Dr. Lyle Malotky. He is the Manager of the Aviation Security Technology Branch, Office of Civil Aviation Security, Federal Aviation Administration. In this capacity, Dr. Malotky is responsible, among other areas, for oversight of security R&D [research and development], explosives detection, K-9s [canines], and aviation explosive security. His topic this morning is the FAA's weapons detection development program.

Weapons Detection Development

Dr. Malotky:

Thank you.

There are many conflicting demands in any sort of screening operation. You have people that you need to move into your nuclear facilities. I have to worry about moving people through the airports. When you are screening someone for weapons, you really have to balance the competing, conflicting demands of speed, detection, and false alarms.

Processing speed is important. We would like a system that is infinitely fast.

It goes without saying that safety is important. Whether you are looking for weapons on people or weapons or other things that may be in hand luggage.

Detection and false alarms are a trade off.

Finally, we need versatility in our detectors. You can't afford to have a system that is going to be optimized to deal with one threat at the expense of letting some of the other threats pass through.

Let me talk about the general problems of detection. Let me conduct a little experiment and get some audience participation. I would like you to all stand up.

All of you who have ever played golf and lost a golf ball more or less in the middle of the fairway can sit down. All of you who have used a word processor, done the spell check and still had mistakes in the document when you were through can sit down. All of you who have ever gone to the market, bought a piece of produce, taken it home, and had it not live up to your expectations can sit down.

(One person remains standing.)

I think this gentleman in white is really the one I should talk to because he doesn't understand what the detection problem is all about. All the rest of you understand what it's about. There are things out there that look like what you want to find but really aren't what you want to find and there are things out there that you want to find, like that golf ball, that you just plain can't find for some reason.

[Mr. Malotky's slides are contained in Appendix A to this report.]

I have plotted signal strength increasing in this direction and some measure of occurrences here. This is a simple chart. It is the ideal performance of a metal detector; it is ideal performance in finding a golf ball; it is ideal performance in finding typographical errors. When you "spell-check" a document, sometimes you find words that you know that the computer's spelling dictionary doesn't know. The computer calls it a mistake; you know it's right. That's a false alarm. Sometimes you may use a word wrong. The dictionary recognizes it, but it is not the proper word in that place in the sentence. That's a missed detection.

Ideally all of the clean people look like this. They give a certain signal to your detector, whatever the detector is. This is the frequency distribution of the signal. If this person is carrying a small weapon, like that North American Arms mini revolver, or a Derringer, they give a different signal, which is a composite of the signal from the clean individual and the signal of the weapon. Likewise, if they are carrying that Uzi or large weapon, you get a much bigger signal. If you set the set points of your detector at this point, all of these people are going to be identified as clean and all of these people are going to be detected. As I said, this is the ideal situation.

Unfortunately, Mother Nature doesn't have square corners. I see her a little more as an earth mother, on the rounder side. This is what our problem really looks like. This is what all clean people look like because somebody is carrying keys, somebody has change, somebody has jewelry, somebody has a watch, and somebody has steel shanks in their shoes. The more junk a person has, the stronger the signal is going to be on the metal detector, and that signal is going to continue to march off in the direction of an alarm.

Unless you are operating in a situation where everybody comes through in paper coveralls with no jewelry, you are going to have some overlap. At least in the airport case we have overlap. When you travel, you have a lot of things with you. This is what makes the problem difficult.

If we look at this ensemble of people and we give each of you a North American Arms mini revolver, we now have a new distribution curve. You see all the things that you normally have, but now you have an extra contribution to the signal.

I think this afternoon Lyle Porter is going to talk about how all of these machines work. I don't want to and would not attempt to preempt him on that. We are just thinking right now about the general philosophy of detecting anything. It really holds if you are worrying about finding folks coming over the wire into the back part of your facility as well. Sometimes you are going to see them and sometimes you are not. I think that is a fairly difficult concept for a lot of people, myself included, to recognize. So please bear with me.

Let's say our threat is just a large weapons set. That would be the peak on the far right. That is pretty simple. Because lo and behold, the metal detector does pretty well separating the clean people from the people with weapons.

If we want to complicate the problem, however, we start giving these people the small weapons. You can see that no matter where we set this set point we are going to end up with missed detections, which is this whole area underneath the curve.

If we say, "I can't tolerate these missed detections"; then fine, we redraw the line. If we redraw the line, we don't have those missed detections, but lo and behold, we are going to have an incredibly high number of false alarms. If we have enough false alarms, our screening people are going to have to resolve them by hand searches or hand wands or whatever, and then the effectiveness of that system is going to begin to be degraded, because the people who are resolving these nuisance alarms will not be expecting to find a threat, and they only find what they expect to find.

This is really the problem that we all have to deal with. How do we go about solving this problem? We have about three or four things we can do.

We really want to make things look like the first viewgraph. How do we go about doing that? We go about doing that by dramatically increasing the quality of the equipment that we have. The reason we have this distribution is that things that we are not looking for are contributing to the signal.

The ideal situation is to narrow the distribution. We found that the newer versions of metal detectors that use digital signal processing and so forth, tend to be heading more in this direction. We can change the equipment. I mentioned before, we could have people walk through in paper coveralls with no jewelry or money or keys.

The other thing to do is change the weapon. If you are only looking for a large threat weapon, then you are okay. If you are looking for smaller threat weapons, or if as the Marshal Services does, for example, you want to stop the assassination of one specific individual in a specific location, then you need to find a small gun. Then you have a real problem.

We really have mixed feelings in the FAA about the effectiveness of that North American Arms mini revolver as a hijack weapon. If you are going to be an effective terrorist, you have to somehow strike terror in the hearts of your victims. Those of you who came up and saw the display that the ATF brought, know what I mean; it may be difficult to terrorize someone with a weapon that doesn't extend outside your hand. A shotgun or whatever looks much more impressive as a terrorist weapon.

You have to decide what it is that you are trying to detect. If you want to detect something that is smaller, then there is a price that you are going to pay.

I would like to talk about the FAA's existing program to put things in perspective. Our business is different than yours. We are concerned with the movement of people around this country, and in the process, screen the half a billion or 600 million people who fly every year and go through our security check points. We have about 1400 metal detectors and associated X-rays in the United States.

In the process of screening about one billion people per year—because you screen "meeters" and "greeters" and you screen staff and everyone else and sometimes you screen passengers a couple times—we have found about 3000 handguns per year. About 95 percent of these were found with the X-ray. Over half of the weapons were loaded. Of the remaining ones, well over half of the individuals possessing the weapons had easy access to ammunition.

I just looked at the data that we have from the last quarter out in the southwest region, which shows that during that time about 150 handguns were found. The most sinister thing is that 53 percent of them were carried by women—not your typical hijacker. Indeed we arrest about half of these people. We have civil penalties brought against the other half.

So we have a system that is being challenged fairly often. Probably, in most cases, not by people that are planning on doing harm. Yet at the same time, we don't want to have these handguns aboard our aircraft.

This is what we don't want to happen. We don't want security to be so offensive, so time consuming that it affects the way that we live here in the United States. I think we take free and open travel for granted. I think if we had to show up two hours early to get security checked to take the shuttle up to JFK that we would find that the bad guys have won; they have changed the way that we do business in the United States. To preclude them from doing that, the FAA has been doing some research and development.

We are looking at automated X-ray screening. We have "screeners" who have to look at X-ray images of a billion pieces of carry-on luggage, over the length of a year, and the expectation of them actually finding a handgun is fairly low. Probably they have to look at a third of a million bags before they actually see something. There is not a very high expectation of seeing something. So we need to, using today's technology, augment their performance by some computer automation. Computer automation may be fairly close for looking for handguns. It may be a much more difficult problem if we want to look for something as nebulous as explosives.

We obviously want to improve metal detector performance. In this country it is not too bad where they are currently set. Nuisance alarms probably aren't that high, 5 or 10 percent. I have some bad news for you, though. It's going to change. I will get to that in a few minutes.

We need to improve metal detector performance. At the direction of Congress, and really at our own suggestion as well, we are doing research and development in the detection of nonmetallic weapons.

How do we do automated X-ray screening, and why is it a problem? It's a problem because you have overlapping images. To illustrate that, with the projectionist's tolerance, if you could take all of the viewgraphs that are on the floor and place them on the screen at once. All of the information so far as overlapping images is still there and you could read it, but it is a matter of separating the signal from the noise, the information you are looking to find. That is, is that a handgun in there? Is that shielding material in there from somebody's briefcase, tool kit, lunch box, or whatever? This is what we mean by overlapping images.

We have problems with weapon orientation. A handgun is fairly easy to recognize on an X-ray if you put it in the classic presentation where you can pick out some of the salient features, the trigger guard, the barrel, the grip that is at a fairly characteristic angle. But if you stand it on edge so it looks like a bar, it doesn't look nearly as ominous.

We have weapon types. You saw some here. Some can be very small, much smaller than some of the other clutter that you would have in your bags.

Finally, we have the problem of disassembled weapons. You can take a weapon apart, scatter it around a case, or in the case of the Glock-17, as I guess Jack Anderson did when he brought it into the Capitol—Jack probably carried the nonmetallic components on his person. At least if I were going to try to do it, I'd take the metal parts and put it in with the TV camera. With a cursory examination and running the TV camera through on the X-ray you'd never see it.

You've got to know exactly what to look for on that Glock. You can find it on the X-ray, but it is a problem. It is nearly impossible to disguise that opaque seven-by-one-inch rectangle, but at the same time, if you give your screener enough other confusing things to look at, he's going to tend to ignore it because the gun bell does not go off in his head—a difficult problem.

What have we done so far in automated X-ray screening? This is an area that we have been funding for a couple of years. It hasn't moved along quite as quickly as we would like.

We have a couple of approaches we can use. You can have a large library. You saw a number of weapons laid out on the table and on the screen. But if you could imagine what a library of all possible threat weapons that were coming through your facility would look like, that would be a pretty large library, particularly if you would then want to rotate this library on all axes and try to make a match comparison with what that X-ray looked like on the screen. I think that is something where a human being may do a much better job than the machine, at least taking this approach.

Fine. How does the human being work? I gave you a clue before. You may disagree with me and you may not. You look for critical elements. What elements do weapons have? I think all of these things that were here on the table and probably most handguns, at least that we are familiar with, have a few critical elements. Most of them have trigger guards, although a few of them don't. All of them have a barrel, which is usually two or three inches or much longer, and most of them have a grip, which is two or three inches at 90 degrees to maybe 120 degrees to the barrel. So there you have got some critical elements.

That suddenly becomes an easier problem. The machine takes a look and there are a couple of objects that are semiopaque and have a certain orientation to each other. If they are, then we will call that a weapon. Indeed, there is a firm that is using that approach.

Another simpler approach is to say weapons are X-ray opaque. Let's highlight anything that is dense enough to be a weapon. That perhaps has a higher detection probability. That is, if you have disassembled it, the machine may very well do sort of an integrated density, and if there are enough dense things in there or enough dense areas to give you a weapon component, we will call that a weapon. The problem with that is you are going to have a lot of false alarms because of all sorts of items that you carry in your briefcase, coins or whatever else, that will contribute to the density.

Automated X-ray approaches to weapons detection is an area that we are continuing to fund. I am sure it will pay off someday, but I don't think we are there today.

The gentleman from ATF made reference to the Undetectable Firearms Act of 1988. This act had some specific requirements placed on the Federal Aviation Administration, or I should say the Department of Transportation, as well as the Departments of Treasury and Justice. Fortunately, ATF had the problem of coming up with the exemplar.

What we had to worry about was to identify the state of the art in weapons detection equipment, walk-through metal detectors. We analyzed seven or eight current pieces of gear. We were able to find systems provided by four or five different vendors that met compliance with the law. That is, they would detect what we perceived the security exemplar to be.

That exemplar represents the North American Arms .22 mini revolver. We test these. Some of the units that we tested, however, would not meet the new standard or they would not detect the firearms that we proposed using as our new calibration weapons. Some of the old FS-2, FS-3 units would not be suitable. Most of the new digital technology, if you use it on the right program, will be suitable.

We had to develop a plan for implementing the state-of-the-art equipment and we needed to conduct research and development on the detection of non-metallic weapons.

It is the plan for the implementation that I will tell you about so you can start preparing yourself for how bad things are going to get in the future. Probably by April or June, in the largest airports in the United States, we will require that the metal detectors be set to detect the security exemplar and some other small weapons that we are including in our weapon detector ensemble.

If you went through the metal detector when you came here from your hometown and you didn't have to dump anything out of your pockets, now you are either going to have to start dumping things out of your pockets or there is about a one-in-three chance that you are going to cause a nuisance alarm. I don't think that is a good situation, but that is what we are going to be forced to do to keep these smaller weapons off the aircraft. That means, you as an informed frequent flyer, will soon know to put all your "pocket clutter" in your briefcase and waltz right on through.

So I think it is a solvable problem and the way we are going to solve it is twofold. I saw representatives here from a couple of the metal detector manufacturers. I am sure they are continuing to conduct research to come up with the technology that is going to help narrow up those distributions that I showed you. We are going to modify what our passengers look like by educating them. That will help to narrow it up, but there still will be some false alarms.

What does a security exemplar look like? It should be 3.7 ounces of 17-4 PH stainless steel. That is what Congress told ATF. It should resemble a handgun that weighs 3.7 ounces, which just happens to be what the North American Arms .22 mini revolver weighs.

The philosophy of the bill was to not exclude any existing weapons. All future weapons need to be as detectable as this particular exemplar.

This is the new FAA calibration set. I know there is a fair amount of exchange between NRC and the FAA. This is something that you may want to consider, but I wouldn't necessarily recommend it. The way that you calibrate your metal detectors is a function of what your threat is. Your threat may not be the same as ours. The people that are coming in may not look the same and what you are trying to stop may not look the same. You may say—and I could easily convince myself if I were in your shoes—that a two-shot Derringer is not a threat to my facility, that a mini revolver that is only this long is not a threat to my facility.

If your decision makers can convince themselves of that—and I think it is probably a good decision—to say this isn't really a threat for them, then I wouldn't recommend that you change how your metal detectors are set. If, however, you wish to change it, then I would recommend that you go to an ensemble like this. Not necessarily this set. Pick your own set, but you need to go to a variety of metals.

Back in 1972 when the FAA first started using metal detectors in airports, or requiring them, we picked some weapons from the small end—Saturday night specials, primarily. The ones that we ended up with were all made out of zinc alloy. It poses a problem, because as the metal detector development has become more and more sophisticated they can fine tune a metal detector to detect a specific metal. The problem that this is going to cause for all of us is one of suboptimization. We can't afford to use a metal detector that does very well detecting that 17-4 PH stainless steel, does very well in not having nuisance alarms, but lets through much larger weapons made out of other materials.

Sandia National Laboratory experts helped us develop a set of calibration weapons. Lyle Porter may talk about that as well. What we have tried to do is to cover the waterfront as much as possible. The most difficult weapon to detect for most metal detectors at most settings is the stainless steel .22 caliber mini revolver. The one we are using is actually the long one, which is about 4.4 ounces. The aluminum .380 caliber derringer. If you haven't seen one of these, run it through the X-ray. It is pretty impressive. The barrel and so forth is actually fairly difficult to see. The most striking image on that particular weapon is a steel spring in the back strap. Finally, the zinc Raven Arms .25 caliber automatic, again, on some of the settings this weapon may be difficult to detect as well.

So be aware of this if you are changing detectors, both policymakers and buyers, make sure that the detector that you are buying will deal with a variety of threats. It is easy to get into a suboptimized condition. Some of these new metal detectors may have 100 different programs to choose from. Some of those programs may be appropriate for heavy metal shielding, some of those may be appropriate for precious metals, and some may zero in on stainless steel. Probably none of those would be good if you want to monitor people coming into your facility. You need to work with the metal detector developer to come up with the right profile for your particular threat.

Since about 1986 we have been doing research and development in the detection of nonmetallic weapons. This is one of the few areas where we are in a preemptive position. That is, nonmetallic weapons don't exist. There is some question by some experts whether they ever will exist.

With the amount of press that the Glock-17 received, with a company down in Florida that claims it is on the verge of making a nonmetallic weapon at any moment, all of the publicity, the testimony on the Hill and so forth, we said, "Well, maybe the nonmetallic weapon, particularly if it would be carried on someone's person, is something that we should worry about." We feel quite strongly that if they are in carry-on baggage and you run them through an X-ray, they will be visible, because that part of the weapon that is designed to take the high pressures of the breech is going to have to be substantial, made out of plastic, or more likely made out of ceramic, and we feel that it will be X-ray opaque. So there will be something there for us to detect. Probably a more difficult problem, but a similar problem, to finding the Glock-17 on the X-ray. The grip is fairly difficult to see, but the barrel where the high pressures are will be fairly easy to see.

On the other hand, if you are carrying this on your person, tucked in your belt or whatever, you could walk right through a metal detector. That causes us problems, because we don't want a number of these weapons "flying around" without our permission.

What have we looked at? We have looked at several things that haven't worked. We have looked at infrared imaging. It sounded great at the time and there were some apocryphal stories about how well it worked, but if you think about it a little more, one of the reasons people wear clothes is to prevent the traverse of infrared radiation. You want to stay warm; you want to keep this radiation that is here from getting out into the great out of doors. Lo and behold, if you put on a couple layers of wool, you couldn't see a simulated plastic weapon.

We looked at acoustic imaging. That did not work very well because you didn't get good acoustic penetration through a couple layers of clothing.

We finally are looking at a couple approaches to millimeter wave imaging. This is something that you may be familiar with from other applications. It is used in the military. I believe it is used in intrusion detection as well. This should have the potential of being real time or near real time. We currently have research underway with a couple of vendors.

A concept of operation would be to illuminate the individual with millimeter wave radiation and look for the back scatter off anomalous objects. It would probably have to be on both sides. This is certainly not an ideal situation, because any source of anomalous objects that you have in your pockets, like your wallet and keys, calendars, whatever, will give you back-scattered images as well. So we are probably going to have a semi-automated system to do this anomaly resolution. The system has the potential, we feel, of making the detection. At the same time, both approaches that we are pursuing look like they will cost about a million dollars a copy, which is not the direction we want to go if you are talking about covering 1400 airport screening points.

The nice thing about millimeter waves is we are going to be operating at very low power levels and they are not reflective from the skin. Since it is not reflective from the skin, it does lend itself well to automated triggering, because if you walk through and you are not carrying anything on your person, then the sensing system basically receives no signal. It is only when you do get a signal that you need to worry about its resolutions.

That is all the prepared text that I have. Does anyone have any questions?

Participant:

On the millimeter wave imaging, I was wondering about public acceptance problems, the health effects problems, or is the power level so low it doesn't matter?

Dr. Malotky:

The question related to public acceptance problems, health effects problems with the millimeter wave imaging.

I was told by the developers, and indeed I am easily fooled because I don't understand some of these things, that if you lay out on the beach in Miami you get a higher dose of millimeter wave radiation coming from the sun than you would get walking through this particular system. It is a critical point. It is something that we need to worry about. I have been told that the power levels that we are currently operating at with both approaches are about tenfold below what the acceptable standards for public exposure currently are. However, it is a real concern.

Participant:

Does the FAA have a required training course for X-ray operators at airports?

Dr. Malotky:

Unfortunately, the answer is no. If I can digress for about a minute to explain how things work in our industry. The responsibility for screening passengers is that of the air carrier. The FAA is in a regulatory position. We specify the types of equipment that they can use. The air carrier then can basically pick equipment off our list that best suits his needs.

We have about 400 special agents in the United States that will periodically go around and challenge these screening locations and try to get weapons through either on their person or in carry-on baggage.

We do require a certain level of training, so many hours of training. We do have a limited number of training videos that I have made available to some of the folks at NRC. I am sure dissemination hasn't been total. We do require that the X-ray operator have detected all of the FAA test objects under operational conditions.

It is not an ideal situation, I will grant you that.

Any other questions?

(No response.)

(Applause.)

AFTERNOON SESSION

Mr. Burnett:

Next on our agenda is Mr. Robert Dube. He is currently the Chief of the Performance Evaluation Section in the NRC's Office of Nuclear Reactor Regulation. He is responsible for doing all of the RERs [regulatory effectiveness reviews] at the power reactors. He is now going to bring us up to date on where the NRC staff is, what it has found, and where it is going.

NRC's Regulatory Effectiveness Review Testing of Search Procedures at Nuclear Facilities

Mr. Dube:

Since there are a few people here who are not in the nuclear power reactor business, I want to start out spending just a few minutes giving folks a little background on NRC's regulatory program and how the RER program fits into it. NRC's regulatory program for physical security at nuclear power plants has always included several basic elements. These include a set of performance-oriented regulations, licensing review of a utility's physical security plan, and periodic inspections by NRC's regional offices.

The Regulatory Effectiveness Review program was created in 1981 by Bob Burnett to supplement the traditional regulatory program. An RER is a headquarters-based team inspection of physical security. RERs are currently being conducted at the rate of 14 reactor units per year and complement the more frequent regional inspections.

The purpose of the RER program is twofold: First, to ensure that safeguards implemented at licensed power reactors meet NRC performance objectives. Second, to ensure that NRC safeguards regulations adequately support those objectives. In addition to evaluating the effectiveness of physical security at a power reactor facility, we also review safety/safeguards interface to ensure an appropriate balance between safety and safeguards.

As Commissioner Rogers discussed in his keynote address, in the mid-1970's the NRC recognized that to ensure that safeguards meet performance objectives, it is necessary for NRC to provide a design-basis threat.

After extensive studies, a design-basis threat for radiological sabotage was developed and published in 10 CFR 73 [Title 10 of the *Code of Federal Regulations*, Part 73]. The characteristics of that design-basis threat include an insider in any position or several persons who are highly trained and motivated with hand-carried weapons and equipment, up to and including automatic weapons and explosives, with help from an insider. This design-basis threat is the primary benchmark used by an RER team in reviewing the ability of a licensee's safeguards program to provide high assurance of protecting against radiological sabotage.

To the extent practical, our reviews rely on performance testing of both systems and procedures. On Tuesday, Mal Knapp, the Region I Division Director with responsibility for safeguards, encouraged you to think like an adversary. That is exactly what we do in our performance testing. We frequently discover that licensees expect us to arrive in the dead of night, in blackout, trying to sneak into your protected area. That is not what we do. Our testing is normally conducted with full awareness of all security personnel potentially involved or affected by the evaluations. Although some limited testing of human performance does require withholding of information from some participants, all testing is done with full knowledge of the site security director and in the presence of at least one site security officer who maintains communications with the primary and secondary alarm stations.

Our team is typically on site for one week. A three-unit site normally requires nine to ten days on site.

The team normally consists of an NRC nuclear engineer who gets involved in the safety/safeguards interface review and who also gets involved in target analysis, which we do before coming on site. It also includes three NRC security specialists and three members of the U.S. Special Forces working under an interagency agreement with NRC. Currently two of the security specialists are from headquarters and one from a regional office.

The team members have extensive experience, including combat, and specialized training in all aspects of physical security and armed response. Most of the team members have received a week of training in access controls and search equipment at Sandia National Laboratories and have extensive experience in evaluating and testing access controls and search equipment.

The team evaluates all primary elements of physical security that are essential to protect against an adversary with the characteristics of NRC's design-basis threat. The systems and human elements tested include perimeter intrusion detection systems, alarm assessment capability, night lighting, armed response capabilities, weapons proficiency, and firearms and explosives search procedures. Although the team does not evaluate other programs, such as access authorization and fitness for duty, the existence of such programs is considered when judging the relative significance of team findings.

Evaluation of access search equipment includes an evaluation of the overall layout of equipment, procedures, and flow of people and packages. We then test specific pieces of equipment. This includes effectiveness testing of metal detectors, carrying weapons in various locations and varying our movement through the detectors. We typically perform these tests using the licensee's test weapons, such as a small .25 caliber weapon. We sometimes also use the licensee's duty weapon for additional testing. Pat Laird has already discussed some of these tests and in a few minutes we will show a video tape of some of the tests we performed.

We also perform operability tests of explosives detectors. Up to the present time we have conducted these operability tests using the licensee's test source. Obviously we don't want to run the risk of getting caught in an airport with a small quantity of explosives material, whether it is high explosives or low explosives.

We do two types of testing of X-ray machines. We first test the sensitivity of the machines using an ASTM [American Society for Testing and Materials] standard F792-82 test wedge. Second, we try several methods of passing weapons through an X-ray machine without detection. Some of these testing methods were also discussed yesterday by Pat Laird and some of them will be shown briefly in the videotape that we will be showing.

Finally, we observe pat-down searches and searches with hand-held detectors.

Normally in a presentation to a restricted audience, we provide detailed information on specific weaknesses that we have identified in some of the systems that we have tested. Obviously we can't do that in an open meeting. In every test that is included in this videotape the equipment successfully performed its detection function. Some specific pieces of equipment at some specific installations don't always function properly. If you haven't already done so, we encourage you to try some of these testing techniques on your own equipment.

(Video shown.)

As I have already indicated, we start out looking at equipment layout and general procedures.

We see a metal detector here followed by an explosives detector. As we pan around, you will see X-ray machines. Note the positioning of the security officer here right at the front of the X-ray machine. The importance of that will become obvious in a few minutes. Looking at the layout, we also look at things like the amount of space that you have on the back side after people pass through the detectors.

This is a different installation. Here we are going through explosives detectors first and then metal detectors. Note the position of the security officer at the desk. There are two X-ray machines at this facility. Both of them are in close proximity to his location and he can visually observe anybody placing objects on the X-ray machine.

We also look at the overall layout to see how much space you have to segregate people if an additional search is necessary. If you look right in the center, towards the top of the screen, that is a mirror so that the security officer that is operating the X-ray machine can also observe the belt and observe people placing objects on the belt.

Here you see a team member with a small weapon in his hand. He was carrying it through at his waist. Now he is going through with the weapon under his armpit. Now he is trying to swing it through the metal detector. This particular metal detector was functioning well. It detected the weapon during all of these tests.

Now he is placing it in his sock. Yesterday Pat Laird mentioned a kick-through technique that we use in testing. You will be seeing that in a few minutes. Here is a technique that the licensees use to help detect against somebody getting a weapon through with a kick-through. As you can see, a little ramp has been built to elevate the person into an area of the metal detector that has greater sensitivity. This worked quite well. We tried several different techniques getting through and nothing worked.

I am not going to provide detail as to which of these techniques tend to be most effective. The RER team is here, and during the break they can give you more details as to which of these things tend to work better. Some things work better on some machines than on other machines.

There are a couple of dots painted on the bottom of this metal detector. The licensee instituted a procedure for people to stop on those dots for one second. That solved the kick-through problem at this installation.

With explosives detectors, the only thing we are doing right now is operability tests. We are using whatever test samples the licensee has available. In this particular case, the licensee had placed a dynamite wrapper inside the pocket of a security officer's uniform shirt.

As you can see, we do a number of tests. Here is one of the security officers doing an operational test using a small jar of some type of nitrate material. Again, this system was functioning properly.

That's the step wedge that we use in testing X-ray machines. In the next scene, the step wedge does not show on the screen. The objects you are seeing there are things other than the step wedge. It was too thin to activate the beam. Now, when we place the step wedge on a box and send it through, you can see it. When we see this sort of situation, the next thing that we immediately check is whether someone could send a weapon through.

You just saw one of the team members trying to slide a weapon past the activating beam of the X-ray machine. This is something that Pat Laird mentioned yesterday. In this particular situation it didn't work. In a second you will see the weapon on the monitor.

Again, I would indicate that these tests don't work on all machines and they don't work at all installations.

We have a weapon placed in this box, testing for corner cutoff, which was something that Pat Laird discussed yesterday. Here is the fix that was made for the push-through technique. It is simply a barrier that was built on the front of the X-ray machine that prevents anybody from gaining the kind of access they would need to slide a weapon through.

We also observe pat-down searches and searches with hand-held detectors. A team member has just generated an alarm in the metal detector and is about to be searched by the security officer. This is one of the limited types of tests we do where the security officer didn't know it was a test. As I indicated earlier, however, somebody in the security force who was present knew that we were doing this. You can see the security officer detected the weapon that was tucked away in the sock.

These types of tests aren't unique to the RER program. They are also being used in some regional inspections.

(End of videotape.)

At some sites, fully searched people were co-mingling with people who had not been fully searched. This could provide the opportunity for an unsearched individual to pass contraband to a searched individual.

At other sites, we noted interference with proper equipment operation because of location. This has already been discussed in more detail by Frank Conrad for explosives detectors. Similar problems obviously exist for metal detectors.

We have seen poor sensitivity or resolution of all types of detectors. Also, detection by some equipment could be circumvented with special techniques. We have shown you some of the special techniques that we try. Finally, we have witnessed some poor pat-down techniques. Again, I have intentionally kept this very general.

We would be pleased to provide our licensees with more detailed information that could help them improve their programs. Dave Orrik and Mike Warren of my section have participated in RERs at 40 or more sites. They would be glad to share their knowledge and experience with you. If you have more detailed questions, I suggest you try to catch them during a break for a one-on-one discussion.

One of the things we do when preparing our reports is to categorize our findings by significance. To date we have identified significant deficiencies related to access controls that warranted prompt corrective action at only two of the 57 sites. At about two-thirds of the sites visited, we also have identified at least one weakness that was of lesser concern but that still warranted correction. At about 20 percent of the sites, we identified at least one notable strength related to access controls.

What does this mean? Well, for one thing, a lot of people are doing a lot of good things. Also, obviously, improvements could be made. Remember Hugh Thompson's caution on Tuesday about resting on your laurels. As discussed this week, there are equipment limitations. The more you understand about these limitations the better able you are to compensate for them.

Finally, the frequency results are subject to change, for several reasons. Let me give a specific example.

Early in the RER program we became very proficient in testing perimeter intrusion detection systems and alarm assessment capabilities. Significant findings became dominant in these two areas. As time progressed, the excellent communications network between licensees led licensees who had not had RERs performed to take the initiative to apply lessons learned to their sites. As a result, licensee performance in these areas has become progressively better.

At a later date, we began to improve our evaluation techniques in the area of armed response. One of the things we did was to perform a target analysis before coming on site, and we asked licensees to conduct drills and tabletop exercises using several sets of targets. We also assume when we do these analyses that you have loss of off-site power similar to what almost occurred at Palo Verde.

Some findings in this area became dominant. Initially we identified the need for closer coordination between security and operations personnel to identify the most critical equipment from a saboteur's point of view.

We also identified the need for more realistic drills. For example, how effective would your response strategy be in the face of a determined violent assault by several persons with the type of weapons discussed today by Mr. Demski? Remember, these weapons fall within the scope of NRC's design-basis threat.

Again, performance improved as you shared lessons learned from each other. The last several RERs we performed showed that licensees had significantly improved their performance during drills or that they were in the process of implementing new programs that clearly were going to be more effective.

I am sorry Pat Laird had to leave early. He joked yesterday that we have been giving him some problems related to their capabilities in armed response. A few weeks ago we were at Quad Cities, which is a Commonwealth plant, and they did an outstanding job of demonstrating their armed response capability. We applaud this type of effort.

The RER program has been continually evolving. Our testing of access controls currently focuses on equipment rather than the human element. As Dr. Fetterolf of the FBI and Hugh Thompson discussed earlier, detection devices are only tools. People have to be properly trained in how to use them. We anticipate that our testing techniques, including those related to access controls, will continue to be more challenging in the future.

Thank you.

(Applause.)

Any questions?

(No response.)

Again, Mike and Dave would be glad to entertain any more detailed questions that you might want to discuss in a little more privacy.

Mr. Burnett:

Thank you, Mr. Dube.

I do encourage you to talk to Mike and Dave. They have done between them, I would guess, 70 or 80 sites. They know what to look for and can help you be prepared.

Continuing with our program, I would like to introduce Lyle Porter, representing Sandia National Laboratories. He will speak to us on metal detection equipment evaluation. Mr. Porter is actually retired from Sandia after 37 years with the laboratories. Very impressive credentials.

He has been involved extensively in the technology and the detection of contraband. He is currently a consultant to Sandia and is an adjunct faculty member of DOE's Central Training Academy.

Metal Detection Equipment Evaluation

Mr. Porter:

As far as being at Sandia for 37 years, what that means is I can think of a variety of answers and since I have retired I have heard them all. Some are good and some are not so good.

Before I start on the slides that I have, let me emphasize a couple of things Lyle Malotky talked about this morning. In my judgment, it was a very impressive presentation.

The first thing that stands out from that presentation is that it pays to think carefully about what threat you are interested in protecting against. For example, some people here have to worry about courtrooms. A very small weapon in the hands of someone emotionally aggravated at a judge can be a very lethal weapon in that setting. It might not be so at a nuclear reactor unless one of the scenarios you want to consider is that of taking someone in upper management hostage. But probably not much damage to equipment could be done with a relatively small weapon. So it pays to think through the threat, define it, and let people know what it is and why you selected that threat.

I now want to add to what Dr. Malotky introduced, that is, to talk a little bit more about the specifics of why metal detectors do what they do or what they don't do.

One of the comments made this morning is that there are no weapons out there that can't be detected by these metal detectors. Well, that is only true if you take certain things into consideration. Number one, you have to have the latest technology as far as equipment is concerned, and number two, that equipment has to be set up correctly. Otherwise at least some weapons may not be detectable.

So today, by way of outline, I want to talk about the details of the methods of detection. I will talk about some of the detector programs that were mentioned this morning and about some of the influences that affect detection. We did some metal detection tests at Sandia. I will outline those briefly and present some results. Then some of the things that people who use metal detectors ought to consider. Finally, some brief comments about standards and criteria.

In the early 1970's when metal detectors first became popular for use at airports to eliminate or to reduce hijacking, the primary method of detection used then was "continuous wave." It was simply a balanced circuit that caused an alarm when it became unbalanced. There is only one such metal detector manufactured today and it operates at 280 hertz.

[Mr. Porter's slides are contained in Appendix A to this report.]

Next came the pulse-type or eddy-current metal detectors. They are particularly important now because that is mostly what is in use today. I think probably in the NRC only pulse detectors are being used.

In case you want to make a note, the pulse rate of pulse detectors is from about 100 to 900 hertz.

Then finally, hand-held metal detectors, which I will only mention today, are continuous wave and they also use the unbalanced-field method of detection.

I don't expect you to appreciate all of this circuitry. The main thing I want to show with this vugraph [transparency] is the complexity of the continuous-wave metal detector. In this case, if you will notice, there are some nulling [null-current] circuits; there is a threshold adjustment; there are time-constant controls.

The problems that people had were, first of all, when components drifted they had to keep re-nulling [adjusting] the field. People also found that continuous-wave detectors were very sensitive to outside influences, such as having metals anywhere in the general vicinity, and so forth. People didn't like them very well because they were difficult to keep balanced and in control—although they could be made quite sensitive. Of course, the more sensitive they were the more those problems arose.

The next slide is a very simple illustration of how most of the metal detectors today work. This eddy-current method of detection came along as a replacement for the old continuous-wave or balanced-field metal detectors. They work simply like a transformer. If you notice the various windings: on the left is a battery and a switch, and that ties into what would be called the primary of the transformer, and then, in this particular viewgraph, the secondary of the transformer is hooked to an oscilloscope, illustrating the waveform generated as an output of the transformer.

Imagine the switch being closed and current flowing through the coil, but nothing happens because it is a dc current. If I now interrupt that flow of dc current, that is, when the switch is opened, the electromagnetic field of the transformer collapses. As it collapses, it introduces eddy currents that cause voltage to appear in the secondary winding in the manner shown on the oscilloscope.

All you have to do to understand how a pulse-type metal detector works is to imagine that the primary of the transformer is in one side of the arch and the secondary of the transformer is in the other side of the arch and the metal core is the weapon that you might be carrying. So what the pulse-type detector looks at is eddy currents as the field is turned off.

Let me talk a little bit more about what has happened with the detection process. When people began to use this eddy-current method of detection they realized that there were some things you could do to fine tune detection. So they developed a variety of programs.

The first eddy-current detectors developed had just a couple of settings. One was called discriminate. That setting was to detect weapons, but without detecting a lot of personal possessions. It wasn't very sensitive. The other setting was called the sensitivity mode, which sure enough was better at detecting weapons, but also detected a lot of personal possessions.

In the case of the present pulse-type, or eddy-current metal detectors, there are many program choices, but sometimes they offer more choices than I personally think we really need.

If you will notice, with the Outokumpu Metor 118 there is a high sensitivity, a normal sensitivity, and a low sensitivity as far as ability to detect is concerned. But there are about 16 programs. With each sensitivity setting one can also select noise attenuation; a normal or fast speed of the walker and various other things. Thus one has to be careful about what is happening when a specific program is selected.

Let me talk a little bit more in detail about how that programming works. This is a pulse train from one of the digital-type metal detectors. RC1 is the pulse spacing, or rate. For a few milliseconds to several microseconds the transmitter for the coil on one side of the arch is turned on (T_x). It is then turned off and another few microseconds pass (D_x); then the receiver is turned on (R_x). So the only time the receiver is looking at anything (when detection can take place) is during that very short pulse. What that means is you don't have to balance the circuity; you are not plagued as much with noise; and you have a very nice operating system that looks for eddy currents in that short period of time only.

This vugraph contains examples of eddy-current voltages produced by a metal detector when separately detecting copper [Cu], aluminum [Al], and iron [Fe]. Note the considerable difference in the characteristics of the iron curve as compared with the other two. Now imagine the pulse train presented in the previous vugraph. If the receiver was turned on at the same time for each of these curves, in at least one case detection would not take place. If the capability exists to change that receiver on time, which is the equivalent of selecting another program, I can then, by that selection, detect each object well. Or, as another alternative, I can select pulse times that allow the best average detection of all three metals with the same program.

In addition to the selection of programs, there are many other things that influence metal detectors: the type of metal, object size, orientation, and other features, such as the walker [person walking through the walk-through metal detector] characteristics. For example, the size of the walker, his/her velocity, position of the weapon on the body, and so forth. When Sandia did a series of tests on metal detection, it was decided to eliminate some of the walker influences because there was a lot of variation in those effects. You could have two or three different people walk through and get two or three different results. Sometimes, the results change from one walk to another with the same walker.

To do this, Sandia designed and fabricated a device that allowed us to run objects through the metal detector without the presence of a walker and without any variation. It turns out that the metal detectors are quite consistent during tests using such a device.

Also, of course, environmental characteristics influence detection, such as where you use a metal detector and how you install it.

In spite of all of these things, you can get a good state-of-the-art metal detector for about $5000. I personally think that's a bargain. It's a good piece of equipment for a fairly low amount of money and many of the negative effects, if not eliminated, have been reduced some.

The primary detectors tested at Sandia are listed here. The oldest model is the HS2S. The rest of them are rather recent designs, that is, state-of-the-art detectors.

Infinetics is the only company that now builds continuous-wave (CW) detectors. Sandia purchased a system from them that was modified so we could select any one of four operating frequencies. This was done to determine the effects of frequency on detection.

When tests were first started, we were not particularly interested in finding out which metal detector was best, nor were we interested in how well they detected weapons. We just wanted to understand what was happening, how these metal detectors worked, and what the primary influences were on their performance.

For test objects, several right circular cylinders were fabricated, with diameter and length equal. These objects were made from eight different metals and in five different sizes, as presented in this vugraph.

As an example of the size variations of these objects, which you will see later is important in detection, the lead cylinders ranged from about 1.5 to 3 centimeters while the aluminum objects went from about 2.5 to 5 centimeters over the 30–300 gram set.

Our first tests with the cylinders were to determine frequency effects. The Infinetics metal detector was utilized for tests at four different frequencies. It is interesting that voltages measured during these tests were approximately proportional to the size of the object, particularly when from the same material. Background noise was low enough so that only at the lowest frequency (280 hertz) did we see a significant enough level to prevent detection of the smaller objects. At higher frequencies, especially for the larger objects such as those manufactured from aluminum, detection was very easy to obtain.

This next vugraph presents test results of several lead objects using a frequency of 18 kilohertz. Some of the objects were solid, some hollow, and varied in both mass and size. Notice the ambient (background) signal level. Each object shown could be detected.

Another interesting thing about programs is shown in this next slide. It isn't particularly important that you gather all the details, but as you can see with the Infinetics at the low frequency [280 hertz], aluminum is the easiest to detect and stainless steel is the most difficult.

Notice that the two Outokumpu programs indicate detection in about the same order. However, notice that in the Del Norte programs the order changes considerably going from program 1 to program 4. For example, cast iron is the second easiest to detect with program 4, but it is about the third worst in program 1. Brass varies quite a bit, as do several others. This is another illustration of why selecting a particular program may or may not be the right selection, depending on what it is you want to detect.

Also notice that the order of the metals detected in the continuous-wave metal detector [Infinetics] are just about the same as program 4 of the Del Norte.

I happen to think after looking at a lot of past history that one of the problems about getting into pulse-type metal detectors and away from continuous-wave metal detectors was that very early there was a comparison made between some very well-designed pulse-type metal detectors and some poorly designed continuous-wave metal detectors. It isn't clear that we should have moved that rapidly away from continuous-wave detection. There may be some things that would be beneficial there. But the comparison, among some other things, sold everybody on pulse-type metal detectors.

About all you need to note in the next slide are the curves that are solid as compared with those that are dashed. The interest here is in how mass affected detection as compared with size. It turns out that size is clearly the predominant feature. We took a right circular cylinder of 300 grams and hollowed it out, then compared the two different amounts of metal (solid vs. hollow), and in each case the lighter object was at least as good and sometimes many times better detection-wise.

There is a skin effect that takes place and it is easy to conjure in your mind why this would work: If I had a lead balloon, very thin skinned but blown up a foot in diameter, it would be very easy to detect, but it may not be very heavy.

A comment about some of the data being presented. You might have noticed the label "Number of Lights" on the ordinate in some of the vugraphs. Several of the newer metal detectors are equipped with from 8 to 12 lights that are designed to roughly indicate the level of signal generated during passage through the metal detector. This turned out to be a simple way to record results of comparison tests.

Detection level, alarm level in this particular case, was set at the dashed line. However, the primary interest was in the comparison of performance over the range of several programs. Thus, the signal level (number of lights) was selected to allow a direct comparison to be made.

The velocity of the walker, which in this case was the Sandia mechanical device, is at the low end of the spectrum, that is, at about a half meter per second. Near 2 meters per second is the advertised high end of the velocity range for most commercially available metal detectors. Observe the results of the slow and fast walk on program nine. Results are about the same. Now look at the results using program zero. The slow walk provides a much better signal than the fast walk. Thus, by changing programs I have not only affected detection of specific objects, but also the velocity at which they are best detected.

By now we were thinking that maybe we ought to look at detecting some weapons. We were aware of what the FAA had done in preparing to introduce new weapons. We talked to them and looked at their selection of test weapons, their construction, the materials that were used in them, and so forth. We wanted to compare them with what we were learning about detection of various metals. After some tests, we concurred very much with them in their selection of a spectrum of weapons.

This vugraph lists some features of the three weapons that Lyle Malotky talked about this morning. We understand they will be introduced in some airports this coming year. Included are a stainless steel revolver, a .25-caliber zinc-frame automatic pistol, and a .38-caliber aluminum frame derringer. The .25 caliber zinc frame automatic includes 90 grams of steel, but the remainder is a zinc alloy. What is beginning to happen is that weapons manufacturers are using different combinations and alloys of metal. Where each metal might be detected separately one way, the combination is going to be a different matter.

This next vugraph is the best illustration that I have about how carefully you need to set up metal detectors. If I wanted to detect the .22 caliber stainless steel gun and was using a Del Norte, I would certainly select program 4 to detect that gun because it obviously provides better detection than any of the other programs. But if I selected program 4, I would not detect the aluminum gun [.38 caliber] at all, nor would I detect the zinc gun [.25 caliber], although both are larger, particularly the zinc gun, which is 400 grams.

So the advantage of having a spectrum of weapons is that the user or designer of the metal detector must come up with a combination that will allow all of those guns to be detected—however, none of them can be detected as well as if the designer were allowed to design for detection of any one weapon only.

There is always a problem with personal possessions. This vugraph illustrates in some detail how difficult that problem might be. The information is taken with the Infinetics detector using the standard 280-hertz frequency. As mentioned previously, this metal detector is equipped with two voltage readouts, one for ferrous and one nonferrous. Generally, but not always, the higher reading correctly identifies the category of the material. In addition, rather than using a walker, the objects were moved through the portal with the Sandia mechanical device described earlier.

Across the bottom of this plot there is a list of various possessions: a zipper, buckle, watch, and so forth. Data at the left was obtained when all objects were present. They were then removed, one object at a time, until only the knife remained. Notice what happens. As each object is removed, things change, but not necessarily the same way each time. When an object is removed, the remaining set is not always more difficult to detect; sometimes the remaining objects are more easily detected. We have also discovered that moving the objects around to different body locations has an effect on detection.

This next slide is one more test illustrating the same thing. It's a belt buckle test. This is four of several belt buckles we ran tests on using five different programs on the Del Norte. Notice the difference in detection by changing programs. For example, on program 2 the Navy belt buckle is not detected very well, but on program 2 the large belt buckle is detected very well. So again, changing programs affects how you detect not only the weapons, but also personal possessions.

In setting up a metal detector, as you increase the gain, you will come to a point where you can get at least 95 percent or 100 percent detection, whatever you are looking for, and beyond that you can't do any better as far as detecting the weapons. But as you increase gain, what happens is you detect more and more personal possessions. So the best operating point is at the top of the curve, just after the knee. At that point you are now operating where you can detect the weapon you are interested in, but at the same time detect a minimum number of personal possessions.

Once you do that with a given detection, then it is fair to say that there is nothing you can do with that equipment to make it better. There are some other things you can do, but not with the equipment. If you don't like that metal detector, you are not satisfied with its performance at that point, then you are going to have to look for a better metal detector as far as discrimination goes, if one exists. If one doesn't exist, then you have to train or require personnel to remove or not wear objects that cause nuisance alarms or you have to get personal possessions around the metal detector with a minimum amount of difficulty.

We have said to the FAA several times that we predict, and I think they agree also, that when they go to the new higher gain setup in the airport metal detectors, the public will learn very rapidly to remove objects that cause difficulty. We did some airport surveys and discovered that a fair number of people, as they approach a metal detector, will automatically take all of the personal possessions out of their pocket and set them in the tray without ever even being tested by the metal detector. These people are the frequent fliers and they know what is going to happen. Whether you can do that in a plant or not, I don't know, but it seems that you would have more control than the FAA would have dealing with the general public.

Now let's talk about some problems. You were presented some information on velocity effects. I don't know how many of you have watched people walking through metal detectors, but if there is a queue, it is very easy to stand in that line and then walk very slowly through a metal detector. If you did that and were carrying a weapon, for example, that weapon, especially if it was small, would probably not be detected. At various times I have personally tried that, but no one has ever told me that I was going too slow. I venture to guess that at most airports security personnel are not very aware of velocity limits.

One of the things that needs to be done is in some way to control that velocity. A metal detector has a bandwidth, a speed bandwidth, if you want to think of it that way. If you move too slowly, it is not designed to detect; if you go too fast, it is not designed to detect.

Perhaps a separate sensor is needed so that a separate alarm sounds if the person is moving too slow or too fast to be detected. Another possibility is to provide better training of security people so they are more aware of velocity limits.

We have heard about the weapon at the ankle and the kick through. One change in design that could help is to make the archway longer as you walk through so that it is impossible to get through without having both feet in the arch.

Still another possibility is to require a pause in the arch with both feet at the center. If people don't mind stopping or if you don't mind stopping them, then that could be a solution to the problem. However, with this approach, one must be careful to ensure that the walker does not enter or exit the portal at a speed too slow to allow detection.

Increased discrimination is one of the major difficulties that we have. We have wondered why metal detector manufacturers don't commutate through the various programs. If that were done at some rapid rate, a person walking through the portal would be scanned not by just one program but by several programs. Whether that would provide an advantage, I don't know. Studies need to be done. If you could commutate through several programs, it may be that you could select a combination of programs that would allow detection of weapons and at the same time do a pretty good job of rejecting the things you are not interested in. It ought to be looked at.

Another solution to this problem might be the use of multiple detection zones. The archway could be vertically divided into four to six different detection zones so that each of those zones operates independe^tly and some judgment could be made about what might be taking place.

Also, some work has been done in examining the eddy-current wave shape to determine if there are characteristics that would uniquely identify weapons.

Then finally there is the problem of weapons breakdown. You have already seen the detection advantages of using higher frequencies. Another thing that has been suggested is random searches by hand-held detectors. That may not be so bad an approach if it is random and well done. If an adversary wants to get something through and he doesn't know that his turn is next to have this hand-held detector scan and it is done very well, it may just provide enough deterrent so that it would do the job. Using higher frequencies would only be good if you worked out a better way of discriminating between pers nal possessions.

On a different subject, let' talk about standards and criteria. Here you see li ed the work NRC, DOE, and ASTM has done, bu not FAA. You might wonder why not FAA. The answer is because they don't have a standard and yet, ir my judgment and apparently in the judgment of so ne people at NRC, the FAA has done a better job of leading the way in metal detection than anyone else. They have done it in a little less formal fashion.

If I were to ask the FAA to furnish some kind of a document that shows their standards or criteria for metal detectors, as far as I am aware, they don't have such a thing. They do know what it is they want to do and they do have some flexibility in changing things. They also have, I guess, a greater motivation to do so because Congress is always telling them every time there is an incident that they have got to get busy and do something.

The NRC has done some revising of their criteria for metal detectors, and I am assuming that you are all familiar with it. I'm not sure. In any event, it is certainly an improvement. DOE is trying to follow suit and do the same thing.

The ASTM has been working for a couple of years now trying to come up with a standard for the evaluation of metal detectors. They are at revision 10 and still do not have a final document. That is an indication of the difficulty of trying to define how you best test metal detectors, but it seems to me that a lot of progress has been made in the last year or so to improve test methods.

Now let's look at one more slide relative to standards and criteria. One of the things that people always like to talk about in standards is probability of detection. That is one thing I don't find the FAA talking very much about. They just say we want to detect it a certain number of times out of a total number of tests. But DOE and NRC have talked about probability of detection with all kinds of sensors and other components of security systems.

Let's look at what that means for metal detectors. People are interested in defining a body position, which may be anywhere, but usually at the shoulder, or top of the head, or the waist, and the ankle. There are usually at least three positions.

In addition, there are usually three orientations of the weapon that are of interest. By the way, the latest metal detectors have significantly improved as far as orientation is concerned. They are much less affected by orientation than the older type metal detectors. They do a better job of detecting and allow you a choice of a variety of programs.

But if we assume we are interested in 85 percent probability of detection and we want a 90 percent confidence factor, that means that at every position and every orientation we would have to make 14 passes without a miss in order to mathematically be correct and say we had that kind of probability of detection. That means, to test a metal detector, we would have to do 126 passes with no misses. Well, it is just not a practical thing to do on a frequent basis, and so most of us don't do that. But if someone were to really say that our testing is not complete, we would have to admit that it isn't.

Suppose, however, we decided on five passes and no misses. The probability of detection would then be 63 percent. The number of passes is more practical, but what can we do about the low probability of detection? We can accept the 63 percent probability of detection, or there are some other possibilities that I think we could consider.

For example, we can average the performance. In other words, we can just say that whatever the total results are, that will count as our probability of detection. If I do three passes with the weapon at the shoulder, three passes at the waist and three passes at the ankle and in three orientations at each body position, I will just sum the results and say I have done 45 passes and maybe had no misses. In that case I have a 95 percent probability of detection.

Another way to handle it is to keep good historical records and use that history to determine the probability of detection numbers.

Finally, I think maybe the one that has the most appeal is to find the worst case and test there. The only problem with that is you would have to keep periodically doing repeat tests to verify the worst case situation.

In any event, I personally don't worry very much. If a metal detector passes five times, with the DOE even eight of ten times in each situation, then I think it is a pretty good metal detector. But somebody may quarrel with me.

I am not sure why this next slide is up there except that it was part of the program and I was supposed to put it up. Sandia tested four different hand-held metal detectors. What this information presents is the average detection range (in inches) for these detectors. Many hand-held metal detectors have different physical configurations. Some have a round antenna, some have a long bar antenna, and then also the object you are looking for, the weapon, has an orientation. The delta shown covers those differences. You can see that some of them have a bigger delta by quite a bit than others. The primary reason is the antenna configuration.

Another important point is the use of higher frequencies for hand-held metal detectors. At very close range they are really quite good at detecting. That means the key to using hand-held metal detectors is the person who uses them.

I personally prefer walk-through metal detectors set at a high gain and with some training to keep people from trying to walk through with objects that cause nuisance alarms. I think that is the best security. People don't like the large number of nuisance alarms but also they tend to avoid working at reducing them.

Finally, just to summarize, in today's world the primary method of detection is the eddy-current method. Lots of things influence detection. In order to get maximum benefit out of the metal detector you need to understand those things, but most particularly is the selection of the program that you want to use. In fact, metal detector manufacturers have worked some with us in changing programs to do a specific thing that we wanted to accomplish, and I am sure they would do so with anyone who wants to do that.

Once detection is attained and you are doing the best you can, then nuisance alarm rates must be reduced by something other than the metal detector.

Specific test objects and methods are important. In addition, a spectrum of weapons is necessary for proper testing. There is a definite need for some improvements if the threat that you decide on requires those improvements.

That concludes my presentation. I would be happy to take questions if you have them.

Participant:

You showed a vugraph with the response of decay currents, some positive and some negative. That raises the kind of possibility in your mind about someone putting a material that was the opposite polarity of a contraband and essentially getting a zero response. Would you like to comment on that?

Mr. Porter:

I guess they could do that. My comment is if I had the metal detector and I had the objects, I would still probably have to spend a fair amount of time being able to balance that out carefully enough so that I would be satisfied with walking through another metal detector. Don't forget the program also affects the detection at the speed I walk and so forth.

But it is a good point and it does explain why sometimes you can go through a metal detector carrying a variety of objects and it does not alarm and you go through it next time and it does alarm and you wonder what has changed. I can't guarantee something hasn't changed, but in theory at least it should not have changed. The only thing that might have changed is the relationship of those objects to each other as you go through the metal detector. So it is possible to go through once and be detected and go through again without much change in the configuration of those items and not be detected.

One final comment: in doing testing it is very important to have a clean tester. That doesn't mean somebody who just goes through and doesn't alarm the detector; it means somebody who goes through without anything to add to the signal besides his own person.

Any other questions?

(No response.)

Thank you.

(Applause.)

Mr. Burnett:

Thank you, Lyle.

Now I would like to move into the area of X-ray. Our final two speakers will be in this area. I would like to introduce Mr. Donald Gould. For the past 15 years he has worked at Sandia National Laboratories in the area of safeguards and security and presently is with the Safeguard Engineering Department at the laboratory.

X-Ray Technology, Present and Future

Mr. Gould:

Before I start, I would like to thank Priscilla and Elizabeth and their staff and their colleagues for a wonderful job on this symposium.

(Applause.)

If you look on the speaker's schedule, you will notice that Ralph Schellenbaum was supposed to give this talk. Ralph is ill and so I am standing in in his stead.

Currently I am working on the enhanced security system at the Baltimore-Washington Airport. So I am leaning toward the FAA viewpoint on X-ray technology.

Actually, some of the airports in the world—Korea, Israel, Saudi Arabia—open a large percentage of the baggage that comes through. It is not unusual to have a large proportion of the items examined.

We are trying to do essentially that, but in a very elegant way. We don't want to upset the passengers or, in your case, your employees, but we do want to do a thorough search.

Lyle was talking about the importance of a threat statement. I always like to have a threat statement if I am going to talk about security. You can consider the adversary, define the contraband, and determine what actions the adversary is going to take; this gives you your threat. It is pretty generic. But the thing is covert movement of contraband. That is what our system is looking for.

Another thing that is obvious is that X-ray machines don't detect anything. The detector is your operator who also does an assessment. When you inspect the system and you only inspect the machine, you are probably looking at five percent of the X-ray system. The operator is the remaining 95 percent. If the machine is operating, that's fine; if the operator is not operating, forget it, the contraband detection system is not working.

You have run into situations in your plants where you can walk up to the security access area and run something right past the screening operator. The FAA inspectors test personnel at airport screening points often enough to know that the operator is the system, not the machine.

[Mr. Gould's slides are contained in Appendix A to this report.]

The newest item in X-ray technology is computer tomography, which is on its way to the market. The first instrument will be on the market about April of 1990.

Transmission X-ray, which is the single-beam, single-detector array system, is what you normally have in your plants right now. It is what you see at the X-ray screening points at the airports. The item passes between the detector array and the source. It is the typical X-ray system. The essential element of the system is the single-beam, single-detector array configuration. The normal image is high-contrast black and white.

You have heard in the presentations about how grenades can be made. A grenade can be made out of a camera; a grenade can be made to look like a lens. Those kinds of problems show up and are what the X-ray operators have to be aware of and spend a lot of time determining what is and what is not contraband.

The single-beam, dual-detector array system is what Astrophysics is calling their E-scan. This system records two energy peaks in its two detector arrays, one array recording the energy levels. This is kind of "now" technology because it's available. It also provides a black and white transmission image.

With the E-scan: blue indicates metal, a high atomic number; orange indicates organic, a low atomic number—carbon, oxygen, nitrogen. Green represents total absorption—a thick piece of plastic or explosives or thick metal.

Another type of X-ray system is the single-beam, single-detector array back-scatter system. The transmission X-ray systems produce back-scattered electrons. That's the nature of the physics of these X-ray systems. They are just not designed to detect the back-scatter X-rays. This particular back-scatter system is produced by AS&E, [American Scientific and Engineering].

Their typical system has the transmission-detector array and the back-scatter-detector array. They first built this system with the idea of detecting a weapon behind a piece of obscuring metal. The technique works because the back-scatter image improves as you go up in atomic number. When you get up into the metals it is much more effective than it is with carbon, oxygen, and nitrogen—plastics or explosives.

AS&E has come out with an explosive detector that puts two of the beams together, opposing beams. The reason for this is that if you have a single beam and the suitcase is placed way over on the edge of the belt with the explosives on the outside, you are not likely to see them, because the back-scatter image is not that strong. So, AS&E has used two imaging systems to counter that problem. What you end up with is the transmission image—typical black and white high contrast—and the back-scatter image. You can see the difference in picking up materials with low Z [atomic] numbers. Again, if you can put the package far enough away from that detector array, you probably won't see it.

The last concept in X-ray technology is computed [computerized] tomography. Imatron technicians in California are developing this technology. Imatron's forte is fast-scan tomography for the medical field; it has a niche in that market. Imatron has produced a system for the Army to use in medical field hospitals and it is taking that particular technology into the baggage examination area. Imatron has produced a multiple-detector array with the detector mounted on a collar so that the array rotates. It is really just a single beam moving around on the collar.

For example, if you had a bag of explosives, the process would produce a picture showing the bag in cross section by first electronically detecting the variation in X-ray transmission through the bag at different angles and then using this information in a computer to reconstruct the X-ray absorption of the materials at an array of points, vertical slices, representing the cross section. This provides 3-D [three dimensional] information. All the other X-ray systems provide 2-D information. This 3-D information is constructed with computer software. All of these images are produced via a very elegant software package.

The neat thing about computed tomography is that you can pick up detonators and wires. If you have a bomb and you run it through this X-ray system, you can determine just how that whole thing is laid out. The only problem with it, from our perspective, is it's slow. Each scan takes about five seconds. If you need 30 scans, you are up to 150 seconds. But this doesn't mean it doesn't have an application. Computed tomography could be used in a system, for example, where you have lots and lots of baggage at a large airport. After you have narrowed the suspect bags down to one percent of your total bags, then the CAT-scan system could be used in the final analysis.

Imatron is considering developing what they call lips-to-hips in 60 seconds. It wants to be able to scan a human body in 60 seconds. If Imatron comes up with that technology, computed tomography will become much more amenable to our FAA applications.

The present X-ray technology has enlargement, or zoom, capabilities. The assessment of an image and detection of contraband is determined by an operator. The most important thing to a successful operation is operator efficiency, how well the operator is trained, how wide awake he or she is, what kind of abilities he or she has to analyze pictures.

It takes 6 seconds for the image to pass through a standard X-ray unit. I think that the average time that an X-ray operator in an airport has to look at an image is 3-1/2 seconds. There are systems that have a two-tier operation. One operator is by the machine and another operator is sitting in a remote booth looking at the same images. The operator in the booth might be looking at the images from three machines. A system like this that we know of is being used by United Airlines at Chicago, Denver, and San Francisco. United people claim that about half their detections are made by the person in the booth. I don't know how it is done—somehow the brain works that way.

Another problem, of course, is the variety of contents. In NRC applications you have pretty consistent contents coming through the X-ray machines as compared to, say, at the screening point at an airport where everything imaginable is seen. I mean literally everything. An airport in Alaska had a case where a baby went through the X-ray unit. Another case occurred when a guy had doped his dog and put it in his carry-on baggage. They saw these little bones. They opened the bag and there was the dog.

It is obvious that the rate at which items pass through an X-ray unit is always going to be faster than the time required to open and hand-search every bag, but that rate can vary from very slow to very, very fast.

The contents can be uniform or cluttered. In the airport setting it is almost always cluttered. By clutter we mean from hair spray to umbrellas to dogs. The operator sits there and does an exception analysis. "It's obvious," the operator says. "Oh, I know what that is; that's hair spray; that's a purse, a key chain." You understand how difficult the job is when you talk to the operators and watch them operate X-ray machines. When an operator says, "I don't know what that is," that's when they open the bag—or should.

How an operator examines images is important, because I think that is what is going to happen when we start automating image processing.

Let's go over a little of the present/future X-ray technology. It is not really future technology because some of it is here now. The E-scan technology in which color—green, blue, and orange—relates directly to the detector array values is available now.

There are improved operator consoles. I saw one that Scantech has produced that has pressure-sensitive switches. You can zoom by hitting the pressure pad. You can change the contrast by running your finger up and down another switch. You can change color; you can introduce color.

When considering these newer items, it is important to decide how it will enhance operation of your system. Is it going to cause the rate to go faster or slower? The new technology is designed by engineers and they have not consulted the customers, the person that operates the X-ray machine. Most of these manufacturers, if you ask them how much human factoring they have done, or how much consulting with the operators has been done, they will tell you none. An engineer designed the system. If I were interested in a system, I would never buy it or use it until I had an operator sit down and go over it—or two operators. Or I would go to a place that is already using it and inquire about operator concerns.

The high-low Z discrimination, back scatter, and E-scan—image enhancement via software—as I discussed when I talked about computerized tomography, the Imatron system, are not cheap systems. The more information you gather and the more complex the software and the more options you pick, the more you are going to have to increase unit cost. That's just obvious. The more stuff you add when you buy your system the more it's going to cost. Software is not cheap. We all know it costs more than the hardware.

More software means more maintenance, a larger supply of spare parts. You are going to have to have people who are familiar with software to be able to sort out what's going awry. You talk to the software expert and its hardware, vice versa. But you have to have somebody who knows how to find out what is wrong with your machine and knows how to put it back on line.

Assessment and detection are still an operator's job. We haven't changed that. We are not smart enough yet to have done that. There are aids out there, but if you are not careful, they are going to degrade your system rather than make it better. I don't believe you are ever going to do away with assessment by an operator.

Future X-ray technology will take over some of the things that operators do. It will include exception-driven methodology. The computers will be able to throw things out; they will have libraries built into the program so that they can examine and recognize a hairbrush or whatever.

Enhanced graphics will get us out of the black and white images and more into 3-D and color; more into real-life presentations. Similar to what we discussed earlier, but even better than that, I would assume.

Now we are talking about really expensive software/hardware startup costs. We are talking about machines at a quarter of a million to a half a million dollars. These machines will require dedicated maintenance.

Even with all these enhancements, an operator still has to make an assessment, not necessarily detection. Now maybe we have an operator who can go to sleep until the bell rings, but when the bell rings, it is the operator that determines what it is the machine is ringing the bell on. That might be worth all the other expense. It probably will be.

Let me finish up with a little bit on lifetime costs. Don't get tied up with initial hardware costs. Look at your lifetime costs. If you are going to buy an instrument, try to at least exceed the regulations that exist now because regulations are going to change, get tougher. If you can buy that machine, buy it, but make sure it is going to do something for you. Remember too that if the machine decreases the rate of processing, it is an added expense. If it costs you more time to put people through, it is going to cost you more money. These new systems are going to require that you have operators that are very well trained. Operators are going to have to be much more professional than they are now; consequently, the expense of wages is going to go up. The maintenance expense will go up too because these machines are going to take a lot more maintenance.

The last life-time cost isn't as obvious. I didn't think about it until I started going over this, but risk—risk is an expense to your system. Here's why.

For any system you put together, you have a built-in risk because no system can offer 100-percent detection. Under ideal conditions, you have an acceptable risk. However, we well know that an acceptable risk exists, and if the real security risk is too far away from the acceptable, you have a terrible expense on your hands. You may have to throw the whole X-ray system away.

In most cases we have found that there is no data on the actual risk. We have to collect data during the airport study before we put in a new system. How can we judge a new system? How can we say we improved anything unless we know how the system operates today? We are attempting to build a system whereby we can take the actual X-ray images and run them through a computer software program that will tell us the areas where contraband could have existed. At the same time we collect that information, we have to determine which one of the bags were opened and what was found. Then we can determine what is the real security risk at that particular screening point, at a particular time of day, or with a particular operator. At least we will have that kind of information.

With that information, we change our system; we can go back and check it again; we can decide if we did or did not improve our system. These are a few of the things that you need to think about as you move into the newer systems. Just be careful that you don't bite into something that bites back.

Are there any questions?

(No response.)

(Applause.)

Mr. Burnett:

Thank you, Don.

We have saved the best for last. It is my pleasure to introduce Dan Hoban, Supervisory Security Specialist with the Munitions Countermeasures Section of the United States Secret Service. He is responsible for the Service's research, development, and deployment of technical countermeasures against weapons and explosives.

X-Ray Interpretation in Explosives and Firearms Detection

Mr. Hoban:

Commercials are always first even when you're last. As my colleague Ron from the Secret Service Technical Security Division said yesterday, basically we are responsible for the physical security features involving protectees of the Secret Service, and most importantly, the President of the United States.

[Mr. Hoban's slides were not provided for distribution.]

Perfect or absolute security is the goal of the Secret Service. However, we realize in this country, in a democratic society, that it is not going to happen. I am not going to stand up here and tell you that you can't defeat our security. What I am going to say is we are attempting to make it as difficult as possible.

We firmly believe in a systems approach. I think that has been brought out time and time again this week. Frank Conrad said it the other night at the reception. He said he prefers a five-nickel approach versus a quarter approach, not having all your assets protected by one system. An X-ray system is just that. It is just another tool to be used in your entire physical security program.

When we are talking about physical security from my standpoint, we are not only talking about our fixed sites, for example, the White House. But we are also talking about protecting, for example, Air Force One when it is on travel status.

Generally, X-ray systems are used at two separate types of locations. One is a fixed-site operation, an access control point, the same as any of your facilities. The second type of locations are remote delivery sites, for lack of a better term. We have set up a procedure where packages, mail, parcels, equipment, supplies cannot be delivered direct to our system. They are delivered to a warehouse and screened.

An X-ray system is used at access control points, such as the main Treasury Building or the White House, basically to stop the walk-in threat. Somebody has got to carry the weapon or explosive in. We are not using an X-ray system at an access control point for somebody to drive a car into it. Vehicle inspections are entirely different. At certain high-threat areas, we might have the people unload their vehicle so we can X-ray the contents at the access control point, but we haven't moved forward to the point that we are looking at total X-ray of vehicles and things of this nature.

In addition to that, we believe that any X-ray system just like any other overt physical security feature—a gate, a guard booth, an officer, a panic button, all the things of this nature—provide an additional mental deterrent.

I can't give you statistics like Lyle did today on how many weapons have been found by Secret Service, because quite frankly I don't know. But what I can say is that I am confident in my mind that the use of an X-ray, a magnetometer, a locked gate, things of this nature, deter individuals. I think that is a very, very important part of operational security. I think we overlook that sometimes.

I firmly believe in the physical deterrent of an access control point. If the guards look sharp, they act sharp, if the equipment is clean, if the area is clean, if you have this imposing X-ray machine—I could stick an "explosives detection" sign on this podium and stick a little probe out the left-hand side—will that deter somebody? It probably will. Is it going to deter your threat? I can't answer that.

I talked about an X-ray system for our mail delivery to detect package bombs and things of that nature. However, there is absolutely no deterrent from a system like this. The bad guys don't know it is there and even if they do, the only thing they are risking is that we will find the device. We have a log-in room and people log the packages and X-ray them, things of that nature.

We are not only looking for hazardous devices. Can you believe that the President gets a lot of mail? I was amazed at the people that write the President and the First Lady and the Vice President and the Secretary of the Treasury. Everyone writes them. We get some strange letters with some strange contents.

We have adopted a system using a video telephone hookup so that we can link the signal from our remote delivery site back to my facility for instant examination. It is a relatively inexpensive system. It is only about $8,000 to $12,000, and it has saved us a lot of response time.

What I am talking about is the visual recognition. Mail comes in and a special officer examines it and sees the words "death before dishonor." Is the sender a nut? There is no return address. The officer X-rays the package. Is it a hazard? No, it isn't a hazard. But is it a threat? This is an additional responsibility that we have. If you can imagine the worst things you could possibly stick into a package and mail to somebody, at one time or another we have had it. We get letters consistently from the other side of the criminal justice system. You recall the criminal our luncheon speaker talked about that is not going to get out of prison. Well, he's got to have a pen pal. So why not the President and the First Lady.

Quite a few years ago, before my time in the Secret Service, there was a campaign in New York City where FALN [Puerto Rican Armed Forces of National Liberation] was mailing letter bombs. Are they threats? Are they real? You're darn right they're real. A letter bomb is a significant threat. It's a significant threat in the United States.

Do they kill? They kill. You have to stop them before they reach their destination. A letter bomb is not going to go off during the handling process 99.9 percent of the time. It is going to go off when it is opened. Normally it is either the intended victim or if the intended victim is high up in the organization, a CEO [chief executive officer] or whatever, it's the secretary.

Define your aggressor. Is it a terrorist group, environmental crusaders, antinuclear protestors? Or is it a person criminally motivated by financial gain? A disgruntled employee—I see that as a major problem.

Regardless of the threat, at a certain point the aggressors are going to have to penetrate your security—I am talking about weapons and explosives. They are going to have to try to beat your system, confuse your search procedures, and somehow get into your plant. That is what you are trying to protect against.

I am going to get into the training aspect. I can't get into specifics of what we do for our people, but I want to try and give you a general overview.

Historically in the United States our threat has been the lone gunman. The President has not been attacked by an organized terrorist group to date. The intelligence is there, and that's the key. Without intelligence you are not going to stop an organized terrorist attack. But I believe that the lone bomber, the lone nut, the lone psychotic, is no different than the lone gunman, the Hinckley. I believe that the lone bomber's weapon of choice is still going to be, in the United States, the pipe bomb. I am not going to talk about the international threat because we dwell on that too much; I think we need to bring it back home.

The pipe bombs will have blasting caps. They are easily obtainable. You might see them and you might not. If it's a pipe bomb, most likely you are going to see some type of improvised blasting cap—a flashbulb filled with black or smokeless powder—very simple to make.

Last Christmas we had an incident in Chevy Chase [Maryland]. Some diplomats' children blew themselves up making pipe bombs. Where were they getting the information? They were getting it off a computer bulletin board. That's an open source of information, ladies and gentlemen. This is what you are facing.

Throughout the years we have seen different pipe bombs and explosives devices in the United States. Nothing fancy, just batteries, power supplies, capacitors, things of this nature.

Throughout this symposium I think the one thing you have picked up is that there are an infinite amount of ways to conceal a bomb. It is only limited by the ingenuity of the builder.

Letter bombs are concealed bombs. You should be able to detect one on a standard transmission X-ray as long as it is not in high-density confusion. One scenario, the office party, is this employee bringing the booze to the office party or did he just get notified that he was fired or that he didn't get that $1,000 Christmas bonus? The disgruntled employee, is it a package bomb? Quite possibly.

Two or three vendors are doing some work. One vendor carries in a briefcase. Can it slip through? You can put 50 sticks of dynamite in a simple government briefcase, and that's a cheap briefcase. Government-issued telephone pad left behind by a vendor. Very simple. Pick it up. What is it? It's very simple. These are old devices. There is no magic in this.

We used my umbrella as one of the test objects. Is it my umbrella or is it the way I am going to defeat your security? Grenades can be concealed. They can be dismantled and hidden. You can take the fuse out of the grenade and put the body in something else. You can mold it into a handle.

Don covered the handguns extremely well and so did Lyle. It is easy to conceal a handgun in an X-ray—high density confusion. I'm not going to get into specifics, but go back and experiment. Take some standard notebooks, pile them up on top of each other in a briefcase and put the handgun in different locations. Slide it up on the side. Just run it yourself. You're going to be amazed at the results.

Read the specifications—that step wedge is great, but guns aren't made out of step wedges. Yes, it meets the specifications, but does it meet your real-world environment?

The training for the operators at fixed-site access control points is identical except for one thing: For the access control point, we strongly believe in profiling by the officers. It is not an exact science although it is getting better. There is a tremendous amount of work being done down at the FBI Academy on profiling the bomber, profiling the arsonist, profiling the lone assassin. The Nuclear Emergency Search Team does tremendous work in profiling, as have the Israelis.

What we are trying to do is institute some type of profiling system. If you haven't figured it out yet, all X-ray machines can be defeated. The only thing you have to know is how the machine works, or determine the training level of the operators. That is all part of the target analysis that you have heard mentioned today.

What's the weak link? Is it the machine or the operator or a combination of both? Is it lack of training, inconsistent training.

The three things we "key on." The first is to train the trainers. We all have former EOD [explosive ordnance disposal] backgrounds and electronics backgrounds, but what did we know about looking at radiographs? We receive our training from the industrial radiography experts.

Then we came back and we talked to the Navy and we asked those people what the most important aspects were. They talked about basic radiation physics, how it works, why the array and why the tube and why the detector are lined up the way they are. We talked about radiation safety. We have even gone so far as to put area monitors on our cabinet-safe X-rays. Why? Because it makes the operators feel better.

Then we concentrate on X-ray interpretation. External recognition points, we spend a lot of time, probably an inordinate amount of time, on deciding if the package fits what is written on it. If it is from Mary Smith, does it look like Mary Smith's writing, is there a return address? The old standbys. Is the package oily? Is there excess postage on it? We get confidential statements all the time—"To be opened by the President only." Things to key on before it even gets into the machine.

I think we have 35 slides of different power sources that can be used with explosives. I've only brought two here. What I want to talk about with regard to the power sources is very simple. We can't teach our operators to understand every piece of equipment that they are going to see. We don't live in a finite environment like that. We believe, however, that we can attempt to let them know what should be in a calculator, what should be in a Betacam, what should be in a 35 millimeter camera. A 35 millimeter shouldn't have a 9-volt battery in this configuration. These are things that we are trying to explain to them. We go over it time and time again so they will be able to pick out the different batteries.

Does an AA battery belong in that device? Does a VHS have D cells or should it have a gel cell or should it have a dry cell? What does a rechargeable battery pack look like? These are the things we key on with our people.

We are dealing with law enforcement officers and special officers who have very little understanding of electricity and electronics. We just give them basics on what a capacitor is and how it works, how long it can hold a charge, and where it should be on the board.

We do two things with different types of flashbulbs and light bulbs. One, we show them basic light bulbs. Two, we use inert black and smokeless flash powder. Then we show them what it looks like when it is filled up.

We have a wide array of blasting caps. This one right here is a Minidet. If you put it into a circuit board, you can't tell if it's a cap or if it's a diode. It is extremely tough to pick out as you are looking at it on X-ray. We look at the bridge wires, should that electronic equipment have a crimp contact like that? This training works extremely well when we are talking about the unsophisticated threat. We live in a society where you have to constantly anticipate the threat. I am here to tell you that in today's environment a sophisticated improvised explosive device either in high-density confusion or hidden in this type of equipment is not going to be detected under normal standard transmission X-ray. Ladies and gentlemen, you are not going to see it. That's a fact.

This is a VCR camera, an RCA. This is the same type with a battery pack right here. Is there anyone in this room that can tell me if that's a bomb in this one, or if that's a bomb in the other one? I can stand up here and tell you that there is an explosive device built into this camera. The interesting thing about this is that this camera still functions. You can still run the tape through it, but the minute you push the button to start the tape it starts an additional timer built into the circuit board and it holds about three ounces of C-4 molded into the lens. The one with the 50 millimeter lens has been modified behind the lens and on the autowind. The point I am making is it will get through every time if you just use standard transmission X-rays.

Can you see a difference in these two Sony Walkmans? They are different manufacturers. Would you or any of your operators stop either one of these devices coming through? This is the device. You have to look real close at this one. Once again you are going to have to take my word on it. It has been modified right in this area to work off the existing electronics. The jack mike was the safety and arming switch. Here is a device in a Marantz recorder. Same thing, the explosives are underneath the battery.

I am not going to beat this to death, but I just want to say that we have taken the posture within the Secret Service that you need a systems approach. Whether that system is a standard transmission X-ray or an X-ray that highlights explosives in some manner, either back scatter, the E-scan, the Z-scan, American Science and Engineering, or Astrophysics, you need an additional tool other than the standard transmission X-ray if you are going to defeat the concealment of explosives.

An additional tool could be the fact that on all electronic equipment coming into your facility the power packs are removed, the batteries are removed, and then the item is X-rayed again with a nonlinear detector to find out if you have still got something in there.

A systems approach is what I am advocating. Aggressive, professional officers are necessary to defeat this type of threat.

Having said that, I will go back to my original statement that I still firmly believe that the major threat in the United States until it is proven otherwise by an increase in terrorism in the United States is still the pipe bomb or the simple dynamite bomb.

I caution you to look at your design-basis threat from the perspective of some type of cost-benefit matrix.

You're in the public sector; the bottom line is dollars. You've got to get more bang for your buck. Believe it or not, our agency is that way because we are a relatively small agency. We spend a lot of time looking at things versus just going out and buying them and trying them. When we buy something, it has to work and it has to last for about 15 or 20 years. That's the environment we work in.

Once again, access control points versus the officer working in the mail room or the package room. I will go back to what my colleague Ron talked about yesterday. If you pay your security force well, treat them like human beings, give them a lot of training, and back them up when they make a decision, you are going to have a better product. He or she has to have the authority to deny entry until that person is either sure in his or her mind that no device is present or a competent supervisor relieves them of that responsibility.

I see it in our environment. I see it everywhere. Too often you can bluff your way right past security officers, and a lot of times it is because we as supervisors don't back them up. I don't know if it can be changed, but I firmly believe that the more you back them up and the more training they get in this environment the better off you are going to be against any threat.

Bill McCarthy was a legend with the New York City Police bomb squad. I think he really summed it up. Bill was addressing a symposium of international bomb technicians. He simply stated, "It's a bomb until it's not a bomb." That's the philosophy of the New York City Police Department's bomb squad. If I can advocate anything, it is change the rules before you get somebody hurt.

Intuitive nature of the officer at access control points. A lot of times this is still the ultimate in today's world. That's the human factor. But is this cost-effective? I'm sure it is not in your environment, but it is for the President of the United States.

We use a systems approach to testing just like we use it for everything else in physical security. Pre-training testing, the actual testing of the officers while they are going through training, post-training testing, and then what we call positive reinforcement techniques.

Pre-training testing, we found, allowed us to identify the duration of the course and the scope of the course. We were surprised. The officers knew a lot more in certain areas than we thought they would and inverse on other things. Testing during the training phase allows us to make sure that the course objectives are being fulfilled. We have daily critiques, actually testing the officers while they are going through the program.

Post-training testing in an operational environment confirms that we have met the course objectives.

Probably the most sensitive issue that we get involved in is testing. Is it fair that Dan Hoban, who knows the machines and knows how to beat them, builds that Betacam, which he knows the machines won't detect, to test the officers? We've heard speaker after speaker talk about the limitations of the magnetometer and the limitations of the X-ray machine. That's because they know everything about the machine. All the bad guys you are going to face, do they know everything there is to know about that machine and how to beat it? Do they know if you stick the bag six inches from the detector array on an American Science and Engineering system that you are going to lose some of the back-scatter image? Or in the Astrophysics Research, in the E-scan, if you put it in a highly cluttered environment, everything will be orange?

What I am saying is your testing has to be realistic based on your threat. It has to be non-punitive. We don't believe in punitive testing for reinforcement of training. We will pull the officer aside; we will work with his sergeant. He just might not be adept at watching an X-ray machine; that doesn't make him a bad police officer.

When you do your testing against your systems, remember that you know the systems. Try and take a step back and think as the aggressor. How much information could he have about your system? Could he have done the target analysis enough to identify the specific system that you use?

Thank you and have a safe trip home.

(Applause.)

Closing Remarks

Mr. Burnett:

I'm the last speaker. I guess I was the first. I would like to solicit any more questions at this time that we could hopefully shed some light on.

(No response.)

Before I wrap it up, I would like to take just a minute to thank the many people involved, and in particular I would like to thank you, the attendees, because without you I would have had no symposium. I would like to thank the many speakers and agencies that gave tremendous support to this effort. And I would like to thank MayaTech.

Last, but certainly not least, I would like to thank the NRC Commissioners that helped support our first symposium and the many staff people who have been involved. I particularly want to thank Priscilla Dwyer who is sitting up here on my far right. She was the lead person in putting this together and I personally think she did a marvelous job.

(Applause.)

Dan mentioned that we were going to have an explosives demonstration. That is very true. I attempted to get this seminar held by midsummer; because of contracting and other impediments, we weren't able to do that. I knew the weather wouldn't be right. If we do this again, we will pick the timing better. We have already laid the groundwork to have an explosive demonstration.

I would like to take just a minute and maybe wrap up at least what I heard at this seminar.

One, detectors are not perfect. I think we all recognize that. However, at our facilities you are required to have a defense-in-depth system. You have equipment and you have personnel. I think this precludes the dependence on any one system and deficiencies that are associated with that single system. Therefore our detectors are just an additional tool to be used. Understand their limitations. Also understand that they have a deterrent value. I think the remark that Dan made about putting a probe on this podium and marking it a detector would kind of discourage at least some level of adversary.

I also predicted there would be conflicts between the techniques that you would hear about today, animal versus machine. I think both have their place. I too came from the Secret Service and I had the honor of writing the first memorandum back in 1971 or 1972 which recommended setting up the K-9 Corps.

I think we noticed that the K-9s would not work in a routine environment where they check person after person. Equipment, even with its many deficiencies, does that best. However, we also saw, from the test that the FBI ran, that equipment doesn't work that well out in the middle of an open area, and that is where the dog performs well. So look at your environment and pick the tool to do your job.

I am happy to see that there is a lot of research going on in vapor detectors, particles, and X-rays. I think that each may have a useful place.

We also heard about terrorism. We heard about the policy of fighting terrorism; we heard about the difficulties associated with it; but we also heard from the FBI that, to date, we have had zero terrorism in America in the past couple of years. We have had none directed at your facilities. I do not believe that should lead us to complacency, which is the reason NRC created the design-basis threat. We were fully aware that we had not seen a threat developed for targeting your facilities. So that's the way we define our goals.

I think we also recognize both from the newspapers and from our presentations that the American Government must keep a watchful eye to the south of our borders. I personally am very concerned about what drugs are going to do throughout the world and what it is doing in American society.

I think you heard over and over and over, human interface, training. Actually, that is the whole theme of this symposium. It has been behind us every minute that we have been here. It is important that you take what you have learned back to your facilities. It is important to pass it on to the people who are running your machines. Tell them about the bombs that you have seen here in various formats. Tell them how hard it is see a minicam. Tell them to question the entrance of that device into your environment, to look for small differences. It is difficult training, but it must be accomplished.

I personally would like to hear (1) how well you have received this training and (2) how well it is passed on to your operational forces back at your individual facilities.

Was this seminar worthwhile? That's the bottom line.

The training information that we distributed, is it worthwhile to you? You might be able to answer that today on your critique sheets. I would like to hear in the future whether it is worthwhile to the people at your home ports. Give them a chance to look at it. Sit down with them, explain it, and give me feedback on whether we can improve it.

Should we have other seminars like this on subjects like this or any other subject? This is really the first attempt by NRC to make available to you, our licensees, the knowledge that is available to us from the other agencies.

What subjects do you want covered? Let us know.

What else can NRC do to raise your level of competency? It is high. It is probably the highest of any commercial facility in America. What can we do to make it better?

I guess that sums up what I have to say. I thank you all for attending. With that, I will be looking forward to your critiques.

(Applause.)

APPENDIX A

SUBMITTED PAPERS AND SELECTED SLIDES

This appendix contains submitted papers and selected slides from the U.S. Nuclear Regulatory Commission's Security Training Symposium, "Meeting the Challenge—Firearms and Explosives Recognition and Detection," held November 28 through 30, 1989, in Bethesda, Maryland. Because of the sensitive nature of the material, some slides are not included. Those slides that are included have been placed in the same order as the speakers' presentations and are identified by the name of the speaker.

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THE BOMB
FAVORED TERRORIST WEAPON

SECURITY TRAINING SYMPOSIUM
U.S. NUCLEAR REGULATORY COMMISSION
NOVEMBER 28-30, 1989

BOMB DATA CENTER
FBI LABORATORY

TERRORISM AS A CRIMINAL ACT

Law enforcement can exert its influence over terrorism by displaying a professional and prepared posture in the face of this extra-normal violence. Rather than attempting to invent or develop a new course of action for combating terrorism, law enforcement will be more successful using and massaging established crime fighting procedures. These well established procedures include initial intelligence and detection, arrest and technical interdiction, and forceful prosecution. The successful use of these tried and true law enforcement techniques will not only result in arrest and prosecution but will also provide a veil of deterrence. This deterrence is based on a demonstration of what law enforcement can do and what we are willing to do. Deterrence is critical to the process of conditioning what the terrorist thinks we can and will do in response to an act of terrorism.

The successful use of law enforcement techniques requires the general agreement that terrorist acts are criminal acts. We must separate the political, ideological and religious motivations from the criminal act. The terrorist act must never be accepted by law enforcement as random and indiscriminate. The victims may be random, but the act was conceived and calculated and its execution represents a criminal act. The target group for a terrorist act is always wider than the immediate victims. Killing innocent people to make a political or sociological statement is a complicated, calculated act and bears the imprint of a criminal atrocity - a heinous crime.

TERRORISM

TERRORISM IS THE UNLAWFUL USE
OF FORCE OR VIOLENCE AGAINST PERSONS
OR PROPERTY THROUGH A CRIMINAL ACT
DESIGNED TO INTIMIDATE OR COERCE
A GOVERNMENT, THE CIVILIAN POPULATION,
OR ANY SEGMENT THEREOF, IN FURTHERANCE
OF POLITICAL OR SOCIAL OBJECTIVES.

TERRORIST BOMB THREAT

HIGH EXPLOSIVE MOBILE BOMB
SUICIDE DRIVERS
ACCURATE LONG TERM TIMING DEVICES
RELIABLE RADIO CONTROL
AVAILABILITY OF EXPLOSIVE
EXPLOSIVE TRAINED ASSETS

INTERNATIONAL TERRORISM

INCIDENTS/BOMBINGS

	INCIDENTS	BOMBINGS	PERCENT
1984	3525	1728	49%
1985	3010	1527	51%
1986	2860	1498	52%
1987	3089	1501	49%
1988	3734	1622	44%

Bombings are most common terrorist act

REGIONAL BREAKDOWN

	1986	1987	1988
SOUTH/LATIN AMERICA	60%	60%	42%
EUROPE	20%	17%	23%
MIDDLE EAST	10%	6%	8%
ASIA	5%	12%	17%
AFRICA	4%	4%	10%
NORTH AMERICA	1%	1%	0

TARGETS

TYPE	PROBABILITY
BUSINESS INTERESTS	52%
GOVERNMENT/DIPLOMATIC FACILTIES	34%
POLICF/MILITARY	12%
OTHER	2%

SOURCE: Business Risks International, Inc.

BOMBINGS

A CRITICAL ELEMENT OF TERRORIST THEATER AND A FAVORED TACTIC:

FEW PERSONS CAN ACCOMPLISH
NO NEED FOR COMPLEX PLAN
TIME TO ESCAPE SCENE
SPECIFIC OR GENERAL TARGET

GOALS OF TERRORIST BOMBER

1) REDUCE PUBLIC CONFIDENCE IN GOVERNMENT, ESPECIALLY POLICE AND MILITARY AGENCIES
2) CREATE PUBLIC CONFUSION AND FEAR
3) KILL TARGET; DESTROY PROPERTY
4) GAIN MASS MEDIA ATTENTION; GAIN A FORUM FOR A STATEMENT OF CAUSE

ESCALATION OF TERRORISM

BOMBINGS

A) HEADLINE ATTENTION REQUIRES ACTS OF GREATER VIOLENCE
B) IMPROVING TECHNICAL PROFICIENCY
C) MORE RUTHLESS MEMBERS (SOCIETAL OUTCASTS)
D) GOVERNMENTAL DIRECTION AND SUPPORT
E) COMMUNICATION AMONG GROUPS
F) RELIGIOUS SANCTIONS
G) PUBLIC CONFUSED BY VICIOUSNESS
H) ANONYMITY OR PROCLAMATION

BOMBING STATISTICS UNITED STATES

	1983	1984	1985	1986	1987	1988
EXPLOSIVES	870	853	940	1033	1083	1094
INCENDIARIES	246	206	217	221	210	231

FBI LABORATORY RESPONSE TO TERRORISM

The FBI Laboratory is an integral part of the anti-terrorism and counter-terrorism programs of the U.S. Government. Involvement runs the gamut from training and research to forensic investigation and operational support. When tasked by the FBI's Criminal Investigative Division, technology and technicians can be swiftly sent to assist at an operational site or an investigative crime scene.

The FBI's role in responding to the terrorist bomb threat is quite unusual. While the FBI has primary jurisdiction within the United States in terrorist matters, the organization has no responsibility for render safe activities against an improvised explosive device. The FBI does, however, through its Bomb Data Center, have responsibility for compiling bombing statistics, publishing general and technical reports on bombs and render safe procedures, and conducting research into the positive use of explosives. It also administers and finances the Hazardous Devices School, the only civilian bomb technician school in the United States. The four-week basic course is complemented by an FBI financed one-week refresher program every 18-24 months. Regional bomb technician/bombing investigator seminars are also held throughout the year.

It is through this training function that the FBI exercises a strong influence over anti-terrorist planning and preparation in the United States. The preparedness of the public safety bomb technician is nurtured by effective training, reliable research, adequate equipment, and a response information network.

The FBI has a central role in each of these components while the nationwide public safety system retains the responsibility for render safe operations and bomb disposal. The preparation of a bomb technician is designed to meet the bombing threat whether it be organized crime, labor disputes, insurance plots or terrorism.

The Laboratory Division possesses two self-contained bomb disposal vehicles, one located at FBIHQ and the other at Redstone Arsenal. The vehicles contain a state-of-the-art bomb containment sphere designed to absorb the deadly pressure and fragmentation of an explosive device. Each truck also contains a bomb disposal robot and a bomb protection suit. X-ray equipment, explosive detectors, and a variety of disruption equipment are stored on the vehicles.

This equipment represents a response package designed to insure a variety of low risk alternatives for the render safe operation. The technical equipment supports the FBI philosophy of training at the Hazardous Devices School - **that no hand entry render safe procedure will be conducted unless a life is in imminent danger and there is no alternative.**

When this technical equipment is requested to support a public safety bomb squad in a special event or major case, the local bomb squad retains responsibility for the choice of removal or render safe procedure. FBI and HDS bomb technicians will assist in the operation of remote technical equipment.

All direct operational support performed by the FBI Laboratory in explosive matters must be in response to request from either the FBI field commander or through him from a public safety agency. All support is coordinated with the Criminal Investigative Division at FBI Headquarters.

The Explosives Unit of the FBI Laboratory provides forensic investigative support to all terrorist bombing crime scenes. They also process bombing evidence for both Federal and local jurisdictions. Their forensic capabilities are enhanced by other scientific elements of the Laboratory, such as the use of Thermal Energy Analyzers and Ion Chromatography. If a thorough crime scene is conducted and samples are properly taken, the explosives can be identified and reconstruction of the device can be attempted. It is critical that samples and evidence be located, even to the point of X-raying victims' bodies for pieces of components. A fully equipped mobile laboratory is stationed at FBI Headquarters to respond to emergency situations and major crime scenes.

For those terrorist incidents which occur beyond the borders of the United States, the FBI has received jurisdiction to investigate under the Protection of Foreign Officials Act and the Comprehensive Crime Control Act of 1984. This new jurisdiction in air piracy and hostage taking cases involving U.S. citizens or U.S. commercial carriers has brought about a new level of international cooperation within the law enforcement community. The FBI Laboratory is prepared to respond with technical assistance when requested by the host government. This assistance can be on-site forensic and technical support or the processing of evidence at the FBI Laboratory. These forensic science services must be coordinated with the U.S. Department of State.

HAZARDOUS DEVICES SCHOOL
REDSTONE ARSENAL, ALABAMA

ESTABLISHED 1971
FBI Administered Since 1981

GOAL: Provide Render Safe (Bomb Disruption and Disposal) Training to Public Safety Bomb Technicians

COURSE: **Basic Course - 4 Weeks**
Employer Pays Travel, Per Diem and Salary
Employer Commitment to Supply Essential Safety Equipment

Refresher Course - 1 Week
FBI Pays Travel and Per Diem
Employer Pays Salary
Recommended Every 36 Months

HAZARDOUS DEVICES SCHOOL
BASIC BOMB TECHNICIAN COURSE

SAFETY REQUIREMENT

EFFECTIVE JULY 1, 1987

The Public Safety Agency Sponsoring a Candidate for Bomb Technician Training in the Basic Course at the Hazardous Device School Must Furnish a Signed Commitment to Provide the Following Essential Safety Equipment Following Graduation or Include the Equipment on the Agency Budget:

1.) Bomb Suit
2.) X-Ray Equipment
3.) Disrupter
4.) Demolition Kit
5.) Quality Tools

ESSENTIAL SAFETY EQUIPMENT ALREADY POSSESSED BY A BOMB SQUAD WILL SATISFY THIS REQUIREMENT

BOMB TECHNICIANS AS A DETERRENT

It would be foolhardy for the United States to discount terrorism as a threat merely because domestic terrorism accounts for less than 2 percent of worldwide terrorism. The statistics demonstrate that U.S. diplomatic establishments, military bases, overseas corporate offices, and the people who work in them continue to be international terrorist targets. While we continue our efforts, in concert with host governments, to improve protection overseas, we should not misinterpret our domestic statistics. Domestic terrorist incidents are declining due to active efforts by law enforcement in preventing terrorist acts. These prevention activities are being publicized so that the American people will maintain their awareness of the terrorist threat while a sense of confidence is engendered regarding law enforcement as a deterrent.

Training is the most critical element in preparing a bomb technician to meet the challenge of an improvised device. Skill, competence and confidence can be accomplished through technical training. There is no question that experience is a key factor but it is not the only critical factor. The role of effective training is to carefully scrutinize an actual render safe procedure from a technical perspective so that a structural diagram of the device can be reproduced for the bomb technician community. For instance, in preparing for the Olympic Games, the Bomb Data Center assembled a technical portfolio of international devices. Bomb technicians were challenged to duplicate the devices and render safe techniques were undertaken in a competitive manner wherein one team constructed a device and another team was responsible for the render safe procedure. Simulation in a training environment is an extremely effective procedure for improving competence and inspiring confidence.

The success of this procedure rests on the unrestricted sharing of technical data on improvised explosive devices. Many countries, including the United States, place security classifications on all information regarding a terrorist act or a terrorist organization. There are very logical reasons for these security restrictions. Unfortunately, however, if the technical information regarding the explosive device is buried under security classifications our concept of simulation in training is doomed. In an effort to minimize these restrictions, the FBI Bomb Data Center has solicited technical information absent any background data on the specific terrorist groups. Most bomb technicians are specialized personnel who do not need to know identities of suspected members of a terrorist group or its political aims. These are areas handled by intelligence officers and investigators. But the bomb technician does want to know how a bomb was created so that the intricacies of the firing train can be painstakingly analyzed for render safe purposes. We believe we have been successful to some degree in uncovering technical data but we also realize that there remains a large body of technical information which is unfairly hidden from bomb technicians because of the all encompassing characteristics of security classifications.

A curious phenomenon occurs when a sufficient amount of technical information is shared within the bomb technician community. The myth of terrorism begins to erode as you study the design of various devices. When the name of the terrorist group is removed from the body of knowledge, when the actual terrorist act in which the device functioned is unknown, when the emotion of the political cause is strained from the technical data, the bomb technician begins to view the bomb for what it really is, a criminal act. The massive worldwide media coverage of terrorist acts has glamorized the criminal act and has deceived the public, and even law enforcement, into believing that terrorism is a separate entity. Our bomb technician community, operating from a body of technical information on devices, has the unique opportunity to treat bombings as a criminal act, the nucleus frequently obscured by labels.

The bomb technician's job is a complex technical job which cannot be effectively executed by a transient population. The technician must make a commitment of time to this profession. In return, we must provide the technician with the best possible training, both basic and refresher, to provide the necessary level of competence and confidence. The technician must have access to technical information to improve acquired skills, and must have the best equipment to limit the risk inherent in the improvised device. These are attainable goals and I believe we are moving in the right direction of minimum standards for training and equipment.

The render safe operation, whether it be a disruption or a removal, should utilize all available technology including X-ray, bomb suits, explosive detection canines, and bomb disposal robots. Each phase of the operation must be conducted in the safest manner possible. If the suspect package is not a bomb, the render safe operation is a realistic training exercise which can be evaluated. It is critical that the bomb squad procedures follow the axiom formulated by the New York City Police Department bomb squad: "Until it is not a bomb, it is a bomb!"

The minimal equipment for a bomb technician should be a proper set of tools, an X-ray machine, a bomb suit, and a disrupter. Ideally, a remote render safe procedure would include the use of a bomb disposal robot and a bomb suppression or containment vehicle. Unfortunately, economics frequently dictate the technical equipment available to a bomb technician and may result in escalating the risk inherent in a render safe operation. While we would expect responsible administrators to adequately equip bomb squads to safely provide a proper response, the fear of civil liability is often the primary motivator and usually follows a disastrous incident.

There has been a conscious effort since 1984 to publicize the level of technology available to bomb squads. On the one hand, administrators are alerted to the technology available while on the other, the public is given a window into a relatively unknown segment of law enforcement. This is all part of the package of law enforcement techniques and technology designed to assuage the apprehension of the public and deter the bombing activities of the terrorist.

It should be noted that the highlighting of available technology does not include the release of actual render safe procedures. Prior to 1984 it was common practice that bomb squad equipment and techniques be hidden from public or media view. During the Olympic Games in Los Angeles, part of the game plan for deterrence included a large scale show of force by public safety agencies. It was well publicized beforehand, and the visitors and spectators at the various events were conditioned to expect a high level of protection. After-action reports indicated that the public felt more secure seeing some of the protective equipment of the public safety agencies. The FBI and other law enforcement agencies utilized a similar approach at political conventions, the fortieth anniversary of the United Nations, the rededication of the Statue of Liberty and the Pan Am Games. With terrorism as a major concern, the public is reassured by a show of protective force. It is always difficult to evaluate the effectiveness of deterrence, but we have not experienced a serious incident at any of these large scale special events.

Bomb Squads within the United States are encouraged to follow these principles in establishing their operational procedures:

1) Preservation of Life is Paramount

   This applies to the citizen and bomb technician. Protection of property should never be the criteria for risking the life of a bomb technician.

2) Procedures Must Be Clear and Consistent

The organization must have established acceptable procedures for handling bomb disposal/render safe activities.

3) Training Builds Technical Competence

The level of technology in this field demands constant acquisition of knowledge and practice with equipment and procedures.

4 Decisions Based on Facts and Technology

Render safe decisions must be based on procedures and available facts. Any operation must utilize all available technology to insure the lowest risk possible.

The bomb technician in America is part of the criminal justice system. The techniques and technology of the bomb technician are focused on the preservation of public safety. It does not matter to the bomb technician that the improvised explosive device was made and placed by a terrorist or an extortionist. They are both criminal acts which require a safe, professional response. The ideology, politics, religion or distorted value judgments of the criminal do not intrude on the technically proficient response. Therefore, the police bomb technician who maintains an adequate level of technical training and professional preparedness is capable of an effective response to a terrorist bomb. If it is a pre-blast scenario, this will hopefully be a successful render safe operation. If it is post blast, the bomb technician becomes a critical player in the traditional law enforcement task of gathering evidence necessary to support a successful investigation and prosecution.

In 1984, shortly after the bombing of the Grand Hotel in Brighton, the Provisional Irish Republican Army issued a communique which stated "you must be lucky all the time, we only have to be lucky once." Effective law enforcement does not rely on luck but rather on progressively developed practices and techniques. If a police bomb technician utilizes the professionally accepted techniques available, technology and sound procedures become preeminent in the render safe operation. While risk can never be eliminated, preparedness removes any reliance on luck.

NATIONAL GUIDELINES FOR BOMB TECHNICIANS

SAFETY PRINCIPLES

1.) Do NOT Hand Enter Pipe Bombs
2.) Human Life Shall not be Placed in Jeopardy for the Purpose of Securing or Preserving Evidence or Property
3.) A Bomb Squad Response Team Must Include Two (2) Bomb Technicians with Essential Safety Equipment
4.) Only Bomb Squad Personnel or Those Requested by the Bomb Squad Shall be Permitted within the Bomb Squad Operation Perimeter
5.) Paramedics and Emergency Fire Personnel Shall be Present when the Bomb Squad Responds to the Scene of a Suspicious Item

OPERATIONAL RESPONSE GUIDELINES

A.) ON ARRIVAL AT THE SCENE

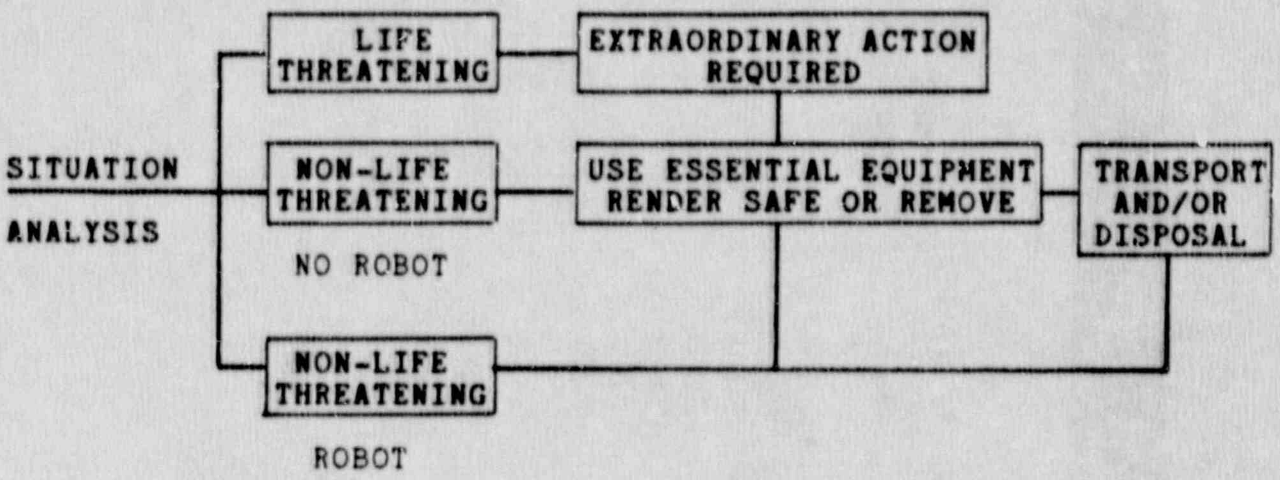
1.) Confirm Evacuation Perimeter
2.) Gather Information for Evacuation

B.) SITUATION ANALYSIS

1.) LIFE THREATENING
- a.) Determine Clear and Present Threat to Life, Including Bomb Technician
- b.) Take Appropriate Action to Reduce Threat
- c.) When Threat to Life is Eliminated, Revert to Non-Life Threatening Procedures

2.) NON-LIFE THREATENING
- a.) Utilize Essential Safety Equipment Unless Physically Impossible Due to Environment
- b.) Employ Remote Procedures and Techniques
- c.) If Possible, Execute Safe Removal, Transportation and Disposal

Decision Making Process



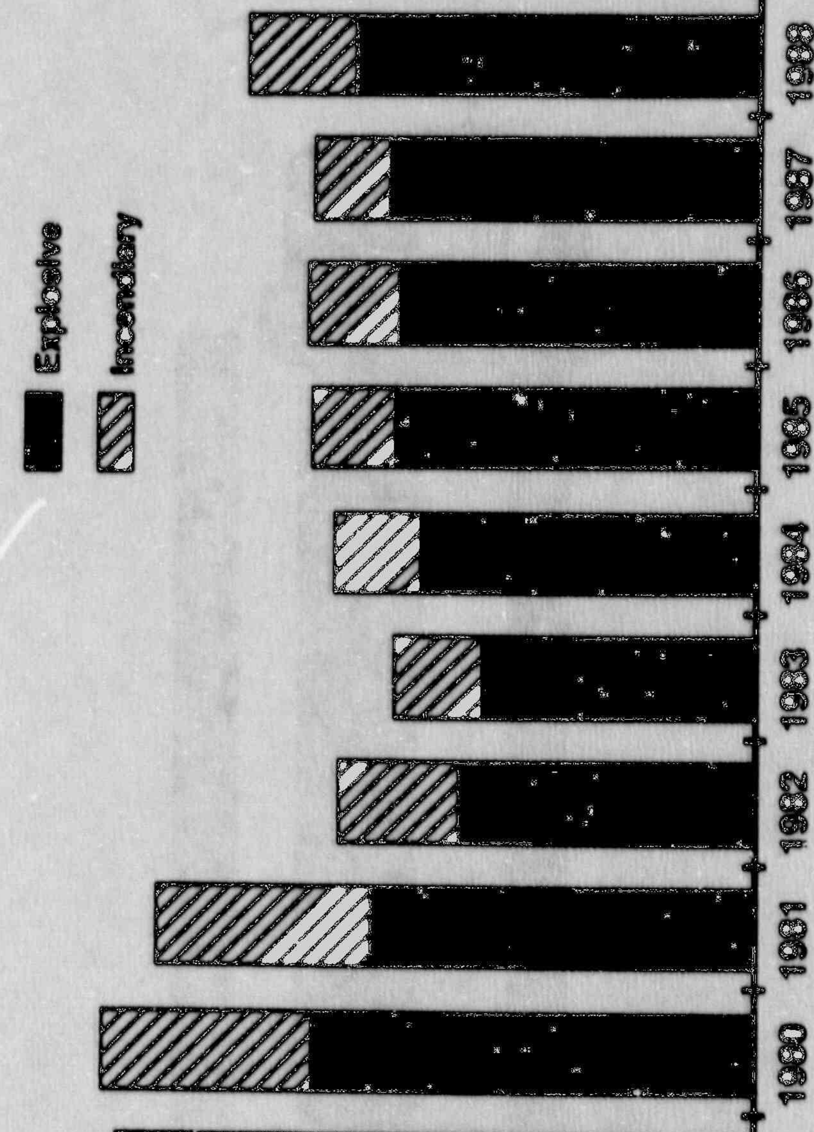
C.) SET PRIORITIES

1.) Public Safety
2.) Safety of Officer on Scene (Including Bomb Technicians)
3.) Protection and Preservation of Public and Private Property
4.) Collection and Preservation of Evidence
5.) Convenience to the Public/Restoration of Services

BOMBING INCIDENTS 1978 – 1988

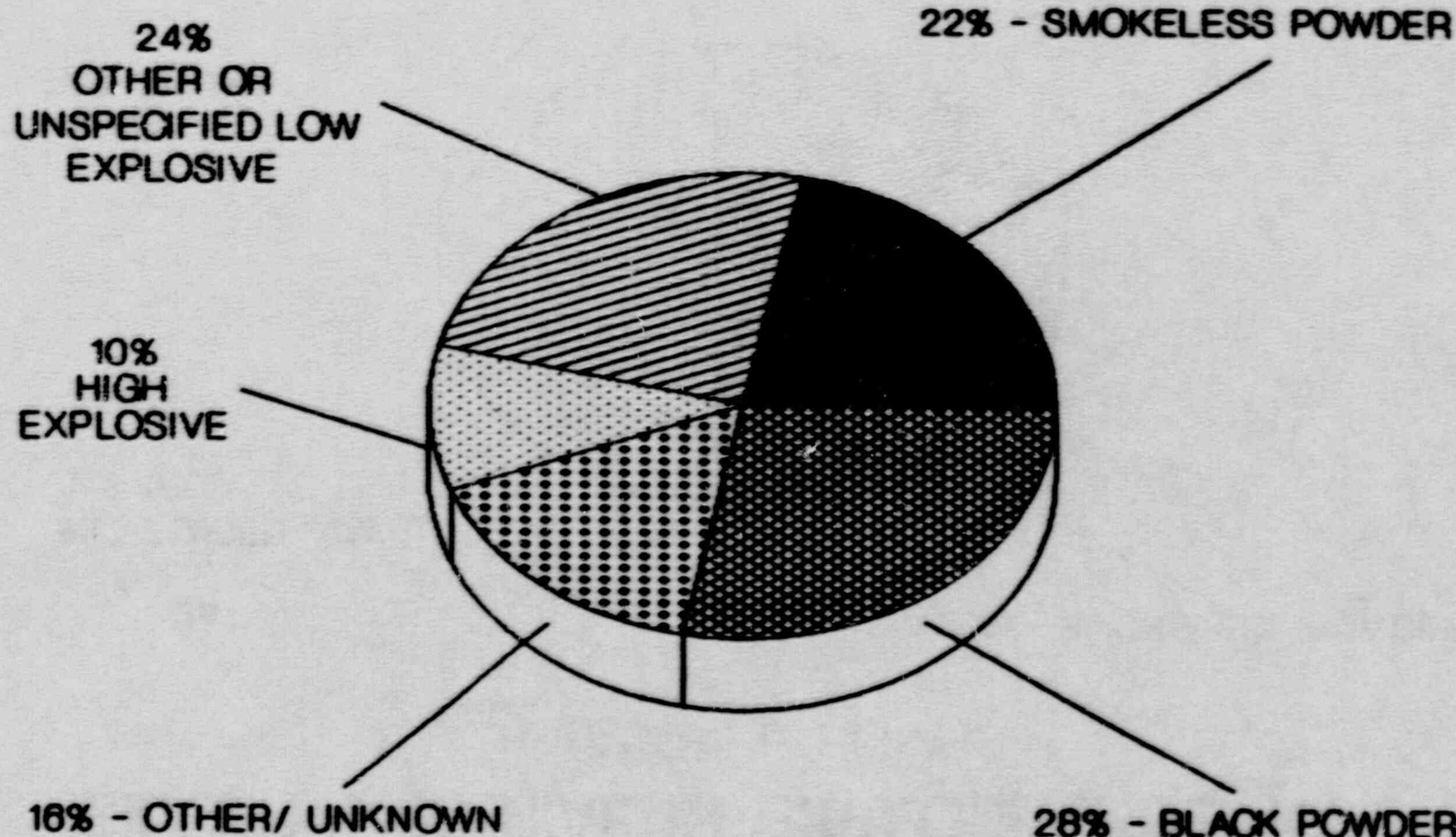
Year	Total	Actual Explo.	Actual Incend.	Attempts Explo.	Attempts Incend.	Property Damage (Dollar Value in Thousands)	Persons Injured	Deaths
Total	**10,727**	**6,668**	**2,244**	**1,149**	**639**	**133,458**	**1,493**	**221**
1978	1,301	768	349	105	79	9,161	135	18
1979	1,220	728	305	104	83	9,273	173	22
1980	1,249	742	336	99	72	12,562	160	34
1981	1,142	637	315	92	98	67,082	133	30
1982	795	485	194	77	39	7,203	99	16
1983	687	442	127	77	41	6,343	100	12
1984	803	518	127	118	40	5,619	112	6
1985	847	575	102	113	57	6,352	144	28
1986	858	580	129	101	48	3,405	185	14
1987	848	600	104	102	42	4,201	107	21
1988	977*	593	156	161	40	2,257	145	20

* Total includes 27 incidents involving combination devices.


Explosive
Incendiary
1400
1200
1000
800
600
400
200
0
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988

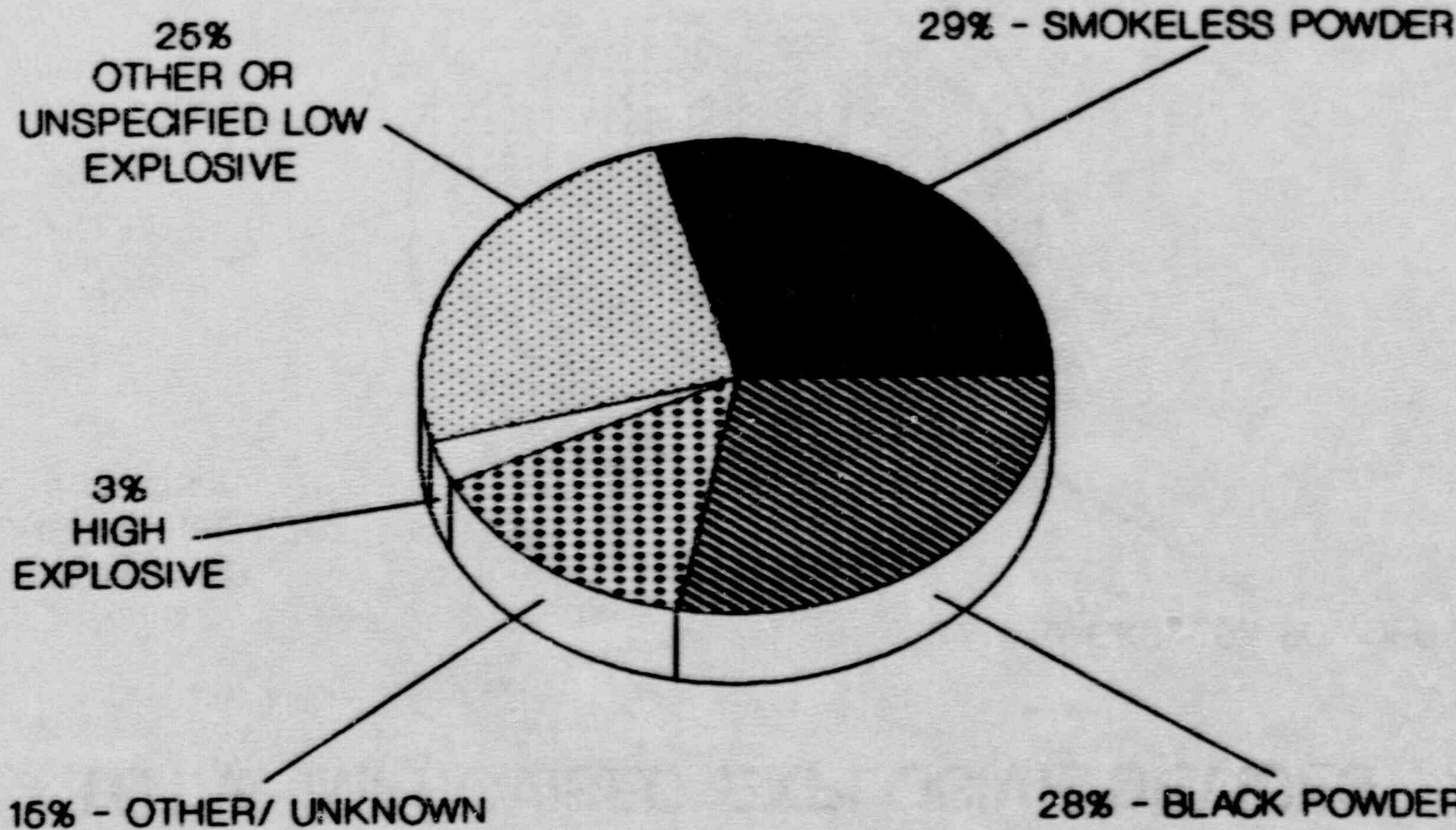

Pipe Bombs Represent 62% of Total IEDS Reported

TOTAL IMPROVISED EXPLOSIVE DEVICES



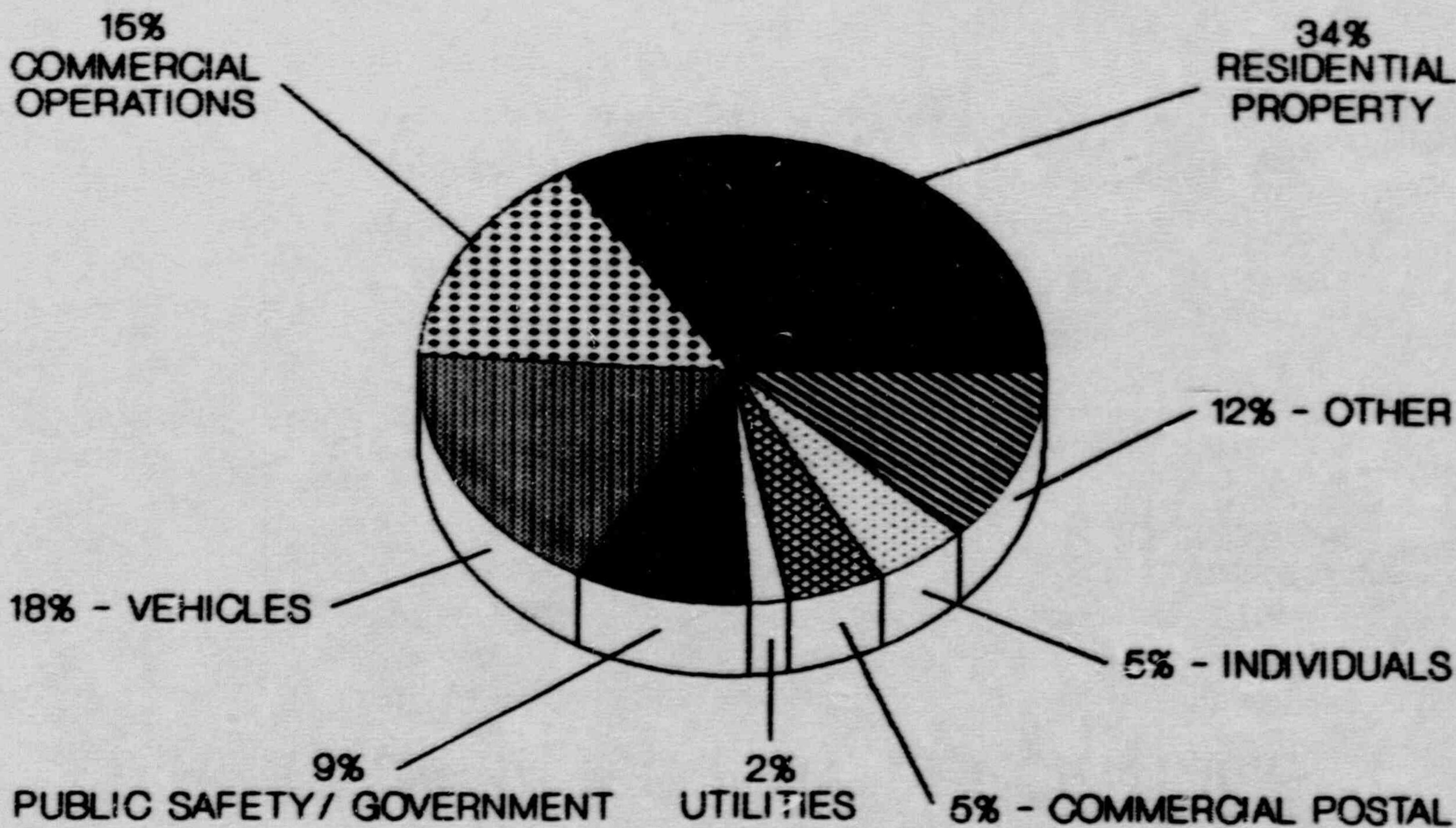
FILLER MATERIAL IN EXPLOSIVE DEVICES

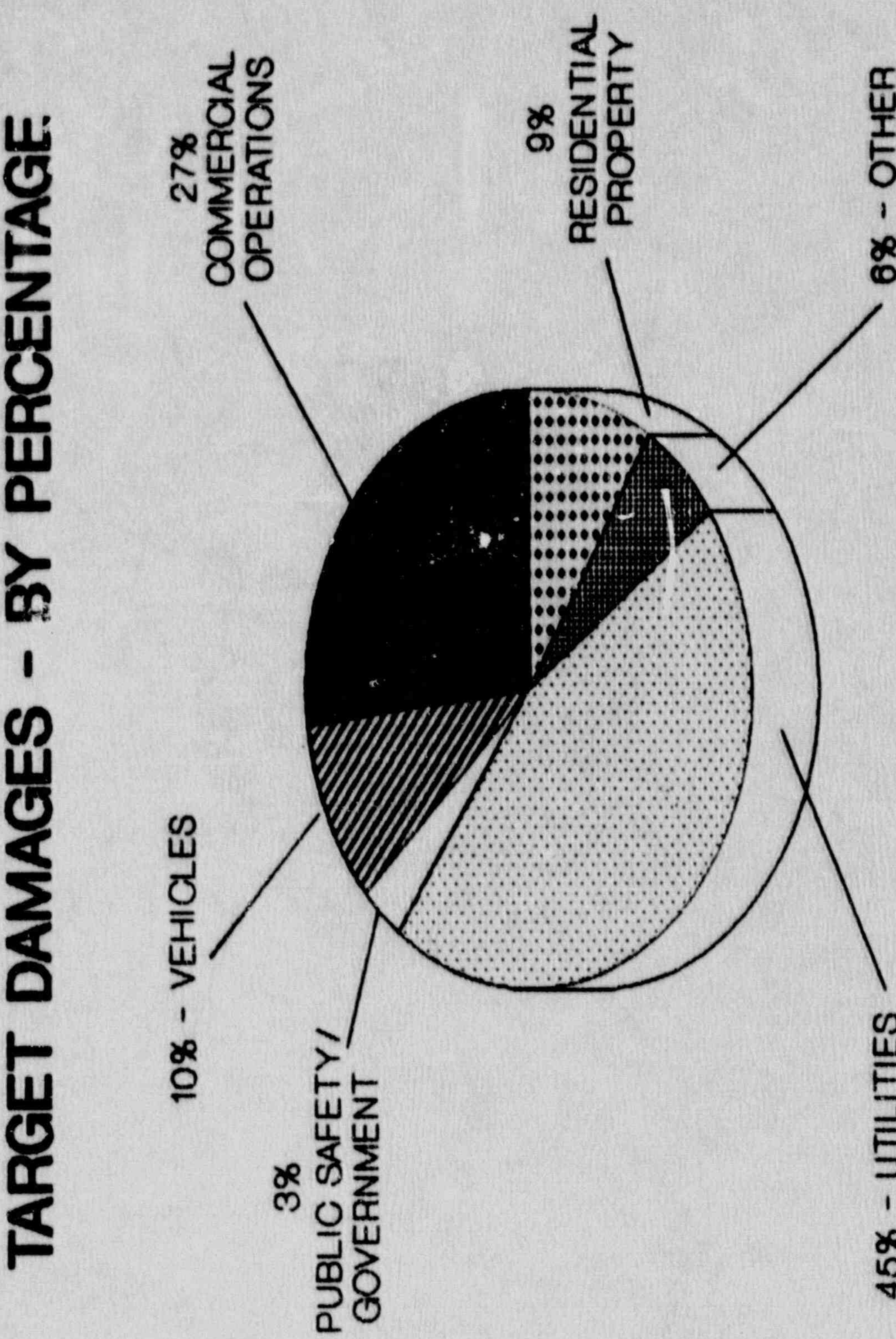
TOTAL PIPE BOMBS



TARGETS - 1988

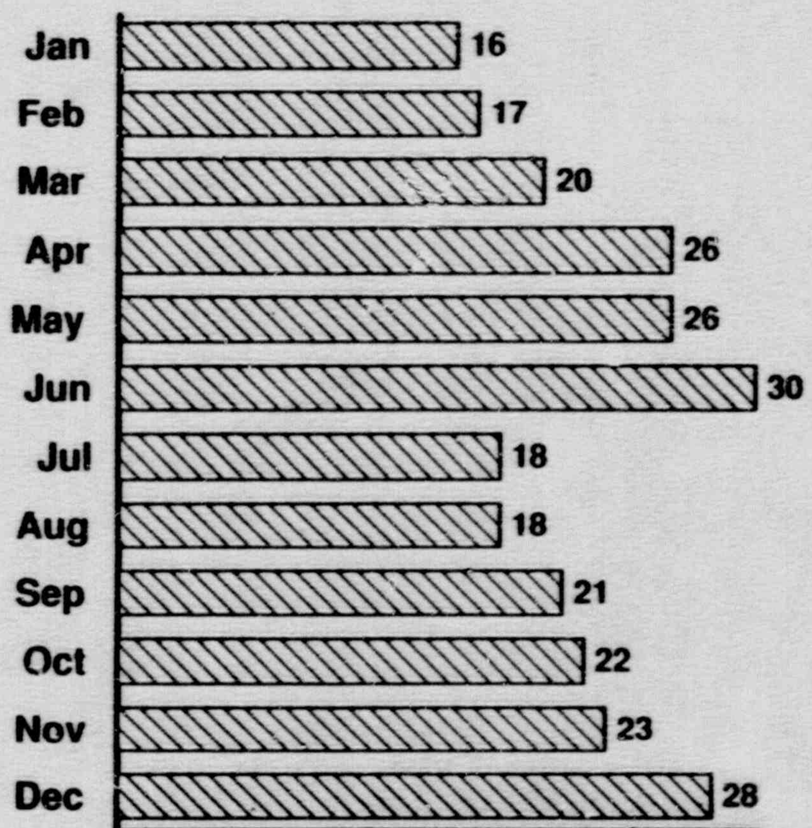
TARGETS - BY PERCENTAGE




TARGET DAMAGES - BY PERCENTAGE
27% COMMERCIAL OPERATIONS
9% RESIDENTIAL PROPERTY
6% - OTHER
45% - UTILITIES
3% PUBLIC SAFETY / GOVERNMENT
10% - VEHICLES

INCIDENTS INVOLVING HOAX DEVICES

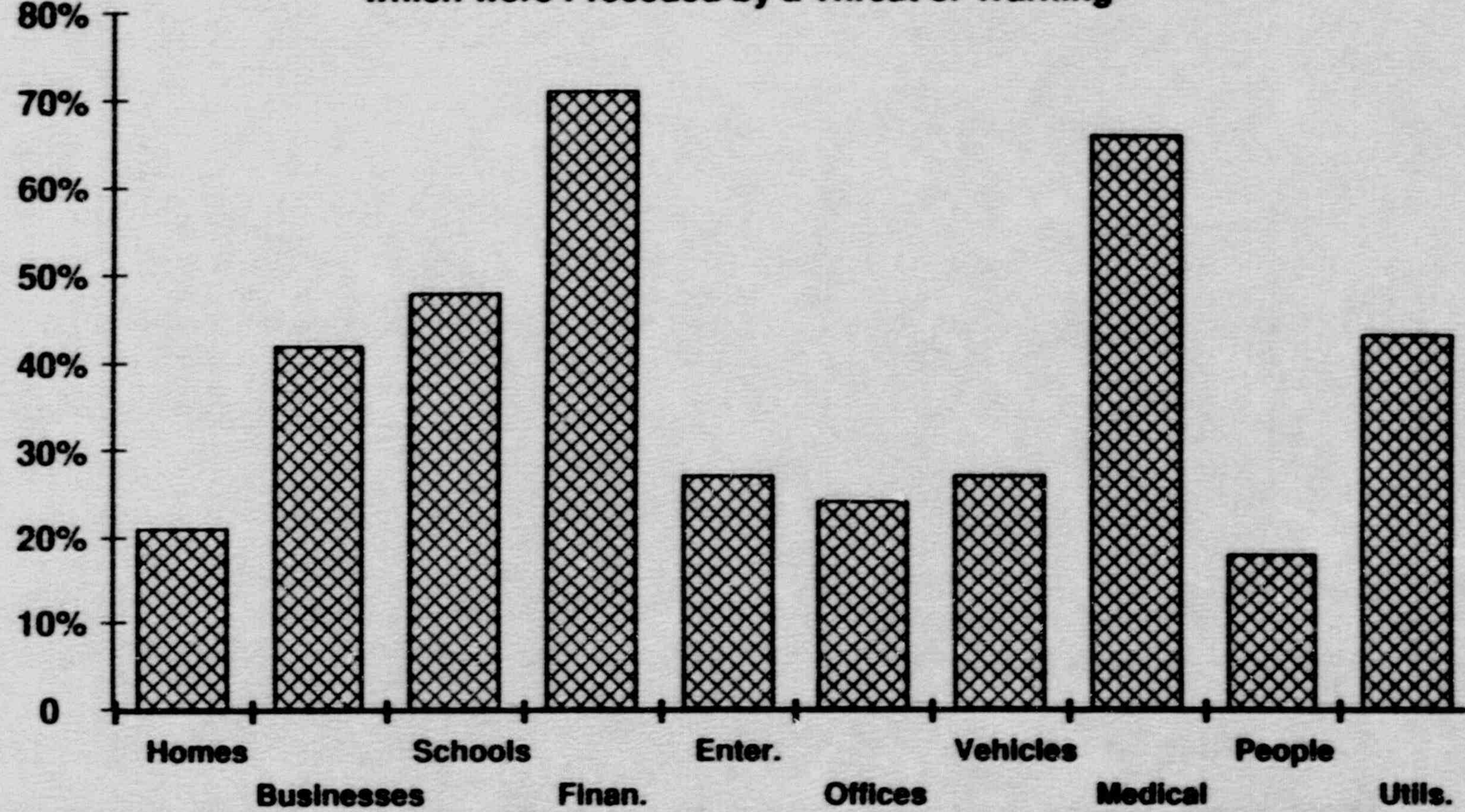
By Month



By Target

Target	Incidents
Homes	38
Businesses	45
Schools	23
Financial Institutions	38
Entertainment Facilities	11
Offices	17
Vehicles	11
Medical Facilities	3
Individuals	11
Utilities	7
Other/None	61

Percentage of Incidents Involving Hoax Devices which were Preceded by a Threat or Warning



U.S. Department of Justice
Federal Bureau of Investigation

FBI
Bomb Data Center
INTRODUCTION TO EXPLOSIVES

(Modified)

SECTION 1

EXPLOSIONS

TYPES OF EXPLOSIONS

An explosion may be broadly defined as the sudden and rapid escape of gases from a confined space, accompanied by high temperatures, violent shock, and loud noise. The generation and violent escape of gases are the primary criteria of an explosion and are present in each of the three basic types of explosions.

Mechanical

A mechanical explosion may be illustrated by the gradual buildup of pressure in a steam boiler or pressure cooker. As heat is applied to the water inside the boiler, steam is generated. If the boiler is not equipped with some type of safety valve, the mounting steam pressure will eventually reach a point at which it will overcome the structural or material resistance of its container and an explosion will occur. Such a mechanical explosion would be accompanied by high temperatures, a rapid escape of gases or steam and a loud noise. Another example of mechanical explosion is that of a dust explosion in a grain elevator.

Chemical

A chemical explosion is caused by the extremely rapid conversion of a solid or liquid explosive compound into gases having a much greater volume than the substances from which they are generated. The entire conversion process takes only a fraction of a second, produces extremely high temperatures (several thousand degrees) and is accompanied by shock and loud noise. With the single exception of nuclear explosives, all manufactured explosives are chemical explosives.

Nuclear

A nuclear explosion may be induced either by fission (the splitting of the nuclei of atoms) or fusion (the joining together under great force of the nuclei of atoms). When fission or fusion occurs, a tremendous release of energy, heat, gas and shock takes place. The nuclear bombs dropped on Japan in World War II were rated as equivalent to 40 million pounds (18.2 million kg) of TNT in explosive power, yet the amount of fissionable material required to produce this energy weighed approximately 2.2 pounds (1 kg).

NATURE OF CHEMICAL EXPLOSIONS

The explosives normally encountered by public safety personnel are chemical in nature and result in chemical explosions. In all chemical explosions, the changes which occur are the result of combustion or burning. Combustion of any type produces several well-known effects: heat, light and release of gases. The burning of a log and the detonation of a stick of dynamite are similar because each changes its form and, in doing so, produces certain effects through combustion. The real difference between the "burning" of the log and the "detonation" of the dynamite is in the rate of the combustion process.

Ordinary Combustion (Slow Combustion)

For combustion to occur, a combustible material (something that can be burned) and a supporter of combustion (something that will stimulate burning) must be brought together and the temperature raised to the point of ignition. The most effective supporter of combustion is oxygen. Air, which contains 21 parts of oxygen, serves as the most common source of support for combustion. In ordinary combustion, which is a common occurrence, the elements of the combustible material unite with the elements of the supporter to form a new and different product.

To build a fire of large logs, it is first necessary to lay a foundation of combustible materials, such as paper or wood shavings, which has a low ignition temperature. Next a layer of small kindling is added and finally, the logs are placed in position. Beginning with the lighting of the match, the process of combustion is progressive and each layer of material is ignited as its ignition point is reached. As long as fuel and oxygen are supplied, combustion will continue, heat will be created and gases will be formed and then released. Flames, which are particles heated to incandescence, and smoke, which is unoxidized particles suspended in air, will be visible. In normal combustion, this progressive sequence can be followed visually and is essentially the same process which occurs at a greatly increased rate in a chemical explosion.

Explosion (Rapid Combustion)

An example of explosion (rapid combustion) is illustrated by the internal combustion automobile engine. Inside the cylinder of the engine, combustible fuel (gasoline) is mixed with a combustion supporter (air) and the mixture is raised close to its ignition temperature by compression. When a flame from the spark plug ignites the mixture, rapid combustion (explosion) occurs. An explosion is merely a rapid form of combustion and ordinary combustion is simply a slow form of explosion. The speed of the burning action constitutes the difference between combustion, explosion and detonation.

Detonation (Instantaneous Combustion)

Detonation can be defined as "instantaneous combustion." However, even in detonation, the most rapid form of combustion, there must be some time interval in order that the combustion action can be transferred from one particle of the explosive compound to the next. Therefore, there cannot be "instantaneous" combustion, but the extreme rapidity of the process, as compared to that of ordinary combustion and explosion, warrants the use of the term.

The velocity of this instantaneous combustion has been measured for most explosives and is referred to as the detonation velocity of the explosive. Detonation velocities of high explosives range from approximately 3,300 f/s (1,006 m/s) to over 29,900 f/s (9,117 m/s). As an illustration of detonation velocity, if a 26,400 ft (8,047 km) length of garden hose were filled with a high explosive called RDX (detonation velocity 26,800 f/s or 8,169 m/s) and initiated at one end, the detonation would reach the other end in less than one second.

A high order detonation is a complete detonation at its designed velocity. A low order detonation is either incomplete detonation or complete detonation at lower than maximum velocity. Low order detonations may be caused by any one or a combination of the following factors.

Initiator (blasting cap) of inadequate power
Deterioration of the explosive
Poor contact between the initiator and the explosive
Lack of continuity in the explosive (air spaces)

EFFECTS OF AN EXPLOSION

When an explosive is detonated, the block or stick of chemical explosive material is instantaneously converted from a solid into a rapidly expanding mass of gases. The detonation of the explosive will produce three primary effects and several secondary effects which can create great damage in the area surrounding the explosion. The three primary effects produced are blast pressure, fragmentation and incendiary or thermal as illustrated in Figure 1.

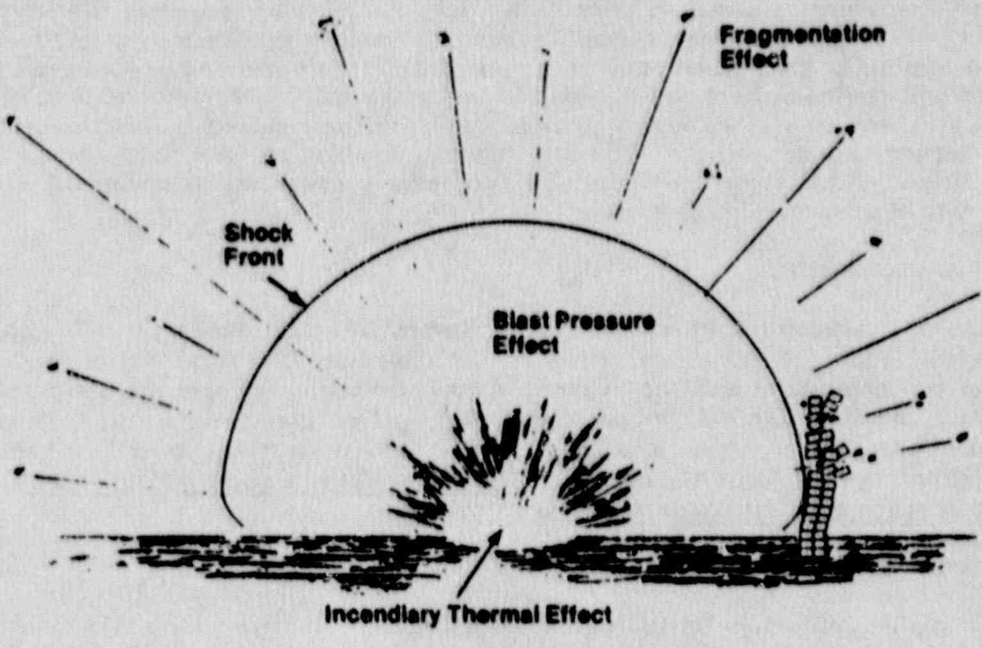


FIGURE 1: EFFECTS OF AN EXPLOSION.

Blast Pressure Effect

When an explosive charge is detonated, very hot, expanding gases are formed in a period of approximately 1/10,000th of a second. These gases exert pressures of about 700 tons per square inch on the atmosphere surrounding the point of detonation and rush away from the point of detonation at velocities of up to 13,000 miles per hour (20,917 km/hour), compressing the surrounding air. This mass of expanding gas rolls outward in a spherical pattern from the point of detonation like a giant wave, weighing tons, smashing and shattering any object in its path. Like an ocean wave rushing up on the beach, the further the pressure wave travels from the point of detonation, the less power it possesses until, at a great distance from its creation, it dwindles to nothing. This wave of pressure is called the blast pressure wave.

The blast pressure wave has two distinct phases which will exert two different types of pressures on any object in its path. These phases are the positive pressure phase and the negative pressure or suction phase.

The Positive Pressure Phase. When the blast pressure is formed at the instant of detonation, the pressures actually compress the surrounding atmosphere. This compressed layer of air becomes visible in some cases as a white, rapidly expanding circle. Known as the shock front, this layer of compressed air is the leading edge of the positive pressure wave.

As the shock front, followed by the positive pressure wave, moves outward, it applies a sudden shattering, hammering blow to any object in its path. Thus, if it should strike an object such as a brick garden wall, the shock front will deliver a massive blow to the wall followed instantly by the strong winds of the positive pressure wave itself. The shock front shatters the wall, and the positive pressure wave gives it a cyclone-like sudden and violent push which may cause all or part of the wall to topple in a direction away from the point of detonation. The positive pressure phase lasts only a fraction of a second. After striking the wall, the positive pressure wave continues to move outward until its power is lost in the distance traveled. Figures 2 and 3 illustrate conditions prior to an explosion and the effects of the positive pressure phase.

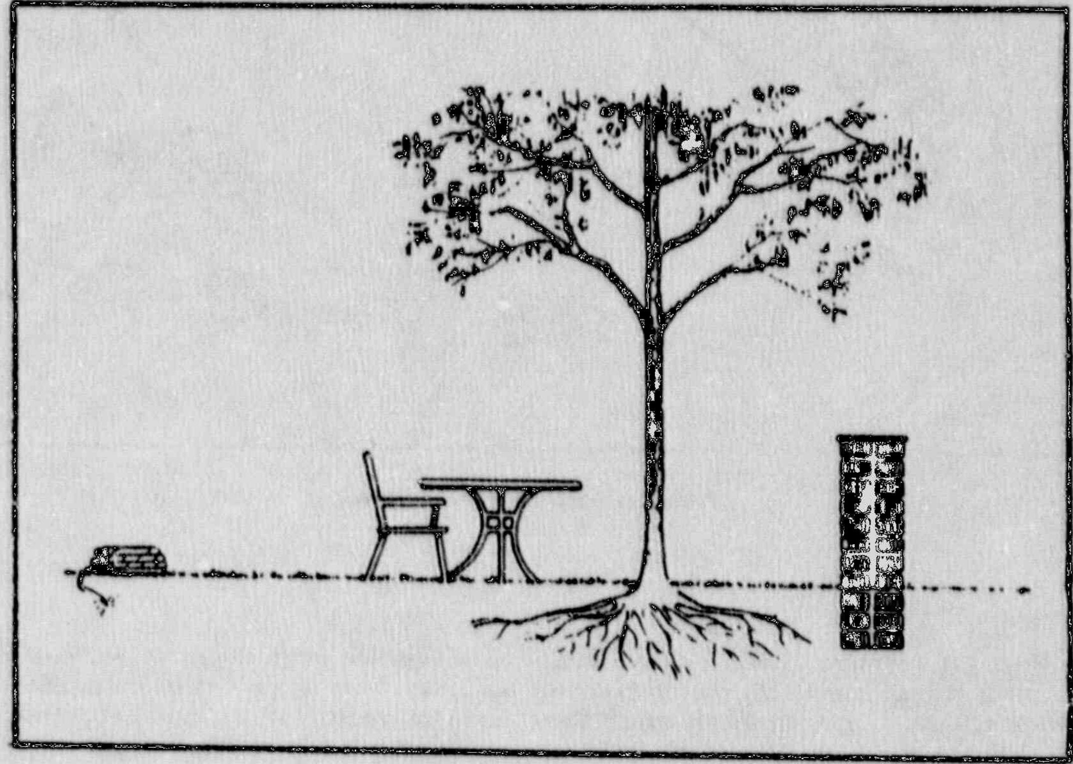


FIGURE 2: CONDITIONS PRIOR TO EXPLOSION.

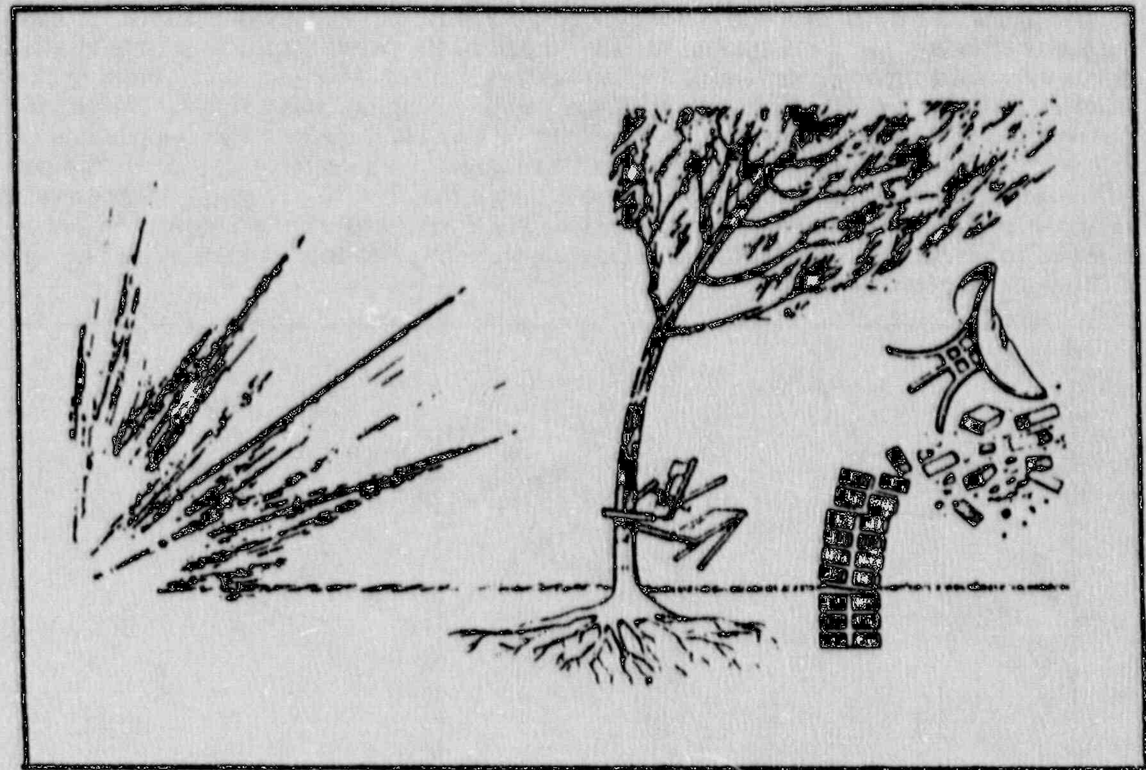


FIGURE 3: POSITIVE PRESSURE PHASE OF AN EXPLOSION.

The Negative Pressure Phase. At the instant of detonation when the positive pressure wave is formed, it begins to push the surrounding air away from the point of detonation. This outward compressing and pushing of air forms a partial vacuum at the point of detonation so that when the pressure wave finally dwindles to nothing, a broad partial vacuum exists in the area surrounding the point of detonation. This partial vacuum causes the compressed and displaced atmosphere to reverse its movement and rush inward to fill the void. This reaction of the partial vacuum and the reverse movement of the air is known as the negative pressure or suction phase.

The displaced air rushing back toward the point of detonation has mass and power, and although this air is not moving nearly as fast inward as the pressure wave was moving outward, it still has great velocity. If the force of a positive pressure wave can be compared to a cyclone, then the negative pressure wave is comparable to a strong gale. This inward rush of displaced air will strike and move objects in its path as shown in Figure 4. When it strikes the brick garden wall, it causes additional portions of the already shattered and violently battered wall to topple, but this time in a direction toward the point of detonation. Figure 5 illustrates the conditions when all explosive effects have ceased.

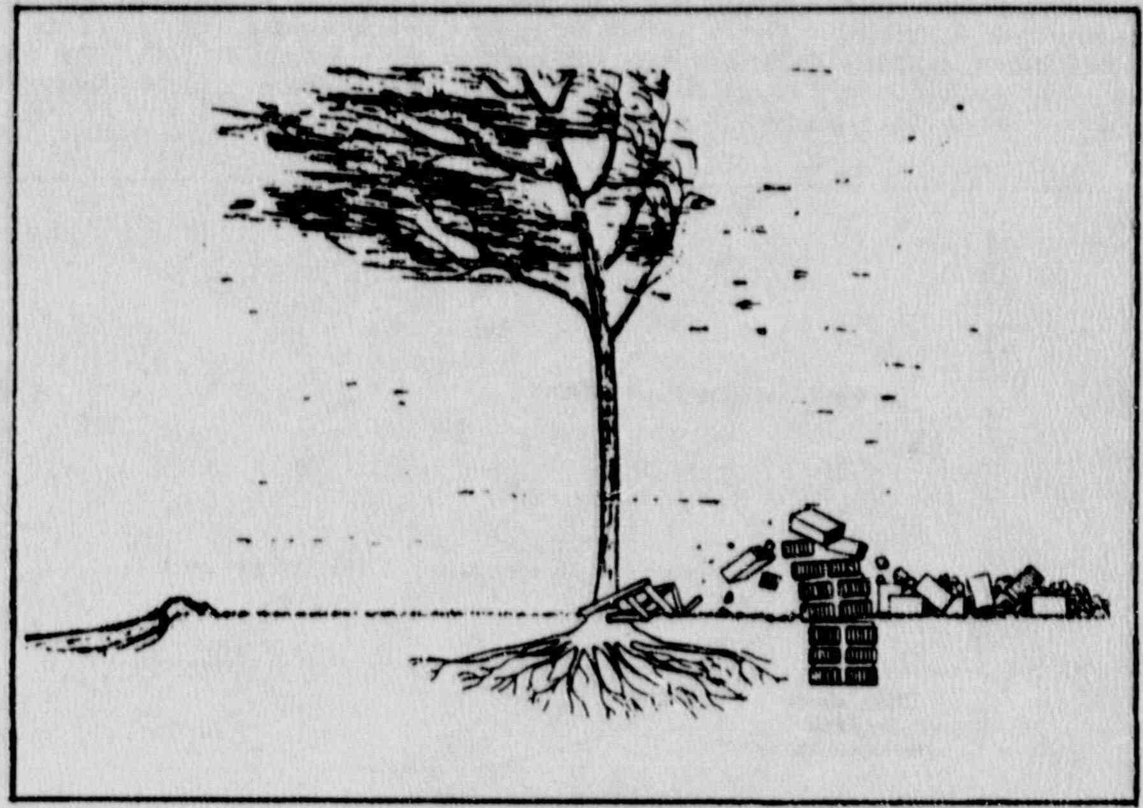


FIGURE 4: NEGATIVE PRESSURE PHASE OF AN EXPLOSION.

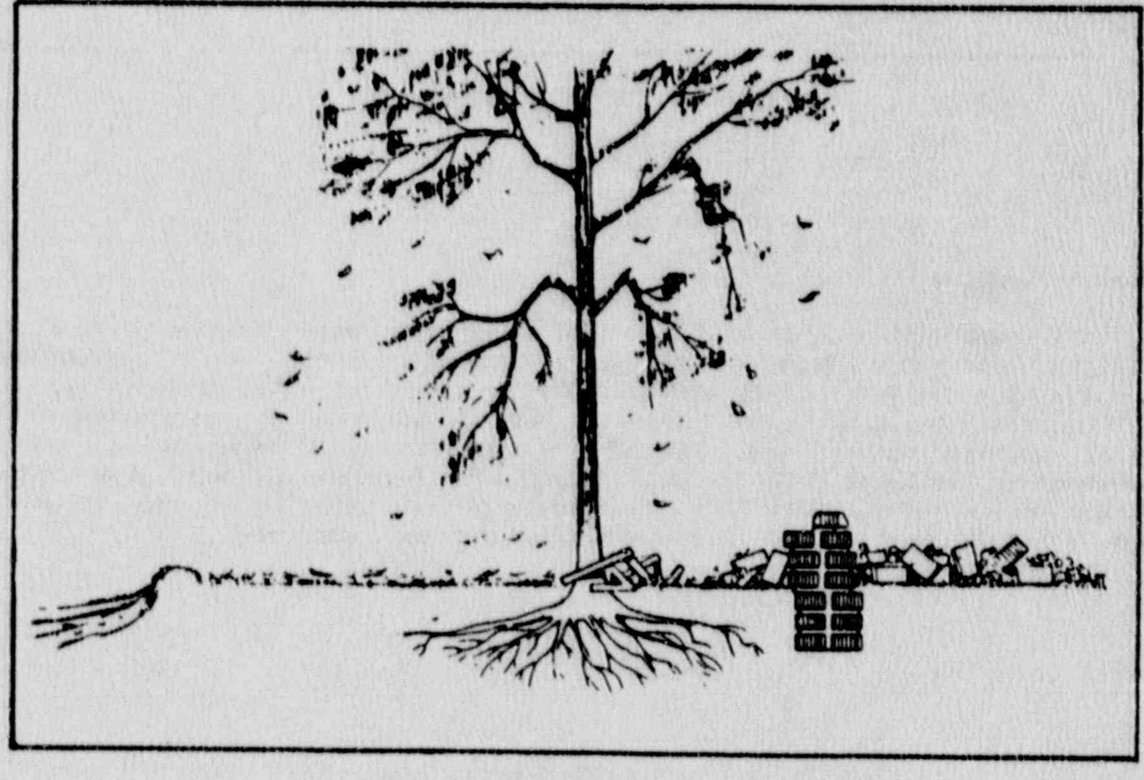


FIGURE 5: CONDITIONS AFTER AN EXPLOSION.

The negative phase is less powerful, but lasts three times as long as the positive phase. This relationship is illustrated in Figure 6. The entire blast pressure wave, because of its two distinct phases, actually delivers a one-two punch to any object in its path. The blast pressure effect is the most powerful and destructive of the explosive effects produced by the detonation of high explosives.

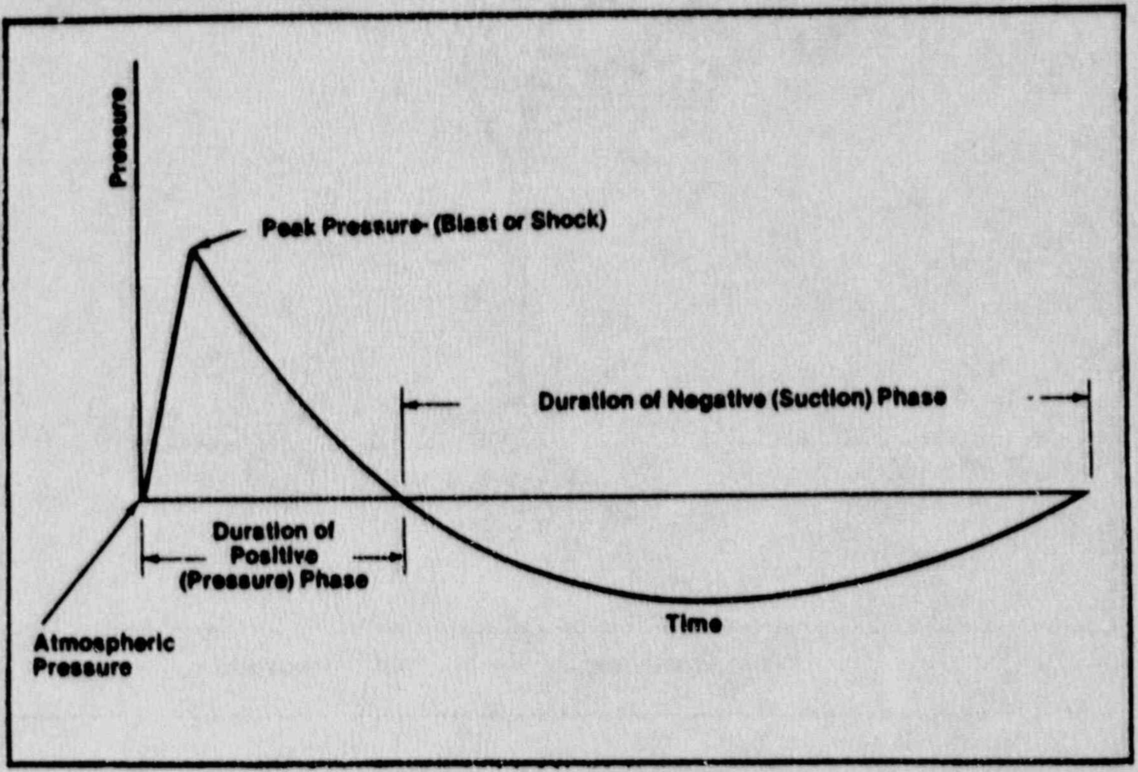


FIGURE 6: TIME PHASES OF A BLAST WAVE.

Fragmentation Effect

A simple fragmentation bomb is composed of an explosive placed inside a length of pipe which has the end caps screwed into place, as illustrated in Figure 7. When the explosive is detonated, not only will the blast pressure effect produce damage, but shattered fragments of the pipe will be hurled outward from the point of detonation at great velocity. The average fragment produced by the detonation of a bomb will reach the approximate velocity of a military rifle bullet (2,700 f/s or 823.0 m/s) a few feet from the point of detonation. These bomb fragments will travel in a straight line of flight until they lose velocity and fall to earth or strike an object and will either ricochet or become imbedded.

When an encased explosive, such as a pipe bomb, detonates, the rapidly expanding gases produced by the explosion cause the casing to rupture and break into fragments. Fragments resulting from the detonation of a high explosive filler have a stretched, torn and thinned configuration due to the tremendous heat and pressure produced by the explosion. In contrast, the detonation of a pipe bomb containing black powder, a low explosive, would produce fragments which are larger in size than those resulting from a high explosive detonation and they would not have a stretched and thinned configuration. Typical low explosive filled pipe bomb fragments are illustrated in Figure 8.

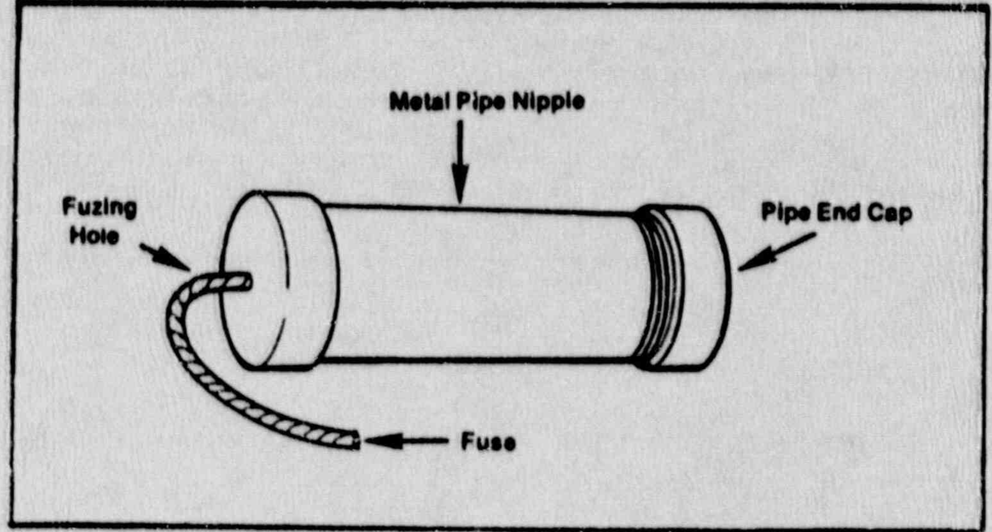


FIGURE 7: PIPE BOMB.

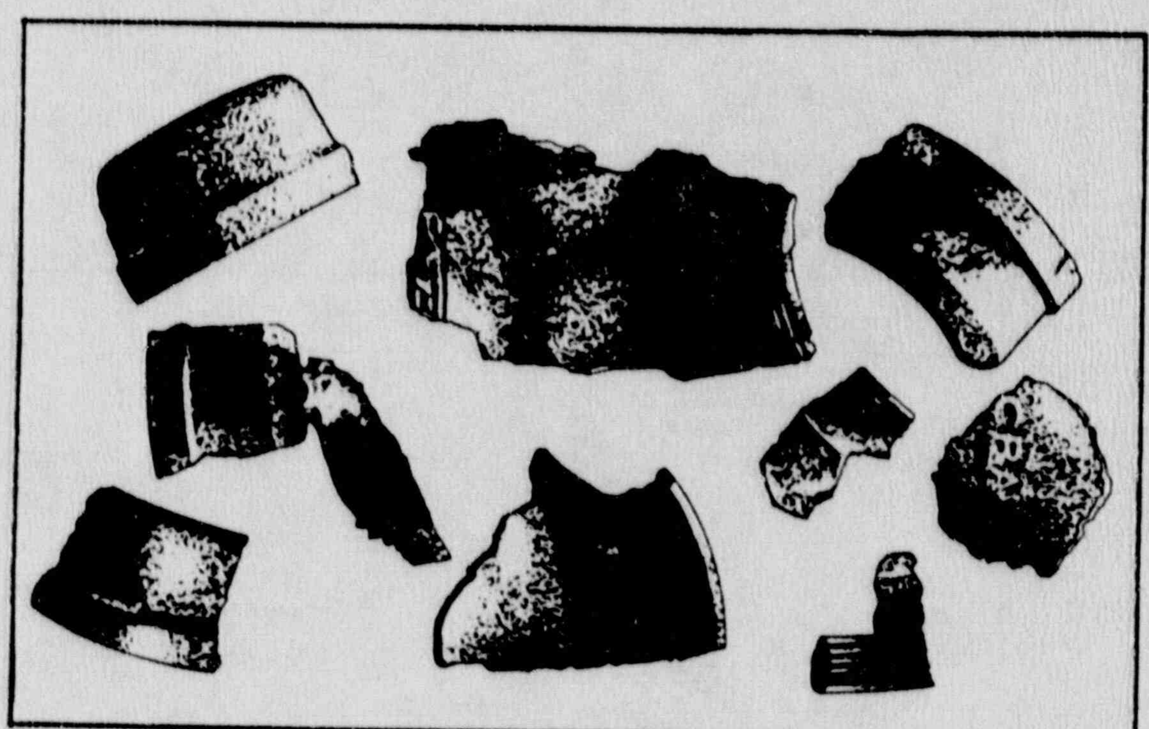


FIGURE 8: TYPICAL LOW EXPLOSIVE BOMB FRAGMENTS

Occasionally, pieces of a pipe bomb will be recovered. If the bomb casing containing either a high or low explosive has been precut or serrated with deep groves, which normally cross each other, then the fragments produced will have a rather uniform size, shape and weight. This technique of grooving, which is known as serration, or pre-engraving, is illustrated, as applied to hand grenades, in Figure 9.

Whereas fragments are pieces of the bomb casing which are formed when it ruptures, precut or preformed objects such as nails, ball bearings, or fence staples, which are placed either inside the bomb or attached on the outside are referred to as shrapnel. Shrapnel serves the same purpose and has the same effect on personnel, material and structures as fragmentation. One advantage of using shrapnel is that part of the energy released during the explosion, which would have been normally expended in fracturing the bomb casing into fragments, is used instead in propelling the preformed, separate pieces of shrapnel. Consequently, the use of shrapnel inside or attached outside the bomb results in an increase in blast damage as well as the projection of shrapnel. A bomb employing shrapnel is illustrated in Figure 10. Fragmentation and shrapnel produce damage by cutting, slicing, or punching holes in materials in the vicinity of the point of detonation.

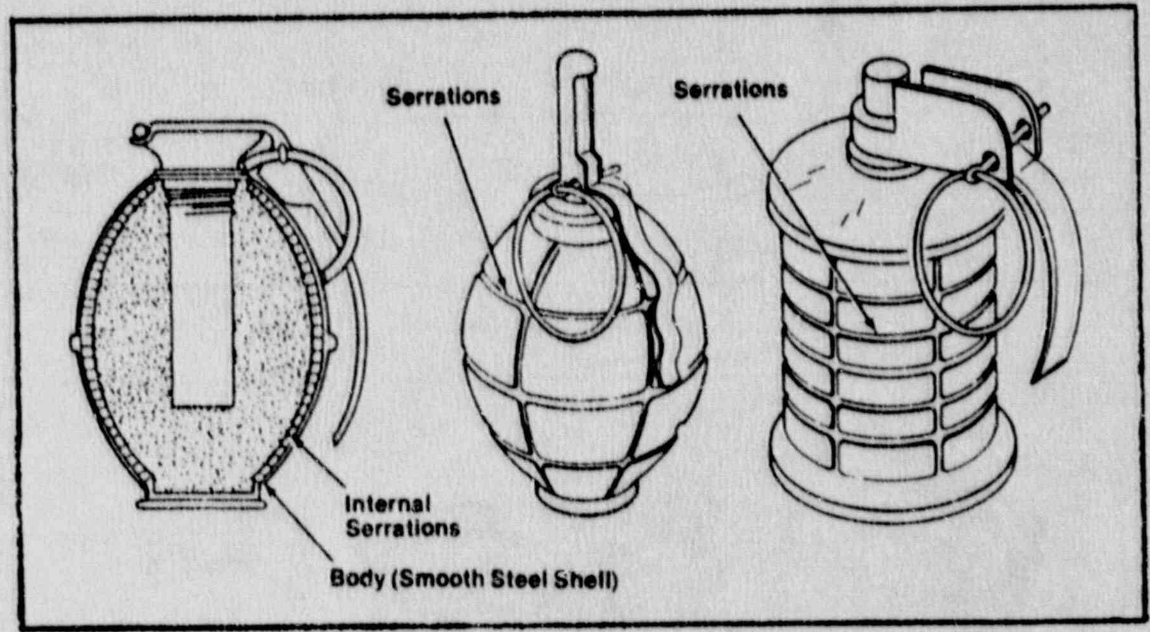


FIGURE 9: SERRATION OR PRE-ENGRAVING OF HAND GRENADES.

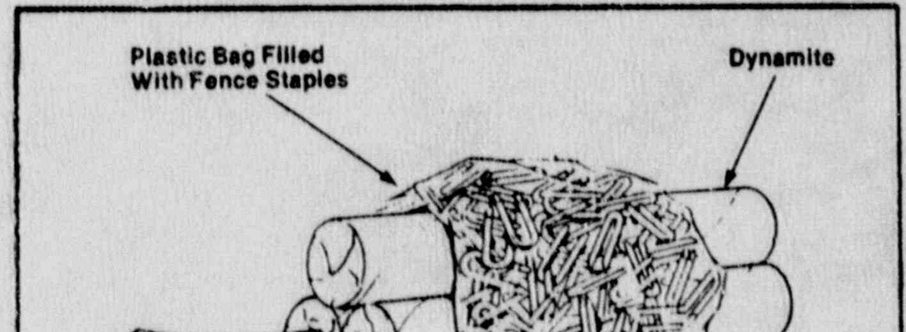


FIGURE 10: SHRAPNEL USED WITH HIGH EXPLOSIVE BOMB.

The heat of fragments produced by the detonation of a high explosive bomb may cause secondary fires. The heat is induced at the instant of detonation and compounded by the stretching and tearing action of the detonation as well as by air friction and impact friction. The hot fragments may, for example, puncture an automobile fuel tank and ignite the gasoline, imbed themselves in combustible material and cause ignition, or start grass fires some distance from the point of detonation.

Incendiary Thermal Effect

The incendiary thermal effect produced by the detonation of a high or a low explosive varies greatly from one explosive to another. In general, a low explosive will produce a longer incendiary thermal effect than will a high explosive. A high explosive will, on the other hand, produce much higher temperatures. In either case, the duration of the effect is measured in fractions of seconds. The incendiary thermal effect is usually seen as the bright flash or fireball at the instant of detonation. If a high explosive charge is placed on a section of earth covered by dry grass and detonated, only a vacant patch of scorched earth will remain. However, if a low explosive charge is placed on the same type of earth and detonated, more than likely a grass fire will result.

Unless highly combustible materials are involved, the thermal effect plays an insignificant part in an explosion. Should combustible materials be present and a fire started, the debris resulting from the explosion may provide additional fuel and contribute to spreading the fire. When fires are started inside a structure which has been bombed, they are usually traceable to broken and shorted electrical circuits and ruptured natural gas lines rather than to incendiary thermal effects. Incendiary thermal effects are generally the least damaging of the three primary detonation effects.

Secondary Blast Pressure Effects

Reflection, Focusing and Shielding of the Pressure Wave. Blast waves, like sound or light waves, will bounce off reflective surfaces. This reflection may cause either a scattering or a focusing of the wave. A blast pressure wave will lose its power and velocity quickly when the detonation takes place in the open. For example, if a block of explosive is detonated in the open, the blast wave will dissipate at a distance of 100 feet (30.5 meters) from the point of detonation. If the same charge had been placed inside a large diameter sewer pipe or a long hallway and detonated the blast pressure would have been still measurable at 200 feet (61.0 meters) or more. This is due to the reflection of the blast wave off the surfaces surrounding it, and the reflected wave may actually reinforce the original wave by overlapping it in some places.

Since the reflected wave is a pressure wave, it will exert physical pressure. Similarly, a blast pressure wave may be focused when it strikes a surface which acts as a parabolic reflector just as sound waves are focused and directed into a microphone by the television soundman along the sidelines at a football game, enabling the home viewer to listen in as the quarterback calls signals.

Shielding occurs when the blast pressure wave strikes an immovable object in its path. If a square, solid concrete post two feet (0.6m) thick is placed in the path of the blast pressure wave, the blast pressure wave will strike the post and the post will, in effect, cut a hole in the pressure wave. The area immediately behind the post is afforded some protection from the pressure of the explosion. At some point beyond the post, however, the split blast pressure wave will reform and continue, but with diminished force.

When dealing with detonations which have taken place inside buildings, many unusual effects due to reflection or shielding will be noted. These effects account for such strange things as the entire wall of the structure being blown out, but a mirror on the opposite wall remaining uncracked. Explosive waves may also be reflected at great distances and even over natural obstacles, such as hills, by bouncing off low clouds or overcast skies. Under these conditions a 50 lb. (22.7 kg) charge could break windows 5 miles (8.1 km) from the point of detonation.

Earth and Water Shock. When an explosive charge is buried in the earth or placed underwater and detonated, the same violent expansion of gases, heat, shock and loud noise results. Since the earth is more difficult to compress than air, and water is not compressable at all, the detonation will seem less violent, but actually the energy released is exactly the same as would result from a detonation in the open air. The effect of this violence is, however, manifested in a different manner. The blast wave is transmitted through the earth or water in the form of a shock wave, which is comparable to a short, sharp, powerful earthquake. This shock wave will pass through the earth or water just as it does through air, and when it strikes an object such as a building foundation, the shock wave will, if of sufficient strength, damage that structure much as an earthquake would. The entire building is shocked from bottom to top. Walls crack, doors jam, objects fall from the shelves and windows shatter. Below ground in basement areas a strong shock wave may buckle walls inward, rupture water pipes and heave concrete floors upward.

For example, if a 50 lb. (22.7 kg) explosive charge is buried 10 ft. (3.0 m) in the ground and detonated, cast iron pipes 30 feet (9.1 m) away will probably be cracked or broken; brick, tile and concrete sewers 40 feet (12.2 m) away could be cracked and broken; and damage to building foundations can be anticipated for 50 feet (15.2 m) and beyond.

An explosive charge detonated underwater will produce damage at even greater distances because, unlike earth, water is not compressable. Since it cannot be compressed and, thus, absorb energy, it transmits the shock wave much faster and farther and subsequently produces greater damage within a larger area.

Structural Fires. When an explosion occurs inside a building, a fire often results. Generally, the structural fire originates not from the detonation of the explosive, but from broken and shorted electrical circuits or ruptured natural gas or fuel oil lines. Any shattered and broken debris also contributes fuel to the fire. Fires of this nature are regarded as a secondary effect of the detonation.

SECTION II

EXPLOSIVES

IDENTIFICATION OF EXPLOSIVE MATERIALS

Federal legislation, which became effective on February 12, 1971, requires each licensed manufacturer of explosive products in the United States to legibly identify all explosive items which are offered for sale or distribution. The identification marks must be placed on each cartridge, bag or other immediate container of explosive material; they must also appear on any outside packaging of individual containers. If the individual units are so small that marks are impractical, as in the case of blasting caps, the manufacturer is required only to mark the packaging material. The marks required must identify the manufacturer and the location, date and shift of manufacture.

The identification marks vary among the different manufacturers, but in every case consist of a series of numbers, or numbers and letters, which indicate the month, day, year, plant and shift of manufacture. Two of the ways that these identification marks may appear are 031773R2, showing the date (03/17/73), plant (R), and shift (2); and D73JY08A, showing plant (D), date (73 JY 08) and shift (A).

Should the necessity of tracing an item through these markings arise, the following information is important: the complete mark, and the brand, type and exact size of the explosive. As a plant may manufacture several sizes of items on each shift, the identification marks may be the same for several sizes of containers. An exact designation of size, therefore, will simplify the tracing process.

A two-year explosives identification program introduced in 1977, by the U. S. Bureau of Alcohol, Tobacco and Firearms utilized a taggant system for dynamites, water gels and slurries. This system involved taggant chips, minute plastic chips of color-coded layers, placed in the explosive filler itself. These chips are not easily removed. Careful examination of the taggant chips allows determination of the manufacturer, as well as the name and grade of the explosive, production lot, its package size, and the name and address of both distributor and the final legal recipient. This taggant system was a pilot test program initiated to determine the overall feasibility of taggant use. The bulk of those explosives tagged have been consumed since the end of that trial period in 1979.

CHARACTERISTICS OF CHEMICAL EXPLOSIVES

An explosive is a chemically unstable material which produces an explosion or detonation by means of a very rapid, self-propagating transformation of the material into more stable substances, with the liberation of heat and with the formation of gases. Shock and loud noise accompany this transformation.

The primary requisite of a chemical explosive is that it contain enough oxygen to initiate and maintain extremely rapid combustion. Since an adequate supply usually cannot be drawn from the air, a source of oxygen must be incorporated into the combustible elements of the explosive or added by including other substances in the mixture. These sources of oxygen are called oxidizers.

Explosive Mixtures

In the case of explosive mixtures, the combustible and oxidizer are blended mechanically. When making black powder for example, the charcoal, sulfur and nitrate (potassium or sodium nitrate) are first separately ground into fine powder and then mechanically mixed together. The result of this type of blending is the explosive mixture. Mechanical blending is generally used when manufacturing a class of explosives known as low explosives or propellants such as pistol and rifle powders. In some cases, a bonding agent such as water is added to the mixture to form a paste. When dry, the paste mixture is broken into pieces and ground to produce a finer mixture than would result from simply blending the separate ingredients.

Explosive Compounds

Explosive compounds are those in which the combustible and oxidizer are molecularly bonded. For example, to create the chemical compound nitroglycerin, glycerin is slowly poured into nitric acid. A chemical reaction takes place forming a new compound. In contrast with low explosives, which are normally physical mixtures, high explosives are chemical compounds.

Classification of Explosives

The classification of explosives by the velocity of detonation or deflagration is a convenient and widely used system for distinguishing between high and low explosives.

Low Explosives. Low explosives are said to deflagrate (burn) rather than detonate (explode). They are used primarily as propellants. In a low explosive mixture the burning is transmitted from one grain of low explosive to the next, and the gases produced build up as the powder burns. This causes low explosives, in terms of performing work, to exert a rapid pushing effect rather than a shattering effect as do the high explosives. Low explosives are used, however, in some blasting operations and are also frequently the filler for homemade pipe bombs.

A bomb using low explosives can be made by confining pistol, rifle or black powder in a length of pipe with end caps. When the confined powder is ignited, the rapidly produced and confined gases will create increasing internal pressures until the pipe container bursts and is torn apart by the pressure. Unlike high explosives, low explosives may be started on the combustion path by the application of a simple flame or acid/flame reaction. They may be initiated also by shock or friction and do not require the shock of a blasting cap. Pipe bombs containing low explosives are commonly used by violent revolutionary groups and other criminals, because the component ingredients are easily acquired and they are relatively easy to construct and initiate.

High Explosives. This type of explosive is designed to shatter and destroy. There is a wide range in the detonation velocities of high explosives, extending from ammonium nitrate at 3,300 f/s (1,005.84 m/s) up to HMX at 29,900 f/s (9,124 m/s).

High explosives differ from low explosives in that they must, in general, be initiated by the shock of a blasting cap. When low explosives begin their combustion, the burning travels from particle to particle because of the granular form of the explosive. This results in the "explosion" of the material. High explosives "detonate," which has been described as instantaneous combustion. When a blasting cap is detonated in a stick or block of high explosive, it delivers an extremely sharp shock to the explosive. This shock breaks the bonds of the molecules of the chemically bonded explosive material and oxidizers. The disruption of the molecules is transmitted as a shock wave radiating outward in all directions from the point of initiation. This internal shock wave is known as a detonation wave. It causes each molecule it strikes to detonate, and the detonation of each molecule causes the wave to move faster until the explosive material is detonating at its maximum rate. When a high explosive detonates, the speed at which the detonation wave progresses through the explosive is called the detonation velocity and is usually expressed in feet per second (f/s) or meters per second (m/s).

Explosive Work

The varying velocities of explosives have a direct relationship to the type of work they can perform.

EXPLOSIVE TRAINS

An explosive train is a series of explosions specifically arranged to produce a desired outcome, usually the most effective detonation or explosion of a particular explosive. The simplest explosive trains require only two steps, while the more complex of military munitions may have four or more separate steps terminating in detonation. Explosive trains are classified as either low or high, depending upon the classification of the final material in the train.

Low Explosive Trains

A round of small arms ammunition is a simple example of a two-step low explosive train. The components in this train are a percussion primer and a propellant charge. The primer converts the mechanical energy of the weapon firing pin into a flame. The flame ignites the propellant charge, and the gases produced by the resulting explosion drive the bullet through the bore of the weapon.

When low explosives, such as smokeless powder and black powder are used in the construction of pipe bombs, a simple two-step explosive train is again required. One end of a length of safety fuse, which is a slow burning time fuse filled with black powder, is inserted into the pipe and the opposite end is ignited with a match by the bomber. The safety fuse transmits the flame, after a delay, to the low explosive inside the pipe. When it is ignited, the low explosive inside the pipe explodes and the confined gases produced tear the pipe apart, resulting in both blast and fragmentation.

The majority of low explosives require only a simple two-step train.

High Explosive Trains

The nature of high explosive trains is affected by a wide range of sensitivity found within the category of high explosive compounds. Sensitivity refers to the amount of external force or effect needed to cause detonation.

For the sake of safety, the extremely sensitive explosives should be used in very small quantities, while the comparatively insensitive explosives are used in bulk quantities. This division, by sensitivity, produces two groups of explosives - primary and secondary. Primary explosives are the most sensitive and are used to initiate the more insensitive compounds which are termed secondary explosives.

Primary Explosives. The most important quality of primary explosives is their extreme sensitivity to initiation by shock, friction, flame, heat or any combination of these and not their potential damage capability. This sensitivity makes them very hazardous to handle. Primary explosives are sufficiently powerful to cause complete instantaneous detonation of other less sensitive explosives. For this reason they are used as the first step in high explosive trains and are packaged for this purpose as blasting caps and in military fuzes.

When used in both electric and nonelectric blasting caps, the primary explosives are detonated by heat or flame. In military fuzes, the primary explosive is usually initiated by shock of impact or heat producing friction. The more commonly used primary explosives are lead styphnate and lead azide.

Secondary Explosives. Compared to the primary explosives, the secondary explosives are relatively insensitive to shock, flame, friction or heat and are, therefore, less hazardous to handle and use. However, as a result of their relative insensitivity, the secondary explosives must be initiated by a very strong explosive wave. Consequently, primary explosives are used to detonate secondary explosives.

Regardless of how many steps it contains, the firing train is nothing more than a series of explosions arranged to achieve a desired end result. If the explosive train is broken or interrupted, detonation of the main charge will not occur.

COMMON EXPLOSIVES

This section will discuss some of the more common explosives likely to be encountered by public safety personnel. This general coverage will include a physical description of the explosive material and information regarding its normal use and packaging.

Low Explosives

Black Powder. The typical composition of black powder is saltpeter (potassium nitrate) or sodium nitrate, 75 parts by weight; sulfur, 10 parts by weight; and charcoal, 15 parts by weight. There has been, however, a wide variation in the black powder formulas that have been used over the years. The black powder mixture ranges in color from coal black to gray black to cocoa brown, and in form, from a very fine powder to granules over ½ inch in diameter. The burning speed of black powder, and therefore to a certain extent its strength, is controlled by the size of the granulation.

Black powder is one of the most dangerous explosives known to man. While it is generally safe when wet, it should be remembered that once black powder dries, it is just as effective and dangerous an explosive as it was the day it was manufactured. Widely used during the Civil War as a bursting charge in artillery ammunition, black powder is often encountered in dealing with Civil War "souvenir" items and has been found to be dangerous and fully capable of explosion in spite of the passage of time.

Sensitivity to friction, heat, impact and sparks makes black powder one of the most dangerous explosives to handle. It is particularly sensitive to both electric and nonelectric generated sparks and should therefore, be handled with wooden or plastic tools. As a further precaution, the body should be grounded by touching a water pipe or other grounded object before black powder is handled. Outdoors, the body can be grounded by rubbing the hands on the ground prior to any physical contact with the powder. In any environment where black powder will be handled, clothing of static electricity producing nylon, wool or silk should be avoided in favor of cotton fabrics.

One use for black powder is as a propellant for certain ammunition. It is sold in tin flasks and bulk tin containers for use in hand loading ammunition or firing muzzle loading weapons. Black powder used for this purpose is irregular in grain configuration and has a shiny, metallic appearance.

Because of its slow action and consequent heaving or pushing effect, black powder was for years the sole commercial blasting agent. Though it has been replaced by dynamite in most blasting applications, black powder is still used for certain special operations. For this purpose it is manufactured in varying granulations, to enable the customer to match the powder to the specific application. It is packaged in 25 pound metal kegs.

As a blasting charge, black powder has about half the strength of TNT and, because the basic ingredients can be readily acquired, it has become one of the favorite homemade explosives of bombers in the United States. Black and smokeless powder, whether homemade or commercial, are the explosives most often encountered in pipe bombs. When confined inside a pipe and ignited with a safety fuse, no blasting cap is needed to initiate the powder, because the flame that spits from the end of the fuse is sufficient to cause the explosion of the bomb. It should be noted that any sparks resulting from an attempt to dismantle a pipe bomb may produce the same results.

Smokeless Powder. Smokeless powder is the world standard propelling powder for small arms, cannons, and in a slightly different form, some rockets. All low explosives currently used as propellants and which have a nitrocellulose base are commonly referred to as smokeless powders. Various organic and inorganic substances are added to the nitrocellulose base during manufacture to give improved qualities for special purposes and these variations are distinguished by such terms as "double-base," flashless" and "smokeless" as well as by various commercial trade names or symbols.

Smokeless powders are produced by dissolving guncotton (nitrocellulose) in a mixture of ether and alcohol to form a mass called a colloid. The colloid has a consistency of melted glue and is squeezed into macaroni-shaped tubes that are subsequently cut in short lengths. The ether and alcohol used to dissolve the guncotton are evaporated, leaving a hard substance. The small cylindrical powder grains resulting from this process are generally used as rifle ammunition powders.

Pistol powders, unlike rifle powders, do not generally have cylindrical grains. Instead, they are manufactured in the form of very fine, thin wafers, flakes or balls. These shapes insure the shorter burning time necessary for full combustion in weapons with short barrels. Shotgun powders are similar to pistol powders in that they burn more rapidly than rifle powders. In fact, most shotgun powders are straight nitrocellulose in composition.

Like black powder, smokeless powders vary widely in both form and color. The majority of rifle and pistol powders are black in color and are formed into rods, cylindrical strips, round flakes or irregular grains. Shotgun powders may be translucent round or square flakes, orange to green in color, or may be black irregularly shaped granules. Smokeless powders of all types are sold in tin flasks, glass jars, plastic containers and kegs of varying weights up to 25 pounds.

Unconfined smokeless powder burns with little or no ash or smoke and, when confined, its rate of burning increases with temperature and pressure. For this reason, it is frequently used in the construction of pipe bombs. It should be noted that smokeless powder manufactured for use in small arms ammunition is usually glazed with graphite to facilitate machine loading and prevent the accumulation of static electricity. Many of these powders are as sensitive to friction as black powder, and the precautions used in handling black powder should be observed for smokeless powders.

High Explosives

Primary Explosives. Primary Explosives are sensitive, powerful explosives used in blasting caps and military fuze detonators which in turn detonate main charges or secondary explosives.

Lead Azide. Lead azide is an excellent initiating agent for high explosives and is used extensively as the intermediate charge in the manufacture of blasting caps. It is inferior to mercury fulminate in detonating the less sensitive main charge explosives like TNT, but is superior as an initiator for the more sensitive booster explosives such as tetryl, RDX and PETN. When in contact with copper and in the presence of moisture, lead azide reacts to produce an extremely sensitive and dangerous compound called copper azide. Because of this reaction with copper, explosive manufacturers do not normally load lead azide into copper shell blasting caps. Lead azide is extremely sensitive to heat, shock, friction and static electricity. The form of lead azide normally used in blasting caps and fuze detonators is called dextrinated lead azide and is white to buff in color.

Lead Styphnate. Lead styphnate is a relatively poor initiating explosive, and is used primarily as an ingredient of priming compositions and as a cover charge for lead azide to make the lead azide more sensitive to detonation. It is used as the ignition charge in blasting caps. Lead styphnate is light orange to reddish-brown in color and is extremely sensitive to heat, shock, friction and static electricity.

Mercury Fulminate. Mercury fulminate was used extensively in the past as an ingredient in priming compositions, but since 1930, has been replaced extensively by lead azide. Mercury fulminate is white to gray or light brown in color and is extremely sensitive to heat, shock, friction and static electricity.

Secondary Explosives

Boosters. High explosive boosters, also called primer explosives, or simply primers, are explosives which provide the detonation link in the explosive train between the very sensitive primary explosives (blasting caps) and the comparatively insensitive main charge high explosives.

Boosters are usually cylindrical in shape, as illustrated in Figure 11, with the explosive encased in a light metal, cardboard or plastic container. Generally there is an opening in the end of the booster container to permit the insertion of a blasting cap or to allow the threading of detonating cord. Some boosters are supplied in tin cans with threaded, interlocking ends that allow the booster units to be assembled into a long, tightly joined unit. Boosters packaged in metal containers are usually employed in wet blasting operations, such as seismic prospecting or underwater channel cuttings.

FIGURE 11: BOOSTERS WITH MATCHBOOK FOR SIZE COMPARISON.

Cardboard and plastic encased primers or boosters of varying sizes are generally used in dry blasting operations, where they are often strung or laced on a length of detonating cord and lowered into a borehole. After the placing of the booster, insensitive main charge explosives in prill (loose) or slurry (liquid-gel mix) form are poured into the borehole. When the charge is fired, the boosters insure complete detonation of the main charge explosives.

Several secondary explosives are commonly used as primers or boosters. These explosives are frequently mixed for booster use and in some instances, are cast together in a homogeneous mixture or are formed with one type of explosive cast around or over the other. Common explosives used in boosters include:

Pentolite. Pentolite is a very commonly employed booster explosive. It consists of a homogeneous mixture of 50 percent PETN and 50 percent TNT. Cast pentolite varies in color from white to yellow to gray and has a detonation velocity of 24,500 f/s (7,465 m/s).

RDX (Research Division Formula X). Alone and mixed and with other explosives, RDX (also called cyclonite) is used in several commercial primers and boosters.

PETN (Pentaerythritol Tetranitrate). Described earlier as a filler for detonating cord, PETN is also used as a booster.

Tetryl. Tetryl is the most common military booster. It is yellow in color, but may appear gray if graphite has been added. When used as a booster, tetryl is usually found in pellet form.

Main Charges

Dynamite. Dynamite is one of the explosives most widely used for blasting operations throughout the world. In the past, dynamite has been relatively easy to obtain by theft or through legal purchase and has consequently been one of the explosives most frequently used by criminal bombers.

While dynamites are generally used in earth moving operations, they differ widely in their explosive content and, therefore, in their strength and sensitivity. In the past, most commercial dynamites were made of liquid nitroglycerin (NG), oxydizers and a binder material. Present dynamites consist of a mixture of ethylene glycol dinitrate (EGDN), a small amount of nitroglycerin with oxydizers and a binder material.

The percentage of commercial straight dynamite is the gauge by which the strength of all commercial dynamite variations are measured. This measurement is based upon the percentage of nitroglycerin by weight in its formula as manufactured. This percentage value can be misleading, however, in determining actual blasting power. For example, a 60 percent dynamite is not necessarily three times as powerful as one marked 20 percent, because the nitroglycerin or other explosive sensitizer is not the only energy producing ingredient present in the total composition. When the nitroglycerin content is tripled, the quantity of other energy producing ingredients is proportionally reduced, offsetting some of the power increase achieved through the greater nitroglycerin content. Thus, the 60 percent straight dynamite is actually only about 1½ times as strong as 20 percent straight dynamite.

Unless it is packaged loose in boxes or bags for specialized applications, dynamite will usually be found in cylindrical form or sticks, wrapped in buff, white or red colored wax paper. These sticks or cartridges are obtainable in a variety of lengths and diameters. The most common sizes range from 1 1/8 to 1½ inches in diameter and are about 8 inches long. In less common sizes, dynamite cartridges may be up to 12 inches in diameter and from 4 to 36 inches in length.

Because of the wide variety of formulas, ingredients and packaging, dynamite is not always easy to identify. Consequently, any packaging materials available should be retained as a means of determining the actual composition and strength of recovered dynamite.

U. S. Department of Transportation (DOT) regulations limit the largest size cartridge that may be shipped to 50 pounds in weight, 12 inches in diameter and a maximum length of 36 inches.

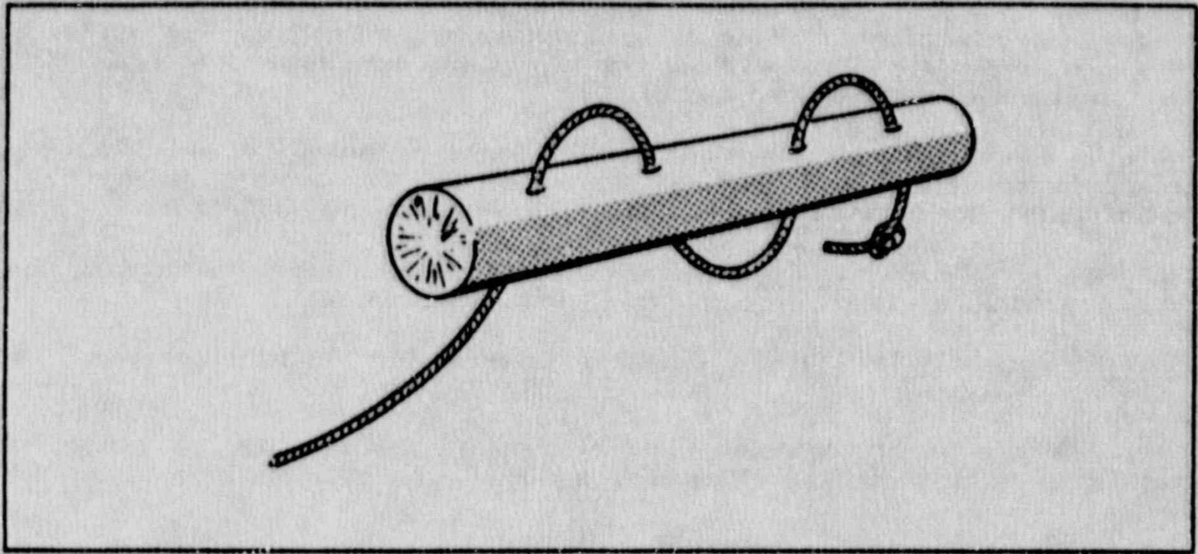


FIGURE 12: DYNAMITE PRIMED WITH DETONATING CORD.

Permissibles or Permitted Explosives. A permissible explosive is one which has been approved by the U.S. Bureau of Mines or the British Ministry of Fuel and Power for use in gas or dust-filled mines. When detonated or exploded, all explosives produce a flame that varies in volume, duration and temperature. Black powder produces the longest lasting flame, while dynamites typically produce a shorter lasting, but more intense, flame. Permissible explosives are especially designed to produce a flame of low volume, short duration and low temperature. This is accomplished by adding certain salts to the explosive formula in order to cool or quench the flame to prevent the ignition of gas or dust within the confined space of a mine.

Permissible explosives are generally modified types of gelatin or ammonia dynamites. They are similar in packaging and appearance to other dynamites.

Blasting Agents. A blasting agent is an insensitive chemical composition or mixture, consisting largely of ammonium nitrate, which will detonate when initiated by high explosive primers or boosters. Since they contain no #8 cap sensitive material such as nitroglycerin, blasting agents are relatively insensitive to shock, friction and impact and are, therefore, safer to handle and transport.

Ammonium Nitrate. Ammonium nitrate is one of the least sensitive and most readily available main charge nigh explosives. It ranges in color from white to buff-brown, depending upon its purity and has a saline or salty taste. Colored dyes may be added to facilitate identification. Ammonium nitrate is usually found in the form of small compressed pellets called prills. While it is extensively used as a blasting agent and by the military as a cratering charge, it is also an ingredient in the manufacture of certain dynamites and is widely employed as a fertilizer.

Ammonium nitrate requires the use of a booster for detonation. For military cratering charges, TNT is often used as the booster, while in commercial applications, RDX or pentolite boosters or primers are frequently employed. The detonation velocity of ammonium nitrate ranges from 3,300 f/s (1,005.8 m/s) to 8,200 f/s (2,499.4 m/s). Due to its hygroscopicity, and the fact that it loses power and sensitivity in direct ratio to its moisture content, explosive charges composed of ammonium nitrate are usually packaged in some form of waterproof container.

Its use as a commercial fertilizer makes ammonium nitrate readily accessible to anyone, including bombers. Ammonium nitrate, used as fertilizer, can be sensitized by the addition of fuel oil. This mixture is referred to as "prills and oil" or ANFO, and its use is widespread because of its low cost.

Ammonium nitrate should be handled with some degree of caution, because it is a strong oxidizing agent and has the ability to increase the combustibility of other flammable materials with which it comes in contact. If it is recovered as the result of a bombing incident, brass or bronze non-sparking tools should NOT be employed because they react with the ammonium nitrate to form an explosive which is as sensitive to impact as lead azide.

Nitro-carbo-nitrates (NCN). One group of blasting agents is called nitro-carbo-nitrates. NCN is manufactured mainly of ammonium nitrate and oil, with special ingredients added to reduce static electricity and prevent hardening and caking of the agent during storage. It is packaged in sealed waterproof cans, multiwall paper bags, polyethylene lined burlap bags or flexible plastic bags which provide water resistance as long as the containers are not opened or damaged. Container sizes range from 3 to 9 inches in diameter, up to 24 inches in length and weigh up to 80 pounds. NCN is similar to 50 or 60 percent blasting gelatin in strength, but is much less sensitive.

Free running explosives consisting of NCN make up another group of blasting agents. Because of their granular or small pellet form, free running blasting agents can be poured around rigid explosive charges to fill all of the available space in a borehole. They are also useful for pouring into rough, irregular or partially blocked holes, and some free running blasting agents can be submerged underwater for a period of time without loss of effectiveness. Free running agents are packaged in 12½, 50 and 80 pound multiwall paper bags, polyethylene lined burlap bags or plastic bags. Sometimes a dye is added to the agent to facilitate visibility.

Water Gels. A final common group of blasting agents is made up of blasting slurries or water gels. These consist of NCN mixtures, with or without the addition of TNT, in a gel-like consistency. Some of the blasting slurries have powdered metals, such as aluminum, added to increase their performance. The blasting slurries, because of their consistency, can be poured into irregular or wet boreholes to fill all available space with explosive.

(Note: Cap sensitive blasting slurries or water gels such as those containing TNT are not, by definition, considered blasting agents.)

Although most of the blasting slurries require a primer or booster for detonation, some manufacturers now make blasting slurries that are cap sensitive. In recent years the use of water gels has increased markedly at the expense of dynamite manufacturers. Water gels are packaged in polyethylene bags 1¼ to 8 inches in diameter or may be delivered to the blasting site by special pump trucks.

Two Part Explosives. Two part explosives consist of two inert components which are non-explosive until mixed. After mixing, the solution becomes cap sensitive and is considered a high explosive. Unmixed compounds may be shipped by common carrier or by air freight with no special handling required. An example of this type explosive is Kinepak (Figure 13).

Sheet Explosives. Sheet explosive, also known as Flex-X or Detasheet, is a flexible, rubber-like explosive which can be easily cut with a knife, remains flexible through a wide temperature range and is waterproof. Military sheet explosive is packaged as shown in Figure 14 or in 50 foot rolls. It has a pressure-sensitive adhesive backing, making it possible to quickly apply the sheet to irregular or curved surfaces. Sheet explosive can be manufactured in a variety of shapes and sizes. The military version is dark green in color while that manufactured for commercial use is normally red, although sheet explosives can be custom manufactured in almost any color desired by the customer.

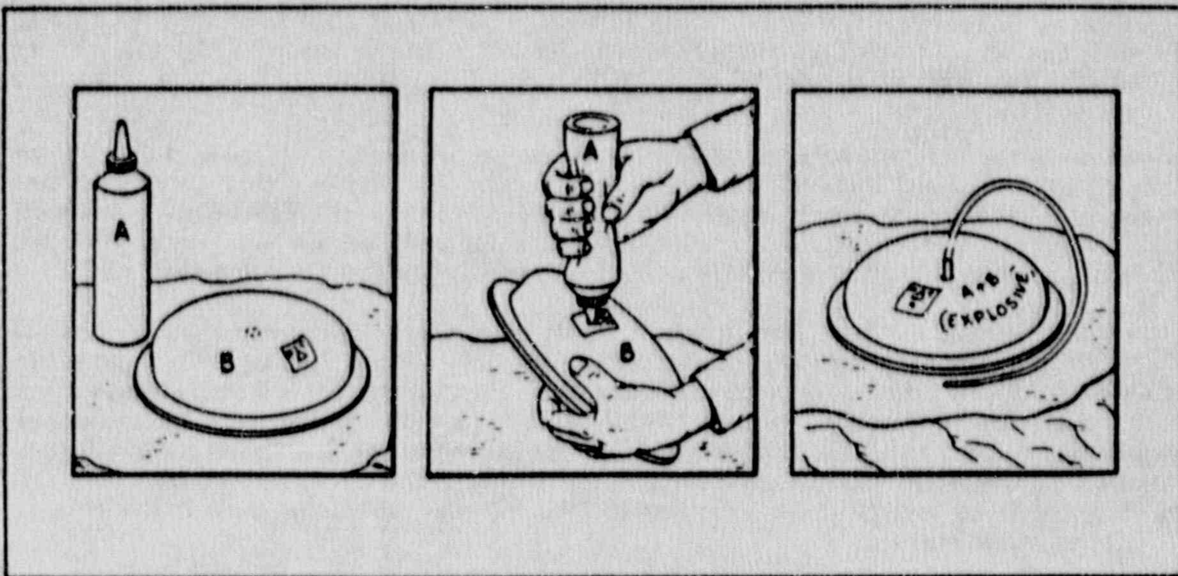


FIGURE 13: KINEPAK.

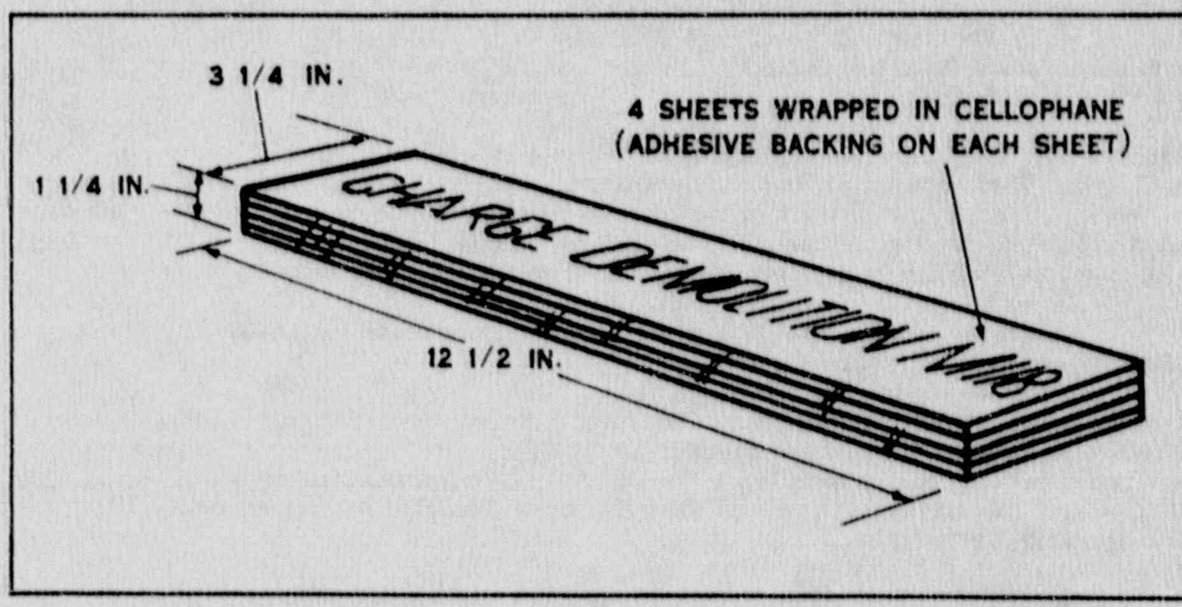


FIGURE 14: MILITARY M118 BLOCK DEMOLITION CHARGE.

Military Explosives. Explosives made for military use differ from commercial explosives in several respects. Military explosives, designed to shatter and destroy, must have high rates of detonation and, because of combat conditions, must be relatively insensitive to impact, heat, shock and friction. They must possess high power per unit of weight, must be usable underwater and must be of a convenient size, shape and weight for troop use.

TNT (Trinitrotoluene). TNT is the most common military explosive and, alone or part of a composite explosive, is widely used as a booster charge, bursting charge and demolition charge. It is used as a standard explosive against which other military high explosives are rated.

The TNT most often encountered by public safety personnel will probably be in the form of the ¼, ½ and 1 pound blocks illustrated in Figure 15. Each block has metal ends with a threaded blasting cap well in one end. When TNT is removed from its cardboard container, it is light yellow to light brown in color and gradually turns dark brown after several days' exposure to sunlight. TNT, of recent manufacture, could be gray in color due to the addition of graphite during the manufacturing process.

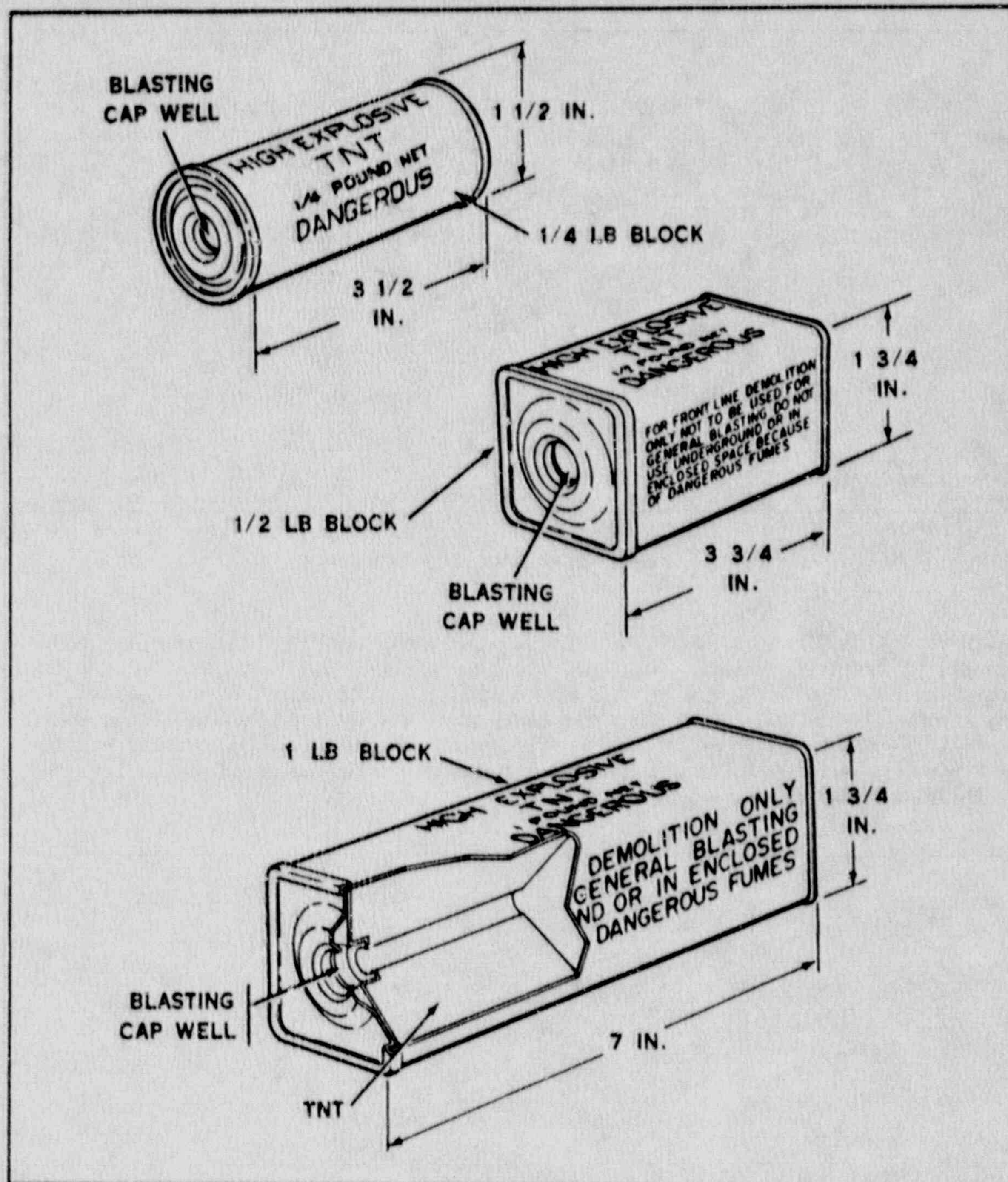


FIGURE 15: MILITARY TNT BLOCKS.

Tetrytol. Tetrytol is effective as a cutting or breaching charge and may be used as an alternative to TNT in general demolition work. The M2 block demolition charge (Figure 16) is composed of 75 percent tetryl and 25 percent TNT. The block has a tetryl booster pellet and a threaded cap well in each end. Each block is wrapped in olive drab, asphalt-impregnated paper and weighs 2½ pounds. They are packed eight blocks per haversack and may be used as an underwater demolition charge. Tetrytol demolition blocks are being eliminated, and no M2 demolition blocks will be issued when present stocks are exhausted.

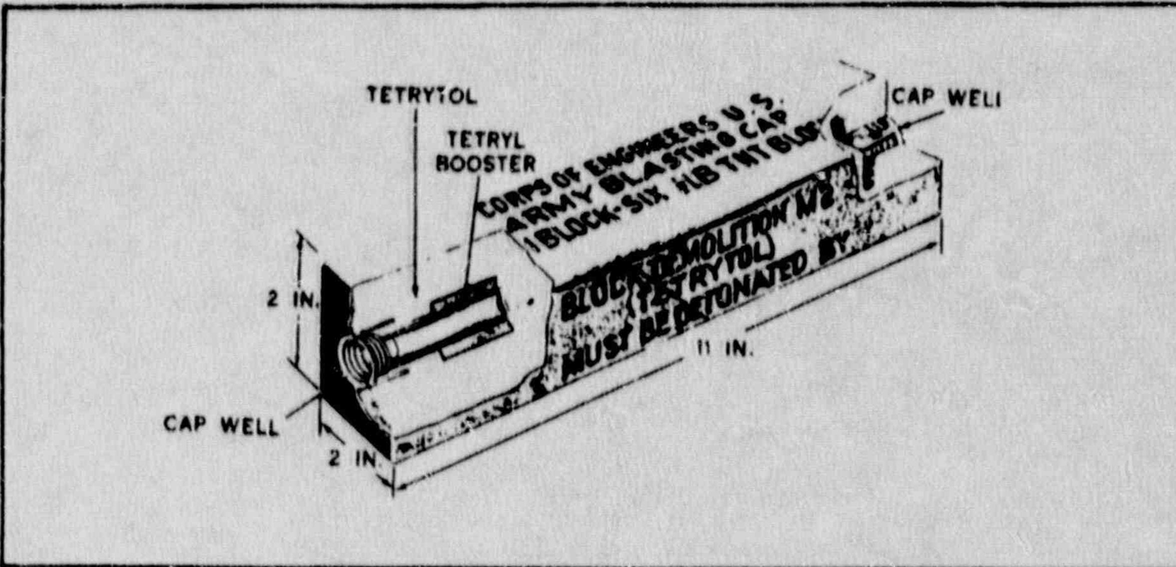


FIGURE 16: M2 BLOCK DEMOLITION CHARGE.

Composition C-3. Composition C-3 is a plastic explosive composed of RDX and plasticizers. It is a yellow putty-like solid substance which has a distinct, heavy, sweet odor. When molded by hand in cold climates, C-3 is brittle and difficult to shape. In hot climates, it is easy to mold, but will stain the hands and clothing. C-3 will most likely be encountered in the form of M3 block demolition charges (Figure 17). The M3 Block is enclosed in glazed paper which is perforated around the middle for ease in breaking open and weighs 2¼ pounds. The M3 block does not have a cap well.

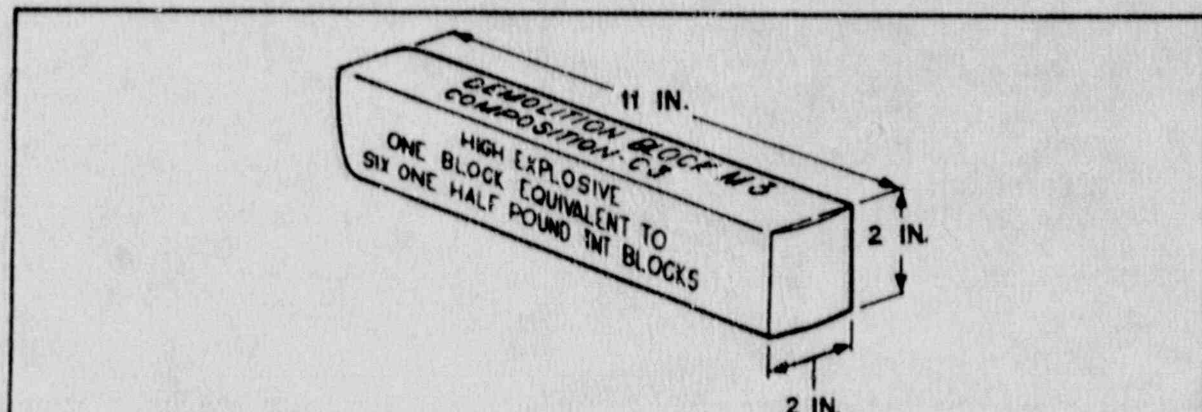


FIGURE 17: M3 BLOCK DEMOLITION CHARGE.

Composition C-4. Composition C-4 is replacing C-3 in military use. It contains RDX and has a greater shattering effect than the earlier C-3. C-4 is white to light brown in color, has no odor and does not stain the hands. The M5A1 block demolition charge (Figure 18) consists of composition C-4 encased in a clear white plastic container with a threaded cap recess in each end. The M5A1 weighs 2½ pounds. Composition C-4 also comes in the M112 block demolition charge (Figure 19) which is an improved version of the M5A1 block demolition charge and replaces the M5A1 as the standard item of issue. The M112 contains 1¼ pounds of composition C-4 with a pressure sensitive adhesive tape on one surface, protected by a peelable paper cover. In blocks of recent manufacture the C-4 is white in color and is packed in an olive drab mylar-film bag or in a clear mylar-film bag.

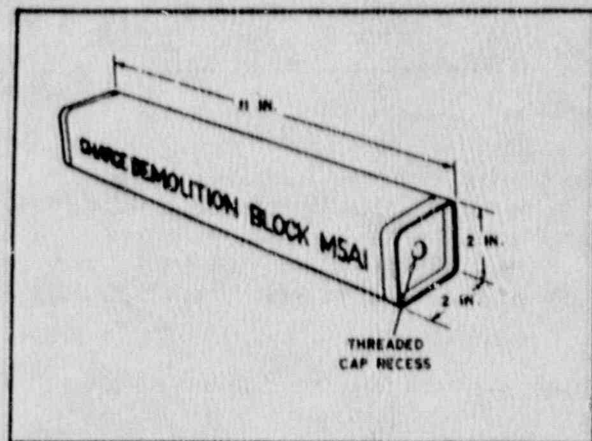


FIGURE 18: M5A1 BLOCK DEMOLITION BLOCK.

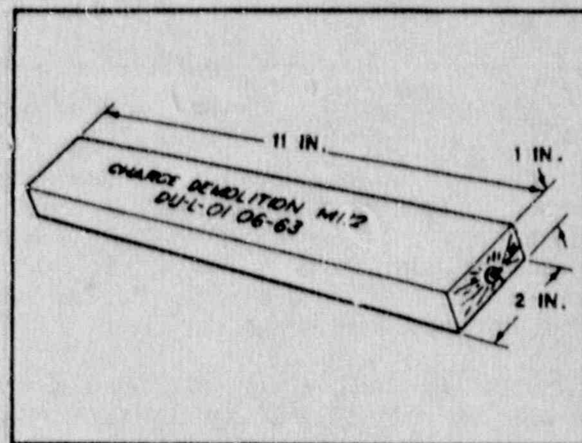


FIGURE 19: M112 BLOCK DEMOLITION CHARGE.

Military Dynamite. Military dynamite is not a true dynamite in that it is manufactured of 75 percent RDX, 15 percent TNT, 5 percent SAE 10 motor oil and 5 percent guar flour. It is packaged in standard dynamite cartridges of paraffin coated manilla paper and is marked either M1, M2, or M3 on the cartridge as illustrated in Figure 20. This marking identifies a cartridge size difference only, since all military dynamite detonates at about 20,000 f/s (6,096 m/s).

Military dynamite is used as a substitute for commercial dynamites in military construction, quarry work and demolitions. It is equivalent in strength to 60 percent straight dynamite. Since it contains no nitroglycerin, military dynamite is safer to store and transport and is relatively insensitive to heat, shock, friction or bullet impact. When removed from its wrapper, military dynamite is buff colored granular substance which crumbles easily and is slightly oily to the touch. It does not have a noticeable characteristic odor, nor does it cause headaches typical of the true dynamites.

<u>Improvised Explosives</u>. When manufactured explosives are not available, it is relatively easy to obtain all of the ingredients necessary to make improvised explosive materials. The list of existing materials and simple chemical compounds which can be employed to construct homemade bombs is virtually unlimited. The ingredients required can be obtained at local hardware or drug stores and are so commonplace that their purchase rarely arouses any suspicion.

FIGURE 20: MILITARY DYNAMITE.

Starch, flour, sugar or cellulose materials can be treated to become effective explosives. Powder from shotgun shells or small arms ammunition, match heads, firecracker powder and ammonium nitrate fertilizers can all be accumulated in sufficient volume to create a devastating main charge explosive. To explode or detonate the improvised main charge, some means of initiation is required. The most common methods of ignition of improvised explosives are summarized below.

Blasting Caps. Blasting caps, when available, provide the most successful means of causing the complete detonation of improvised explosives.

Percussion Primers. Shotgun, rifle or pistol ammunition primers have served as initiators in some bomb assemblies, particularly with explosives that are sensitive to heat.

lashbulbs. Although not explosive by nature, carefully prepared flashbulbs or light bulbs can be used as initiation devices when placed in contact with explosive materials that are sensitive to heat and flame. They can be initiated electrically to provide the necessary heat required to ignite black powder, smokeless powder and other heat-sensitive explosive or incendiary mixtures.

As noted above, improvised main charge explosives are limited only by the materials available and the training and imagination of the bomber. Some main charges are produced by using existing commercial compounds converted to the bomber's tactical use, and in other cases the main charge explosive is chemically formulated and manufactured from materials available from grocery or drug stores.

One of the most widely used improvised main charge explosive is black powder. Black powder is especially easy to manufacture and, when dry, is also one of the most dangerous explosives to handle because of its sensitivity to sparks, flame or friction.

Other common improvised explosives include:

Match Heads. A main charge consisting of ordinary match heads confined inside a steel pipe will produce an effective explosion. Bombs filled with match heads are extremely sensitive to heat, shock and friction and should always be handled with care.

Smokeless Powder. Smokeless powder, obtained from assembled cartridges purchased for hand reloading, is widely employed as a main charge, particularly in pipe bombs.

mmonium Nitrate Fertilizer. Fertilizer grade ammonium nitrate mixed with fuel oil makes excellent main charge explosive. A booster is required for detonation unless the prills are pulverized.

TERRORIST EXPLOSIVE DEVICES

Terrorist bombings are not a new phenomenon; they have been taking place for centuries. Explosives have also been employed during political unrest, labor strife and in criminal extortions. In 1605, for example, Guy Fawkes tried to blow up the British Parliament with gunpowder. High explosive bombs have been used since the invention of dynamite by Nobel in 1867.

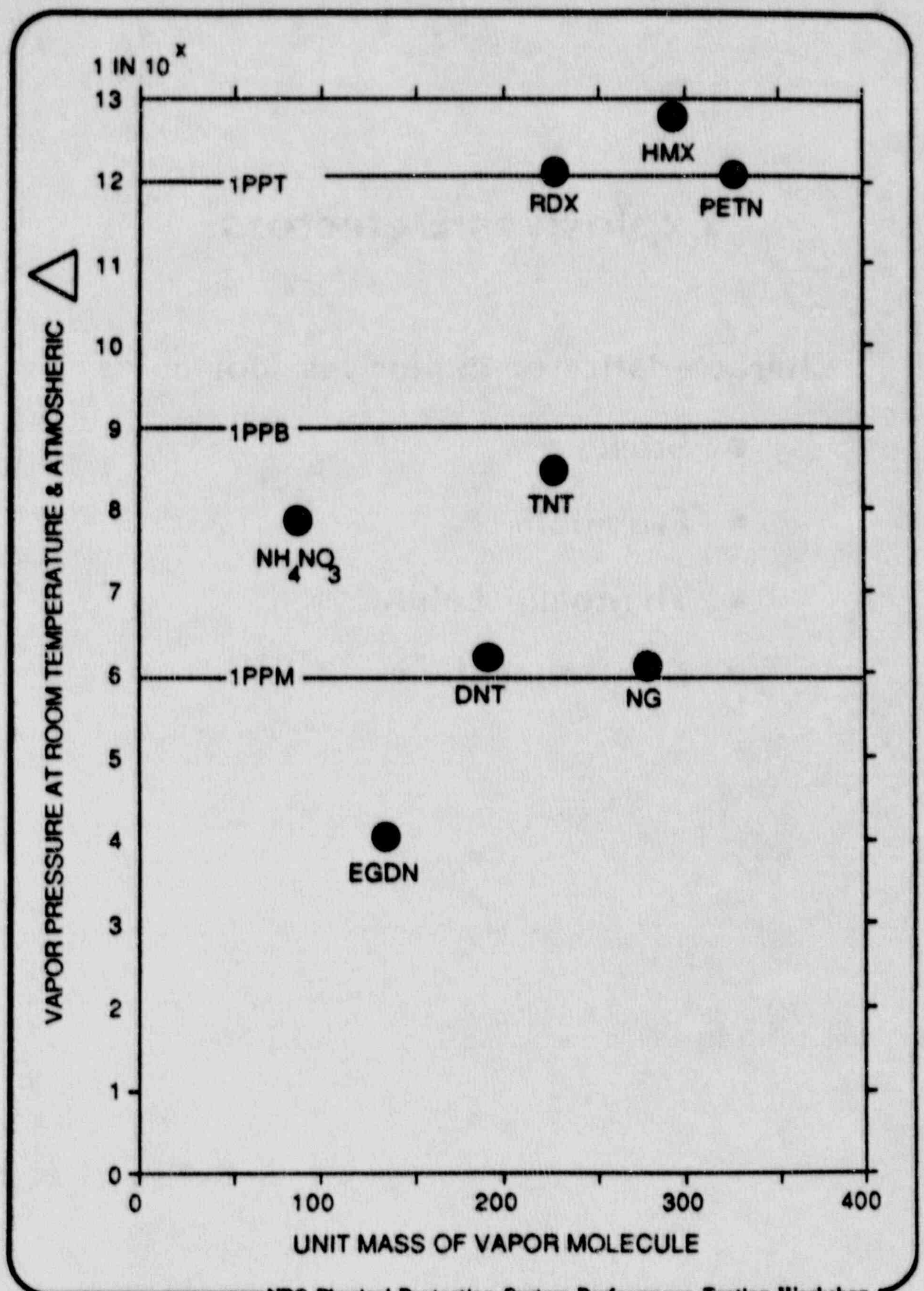
This presentation will cover the basic components of improvised explosive devices (IED's) and give examples of terrorist bombs and their lethal effects. It is important to note that the physical characteristics of an IED are limited only by the imagination of the bomb maker. Explosive devices can be as simple as a cartridge of dynamite with a burning piece of time fuse connected to a non-electric detonator or as sophisticated as a device with a solid state electronic timer and altimeter hidden inside a radio/cassette player. As physical security systems improve, we can expect to see corresponding innovations from the makers of terrorist explosive devices in an attempt to overcome these systems.

There are two basic types of explosives. Low explosives, with a reaction rate below 3280 feet per second, include smokeless and black powders and propellants. Most low explosives will not detonate unless they are confined. One of the most common IED's is the pipe bomb which is filled with a low explosive mixture. High explosives, with a detonation rate greater than 3280 feet per second, will explode unconfined from the output of a single detonator (blasting cap). Detonators are made in two varieties - nonelectric (initiated by burning time fuse) and electric (requiring a power source such as a battery). Both contain extremely sensitive primary high explosives which are particularly susceptible to heat, shock, static electricity and friction.

Explosive devices are almost always initiated by one of the following methods: timed control, remote control, or by motion control or anti-disturbance. Timed control delay techniques involve burning fuse or powder trains, corrosive delays such as acid "eating" through a metal or rubber container, electrical timers and mechanical watches and alarm clocks. Motion controls are used in booby traps where the slightest movement (up, down, right, left, forward, backward, twist, tilt) singularly or in combination can close the circuit causing an explosion. Finally, remote control initiation can be achieved mechanically or by electronic or electrical means such as a command firing wire or a radio control receiver such as a garage door opener or a model airplane controller. Remote control devices are often used by assassins who need to ensure that they kill a target victim at the time and place of their choosing.

There are few differences between the types of IED's encountered in one country over another. Generally speaking, a terrorist bomber will use the most powerful explosive available with a delay mechanism best suited to his intended target. Military explosives, when available, are invariably the material of choice because of their stability and performance characteristics. They have detonation velocities exceeding 20,000 feet per second (fps). Examples include plastic explosives (Composition C-4 and Semtex-H) and cast explosives like TNT. Since military demolition explosives are tightly controlled in nearly all countries, commercial blasting explosives with detonation rates between 7,000 and 20,000 fps (dynamite, water gels, slurries, etc) are the next best choice. Finally, when all else fails it is relatively easy to obtain all of the ingredients necessary to make improvised explosives. Potassium chlorate and sugar or fertiliser (ammonium nitrate) and fuel oil (ANFO) are the most commonly used improvised explosives.

In our efforts to detect terrorist IED's and prevent them from entering sensitive areas, we must be aware of their components and train our security personnel to recognise them. There are a number of different ways to do this including: physical search, metal detectors, X-ray machines, explosive vapor analysers, and thermal neutron activation (TNA) analysis machines , to name a few. There is no single, fool-proof way to solve this complex problem. Each facility requires detailed, multiple layered security measures and well coordinated contingency planning to counter the terrorist explosive device threat.


1 IN 10^x
VAPOR PRESSURE AT ROOM TEMPERATURE & ATMOSHERIC
13
12
11
10
9
8
7
6
5
4
3
2
1
0
1PPT
1PPB
1PPM
HMX
RDX
PETN
TNT
NH4NO3
DNT
NG
EGDN
0
100
200
300
400
UNIT MASS OF VAPOR MOLECULE
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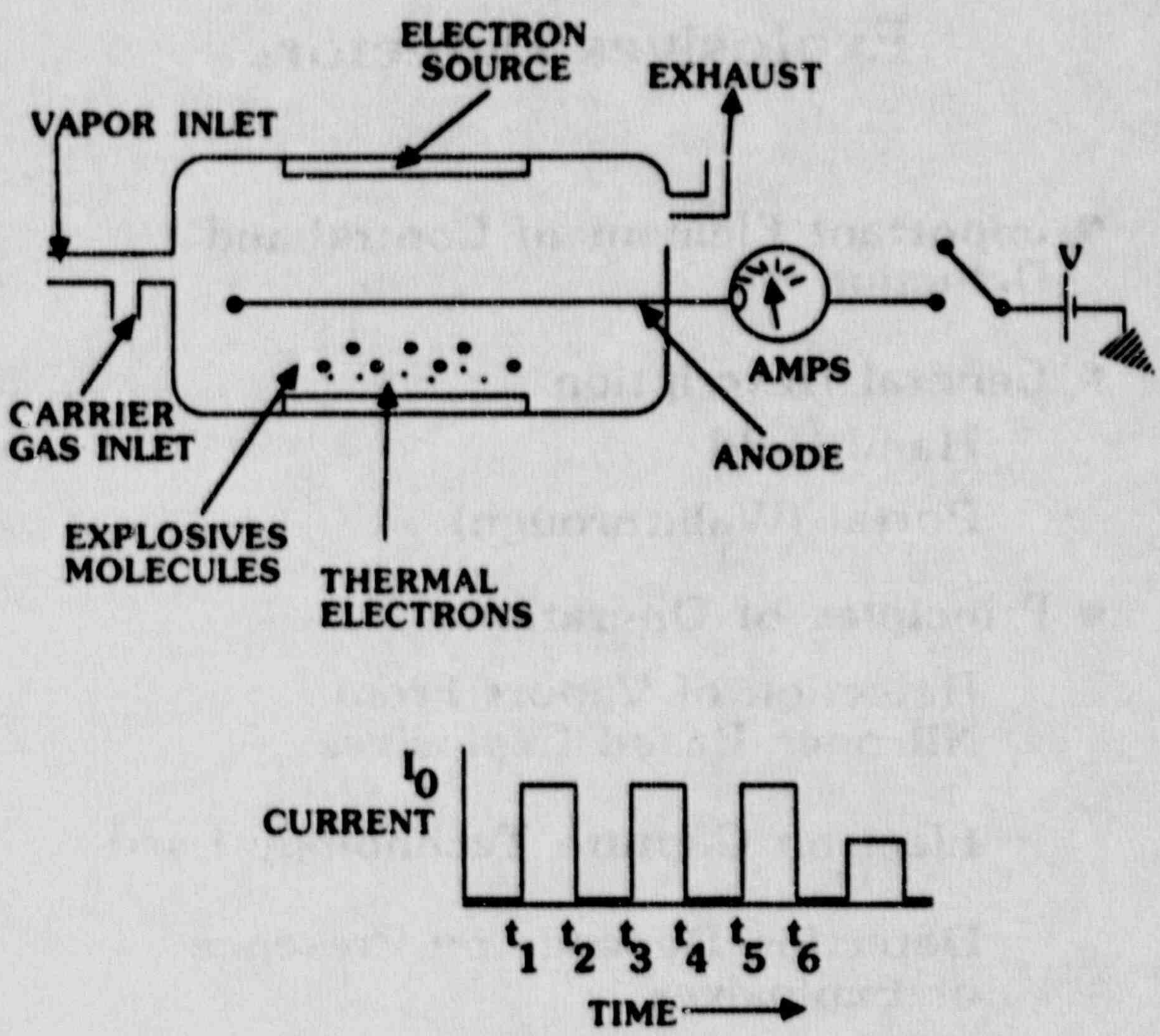
Explosives Detectors

Characteristics of Explosives Molecules

- Sticky
- Frangible
- Thermally Labile
- Electronegative



Electron Capture Detector (ECD)

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Explosives Detectors

- Important Element of Contraband Detection
- General Description
  - Hand-Held
  - Portal (Walkthrough)
- Principles of Operation
  - Detection of Vapors From Nitrogen-Based Explosives
  - Electron Capture Technology Used
  - Detection Depends on Presence of Explosives

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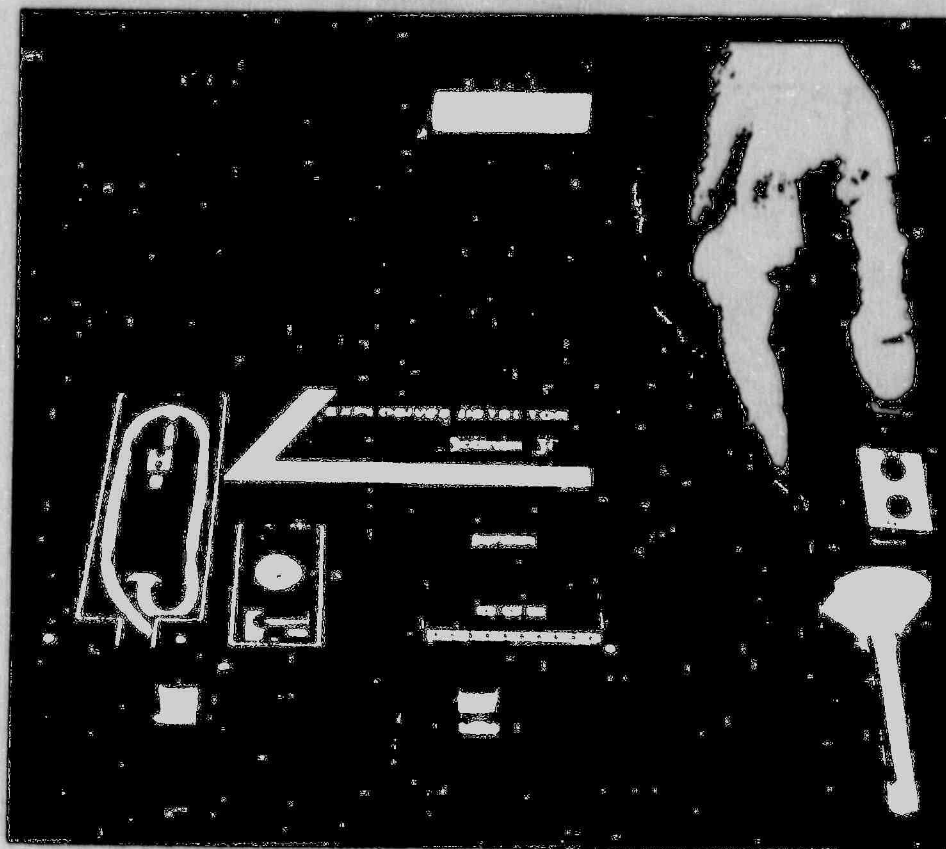

Hand-Held Explosives Detector

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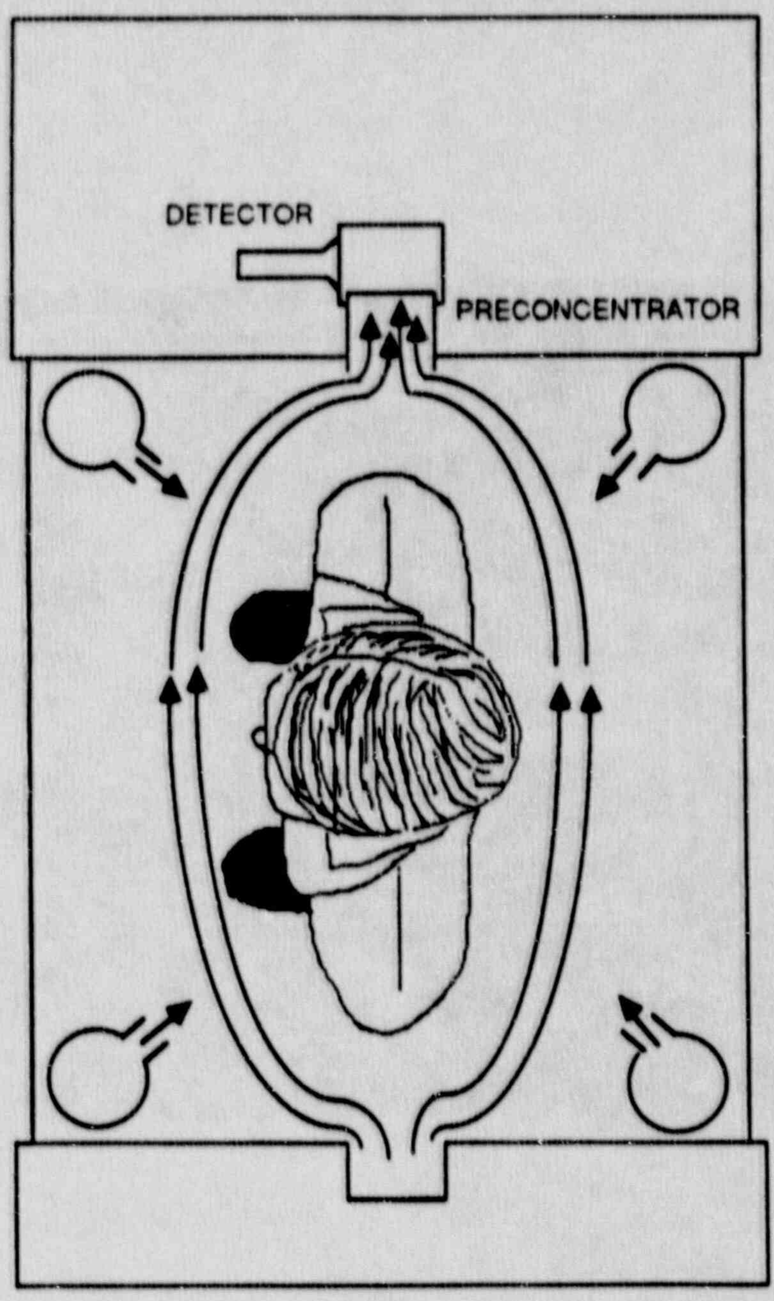

Portal Vapor Collection

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Explosives Detectors

- **Performance Characteristics**
  - **Throughput Rate/Detection Cycle (3-30 Seconds/Cycle)**
  - **Nuisance Alarms Triggered By Non-Explosive Material Vapors**
  - **Probability of Detection Dependent on Effective Collection of Vapors**

Explosives Detectors

- Maintenance
  - Low Maintenance Requirement
  - Membrane Changed Frequently
  - Gas Bottle Replacement
- Vulnerabilities
  - May Not Detect Explosives With Low Vapor Pressure
  - Sensitive to Some Non-Explosive Vapors
  - May Not Detect Explosives in Hermetically Sealed Package
  - Special Gas Required

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Explosives Detectors

- **Performance Characteristics**
  - Throughput Rate/Detection Cycle (3-30 Seconds/Cycle)
  - Nuisance Alarms Triggered By Non-Explosive Material Vapors
  - Probability of Detection Dependent on Effective Collection of Vapors

Explosives Detectors

- **Performance Tests**
  - **"Hourly" Tests**
  - **Test Sample (Vapor from a Small Amount, a Few Grains, of Double Base Shotgun or Pistol Powder**
- **Installation**
  - **Avoid Drafts**
  - **Avoid Areas Near Smoke, Exhaust Vents, etc.**

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Explosives Detectors

- **Maintenance**
  - Low Maintenance Requirement
  - Membrane Changed Frequently
  - Gas Bottle Replacement
- **Vulnerabilities**
  - May Not Detect Explosives With Low Vapor Pressure
  - Sensitive to Some Non-Explosive Vapors
  - May Not Detect Explosives in Hermetically Sealed Package
  - Special Gas Required

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Canines As Explosives Detectors

- Alternate Method
- Success Depends On:
  - Training and Retraining of Canine and Handler
  - Health of Canine
  - Working Time
  - Background Odors

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METHODS OF DETECTION

- THERMAL NEUTRON ACTIVATION (TNA) $^{14}N(n,\gamma)^{15}N$ (BAGGAGE, BOXES, ETC.)

- X-RAY (BAGGAGE, BOXES, ETC.)

- VAPOR (PERSONNEL--PORTAL and HAND-HELD) (MS/MS, GC/ECD, CHEMILUMINESCENCE, IMS)

- CHEMICAL SPOT TEST (ISRAEL INSTITUTE FOR BIOLOGICAL RESEARCH)

NUCLEAR TECHNIQUES

- THERMAL NEUTRON ACTIVATION (TNA)

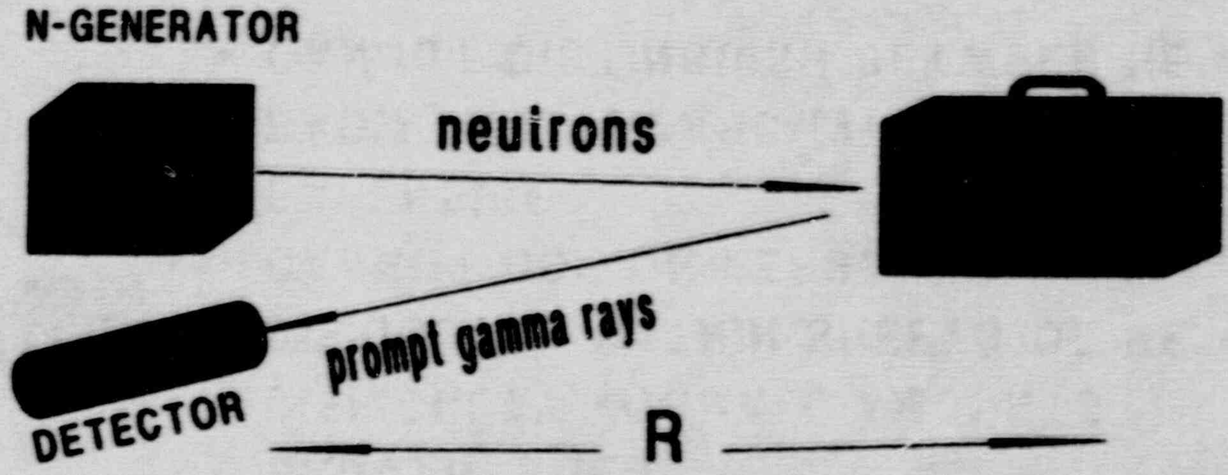
$^{14}N(n,\gamma)^{15}N$ measure 10.83-MeV prompt gamma ray

- FAST NEUTRON ACTIVATION/SCATTERING

(n,2n), (n,p), (n,n'), etc.

- BREMSSTRAHLUNG

$^{14}N(\gamma,n)^{13}N$ positron formation(β^+) = 0.51 MeV gamma rays

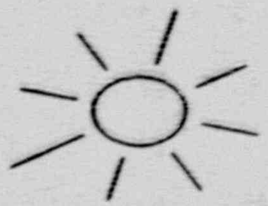


no. of gamma rays = $[N_a \times M \times \sigma / A][N/4\pi R^2][1/4\pi R^2][D \times E]$

where

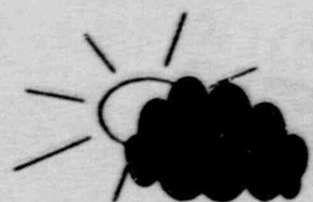
- N = number of neutrons/sec emitted by n-source
- N_a = Avagadro's Number
- M = total mass of nitrogen in target
- σ = cross-section for neutron reaction
- A = atomic weight of nitrogen
- D = active area of detector face
- E = counting efficiency

THERMAL NEUTRON ACTIVATION (TNA)



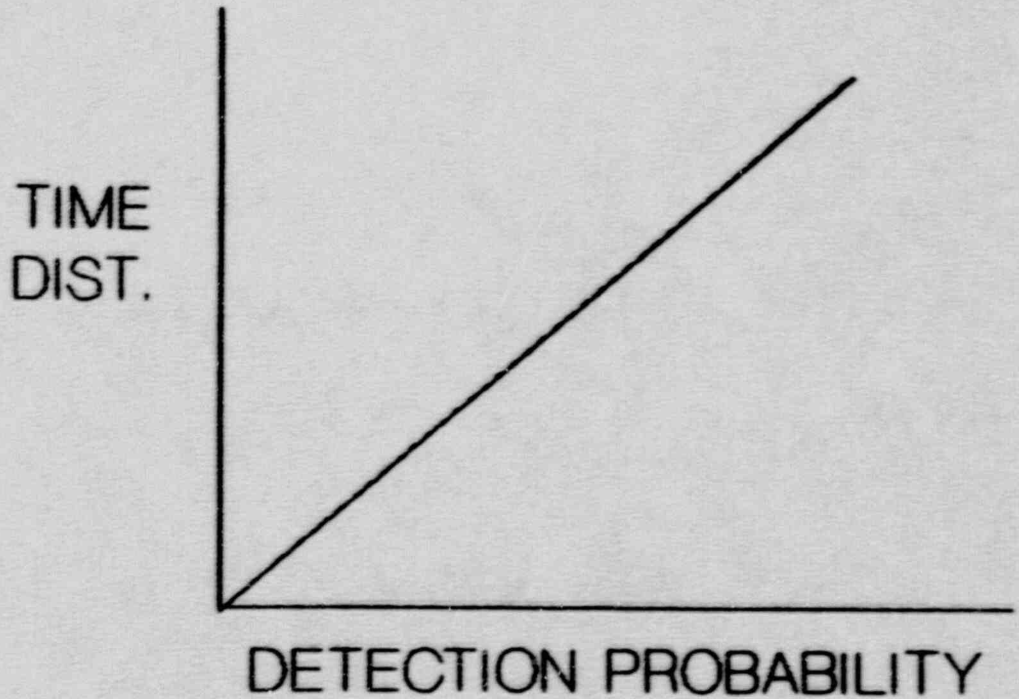
ADVANTAGES

- RELATIVELY RAPID (10 SEC.)
- NON-INVASIVE
- GOOD RELIABILITY
- LOW FALSE POSITIVE
- LOW FALSE NEGATIVE
- SPECIFIC FOR NITROGEN



DISADVANTAGES

- DIFFICULTY W/SMALL AMOUNTS
- DIFFICULTY W/THIN SHEETS OF HE
- CANNOT USE ON PERSONNEL
- EXPENSIVE
- RADIATION HAZARD (?)
- CANNOT DISTINGUISH BETWEEN HE's



DISTANCE = INVERSE

FBI LABORATORY EVALUATION OF PORTABLE EXPLOSIVES VAPOR DETECTORS

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FBI LABORATORY EVALUATION OF PORTABLE EXPLOSIVES VAPOR DETECTORS

Dean D. Fetterolf

FBI Laboratory, Forensic Science Research Unit
FBI Academy, Quantico, Virginia, 22135, USA

ABSTRACT

In March, 1988, the FBI Laboratory conducted an evaluation of commercially available explosives vapor detectors under operational scenarios typically encountered by law enforcement and security personnel. Three gas chromatograph/electron capture-based detectors, the Ion Track Model 97, the Scintrex EVD-1, and the Sentex Scanex Jr. as well as the ion mobility based Graseby PD-5 were evaluated.

The explosive detection and operational capabilities of each detector were examined by sampling laboratory reference standards, the test explosives and potential interferants. Bomb quantities of a variety of explosives were hidden in packages, briefcases, and luggage. Practical search problems also involved locating explosives hidden in automobiles, mail, motel rooms and a townhouse.

Only a few positive responses to potential interferants were recorded. Dynamite (NG and EGDN) was readily detected with only 2 hours soak time in the various test items and search scenarios. TNT was also found in some cases. The less volatile explosives including an NH_4NO_3 emulsion, PETN Deta Sheet and the C-4 were undetected in any test item after 18 hours soak time or in any of the practical search problems. Summarized test procedures and results are presented to allow the reader to evaluate the data with respect to his/her own operational requirements.

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1. INTRODUCTION

The rise in domestic and international terrorism in the last decade has generated an increasing interest by law enforcement and physical security personnel in the operational uses and capabilities of commercially available portable explosive vapor detectors. These uses include the security screening of personnel or items entering a building or secure facility. Law enforcement uses include such scenarios as bomb threats, suspicious packages or searching for secondary devices following an explosion.

A number of laboratory studies were carried out in the late 1970s by Sandia National Laboratories, the United States Department of Transportation, and the Naval Explosives Ordnance Disposal Facility. In April, 1981, a comprehensive field test of commercially available explosives detectors and dogs was carried out by the Research and Development Division of the Bureau of Alcohol, Tobacco and Firearms, U.S. Department of the Treasury.

This paper, condensed from a final report of 126 pages, summarizes the test procedures, provides a brief functional description of each detector, and presents the results from their evaluation under operational scenarios of interest to law enforcement and security personnel. The evaluation, conducted by the FBI Laboratory during March 21-24, 1988, was directed toward the needs of the "user" while maintaining a fair and impartial test environment.

It was made clear to the manufacturing representatives that participation in the test and the results thereof does not constitute or imply endorsement, favoring or recommendation by the U.S. Government or any agency or employee thereof. No specific recommendations regarding overall detector performance are made. The reader must evaluate the data with respect to his/her own operational requirements.

The explosive detection and discrimination capabilities of each detector were examined by sampling laboratory reference standards, the test explosives and potential interferants. Bomb quantities of a variety of explosives were hidden in packages, briefcases, and luggage. These test items were treated as suspicious items. The briefcases were also sampled using the EOD Technician procedure called "burping" which calls for the compression of the briefcase forcing vapor-enriched air to escape, thus enhancing the probability of detection. This procedure was included at the request of some of the manufacturers. Practical search problems also involved searching for explosives hidden in automobiles, mail, motel rooms and a townhouse. These were directed searches in which several specific location were labeled and searched. This effectively eliminated the ability of the operator to conduct a proper search as an uncontrollable variable and placed the emphasis on the detector.

II. TEST PROCEDURES AND GUIDELINES

Bomb quantities of live explosives were used in the packages, briefcases and suitcases. The explosives typically weighed from 1 to 1.25 pounds. Only 1/4 pound of dynamite was used due to the highly volatile nature of nitroglycerine (NG) and ethyleneglycol dinitrate (EGDN) and the fear of contamination. PETN Deta Sheet, Atlas 7D emulsion, TNT and C-4 explosives were selected from "sterile" (non-dynamite storage) bunkers. Hercules Red Dot smokeless powder was purchased a few days prior to the evaluation. The Hercules Unigel dynamite was stored in a separate bunker.

A soak time (time since package preparation and examination) of 18 hours was provided for packages and briefcases containing PETN, TNT, C-4, Atlas 7-D and smokeless powder. The soak time for dynamite was only 2 hours.

Great care was taken to avoid cross-contamination of the explosives and the test items during preparation, storage and handling. Double gloves were worn during the preparation. Storage was provided by double wrapping each item containing explosives in plastic garbage bags. These items were stored separately from blank items or those containing interferants. No dynamite or test items containing dynamite were permitted in the test facility until just before the testing began.

The manufacturing representatives were invited to attend the evaluation in January of 1988. A brief outline detailing which explosives would be used, the operational test scenarios, types of interferants, testing schedule, and figures of merit for the evaluation were provided.

Prior to the test, four operators were chosen by personnel of the FBI Laboratory because of their recognized expertise in explosives and their familiarity with the requirements of explosives detection in the forensic and law enforcement communities. Their observations provided valuable insight into the state of the art in commercial explosives vapor detectors which would not have been obtained through the use of nonexperts or the manufacturing representatives.

Each manufacturer was provided an opportunity to describe their instrument to the operator and to provide training in its operation. As part of this training phase pure explosive compounds and the actual test explosives were sampled. Forms detailing the instrument model and serial number, operation within specifications, and satisfaction with the operator were completed by the manufacturing representatives. Following the training and on subsequent days the instruments were secured in locked laboratory space until the following day.

The actual search problems were done in teams. The search teams consisted of the trained operator, who made the decision as to a positive detector response; a scorer/observer, who recorded the results; and the manufacturing representative(s) who functioned as a witness. The tests were conducted in the blind mode so that none of these individuals had any knowledge of the explosives or their location. Simultaneous tests were conducted and the teams rotated. Observers from over 40 U.S. Government and foreign agencies attending the test were segregated from the testing areas but had the opportunity to observe each instrument in the various phases of the evaluation. The manufacturers, the trained operators, and the observers were invited to provide written comments following the evaluation for inclusion in the final report.

III. DETECTORS EVALUATED

Four detector manufacturers volunteered to participate in the evaluation. Table 1 provides a comparison of the various operating characteristics of each detector. A brief operational description of each is provided.

Graseby PD-5: The Graseby PD-5 is the only ion mobility spectrometer (IMS)-based portable explosives detector commercially available. This rechargeable, battery-operated detector is totally self-contained and requires no replenishing of carrier gas supply. After 2 minutes of warm-up and automatic calibration the instrument operates in a continuous sampling mode with a 3-second response time. Two to 3 sampling intervals were used for each test item.

In operation, outside air is drawn in through a hand-held probe, by a pump contained within the briefcase unit. Air and explosives molecules diffuse through a membrane into a chamber where a sealed ^{63}Ni radioactive source ionizes the sample. Under the influence of an electrical field 20 millisecond bursts of ions drift toward the collector electrode. The larger and heavier explosive molecules drift more slowly than the air molecules. The microprocessor system recognizes these peaks at specific points in time and triggers an adjustable audible alarm. A digital display indicates the relative concentration of the explosive being detected.

Ion Track Instruments Model 97: The Ion Track Instrument (ITI) Model 97 is a dual gas chromatograph/electron capture-based detector. This portable detector is supplied with a rechargeable battery pack. Argon carrier gas is supplied from a 4 ft^3 refillable gas tank. After approximately 15 minutes of warm-up time this detector operates in the continuous mode with a 2-10 second response time.

Suspect vapor is drawn into the instrument through a membrane which isolates it from ambient air. The vapor is mixed with Argon, an inert carrier gas, and fed down both columns. One of the columns is coated with a chromatographic support which retards the progress of explosives molecules. Each column terminates in an electron capture detector (ECD).

If electronegative molecules, such as explosives are present they reduce the standing current in the ECD and trigger an alarm. The relative strength of the signal is displayed on a pseudo logarithmic bar graph display. The timing sequence of the signals from the twin ECDs discriminates between explosive vapors and those produced by similar nonexplosive substances.

Scintrex EVD-1: The Scintrex EVD-1 is a 2-component system consisting of a battery-powered, hand-held sampling unit and an analyzing unit which can be AC or battery operated. This analyzer unit consists of a desorber, chromatographic column and an ECD with a response time of 1.5 minutes.

The sampling unit consists of a battery-operated metering pump which draws air through a 7-cm quartz collection tube containing Tenax adsorbent at 600-800 ml/min for a preset time of 15 seconds. The tubes are normally ready for reuse after each analysis.

The sample collection tube (containing the adsorbed vapor) is placed in the desorber portion of the analyzer. The tube is heated and purged with pure carrier gas. The vapor sample then enters the analyzer unit into a secondary adsorber, then to the chromatographic column and finally into the ECD. The electronic section of the detector monitors the standing current in the ECD. A microprocessor software algorithm decides whether there is a signal within preset retention time windows corresponding to an explosive. The results are then sent to a digital LCD display.

Sentex Sensing Technology Scanex Jr.: The Sentex Scanex Jr. manufactured by Sentex Sensing Technology is also sold under an exclusive license as the XID Corporation Model T-54. This portable detector consists of a preconcentrator, a gas chromatograph, an electron capture detector, and a rechargeable battery pack. Helium carrier gas is supplied from a refillable gas tank. Following 20 minutes of warm-up time the detector operates in the batch mode with an 8 to 20 second response.

The hand-held sampling probe is push button activated, drawing air into the unit as long as the button is depressed. According to the manufacturer the sampling pump should be activated between each item to clear any remaining material and to reestablish baseline operation. The sampling probe is connected to the briefcase unit by a 1 meter heated teflon tube.

An adsorbent material coated on a coiled platinum wire collects the explosive vapors if present. The platinum wire is then heated and the vapors desorbed onto a chromatographic column where seperation takes place. The sample then passes into a tritium foil ECD. The microprocessor decides whether there is a signal within a preset retention time window and triggers an audible alarm and an LED bar display.

TABLE 1. Detectors Evaluated

DETECTOR	TYPE	CONCENTRATOR	OPERATION	EXPENDABLES	WARMUP	RESPONSE
Graseby PD-5[1]	IMS	Membrane	Continuous	None	2 min	3 sec
ITI Model 97[2]	GC/ECD	Membrane	Continuous	Ar Carrier	15 min	2-10 sec
Scintrex EVD-1[3]	GC/ECD	Tenax Tube	Batch	He Carrier	30 min	1.5 min
Sentex Scanex JR.[4]	GC/ECD	Pt Coil	Batch	He Carrier	20 min	8-20 sec

1. Graseby Ionics Ltd., 6 Millfield House, Woodshots Meadow, Watford, Herts, England WD1 8YX
2. Ion Track Instruments, 109 Terrace Hall Avenue, Burlington, MA 01803, USA
3. Scintrex Security Systems, 222 Snidercroft Road, Concord, Ontario, Canada L4K 1B5
4. Sentex Sensing Technology, Inc., 553 Broad Avenue, Ridgefield, NJ 07657, USA

IV. STANDARDS, TEST EXPLOSIVES AND INTERFERANT RESULTS

Pure Explosive Compounds: Samples of laboratory reference explosives listed in Table 2 were sampled in near contact by each detector. It is quite clear from this data that the detectors evaluated respond to the higher vapor pressure NG and 2,6 DNT without any difficulty. In general, and as expected, the lower vapor pressure pure explosives (TNT, RDX and PETN) provide an increasing challenge to these detectors.

The response of the Sentex/XID detector to pure PETN and RDX is unique and deserves a brief discussion. It has been demonstrated at Sandia National Laboratories that explosive vapors will adsorb on any surface. There is a rank-order of preferential adsorption by the various explosive compounds. In simple terms this means that EGDN or NG adsorbed on surfaces can be preferentially replaced by RDX or PETN. The released EGDN or NG reaches the detector and provides a response. The result is that one falsely believes that the detector is responding to RDX or PETN directly. Such behavior has been observed experimentally at Sandia on short pieces of teflon tubing. The Sentex Scanex Jr. is equipped with 1 meter of teflon tubing between the sample pump and the briefcase unit.

TABLE 2. Laboratory Standards Results

PURE COMPOUNDS	GRASEBY	SCINTREX	ITI	SENTEX
NG Tablets	+	+	+	+
Ammonium Nitrate	-	-	+	-
2,6 DNT	+	+	+	+
TNT	-	-	+	+
PETN	-	-	-	+
RDX	-	-	-	+

Test Explosives: Small pieces of each of the test explosives were sampled in near contact by each detector. Great care was taken to prevent cross contamination of the explosives or contamination of the instruments or test facility during this stage of testing. For this reason no Hercules Unigel dynamite was sensed in this phase as all detectors responded to NG tablets. The results of sampling the test explosives are shown in Table 3. Some important points can be made by comparing the data from Tables 2 and 3.

All instruments readily responded to the Hercules Red Dot, a double-based smokeless powder which contains a relatively high percentage of NG. No detectors responded to the military explosive C-4. These responses were consistent with Table 2.

Several noteworthy differences can be seen between Table 2 and Table 3. For example, the Graseby PD-5 and the Scintrex EVD-1 alarm on military TNT is due to the higher vapor pressure 2,6-DNT impurity and not the TNT itself. In addition, while all detectors responded to the Dupont Deta Sheet they failed to directly detect the pure PETN with the exception of the Sentex Scanex Jr. The detectors are most likely responding to a volatile component in the formulation.

The response between the ammonium nitrate and the Atlas 7-D appear to be inconsistent. The ITI detector responded to the pure ammonium nitrate but failed to alarm on the test explosive. The Scintrex and Sentex detectors failed to respond to the pure ammonium nitrate but alarmed on the uncontaminated Atlas 7-D. It should be noted that the Atlas 7-D also contains a sensitizer, ethylenediamine dinitrate. However, without laboratory evaluation of each detector it is difficult to determine if this caused the detectors to alarm.

TABLE 3. Test Explosive Results

TEST SAMPLES	GRASEBY	SCINTREX	ITI	SENTEX
Hercules Red Dot Smokeless	+	+	+	+
Atlas 7-D	-	+	-	+
TNT	+	+	+	+
C-4	-	-	-	-
Dupont Deta Sheet (PETN)	+	+	+	+

NOTE: Dynamite not tested to avoid contamination.

Interferant Results: Twenty-five potential interferants were analyzed in a laboratory environment. These samples were chosen because of their chemical composition and past experiences with various detectors by a number of individuals. Table 4 shows the interferant results for the detectors.

Most notable is the fact that the Scintrex EVD-1 and the Sentex Scanex Jr. recorded no positive responses to any of the interferants chosen. Both instruments operate on a preconcentration step which involves adsorption of the explosives vapors prior to analysis. These volatile vapors are not adcorbed or chromatographic and detection conditions are such that these compounds do not co-elute or alarm as explosive molecules.

The 2 positive responses by the Graseby PD-5 are easily explained. The Skoal Wintergreen Smokeless Tobacco contains methyl salicylate (the wintergreen flavoring). This detector is programmed to respond to this chemical as this is the same basis used to check for decontamination in chemical warfare training exercises by the British military. The microprocessor could be reprogrammed to eliminate this alarm. The response to the diesel fuel sample was, as later determined in laboratory tests, due to contamination on the plastic cap and not the diesel fuel within the vial. The p-Cresol alarm was unique to the Graseby and unexplainable.

The ITI Model 97 responded to the Coty Wild Musk and Obsession colognes both which contain musks. The chemical structure of musks is similar to that of TNT. The response to the Cepacol mouthwash cannot be explained without further laboratory investigation. The Super Glue response was due to the fact that the glue was still wet, an unlikely event in real situations. The response to the Skoal Wintergreen Smokeless Tobacco is most likely due to the flavoring chemicals.

Table 4. Interferant Results

	GRASEBY	ITI	SCINTREX	SENTEX
Men's/Women's Toiletries				
Shield Deodorant Soap	-	-	-	-
Kiwi Shoe Polish (Black)	-	-	-	-
Cepacol Mouthwash	-	+	-	-
Coty Wild Musk Cologne Spray	-	+	-	-
Gilette Right Guard Spray	-	-	-	-
Obsession Cologne	-	+	-	-
Household Chemicals				
PineSol Cleaner Disinfectant	-	-	-	-
Enoz Moth Balls	-	-	-	-
Lysol Spray Disinfectant	-	-	-	-
Raid Ant and Roach Killer	-	-	-	-
Pledge Dusting/Waxing Polish	-	-	-	-
Super Glue	-	+	-	-
Food Stuffs				
Chicken of Sea Tuna (Oil)	-	-	-	-
Fisherman's Net Sardines	-	-	-	-
McCormick Ground Cloves	-	-	-	-
Smoking Materials				
Captain Black Pipe Tobacco	-	-	-	-
Skoal Wintergreen Smokeless Tobacco	+	+	-	-
Laboratory Chemicals				
Perchloroethylene	-	-	-	-
Acetone	-	-	-	-
Gasoline	-	-	-	-
Diesel Fuel	+	-	-	-
Potassium Chlorate	-	-	-	-
Chloroform	-	-	-	-
p-Cresol	+	-	-	-
Dioctyl phthalate	-	-	-	-

V. TEST ITEM RESULTS

Package Results: Twenty-five 1-ft^3 sealed, and paper-wrapped cardboard boxes were used in this test segment. These packages were treated as a typical law enforcement scenario, the unidentified suspicious package. The operator, scorer/observer, or manufacturing representative was not permitted to touch the packages. Sampling was permitted along the taped edges of the package. No penetration or puncturing of the test item by needles or probes was permitted.

The packages were placed in a sample grid within a 250-seat auditorium. Great care was taken to surround the package containing the 1/4 stick of dynamite with blank boxes. This proved useful as in less than 1 hour it was not possible to approach this package without alarming the Graseby PD-5 detector. The packages were moved outdoors to avoid contaminating the test facility or the other packages.

The package test consisted of 10 blanks boxes, 6 explosives, and 9 interferants. The interferants chosen from Table 4 were perchloroethylene, Coty Musk Perfume, Kiwi Shoe Polish, mixed tobacco products and moth balls. Results of the test for the explosive containing packages are shown in Table 5 for the Graseby PD-5, the ITI Model 97 and the Scintrex EVD-1. The Sentex Scanex Jr. which failed to operate correctly was withdrawn from the evaluation.

The only explosive detected by all the detectors was dynamite in package number C8. Only the ITI Model 97 responded to the package containing TNT. All other explosives were undetected. The Graseby PD-5 provided the only positive response to a blank or an interferant package. The Graseby response to package number G8 is unexplained.

TABLE 4. Package Results

ITEM	CONTENTS	GRASEBY	ITI	SCINTREX
A14	PETN Sheet	-	-	-
C8	Dynamite	+	+	+
E1	C-4	-	-	-
E14	Atlas 7D Emulsion	-	-	-
H14	Smokeless Powder	-	-	-
J11	TNT	-	+	-

<u>Briefcase Results</u>: Twenty-five new molded plastic briefcases were used in the examination. Seven briefcases contained explosives, while 8 contained interferants and 10 were empty or blanks. The briefcases were placed at least 8 feet apart in the 3rd-floor hallway of the test facility.

This test involved 2 examinations, the first being a sampling of the briefcase along the metal-lined edges, locks and hinges. This search procedure would be typical of a suspiciously placed briefcase. To simulate a physical security scenario, the second sampling involved "burping" the briefcase by the scorer/observer in order to release trapped air from the briefcase. This procedure was included at the request of some of the manufacturing representatives.

The results of the briefcase test are shown in Table 6. The Graseby PD-5 correctly alarmed on the Hercules Red Dot smokeless powder and the 2 dynamite briefcases. A positive response was recorded for the Skoal Wintergreen Smokeless Tobacco. Unexplained responses to Musk and Pledge were recorded.

The ITI Model 97 correctly located the TNT and the 2 dynamite briefcases. Positive responses were recorded for 3 interferant briefcases 1 with Skoal Tobacco and 2 containing Coty Musk Perfume. These responses are consistent with the interferant study results. A positive response was also recorded to a blank briefcase.

The Scintrex EVD-1 correctly located the TNT, smokeless powder, 2 dynamites, and the Atlas 7-D briefcases without the need for "burping." No positive responses to blanks or interferants were recorded.

TABLE 5. Briefcase Results

ITEM	CONTENTS	GRASEBY	ITI	SCINTREX
3	TNT	-	+	+
7	Smokeless Powder	+B	-	+
11	PETN Sheet	-	+/-	-
13	Dynamite	+	+	+
16	Atlas 7-D Emulsion	-	-	+
20	Dynamite	+	+	+
23	C-4	-	-	-

Note: (+) denotes positive response without burping; (-) denotes negative responses; (+B) denotes positive response on burping only; (+/-) denotes positive response without burping and negative response on burping.

Luggage Results: An assortment of 10 pieces of luggage of various types (soft sided, carry on, etc) filled with clothing were sampled. One item, a soft-sided zippered, bag contained dynamite. The Graseby PD-5, ITI Model 97 and the Scintrex EVD-1 correctly identified the bag. No other alarms were recorded.

VI. Practical Search Exercise Results

The practical search problems were set up in the FBI Hogan's Alley training complex located at the FBI Academy. This multiuse facility was designed to provide a realistic environment for law enforcement training exercises. It also houses office space and additional Academy-related services.

The search problems were set up to evaluate the capability of each detector in routine physical search scenarios. This test was designed not to evaluate the operator/detector combination but the detector itself. Each item or area to be searched was clearly labeled with a 3x5 card as to where and what was to be searched. For example, if a desk drawer was to be searched it would already be partially open (1/4 inch) and clearly labelled as to search along the open edge. No test area could be opened, moved, or otherwise disturbed by the search team. This directed search eliminated the operators' ability to conduct a thorough search as an uncontrolled experimental variable and ensured an equal opportunity for all detectors to respond to the hidden explosives. The Sentex Scanex Jr. was voluntarily withdrawn from these searches by the manufacturer due to instrument failure the previous day.

Post Office: This search scenario centered around a typical small town post office. A service window and locked mail boxes were located here. The purpose of this scenario was to simulate a search of mail. A letter, a manila envelope, and a package addressed to the test coordinators were individually searched. A standard exterior mail box was also searched.

The manila envelope contained PETN sheet explosive. The Graseby PD-5, the ITI Model 97 and the Scintrex EVD-1 failed to locate the PETN explosive. It is of interest to note that all 3 of these detectors responded to the PETN test explosive in Table 3, when in near contact with the sample. No false alarms were recorded by the detectors on the other test items.

Telephone Booth: A suspicious black gym bag was left in a sidewalk-style telephone booth outside of the bank. A porous brown paper lunch bag containing Hercules Red Dot double-based smokeless powder was placed on top of the clothes in the gym bag. For safety reasons the powder was not placed in a metal pipe as would be the typical case if an improvised explosive device was used. No detector responses were recorded. It should be noted that all 3 detectors responded to the test explosive when in near contact with the sample. No false alarms were recorded in the area.

Automobile No. 1 Exterior Search: A late model Chevrolet sedan was searched from the exterior. Such a search might be undertaken of vehicles entering a secure facility. Only selected areas of the automobile were searched. Two wheel wells, cracks of the hood, trunk, and passenger side front door were searched. An interior air sample was taken through the partially open drivers' window. A quarter (1/4) stick of Hercules Unigel Dynamite was placed in the trunk on top of the spare tire.

The Graseby PD-5 and the ITI Model 97 correctly responded to the dynamite while searching along the crack of the trunk after about 1 hour soak time. No other alarms were recorded by these 2 detectors. The Scintrex EVD-1 performed this analysis in the afternoon and also correctly responded to the dynamite in the trunk. The only other positive response was recorded in the afternoon by the EVD-1 on the interior air sample. This is most likely due to explosives vapors penetrating the rear seat or through the speaker area due to the longer soak time.

Automobile No. 2 Interior Search: The interior of a late model Lincoln Towncar was searched. Samples from inside the trunk, glove box, under the passenger and drivers' seat and the interior air were obtained. One-sixth pound of TNT was placed under the driver's seat.

The Graseby PD-5 and the ITI Model 97 correctly responded to the presence of the TNT under the driver's seat. An unexplained intermittent alarm was recorded in the trunk near the right rear speaker and in the glove box by the ITI detector. The Graseby PD-5 also alarmed under the passenger seat. No alarms were recorded by the Scintrex EVD-1. This was atypical of the performance of this instrument in other portions of the evaluation where it successfully located TNT.

Motel Room 117 Search: This standard single occupant motel room was labeled with 3x5 cards at six locations. Based upon our experience the previous day with dynamite vapor , only a small piece of dynamite wrapper was used. A 2x2-inch piece of dynamite wrapper was placed inside a styrofoam coffee cup in an office size garbage can. The lid was placed on the cup with the tear back drinking hole exposed. The garbage can was partially filled with trash (soda cans, snack food bags, etc.). The cup was placed near the top of the garbage can being partially covered by a snack food bag.

Both the ITI Model 97 and the Scintrex EVD-1 correctly located the dynamite wrapper in the garbage can. The Graseby PD-5 alarmed on room air upon entering the room but failed to alarm on the dynamite wrapper in the garbage can. The Graseby alarm on the desk drawer is inconsistent with its response in other empty desk drawers. The alarms by the Graseby PD-5 and the Scintrex EVD-1 on a clock on one of the tables are unexplainable.

Motel Room 118 Search: An identical adjoining room was sampled in six locations including desk drawers, a night stand, under the bed and a chair cushion. One desk drawer contained 1/4 pound of C-4 explosive. The desk drawer was partially open. This explosive was not detected by any of the detectors in this scenario. This is consistent with each detector's failure to detect the C-4 explosive itself. No other positive responses were recorded in this room.

Motel Room 125 Search: Motel Rooms 125 and 126 were prepared in such a manner as to simulate an overnight guest. The shower was run for a few minutes and the toilet flushed and deodorized. The room preparer shaved, brushed his teeth, gargled with a mouthwash and used an underarm deodorant. Several bursts of a room deodorizer were sprayed into the room. Windows within the motel rooms were also cleaned with Windex.

Hercules Red Dot smokeless powder in an open ziplock bag was placed in a dresser drawer. For safety reasons the powder was not placed in a pipe as would have been the case if an improvised explosive devise were present. No detector responded to the smokeless powder in the drawer. No other alarms were recorded to searches of a different drawer, the sink or toilet area.

Motel Room 126 Search: This adjoining room was prepared in an identical fashion to Room 125. There was no explosive material located in this room.

One dresser drawer contained a small amount of Skoal Wintergreen Smokeless Tobacco. The Graseby PD-5 alarmed on this drawer. This alarm is consistent with previous exposure (Table 4) to Skoal Wintergreen Smokeless Tobacco during the interferant test. The Scintrex alarms on the tobacco drawer and a heater vent are unexplained.

The ITI Model 97 alarm under the bed was also unexplained. The ITI also failed to alarm on the Skoal Wintergreen Smokeless Tobacco as it had during the interferant test.

Townhouse Search: The living room, kitchen, and a second floor office of a 3-story townhouse were searched. A piece of dynamite wrapper (approximately 2"x 3") was placed under one of the sofas in the living room. No explosives were placed in the kitchen. A one pound stick of Atlas 7-D emulsion was placed in a desk drawer in the office.

All three detectors correctly located the dynamite wrapper under the sofa in the living room. The Graseby detector produced no other alarms in this room. Intermittent and unexplained alarms were observed on a second sofa by the ITI Model 97 detector. The Scintrex EVD-1 also alarmed on the room air and near a table drawer holding a video cassette recorder. These alarms on air samples are consistent with this detectors response when sampling air in the areas where dynamite or dynamite wrappers were located.

No explosives were located in the kitchen. Recent plastering in the kitchen produced an unexpected background odor which did not interfere with the operation of any of the detectors. Samples were obtained under a sink which had household chemicals stored there, behind a washing machine, in a china cabinet, and room air. The only alarm recorded in the kitchen was the Graseby PD-5 alarm in an old unused refrigerator. This alarm is unexplained.

A stick of Atlas 7-D was placed in the desk drawer in the second floor office. No detector located this explosive. No other alarms were recorded on the file cabinet, a trunk, under a chair or from the air sample.

VII. SUMMARY

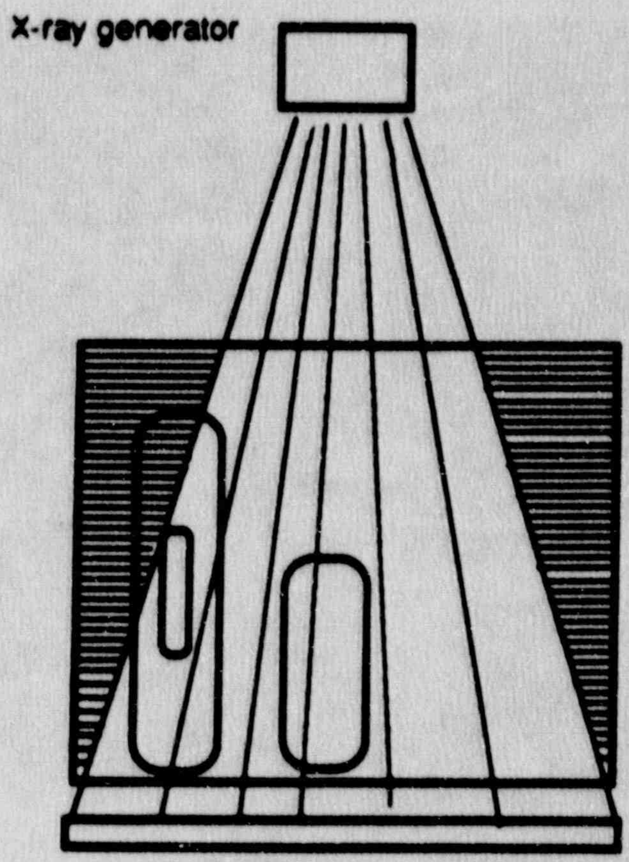
This evaluation was designed to examine the commercially available explosives vapor detectors in operational scenarios. The scenarios chosen were typical of those encountered by law enforcement and security personnel. No specific conclusions or recommendations are made. The readers must judge the data with respect to their own specific operational requirements. Several general conclusions are apparent from the data.

The 2 electron capture detectors, the ITI Model 97 and Scintrex EVD-1 and the ion mobility based Graseby PD-5 detector completed the entire evaluation without experiencing instrumental failure. In general, these detectors readily and reliably detected the higher vapor pressure ethyleneglycol dinitrate (EGDN) and nitroglycerine (NG) containing explosives in the test items (packages, briefcases, suitcases) and the area searches in Hogan's Alley. In fact, only a small amount of residual particulate matter or a piece of wrapper from the dynamite was necessary for detection. Military TNT containing the more volatile DNT component was also detectable in some cases.

The lower vapor pressure inorganic explosives (water gel/slurries and emulsions) such as Atlas 7-D and the organic (PETN and RDX) plastic explosives such as PETN Deta Sheet and C-4 were undetected in the various area search scenarios even though the detectors were directed to search specific areas. It should be noted that both of the inorganic explosives are widely used commercially in the United States. PETN and RDX-based explosives are commonly used by militarys throughout the world. It should be pointed out that these explosives were obtained from "sterile" sources and not exposed to contamination from the nitrated esters EGDN and NG.

Over the last 10 years or so there appears to have been a general improvement in sensitivity of the commercial detectors toward NG, EGDN and TNT. The challenge still remains to find a small portable hand-held detector able to reliably detect the inorganic and plastic explosives in operational scenarios.

To meet this important challenge, it will be necessary for explosives manufacturers, instrument companies, forensic scientists and law enforcement personnel to work together.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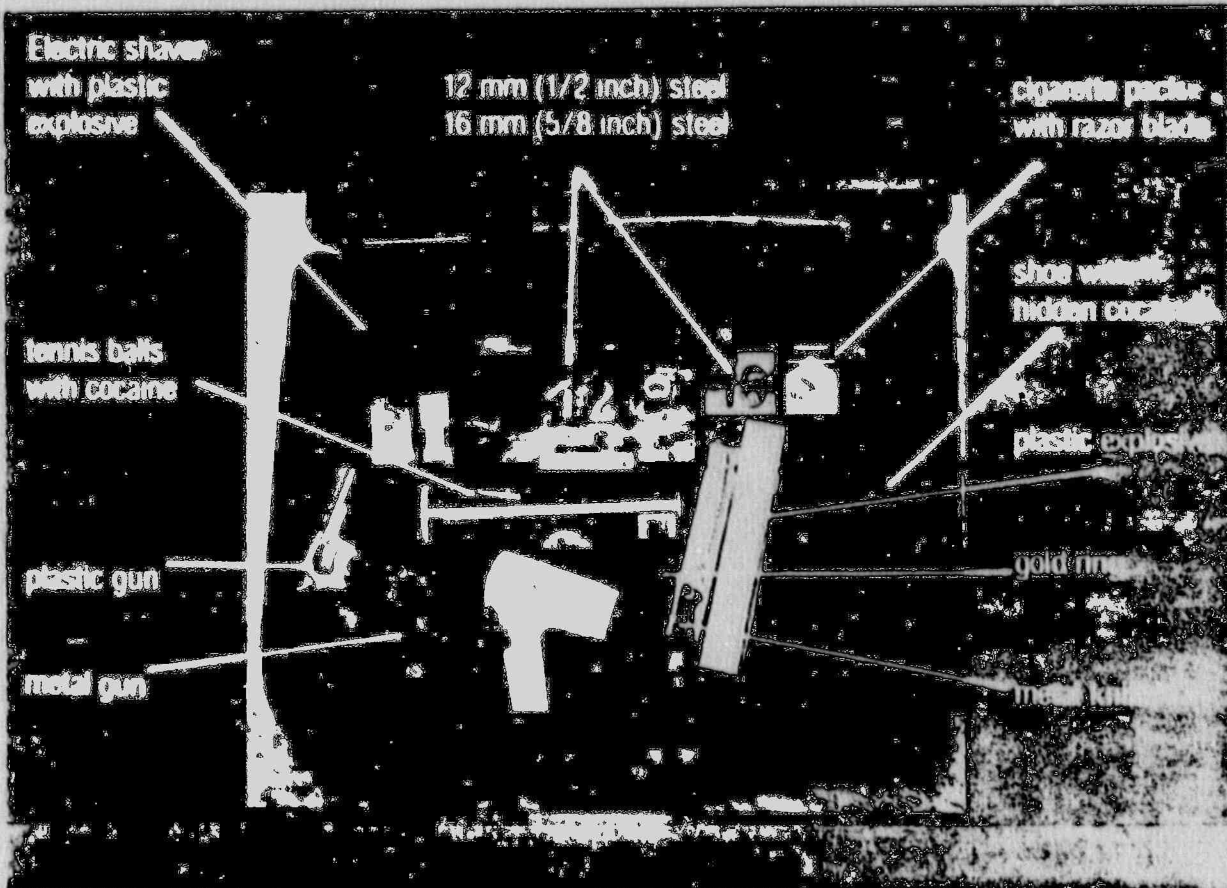
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explosive
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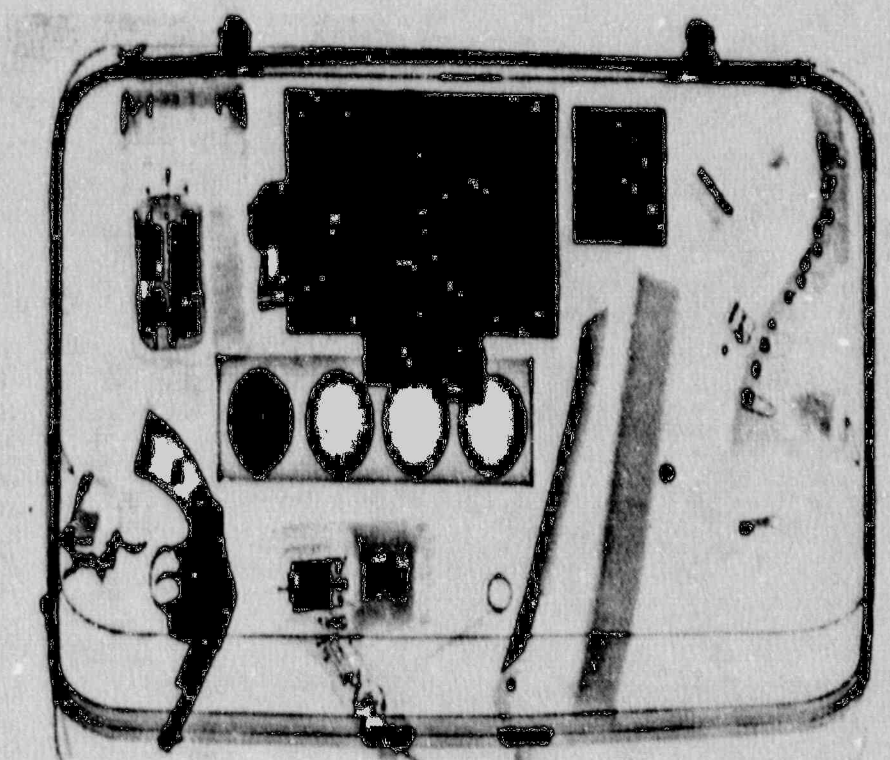
16 mm (5/8 inch) steel
tennis balls
with cocaine
plastic gun
metal gun



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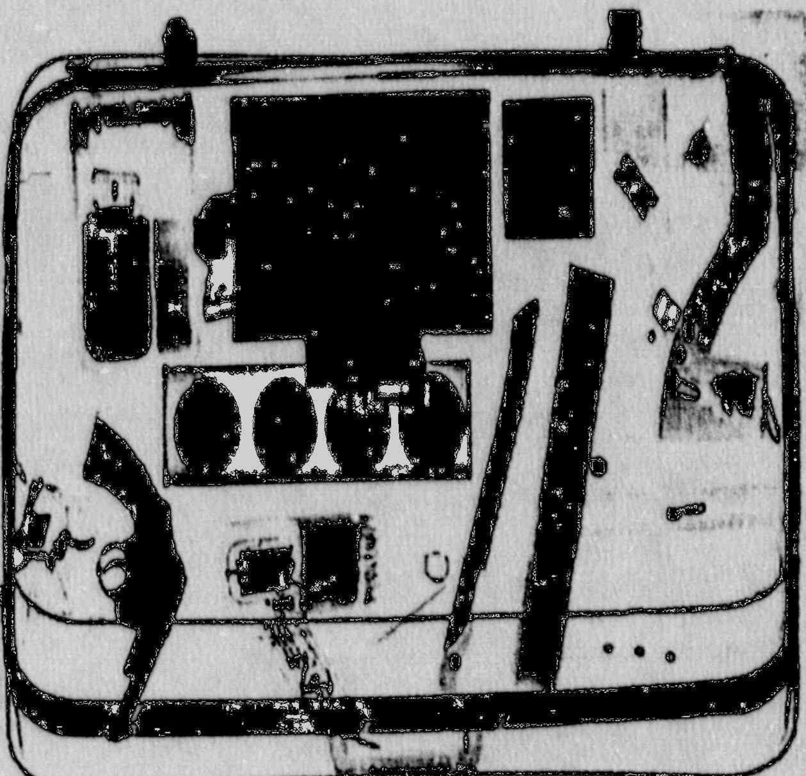

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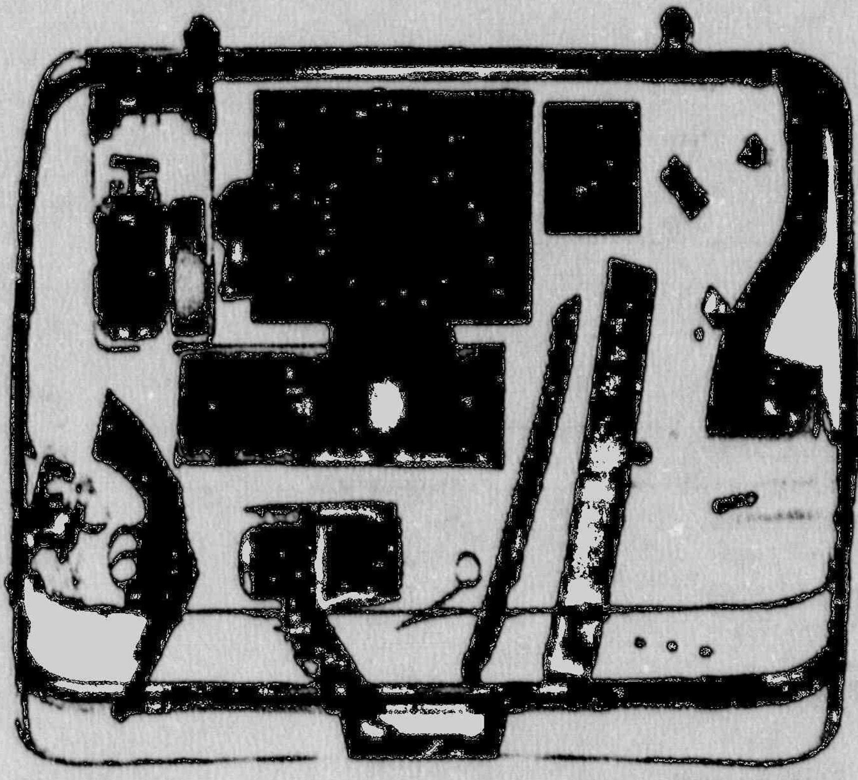
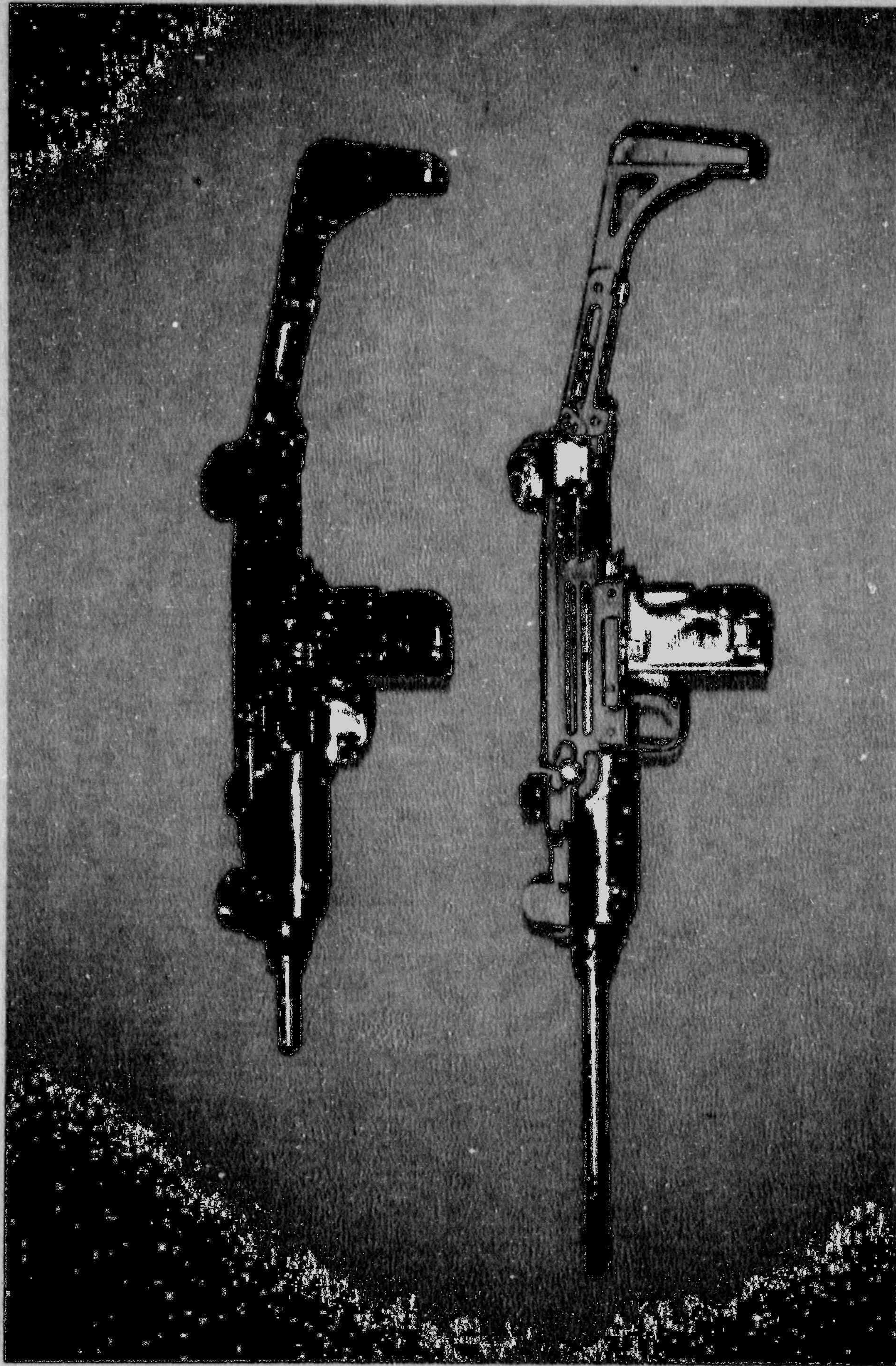
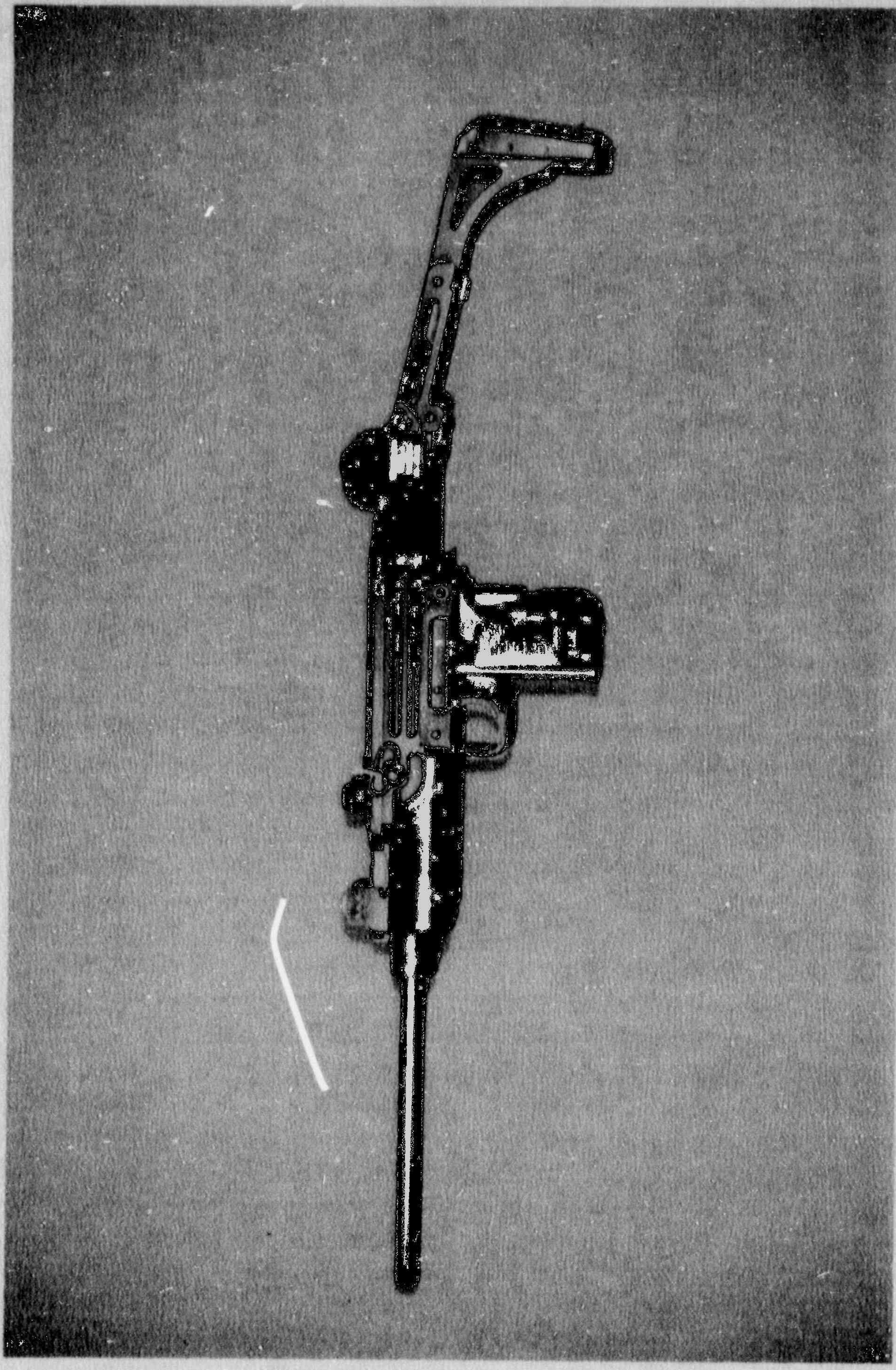


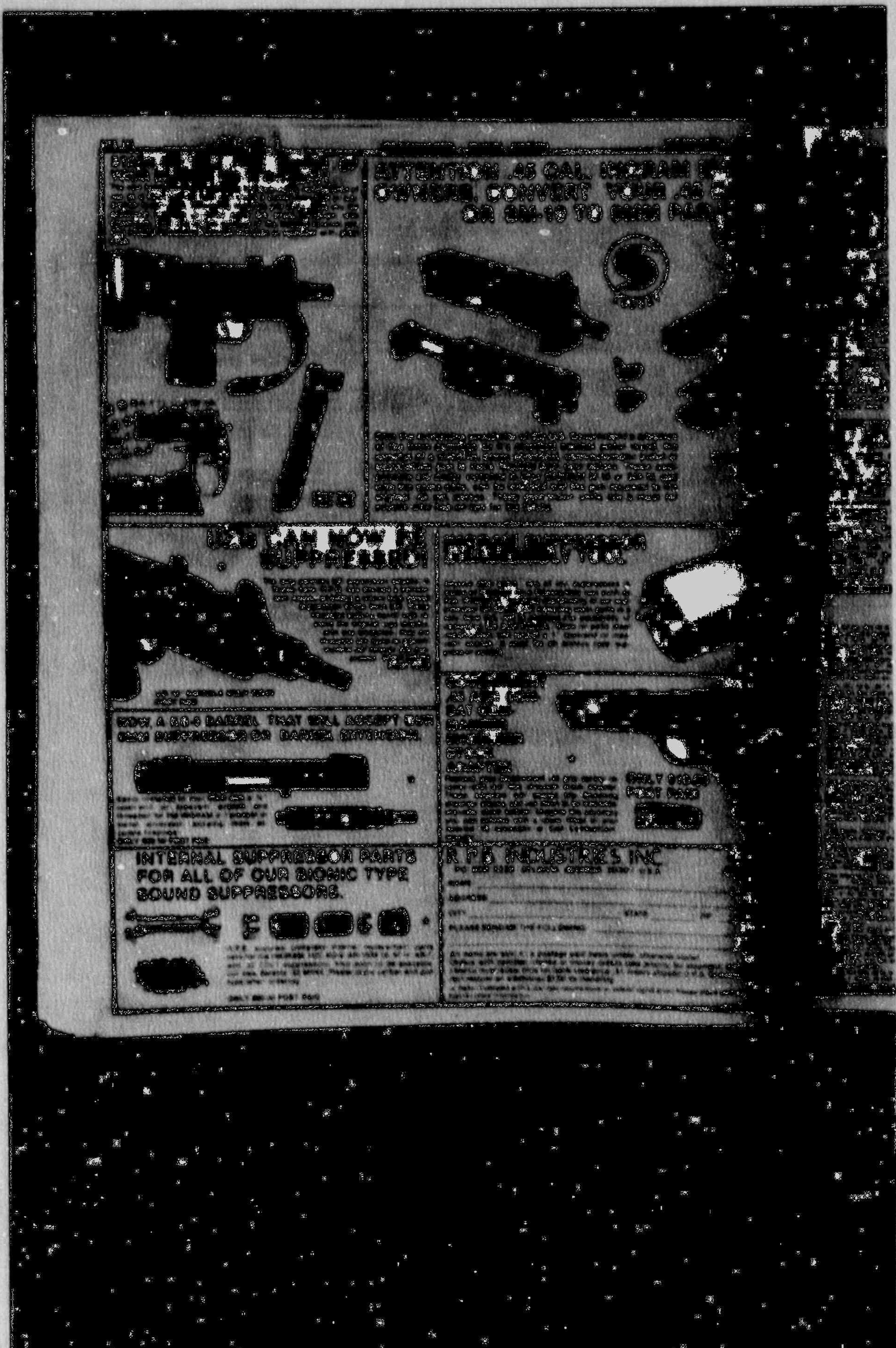
PSEUDO COLOR X-RAY

	Organic	Mixed Organic & Inorganic	Inorganic
	Orange	Green	Blue
Dangerous	• Plastic Explosives • Plastic Guns • Narcotics	• "Homemade Bombs" (Chloride/Sugar)	• Guns • Knives • Razor Blades
Not Dangerous	• Leather Briefcase • Clothing Material • Clothing Purses • Plastic Objects • Paper Products • Books/Files • Food • Wood & Plants • Drugs & Food • Prescription Drugs	• Light Metal • Combination of organic/inorganic materials	• Pens • Batteries • Portable Phone • Portable Radio • Keys


BUREAU OF ALCOHOL, TOBACCO AND FIREARMS






ATTENTION .45 CAL. INGRAM
OWNERS, CONVERT YOUR .45
INTERNAL SUPPRESSOR PARTS
FOR ALL OF OUR BIONIC TYPE
SOUND SUPPRESSORS.
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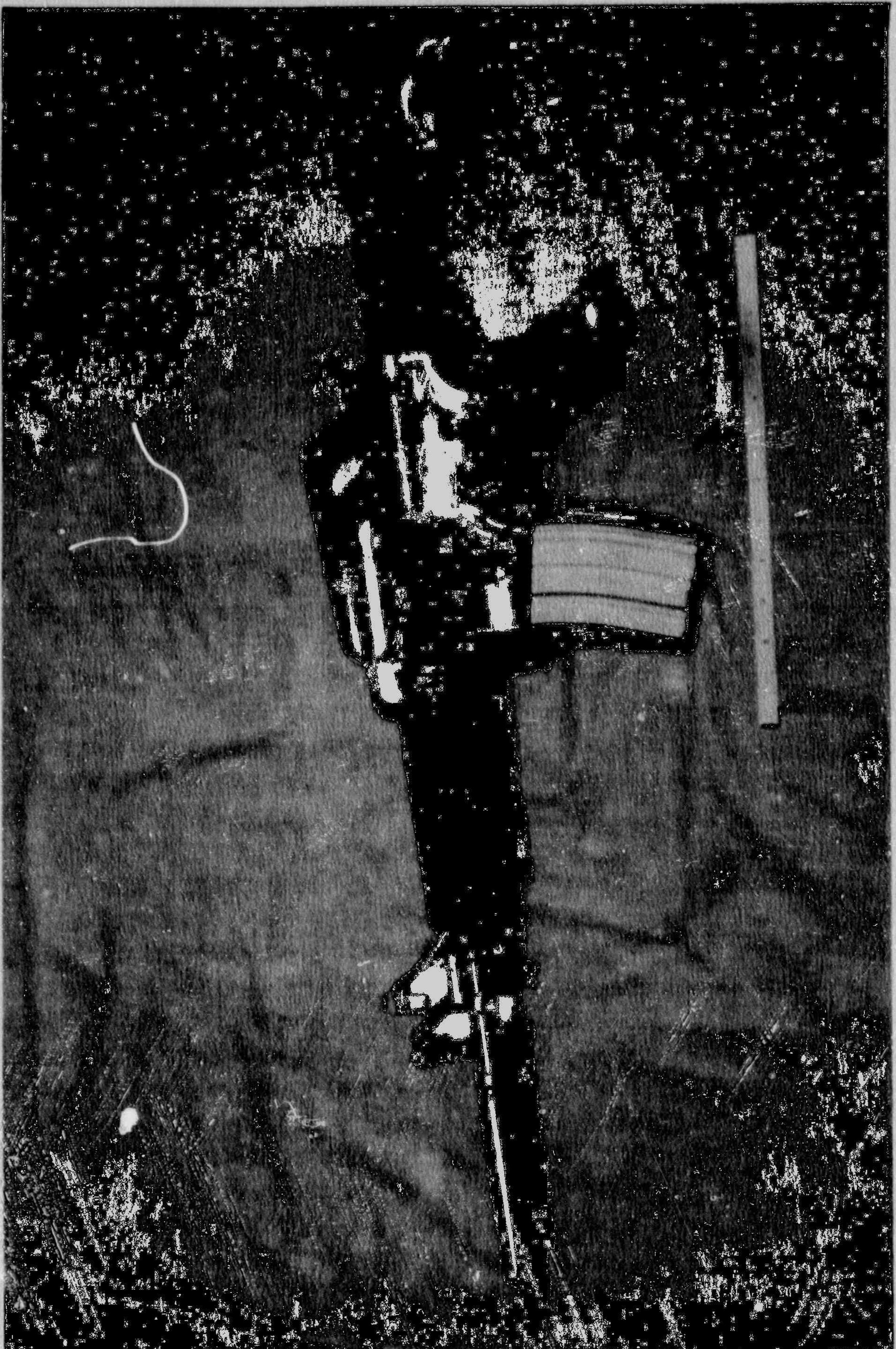
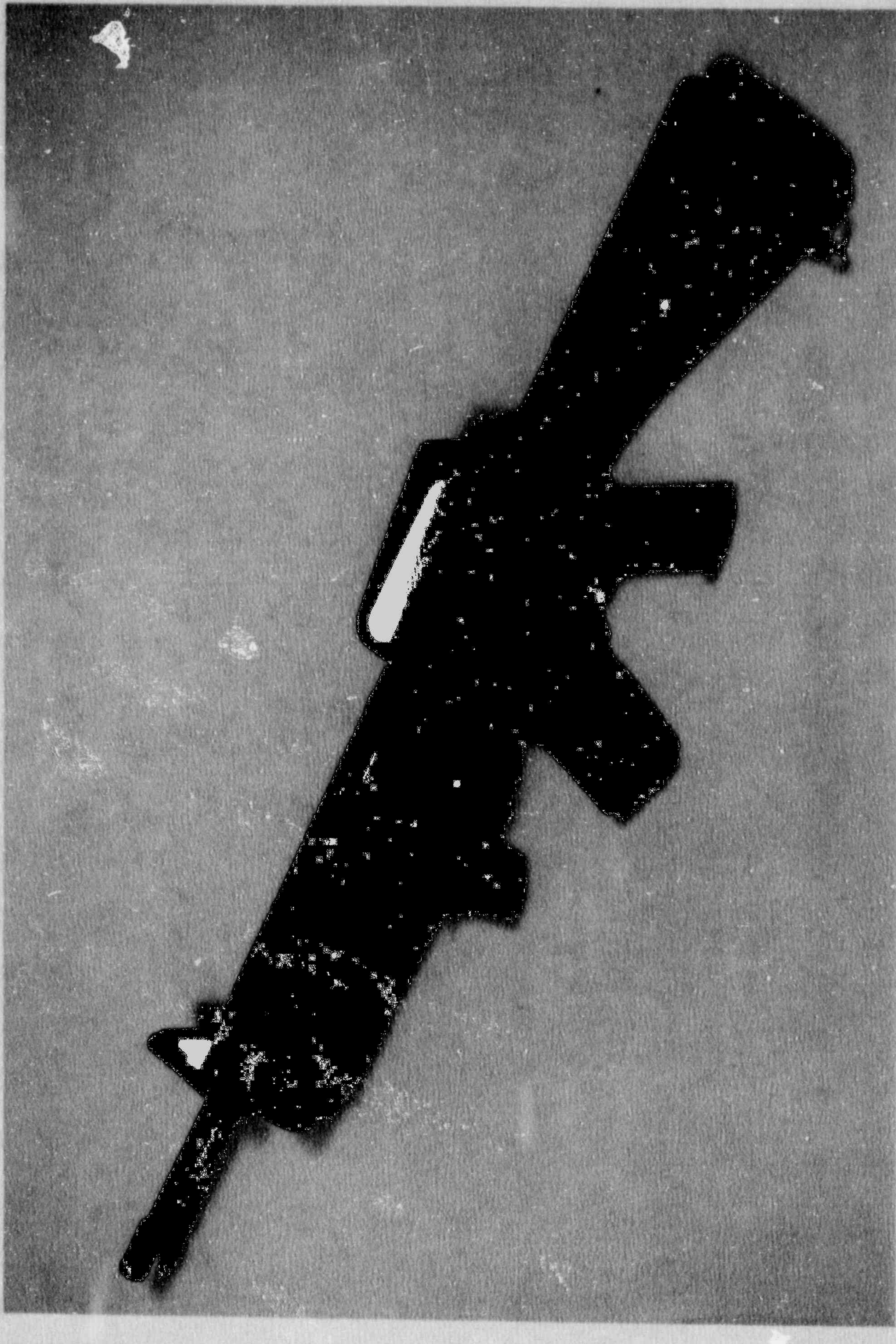
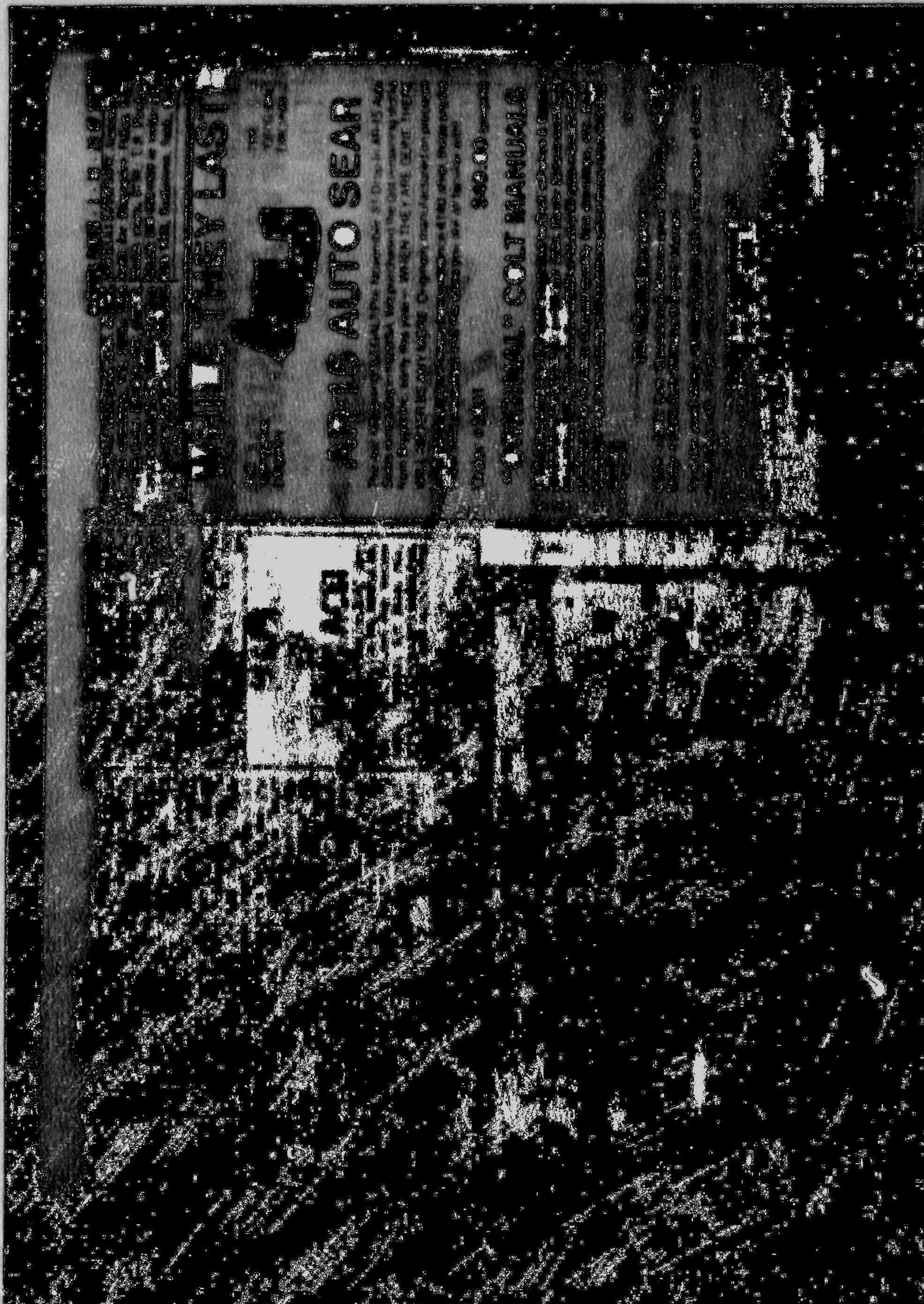
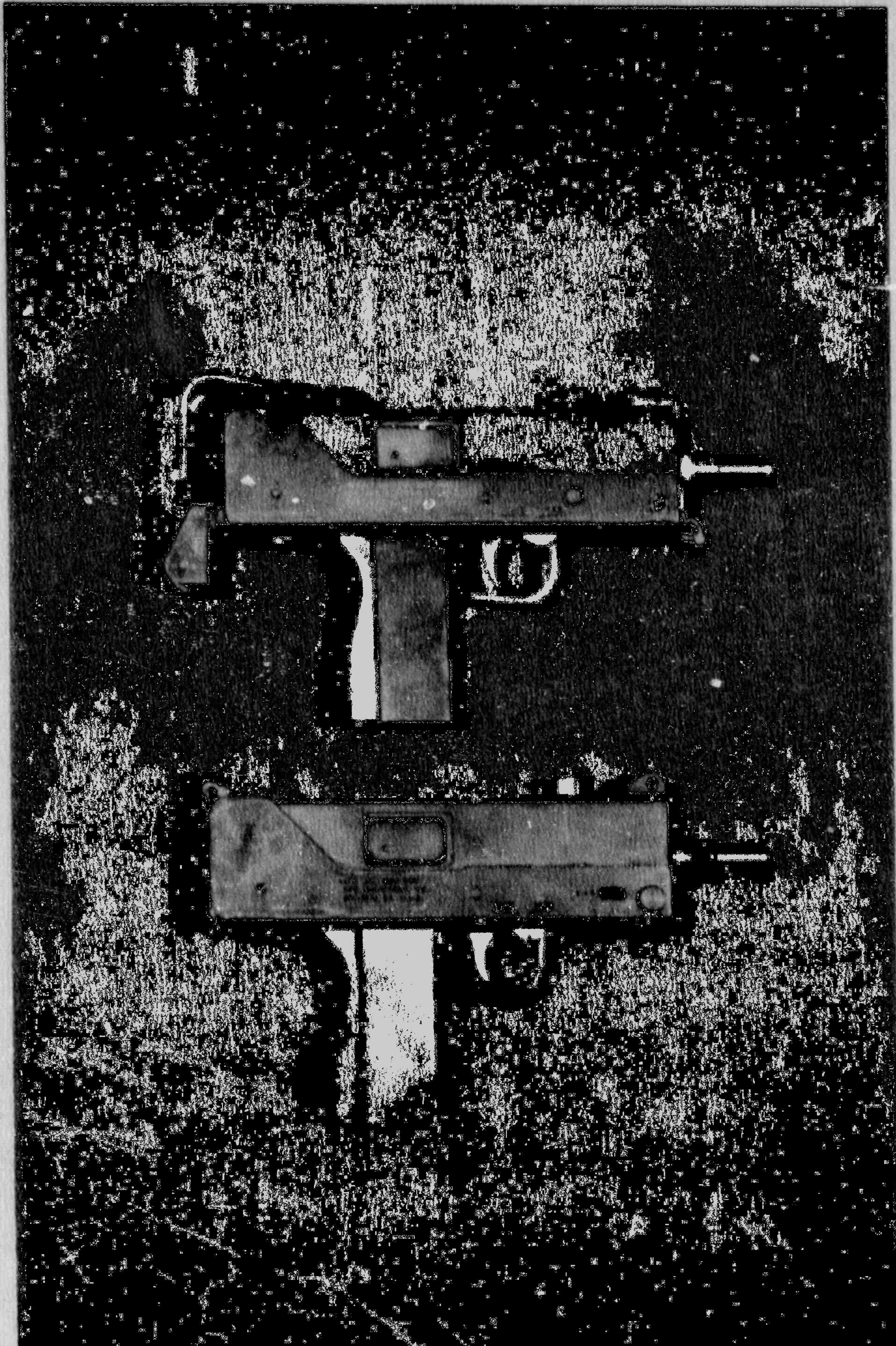
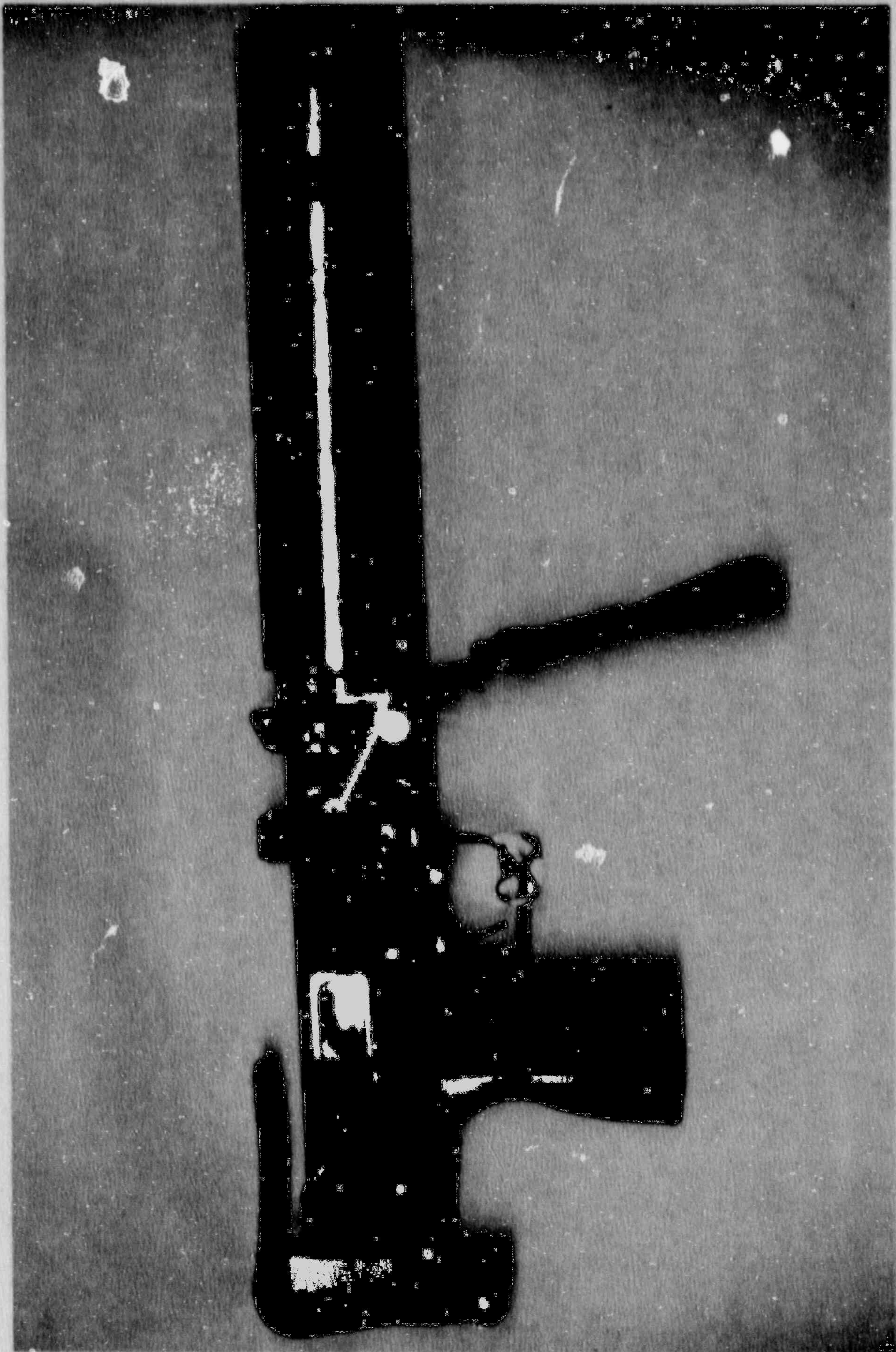
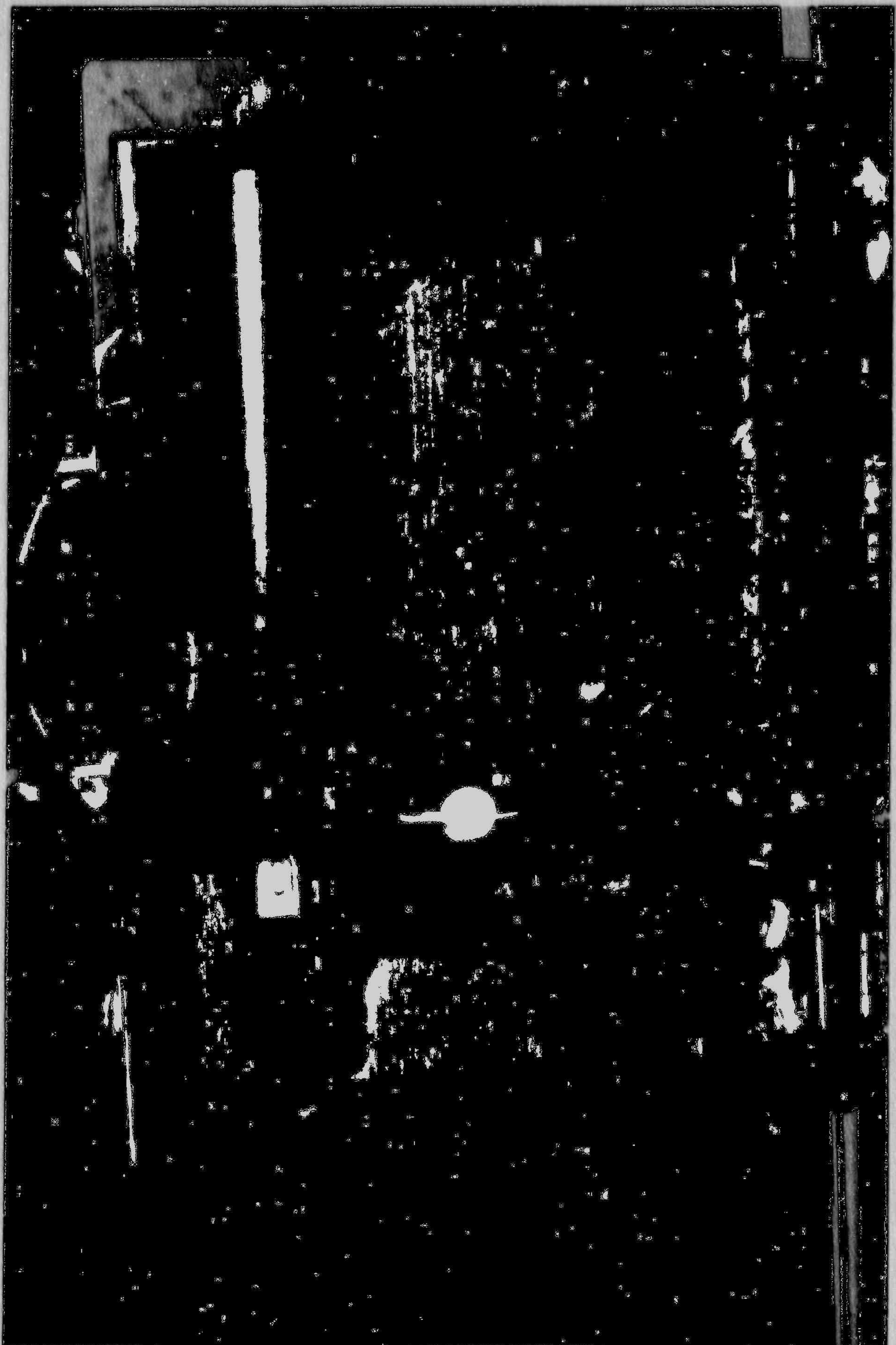


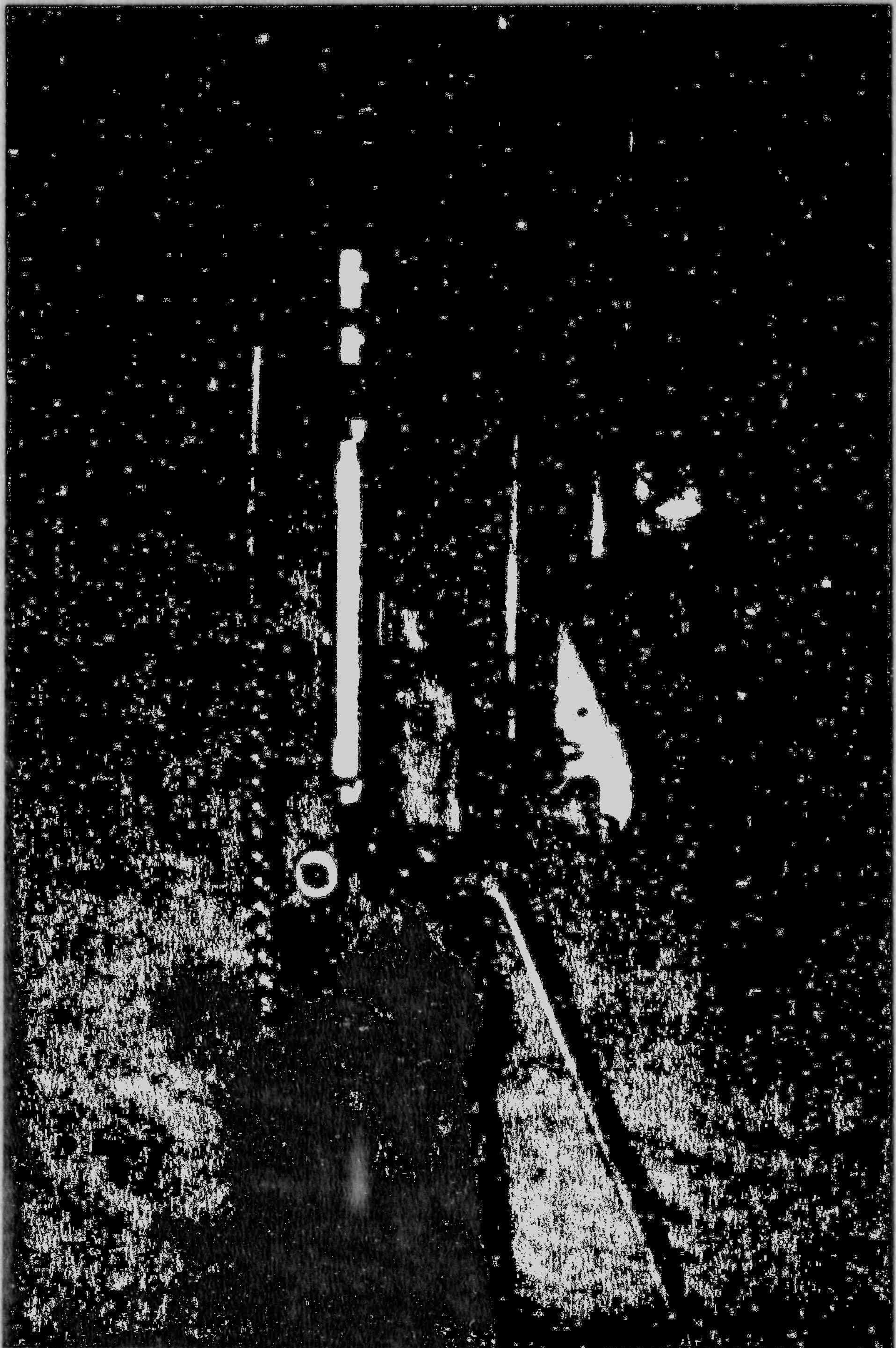



WHILE THEY LAST
AR15 AUTO SEAR
$40.00
"ORIGINAL" COLT MANUALS









shotguns. Send $2. for complete information and yours mailing list of other fine guns: Quality Arms, Inc., Box 19477, Houston, TX 77224, 713-870-8877. TF-3

BUYING WINCHESTER 21 doubles, Model 12, 20 Ga. and All Pre-1964 rifles, shotguns. Pre-war Colts Wanted. Give us last chance: Bedian's, Inc., Box 244, Fairbury, NE 68352. Ph. 402-729-6112. TF-3

[illegible] Put your Bernardelli in a Bernardelli case. 5-day inspection. Charge cards welcome. $160.; Add $5. postage; Quality Arms Inc., Box 19477, Houston, TX 77224, 713-870-8877. 6-3

FIRST TIME OFFERED: Ithaca 4E Double 12, Serial #457500, fancy wood, engraving, Auto Eject, cocking indicators, Vented Rib, exc. cond., best cash offer: Wenatchee, WA. 509-663-8886. 7-3

[illegible] Westley Richards [illegible] guns, Drop Locks, [illegible] also Browning, Winchester [illegible] Purdeys, English and European Guns; Call or write for free list (314) 335-4103, Don L. Shrum's Cape Outfitters, 412 South Kingshighway, Cape Girardeau, MO 63701. TF-3

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- Barrel bushing [illegible]
- [illegible]
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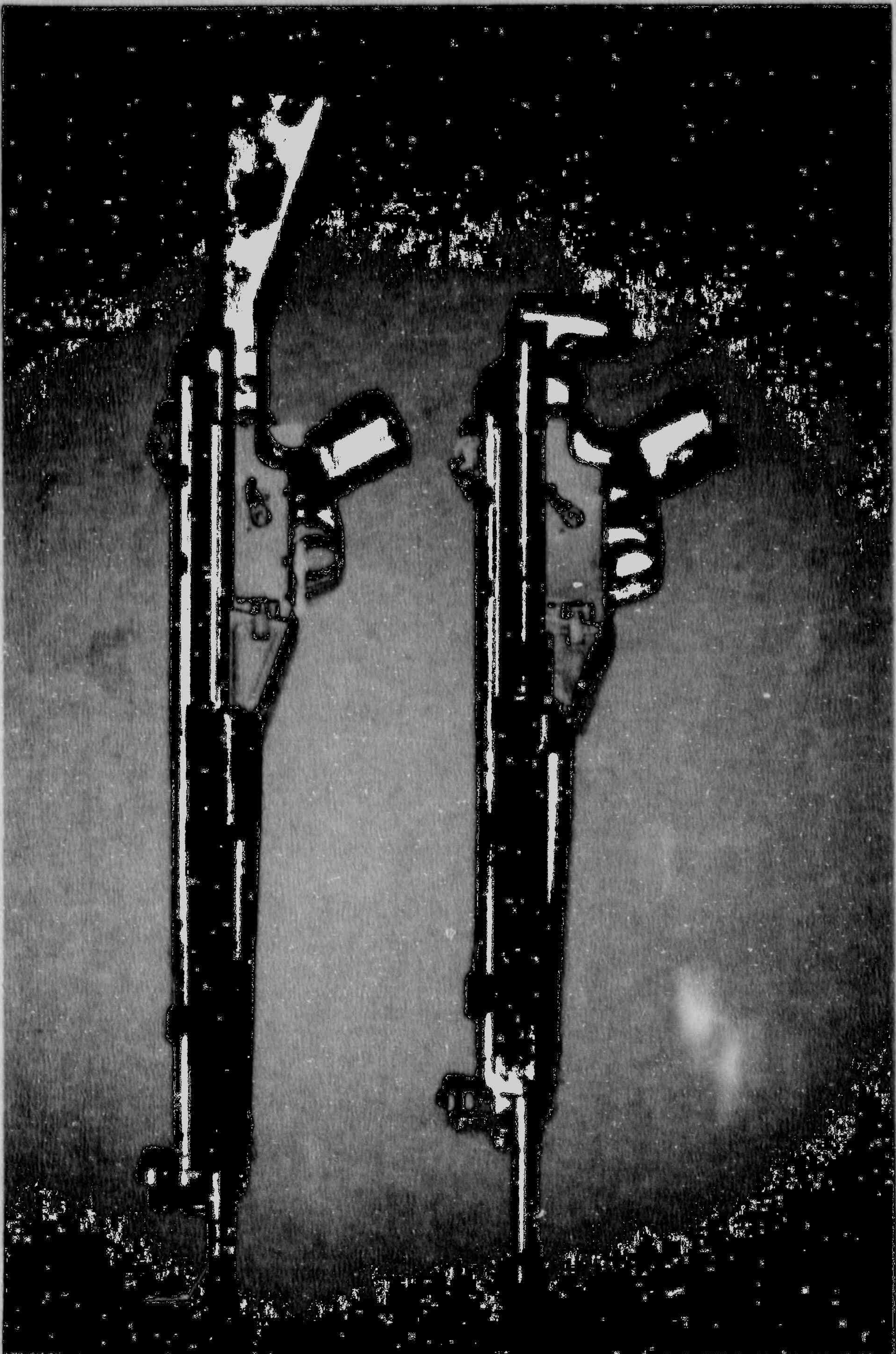
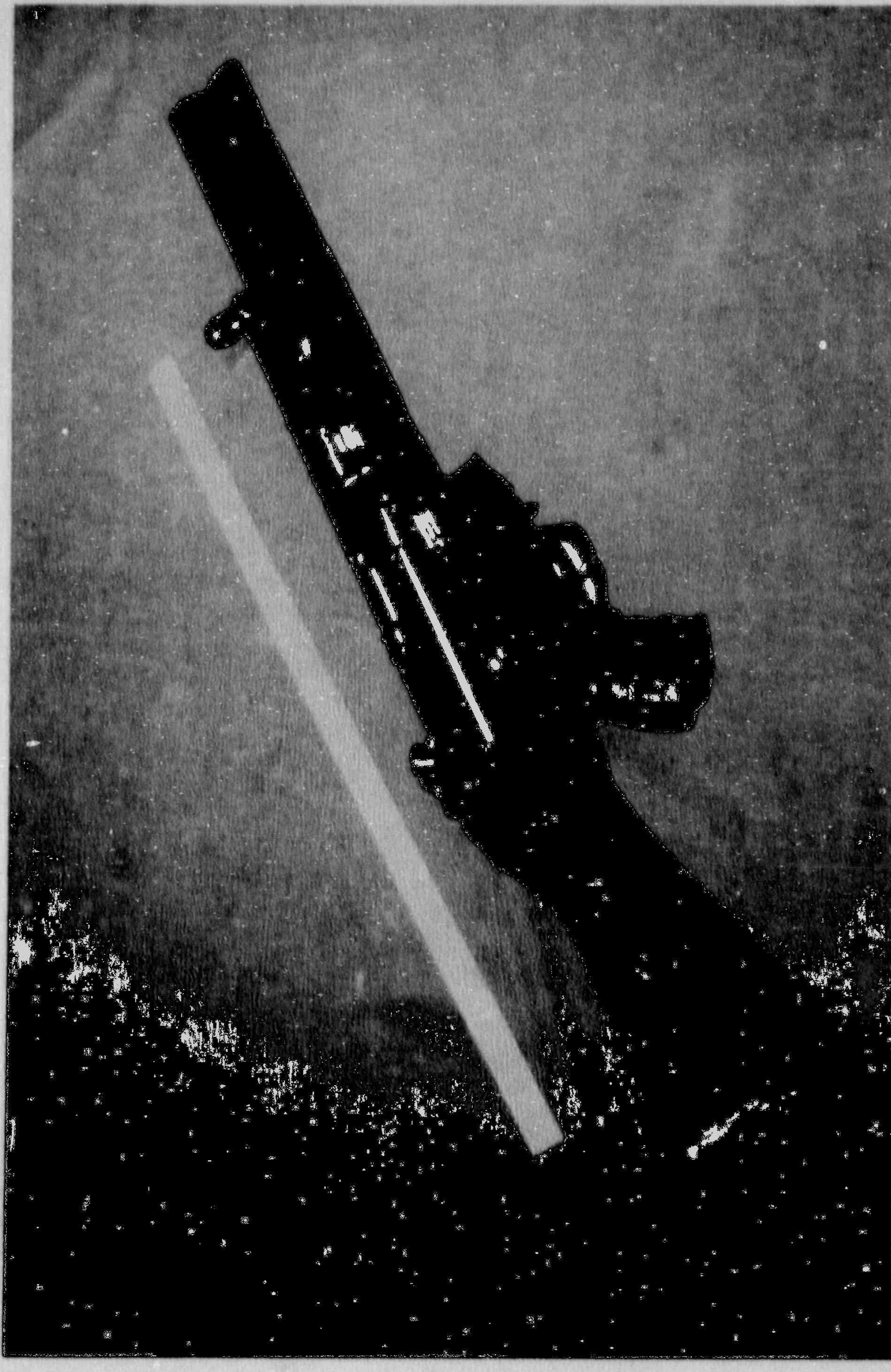
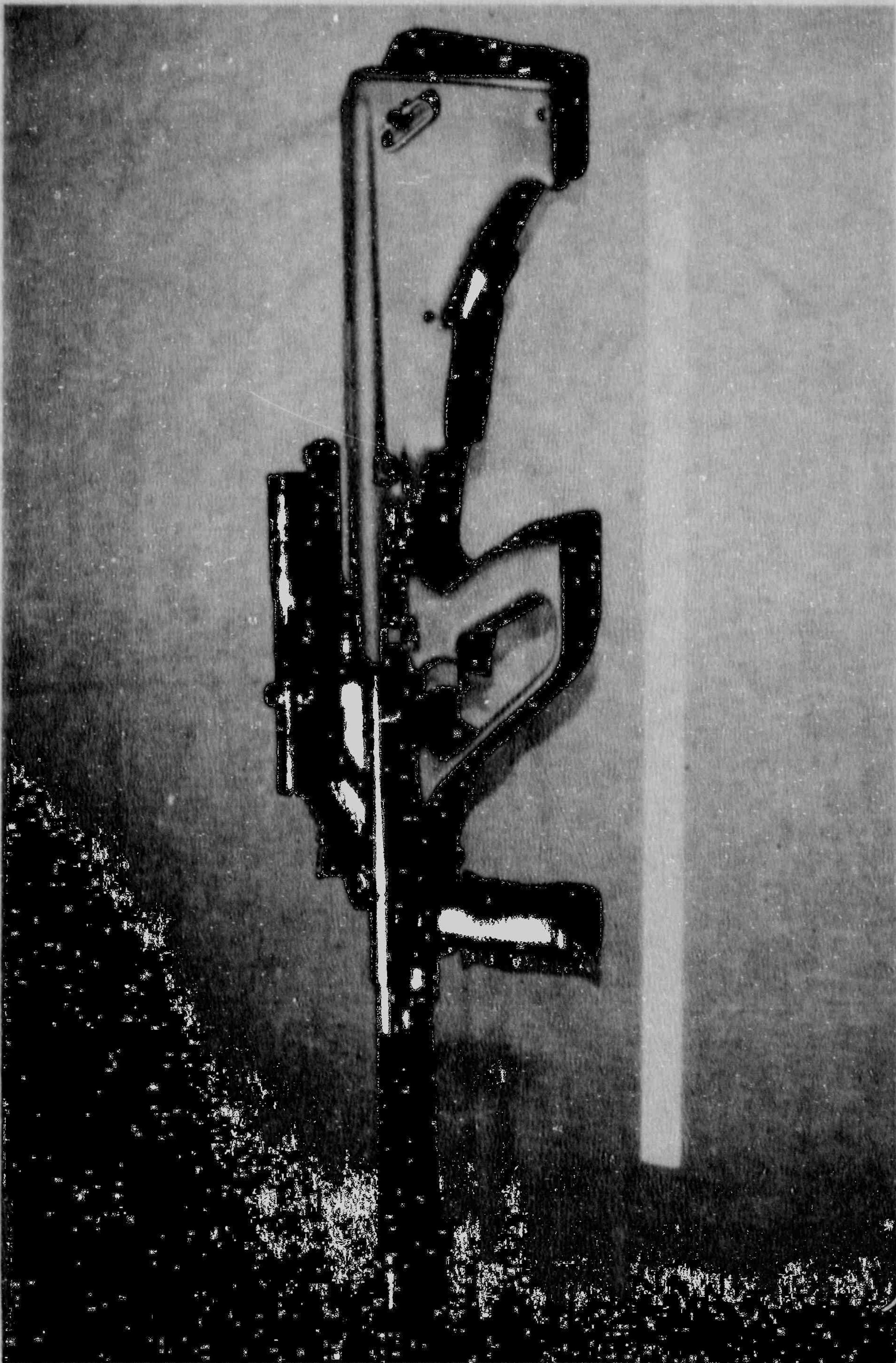
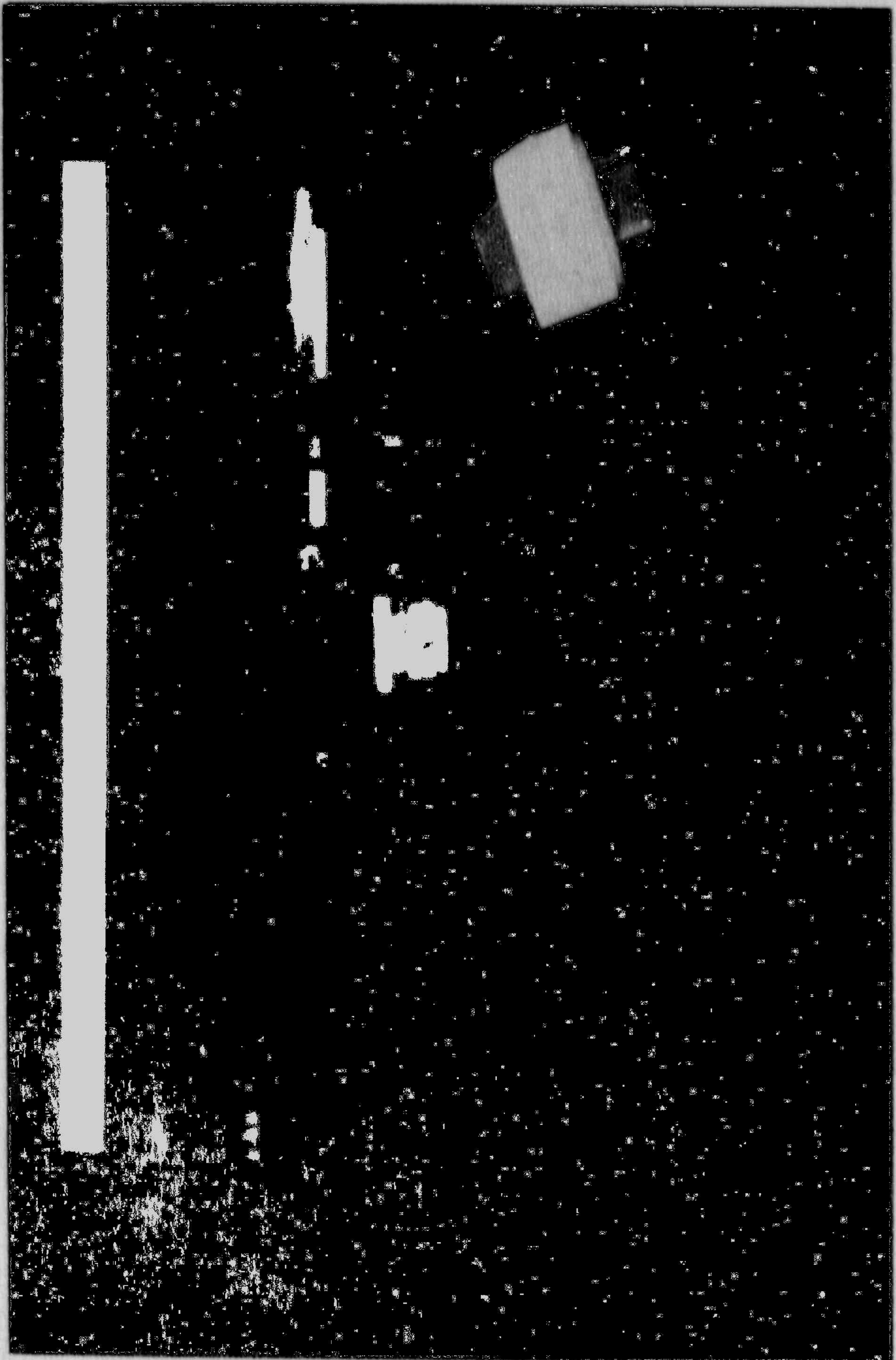
316 California Ave., 341
Reno, NV 89509
or Call 702-[illegible]

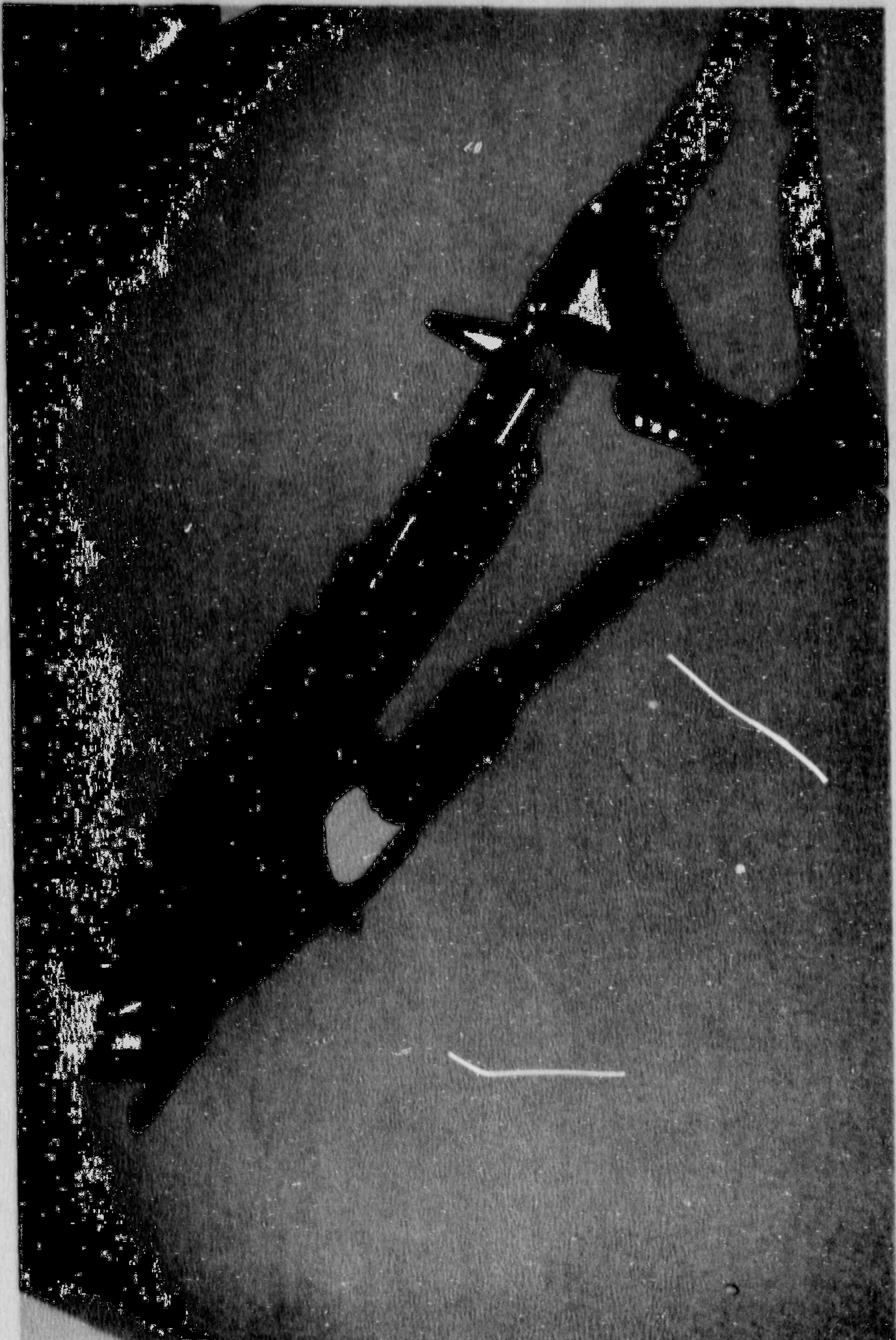
[redacted]

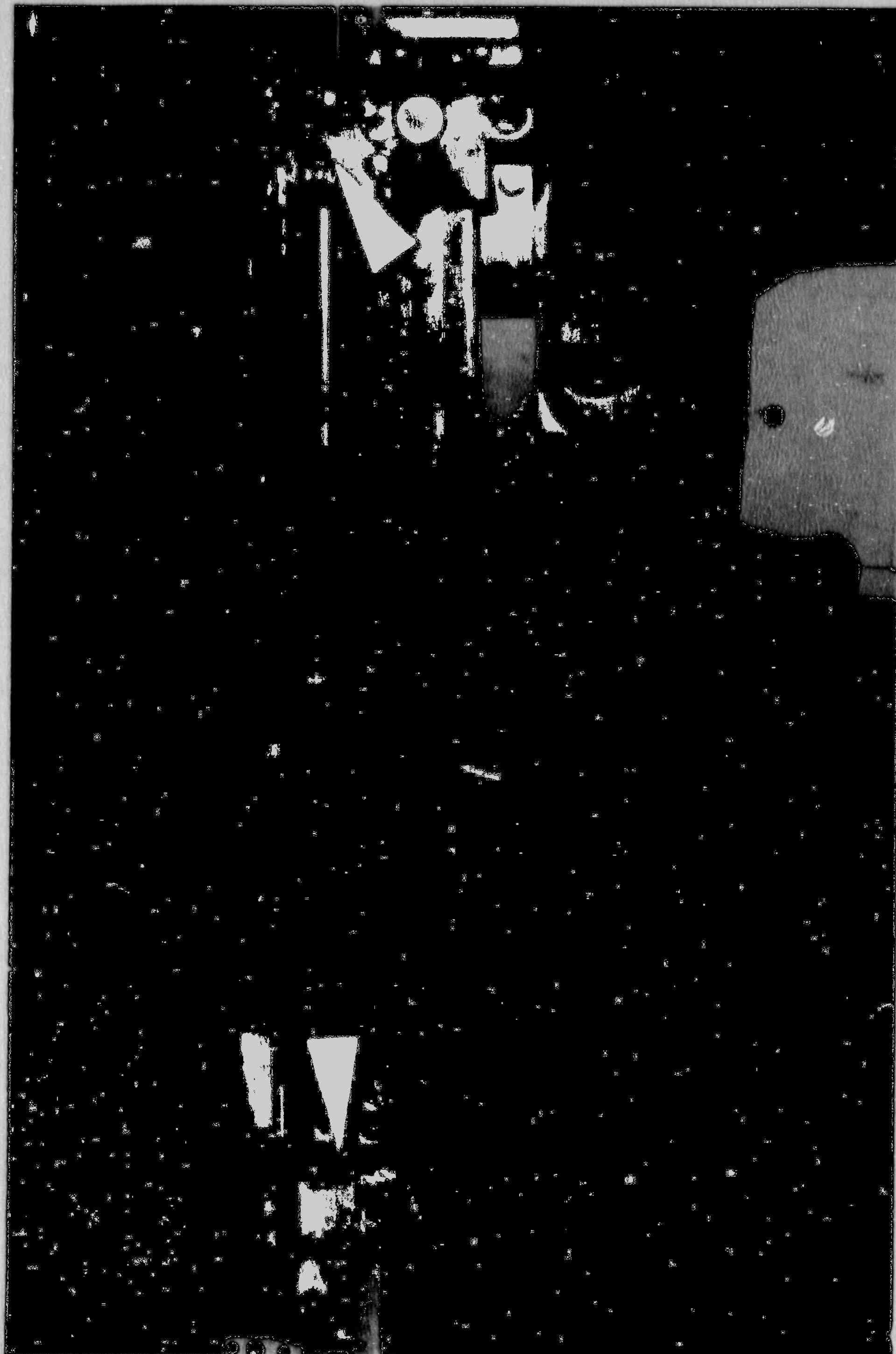


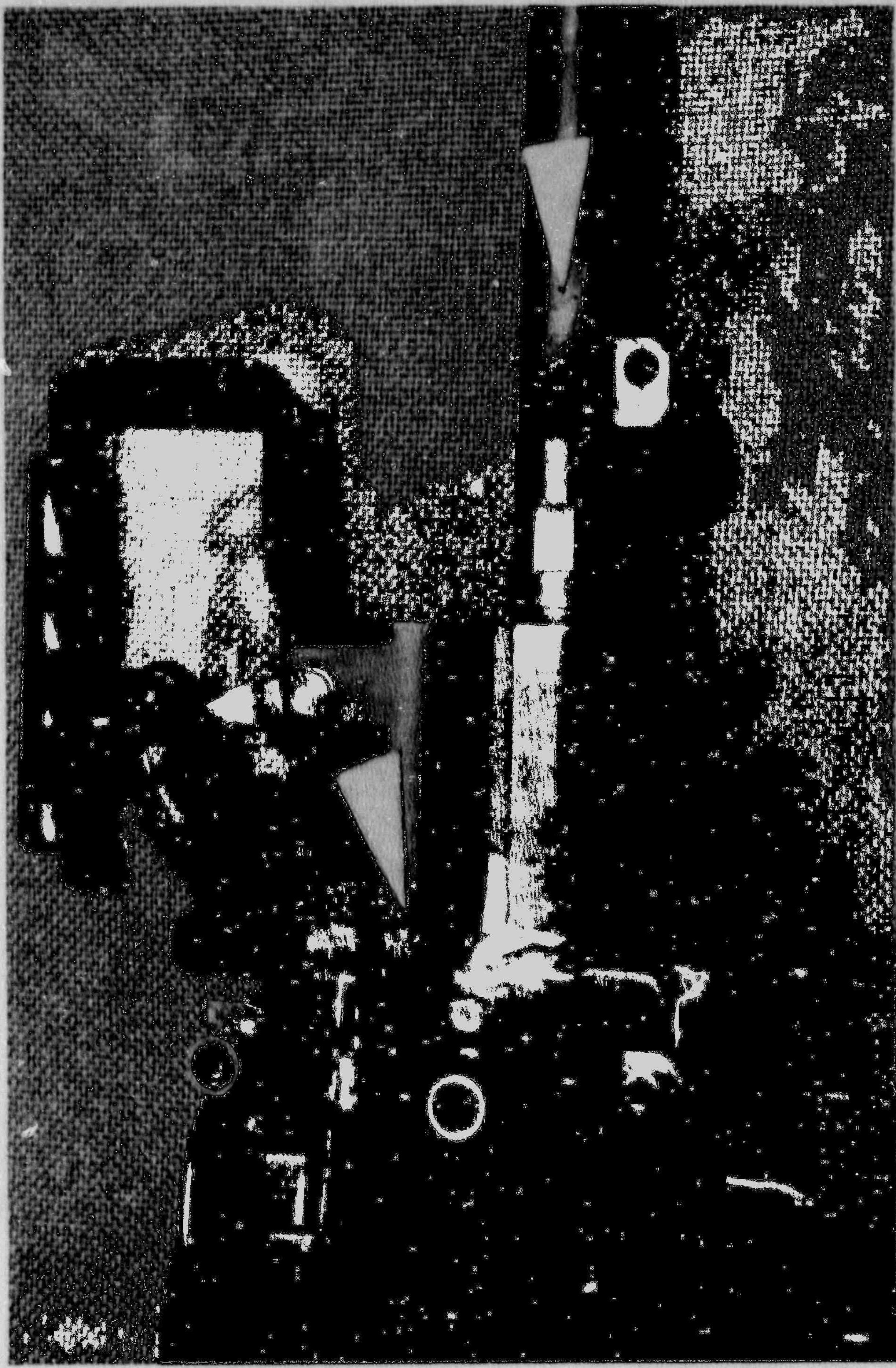


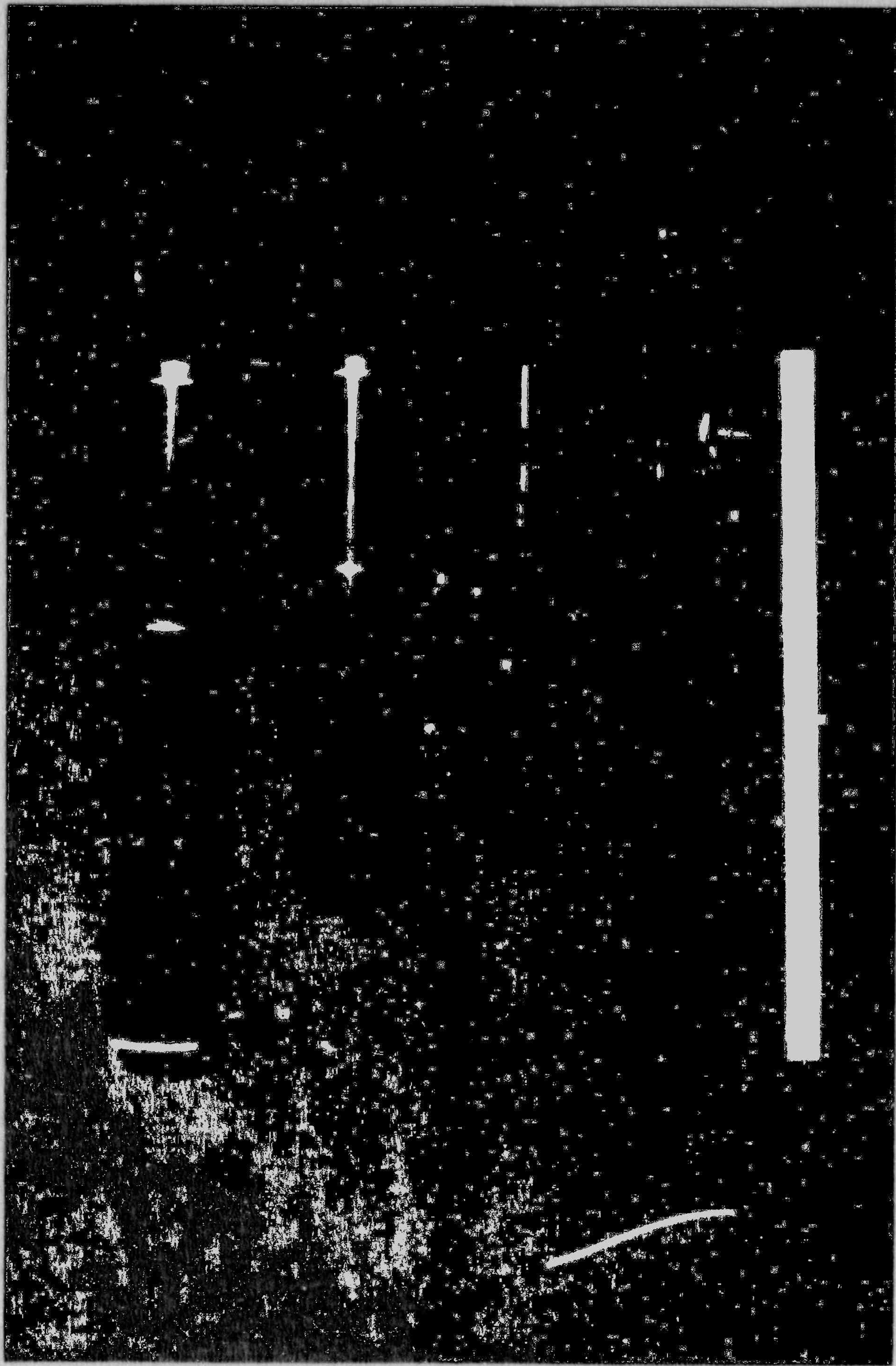


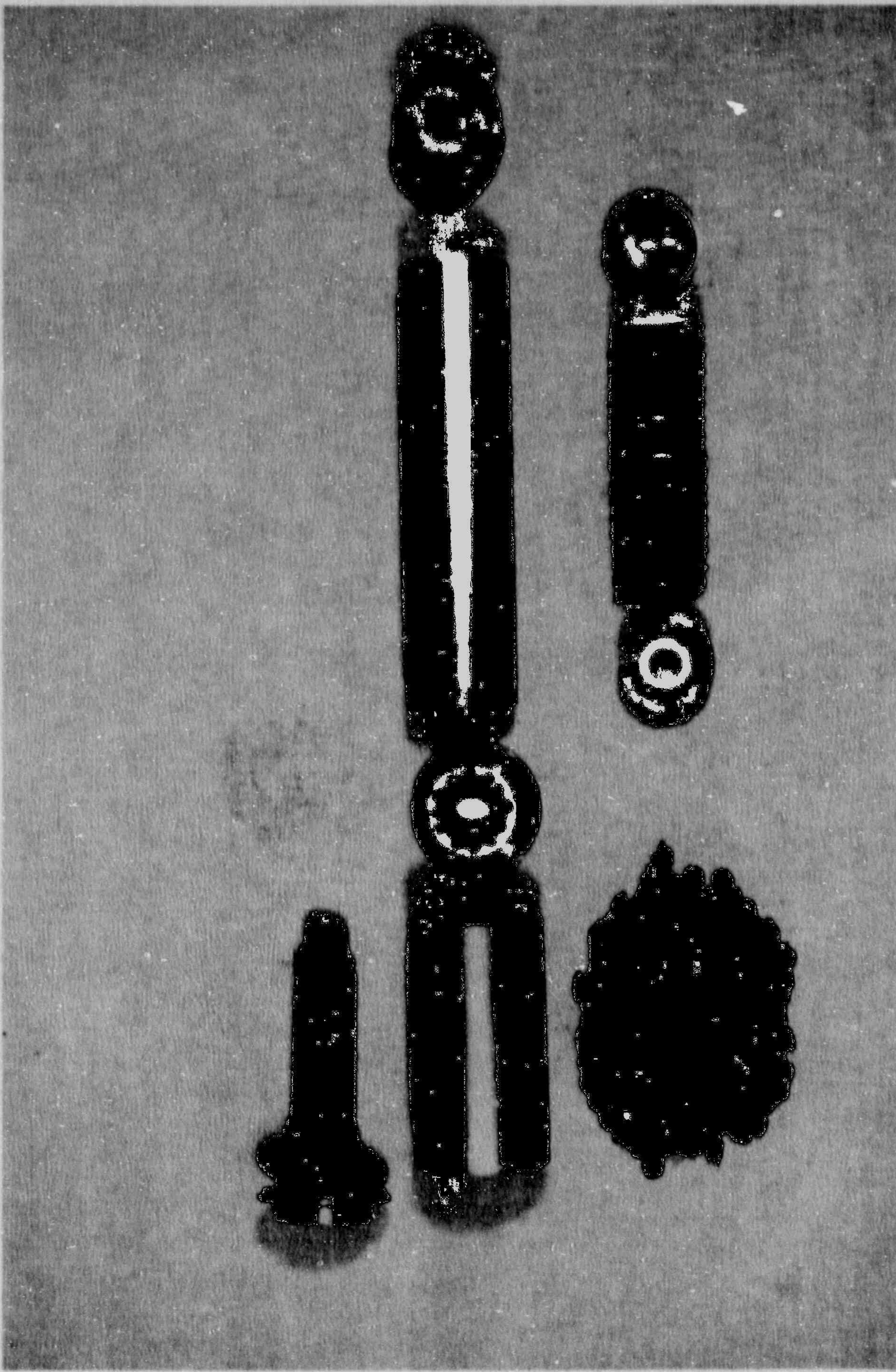


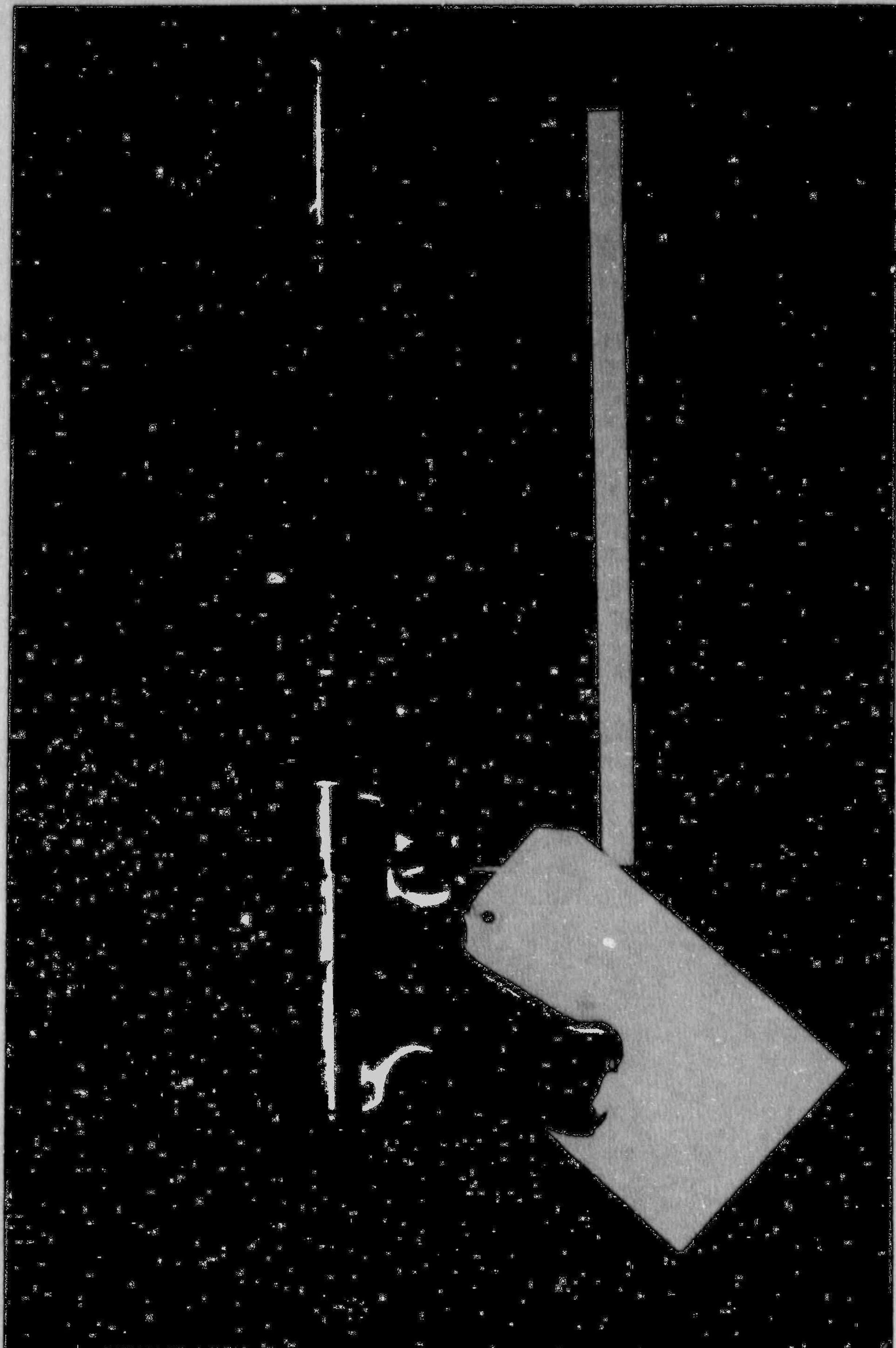


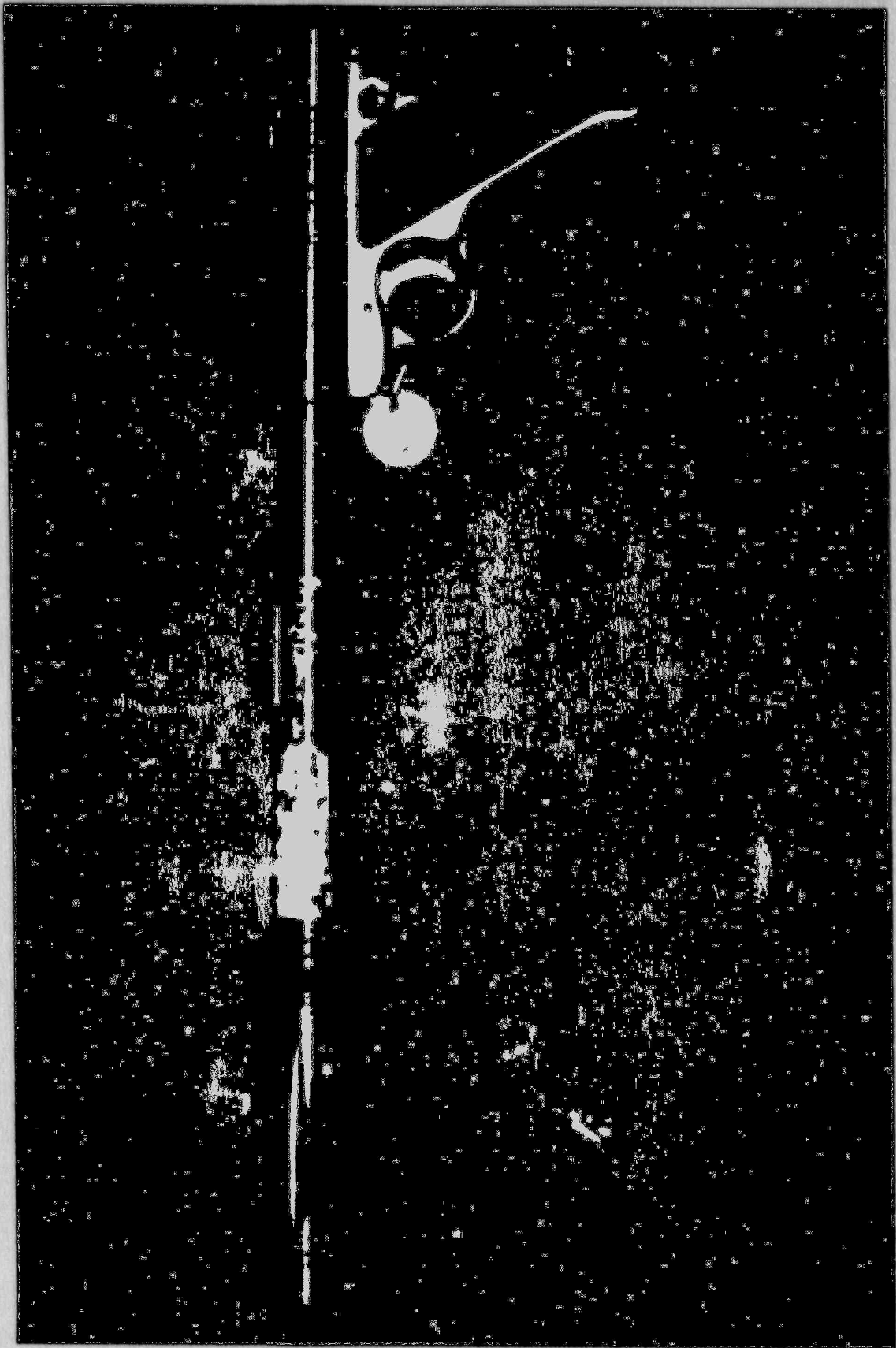


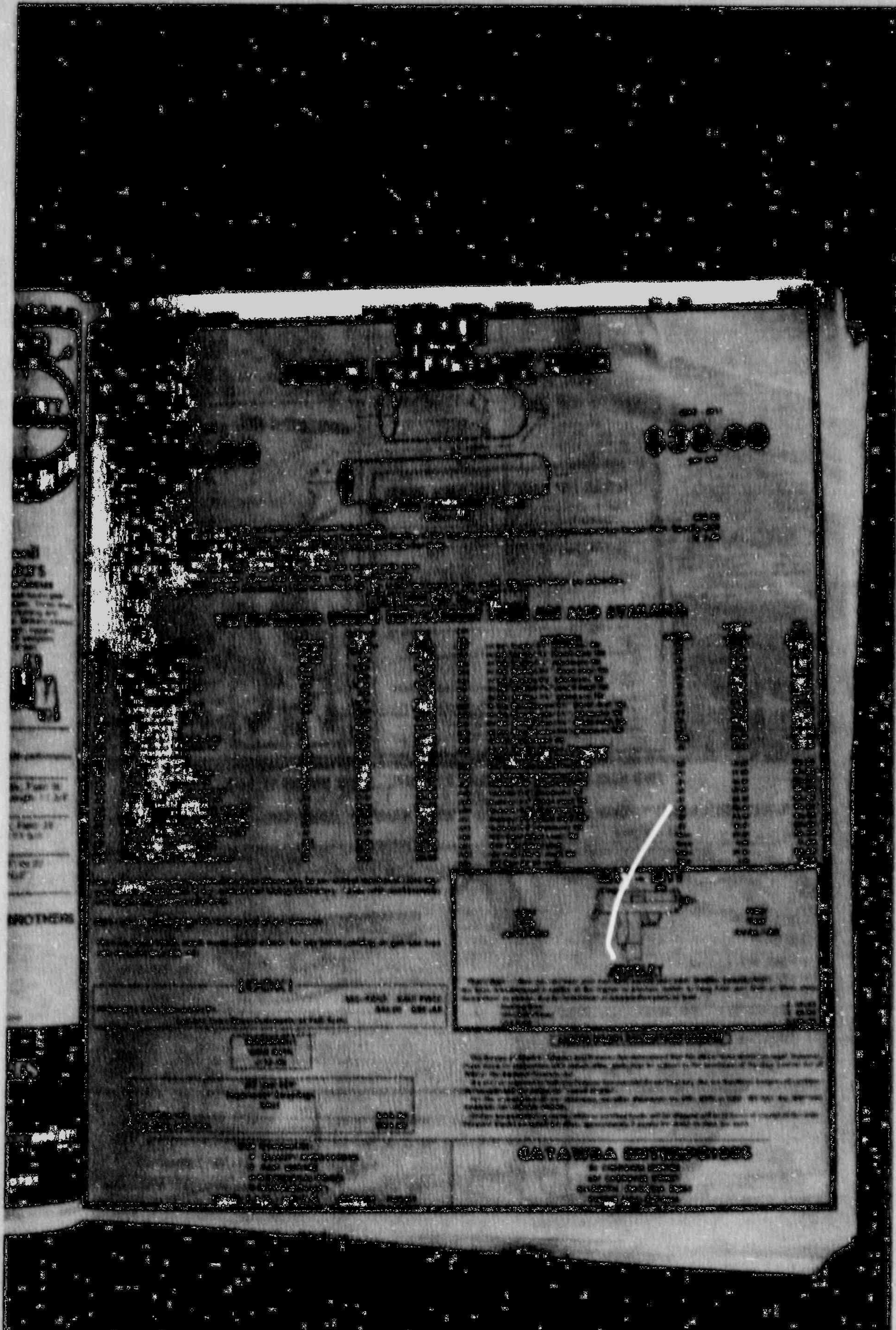




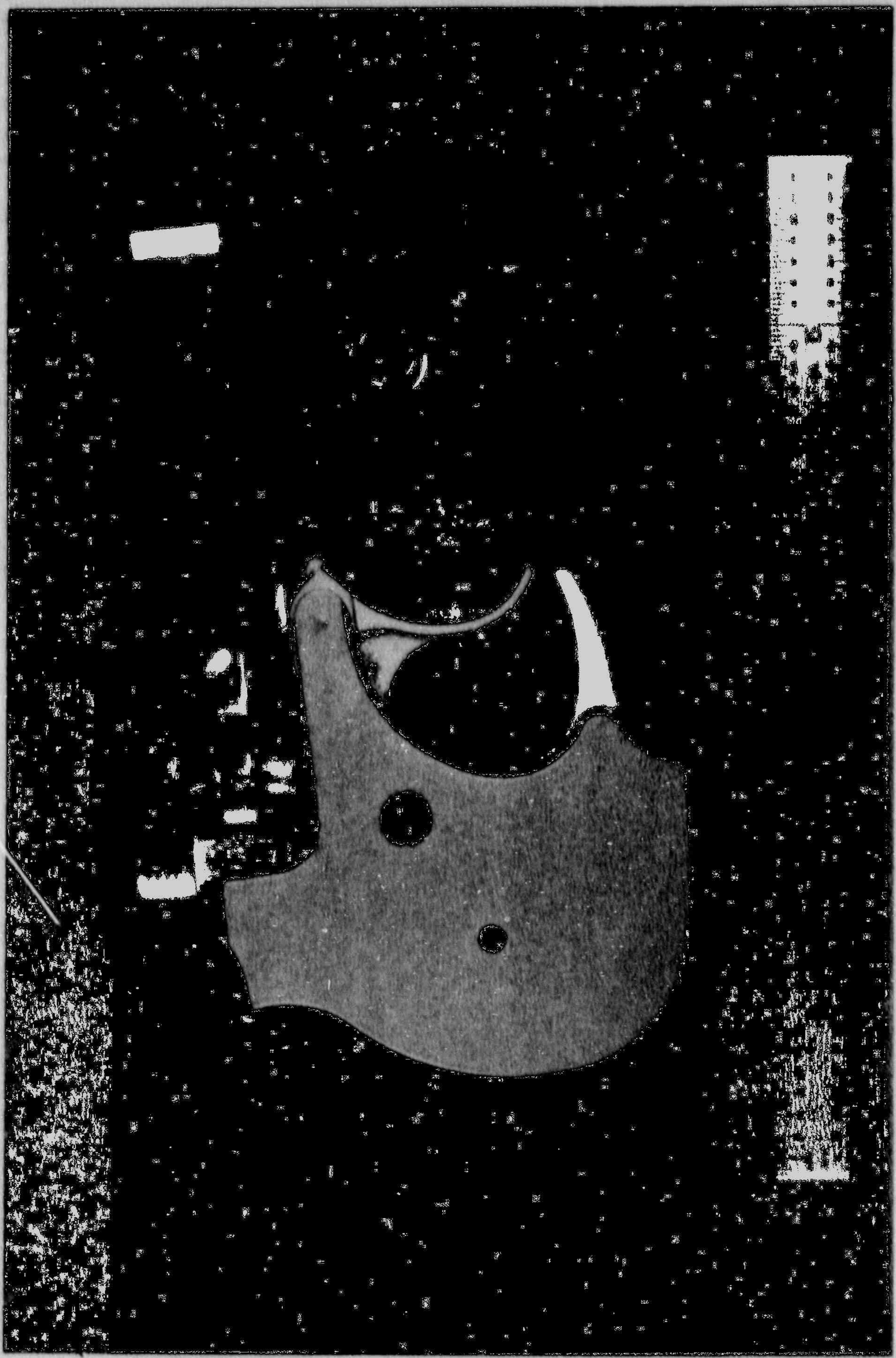


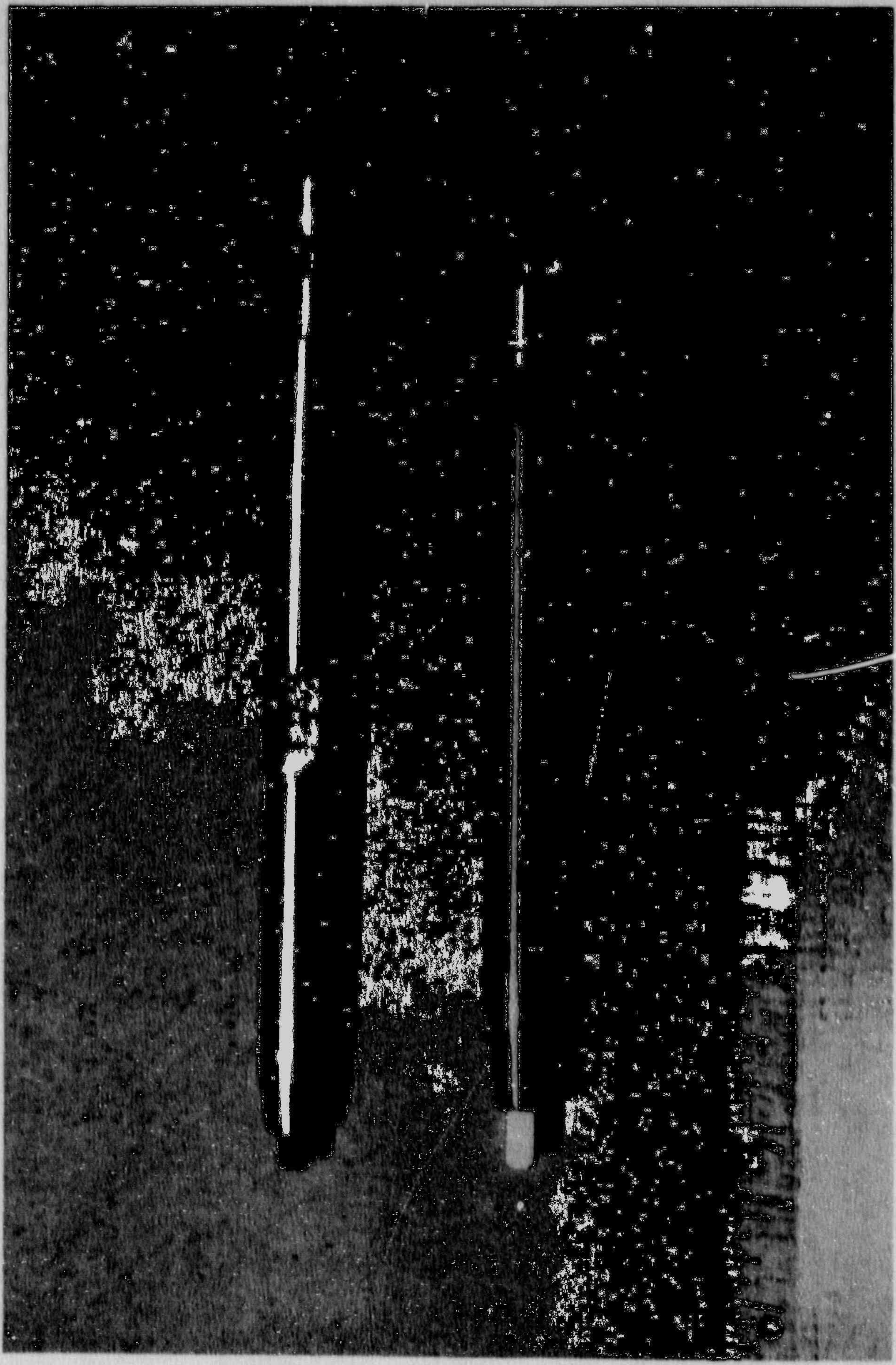


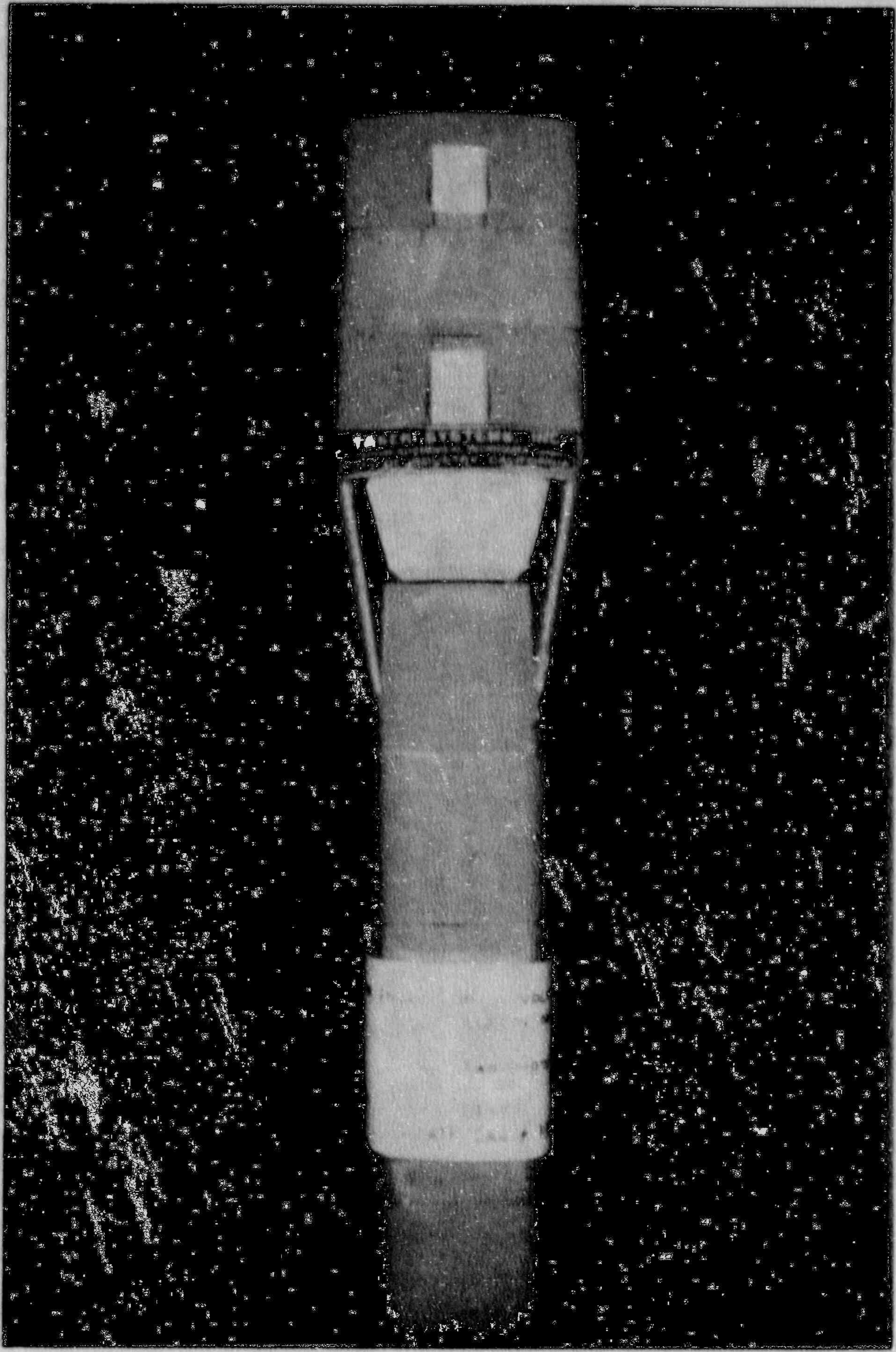


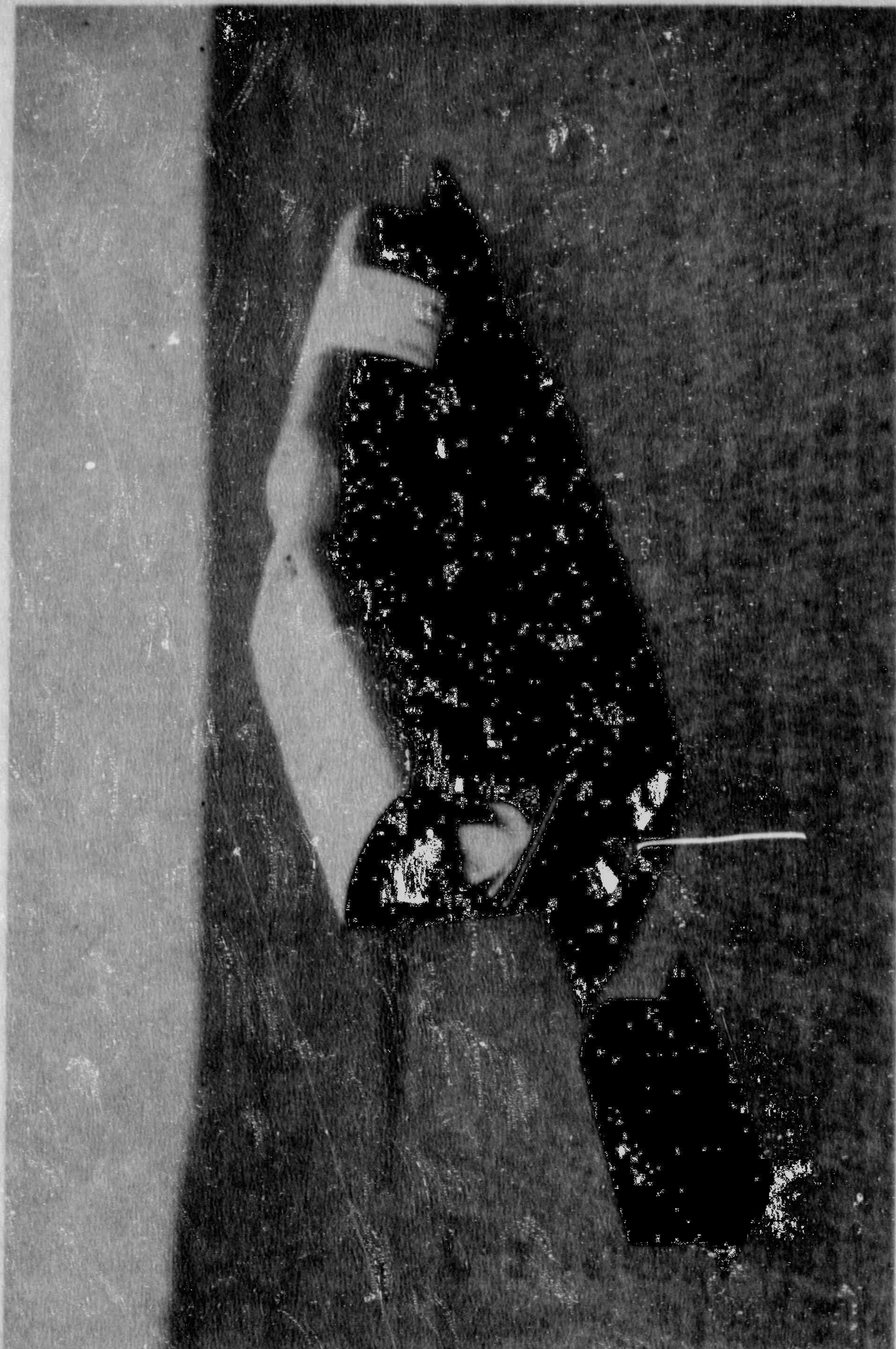

BROTHERS
CATAWBA ENTERPRISES

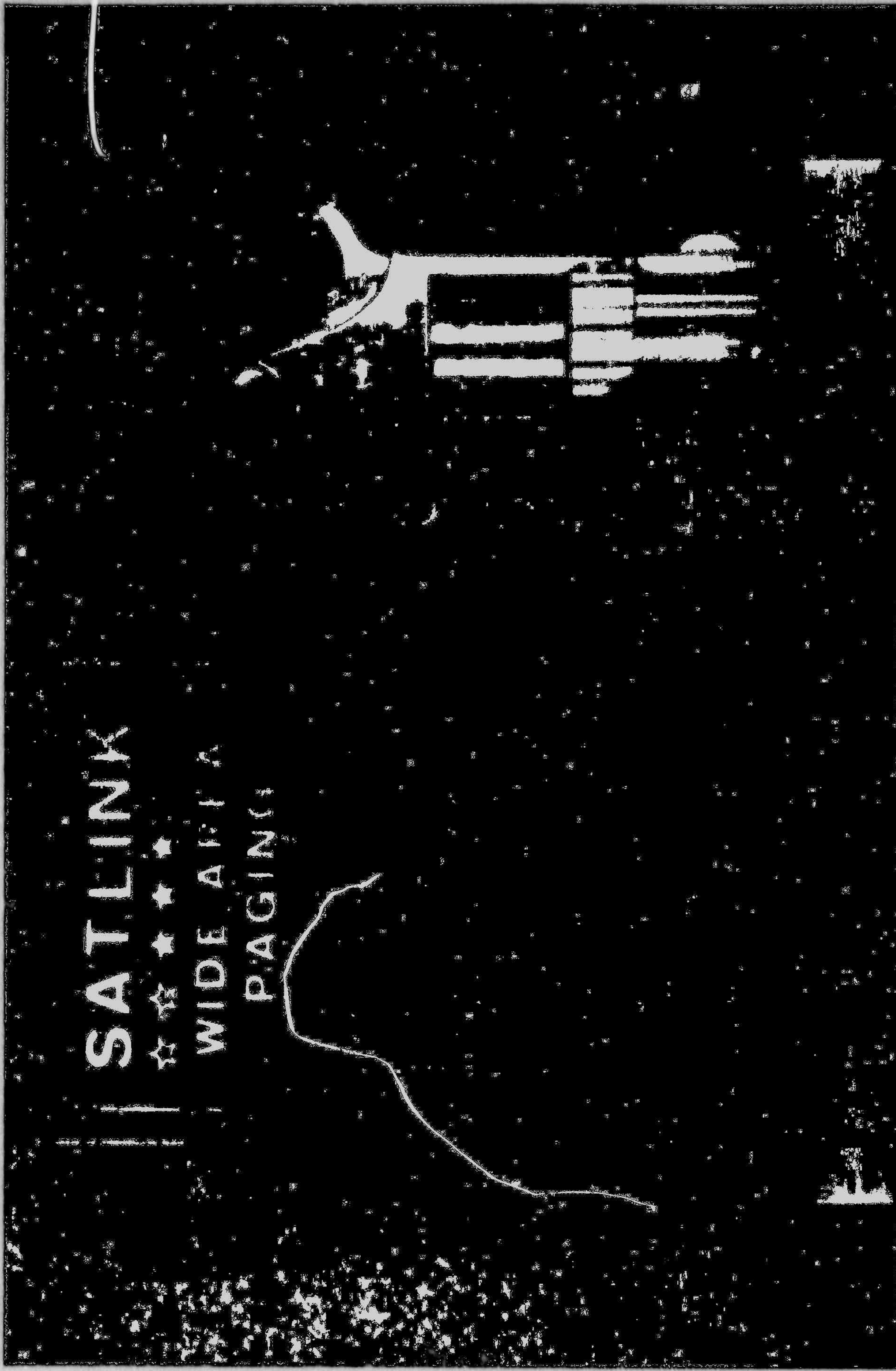

SILENCER
PARTS
SETS







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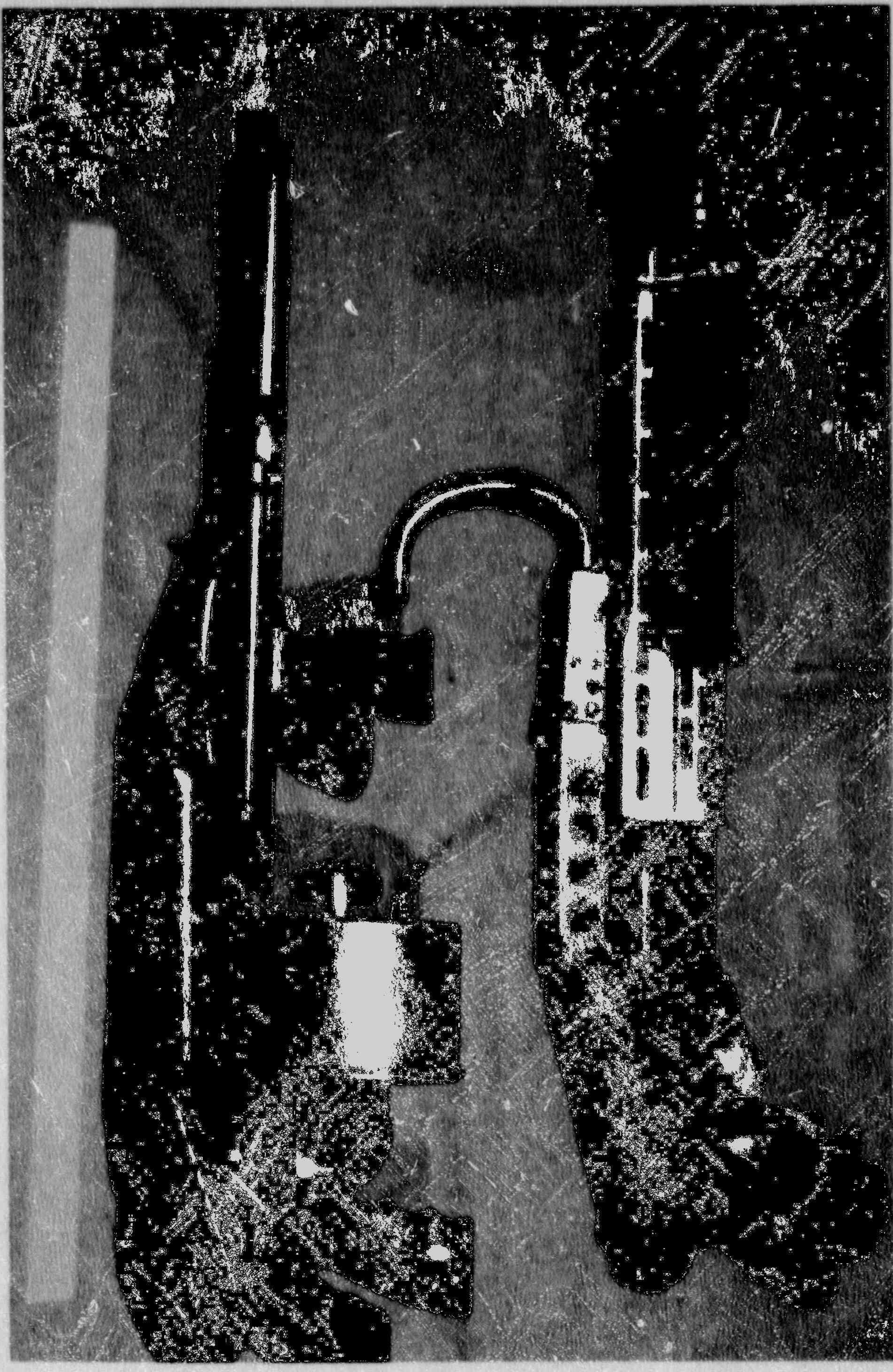
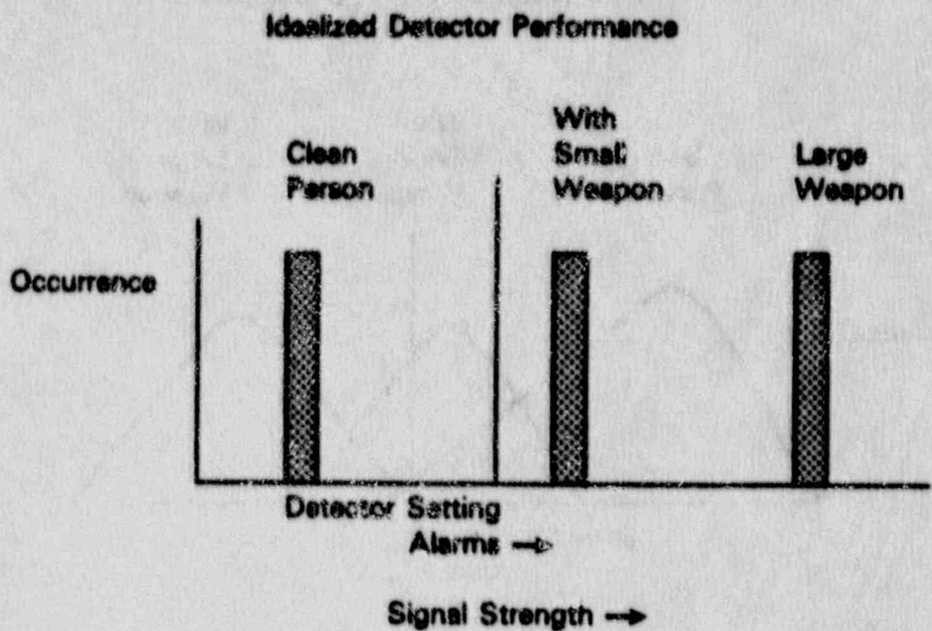
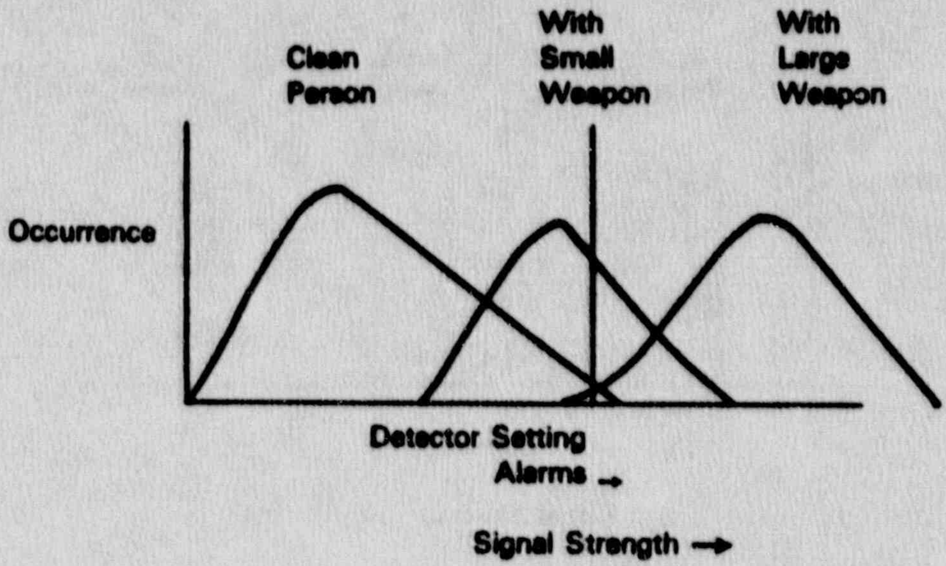



Idealized Detector Performance
Clean
Person
With
Small
Weapon
Large
Weapon
Occurrence
Detector Setting
Alarms →
Signal Strength →

Real World Detector Performance



BASIC CHARACTERISTICS

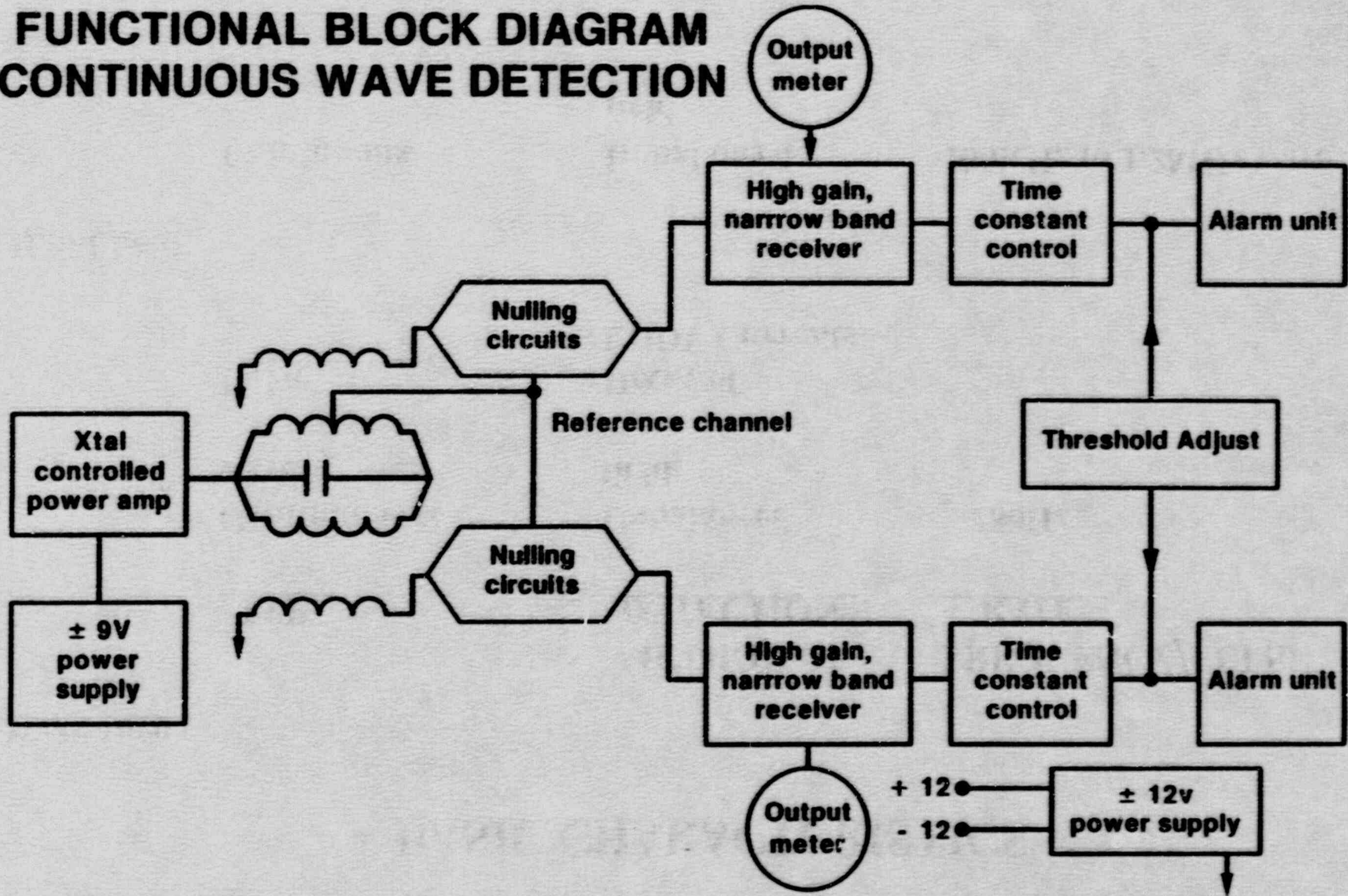
Walk-thru

TYPE	METHOD OF DETECTION	FREQUENCY/PULSE RATE
Continuous wave	Unbalanced field	280Hz
Pulse	Decay of EDDY Currents	

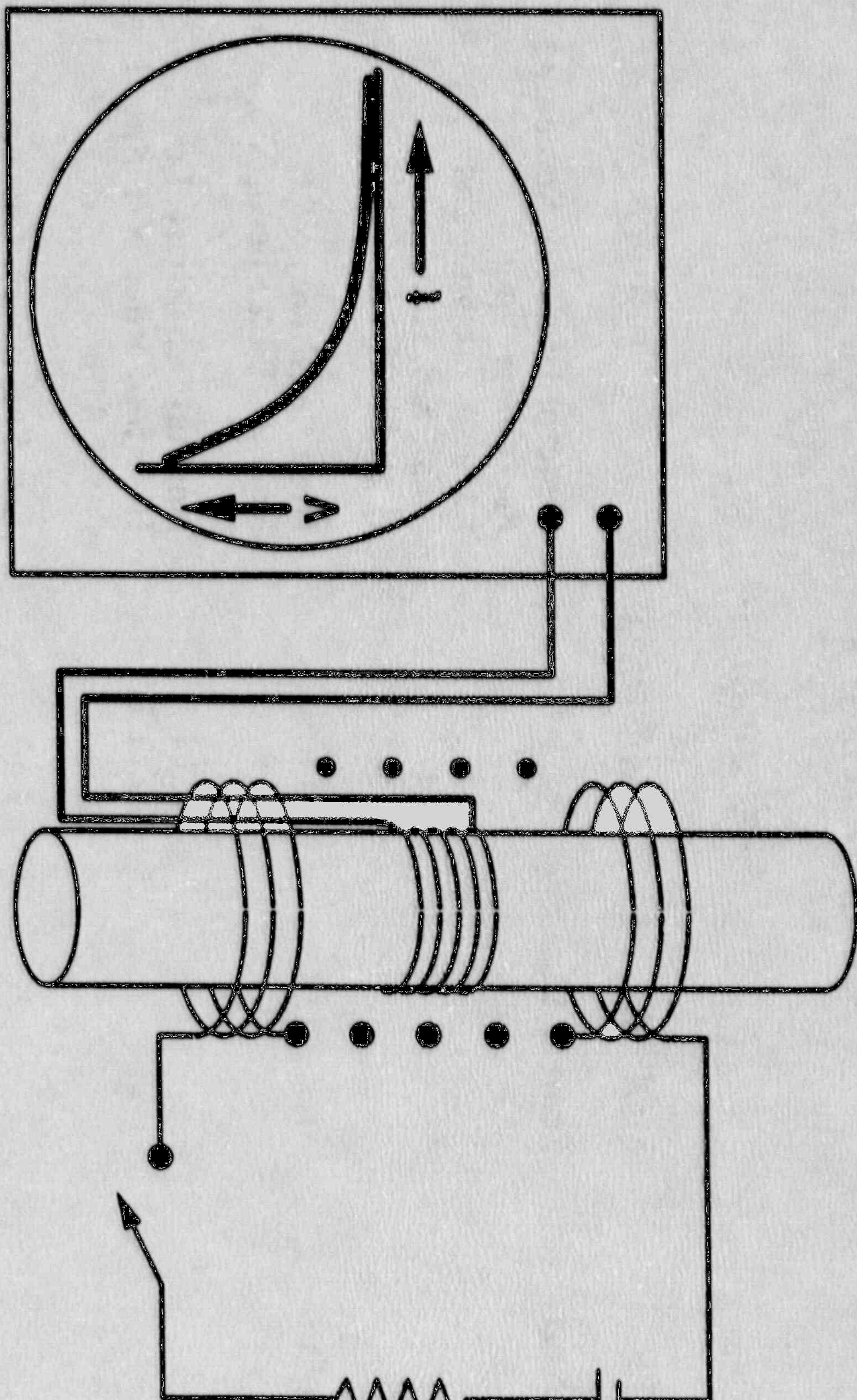
Hand-held

TYPE	METHOD OF DETECTION	FREQUENCY/PULSE RATE
Continuous	Unbalanced field	100KHz to 1.2MHz wave

FUNCTIONAL BLOCK DIAGRAM
CONTINUOUS WAVE DETECTION



EDDY CURRENT DETECTION

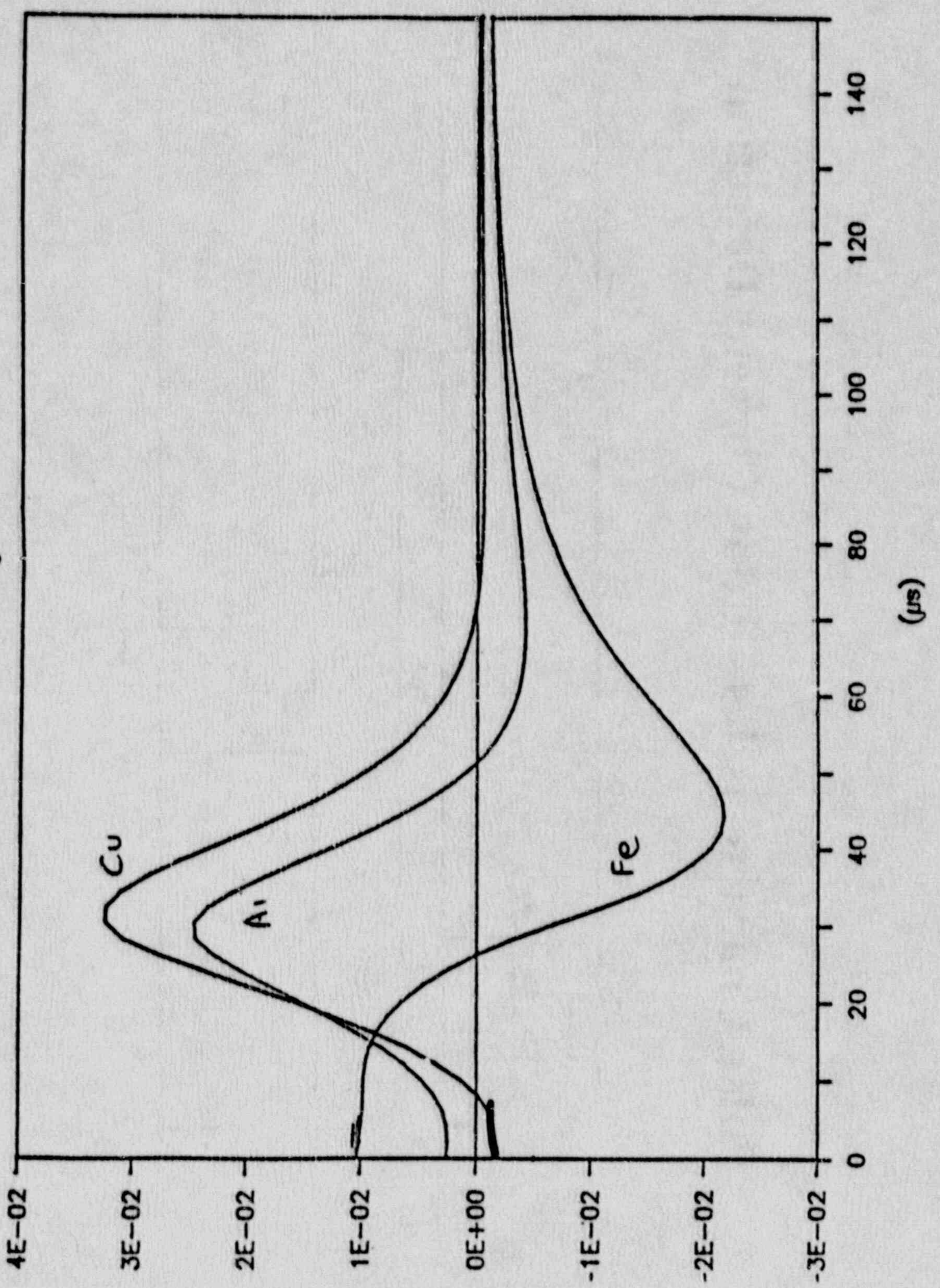


Metal Detector Programs

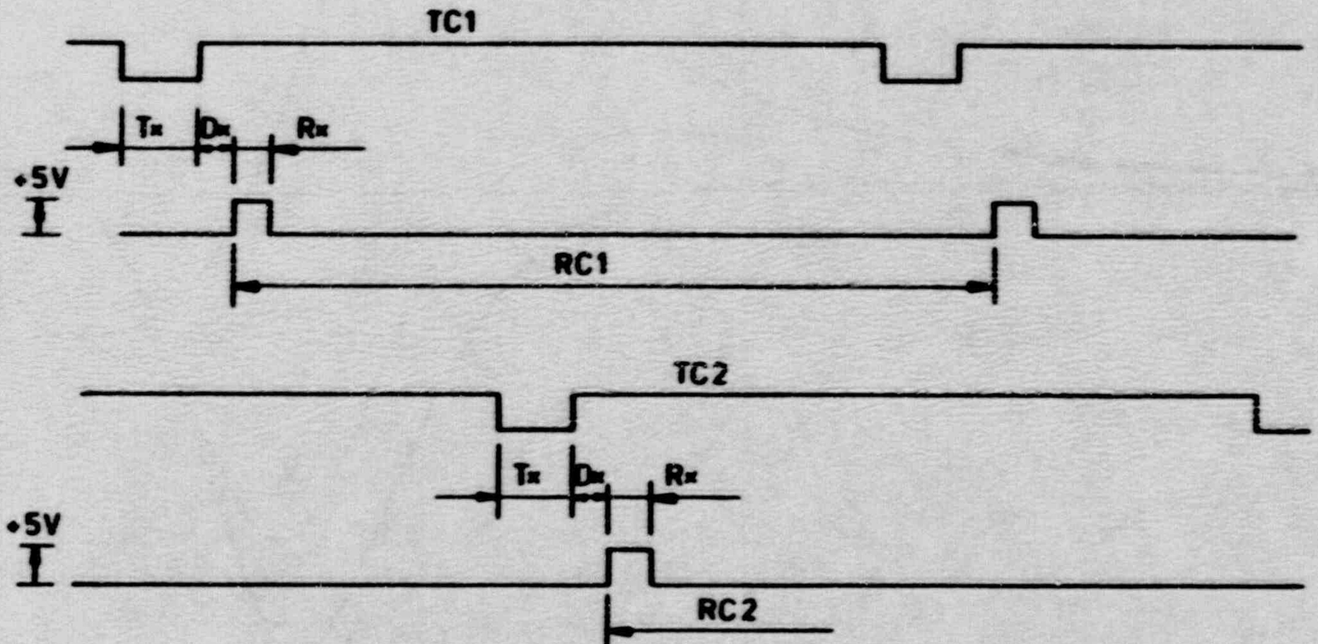
--Examples--

MFR	MODEL	PROGRAM	PURPOSE
Del Norte	Sentrie AT	1	General Handgun Screening
		2	Ferrous Weapons
		3	Large S.S. Handguns
		4	Small S.S. Handguns
		5	High Sensitivity
Outokumpu	Metor 118	0,1	High Sensitivity
		8,9	Normal/Fast Speed, Noise Attn.
		2,3,4, 10,11,12	Normal Sensitivity, Low Discrimination, N/F Speed, Noise Attn.
		5,6,7, 13,14,15	Low Sensitivity, Low or High Discrimination, N/F Speed, Noise Attn.

Eddy Current Decay Curves



Pulse Characteristics—Eddy Current Detection



WALK-THRU METAL DETECTORS
INFLUENCES ON DETECTION

OBJECT CHARACTERISTICS

1. Mass
2. Size
3. Shape
4. Orientation
5. Type & Combination of Metals

DETECTOR CHARACTERISTICS

1. Method of Detection (Pulse VS CW)
2. Frequency/Pulse Rate
3. Detection "Program" Selected

WALK-THRU METAL DETECTORS
INFLUENCES ON DETECTION cont'd

WALKER CHARACTERISTICS

1. Size
2. Velocity of Walk
3. Object Position on Body

ENVIRONMENTAL CHARACTERISTICS

1. Electromagnetic Background
   a. At Receiver Frequency
   b. Via Power Lines
   c. Radiated (RF)

2. Nearby Metal Objects

Walk-thru Metal Detectors

Tested By Sandia

MFR	MODEL	Type Detection	Comments
Outokumpu	Metor 118	Pulse	
	Metor 120	"	
Del Norte	HS2S	"	
	AT portable	"	
	AT standard (+ Mark 100)	"	
Infinetics	Design 500 Model 1T1D, Type 597D, Series 570, Config. 1	CW	Modified - 4 frequencies, selectable (280 Hz, 2.2, 9.0, 18.0KHz)

TEST OBJECTS

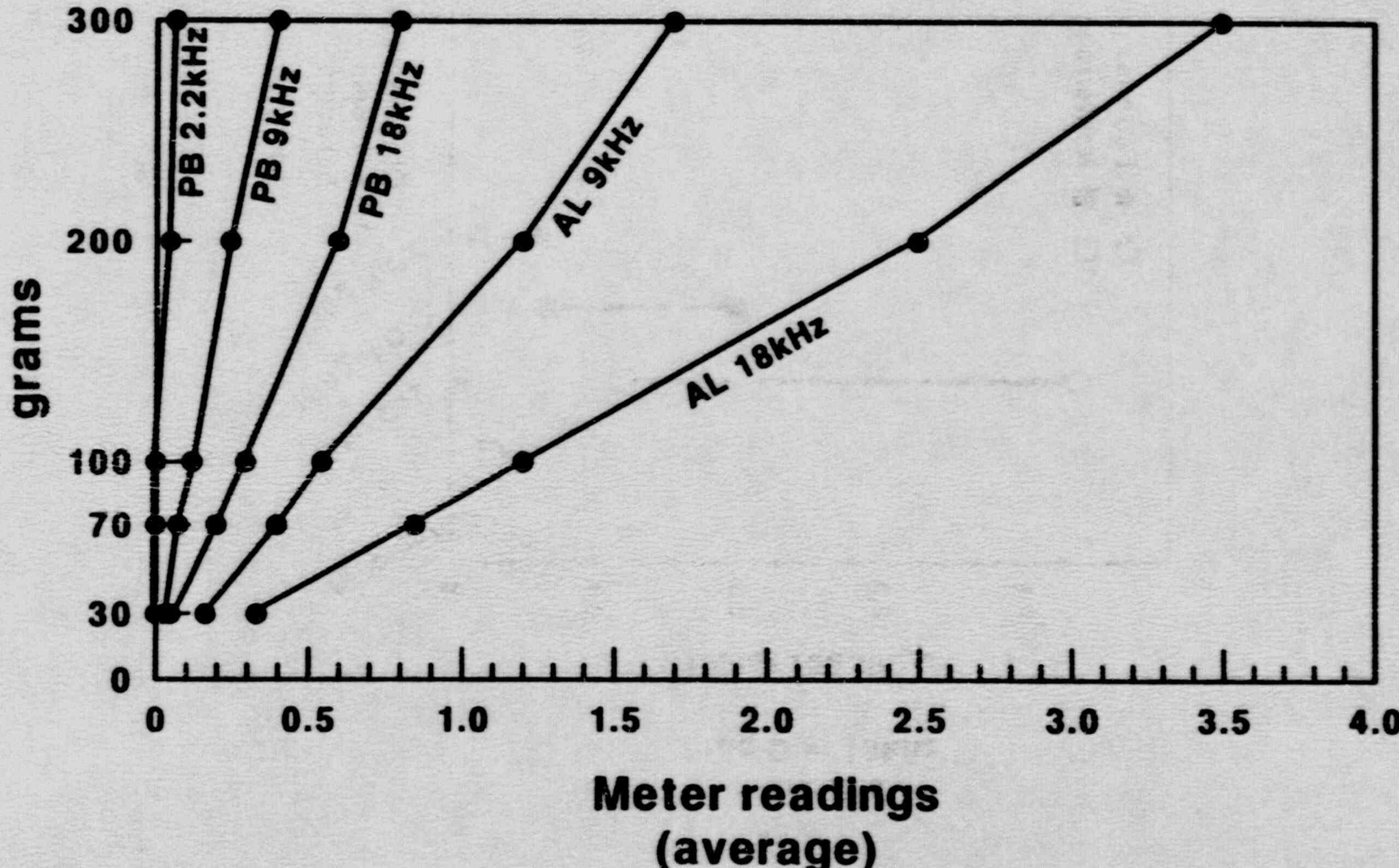
METALS

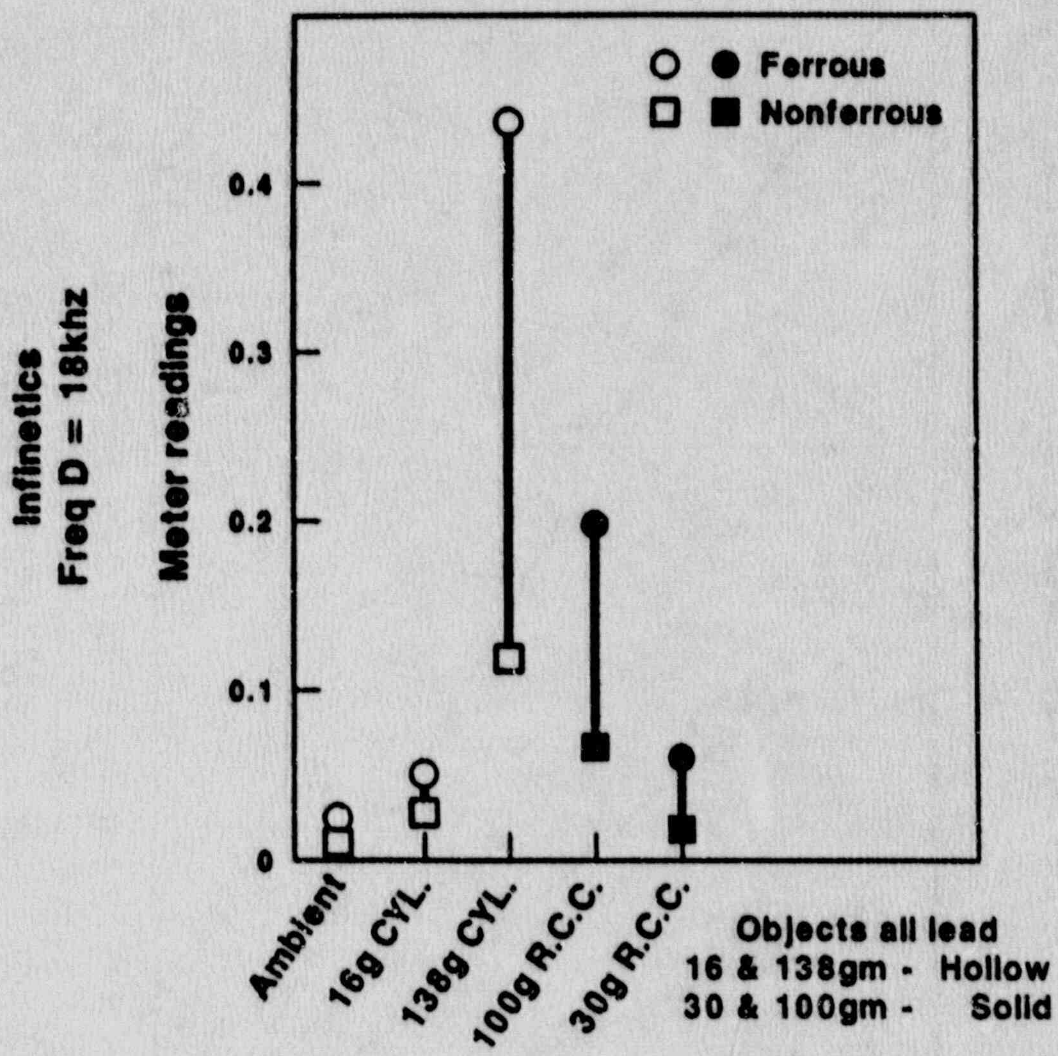
Alnico (#5)
Aluminum (20/24 T4)
Brass
Carbon Steel (1018)
Cast Iron
Lead
Stainless Steel (#303)
Zinc

MASS (5 sizes for each metal)

30 grams
70 grams
100 grams
200 grams
300 grams

FREQUENCY EFFECTS



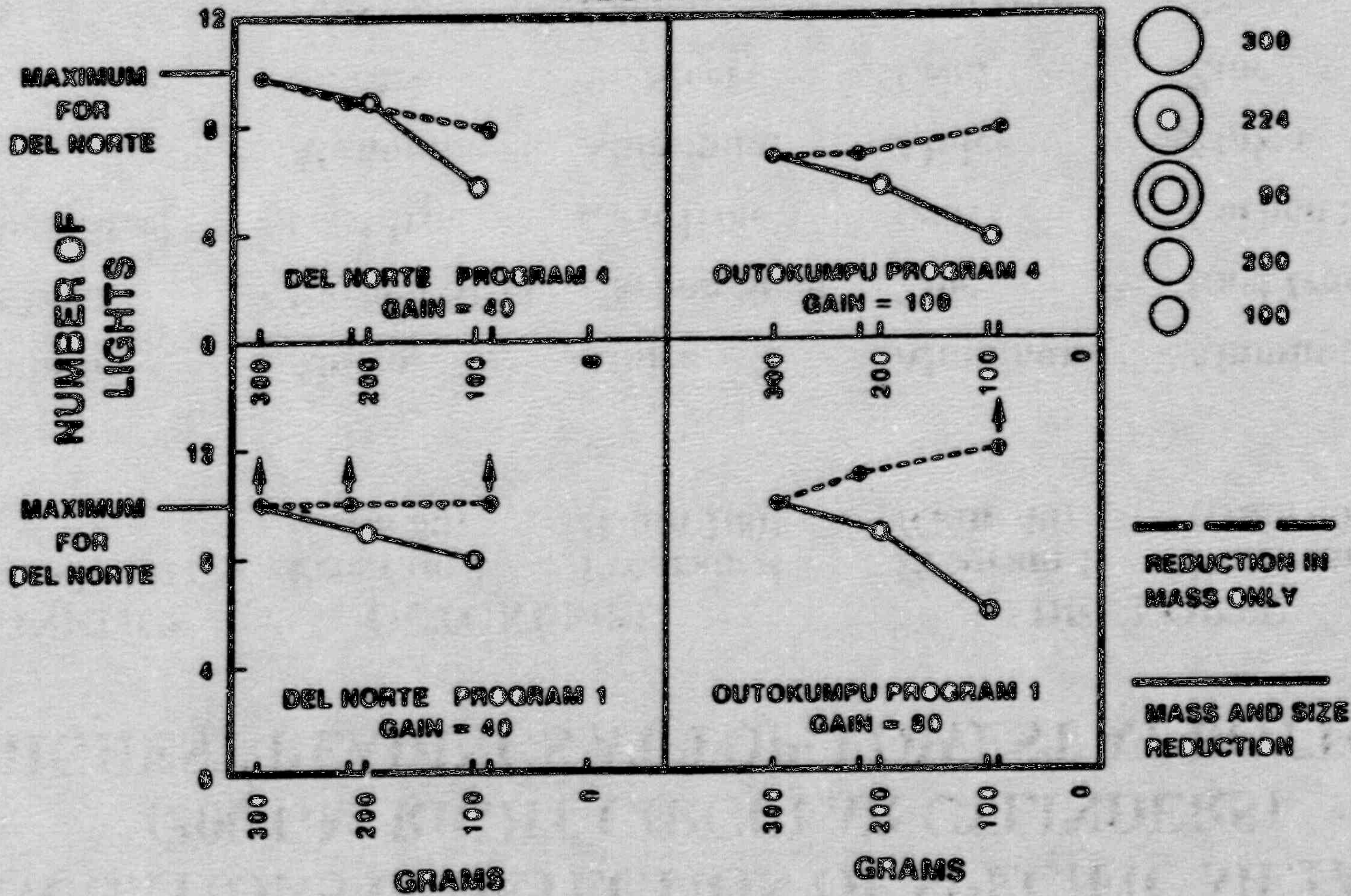

Infinetics
Freq D = 18khz
Meter readings
Ferrous
Nonferrous
0.4
0.3
0.2
0.1
0
Ambient
16g CYL.
138g CYL.
100g R.C.C.
30g R.C.C.
Objects all lead
16 & 138gm - Hollow
30 & 100gm - Solid

VARIATIONS IN DETECTION OF SPECIFIC METALS (300 GM RIGHT CIRCULAR CYLINDERS) (HIGHEST READINGS AT TOP; LOWEST AT BOTTOM)

INFINETICS	OUTOKUMPU		DEL NORTE	
Freq.A-280 Hz	Program 1 (Gain 80)	Program 4 (Gain 100)	Program 1 (Gain 40)	Program 4 (Gain 40)
Aluminum	Alnico	Alnico	Aluminum	Aluminum
Cast Iron	Carbon Steel	Carbon Steel	Zinc	Cast Iron
Carbon Steel	Cast Iron	Cast Iron	Brass	Carbon Steel
Alnico	Aluminum	Aluminum	Alnico	Alnico
Zinc	St. Steel	St. Steel	Lead	Zinc
Brass	Brass	Lead	Cast Iron	Brass
Lead	Lead	Brass	St. Steel	St. Steel
St. Steel	Zinc	Zinc	Carbon Steel	Lead

RIGHT CIRCULAR CYLINDER METAL DETECTOR TESTS

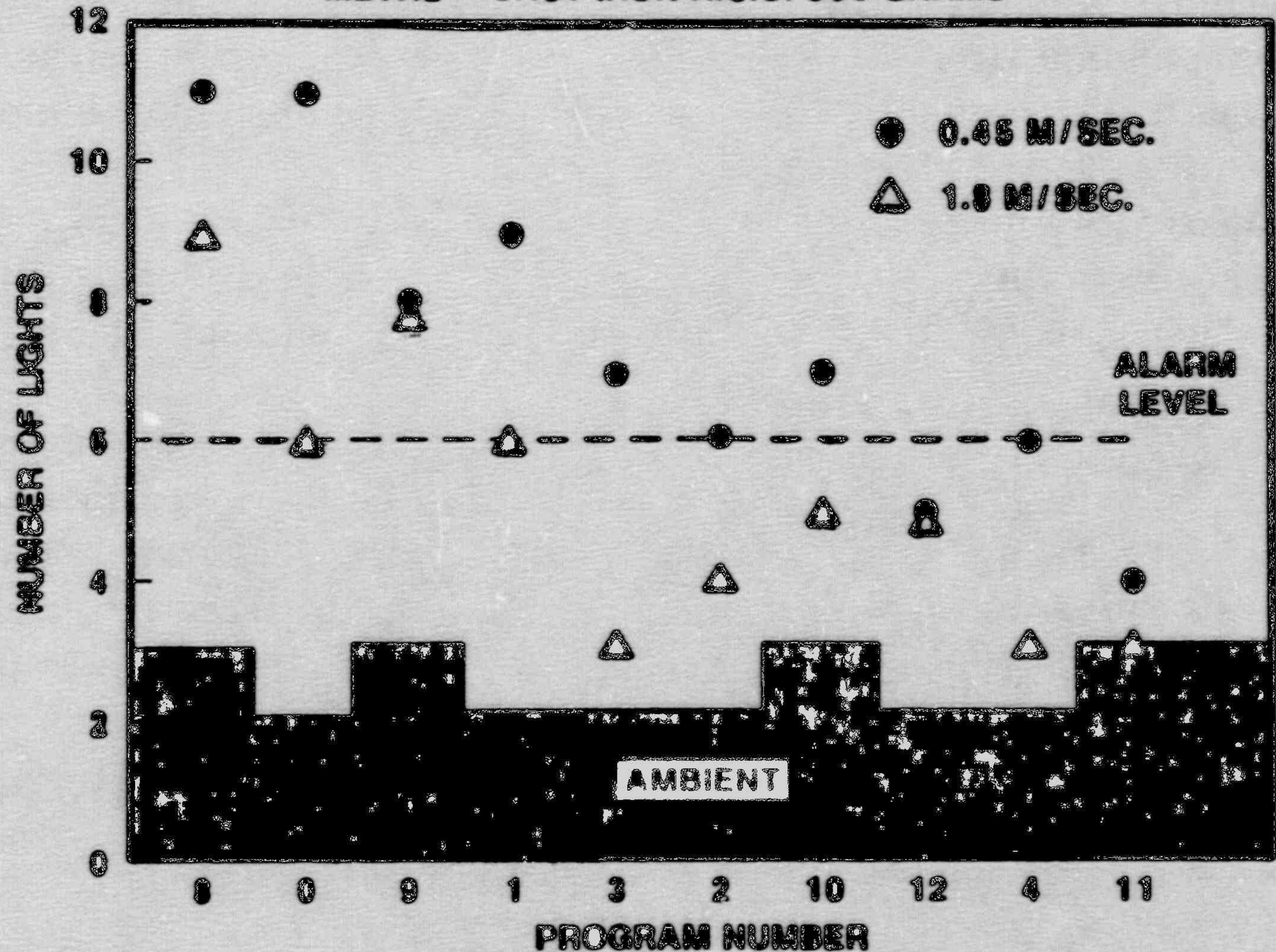
ALUMINUM



OUTOKUMPU VELOCITY TEST

GAIN = 50

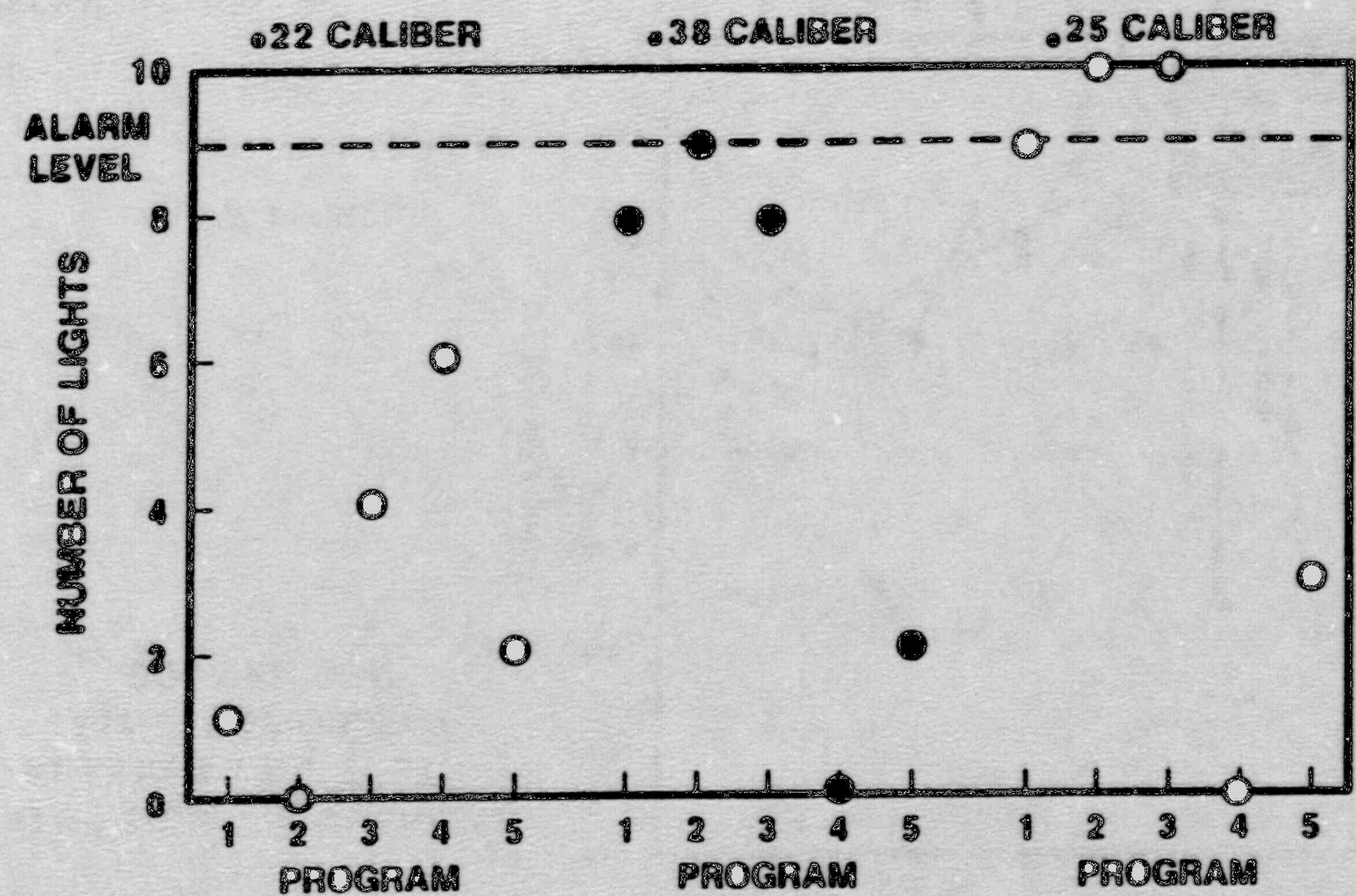
METAL = CAST IRON R.C.C. 300 GRAMS



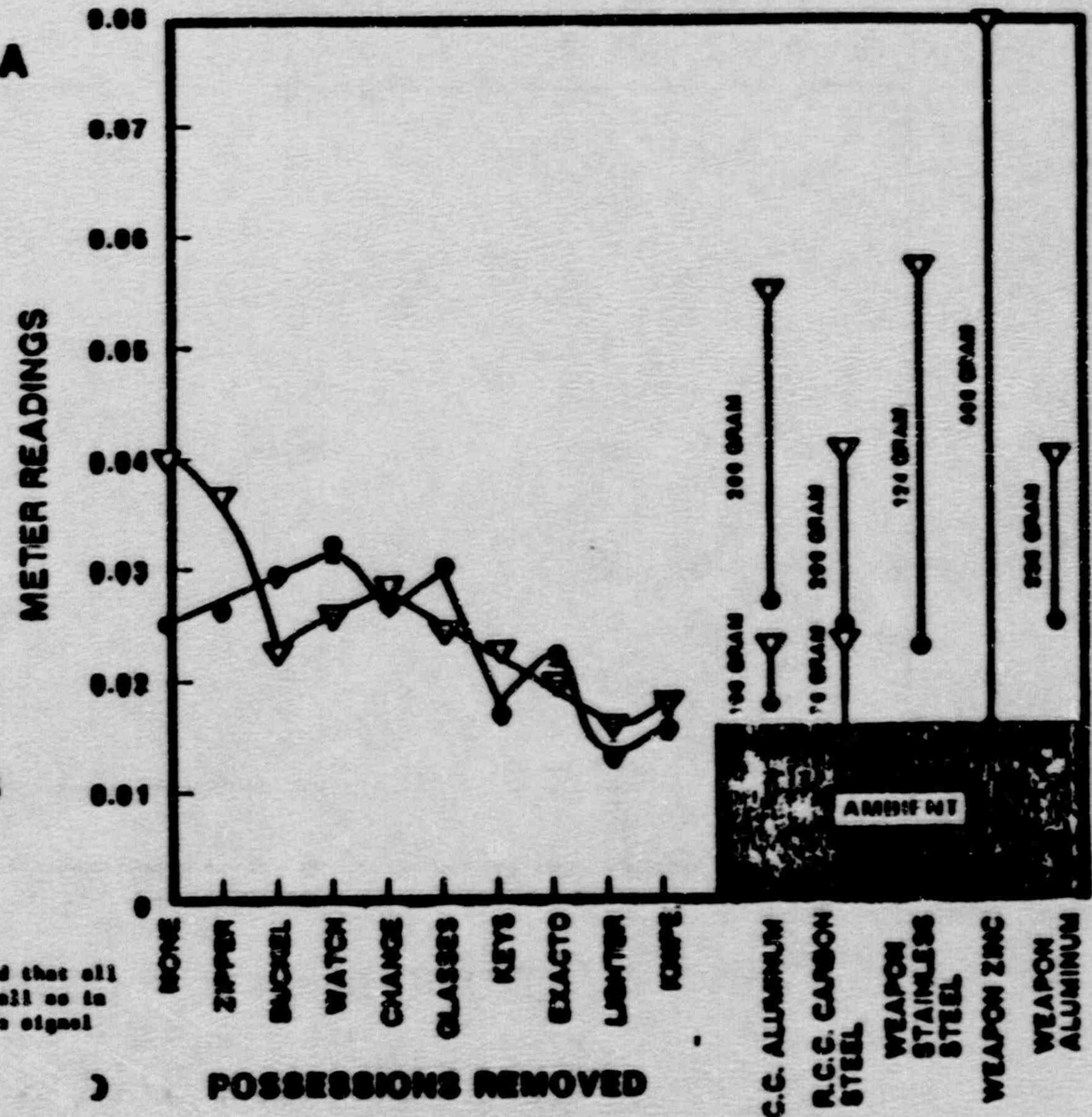
WEAPONS

	DESCRIPTION	WEIGHT	COMMENTS
1)	Stainless steel mini-revolver. 22 Long with with 1 1/8" barrel. Manufactured by North American Arms	128gm	All stainless steel except one spring. Steel is cast, 17-4
2)	Zinc frame automatic pistol. MP-25, 25 cal ACP. Mfg. by Raven Arms	400gm	About 90 gm is steel. Zinc is Zymac #5, an alloy with some copper.
3)	Aluminum frame Model 7 .380 cal. derringer Mfg. by American Derringer Corp.	234gm	Barrel & frame are aluminum. Other parts are stainless steel.

DEL NORTE PORTABLE AT
GAIN = 10
VELOCITY = 1.1 METER/SEC.



INFINETICS, FREQUENCY A POSSESSIONS TEST, WITH TEST OBJECT COMPARISON



▽ FERROUS

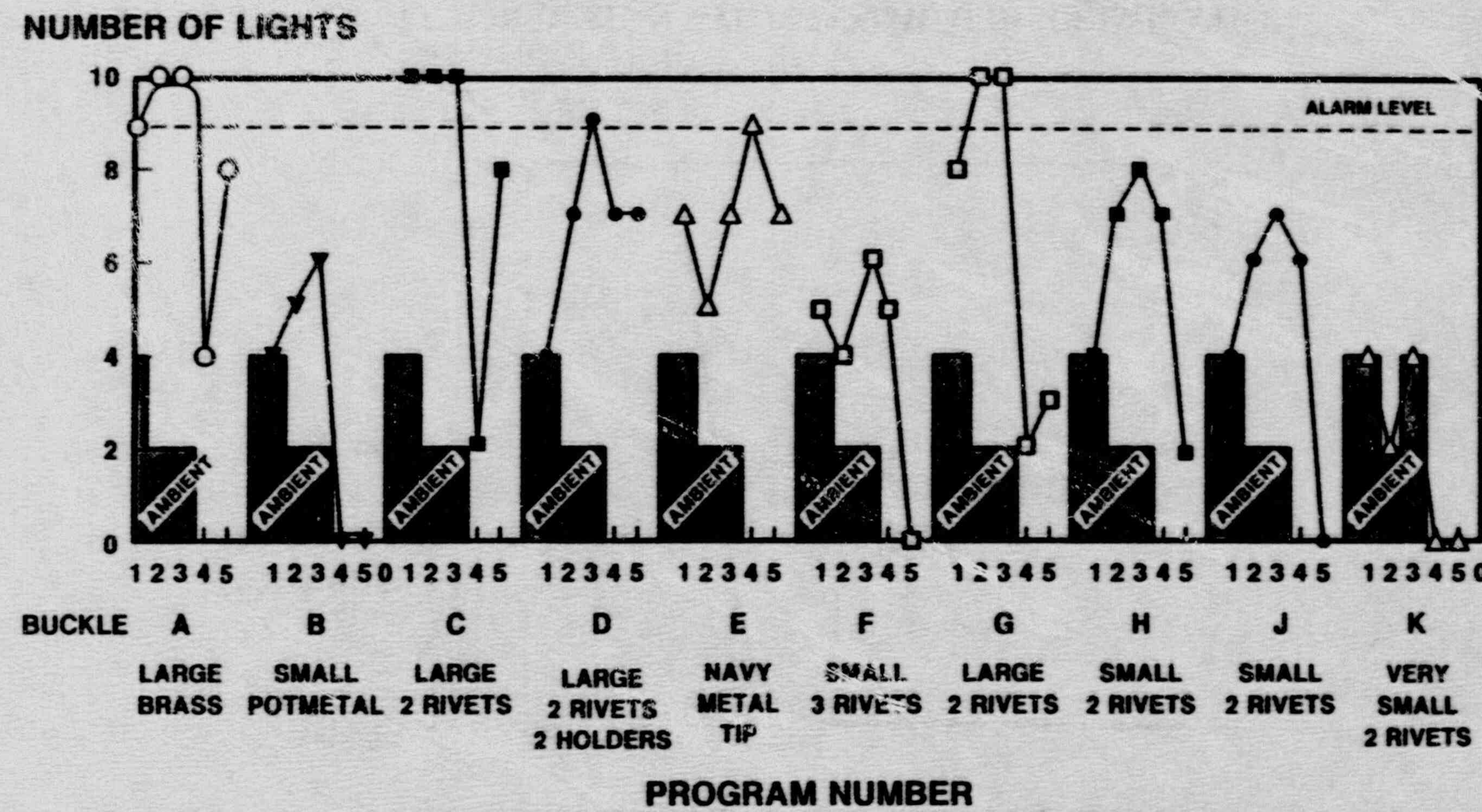
● NONFERROUS

Processing of the Detection Signal

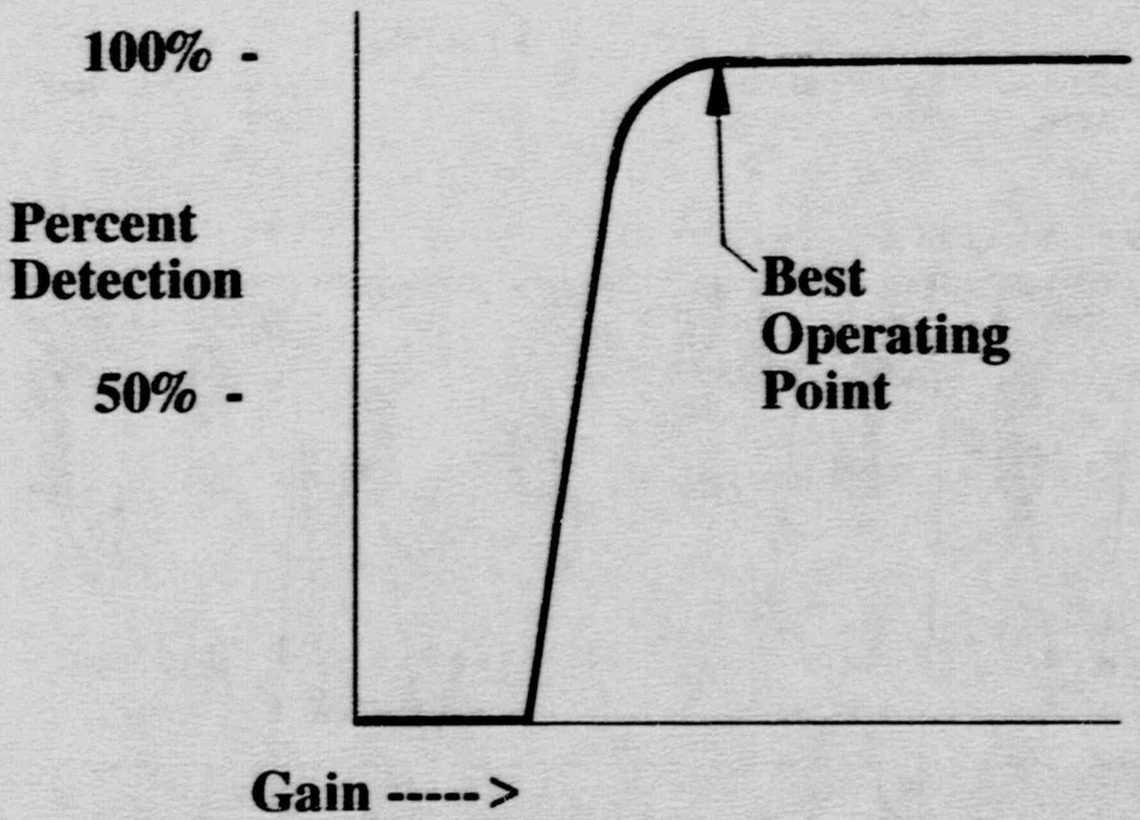
Keep in mind that all ibutory signals may also vary in algebraic sign, as well as in ate value. That is, they may add or subtract from the signal .

DEL NORTE PORTABLE BELT BUCKLE TEST

GAIN = 45 VELOCITY = 1.1 M/S



NUISANCE ALARMS VS. DETECTION



STEPS TO DECREASE NUISANCE ALARMS

1. **METAL DETECTOR DESIGN WITH MAXIMUM DISCRIMINATION.**
2. **TRAIN OR REQUIRE PERSONNEL TO REMOVE OR NOT WEAR OBJECTS THAT CAUSE ALARMS.**
3. **PROVIDE SIMPLE WAYS TO SHUNT PERSONAL OBJECTS AROUND DETECTOR.**

PROBLEMS VS. SOLUTIONS

PROBLEMS	POSSIBLE SOLUTIONS
1. Velocity too Low or High	a. Sensor to Provide Separate Alarm When Occupant Too Slow/Fast.
2. Weapon at Ankle	a. Longer Arch at Foot Level b. Require Occupant to Pause in Arch, Both Feet at Center
3. Increased Discrimination	a. Commutation of Detection Zones b. Multiple Detection Zones
4. Weapons Breakdown	a. Use Higher Frequencies b. Random Searches by Hand-Held Detector

Standards & Criteria
--Metal Detectors--

NRC: **NUREG - 1329**
"Entry/Exit Control at Fuel Fabrication Facilities Using or Processing Formula Quantities of Strategic Special Nuclear Material"
--December 1988

DOE: **Presently Under Revision**

ASTM: **Revision 10--Not Final**
"Standard Practice for the Evaluation of Metallic Weapons Detectors for Controlled Access Search & Screening"

PROBABILITY OF DETECTION

1. **Points of Interest:**

   a. **Body Position (location)**
   b. **Object Orientation**

2. **85% Prob. of Det. at 90% Confidence**

3. **Any Single Body Position/Orientation**

   14 Passes, no Misses
   25 Passes, One Miss

4. **3 Body Positions, 3 Orientations = 126 Passes, No Misses**

5. **With 5 Passes, P_D=63%, No Misses**

6. **Possibilities:**

   a. **Average Performance**
   45 Passes, No Misses = 95% P_D
   b. **Keep Historical Records**
   c. **Find Worst Case, Test There**

HAND-HELD METAL DETECTORS
--PERFORMANCE INFORMATION--

MFR	MODEL	FREQ.	WEAPONS/ DETECTION RANGE (INCHES) 22 (SS) AVG.	22 (SS) DELTA	25(ZINC) AVG.	25(ZINC) DELTA	38(AL) AVG.	38(AL) DELTA
INFINETICS	REDEE	156KHz	3	-	2	-	1.5	0.25
FED. LABS	6040	1.9MHz	3.25	0.25	2.75	0.25	3.0	1.0
SOLCO	ELECTRO-SEARCH	735KHz	3.75	0.75	4.5	0.5	3.0	1.0
RENS	25	131KHz	4.5	-	3.75	0.75	4.5	0.5

SUMMARY

1. **Primary Method of Detection: Eddy Currents**

2. **Many Factors Influence Detection**

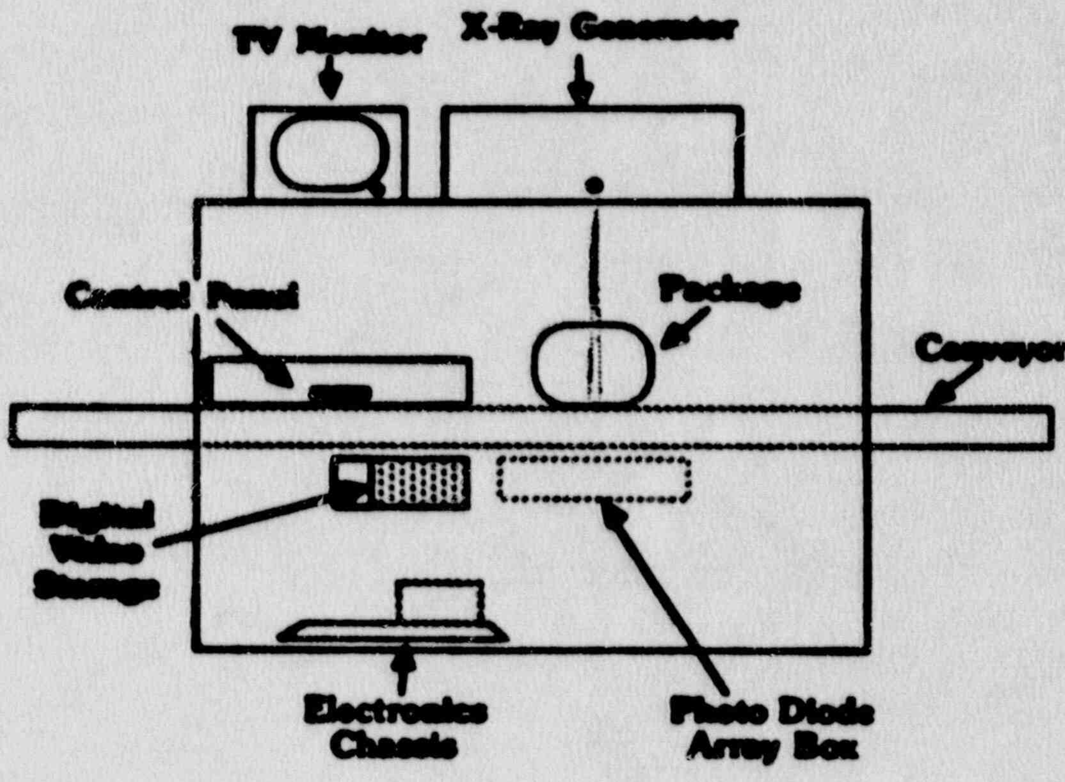
3. **Important to Understand Effects of Program Selection.**

4. **Once Detection Obtained, Nuisance Alarms Reduced in Non-Equipment Ways.**

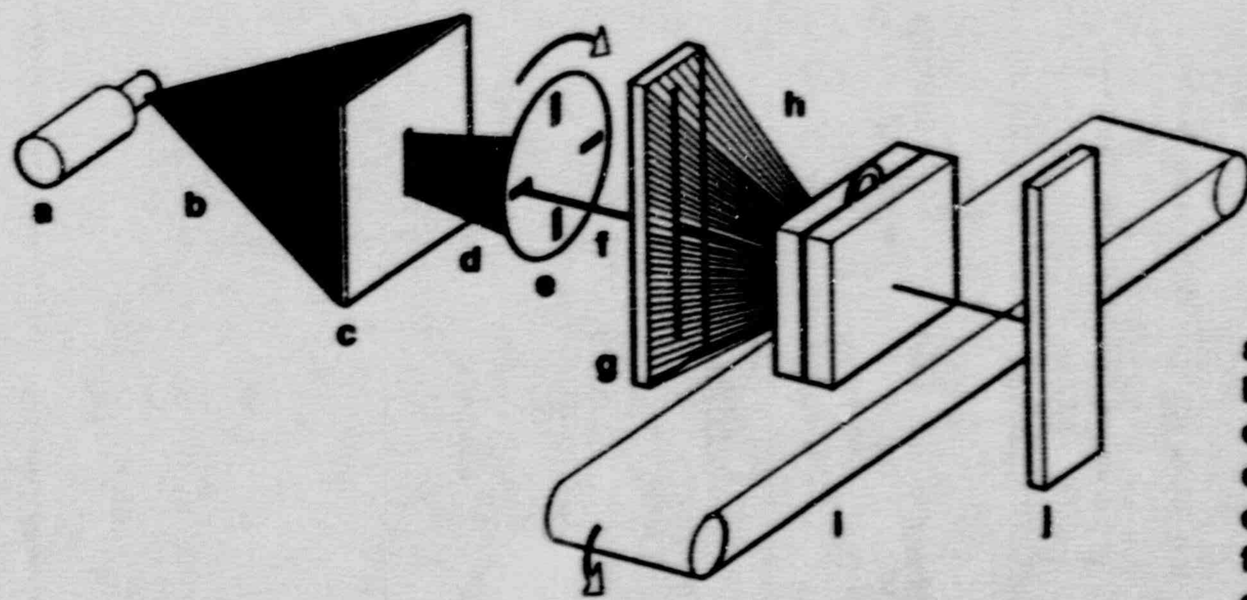
5. **Specific Test Objects & Test Methods are Important.**

6. **Need for Improvements**

X-Ray Package Search System

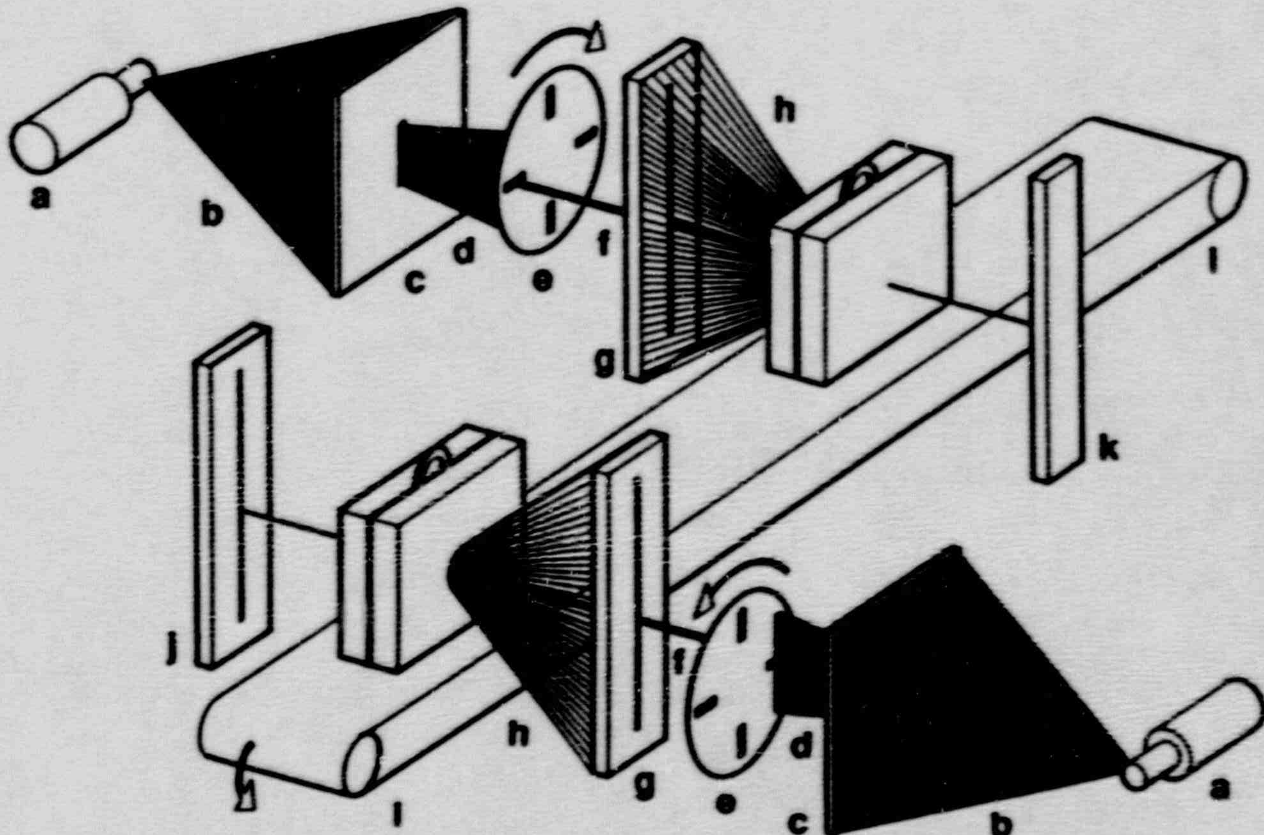


Principle of Operation



a. X-ray Tube
b. X-ray Beam
c. Collimator
d. Collimated Fan Beam
e. Chopper Wheel
f. "Flying Spot" Pencil Beam
g. Backscatter X-ray Detector
h. Backscatter X-rays
i. Conveyor
j. Transmitted X-ray Detector

Principle of Operation



a. X-ray Tube
b. X-ray Beam
c. Collimator
d. Collimated Fan Beam
e. Chopper Wheel
f. "Flying Spot" Pencil Beam
g. Backscatter X-ray Detector
h. Backscatter X-rays
i. Conveyor
j. Transmitted X-ray Detector
k. Transmitted X-ray Shield

APPENDIX B

LIST OF REGISTRANTS AND ADDRESSES

Leland G. **Adams**
Georgia Power Company
Plant E. I. Hatch Security Department
P.O. Box 439
Baxley, GA 31513

John W. **Albert**
Virginia Power
Security Department
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Richmond, VA 23261

Tom R. **Allen**
ERC Environmental and Energy
Services Comp., Inc.
1359 Silver Bluff Road
Suite B-5
Aiken, SC 29801

John W. **Aitoonian**
U.S. Department of Energy
S&S Division
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Roland J. **Bailey**
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Liz **Barber**
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A. G. **Barkhouse**
Royal Canadian Mounted Police
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Ottawa, Ontario, CN

A. Bill **Beach**
U.S. Nuclear Regulatory Commission,
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Suite 1000
Arlington, TX 76011

Sharon **Beall**
U.S. Secret Service
1800 G Street, NW
Washington, DC 20223

Spencer A. **Becton**
U.S. Customs Service
1301 Constitution Avenue, NW
Room 5106, ATTN: E:I:A:C
Washington, DC 20229

James L. **Belanger**
U.S. Nuclear Regulatory Commission, Region III
799 Roosevelt Road
Glen Ellyn, IL 60137

Barry L. **Bennett**
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APPENDIX C

TRAINING SYLLABUS

FIREARMS AND EXPLOSIVES RECOGNITION AND DETECTION

I. Explosives Recognition

A. Description of Domestic Threat

1. Bombing Events and Statistics
2. Non-Nuclear Explosives

    - Types

        - Commerical
        - Military

    - Effects

3. Improvised Expl sive Devices

B. Description of the Foreign Threat

1. Events
2. Devices

II. Explosives Detection

A. NRC Policy on Explosives Detection

B. Detection Theory Overview

1. Vapor Detection

    - Physical Properties of Explosives Molecules
    - Issues Associated With Explosives Detection

        - Installation
        - Test/Maintenance

    - Overview of Comercial/Development Units

2. Animal Olfaction
3. Bulk Detection Overview

C. Description of Selected Federal Programs

1 U.S. Secret Service Canine Program for Explosives Detection

- Training Program
- Detection Capabilities
- Uses

2. FAA Explosives Detection Program

- Personal (chemiluminescence)
- Baggage

    - Thermal Neutron Activitation
    - Automated X-Ray
    - Dual Sensor (Thermal Neutron and X-Ray)

- Comments on New Technologies
- Other Initiatives

D. Evaluation of Commercial Explosives Detectors
E. Nuclear Industry Issues Associated With Contraband Detection

1. Generic Issues
    - Problems
    - Practical Solutions
2. Suggested New Initiatives

III. Firearms Recognition

A. Description of Threat

1. Statistics
2. Types of Firearms and Weapons

B. Firearms Display

IV. Firearms and Weapons Detection

A. NRC Policy on Firearms and Weapons Detection
B. Description of FAA Programs

1. New Technology in Weapons Detection
2. Commercial Metal Detector/X-Ray System Test and Evaluation Program
3. Automated Weapons Recognition by X-Ray
4. Threat Studies
5. Impact of Federal Legislation and Congressional Initiatives
    - Public Law 100-649, "Undetectable Firearms Act of 1988"
    - Other

C. Evaluation of Commercial Metal Detection Equipment

1. Portal Metal Detectors - Theory
    - Pulsed
    - Continuous Wave
2. Hand-Held Metal Detectors
3. Considerations in Metal Detection
    - Ferrous Versus Non-Ferrous
    - Installation/Setup
    - Sensitivity
    - Testing and Maintenance

V. X-Ray Equipment

A. Current X-Ray Technology
B. Development X-Ray Technology
A. X-Ray Interpretation in Explosives and Firearms Detection

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