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SUPERVIOLENCE:

THE CIVIL THREAT OF MASS DESTRUCTION WEAPONS

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BTX	Botulinum toxin
BW	Biological warfare
CB	Chemical and biological
FLQ	Front de Libération du Québec
IAEA	International Atomic Energy Agency
INW	Illicit nuclear weapon
MDW	Mass destruction weapon
MUF	Material unaccounted for
NOL	Normal operating loss
NPT	Non-Proliferation Treaty (Treaty on the Non-Proliferation of Nuclear Weapons)
OPA	Organophosphorous anticholinesterase
PFLP	Popular Front for the Liberation of Palestine
SNM	Special nuclear material

CHAPTER 1
SUMMARY, FINDINGS, AND RECOMMENDATIONS

The subject of this study is superviolence: the illegitimate, unsanctioned use of mass destruction weapons—nuclear, chemical or biological—by domestic agents for attack or threat directed against US civil society.

The problem has its genesis in the growth of the civilian nuclear power industry, especially that based on plutonium fuels, which will make available the essential ingredient for the illicit fabrication of the "poor man's atom bomb." Coupled with the availability of technical information, and in the context of a decade of heightened civil violence, this would permit individuals with appropriate skills to acquire such a device and use it to the detriment of society

Our purpose is to investigate the broader aspects of the problem, to estimate its magnitude, and to identify its solutions. Among the broader aspects are: the full spectrum of mass destruction weapons (MDWs), chemical poisons and bacterial pathogens as well as nuclear explosives; the kinds of individuals who might become involved in their use; the motives which impel these individuals to act; the resources required to fabricate such devices; and the ways in which they might be used.

Hazardous materials abound in our technological environment. Their danger if uncontained is well known, but the threat of their malicious use in forms designed to maximize their impact on society is a novel concept. No actual attacks of this sort have ever occurred other than in war, and only a few examples of (unsubstantiated) threats of their use have come to light. Consequently, no objective basis for estimating the likelihood of superviolent incidents exists; the magnitude of the threat (in contrast to the impact of an attack) is, for the time being, a matter subject only to informed speculation. Yet, if the threat is potentially real, means for its prevention or control must be sought and, if justified, implemented. It is to an objective assessment of these questions that this study is addressed.

OVERVIEW

Until about 1965, concern over the diversion of fissionable material was largely limited to the problem of nuclear proliferation to non-nuclear nations. At that time, the increased turmoil of riots, confrontations, and "politically motivated" bombings in the United States led to the inclusion of "political dissidents" among those who might seek a nuclear weapon capability, with the suggestion that organized crime might be the presumptive supplier of the stolen special nuclear materials (SNM) from which the weapons would be fabricated. It is this latter context which interests us here; specifically, the near- to mid-term (ten, perhaps fifteen, years) future prospects of domestic, politically or criminally motivated efforts to obtain nuclear devices for the purpose of executing attacks or issuing credible threats against US civil society. Excluded from this central concern (although alluded to as appropriate, in the body of this report) are such matters as the clandestine provision of nuclear weapons or components by foreign nations to their agents or domestic terrorists in the United States to assist pre-emptive nuclear attack or to precipitate nuclear war, diversion of SNM or theft of weapons for terrorist or national use abroad, and diversion or theft of SNM for purposes other than weapon fabrication, whatever those might be.

In approaching our central theme, we have tried to deal with fact rather than create fiction. Fact requires that a reasonably complete and consistent description of the problem be presented: from motive to intent to human and physical capabilities to mode of use and consequences. Fiction is free to violate consistency, to pick and choose from this sequence to emphasize the dramatic, and to invent rationales where none can be found to exist.

This report is organized along the lines of the same sequence of ideas. Chapters 2-5 examine the background for superviolence: its possible political (Chapter 2), psychological (Chapter 3), and criminal (Chapter 4) motives, and—in Chapter 5—those characteristics of the nuclear industry which bear on the availability of information and materials for fabricating an illicit nuclear weapon (INW). Chapter 6 makes the transition from background to practice by summarizing some of the known incidents.

The development of an INW capability is investigated in Chapter 7. Because the question of technical feasibility has been extensively documented elsewhere, the emphasis here is placed on the motivating and behavioral aspects of the threat group, the different routes which could be taken, and the factors likely to determine whether the effort succeeds or fails. Our extension of superviolence to include poison and disease is developed in Chapter 8 where the technical problems of production and dissemination of chemical and biological (CB) agents, as well as their utility to the terrorist, are described.

Chapter 9 focuses on the threat proper. Modes of employment, delivery means, potential targets, and impact are considered for the three kinds of MDWs. An essential distinction is made between direct attack and coercive threat, and—because the latter affords the basis for a sham threat—it is investigated in some detail. Our estimate of the relative likelihood of various forms of superviolence is presented. Finally, in Chapter 10, the threat process is reviewed in the search for methods of controlling and responding to it, and the recommendations of the study are derived.

SUMMARY AND FINDINGS

Background Factors

There are many issues in present US society which provide a basis for political activism and violence: race, minority rights, foreign policy, representation, poverty, environment, etc. There are a few extremist organizations which have shown a propensity for violence as a means of publicizing or attempting to achieve their political goals.

The decade just past has been characterized by a high level of turmoil and violence associated with racial strife, campus unrest, opposition to the Vietnam war, and attacks on institution establishments. When this activity is normalized for increased population size and expanded mass media, however, it is found that the violence of the present period is not significantly different from that of earlier peaks in US history and that its intensity (as measured by number of deaths and injuries) is lower than that of earlier peak periods. This recent experience has made us more sensitive to the matter of violence, but should not be confused with the factors which determine the likelihood of supervioleht incidents.

Unless new channels and opportunities for serious consideration and partial resolution of legitimate political demands are created, a continuation of political violence can be expected. This violence is usefully categorized as <u>turmoil</u> (expressive, spontaneous, popular, unorganized), <u>conspiracy</u> (instrumental, planned, elite, organized), or <u>internal war</u> (widespread, popular, highly organized, insurgency); the superviolent forms of interest are seen as belonging to the conspiracy and internal war categories, but the unlikelihood of the latter in the foreseeable future excludes it from further consideration.

A particular form of conspiratorial violence, terrorism, affords a possible context, but its doctrine of selective attack on symbolic targets (with avoidance of unnecessary deaths and its objective of splitting the polity from support of the incumbent authorities) seems ill-suited to the capability of mass destruction weapons and poorly adapted to conditions in the US.

The motives of political violence are classified as rational (attack well matched to character of issue-related target), retributive (punishment for perceived offenses against a group), manipulative (designed to accelerate desired social or political change), self-assertive (for purposes internal to the functioning of a dissident group), irrational (based on fanatical ideologies or severe mental imbalance), and coercive (for the purpose of achieving ends other than those produced by the use of MDWs).

A great variety of types of individuals (agents) has been associated with past political violence; no diagnostic profile of these individuals appears possible. For involvement in a superviolent plot, individuals would have to show an unusually high degree of commitment, a readiness to take lives on a large scale, and specific scientific-technical skills. This is a rare combination.

The general functions of an organization are to obtain the resources needed to achieve its goals, to motivate and maintain the commitment of its members, and to allow an efficient division of labor in conducting its operations. In fact, existing fringe political groups can be characterized as loose, flexible, non-authoritarian, non-cohesive, subject to extensive factionalism, and beset with internal personal and ideological rivalries. No such groups appear to command the resources needed for nuclear superviolence, nor does their doctrine (in contrast to some instances of their rhetoric) call for a superviolent capability. Nevertheless, certain of their goals could be viewed as compatible with superviolence, especially for coercive purposes. Coercive threats, however, cannot be used to enforce widespread change in social attitudes or the adoption of legislation under duress.

Mentally or emotionally unbalanced, irrationally motivated individuals could provide the impetus for an attempt at superviolence. It is estimated that some ten percent of the population will suffer severe neurotic or psychotic interludes during their lives, and about one percent of the population will experience dangerous psychotic episodes. Given the necessary skills and resources, one or two mentally or emotionally imbalanced individuals could mount a chemical or biological superviolent threat; nuclear superviolence, however, because of its larger skill requirement, demands an irrationally motivated group.

The formation of such autocratic groups is not improbable. They would be characterized by a hypnotic, charismatic leader; a self-legitimizing, ethnocentric perception of their own sovereignty; a viewpoint which dehumanizes and depersonalizes their enemy; a high degree of isolation and incommunicativeness with respect to society; and a belief that superviolence is essential and that loss of life is inconsequential. Such groups would be prone to the use of internal terror to force compliance of the membership with the leader's demands, and would probably demonstrate bizarre behavior patterns which, if detected, could well lead to discovery of the group.

The psychotype most likely to fill the critical role in a superviolent plot is the <u>organized paranoid</u>. His is an extremely rare psychosis characterized by long-term stability, brilliance, conviction, and—most importantly—overt personality traits which hide his true nature from all but the most searching psychiatric examination. Under the influence of such an individual, a second personality type, the sociopath (psychopath), constitutes another potential contributor to superviolence. While not technically (or legally) insane, his dys-social amorality is entirely compatible with superviolent behavior, yet not so deviant as to signal his abnormality on casual inspection.

The number of individuals who, because of mental illness or personality make-up, might become involved in superviolence is not inconsequential. The psychiatrists and sociologists interviewed invariably feel that the intent and psychological capability underlying the threat is real and that control of the physical capability for superviolence is more effective than attempts to profile and screen potential perpetrators.

The motive for criminal involvement in superviolence is profit. Criminal motivation is rational, selfish, non-symbolic, non-ideological, and conditioned by the expectation of payoff adequate to compensate for the risks and consequences involved. Profit can be achieved by extortion (coercion) based on superviolent threats, whether real or sham; or by SNM black market sale or reward for its return—methods which do not involve weapon fabrication.

Of all the options for superviolent plots, genuine criminal skills are required only for overt SNM acquisition. Amateurs are likely to be incompetent at this task, and professional criminals quite leery of it since, should the plot be discovered, they could be implicated in a heinous crime by others in whom they may have little trust. As a regular activity, SNM theft and black marketing satisfies almost none of the criteria used by organized crime: consistent and profitable activities, repeat customers (preferably for widely wanted but illegal goods or services), nothing too detrimental to public relations, not a "dirty" business, no need for excessive secrecy, and avoidance of unnecessary contact with the government. With its already huge annual profits, organized crime can undoubtedly find much better opportunities for the conduct of what it views a continuous, long-term business.

Nuclear Industry Controls

A dilemma was created by the implementation of the "Atoms for Peace" concept and the subsequent growth of the domestic and international civil nuclear industry. This environmental change required the declassification of information and special nuclear material (SNM). In the process, the character of the information was changed but not the character of the SNM—it remains the direct or prototype resource for a nuclear weapon. The US sought to compensate for the removal of SNM security controls via the implementation of safeguards—a collective term describing measures to guard against the diversion of material including awareness of SNM distribution and management, physical protection, facility inspection, and penal provisions. (It is also characterized as a triad of materials accounting, surveillance, and containment.) At present, considerable emphasis is placed on the accounting and management aspects. The contemporary diversion threat is considered to include petty thieves, organized criminal groups, disgruntled plant employees, and politically motivated dissidents, but not plant and facility management. Safeguards are also needed because of the hazardous nature of the material, its monetary value, and for quality control of the industry.

The limitations of physical measurement and the constraints of competitive economics are such that weapon-sized quantities of SNM can be diverted with relatively low risk of detection. This is especially true of a future characterized by a significant increase of SNM quantities, facilities, reactors and vulnerable transportation links. Projecting safeguards performance from present experience to the context of a hundred-fold increase in civil industry plutonium within the next 20 years is uncertain. The rationale of deterrence of SNM diversion by detection is open to question; there is great uncertainty regarding the quantitative relationship between deterrence and the safeguard system factors of detection probability, false alarm penalties, containment, and alarm responses. Quantitative cost-effectiveness decisions on safeguards cannot yet be made and subjectively based safeguards apportionment is uncertain. Thus we concur that continued effort in the development, measurement, understanding and application of the material facets of safeguards is required.

The complement of this system concern is that of the human factor. Because the half-life of SNM is at least a thousand times longer than the classified life of sensitive information, personnel with access to SNM are a key factor for a diversion-free society. We conclude that though it is neither necessary nor, as some see it, desirable to require Q-clearance for civil nuclear industry employees, an effective employee screening and review program, sensitive to the implications of diversion to society, is needed. The uncertainties of discerning the complete person and the desires for full realization of the civil rights of each individual make this a formidible task.

The Techniques of Superviolence

The actual or threatened use of a mass destruction weapon in a domestic context is an extraordinary act; it is not merely an extension of familiar forms of violence. The gap between "ordinary" violence and superviolence is a real one, requiring special motivation, great commitment, psychological capability, technical skill, and unique resources to cross.

A handful of incipient superviolent incidents have occurred, including claims of intent, aborted or discovered plots, and sham threats. None was conducted effectively or was successful. If extensive destruction or death is the goal sought, the vulnerabilities of civil society offer many opportunities for its effective accomplishment by conventional (high explosive) methods; resort to exotic weaponry is unnecessary.

While there is evidence of increased politicization on the part of American scientists, the indications are that the extent of this trend has been exaggerated by the news media. There are no general data regarding scientists actually supporting extremist activities, although some involvement in radical organizations has been disclosed.

No known political or criminal plots are even marginally comparable to the superviolent plots envisioned in this study when the totality of motives, skills and resources required for the superviolent process are taken into account. Because there is no unique adaptability of superviolent weapons to the political, psychological, and criminal motives identified—with the possible exception of coercion—it is impossible to estimate the occurrence or frequency of superviolent incidents. (The problem of coercion is treated later.)

Nuclear. In the next five to ten years, society is expected to become significantly aware of the threat implications of the civil nuclear industry. Concurrently, the illicit weapon potential will be stimulated in some. The civil nuclear industry may be perceived as susceptible to penetration via a sympathetic or coerced employee or by an overt attack against some facet of it. This increased awareness will raise the likelihood of both the sham threat and the start of implementing a superviolent capability.

The process of initiating, planning and fabricating an INW requires: personnel, skills, information, money, facilities, equipment, supplies, security, SNM or a stolen weapon and, usually, other specialized and hard-to-obtain items. In contrast, a credible sham threat requires primarily the resources for an effective communication. There is a high probability of the threat group selecting the credible sham threat as opposed to INW fabrication if the intent is coercion because of the resource differences, lesser group risk, and the fewer modes of failure.

The key phases in NDW implementation are idea conception; group formation, evaluation, and planning; and weapon fabrication. The application and social consequences phases complete this sequence. Each step of a phase generally requires input stimuli, resources, and group decisions. Although INW fabrication is both plausible and feasible, its concomitant emanation of intelligence indicators and a broad range of environmental, technological, and personnel failure modes are significant reasons for estimating a low probability of success. Because of the many possible failure modes and human factor variables, a quantitative assessment of overall success is highly uncertain. Assuming adequate SNM requiring chemical processing has been obtained, that no failures occur, that a 5-13 man-year level of effort and $150,000 are invested, our subjectively quantified interpretation indicates a 0.9 probability of successful weapon fabrication.

Unless members of the group have actually performed key nuclear weapon design, planning, and production tasks, it is expected that the group will optimistically misjudge their capability and fall heir to more than the already significant difficulties and chances of failure. For us, the most frequently recurring thought, one that cannot be documented or dismissed, is the low probability that a threat group will simultaneously possess the composite of skills, motivations, resources, and opportunities to initiate and steadfastly pursue the steps of INW fabrication.

Materials access and group capability are the basic defining elements for selecting a modus operandi for fabrication. The threat group will probably consider tradeoff combinations involving overt theft or covert diversion, SNM state, processing requirements, and its own estimate of the time period during which it can maintain its security. This tradeoff is nebulous enough that the probability of successful, illicit manufacture is about the same as that of stealing a tactical nuclear weapon. The probability of theft of a strategic nuclear weapon is significantly lower.

Various input forms of SNM with their particular access susceptibility force significantly different implementation steps and effort. Alternate routes to an INW capability are compared on the basis of implementation cost and subjective assessment of overt and covert access effort and likelihood. Such comparison indicates that metallic or ceramic SNM obtained from the civil industry is a likely form to be diverted and presents the least access and implementation effort to a threat group seeking an INW capability. Successively less likely and more difficult alternates are: unprocessed SNM from the civil industry; metal, weapon components, or weapons from the military industry; and unprocessed SNM from the military industry.

Chemical. The primary characteristic of chemical weapons is their anti-personnel nature, hence they are of utility in only those plots which involve the death or incapacitation of particular individuals or groups. In marked contrast to the INW threat, in which fabrication poses the greater difficulty and attack delivery the lesser, chemical weapons offer relatively easy preparation of the toxic materials but considerably greater difficulty in their dissemination. Because of delivery problems and quantities required, chemical poisons are limited to much smaller scale attacks than is the INW; these attacks may be overt or covert, largely depending on the target configuration and environment.

Three kinds of poison are investigated as potential substances for superviolence: two synthetic classes (the monofluoro aliphatic compounds and the organophosphorous anticholinesterases or OPAs, of which the nerve gases are examples) and one bacterial product (botulinum toxin or BTX). Selected substances in these classes range in median lethal dose for a normal adult from 42 milligrams for 8-fluorooctanol, through the 10 to 1 milligram spread for Sarin (GB) and the thiocholine esters (V-agents), to approximately 1 microgram for BTX (Type A). For each, the report presents toxicity data; discusses their mechanism of action, symptoms of poisoning, and such therapy as is available; and describes in some detail the open scientific literature reports of procedures for their preparation. The practicability of acquiring and using these materials and their utility to the terrorist is examined.

Biological. The effectiveness of biological pathogens as a mass destruction weapon has been significantly increased within the past 25 years by three technological breakthroughs: continuous culture of microorganisms, production of monodisperse aerosols, and stabilization of organisms to maintain their viability in aerosol dissemination. Techniques appropriate for the terrorist use of pathogens are not far removed from the traditional concepts of biological warfare and, other than for strategic attacks, are practicable as laboratory-scale operations.

Seven criteria are of special interest to the terrorist whose proclivities run to the use of biological pathogens for superviolence: infectivity, casualty effectiveness, availability (from the research environment, medical sources, or natural reservoirs), resistance (of the organism to dissemination stresses), transmissability (primary infection by artificial means), epidemicity (secondary, man-to-man infection), and Immunization (both as a target vulnerability and for his own self-protection). (Three other criteria—therapy, detection, and retroactivity—are of much less importance in the context of superviolence.) Eight diseases are investigated as potential terrorist choices: anthrax (respiratory form), brucellosis, pneumonic plague, tularemia, coccidioidomycosis, cryptococcosis, Rocky Mountain spotted fever, and psittacosis; of these, respiratory anthrax is selected on a number of additional, terrorist-related grounds as an exemplary choice for further investigation.

The process of mounting a terrorist BW attack consists of acquiring a seed culture of the selected organism, growing it in the required quantity, and disseminating it effectively. The first two steps are essentially routine ones for a competent microbiologist; the last is best accomplished by generating a fine aerosol. Various aerosolization techniques and the physical and infective properties of the cloud produced are described. The casualty producing effectiveness of a practicable biological threat is found to be frighteningly great and to require a level of effort and resources at least an order of magnitude smaller than that of the INW threat.

Attack and Threat

Assuming that the superviolent group has successfully acquired its weapon, the options of direct attack and coercive threat are open to it. Representative direct attack modes of employment might involve prepositioning a nuclear weapon or, better, building it into a small van. A 1 KT weapon could produce a loss (including a few hundred thousand lives, valued at $300,000 apiece) approaching $100 billion in its most damaging use. Depending on the chemical agent selected, dissemination may be by vaporization, spray, aerosolization, bursting munitions, or covert administration in food or drink. Under the most ideal circumstances, however, effective exposure of more than a few thousand target individuals is impossible with the quantities a small threat group could handle. In contrast, biological weapons can be effectively scaled to the target. Several attacks are described including one on a large city using 90 liters of anthrax spores distributed over a 32 kilometer course; under the proper conditions, over a half million fatalities could result. The popular "reservoir attack" with chemical or biological agents is examined and shown to be both costly and ineffective.

Because of their number, variety, and widely differing characteristics, the specification of potential targets is found to contribute almost nothing to the understanding of superviolence; the many motive and issue combinations provide more insight than do mere lists of vulnerable properties and people. Yet, as indicated previously, the central question of the coalescence of motive, intent, capability, resources, and all else needed to mount a direct superviolent attack, coupled with the doubtful utility of its results and consequences, precludes assigning this option a sufficiently high likelihood to warrant practical concern.

The objectives that might be achieved by coercive superviolent threats, however, is another matter. Two specific examples of recent efforts by terrorists to coerce powerful national governments, the FLQ kidnapping of James Cross and the PFLP coordinated hijacking of four international flights, are summarized. These incidents are analyzed using some formal concepts derived from game theory, coercive diplomacy, and bargaining and negotiation strategies. It is concluded that effective, coercive threats are characterized by <u>strong and asymmetric motives</u> favoring the threatener; the statement of <u>clear, urgent, and achievable demands</u>; validated, usable, and (practically) uncounterable <u>force options promising unacceptable costs</u> for resisting the demands; and <u>precise terms for compliance</u>. In this sense, the function of the superviolent capability is not to demand the unachievable, but to provide the leverage which a small group requires to coerce a powerful nation. Further, we argue that an effective, coercive threat would (at least, should) be directed against the national leadership even if its demands are of local applicability; in this way, the threatener aids his own security by denying target location information.

Another aspect of a sophisticated, coercive threat is a high likelihood of its being conducted through confidential communications between the threatener and the coercee. Nevertheless, the threat might become public knowledge, or it might be publicly made, and the question of public panic arises. A review of panic and disaster research indicates that this is not likely. Rational, adaptive escape from a localizable danger is an expected form of behavior, but it is not panic. The fear-provoked, terror-driven, non-adaptive flight of panic from a personal threat to survival is a very rare phenomenon which depends on the simultaneous operation of factors such as suddenness, immediacy, intensity, incomprehensibility, confusion, helplessness, and an awareness of limited escape routes. In the superviolent threat context, momentary and localized panicky behavior is conceivable; mass panic is not.

To the extent that coercive threats of superviolence are effective, credible sham threats are equally so. The threatener's problem is to convince his victim of both the credibility of his threat and his resolve to execute it. A coercive threat communication which simulates everything expected of a real threat communication is a technically demanding task for the threatener, though not as demanding as a real capability. Since real superviolence is quite unlikely, we adopt the proposition that superviolent threats are shams until adequate contrary evidence shows otherwise. This is not an imprudent position since executing the attack does not serve the threatener's objectives; communication, negotiations, and attempts at verification of the threat buy time for investigation and possible countermeasures.

We summarize this analysis in the following eight propositions, arranged in order of decreasing intuitive probability.

1. Threats and attacks with conventional means are far more likely than those involving weapons of superviolence.
2. Statements and rhetoric alluding to instruments of superviolence are more likely than the occurrence of superviolent incidents (direct attack, real threat, or sham).
3. Coercive threats based on superviolence are more likely than direct superviolent attacks.
4. Sham threats of superviolence are more likely than real ones.
5. Threats of superviolence involving chemical or biological weapons are more likely than those involving nuclear weapons.
6. The likelihood that a serious attempt to acquire instruments of superviolence will be initiated is greater than the likelihood that it will prove successful. In particular, the probability of an INW start is much greater than the probability of its successful completion, while the probability of successfully concluding a CB effort, given a serious start, is greater than 0.5.
7. The probability of successfully fabricating an INW is of the same order as that of successfully stealing a tactical nuclear weapon, and greater than the probability of stealing a strategic nuclear weapon.
8. The probability that some community in the United States will be exposed to a real, superviolent threat or attack in a given time period is greater than zero.

Controls and Responses

The superviolent threat and attack process that has been described constitutes the basis for defining the necessary controls and responses. As a criminal act, much of the process is subject to control by the existing law-enforcement system; what is sought, therefore, is the identification of incremental controls specifically directed against superviolence.

Taking a systems view, the threat process is analyzed as a sequence of five phases; each phase comprises a series of steps; and each step involves motivating stimuli, required resources, a series of actions, and various options. Although the network of alternative paths to superviolence resulting from these options is too complicated for detailed emphasis, the flow of stimuli, resources, and actions in general denotes potential intelligence indicators and controls. General controls serve to deter, protect, alarm, detect, and provide intelligence; specific controls, to react, recover, neutralize, apprehend, or otherwise respond to the threat.

Idea Conception (Phase I). This phase determines the main outlines of the threat: conventional violence is rejected in favor of superviolence; the choice of nuclear, chemical, or biological instrument is made; the question of direct attack or coercive threat is (tentatively) answered and, if the latter, the option of real capability or sham is determined; whether the effort is a one-man or a group operation is assessed; and the ability to assemble the required resources dictates whether the plot is to proceed. Intelligence about this phase is virtually impossible to obtain, and such general controls as effective law enforcement agencies and a good security image on the part of affected industries are no more than potential deterrents; no specific controls exist.

Group Formation and Planning (Phase II). The many assumptions involved in the leader's ability to form a strongly committed, full-capability threat group, designate roles, assure internal trust, and guarantee the availability of needed resources are examined; process risks and detection risks (leading to murder conspiracy charges, at the least) must be weighed against the anticipated payoff and other alternatives before potential group members accept their roles. In the INW case, planning must encompass detailed examination of SNM acquisition methods capable of filling the particular weapon design requirements without disclosing the operation.

Intelligence indicators of this phase are personnel oriented: surveillance of selected suspects, use of informers, infiltration of violence-prone organizations, solicitation of defectors by offer of reward, personnel security screening, investigation of changed or bizarre behavior patterns, etc. Implications are derived for intelligence community and law enforcement agency involvement. In particular, undercover agents with appropriate skills or contacts could let their availability be known in an effort to solicit recruitment to a threat group.

Weapon Fabrication (Phase III). The actions of this phase, detailed elsewhere in the report, are the only ones with direct implications for physical control. This is most clearly seen in SNM protection or containment. The justified level of protection, however, must be based on the overall credibility of the INW threat, not just its technical feasibility. Other forms of superviolence are less subject to such control to the extent that they are less dependent on special materials. Potential sources of intelligence regarding the actions of this phase may arise from investigation of unusual or suspicious attempts to procure other specialized materials required for weapon fabrication, from investigation of ancillary crimes related to the threat process (such as bank robberies), and by an enhanced awareness of possible terrorist activities on the part of public safety personnel (such as fire inspection).

It is important to recognize that until the threat group has at least a minimal superviolent weapon capability, they are as vulnerable to apprehension as other criminals, and every community possesses the resources for this. Consequently, the ability to obtain information concerning the existence of a threat process may well be of greater utility than enhanced physical security which simply increases the cost of access.

Application (Phase IV). If a threat group bent on direct attack successfully completes the weapon fabrication phase without being discovered, there is little chance that the attack itself can be controlled. Its consequences are discussed in Phase V.

The steps of issuing a coercive threat have already been described. The responses available to the coercee are investigation and decision; the investigation attempting to verify the threatener's claim and counter it, and the decision leading to negotiation before selecting a comply or resist course of action. The primary purpose of the verification attempt is, of course, to detect sham threats as such. The specialized scientific content, the great potential impact, and the likelihood that credible threats will be levelled against the national authorities in order to prevent localization of response dictate the necessity for establishing the responsibility for dealing with superviolence at the Federal level. This may be accomplished through legislation making such acts Federal crimes and assigning responsibility for their management to an existing department or agency, or by establishing this capability as an advisory function available to any threatened jurisdiction as needed.

The effort to counter an apparently verified superviolent threat, to neutralize it at its source, depends on the ability to localize it in place, and the effort to reduce its impact by pre-attack measures depends on localization in both place and time; neither piece of information is a necessary ingredient of the threat communication. Appropriate responses to a verified, localized threat will depend on the details of the situation; the great variety of possible threats precludes specific solution of this problem. Pre-attack responses to an unlocalized threat are even more difficult to plan; mobilization of resources for deployment to a disaster area is an evident and necessary precaution.

Consequences (Phase V). There are four possible outcomes of superviolent plots from society's point-of-view: no loss, compliance loss, damage loss, and compliance plus damage loss. Few communities have the resources to respond to damage losses of the kinds considered here; post-attack response would have to depend on assistance from the surrounding area and the Federal government in much the same fashion as natural disasters and large-scale accidents are handled.

The consequences of compliance loss are too potentially variable to evaluate, and must be viewed in their total context. We indicate again, however, that superviolent coercion does not imply unachievable demands so much as a higher probability of realizing achievable demands. The successful threatener becomes a hunted criminal; perhaps his ability to enjoy the fruits of his labors under these conditions is another prerequisite of his psychotype.

All technologies produce adverse outputs in addition to their benefits; the technological component of superviolence must be understood in the context of the undesirable exploitation of legitimate industries. Awareness of the risk levels which pervade socially accepted activities in general affords a basis for decisions affecting the likelihood of superviolent plots. Involuntary risks are imposed by many hazardous industries as well as by the requirements for national security; widely varying degrees of relative risk acceptance are found for reasons ranging from public ignorance or apathy at one extreme (pollution, auto safety) to wide support at the other (national defense).

Expected impact significance is defined as the product of the probability of occurrence of superviolence and its resultant devastation, but the concept is difficult to apply because the probability term is beyond the proficiency of science to estimate with stated uncertainty and the devastation term is a strongly subjective factor. Aspects of this subjective quality are seen in the differing perceptions of the pervasiveness of a threat to a defined class of victims and of the propriety of risk relative to the victim's activities. Examination of experienced death rates for defined classes as a function of their size and of population-property value relations for potential targets assists in placing the superviolent threat in a more familiar perspective. Risk levels associated with the wrongful use of nuclear weapons by individuals who otherwise have legitimate access authority or with the probability of purely accidental detonation establish the goal toward which control of illicit weapon capabilities should be directed.

Evaluation of Controls

While the concept that control decisions must take into account both benefit and risk is an indisputable one, it is impossible to objectively evaluate the adequacy of particular control and response systems. The technological pressures that make such threats possible are broad and irresistible. The confidence levels associated with capabilities for controlling superviolent incidents are necessarily low because of the extremely low a priori probability of the phenomenon, the variety of forms it can take, and the fact that most of its intelligence indicators show high ambiguity (low relatedness). Existing control and response facilities extensively overlap those identified as appropriate for the superviolent threat; only a few additional concepts suggest any elements of uniqueness. The inability to quantify notwithstanding, those near-term actions that appear to be warranted by the threat are summarized.

RECOMMENDATIONS

1. As a result of this study, we recommend that the phenomenon of superviolence be recognized as a national-level problem.

2. In consonance with this recognition, legislation should be enacted or executive action taken to assign responsibility for the management of superviolent incidents to a Federal agency. The duties of the designated agency should include the planning required for coordinated use of government capabilities for investigating superviolent incidents and mobilizing response resources; its primary function should be the verification of claims of superviolent capability associated with coercive threats.

3. Certain control measures are particularly advocated for consideration by the designated agency. Among these are:

   a. coordination and training of the civil intelligence and law enforcement community to increase its awareness of the problem of superviolence, especially its behavioral aspects, for more effective surveillance and informant handling; and

   b. the employment of scientifically qualified, underground agents whose apparent readiness to be recruited by a superviolent threat group would disclose that group's existence.

4. Two supporting studies are advocated. One comprises an interdisciplinary investigation of the behavioral dynamics of elite, conspiratorial, violence-prone groups and the acquisition of data bearing on the statistical incidence of psychotype factors found in such groups; its objective would be the development of valid, threat personality profiles.

The second constitutes a study of the feasibility of recognizing unusual or suspicious acquisitions of particular items in unregulated commerce which are likely to be sought in the fabrication of superviolent weapons.

5. While not a recommendation, we record our advocacy of the continued extension and improvement of the nuclear safeguards program as the best-justified control of SNM acquisition attempts for illicit nuclear weapon fabrication, in addition to its other beneficial functions.

CHAPTER 2
POLITICAL AND SOCIOLOGICAL ASPECTS

An attempt to change the power relationships found in the US polity is one possible reason for the use of a mass destruction weapon (MDW); others are financial gain and as a result of severe mental illness. This chapter examines the politically motivated threat of MDW use in the context of the past decade of civil violence in the United States and the broader background of political dissidence, insurgency, and revolution in general.

Knowledge of past political violence is of questionable applicability in studying superviolence because it is an extraordinary act, not a projection or expansion of conventional forms of violence. Mass destruction weapon use in the political context is an unprecedented and unique act involving values, skills, and risks never before encountered in traditional forms of politically motivated activity. Simple extrapolation from past experience to encompass the MDW threat may be misleading. Nevertheless, examination of the causes and motives which have impelled conventional political violence in the past can help in analyzing the nature of the threat, and knowledge of earlier participants can assist in estimating the intent and capability of dissident groups as potential agents of superviolence.

Because the most fundamental basis for political behavior lies in the nature and structure of society itself, we begin our investigation of politically motivated superviolence by surveying some underlying, sociological factors.

SOCIOLOGICAL BACKGROUND

There are sociological, economic and political conditions in the US that adversely affect a significant fraction of the population. Little is known, however, of the relationships between the actual and perceived environment, the extent to which adverse perceptions correlate with particular forms of anti-social behavior, and the full significance of current patterns of belief. No sociological models derive from a context encompassing the subversive use of modern weapons of mass destruction; on the other hand, there is no evidence to support the postulate that an extremist group would never use such devices to achieve its goals.

Social Groups and Interactions

A general sociological model recognizes the domains of environment, social groups, and resources; and the interactions of information flow and action. Each social group perceives the environment differently, determined by the experiences and coping characteristic of its members. The resultant perceptions serve as motivating inputs to individuals and groups, shaping their intents through characteristic decision processes. Planning and action by social groups are then accomplished within the constraints of available resources. These resources are either in the information domain, used to modify the group's image of the environment, or in the material resources domain, used for manipulation of the environment and for communication with other groups.

Elements of the US mass opinion majority have been described (Campbell et al., 1970 pp.56-84). Excluding the very poor (who are essentially without resources) and the very well-off (who can exercise independent power), he identifies the remainder as the forgotten man, the silent majority. This group comprises blue-collar and lower echelon white-collar urban and suburban residents in the median annual income class with median educational achievement (high school or less). This group is characterized by resentment, envy, disappointment and uncertainty: resentment from perception of loss of status and power to less well-off men (e.g., black Americans), envy that "power-grabbing" out-groups are climbing the social ladder, disappointment that the government has "gone over" to support the power-grabbers and have it in for the little guy, and uncertainty as to where the government is heading and the possibility that it all may come crashing down.

In sharp contrast to the large portion of US society is the Movement, the counter-culture. It is an alternate society in the United States, and has become a significant social force within the last decade. It is important to consider because:

1. It is a growing aggregation of primarily young people attuned to new value systems and new modes of philosophic thought addressing a wide range of public and personal issues;

2. It will probably stimulate reactionary elements in the US into more overt action to preserve the older value systems; and,

3. Similarly, it will probably induce efforts by the establishment elite to counteract the rising Movement and its political manifestation, the New Left.

Alternate social groups have always existed in the US since there has always been the need to provide a focus for various forms of alienation or rebellion from the social norm. The current movement, however, appeals to more widespread needs because of its diversity, and may be the beginning of an emerging counter-nation diffused throughout the US.

As seen by Neuhaus (1970), "the Movement is the cluster of persons, organizations, world views and activities located on what is conventionally called the Left and acting in radical judgment upon the prevailing patterns, political, economic, social, and moral, of American life." Its essentially unifying rationale is a sharp rejection of US social, political, and economic institutions and an emphasis on highly personal, human interactions.

It is a thesis here that the features now visible express a shift in basic thinking that has made significant entree throughout the US. It is certainly consistent with the general description of a movement as pluralistic behavior functioning in an organized mass effort directed toward change of established folkways and institutions, or more specifically a revitalization movement, a deliberate, organized, concious effort by the members of a society to construct a more satisfying culture oriented to a more ideal future (Oppenheimer, 1969).

Social movements begin with informality, spontaneity, and face-to-face relations, and progress toward more formal, structured, and bureaucratic relations. A significant disruption, strain, or dysfunction of the usual social order is needed before people engage in a social movement. This disruption can emerge in several ways. In the anthropological sense, it occurs by the introduction of new technology to a receiving culture by a donor culture. In the sociological sense, it can be stimulated by deviant individuals. In the historical sense, the development of successive stages of society can be such that relief is sought from the technological and economic conditions of society.

The distinctive dogma of the Movement is "evil is inherent in, and not accidental to, the American way." The offense is by habit and not by exception; the system itself must be changed. Neuhaus (1970) sees the Movement as a classical pre-revolutionary situation in America. It is interesting to speculate whether the Movement and the New Left may eventually become analogous to other "scapegoats" in US society. Szasz (1970), for example, traces the analogy between the mentally ill and early witch hunts. He cites a sociological study to the effect that people do not recognize "mental illness" as a behavioral condition but infer it instead from the association of the subject with the stigmatizing official. Here official attempts to stigmatize the Movement will be aided by its high visibility and the stigma already attached by many.

There are, however, few identifiable entities of the counter-nation that can be openly attacked by the US without it representing itself as obviously repressive. It will not now eliminate the counter-media (if it did, the underground press could then truly be fulfilling the implication of its descriptive phrase). It will not even eliminate the drug culture. In fact, partial, legal assimilation of marijuana use is now viewed by liberals as a viable possibility.

The role of the campus in the growth of the Movement is an important one. Students in general are quite diverse in perceptions, but the radical student and the Movement concur in their opposition to US institutions. Indeed the radical college student has been the dominant life source of the Movement.

> The emergence of the student movement in the 1960s signifies a fundamental social change. The convergence of certain social structural and cultural trends has produced a new class, the intelligentsia. Despite the apparent material security of many in this class, its trajectory is toward revolutionary opposition to capitalism (Flacks, 1971).

The radical student is linked to a youth culture produced "by the combination of two trends—a shift in the demographic constitution of modern societies and a shift in the demands of the labor market. Society has unclear notions about the proper purposes, the rights and obligations, and even the institutional forms of the youth culture." Contemporary youth culture is a spontaneous creation, an attempt to provide the cultural definitions that the larger society has failed to come up with. The youth culture also has values and forms of concious-ness located at the point of conflict between the ethos of modern childhood and the ethos of bureaucracy. This conflict of personalistic and impersonalistic values and conciousness leads to a feeling of alienation under circumstances that previous generations accepted as a pragmatic necessity. Finally, the youth culture is both communalistic and personalistic, a tension which enables individuals to find themselves. Youth culture as a whole represents a permanent institutionalization of "identity crisis" (Berger, 1970).

Unchecked growth has effected a profound change of the nature of human existence and the character of man. In a sense, the most severely alienated students have adequately adjusted to a society that is about to exist, and yet are miserable and ineffective. Other sources of unrest, considered legitimate, are the student effort in opposition to the war in Vietnam, the deterioration of life and the environment, and the status of civil rights. These are frustrated, however, by feelings of political hopelessness (mass society cannot be changed) and a "diagnosed" mass paranoia in the US, about the need for US vs. Soviet competition in ideological, political, military, and educational institutions. Lesser sources of unrest are permissive rearing, a feeling of non-responsibility for their own behavior, affluence, family conflicts, and education in a context dominated by the message of science (rationality and perfection) (Halleck, 1970).

The implications of the relative calm in the student movement at present is unclear. The Movement and the New Left having gained strength also gained weakness. Flacks (1971) explains the paradox:

> For once one came to a revolutionary frame of mind, one was confronted with a certain set of grim facts:

1. There exists no precedent in advanced industrial society for revolution.

2. One cannot make revolutions against the majority of a people. (The insurgency of students and intelligentsia, the blacks and the poor is largely isolated from the majority of the people.)

3. The insurgent movement, geared to resisting and disrupting racism, imperialism and militarism, offered little clarity for organizing a new social order.

Casual observers of the political statements of radicals have often confused the impact of shock phrases (a gambol in the domain of free speech) with hard-hitting, deadly serious, revolutionary doctrine. An outstanding example of the latter is offered by Neuhaus (1970):

> Earnest revolutionaries must begin to make the kind of distasteful judgements, now left to the Pentagon. What for instance, is an "acceptable" number of casualties in a revolutionary struggle? Deaths, blindings, cripplings, children orphaned, and families homeless—this is the stuff of revolutionary strategy.
>
> So we compare the high price of revolution with the high price of not having a revolution.
>
> The revolutionary must be prepared, for the sake of the revolution, to exploit friendships, betray personal trust, to tell lies. Especially in guerrilla warfare, the revolutionary should be ready to utilize torture, the most degrading and dehumanizing violation of humanity. In short, the revolutionary is prepared to act in specifics against all his most humane and compassionate instincts in order to achieve the higher good of the revolutionary purpose. The more the revolutionary is repulsed by the harsh necessities of revolution, the more essential it becomes for him to think through the humanizing rationale, the justification, of the revolution.
>
> The revolution must credibly assert that it cares more, not less, about human life than does the regime it opposes.

Perceived Deprivations, Alienation, and Anomie

Perceptions of the environment by the people as a stimulus for discontent or anger can give rise to aggression for social change. This is the concept of relative deprivation. It is a state of mind aware of a discrepancy between people's expectations of the goods and conditions of life to which they are justifiably entitled on the one hand, and on the other, their value capabilities—the degree to which they think they can attain those goods and conditions (Gurr, 1970).

Four types of temporal changes in capability relative to expectations are particularly severe. These are: the two cases of aspirations rising faster than either a non- or slow-rising national capability can fulfill them and the two cases of stable aspirations being frustrated by a lower, stable, or a decreasing national capability.

The significance of perceptions rather than objective measures of a material environment is exemplified by the personal experiences of mankind. These range from the philosophy of Paul in the early Christian church: "whatever state I am in, therewith to be content," to our awareness that material aggrandizement of men (and nations) does not automatically produce contentment nor does a state of absolute want produce violence.

> The spirit of rebellion finds few means of expression in societies where inequalities are very great (the Hindu caste system) or, again, in those where there is absolute equality (certain primitive societies). The spirit of rebellion can exist only in a society where a theoretical equality conceals great factual inequalities (Camus, 1956).

Conflict among social classes occurs when they are not in sufficiently intimate and continuous interaction with one another to permit the gradual development of a system of common rules and understandings. As a result, actions and expectations of people often work at cross purposes, social disintegration sets in, and the body of common rules regulating the interaction within the social system breaks down, a condition called "anomie" (Durkheim, 1964).

Fundamental to this disruption are the human wants: in principle, infinitely expandable for there is no "natural" limit to what men might crave, and therefore, to what might provide them a sense of satisfaction and fulfillment. The limit to men's desires are instead set by social rules that define, for each class of men, what it is legitimately entitled to. These rules, incorporated into the individual conscience, regulate and discipline men's aspirations, and thereby create the possibility of a sense of satisfaction and fulfillment.

Rebellion characterizes one who regards the institutional system as a barrier to the satisfaction of legitimized goals. If it goes on to organized political action, the allegiance of persons such as the radical or revolutionary must be withdrawn from the existing social structure and transferred to new groups with new ideologies. The rebel challenges the legitimacy of social norms, and appeals to a "higher morality" in seeking to change them (Durkheim, 1964).

Can the incorporation of mass destruction weapons into the suicidal bent of an anomic group constitute a credible sociological context? "The man who kills (only) himself never makes use, in order to dominate others, of the enormous power and freedom of action which his decision to die has given him" (Camus, 1956).

Powell (1970) translates anomie into self-destruction in the following way: Man derives his identity from his action. His action encompasses a motivation and purpose or a pursuit of a goal. Without some aim beyond the moment, life becomes intolerable and meaningless. All of man's acting, proving and exerting himself implies that his efforts are not in vain. If he does not advance toward his goal or if his goal is infinite, weariness, despair (the logical end of an endless pursuit), and suicide follow. Those that condemn our institutions and seek complete change are pursuing goals, it seems, which must approximate something unattainable to them. Yet, to pursue a goal which is unattainable is to condemn oneself to a state of perpetual unhappiness. Combining this state with the contemporary mental set of volitionally acting in history and validating oneself makes the context of intent of mass threat a viable one.

The subjective side of anomie finds that a person, confronted with an environment he perceives as chaotic, panics. The strange or unstructured situation sets off a reaction of fear, anger or anxiety. Anomie promotes the militarization of society. Violence (deterrence) is increasingly used as an instrument of social control and it further undermines the concensus which is the real base of every social order. Sorokin (as cited by Powell, 1970) states, "Internal and external disturbances, revolution and war are but logical and factual consequences of the disintegration of the crystallized system of social relationships." His massive statistical work showed that revolution occurred with greatest frequency and intensity in periods of socio-cultural transition. Crime and suicide, as individual manifestations of the collective discord of anomie signify an unconcious repudiation of existing society. The utility of such an indicator as a precursor or measure of a priori states of increasing mass threat is unknown. In the political sphere the repudiation becomes articulated as an organized attack on the institutions of capitalism.

With the spread of anomie, criminal rate and punishment increase. The total amount of crime increases in times of social upheaval because the establishment, threatened by loss of a supporting concensus, resorts to law to maintain its order. Thus increased crime rate is usually the composite of increased criminal action and increased police action.

At question here is whether a person or group displays any difference in degree of intent as a function of his personal view of himself as a criminal or as a representative of a different moral framework.

> Today, especially, violation of the law represents more than social deviance. Much of the criminally defined activity is actually political behavior as actions against the law are becoming ideological in orientation in seeking the restructuring of social and political order (Stenmeyer, 1971).

There appears to be little specific knowledge that can be brought to bear on the feasibility of controls for deterrence of the use of weapons of mass destruction. Zimring (1971) identifies the "empirical study of crime control policies as in the prehistory stage with behavioral models more suggestive than definitive."

> The theory of simple deterrence is that deterrence threats can reduce crime by causing a change of heart, induced by the unpleasantness of the specific consequences threatened. This crime and this penalty are weighed—but the individual's sense of right and wrong are not altered. Beyond that the search goes on for the role of deterrence as a habit-building mechanism, a rationale for obedience and a mechanism for building respect for law.

Whether domestic political violence will escalate to the use of weapons of mass destruction will depend primarily, we believe, on the intent of some man to seek to attain this capability. This intent may be crystallized if other alternatives (ranging from effective political power to escalated conventional weapons) are insufficient to satisfy the need to change US institutional forms to a compromise set more satisfying to all.

CAUSES OF POLITICAL VIOLENCE

This section reviews various theories about the causes of political violence in order to assess the likelihood of future incidents in which the MDW threat could appear. There are many theories, some emphasizing political variables; others, sociological factors; some are abstract, others focus on more concrete variables. This survey examines a selected few of these theories and notes only some of their variables. Regardless of the theory used to explain past political violence in the United States, the conditions they describe have not been permanently altered, and hence the possibility for future political violence exists.

One theory derives from a systems approach to the concepts of political science (Easton, 1965). It views the political system, like a factory or any other system, in terms of inputs, outputs, and a mechanism for converting the former into the latter. Failure of the system occurs because of weakness at any of those points. Critics of our political system point to weaknesses at the demand input stage. They cite the inadequacy of the electoral process to communicate policy demands or to control the elected representatives. These representatives are neither a cross-section of the population nor are they free of the economic elite who exercise great influence over them through campaign contributions, the mass media, and organized interest groups. Even if demand inputs were to enter the system, the machinery to convert them into policies is often immune to all but the strongest public pressures; Congressional committees are independent duchies, and the independence of bureaucracies can withstand the demands of even the strongest Chief Executive. The result is that the political demands of the mass of the population are ignored; the have-nots in our society continue in that status, and in fact, the gap between the rich and the poor is increasing. Failure to heed demands in the political system serves to reduce its support; the system loses some of its legitimacy. An increasing number of people are not only critical of the régime (the particular people who are governing) but of the system as well. Many critics feel that relying on the constitutional opportunity of changing the decision-makers—a classic definition of democracy—is insufficient under the circumstances.

They urge more fundamental changes, and some no longer look to democratic, non-violent means to achieve them. One explanation, therefore, of the political violence of the past decade in America, are these systemic weaknesses or failures in the political system.

What of the future? Some critics feel that these fundamental weaknesses have not been corrected; that the criticisms made in 1962 are as applicable in 1972. To them, the need for revolution is as necessary as ever. But others are more optimistic. They point to a wide range of reforms in policies (suggesting that demands are being converted to actions), structures, and processes. Some observers believe that the elite has recognized the need for change. Others suggest that the institutional reforms recently enacted will lead to further change, defuze the appeal of revolutionaries, and may have already reduced the level of political violence from this cause. This analysis suggests that the escalation of political violence beyond the level of spontaneously reacting to localized frustrations (turmoil) is unlikely, and under those circumstances, the potential for superviolence is much decreased.

Other theoretical explanations of political violence provide similarly mixed views, depending upon the analyst's interpretation of recent and current events and his optimism concerning the future. For instance, those who view political violence as stemming from social disequilibrium (Johnson, 1966) can be optimistic and point to current reforms as evidence of elite recognition of the disequilibrium. On this basis, they predict a re-synchronization of values and environment and the end of the revolutionary threat. They also provide evidence of changes in the American value structure, suggesting that force also is moving toward re-synchronization. But the symptoms of dis-synchronization remain: increasing crime rate, suicide, deviant behavior, personal tension, polarization.

The difficulty of predicting the future even with a theory capable of explaining the past is exemplified by the problems of measuring and predicting the necessary variables. Gurr indicates that civil strife is a function of three sets of variables: "Deprivation-induced discontent," "people's attitudes about the legitimacy of their political system and the justifiability of civil strife," and "structural characteristics... that facilitate or minimize violent responses to discontent" (Gurr, 1970). Deprivation is defined as a gap between "people's expectations about the goods and conditions of life to which they are justifiably entitled... and...the degree to which they think they can attain those goods and conditions." Deprivation may be a persistent condition or a short-term situation reflecting a decline in economic conditions or governmental policies. Perceptions of what people expect and of their ability to attain them are a function of many other factors difficult to predict. Similarly, the perceived legitimacy of a system and the justifiability of violence can be altered as a result of action by the regime as well as by attitude changes stemming from other sources. Although structural characteristics (such as the strength of political and economic institutions) are slow to change and therefore easier to measure and project, other inhibiting or facilitating factors (such as the coercive capacity of a government's armed forces or the existence of extremist or revolutionary groups) can change suddenly, making prediction of their future state virtually impossible.

From this brief examination of alternate, complementary theories of political violence, we conclude that the factors responsible for political violence in the past cannot be said to have vanished nor can it be said that they will be absent in the future. Analysts of the 1950s stressed concensus and the strengths of our society—and few of them would have predicted the havoc of the 1960s. Today we are attuned to cleavages and problems in society, and may be equally prone to project the present (or recent past) into the future. The optimistic analyst sees it one way; the pessimist, another. The inability to adequately and accurately quantify and project the variables precludes resolving this dilemma. We cannot say the probability of political violence in America in the future is zero; the United States has persisting deprivation and a history of turmoil which facilitates strife. But neither can we say that the probability of serious civil strife is high; our political system enjoys a high level of legitimacy, our political and economic institutions are strong, the coercive potential of the government is great, and facilitative conditions for serious strife (such as large or strong extremist political organizations, or foreign material support) are low.

FORMS OF POLITICAL VIOLENCE

Extrapolation of the forms and techniques of political violence to encompass the use of mass destruction weapons is a purely subjective, hence somewhat questionable, exercise if done in the absence of reasonably valid theories regarding the dynamics and effects of political violence. Yet theory-building in this area is in a very primitive state; even the pre-theoretical stages of delimitation of subject matter, classification, analysis, and problem formation do not presently converge toward any broadly accepted point of view.

> The variety of classification schemes now in use not only increases misunderstanding but is a positive barrier to the development of knowledge (Eckstein, 1964).

There are some concepts of classification which embody the general thesis that forms of political violence can be ranked in a manner suggestive of increasing intensity or seriousness, from legitimate methods of protest to open, intra-state warfare, either conventional or irregular. One scheme, applicable to the development of insurgencies, recognizes a legal-political phase which is followed in succession by insurgent and conventional warfare phases; flexible interpretation accounts for protracted periods of indecisive movement along the boundary between the legal-political and insurgent phases during which repeated violent outbreaks occur (Scott, 1970 p.7ff).

Another scheme classifies civil strife in three stages emphasizing differences in degree of organization and extent of popular support (Gurr, 1970 p.574):

> Turmoil. Relatively spontaneous, unorganized strife with substantial popular participation, including political demonstrations and strikes, riots, political and ethnic clashes, and local rebellions.
>
> Conspiracy. Highly organized strife with limited participation, including organized political assassinations, small-scale terrorism, small-scale guerrilla wars, coups d'etat, mutinies, and anti-government plots.
>
> Internal War. Highly organized strife with wide-spread, popular participation, accompanied by extensive violence and including large-scale terrorism and guerrilla wars; civil wars; "private" wars among ethnic, political and religious groups; and large-scale revolts.

Mass destruction weapons may play a role in each of the three stages. What emerges from such consideration is the potent psychological impact of the MDW in the political context. In terms of direct physical damage and killing, one or even a few nuclear weapons, for example, will not destroy the social, political, or economic structure of the United States; the role of such a weapon is most closely related to the techniques of terrorism as a form of political violence. Although the classical examples of terror as a political weapon are generally foreign to the United States' experience, this activity has been extensively examined, and therefore, will contribute to the analysis of motive and style for the use of mass destruction weapons.

Conspiratorial Violence

The fabrication and use of mass destruction weapons involve organization and planning. They are therefore not likely to be found in turmoil context, marked by spontaniety and a lack of organization. This suggests that much of the literature on riots is inapplicable to analysis of the MDW threat, even though the conditions that give rise to riots and turmoil may also produce other forms of political violence. The more likely contexts for MDW use, then, are conspiracy and internal war. But the latter suggests an additional problem. Popular support is an essential ingredient of internal war, but the use of mass destruction weapons is so physically and psychologically devastating that it cannot serve to gain popular support. Such use would be likely to alienate all but the most dedicated adherents (especially since the lives of innocent people would be lost). In addition, internal war in the United States is unlikely in the foreseeable future because of the widespread governmental and institutional legitimacy found here. The most likely context, therefore, is that of conspiracy.

Analysis of turmoil, conspiracy, and internal war events in the world of 1961-1965 suggests some interesting insights (Gurr, 1970). For instance, conspiracy was more likely to involve the middle class than the working class, in contrast to turmoil which was most likely to involve the working class. (This may be relevant to an analysis of the MDW threat as it is the middle class that is more likely to have the education needed for such involvement.) The data also indicate that many conspiracies involve participation by "regime classes"— e.g., the military, or civil servants. Although economically developed nations and those with a polyarchic political structure (i.e., basically similar to the Western democratic political structure and process) are far less likely to experience regime class conspiracy, it has been known to occur. This, too, may be relevant as our analysis suggests that the role of an "inside man" or defector may be crucial in the acquisition of special nuclear material or a nuclear weapon. Another difference between turmoil and conspiracy is that the objectives of turmoil are much more limited—e.g., the political motive most frequently attributed to turmoil was opposition to particular governmental policies. The objective was to change or eliminate a policy, while for conspiracy, the objective was to seize power. The limited utility of the MDW threat in attaining either of these objectives is noted later.

Although these relationships may appear relevant to an analysis of superviolence, the world-wide data base used may include many situations inapplicable to the United States' political system. Similarly, the caveat about extrapolation from conventional political violence must be retained—the MDW threat may not be comparable to the conspiratorial events Gurr investigated.

Terrorism

One form of conspiratorial violence, terror, bears a strong relationship to the MDW threat and must be examined further. Whether intended or not, terror is a likely consequence of superviolence. A further examination of terror, therefore, provides several valuable insights into the MDW threat and its potential effectiveness.

Thornton (1964) has defined terror as "a symbolic act designed to influence political behavior by extranormal means, entailing the use or threat of violence." He treats terror, in the context of internal war, "as a tool to be used rationally." A distinction is made between "agitational terror...the activity of insurgents who wish to disrupt the existing order and achieve power" and "enforcement terror...the activity of the incumbents who wish to suppress a challenge to their authority." This distinction is to be preferred to that of terrorism vs. counter-terrorism since a period of terror may be initiated by either the incumbents or the insurgents.

In analyzing the doctrine of terror, emphasis is placed on the symbolic character of the act or threat; it is this which distinguishes terror from personal attacks (assassination), or attacks on property (sabotage). The terrorist act is characterized by a dual target: the immediate victim and the group that identifies with him; the real target is the latter, the "resonant mass." To groups opposed to the victim, the terrorist act may provoke enthusiasm for their cause; to groups of which the victim was a member, responses range from fright through anxiety to despair. By extension, these outcomes contribute to morale-building within and publicity for the terrorist organization and its policies on the one hand, and to disorientation on the part of the target group and consequent weakening of its base of support on the other. Ancillary objectives of terror are, of course, the elimination of opposing forces (the immediate victim) and the provocation of counter-measures for suppression. If the terrorists are effective, this "cure" may injure the society so severely as to aid the insurgent cause.

The complex social mechanisms involved in the use of terror lead to the widely accepted concept that effective terrorism must be highly discriminate. Ideally, agitational terror is directed against the incumbent elite in ways which demonstrate their inability to protect either themselves or those who support them and, at the same time, which provoke the repressive measures that further weaken their cause.*

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*But it should not be presupposed that this ideal outcome is necessarily achieved, as demonstrated in Algeria in 1962, where "both terrorist and counter-terrorist put political and philosophical goals aside in order that the blind killing could continue" (Simpson, 1970).

The impact of the MDW vis a vis an inability of the US to protect its people is unlikely to be the same as in an underdeveloped nation. In the latter, government protection may be one of the few outputs or services it provides. Therefore, to demonstrate that it cannot even perform that minimal function is to present a powerful argument to desert it. But in the United States the level of government output is quite high and, though it may not be distributed ideally, even the lowest classes receive the benefits of government actions. Inadequate physical protection will not signal that the government can do nothing. Support for the US government, therefore, even if reduced by terrorism, would still remain high compared to the situation found in less developed countries.

A harsh campaign of repressive control measures by the government not only alienates the people but provides publicity for the terrorists by demonstrating that they are an active, viable group. This added attrativeness may even serve to recruit new members. When the cost of suppressing the terror is greater than the objective in dispute, rulers have been known to yield. But essential ingredients of such situations are a capability for repeated terrorist acts and an awareness on the part of the government of the costs likely to be involved. Little fear on the part of the resonant mass can be generated if it is clear that the terrorist act is unique and non-reproducible.

Though terror can be useful in gaining enforcement of edicts by the terrorist, it is unlikely to bring him support or legitimacy unless the victim is hated by the people. Assassination campaigns usually begin against the worst government officials, but when the movement has gained strength it focuses on the effective governmental administrators (the best). Terror, therefore, may be used initially to build support, or it may simply aim at destroying important government resources and neutralizing the behavior of the target population.

At its best, terror has proven to be both an effective and an efficient psychological weapon; under pre-revolutionary conditions, no other technique is as immediately available to the insurgent or offers as much of a return for a relatively small investment as does agitational terror, selectively applied. But the appropriateness of the conditions is important; "the competent practitioners of terrorism usually know how their actions will affect their enemies and what reactions they can expect from those not directly involved" (Simpson, 1970).

There are, however, severe limitations to a terror campaign. Most authorities on terror stress that it is a tactic of the weak, and that it usually is not utilized unless the organization has such limited resources or opportunities that it cannot do much else. This image of traditional forms of terror may reduce their effectiveness, but the substantial resources and technical sophistication needed suggest that the image of weakness may be overcome by terrorist superviolence.

Even the analysts who suggest that terror can be an effective tactic for coercion agree that success requires an understanding on the part of the public of what is intended, that appropriate penalties are involved, and that innocents are spared (Leites and Wolf, 1970, p.156). But mass destruction weapons violate all these criteria; they are bound to kill or injure innocent people, their penalties far exceed the accepted norms, and their message must be lost in the revulsion engendered in a society so attacked. A terror campaign, using whatever weapons, which runs counter to effective practice will more probably increase the people's will to resist than serve the terrorist's ends.

Another difficulty involved in applying terrorist doctrine to the threat posed by mass destruction weapons stems from the fact that much of the political and social science analysis of terror is set in the context of revolutionary situations. What becomes a distinct threat when a significant fraction of the polity supports an insurgent or revolutionary movement, or at least can be intimidated to the point where its active support of the incumbent government ceases, is extremely unlikely under the more stable conditions of a majority belief in the legitimacy of the incumbent government. It is this latter situation which pertains in the United States today. Terror, like other possible motives for using mass destruction weapons, must be considered on a contingency basis.

MOTIVES AND OBJECTIVES

To assess the nature and likelihood of the politically motivated superviolent threat, it is first necessary to consider questions of specific motives and objectives. What would incite individuals to form a threat group? What actions might they take? What might they hope to accomplish that would warrant the costs and risks involved in attaining a mass destruction weapon capability? Could these same goals be accomplished by a less costly or less risky method?

General

The process of creating a mass destruction weapon capability is a deliberate, purposeful act—an act of commission. As such, the intentions and intended consequences of the agent, the perpetrator of the act, are vitally important to its understanding. But more than an outsider's objective analysis is required; the agent himself will face the same questions. Since the action is most likely to involve more than one person, we can speculate that attempts to recruit co-conspirators will raise the question of motivation and the objectives to be gained from the operation. Even if such group scrutiny does not surface initially, the calculating process of fabrication inevitably must expose these questions, particularly in the event that setbacks occur.

Our investigation shows that while there are possible motivations for the MDW threat, many of them can be satisfied by conventional methods. Furthermore, there is a class of conceivable objectives which, within the current and likely future conditions in the United States, the MDW threat could not hope to accomplish. This observation suggests one of the dilemmas in studying the motives for an unprecedented act. If we are concerned with factors which will drive a potential agent to be involved in the MDW threat, we must examine his perceptions and evaluations of the objective and not those of the analyst. Even if the external observer asserts that a goal cannot be accomplished, it does not mean the potential agent will make the same evaluation. Specifically, it is our conclusion that the threat or use of superviolence cannot overthrow the government of the United States. There is no single target that is essential to the continuing functioning of the governmental system. But we cannot ignore the possibility that potential agents may believe otherwise.

In addition, there is the problem of inferring motive. Even when overtly communicated, motivation is frequently questioned. This is even more a problem since there has been no politically motivated, superviolent behavior from which motives have been inferred or for which they have been offered. The only method available is to examine the motivations for and objectives of previous political violence and assume that these are applicable to superviolence. But the caveat remains; the MDW may not represent a simple extension of conventional political violence. It involves extraordinary weapons, and extrapolation from conventional concepts may be misleading.

Even if apparent motivations are communicated, there remains the problem of determining whether they are actual driving forces or post facto rationalizations. Statements about the use of mass destruction weapons are rare; when they have occurred, it is not clear they are anything more than "rhetoric" or symbolic statements about destruction of the system. If a Black Panther leader proclaims that they will take a nuclear weapon from a SAC base, it is more likely to be a symbolic utterance or merely "talk" rather than an indication of intent.

The literature of conventional political violence offers wide range of political goals and motivations for superviolent threats. There are the personal and psychological desires of the agent such as the idea (derived from Fanon) of proving one's manhood through violence. There may be motivations to attain group goals (demonstrating or increasing power or cohesion, attracting new membership), or those which focus on the broader society or the state (gaining concessions from the government, weakening it through economic or political damage or as a result of repressive counter-measures) so that a new regime or political system can emerge. Some objectives can be accomplished only if the weapon is used, while others depend more on the ability to communicate a credible threat.

Motive Clusters

The foregoing examples suggest the problem encountered in attempting to classify the motives appearing in the literature of political violence. Based on what can only be described as a subjective factor analysis, we offer the following six "motive clusters" encompassing the key ideas identified by students and practitioners of political violence. Very few politically motivated violent acts can be characterized as having a single motive; the <u>post facto</u> analysis of most such events represents a melange of views as to its cause. Nontheless, these six constitute the basis of the discussion to follow. The motives are stated without reference to particular issues; their applicability to any number of issues is immediately apparent.

1. Rational: seize power, block unwanted actions, destroy facilities supporting opposition strength, develop a force option for future use.
2. Retributive: punish, retaliate, vent sense of outrage.
3. Manipulative: provoke repression and consequent radicalization, accelerate social or political change, embarrass, disclose vulnerabilities.
4. Self-assertive: demonstrate capability and commitment, obtain attention and publicity, declare legitimacy, "propaganda of the act."
5. Irrational: pathological fanaticism, degenerate anarchism, violence without calculation, "blow up the system."
6. Coercive: extortion oriented toward negotiation to achieve political objectives, intimidation, insult.

The first five motive clusters account for the commonly proposed purposes that have underlain actual political violence in the past; one or more of them can be associated with a great variety of violent acts. The sixth, the coercive or extortive motive, is rarely found in pure form in the political context; it is far more common as a profit-motivated criminal activity. The clusters are arranged in the order shown to illustrate this point and to emphasize a distinction of critical importance to the problem of superviolence: the first five sets of motives may account for direct attack with mass destruction weapons; the last—and it alone—accounts for threats of superviolence. This distinction is investigated further in Chapter 9.

To what extent can these sets of motives account for superviolence in the political context? In what follows, each is interpreted from the viewpoint of the political dissident who might seek a nuclear, chemical or biological weapon to aid in achieving a political objective. The reader must determine whether the arguments presented are credible or not.

Rational. This category includes motives which demonstrate prudence or judiciousness as evidenced by an intrinsically good match between the characteristics of a policy-related target which is to be attacked and the capability of the weapon chosen. For example, a limited political objective for the MDW may be destruction of the ability of the government to carry out a particular act. But it is unlikely that any single target is essential to the execution of a policy, such that its elimination via even a nuclear explosion would unalterably prevent the implementation of that policy. As important as the Pentagon may be to the military function, its destruction would not mark the final conclusion of any particular policy. Similarly, although damage to the Rocky Flats plutonium facility may be a severe blow to our nuclear weapon capability, it would not bring an end to the nuclear arms race. Such analysis suggests there is no target that is irreplaceable and essential to implementation of a particular policy. Nevertheless, there are targets which are intimately associated with particular policies whose destruction would require a nuclear weapon. Such use would be considered an example of a rationally motivated attack.

Retributive. This is a motive which does not focus on gaining power. Rather than being future-oriented, a group may be motivated purely by their past experiences. A group which feels it has suffered in the past may be driven by a desire to punish those involved or to vent a sense of outrage. A desire for retribution may be related to preventing similar acts in the future, but it may also be driven by a desire for retaliation. The abuse that generates the desire for retribution may have been one which the group as such experienced (e.g., the experiences of the Black Panthers) or one that all members of the group suffered in a broader identification (e.g., all Black Panthers have shared the deprivations and frustrations of blacks in America). The desire for retribution may also stem from personal injustices perceived by a leader who is then able to gain adherents because of his charismatic qualities. For example, a person like Charles Manson could be driven by a desire for personal revenge, and have the personality or charisma necessary to gain a following.

The "inside man" in the nuclear industry is a key factor in a successful INW plot. His motive may not belong to the broader drives described earlier, but may stem from a perceived personal injustice which he wishes to revenge.

Retributive motives may be a significant source for the drive needed to initiate and maintain the quest for the MDW capability. But we are again faced with the question of whether the potential agent could satisfy this retributive desire through a lesser means. Though a conventional act of violence may be more "cost-effective" (especially given the probability and risk of INW failure), the group may still choose the INW alternative.

Manipulative. All of those motives which attempt to achieve objectives other than the direct results of an attack as a consequence of actually making the attack are termed manipulative. In this sense the MDW threat could, for example, aid the cause of a revolutionary group. This cause may be the overthrow of the government in favor of either the threatening group or no group (anarchy), or it may be the milder goal of merely changing the policies, personnel, or structure of the government.

How can a revolutionary group benefit from the MDW? To answer that we must ask: how can a revolution become successful? One way is for the government to lose its ability to fight against the revolutionary forces; in other words, to be unable to defend itself militarily. Another way is for the rulers to capitulate because they no longer have the support of the population. Lack of support would make it very difficult for the incumbents to continue in power because it increases the costs of maintaining control; much greater force is required to gain compliance than would be needed when the government is seen as legitimate and worthy of the support of the population. If the rulers feel that continued rule is not worth the increased costs, they will yield to the revolution.

Can domestic superviolence aid the accomplishment of any of these revolutionary objectives? The military might of the US government cannot be eliminated by a single nuclear weapon or a small number of nuclear weapons or by the superviolent scale of CB weapon use. Therefore, a revolutionary group cannot defeat the US government in a military confrontation, even with mass destruction weapons.

> Too often rebels have believed the seizure of power was merely a technical problem—that they had only to seize the "levers" of government in order to achieve their objectives. Nothing could be further from the truth. The resort to violence must be in response to real needs of politically organized peoples if it is to be accepted by them as humane, logical, and tolerable behavior. (Johnson, 1966 p.165)

In this case, the use of MDWs can be seen as counter-productive. The death and destruction that could stem from such use is so horrifying that it would be difficult (if not impossible) to justify its use within a domestic context. The revolutionary group could expect opposition rather than support from the population.

That leaves only the possibility that MDWs could be used to convince the authorities that the cost of continuing the struggle is not worth it. This is the strategy behind the continued wave of bombings and sniping by the IRA in Northern Ireland, and the persistent attacks of the Viet Cong and North Vietnamese in Vietnam. But the essence of this strategy is its prospect of continuing unabated over a long period of time. The INW threat, however, is most likely to involve one or, at most, a very few such weapons; it is extremely unlikely that a group would have the resources or the stamina to produce and stockpile a nuclear arsenal. The government could conclude that although the damage would be costly, the threat has probably vanished and there will be no further costs incurred. For a nuclear blast to constitute a "death blow," there must have been a long and potentially successful revolutionary struggle previously; it is unlikely that such a struggle will develop in the United States within the foreseeable future. While repeated use of a CB capability is more reasonable than repeated use of an INW, the inutility of CB weapons in a revolutionary context minimizes this threat.

We conclude that the benefits to a revolutionary group of MDWs are not great enough for it to undertake the effort to acquire and use.

The classic form of the manipulative motive is that in which the dissident group provokes the authorities to repressive overreaction which, in turn, radicalizes the population in support of the dissidents. We cannot see how this mechanism can be exploited by superviolent weaponry with its malignant, indiscriminate effects. Public response to either the threat or use of superviolence would undoubtedly crystallize massive support for the authorities rather than the attackers. We conclude that the MDW potential in support of manipulative motives is virtually nil.

Self-Assertive. In fulfilling self-assertive motives, the importance of the act derives from its function as a communication device. An examination of previous political violence shows that, at times, acts were undertaken more for altering the perceived image or the internal operation of the group than for changing the political system. A group may develop a campaign of violence, for example, in order to attract new membership; it can argue that it is an active, influential organization.

By the same token, the effort involved in acquiring an INW may serve to increase or to demonstrate the level of cohesion and capability within the group, and make it a more powerful, hence more attractive, organization. These gains may be enough to stimulate conventional political violence with its relatively low costs, but an INW "campaign" for image is very costly; it is unlikely that a group will expend that kind of effort merely to attract new members. Furthermore, the publicity and new attractiveness occur only after the fact; the need for secrecy would prevent the group from advertising its activity. Therefore, its gain of new adherents would be modified by the acceptability of the act. As an example of self-assertive political violence, the Weathermen may very well have increased in number by demonstrating their devotion to action during the so-called "Days of Rage" in Chicago in October 1969, but one of its results was that many allies and potential adherents were repelled by what they viewed as senseless violence.

No doubt the anticipation of a dramatic, superviolent attack on a symbolic target would appear to satisfy an attacker's needs for self-assertion; what better way to "let the world know who we are!" The reality of the process, however, must soon turn that anticipation to a weighing of costs and risks and second thoughts about the consequences of the attack; "there must be a better way to assert oneself." If these considerations do not crowd in on the potential attacker, it can only be because of his violence-oriented individuality, a motive set more closely akin to the irrational then the self-assertive.

Another aspect of self-assertion warrants comment: redemption through violence (Fanon, 1966). The doctrine asserts that only by violence can the oppressed and downtrodden, "the wretched of the earth," achieve manhood and identity. But it is an error to assume that the violence intended by Fanon is the indiscriminate, impersonal superviolence referred to here;

what is advocated is fierce, face-to-face revolutionary action on the part of "third world" peoples in redeeming themselves from colonial exploitation. By no stretch of the imagination do the sophisticated manufacturers of an INW or its CB analogues achieve the emotional experience of which Fanon speaks, nor is it "transferable" by effecting superviolence in the name of the oppressed. In short, motives of self-assertion fail to provide a justification for superviolence.

Irrational. The cluster of motives designated as irrational is a catch-all, encompassing everything from the fanatic blindly dedicated to a cause to the victim of severe mental or emotional pathology. Throughout this range, identification with political positions or issues is a common symptom seized upon by irrational individuals to justify their emotional needs. Hoffer (1951) characterizes "the true believer—the man of fanatical faith who is ready to sacrifice his life for a holy cause—" as the product of frustration, the feeling that one's life is "spoiled or wasted." From this thesis, he analyzes the history of fanatical mass movements, be they religious or political, as deliberately fostering in their adherents a frustrated state of mind amenable to exploitation by the movement's leaders.

The other dimension, severe mental pathology, is addressed in Chapter 3 of this report, and so is barely touched on here. We simply point out that to the extent that irrational motives are not subject to rational explanation (other than attribution to irrationality), they can be invoked for any and all types of superviolence. When a mentally unbalanced individual issues an obviously incredible threat, we shudder at the thought—but double check its incredibility to be sure. If the threat is posed in political terms, we associate the policy with our assessment of its supporter to some extent. We shall see (Chapter 3) that psychiatrists and sociologists are virtually unanimous in their belief that no conceivable level of terror or outrage transcends the psychological capabilities of mentally disturbed individuals; the drive and motivation for superviolence most certainly can (and does) exist. But the real issue is the extent to which such individuals possess or can impel the physical capabilities needed to carry superviolence from wish to fact. Since we cannot state categorically that no such person exists or can exist, it follows that irrational motivation constitutes a basis for superviolence and that it may appear in the guise of political purpose. Much of the latter part of this report (Chapters 6 — 9) is best understood on the grounds that irrational drives must be harnessed to rational actions to produce a superviolent plot.

Coercive. The primary characteristic of coercive superviolence is that the result of weapon use is not the political objective sought. In fact, there may be no intent to use the weapon at all, although this fact must be kept from the authorities if the threatener hopes to be successful with the threat. The objective may be to acquire "payments" for the threat group, thus directly increasing its power, or it may be more altruistic by attempting to gain "payments" to be made directly to a third party with its increase of power coming from the support of the receiving group. Alternately, the demand on the authorities may be to deny resources to others, to improve the threat group's relative position by confiscating the property of others, or to compel some particular desired act.

Coerced "payments" may be money (as in numerous airplane hijackings), other resources (arms, food, medical supplies), the release of specific prisoners or a class of prisoners, or policy concessions of many sorts.

The past successes of coercion-extortion plots using conventional means suggest the coercive motive may be a significant stimulus for the MOW threat. But two evaluative viewpoints are possible. If conventional means (airplane hijacking, kidnapping politicians or other prominent or wealthy individuals) can gain large concessions (the $5 million ransom paid by West Germany for a hijacked airplane) why use a more expensive, dangerous, and risky weapon? The second viewpoint is that still greater payments would be granted because of the greater implied threat, i.e., the demands would be rejected if something less than a mass destruction attack were threatened. But since the demands made cannot be made exhorbitant, the additional "coercive power" may not be proportional to the additional "cost" of implementing the threat.

Another demand limitation is the time needed to deliver the "ransom." The longer it takes, the greater the likelihood that the threat group will be detected or that the coerced population will stiffen its resistence with, possibly, the formation of counter-terror vigilante groups. A long negotiation period may also enable the authorities to develop a propaganda campaign against the threateners, as well as develop and implement defensive counter-measures.

Finally, the demand cannot be a revocable one. A demand for a new law may be granted under duress, but once the weapon is surrendered, the law can be repealed, not funded, or not enforced. Although the government may lose face in revoking an agreement, it is established in Western law and morality that agreements made under duress are not legally (and presumably, therefore, not morally) binding.

This analysis suggests, then, that MDW use to coerce or extort the authorities is a potential motive, but that its severe limitations would not induce a rationally calculating threatener to choose it for a coercive threat. One rationale (discussed further in Chapter 10) coldly evaluates the worth of a life at $300,000. On this basis, a million dollar aircraft hijack demand represents about 1 percent of its hostage value to legitimate society. For a directly proportional hostage-demand relationship, a credible superviolent threat placing 100,000 people at risk could conceivably seek almost a half billion dollars in ransom. It is difficult to accept this as a practical concept. We cannot be sure that the threatener will be rationally calculating (although it is a tenable assumption that anyone undertaking a real MDW threat had better be such if he hopes to succeed) or that his analysis of benefits and costs matches the one above. The coercive motive and its modus operandi is analyzed more completely in Chapter 9.

THE AGENT: CHARACTERISTICS AND PRECONDITIONS

An examination of the agents—either as individuals or as groups—involved in political violence in America in the past decade indicates that there is no single type of participant. Participants have ranged the political spectrum from extreme left to extreme right; they included blacks and whites; they were poor, but they were also the children of the rich; they were members of minority ethnic or religious groups, but the white, Anglo-Saxon Protestant participated too. And their range of personality types was broad, as the studies of student activism indicate (Liebert, 1971; Horn and Knott, 1971; Flacks, 1967).

Similarly, the characteristics of the groups that have been involved in political violence varied. Some were tightly organized into cells; others, barely organized, were more like a social movement. The size, wealth, and unity of the organizations varied, but almost all were subject to factionalism and the effects of a membership that fluctuated in size and commitment.

Dissident Individuals

If all kinds of individuals have participated in political violence in the past, what characteristics can be used to estimate the size of the population of potential participants? The time and secrecy requirements of superviolence are great enough to require an expecially high degree of commitment. In contrast to conventional violence, participation in a superviolent plot is less self-sustaining. It lacks the revitalizing exhilaration of rioting, running in the streets, confrontation, or even of seeing the results of one's efforts in bombing or sabotage. The ebb and flow of membership and commitment in extremist organizations suggest that this high degree of dedication is largely absent in those who participate in conventional political violence.

A necessary characteristic, not as obviously required in conventional violence, is a readiness to take lives. Not only the lives of the "enemy" but of innocents too, as the effects of superviolent weapons cannot be contained as can those of a smaller, conventional explosive. And it is not only a few lives, but perhaps tens of thousands, that are involved. There is evidence that this trait, especially to the degree just noted, is not readily found other than as nation-sanctioned war behavior. The outcry against violence that results in loss of life suggests that our cultural abhorrence of such violence has not been without impact. When an innocent person is injured or killed as the result of an act of political violence (as in the bombing of a building), denial of the deed is almost immediate; it is rare for a person or organization to take credit for such acts. Political bombings frequently have been preceded by telephoned warnings. Even if this were merely a tactic designed to retain popular support, it suggests the power of this cultural value. This attitude applies to the extremist group as well as to the general population. The failure of the elaborate Gunpowder Plot to blow up Parliament in 1605 stemmed from the warning given by the plotters to their co-religionists. Liebert (1971 p.163) comments about police-student confrontation at Columbia University in 1968: "The white radicals on the campus were virtually incapable of acts of violence against individuals."

But a history of the relatively recent past is not entirely sanguine. Although acts of violence against individuals are impossible for many, the act may be impersonalized and thereby facilitated, as we have seen in the vastly milder reaction of Americans to aerial bombing of civilians than to more personalized massacre (as at My Lai). Impersonalization may also be produced by defining the target population as outsiders or even less than human—labeling policemen as pigs is not without escalated peril. Our generation has known genocide, and may have become further brutalized by TV coverage of the Vietnam war and the government's attempt to legitimize its violence in that conflict (McLuhan and Fiore, 1968). Although it may be difficult to plan the death of people who share one's group identity, the Northern Ireland conflict has shown that a continued campaign of violence can be maintained and a remarkable tolerance for loss of innocent lives can be developed. The enforcement terror practiced by organized crime and by the rebels in some insurgencies are other examples. All of this may suggest that the impersonalization which enables violence may be rare, but it is far from impossible to find.

The third essential characteristic of participants is to have the highly developed scientific-technical skill necessary for the manufacture of superviolent weapons; these skills are spelled out elsewhere in this report. The point to be emphasized here is that people with such skills are likely to be successful within the sanctioned institutions of society and, therefore, relatively unlikely to participate in politically motivated plots. We caution against identifying the campus as a hotbed of political activism with the campus as a source of politically motivated superviolence.

> Today some believe that the new leftish student movements, which are worldwide, form the vanguard of a new revolution, the first true revolution in advanced industrial societies. If so, it will be the first in modern history which has not attempted to ally itself with science. So far as its ideology is discernible

> at all, it seems to be antiscientific and antirational, more akin to the early Christians than to the modern Marxists, despite its Marxist slogans. (Brooks, 1971).

Not all participants in political violence are from obviously marginal positions; the children of the rich have participated in extremist political organizations. Their motivation to participate in a politically oriented MDW plot may stem from psychological or personal needs rather than a desire to change the political system; nor can the profit motive be eliminated as an incentive for participation of the technically endowed.

Despite these caveats, we nevertheless conclude that it is extremely rare to find individuals with the technical skills and the readiness to inflict death and the personal commitment necessary to sustain the prolonged effort of a superviolent plot.

Role of the Group

The role of any organization, whether engaged in political violence or not, is to mobilize and coordinate the efforts of individuals or subgroups in pursuit of joint objectives. The functions of organization, therefore, are to acquire the resources necessary to reach the objectives, to attract individuals with the necessary skills, to motivate them to participate and maintain their commitment, and to provide an efficient division of labor to attain the common goals.

Two organizations with reputations for political violence have been examined as prototypes for a larger number of organizations: the Weathermen, as representatives of a New Left orientation, and the Black Panther Party, as an extremist, black organization. The changes that these organizations have undergone illustrate both their instability and the problem of predicting their actions in the face of that instability and a lack of publicly available information.

Weatherman began as a faction within Students for a Democratic Society (SDS) in 1968, went underground in December 1969, and little had been heard from them since. Whether the organization has died or whether it is busy planning future violence is not determinable from open sources. The Black Panther Party, which began with a community service orientation in October 1966, developed its line of revolutionary rhetoric in 1967, readopted a program of community service in late 1968, dropped its revolutionary ideology in 1971, and pledged to work for change within the system in January 1972. Even this brief outline of these organizations' histories indicates the great variation to be found among extremist groups. Weatherman arose from an organizational schism, and became increasingly radical and violent as its actions failed to lead to uprising; its frustrations led to greater violence, increasing police pressure in consequence, and ultimately to its retreat underground. The Black Panther Party, on the other hand, was founded as one of many black power organizations which readopted a community service orientation eschewing underground organization, when its increasingly radical and violent rhetoric was met by police retribution rather than political revolution.

When we focus upon the organization's task of finding and motivating individuals with particular qualifications, we discover some of the problems faced by these organizations. The most likely participants—as seen in these two cases as well as from other evidence—are youth, who have energy and commitment but who are unlikely to have the scientific training and experience necessary for successful MDW plots, if not for sham threats. In addition, all-black organizations may have even more difficulty finding scientifically skilled participants, as the pool of black people from which to draw recruits is smaller. But, a cautionary note must be sounded. The increasing radical agitation within scientific organizations suggests that some scientists are losing their previous apolitical orientations, and may constitute an increasing pool of potential participants.

Attracting monetary resources need not be a problem for a large organization. Besides contributions from its own members (more for Weatherman with a higher proportion of middle class members than for the Black Panthers, who emphasized the "lumpenproletariat" background of its members and always had difficulty attracting college trained or middle class supporters), contributions from supporters and legal fund-raising methods are available. The Black Panthers (it is charged) emulated other insurgent movements by resorting to crime for the funds needed to carry out their program. But the Panthers were always hard-pressed, especially in view of the expenses incurred in raising bail for its members arrested as part of the police program of repression.

Although an organization can raise money through the legal and illegal channels noted above, conflicting demands for these resources will lead to competition and friction within the organization to support other objectives to which such organizations are committed.

The organization's ideology or body of doctrines is its primary source for recruiting both personnel and resources. It is therefore important that its ideology be structured to attract adequate resources and motivate its members. As an example, both the Weathermen and Black Panthers proclaimed the necessity of revolution and saw themselves as its vanguard; both called for the destruction of the current system, which they labeled capitalism or imperialism; both saw a positive role for violence. The Black Panthers borrowed Fanon's view that violence was necessary to purge the colonial (the black) of his inferiority feelings so that he could become a new man in a new order. Their ideology was important in developing a sense of common cause, thereby building solidarity among the blacks. In addition, their concept of self-defense included pre-emptory action: "If you don't get him today, he will get you tomorrow," they warned. The Weathermen saw the nation at the brink of revolution needing only a wave of violence to plunge it into an armed struggle against the state. These views repeatedly expounded in "political education" or indoctrination sessions, can serve to motivate superviolence.

Not only did the original Panther position extol revolution; it rejected reform. At one point in the party's history, reformers were high on their list of enemies. When they spoke of negotiations, however, they lauded the role of violence in giving them, as destroyers of wealth, sufficient weight to bargain with the economically powerful elite. Their literature praised Bakunin and his references to the need for assassination and destruction, as well as his admonition that revolutionaries die young. The theme of self-sacrifice is seen in other Black Panther statements. Huey Newton expounded the doctrine of "revolutionary suicide" in preference to what he called "reactionary suicide," permitting yourself to be killed physically or spiritually. The believer in "revolutionary suicide," he claimed, would not accept death meekly, but would engage in head-on conflict even when the odds against him were overwhelming. Such support for "suicidal" acts would seem to prepare the Black Pathers for a role in superviolence. Cleaver, for example, proclaimed: "We say if there's going to be massive death for black people, the best we can do is get into a position so that there'll be massive death for white people...let us be in a position to lay waste."

The Weathermen, similarly, placed an emphasis upon destruction, although for a different purpose. Their unsuccessful Days of Rage campaign in Chicago in 1969—which involved acts of vandalism designed for publicity, confrontation and provoked repression—resulted in ideological praise of chaos, barbarism and terrorism. Disruption of the social-psychological-ideological fabric of society was seen as the equivalent of material damage. That campaign also led to criticism from other radical organizations for their having ignored the need to build a base of popular support, and pushed them into their underground phase.

Inferring Superviolence from the Evidence

Many of the statements of these two politically activist groups are supportive of their potential participation in superviolence. But there are several problems with the use of these statements as conclusive evidence. First, they may merely be rhetorical or abstract utterances rather than bona fide expressions of intent.

Second, there is the possibility of misinterpretation of the meaning of the words. Even relatively straight-forward language is open to several interpretations. For instance, destruction of the capitalist system may not involve physical damage. Zolberg (1971) notes that for all of Fanon's talk about the functionality of violence, his program for the destruction of imperialism refers to closing Africa's markets to Europe. Some of the most explosive comments by Black Panther leaders were "explained" away on much the same basis. The more powerful interpretations may be the real meaning, or it may intentionally signify different things to different audiences.

Third, there have been no direct statements advocating mass destruction of the population. The dogma of all revolutionists proclaims the need for popular support.

Fourth, change occurs. The views expressed at one point in an organization's history may not be applicable in a subsequent period. The Black Panthers' projected image has moved from community service to revolutionary vanguard and back to community service. Change is illustrated by the apparent decline in importance of these two organizations. Thus, an ad hoc organization—one most probably not now in existence—is more likely to be the agent of future superviolence than one currently indulging in revolutionary rhetoric.

The MDW Development Cell

Revolutionary organizations have traditionally adopted the cell structure as a means of permitting an efficient division of labor while maintaining secrecy and security. The importance of various resources for developing a superviolent capability makes intimate access to the organization's centralized leadership crucial. But a cell structure generally emphasizes independence from centralized leadership. In fact, this problem occurs even where the independent cells are not the basic unit of organization; the Black Panthers' centralized leadership has had great difficulty controlling local units that came into existence as the group became a nationwide organization. The local units wanted to focus on local problems rather than necessarily adhere to national priorities; they resisted interference from national or regional headquarters.

An underground cell structure may also conflict with other organizational objectives. The Black Panthers eschewed underground organization because they saw themselves as the vanguard of the revolution, and felt they could gain popular support in the ghetto only by being a visible organization. Weatherman, on the other hand, utilized a cell structure of semi-secret, tightly disciplined "revolutionary collectives" which later evolved into still smaller, more secure "affinity groups." In such organizational structures, problems and difficulties of leadership, communication, and control can be expected.

CHAPTER 3
PSYCHOLOGICAL ASPECTS

This chapter deals with the psychological characteristics of individuals who might participate in civil threats or attacks involving nuclear, chemical or biological weapons, whether for political or other ends. It also examines elements of the interpersonal morphology of groups capable of engineering such plots.

The physical, mechanical and chemical aspects of various super-violence weapons are described in detail in other chapters of this study. Our research interest in chemical and bacteriological weapons has been limited to considering them as competitors to the sub-national use of nuclear weapons. Recognizing that both individuals and groups of individuals—referred to generally as "agents"—might be involved, the following taxonomy is proposed:

1. Agents who might utilize nuclear material for financial gain;
2. Agents who might utilize a weapon to secure compliance with a set of political or non-political desires by threat of destruction; and
3. Agents who, on a sub-national basis, might use nuclear weapons to destroy national capacities to act, create, build or transport.

Throughout this report, different organizational patterns of threat groups are described or suggested. They may be categorized as follows:

1. Individuals or groups which have no formal connection with a weapon or material system;
2. Groups with some member or members who are accredited employees or participants within a weapons or material system;
3. Groups with all members affiliated with a weapons or material system;
4. To all the above groups, add the potential membership of individuals formerly accredited members of a weapons or material system; or
5. To all of the above groups, add the potential membership of individuals who are not accredited members of a weapons or material system, but who have access to useable intelligence pertinent to a sub-national use of a superviolent weapon.

This categorization allows later discussion of the potential size of the threat groups in terms of the incidence of neurotic, dys-social and psychotic behavior.

THREAT ESTIMATES

Threat Population Size

Until recently, the theft of nuclear materials from the Armed Forces charged with protecting them has posed the major threat with regard to sub-national use of nuclear weapons. In his book "Nuclear Weapon Safety and the Common Defense" Larus (1967) gives a relatively thorough treatment of the early history and gradual development of inner defenses by the US Armed Forces for the common defense of the US and other countries from irresponsible and/or irrational actions by personnel in the US nuclear weapons systems. The remarkable record of success by the people charged with establishing this protective system is clearly delineated.

Larus, however, is no cream-puff apologist for the weapon systems security people. His work is searching and critical. Despite his encomiums for the system and its techniques, his worry that the system could and might be breached shows clearly in his work. The very large number of individuals involved (several hundred thousand) and the variability of human behavior worries Dr. Larus, and is reflected in his new work in the pre-publication stage which deals with human reliability aspects of the nuclear threat.

The burgeoning civilian nuclear materials industry must also be investigated because of the potential threat it may pose. Some estimates indicate that within ten years more than 200,000 workers will be employed in this industry. Application of the most generalized psychological statistics available implies that perhaps 10 percent of these individuals will have severe neurotic or psychotic interludes. Perhaps one percent will have dangerous psychotic interludes. Our research has not developed a way to estimate the probability that such psychotic interludes would precipitate nuclear threats.

Non-nuclear threats could be mounted by a much larger set of disturbed or disaffected individuals. Such individuals, having no connection with nuclear weapon or material systems, could link to either a nuclear or non-nuclear threat. Psychiatrists consulted during the course of this study estimated the US potential threat group as ranging from 500,000 to more than 1,000,000 people. Note: Each individual in the "threat" group probably has a very low probability of becoming part of a superviolent incident.

Dys-social Individuals and System Defense

Dys-social individuals interested in pecuniary gain constitute a potential threat either as masterminds or instruments of a threat group. These are criminal types. The best initial defenses against them are security check-ups on individuals in sensitive spots. In addition to the routine checks for previous records security should include some form of psychological testing. A sensitive spot is defined as a point from which intelligence can be gathered or action taken to seize a weapon, material for a weapon, or plans for a weapon.

The physical defensive practices within the civilian sector of the nuclear materials industry against dys-social threats must be highly tactical, based on audit procedures which are economically practical and prudently sufficient to quickly call out the loss of dangerous materials through illicit actions so that interrogation and recapture and search procedures can begin. Even if the theft process was entirely exterior to the system in terms of the threat group personnel, such exterior threat groups would have required internal system intelligence and intersection with some of the weapon material system personnel or data. Thus, discovery queries undertaken as quickly as possible and related to the point of disappearance will increase the probability of recovery and decrease the probability of utilization of the stolen material.

Individuals or groups other than dys-socials might also be motivated to the use of a superviolent weapon. Within these groups, self-disclosure can be avoided by certain categories of psychotic who are able to mask their motivations by the simple expedient of not revealing them and by substituting false fronts for the true bases of their actions. Once again, the most practical defense appears to be an internal checking system which defends and audits quickly, which protects and checks the exits of material and which defends the transit of these materials so that theft of weapons or materials is made very difficult.

Various psychiatrists consulted over the course of our study believe that the formation of dys-social groups capable of planning such long or short-term actions is not improbable. But, they could not quantify the probabilities. The consensus seems to be that threat groups would tend to include some members with bizarre behavior patterns. se bizarre patterns are apt to erupt into actions which would bring police and security interrogations that might reveal the purposes, and plans of organizations aiming for sub-national nuclear threat. would be most probable if the threat groups were to function over ong period of time. Potential for self-revelation may be particularly strong in a group which is largely internal to a security conscious weapon or materials system. The most dangerous kind of group was thought to be that which had limited, non-self-revealing but important members accepted in the nuclear weapon or materials system working in conjunction with technically competent external members whose bizarre activities might not attract security-oriented questions. We have not been able to discover or construct credible estimations regarding the number or percent of system employees, dys-social individuals, who, for pecuniary gain, would assist a mixed superviolent team to carry out its threats.

The psychologists, sociologists and political scientists we interviewed felt that the physical protection systems against the sub-national group were of critical importance. As indicated earlier in this chapter and in many other places in this report, the great importance of internal control and audit of materials on a very rapid basis was commonly and almost instantly put forward by the people we interviewed. A kind of secondary psychological exposure procedure would be set into motion once the audit system had indicated that materials were missing. The more quickly the missing materials were identified, the better the possibility that interrogations and psychological reviews to blockade the conversion of materials or to keep the placement of weapons from taking place would be successful.

The Armed Forces technique of alerting commanding officers to "bizarre" behavior and having them call on trained psychiatric assistance for determination of fitness for duty appears to be worthy of conversion to a civilian system since the threat of a sub-national nuclear utilization, though not precisely measurable, does not appear to be inconsequential. It is possible that during a ten year period at least 2,000 employees within the civilian nuclear materials system could be potential psychotic threats. And while it is true that almost all of these individuals would have a proclivity to release their tensions in non-nuclear personal eruptions, they could be attracted to, set up, or inspire a partnership with an outside person or group which could, in fact, mount a sub-national nuclear threat.

Intelligence Community Understanding of Distorted Perceptions

Another area in which a multi-disciplinary team should concentrate further research efforts is that of distortion in perception that would exist in superviolent groups. Here again a vast literature exists and an extrication by psychiatrists, political scientists and sociologists of the essential information for intelligence groups would be of great value. We have been able to review the literature and note some of its value, but a minimum four man-year project would be needed to carry out the exhaustive study suggested above. The elements of distortion which would be found in superviolent groups would also be found in various non-superviolent groups. Diagnosis of a group's coming into existence would be a matter of art until it actually set up the course of planning to create or steal weapons. The areas of perceptional distortion would have to involve at least some of the elements briefly summarized below:

1. Specific kinds of stereotyping. "The enemy is all x and all evil."
2. Feeling that communication with the enemy is either impossible, worthless or dangerous.
3. The group would have to have some kind of ethnocentricity which would delineate it from "the enemy." A super ethic of self-justification played against the construct of the enemy as irascible, invincibly ignorant, stubborn and pig-headed.
4. The superviolent group would have to have either a mutuality of distortion or a system of internal terror enforcing compliance.

Any intelligence group seeking to identify potential superviolent aggregations of individuals should maintain contact with skilled psychiatric professionals. A set of objective criteria might be constructed by psychiatric experts for intelligence groups which have the identification responsibility.

In addition to distortions, the group would have to have technical capability to carry out its program; these skills are discussed in other sections of this report. Intelligence profiles should not fail to exclude these skill characteristics so that they can be applied to measure or sense the developing destructive potential of a massive, superviolent threat. In a later section of this chapter psychotypes are considered in terms of "security" for the threat creating group. Technical capability can also be considered in terms of psychotype ability to perform complex functions requiring technical intelligence, education and "stability."

CHARACTERISTICS OF POTENTIAL THREAT GROUPS

Sovereignty Concepts

Groups sufficiently deviant and large enough to be under surveillance would have to possess certain psycho-social characteristics before they could carry out a sub-national superviolent attack. It is difficult to attach the word "rational" to the use of such weapons, but we do so for those cases where the "users" have established themselves as "sovereign" groups capable of sanctifying their own actions, capable of acting alone or utilizing alliances with other groups, even through the international level, in order to carry out their goals. Such groups can enter on self-sanctified wars and can, given a proper ethos, utilize the same weapons as larger political entities.

The most threatening groups are small autocratic groups pledging allegiance to a hypnotic father or god-like, charismatic leader. Known groups of this nature have included The Thugee, the Mansons, some nihilists, and certain anarchist groups. A technological spin-off of the capabilities of our age is the upgrading of the potential destructiveness that could be achieved by such groups.

To be capable of using nuclear weapons, a group would have to (1) dehumanize* the individuals who would suffer the consequences of the weapons use, and/or (2) consider the use of the weapon or weapons as the only way to avoid a "catastrophe" or national condition unacceptable to the group and/or (3) consider the sacrifice of lives caused by the use

*Literature on dehumanization at the nation-state level exists in great quantity. Recent studies on the effects of TV violence and on the operations of gangs show that dehumanization is not exclusively a national or military characteristic.

of the weapon inconsequential when compared to gains to be achieved by the coercion value of the chaos caused, and/or (4) consider the substantiation of future threats through the weapon's use worth the damage and (5) give itself sovereignty to impose its own will on the major group.

Stress situations of sufficient power to swing a group into mass destruction activity would differ from group to group depending on philosophy and group composition.

Several hundred thousand trained individuals with knowledge of weapon system procedures are no longer under armed forces discipline. The possibility that some of these individuals might become members of an autocratic group or leaders of an autocratic group is qualitatively discernible, but attempts to accurately quantify this potential are currently difficult or impossible. Our research has revealed that small group dynamics studies, as they apply to the kinds of groups we are interested in, have not been undertaken or are not available in any of the open literature we have found. Such studies would require a multi-disciplinary approach, combining the disciplines of psychiatry political science, social psychology and systems analysis.

Small Group/Nation State Contrasts

It is important to note some of the differences that exist between small groups entering on the path to nuclear warfare and the large sovereign nation taking the same course.

> Modern warfare is a complicated institution, the result of the intermeshing of many factors—social, economic, political and psychological. It requires a complex social organization, intricate planning and preparation and great expenditures of resources... It is not something one man can under ake by himself

> no matter how hostile or aggressive he feels. Once such preparation has been accomplished, however, and once the wheels of the war machine are ready to turn, one man can indeed start it. (GAP, 1964 p.229)

The small group which considers itself a nation behaves in a manner resembling the large nation except that it exists within its enemy and must act in a super clandestine fashion. On the other hand, the small group's problems, organizational and technological, are at a far lower level of complexity than the problems besetting a major nation preparing a first strike nuclear war. Moreover, punitive response from the society it is attacking may not be as meaningful to the small group as it is to the large nation. Insanity, dedication, hypnotic fixation; all may conjunct much more sharply and easily for the very small group which is microscopic when compared to a major nation.

Special Problems of Small Groups

The small group faces problems that stem from its existence within its society. Guerrillas may be fish that swim in the sea of the people, but fish do beach themselves, do take bait and often one fish will reveal the location of its companions.

An examination of stereotypes concerning war as applied by the large country indicates that the linkage of "manly virtues, heroism and courage" help form the justification of war from national points of view, and that the incorporation of such concepts into the national mythos lends respectability and desirability while eliminating the negative stigma attached to participation in war. (GAP, 1964 p.233-234) A major nuclear conflict, however, would probably be so deadly and so rapid that the stereotype conditioning would function only before not after or during the type of protracted conflict to which the study refers since there probably would not be a protracted international nuclear conflict.

The GAP volume cited addresses the international level and does not discuss small group stereotypes for sanctifying small group warfare, but it does seem clear that some small groups might attempt to engage in nuclear wars that could last for long periods of time. One can imagine a small cadre within the IRA or Ulster Defense Forces armed with a number of small nuclear weapons destroying factories, harbors, universities, houses of parliament over a long period of time in order to achieve an acceptance of their demands.

Need for Improved Threat Statistics

Classification and compilation of statistics for individuals who constitute the potential cadre for the threat groups studied in our report are very difficult to achieve. The statistical literature we have reviewed is not internally consistent. Definitions vary. Psychotype statistics do not seem to be consistent within compilations. The Air Force has accumulated morbidity statistics for various kinds of psychoses and various categories of dys-social individuals by age, but this work, together with other statistical compilations, is inadequate since we have not been able to determine to what extent psychotype implies superviolence. Even if adequate statistical data were available, our study would have had to penetrate beyond the numbers displayed by simple classification in order to set up probabilistic distributions of the number of individuals in the threat set who might intersect with each other, with the required knowledge, and with the material requirements to mount a superviolent threat. We have not been able to obtain the data needed to create such a model; however, every psychiatrist we interviewed considered the threat personality as real. Many felt that they had treated individuals who, given the "proper environment," might become involved in superviolent activities. We believe that a concerted effort to establish these statistics and the propabilistic model of technical, psychological and environmental intersects is an essential undertaking.

MASS DESTRUCTION AS A HISTORICAL PHENOMENON

Mass destruction of people and property has occurred under combat and non-combat conditions over the course of recorded history with such frequency that almost no fifty-year period is free of such incidents. Those slaughters which have occurred ancillary to and outside of actual combat have required mass sanction, active or passive, from the group in whose name they were carried out. The slaughters have importance for this study because the motivations of the agents and the sanctions of the groups that contained them can shed light on the motivations and the sanctions reviewed in this study.

The cases of greatest interest are of the type generally now referred to as "genocidal," despite the fact that most of these massive slaughters, rather than being truly genocidal, were aimed at coercing the super-set of individuals containing the victims to act in conformity with the desires of the agents' super-set. Chinese/Tibetans, Russian CP/Russian Peasants, Russian CP Functionaries/Russian CP Functionaries, Hausa/Ibos, and Mongols/Asians are coercive cases. Certain purely genocidal cases have occurred and these too have interest for the study: Germans/Jews and Gypsies and Turks/Armenians.

Historical illustrations of non-combat mass destruction differ from the potential mass destruction cases considered here. Prior cases were largely technology-limited; they required large numbers of people to carry out the acts of mass destruction. In many instances they required the forcible collection of the intended victims so that the killing could be restricted to the desired set.

At the present time, only a qualitative distillation can be given of the rationalizations and commonalities that underlie the actions of the agent groups and their super-sets. No quantitative work has been done which determines the conditioning that will move a man to feel that participation in an act of mass destruction is his duty. The lack of quantification also applies to the conditioning required to induce the participant to go beyond obedience to orders and actively agree with the tactics being used. No quantified theories of mass "temporary insanity" have been constructed.

The following summary of qualitative justifications and commonalities is typical of those found.

1. Many of the individuals involved in committing acts of mass destruction felt they were engaged in justified wars or religious crusades.
2. Many individuals who committed acts of mass destruction felt that they had to commit these acts or face unbearable punishment or ostracism for refusal to participate.
3. Although in many instances denials were being made of the fact that the acts were taking place, widespread awareness of them existed both in the committing super-set and in the victim set. Germans were aware of what was going on. Russians certainly knew of the murder of the Kulaks and of alleged political dissidents.
4. Many perpetrators were so dulled that they felt the acts had no reality; hence, no importance.
5. As in the Soviet Union, long-term coercive effects of the acts of mass destruction were indeed achieved.

REVIEW OF PSYCHOLOGICAL THREAT PERSONALITIES

Among the many kinds of deviant personalities, some have greater potential for taking part in the kinds of threat this report considers. The most dangerous are described.

Paranoid

The true paranoid characteristically acts alone; he will not trust other individuals. Hence, he is not likely to be part of a political group planning to use weapons of mass destruction.

Paranoid State

These relatively rare individuals develop complex self delusions over a long time period. They are often brilliant, and their distorted thinking is hidden in their apparently rational personalities. They believe their own positions and are very convincing. They tend to develop rage and deep fear of social system, classes and establishments, and seek to "protect" themselves against the presumed enemy. They may start with a fixation against a particular person, and transfer their attitudes to entire systems. They are probably the most difficult of all mentally disturbed people to detect since they can put on a complete mask. An untrained layman would not know that he was dealing with such a personality; considerable training would be necessary for him to detect this particular type of individual. If a paranoid state individual lay at the focus of an agent group, his personality would not give the group away.

Although individuals of this type are rare, they are very dangerous Often they are good organizers, colorful or charismatic leaders, capable of arousing great loyalty from followers. If such a person with a scientific background had converted his initial paranoia from an individual to society, all the ingredients for a mass destruction threat clear of political roots, but nevertheless masquerading as a political action, would be in place.

The danger from single paranoid state individuals is high, although the number of potential agents of this type is probably low, comprising a small set reduced by a percentage to account for those who will not manipulate weapons of mass destruction.

Later phases of the present study will concentrate on the paranoid type personality. Considering the powerful weapons available, a Hitler or Stalin type of individual could release his paranoid tensions quite easily without the necessity for capturing the entire power structure of a nation.

Paranoid Schizophrenic

These individuals are marked by their delusions of grandeur; they consider themselves the center of the universe. Because they are filled with apparent aggression and hostility, they are easily spotted in most instances although they are not certifiable under all circumstances. They frequently have delusions of being great historical or religious figures such as Jesus, Moses, Lenin, etc. They may be very religious, and perceive their tremendous feeling of "mission" as giving them the right and duty to impose "order" on others or to punish "sinners."

These individuals have such supreme confidence in their own ability that they will often undertake tasks so daring and difficult that no normal man would consider them. Often their actions are of such a nature that no societal defense is contemplated against the first steps of their undertakings because of the low probability that anyone would undertake such actions. As a result, they frequently achieve astounding results.

Eventually, individuals with paranoid schizophrenia become loners like the pure paranoids. Hence, they are most dangerous from the group point of view early in their delusional state. A listing of the bizarre behavior that occurs in the pre-loner state can be made and would be helpful in identifying individuals as potential, irrational threat centers when imbedded in a political environment.

Borderline Mental Defectives (Ideopathic Type)

Mentally deficient individuals who can carry out simple tasks are often desperately seeking acceptance from groups and other individuals as affirmations of personal worth. Such people could be used by extremist groups in various roles as a cadre of expendables too dull to understand what they were doing. Properly handled, they would be incapable of giving away the scheme with which they were connected because they would not know what it is. It is possible that political groups dedicated to the use of weapons of mass destruction might actively recruit such personalities for just this reason.

Schizophrenic Types

At full development, this type of individual will generally operate alone. He will usually not trust groups. If he has had prior scientific training, he will have taken it over the line when he became schizophrenic. This type of individual may be a potential contributor to an extremist group if he is on his way to passing over from the schizoid to the schizophrenic state. In his pre-schizophrenic period, he is apt to be "certain" of his "superiority" in a quiet way while actually suffering from deep-seated fears of inadequacy. He, like the paranoid, is apt to be an intellectually superior individual in need of reassurance and acceptance while in the pre-schizophrenic state. Such individuals could be enlisted by a flattery process similar to that used on borderline mental defectives, but could be used at a much higher level than the defectives.

A schizoid individual would tend to show erratic behavior, making him a poor risk for a group engaged in a long term project. He would generally be usable with more security in a short term project. Before he cracks, the schizoid's danger to group security is a function of the irrationalities that his condition induces in him. He can range from the very cunning individual, quite capable of hiding his difficulty in most life situations, to the individual about to go over into one of the clearly definable psychotic states. Even after reaching the psychotic state, certain schizophrenics might still be usable by groups involved in mass destruction weapon threats. These would be individuals who see themselves as an instrument for some type of "salvation" and who see the group as an ally in the battle to impose or achieve that "salvation."

Passive-Aggressive Personality Type

This individual can become dangerous through his need to overcome the feeling of being rejected. This kind of person is deeply angry and, if involved in an extremist organization, poses an organizational threat because his anger can burst through at any time and lead to a revelation of whatever he knows of the plans developed by the group. This individual's deep hostility and rage would allow him, in many instances, to utilize a weapon of mass destruction without scruple. But since his rages are apt to be unpredictable, he runs the risk of being swept into acts that bring him under the scrutiny of law enforcement agencies. During an interrogation, he is apt to break down or even boast about a scheme to which he has been made a party.

From the intelligence point of view, such individuals might be interesting and important subjects once they had been admitted to membership in a violence-prone group. Leaderships of clandestine, civil threat groups are not apt to have the professional proficiency to diagnose the dangerous self-exposing behavior patterns of such people. Scientific competence, anti-social rage, and a dependency reflecting itself in deep, personal loyalty to the leader or the group might induce the group to falsely expect secure behavior from such individuals. Thus, these security risks could become involved in mass destruction weapon schemes through the errors of a political leadership in its selection criteria for agents.

Sociopathic Personalities

By far, the most probable psychiatric classification for potential agents in mass destruction weapon threats is that of the sociopath. These are individuals who are ill primarily in terms of society and its requirements for conformity. They are antagonistic to the prevailing cultural milieu. Although the superficial complaint of the sociopath is the society in which he finds himself, he quite often suffers from a deeper personality problem only peripherally connected with his opposition to society. The sociopath of interest in the present context usually has neurotic rather than psychotic underpinnings for his opposition to society and for his non-conforming reactions. Some sociopaths will have been the victim of brain injury or brain deterioration. Such individuals will change from acceptable modes of behavior into completely different modes with startling suddenness.

Sociopaths are classified in four basic categories as anti-social sociopaths, dys-social sociopaths, sexual deviates, and drug addicts. Some of these individuals may never have lived in what would be considered "normal" moral environments. Sociopaths with such backgrounds cannot be considered "immoral" since they are really amoral, or have been conditioned to act in accordance with a non-moral, anti-social axiom structure.

The dys-social person may show great loyalty to the group in which he has established his "morality," and he is capable of extremely anti-social behavior with regard to other social groupings. The "code of the underworld" as applied by some members of organized criminal subgroups illustrates this kind of behavior. Dys-social individuals frequently do not show significant personality deviations from "normal" on casual inspection. Part of their diagnosis involves noting the limited sphere of sanction that they require and the actions they will take based on this sanction. It will be important in future work to investigate quantitatively the relationship between the process of political radicalization and the development of dys-social behavior.

The anti-social personality is far different from the dys-social personality. He just doesn't give a damn. While he probably is not dangerous from the point of view of an "axiomatic" or moral use of weapons of mass destruction, he could well be used to plant and trigger such weapons for personal gratifications such as money. He would not act out of conviction, certainly not out of loyalty.

Drug addicts and sexual deviates would probably be too unstable for involvement in the threats considered here.

PSYCHOLOGICAL AND SOCIOLOGICAL STUDIES OF VIOLENCE

Gilula and Daniels (1969) have written:

> We desperately need research on the psychological processes which permit an individual or group to view some violence as good (and presumably adaptive) and other forms

> of violence as bad (and presumably maladaptive). Although the history of violence in man is polymorphous, there likely are psychological mechanisms common to all cultures and times.

We are forced to agree that although considerable research has been done regarding violence, none to our knowledge, deals directly with the psychological aspects of the agent in a non-national use of weapons of mass destruction for political purposes.

Much of the violence literature deals with physiological mechanisms and the utility or disutility of aggressive violent behavior in the abstract. In a work of this type Wertham (1966) describes the conditioning processes which may predispose individuals and groups to the acceptance of violence as a fitting way to achieve certain ends. Given societal sanction and immunity, he shows that even highly educated men, men who have been trained to be humanitarians, can initiate, accept and participate in "massive programs of genocide." In particular, he describes that substantial portion of the German psychiatric community which constructed, participated in, and rationalized the Nazi euthanasia program, and later contributed to the Jewish, Polish, Gypsy and Russian genocidal projects.

If one accepts Wertham's conditioning thesis, then a study of the factors that are now conditioning individuals for the political use of weapons of mass destruction is in order. Some of the literature which might indicate that such a conditioning process is going on, and that the process might under certain circumstances result in the use of mass destruction weapons, is reported below.

A bit of confirmational data might be inferred from the fact that in the works of many psychiatrists who are obviously opposed to violence there are sections, sometimes brief, sometimes long, in which they seem to condone some of the violence that has occurred in the recent past. For example, Horn and Knott (1971), in a study of youth activism in the Sixties, state "that the present parent generation does not feel the sense of moral outrage that some youths have directed at an 'enemy within America' may say more about the rigidity and insensitivity of the older generation than about the excesses of youth." Additionally, Wertham indicates that certain of our societies are beyond rapid improvement except through violence, and cites the example of the Mau Mau as having played a role in improving conditions in Kenya. Ilfeld and Harris (1970) point out that a sense of urgency will often bring about (almost imply) a need to resort to violence. This idea appears in a detailed discussion of the alternatives to violence and the weaknesses in the use of violence as a means of securing redress or social change.

A strong argument of the conditioning for violence which might lead to the use of weapons of mass destruction is offered by Neuhaus (1970). He places his revolution in the time frame fifty years plus, thus eliminating himself from the clear and present danger category. In his description of revolution, he states boldly that a true revolutionary must be prepared to carry out attacks which will result in the death of large numbers of people including women and children. While he does not specify the weapons to be used, neither does he prohibit the kinds of weapons that are considered in the present study.

Masserman (1968) presents a number of articles dealing specifically with the psychological attributes of politically-motivated extremist behavior. Case histories of several activists are presented, and various theories of alienation are propounded. The psychiatrists and psychologists who contributed to this volume either report in depth on a few individuals whom they know well as a result of long analysis or discuss many individuals whom they do not know at all or know only superficially. This illustrates one of the difficulties encountered: too few psychiatric profiles of political activists are available to permit formulation of high confidence generalizations.

CHAPTER 4
CRIMINAL ASPECTS

This chapter discusses two criminal aspects of an INW threat: motivations for the act and the criminal as the agent, either as an individual or as an organization. The two are not entirely distinct, and some discussion of motive and the nature of the crime is also found in the treatment of the agent.

CRIMINAL MOTIVATION

The fundamental criminal motive is one of financial gain or profit; its primary objective is not political, i.e., altering power relationships. It can also be differentiated from those acts intended to satisfy primarily psychological or personality needs. One significant consequence is that the criminally motivated INW threat is less likely to have symbolic aspects associated with it. Since its goal of financial gain is relatively simple and straightforward, it is likely to have been the object of rational cost-benefit calculations, or for such arguments to have dissuaded the criminal contemplating the super-violent threat. In addition, its selfish motivation is less likely to arouse popular support than more altruistic political motivations couched in terms of improving society. The government's problems of response are simplified because it need not be concerned with whether the threat is symbolic of systemic failure nor whether the agent is a madman prepared to sacrifice his life along with thousands of others. Although the fine art of blackmail must leave open the possibility of the threat being carried out (Ellsberg, 1968), a criminally motivated INW threat is less likely to lead to a nuclear detonation than would threats arising from several categories of political motivation.

An INW can be used for criminal profit in three ways. The first involves extortion, a threat to destroy a target unless a payment is made. This use is similar to coercion—extortion for political gain as discussed in Chapter 2, and some of the limitations noted there apply equally to its use in the criminal mode. The second method of financial gain involves the sale of the INW or its components, especially SNM, in a "black market" operation. The third possible method of profiting from an INW is to return the SNM to the government for the reward provisions of the Atomic Weapons Rewards Act of 1955 (or to sell back to the legal owner or his insurance company for a privately negotiated reward).

Analysis of Analogous Crimes

What factors should be examined in evaluating the likelihood of a criminally motivated INW threat? The paucity of data on this subject forces a dependence on what is known of analogous crimes, especially thefts of valuable articles, large sums of money, hazardous materials, or objects with a limited marketability. Similarly, the incidence of extortion plots—whether those involving the threat of harm to many people, as in airplane hijacking, or harm to a single person, as in kidnapping—could provide supporting data. One could also point to the incidence of crimes having some relevant elements even if the crime is not analogous, such as the illicit narcotic industry with its dependence on chemical skills or crimes in which extensive planning played an integral part such as the multi-million dollar Brinks or Mail Train robberies.

Any discussion involving analogies rests upon the assumption of isomorphism of the events. It is possible to argue that crimes involving large sums of money are similar to each other and to crimes involving an INW, and therefore that much can be learned about the latter by examining the former. But the differences are crucial; the theft of money is not the same as the theft of a commodity which must be sold in order to secure its value and the theft of a commodity which is readily salable because of a high demand differs from that for which there is a limited market. Extortion cases involving a threat to property are different than threats involving personal harm; personal harm to a single individual is vastly different than harm to an entire community; and harm from an unprecedented weapon—whether it be biological, chemical or nuclear—has no equivalent.

Our attention has recently been focused on airplane hijackings. While the rate appears to be rising in 1972, what is of more importance to our analysis is that the motivation is no longer a free ride into political exile but rather an extortion attempt, with sums up to one million dollars being demanded, raised, and delivered. Despite a string of failures, the initial apparent success of "D. B. Cooper" and the temporary success (i.e., the ransom money being delivered to the hijacker) of others, seems to spur on new attempts. At the time of writing, disposition by the Algerian authorities of the million dollar hijacking ransom has apparently not been decided.

The limited scientific literature on airplane hijackers, as well as the journalistic accounts of the backgrounds of some of the captured ones, indicates that the problem is more a psychological than a criminal one. Although the motivation for the recent extortive efforts is criminal, the hijacker's background is not. Despite his psychological problems, the hijacker may be less dangerous than the extortionist who plants his bombs and does not physically appear either to make his threat or collect his ransom (Los Angeles Times, March 19, 1972 p.C4). The extortionist's life is not directly in danger, and so his threat takes on a different measure of credibility than does the threat of the hijacker who risks his life along with those of the other passengers.

The "psychologically motivated" hijacker gains his credibility from the unpredictability of his behavior—he just may be "crazy" enough to kill himself along with the other passengers. Thus, just as knowledge of psychologically motivated hijackings tells little about criminally motivated acts, criminally motivated acts using conventional weapons may tell little about extortion attempts using an INW.

The study of black market operations indicates that there is greater variety than the assumption of isomorphism warrants. Black market situations involving a product with a high demand (e.g., drugs) differ fundamentally from situations where the demand is limited to one or a few customers (e.g., art objects). Therefore, what is known about crime involving one type of black market may not be transferrable to a different type of black market. Similarly, knowledge about homicide appears to be of limited utility to a study of the INW threat. Most homicides are not premeditated, most involve relatives or acquaintances—two characteristics which fundamentally distinguish homicides from the potential use of an INW (Clinard and Quinney, 1967).

Therefore, while incidents of analogous crimes may provide plausible support for speculating about the characteristics of a criminally motivated superviolent plot, the differences between the two kinds of crimes are great enough to preclude reaching any supportable conclusions.

THE CRIMINAL AS AGENT

Individual Criminals

Criminologists have developed a variety of classifications of criminals and crimes. For our purposes, the simple distinction between amateur and professional will suffice. An amateur, one for whom crime is not a career, may become involved in an INW plot because of some situation at hand such as his own desperation or the attractiveness of the opportunity. To date, the airplane hijackers who have demanded ransom and parachutes, or others who have capitalized on this publicity to engage in extortion involving a threat to many people (e.g., the Queen Elizabeth II bomb plot), appear to fit into this category. Those who have been apprehended rarely have a criminal record; they can be considered amateurs.

When speculating about a future INW threat, there is a tendency to envision the involvement of people who are not normally considered as criminals: the physicist who speculates about how much money he could get if he had his own nuclear weapon. But he is an unlikely suspect because the complexity of the threat process and the variety of skills required for the complete act make it quite obvious that he will need accomplices. Although it is possible that he can assemble a team of motivated and qualified amateurs, the number of factors limiting his eventual success begins to increase. This is no job for an amateur, especially since there are no guidelines for success such as newspaper reports of previous incidents.

The second type of criminal is the professional, for whom crime is either his full-time occupation or a regular supplement to his income. The professional criminal views his occupation as a highly skilled one. He frequently has received training in his trade, and as a result of this tutelage and his experience, he frequently specializes. He approaches his work rationally, employs a great deal of planning and calculation of benefits and risks and often shows a unique modus operandi as his goal is to "make money in safety" (Sutherland and Cressey, 1970, p.282). Many of the traits of the professional criminal can be found in O'Keefe's (1961) account of the Brinks robbery. The Brinks case becomes relevant to our study of the INW threat because it demonstrates that professional criminals can develop an ad hoc organization with its division of labor, and carry out a complex operation that involves extensive planning over a protracted time period.

This description of professional criminals suggests severe limitations on their expected involvement in an INW plot. Their rational calculation of benefits and risks could indicate a number of situations in which large payoffs could be expected with far less risk. The amount of money that could be demanded and reasonably expected to be paid may not be significantly more using an INW than using carefully selected and applied conventional weapons. Conventional extortion threats have already yielded $5 million (West German payment to Palestinian guerillas for return of a Lufthansa airplane), and conventional bank robberies have yielded as high as $2 million. In addition, an INW plot calls for skills not readily available to professional criminals; their technical skills necessary for sophisticated thefts do not extend to construction of an INW. They may have sufficient criminal skills to participate in a conventional extortion plot, but one involving an INW—with its need to establish credibility—will require unusual sophistication in the threat communications.

Organized Crime

The need for organization above the level of the ad hoc gang and the need for significant capital to finance an INW plot suggest a third criminal entity as the potential agent: organized crime. Although definitions and characterizations of organized crime abound, one is sufficient for our purposes: "Organized Crime...may be conceived as a crime committed by a person occupying a position in an established division of labor designed for the commission of crime." (Knudten, 1970, p.187).

An examination of organized crime indicates a number of characteristi essential for a successful, criminally motivated INW plot. It has money. One estimate of its annual net profit is $18.5 to 22 billion (Salerno and Tompkins, 1969 p.228). It has so much money available that it has had to create the position of money mover to make investments quickly while hiding its ownership through front groups and other methods. (Cressey, 1969 p.233).

Its organizational structure is a hierarchial one which has been described as feudal or even totalitarian. Decision making is centralized at the top, but the top leaders are well insulated and difficult to legally associate with the criminal activities. More important, however, its organization is marked by secrecy. The loyalty of the membership to the organization is strong, and the unwritten code of not being an informer is rarely broken. In fact, so little is really known about the organization, that debate still rages as to whether there is a single crime syndicate (confederation, Cosa Nostra) in the nation or more than one.

Organized crime is of interest as a potential agent of super-violence because of its experience in crimes related to those envisioned as components of presumptively typical INW plots. Organized crime members engage in hijacking cargo shipments and burglary as part of their apprenticeship; death and violence are standard means of enforcement; they have intimate knowledge of assassination; extortion is virtually a daily activity for them; and their black market operations provide both illegal goods and services (PCLEAJ, 1967).

Since theft is the most likely method of acquiring either SNM or a complete weapon, organized crime's experience in hijacking is highly relevant. Current estimates of cargo theft, although not all associated with organized crime, are $1.5 billion in 1970 (Senate

Select Committee, 1971 p.v). Although efforts are concentrated in readily marketed commodities, no product is immune from such theft, including government property. (Senate Select Committee, 1971 p.780). The connections of organized crime with longshoremen's and teamster's unions as well as trucking companies (Bellino, 1969 p.24) are valuable assets for any plot involving cargo hijacking.

Some experts differ with our evaluation and feel that the attitude necessary to carry out an act of premeditated violence against a single person is the same as that necessary for an act of mass violence. Organized crime's experience in murder, therefore, is interpreted as providing support as to its potential participation in an INW plot that may involve the death of many people. Similarly, these same experts feel that all crimes of extortion are basically alike, regardless of the sum involved, the characteristics of the victim, or the nature of the threat. These observers would point to organized crime's daily extortion experiences as relevant to its participation in an INW plot if the motive is extortion rather than destruction. If extortion experience is a necessary prerequisite for criminal participation in an INW plot, then organized crime is its most likely source.

If black market experience is sought, organized crime again is most qualified. It has been linked with the efficient disposal of stolen goods ranging from cigarettes to electronics, an ability aided by its penetration or control of numerous legitimate businesses. In an SNM acquisition attempt, these companies could also serve as legitimate covers or front groups for recruitment of the necessary scientific and technical skills.

The goal of organized crime, as everyone agrees, is to make money. There is some speculation that it will do anything that promises an opportunity for profit. Its past history indicates that it is not constrained by national loyalty. It was involved in black market operations in World War II as well as racketeering that included defense related industries. There were indications of collaboration between some Cosa Nostra leaders and Mussolini after he was considered an enemy of the United States and despite his attempt to rid Sicily of the Mafia (Salerno and Tompkins, 1969 p.287). Organized crime has also served foreign governments by assassination, gun-running, and attempted political influence peddling (Salerno and Tompkins, 1969 p.338).

Not only does this past record indicate experience in crimes relevant to an INW plot, but organized crime is also considered to be flexible and adaptive to new conditions. "Old crimes will be abandoned if the economics on which they are based changes..." (Salerno and Tompkins, 1969 p.365). In addition, its involvement in new crimes that exploit new scientific and business conditions, such as crimes involving computers and credit cards, suggests a possible future involvement with the nuclear industry or an INW plot as a not unreasonable prediction. After all, if the New York Times could speculate about organized crime providing a black market in healthy organs as transplants for patients who are unwilling to wait (cited in Salerno and Tompkins, 1969 p.365), then its involvement in an INW plot is not out of the question either.

Much of the writing on organized crime, however, indicates that it would not tend to get involved in an INW plot. One of the few direct statements on this matter in the organized crime literature contrasts the extortive use of an INW with the black marketing of SNM:

> Herman Kahn and a number of fiction writers have suggested that small, suitcase size nuclear weapons might fall into criminal hands and be used for extortion against a city. While it is certainly possible that a gang could obtain such a weapon, or the material for making one, extortion on such a scale would

> invite extreme reprisals from society. Organized crime prospers not by making war on the government, but by subverting and controlling it. The more likely way to profit from stolen nuclear material would be to sell it to small foreign countries, extremist groups, juntas and the like... Thus the possibility of nuclear blackmail with a small bomb is a real threat within the next decade, perhaps earlier. The possibility that organized crime might use such weapons for extortion is remote, but again holding them for ransom is a distinct possibility. (Salerno and Tompkins, 1969 pp.374-5).

It would not be unreasonable to suggest, however, that fear of public and governmental reprisals would extend to any involvement, even the indirect ones of supplying others, in an INW plot that threatened the lives of Americans.

Other experts on organized crime have focused upon the latter's concern for public relations. The New York Conference on Combatting Organized Crime characterized the organization as having seven characteristics, one of which was "an interest in public relations " (PCLEAJ, 1967 p.59). One observer of organized crime lists ten self-protective measures it uses to insulate its members and leaders from police arrest, one of which reads:

> Public relations—The organization is always concerned with public opinion, and all strong actions which might influence the public must be cleared with the Cosa Nostra leaders... (Reid, 1969 p.14).

Another author notes that organized crime learned several important lessons from the attempt to eradicate organized crime in the late 1930s:

> Rule 1: Crimes of violence, particularly against innocent victims and police officers, are dynamite, sure to arouse even the most complacent. (Goettel, 1970 p.319).

Another rule is the eschewal of public notoriety. Tyler (1962 p.228) comments that a psychopathic killer like Vincent "Mad Dog" Coll, who was proud of his nickname and reputation, was a menace who had to be cleared from the street. Because the public couldn't differentiate between him and a "businessman" like Frank Costello, he constituted an incitement for a "clean-up" of gangsters.

Organized crime has also been compared to a guerrilla movement (PCLEAJ, 1967 p.28). This role stems, in part, from a lack of support for the legitimate government on the part of large segments of the populace, as exemplified by the demand for services that have been declared illegal, such as prostitution. Organized crime needs the indirec support of the population, and does not want to alienate them. Like Mao's guerrillas, it must be a fish in water. Its acts of violence are mostly acts of enforcement against those in the organization or dealing with it; it tries to avoid harming innocent bystanders. Despite a record of violence, organized crime is concerned about its image; it does not want to jeopardize its large annual profits.

Those profits are quite huge. Estimates by experts place the annual net profit of organized crime from gambling operations at $6 to 7 billion; running a close second are the profits from loan sharking, estimated at $5 billion; and the return from other illegal activities is estimated at $7.5 to 10 billion for a total take of $18.5 to 22 billion annually (Salerno and Tompkins, 1969 p.228). Organized crime is like a large, successful corporation, and as such, its main interest is in long term investment.

> In contrast to the criminal gang, which is an active, mobile group, directly involved in crime activity, the criminal syndicate is a relatively stable type of business organization (Vold, 1958 p.394).

Similar to both the prisoner's code and that of successful businesses, the code of organized crime involves rational calculations; it takes risk into consideration and tries to avoid it. For instance, bootlegging plays a small and declining role in organized crime's operation because it represents unjustified risks.

> The destruction of stills and supplies by law enforcement officers during the initial stages, means the loss of heavy investment capital (PCLEAJ, 1967 pp.4,41).

Likewise, kidnapping has not been an organized crime activity since the 1930s. (Salerno and Tompkins, 1969 p.119).

Several authors cite a tendency toward specialization as characteristic of organized crime (Clinard and Quinney, 1967 p.383; Reid, 1969, p.12-13). This is clearly consistent with its goal of maximizing profits while limiting effort and risk. An INW plot does not fit that description. The risk is high, and the payoff is not as great as organized crime's annual profit. An INW threat is primarily a one-shot affair, and this is not typical of organized crime.

> The nature of organized crime...is not the type of criminal activity in which the criminal can make a few secretive hit-and-run sorties and hope to retire. It is essentially a continuous, fairly open life of criminal activity (Johnson, 1963 p.22).

In his economic analysis of organized crime, Schelling (1967, p.124) attributes the lack of organization in such erratic activities as abortion, for example, to several factors:

> First, nobody is a regular consumer the way a person may regularly gamble, drink, or take dope... Second, consumers are probably more secret about dealing with this black market... Third, it is a dirty business...and it [organized crime] may be afraid of getting involved with anything that kills and maims so many customers in a way that might be blamed on the criminal himself...

An INW black market with its single buyer (or few buyers at most), with little likelihood of repeat business, and with much secrecy, will not attract the efforts and resources of organized crime—that is not its kind of operation. Its hijacking activities stem largely from its ability to fence the merchandise through the legitimate businesses it has penetrated or controls. It seeks to avoid needless contact with the government, especially federal law enforcement agencies (Rule IV, Goettel, 1970 p.320), and therefore is likely to avoid the nuclear industry, either as customer or potential partner, because of the extent of government control and regulation that exists within it. Similarly, a desire to avoid government contact mitigates against participation in an IMW plot aimed merely at the payoff potential of the Atomic Energy Reward Act.

In summary, we believe that despite extensive experience in hijacking, extortion, violence and black marketing, organized crime is unlikely to turn to the one-shot, complex, costly, risky, unpopular, and relatively unprofitable venture of an IMW plot.

CHAPTER 5

THE NUCLEAR INDUSTRY

CONTROL POLICY EVOLUTION

Concern about potential SNM diversions to illicit weapons is not new. What is new is the need for a solution under a significantly new set of environmental conditions including a vastly expanding civil nuclear industry and possible internal security threats. Thus, an overview of key nuclear control policy decisions and practices vis-a-vis the changing environment, pressure, and decision alternatives serves to place present and future control problems in useful perspective.

Nuclear control policy is considered here in a broad sense. It encompasses the significant decisions about methods of confining the impact of nuclear technology expertise, products, and by-products to a defined domain. Control policy is shaped in response to mixed considerations regarding the security of information, materials, processes, facilities, personnel, and weapons. At another level, the aspects of worker and plant safety and of public and environmental safety are involved. Its primary concern, however, has been the non-sanctioned proliferation of nuclear weapons which brings with it the implicit consequences of weapon threats and effects.

Issues, Decisions and Practices

The earliest concerns about weapons were basically expressed with regard to information because that was the extent of weapons embodiment. The information to be protected was of a conceptual character, encompassing design and production details, planned use, etc. Weapons control during these times was correlated with and effected by the security of information control and personnel clearance. The military security of the Manhattan Project during World War II under General Leslie Groves epitomized the solution in the form of containment of information. Even Harry S. Truman, while Vice President, was unaware of the existence of the nuclear weapon program.

> "So strict was the secrecy imposed (in atomic energy matters) that even some of the highest ranking officials in Washington had not the slightest idea of what was going on."(Strauss, 1963 p.274)

Pooled information and shared results with some allies* were eventually arranged, but not without the belief by some that nothing could thereby be gained (Lieberman, 1970 p.34).

Nuclear materials of the World War II period were controlled in the context of what the material represented—the embodiment of a vast, $2 billion technological enterprise involving some 600,000 people (Groves, 1962); a possible development race with Germany; and in a sense, the potential essence of military victory at reduced cost of US lives. Thus, for example, the first sample from the Hanford reactors shipped to Los Alamos early in 1945 enjoyed a "convoy of ambulances between two radio-equipped military police cars." (Groueff, 1967 p.311) The plutonium for the Nagasaki "Fat Man" bomb was flown to Taiwan in a special C-54.

> In all cases, the plutonium shipments were accompanied by special personnel to guard against accident and special precautions were taken to ensure that if a plane carrying any of the plutonium did crash, we would have a fairly good idea of where it went down. (Groves, 1962 p.341).

Until about 1956, "round the clock patrols by armored cars and tanks around the periphery of huge reservations" were standard practice. At that

*England and Canada. Proposals for Soviet Union involvement were rejected.

time such patrols were discontinued, but stricter surveillance and higher walls around truly sensitive areas became accepted practice.

The constraints of physical security extended to key auxiliary materials in the project.* Because of the confidence placed in the significantly implemented physical, information and personnel security controls, central nuclear materials accounting (other than courier transfers, for example) must not have assumed a primary role in implementing control policy. Further, materials processing apportionment and loss data was first being collected.

Of SNM materials accounting, Hosmer (1970) said,

> In Manhattan District days and up to just sixteen years ago the materials were kept tightly in possession of the Government. How much oralloy+ and how much plutonium are unaccounted for during this period...I don't know and I doubt if anyone else could come up with more than an educated guess.

Writing in his Memoirs, Truman claimed that:

> In no document in my office, in AEC or anywhere in Government, could anyone find the exact number of bombs in stockpile, or the number to be produced, or the amount of material scheduled for production." (Lapp, 1962 p.40).

Thus, the security policies and practices were relied upon as both deterrents to, and detectors of, information or materials diversion. Numerous episodes of suspected or charged personnel security risks or information diversion characterized some very traumatic periods. These

*Even the 14,000 tons of silver used for the electromagnets of the separators at Oak Ridge were guarded in the process areas on a 24 hour/day basis. Silver shipments were on unguarded railroad cars but on different routes, varying time schedules and with shipment monitoring. (The recovery audit showed only .035 percent loss.) (Groves, 1962 p.108).

+Enriched U-235.

included Churchill's early distrust of Bohr; the publishing of the Smyth Report*; the involvements of the Rosenbergs, Greenglass, Fuchs and others; and the agonizing decision of the Oppenheimer trial.

Military nuclear materials and weapons diversion incidents are almost singularly lacking from the unclassified records.

> In 1947 a former employee of the Manhattan District... took two pieces of uranium to a friend in DOD for safekeeping. The latter recognized both the unlawful nature of the materials possession and the secret information evidenced by the material geometry. In a subsequent Department of Justice interview, the former employee claimed it was a souvenier received from another person. He later produced other similar souveniers. (Strauss, 1963 p.272).

The majority of materials or weapons (e.g., Broken Arrow) incidents referred to generally arose from accidents and negligence; a good account of many of these situations is given by Larus (1967). There probably are some classified incidents of diversion attempts. At least two are suggested. Another author even speculated that the first Russian atomic bomb was stolen from the US (Stewart, 1971). A fantasied takeover of a Polaris submarine control room surfaced in Congressional hearings (Lewis, 1971). But this last incident projects us to current experiences under present controls which are treated later in more detail.

Briefly, then, we return in time to consider the conversion of the policy of information and materials containment implemented by security controls to a policy of domestic and international civil nuclear largesse with significantly revised controls. Thoughts about post war

*Described by Lilienthal as "The principal breach of security since the beginning of the Atomic Energy Project." (Strauss, 1963 p.261).

nuclear materials control started during World War II. At various times, men such as Bohr, Bush, Conant, Stimson and others advocated (in as complete a reversal as peace from war) an international commission with free access to all information and rights of inspection. Others' suggestions included: a) cessation of all atomic activities and destruction of weapons, b) convincing the Soviet Union that the Manhattan Project had failed, and c) post war development with international control and ownership of all activities from the mine to production (Lieberman, 1970). But secrecy as policy still dominated and was accordingly practiced.

Stimson characterized the two basic schools of thought about control policy to Roosevelt in 1945 as "the secret close-in control by those who control it now and the international control based upon freedom both of science and access." (Lieberman, 1970 p.59).

The day after Hiroshima the US people were assured about the US control of information (patents) and materials (sources of uranium ore). In late 1945, despite these periods of international musings, the US publicly tightened its domination of atomic materials and processes and formally declared that "it was holding the bomb in sacred trust until the rest of the world proved itself ready for atomic development." (Lieberman, 1970). Despite this policy announcement a basic issue came up again and again in post war US. It was "what place the military should hold in the atomic energy program." (Major, 1971 p.240).

The first bill setting up the AEC was drafted by War Department lawyers. It triggered a hostile reaction in the scientific community. The prime objections were the intense occupation with secrecy and the use of atomic energy for purely military purposes. An alterate scheme, which eventually became the Atomic Energy Act of 1946, originally declared that basic information in the non-military field was to be made freely available. This expansive, proposed policy was later changed from "dissemination of information" to "control of information" in part under the stimulus of the discovery of a Soviet espionage ring in Canada. Statements urging free exchange of information were struck from the original bill. An inserted amendment required an investigation for all AEC employees by the FBI and the death penalty for the worst violations. (Major, 1971).

But the conflicting pressure on the shape of preferred policy was not completely resolved. One security ambiguity of the 1946 Act surfaced in the form of contradictory instructions (emphasis added) to the new commission, viz:

> Sec. 10 (a) Policy — It shall be the policy of the Commission to control the dissemination of restricted data in such a manner as to assure the common defense and security. Consistent with such policy, the Commission shall be guided by the following principles:
>
> (1) That until Congress declares by joint resolution that effective and enforceable international safeguards against the use of atomic energy for destructive purposes have been established, <u>there shall be no exchange of information with other nations with respect to the use of atomic energy for industrial purposes</u>; and;
>
> (2) That <u>the dissemination of scientific and technical information relating to atomic energy shall be permitted and encouraged</u> so as to provide that free interchange of ideas and criticisms which is essential to scientific progress. (Strauss, 1963 p.266).

The implemented US policy continued to be based on secrecy. In early 1946, for example, Secretary of State Byrnes emphasized his own desire never to let the secrets go. Yet international control was still being considered for presentation to the UN. Secretary of State Byrnes appointed a committee under Acheson (with science advisors under Lilienthal) to study the subject of controls and safeguards. In several ways the group was reminded that, in the context of our expansive international policy concept, the complete control of information and the prohibition on all atomic development were inadmissable solutions. Further, the scientific advisors "were simply too excited by the commercial and humanitarian prospects...to conclude that the best control system was one that prevented all uses of atomic energy. They were looking for a system of control that would impede military uses and encourage peaceful uses." Now a significantly different control policy was being entertained. It was the intentional contamination of fissile materials and was considered effective by Oppenheimer and Lilienthal (as well as Szilard) because "removing the denaturing element (to make a weapon) would take time." (Lieberman, 1970 p.246). The final recommendation of the committee was an international authority with control and ownership of the full atomic procedure from ore deposits to the final plants. The plan which Bernard Baruch presented to the UN in June, 1946, was based on this Acheson-Lilienthal report which saw "no prospect of security...in a system to outlaw weapons...which relies on inspection and police-type methods." The two subsequent years of deliberations, though, ended in the disagreement: "If international control should come before the prohibition of atomic weapons." (Prawitz, 1969).*

After seven more years, the precursor of significant US policy change was President Eisenhower's "Atoms for Peace" program announced at the UN in December, 1953. The selected lifting of the embargo on information

*"The use of atomic weapons in 1945 by the United States against Hiroshima and Nagasaki has a subtle influence on the American attitude toward (their) prohibition. The US has a defensive attitude toward the legitimacy of these weapons because it has actually made a highly controversial use... and is the only country ever to have used these weapons." (Falk, 1970).

and material was primarily based on: (a) the awareness that we no longer had a monopoly of nuclear technology (to what extent it was related to a partial default of our own controls was unknown), (b) the arms control impasse and (c) the desire to place "some new and constructive proposals before the world with the aim of converting the dismal climate to one of hope." (Seaborg, Corliss, 1971). More specifically, Eisenhower characterized the program as his answer to the real need for a change of atmosphere "to hasten the day when fear of the atom will begin to disappear from the minds of the people..." (Wiley, 1955 p.5). The Atomic Energy Act Amendments of 1954 authorized the subsequent US distribution of information and nuclear materials and now also permitted private industry to possess and use nuclear materials under AEC license (AEC, 1970).

Of this change in materials availability, Lapp (1968) wondered,

> Nuclear proliferation was the very thing which frightened the scientists because of the honey-venom nature of reactor fuel. Had anything happened since 1945 to make such a global nuclear sharing safe?

And, in the UN in 1954, Henry Cabot Lodge's response to the similar Soviet concern was this:

> The Soviet Representative contended that the exploitations of atomic energy for peaceful uses inevitably implies an increase in the supply of fissionable weapon-grade materials; ...he thereby implied that the agreement for peaceful uses of atomic energy must include an agreement to eliminate atomic weapons. We believe, however, that it is not necessary to solve the entire problem of international control of atomic energy and the elimination of atomic weapons before we can have peaceful projects utilizing atomic fission consistent with international security. It is theoretically possible, as the Soviet Representative suggested, to build power reactors that will increase the supply of fissionable weapon-grade materials, but it is not inevitable. We believe that as power-producing reactors are designed and built in the future, the ingenuity of the scientists and statesmen will find ways of assuring that materials are not diverted to war-like industries. (Wiley, 1955 p.306).

Thus, the future environment of our present concern was "not inevitable" in 1954. But prudent actions, we know, are defined differently as a function of time. Thus in 1946, "simple prudence dictated stringent security regulations aimed at prolonging our monopoly," and in 1954, "control of information must now be revised (i.e., loosened) to protect our national interest..." (Wiley, 1955 p.58). The decision, at this point, was that national interest was best served by relaxation of the initial stringent security requirements. Seaborg and Corliss (1971 p.310) characterized the decision makers of that time as ones who "could not and did not accept the easy solution that the risk of harmful consequences was so overwhelming that mankind had to be denied the benefits." They sought "to reduce the risks to manageable levels."

Eisenhower's attitude was: "the ingenuity of our scientists will provide safe conditions under which such a bank of fissionable material can be made essentially immune to surprise seizure." This period saw again "a short-lived flurry of speculation and hope centered on a technical process for rendering fissionable material safe, but this did not hold up." (Lapp, 1968). The Act of 1954, nevertheless, did not require that inspections or any other type of safeguards had to be applied to nuclear materials as a precondition to export. The country concerned must guarantee only that the US assistance would not be used for nuclear weapons or any other military purposes. "The decision to apply safeguards to permit verification by the US that the soverign guarantee...was being fulfilled" was a later policy decision taken by the Executive Branch in 1955 (Seaborg, Corliss, 1971 p.307). Thus, there was again some retrenchment after an expansive increment in policy. The policy changes of 1954, though, opened the way for international and domestic expansion. The accompanying information flow which saw some 10,000 AEC documents declassified by 1955 (Wiley, 1955 p.560) exceeded 500,000 by 1972 (AEC, 1972 p.190). (The special case of information control as it affects SNM production control is discussed later.)

> Since the Eisenhower administration the exchange of peaceful nuclear technology has been a component of our foreign policy. The peaceful atom has been internationally promoted with enough effect that access to technology is a significant factor in obtaining signatures to the Non-Proliferation Treaty." (Geesaman, 1971).

The accompanying IAEA safeguards under the NPT are not, however, the main constraint or deterrence against proliferation, but rather:

> The willingness of many nations to forego the production of nuclear weapons depends on a carefully balanced calculation— a calculation that says the US can provide greater security at less risk than going it alone with a national nuclear capability." (Rostow, 1972).

Willrich (1971a pp.46,47) summed up the irresistable political momentum of "Atoms for Peace" as a conjunction of ideals and interests:

> For the United States, international cooperation in the peaceful uses of nuclear energy was both atonement for the guilt associated with having been the first nation to develop and use nuclear weapons and an essential part of a long-term policy of non-proliferation of nuclear weapons. Once the Soviet Union had broken the US nuclear weapons monopoly, the continuation of a policy that sought to deny peaceful as well as military uses of nuclear energy to the rest of the world appeared to be politically unworkable, as well as morally unjustifiable. A policy to prevent proliferation of nuclear weapons to other nations seemed to require a willingness on the part of the United States not only to guarantee the nuclear security of its allies, but also to foster development of the peaceful uses of nuclear energy among all nations.
>
> For other governments apart from the Soviet Union (it) represented a least common denominator from which to work. The same road leads most of the way to both a civilian nuclear industry and a nuclear weapons capability. The fork is reached only after a long, costly journey. Implicit in Atoms for Peace was an authorization for any nation to travel quite some distance down the nuclear road without fear of reprimand or reprisal and

> with assistance from other nations... (it) signaled a major reordering of priorities,...now development came first and international inspection and control second, if at all. Once taken, the decision to promote the peaceful uses of nuclear energy throughout the world soon became as irreversible as the presence of nuclear weapons.

Domestically, one-way doors opened to newly formed environments.

> Atoms for Peace as a foreign policy fit nicely with private ownership of nuclear industry and government subsidies to the private sector... In the promotion of nuclear power, governmental and private interests in the US fuzed into a dynamic partnership. (Willrich, 1971a).

In 1954, key provisions governing the distribution of SNM to private and public organizations stated "the licensee must keep records of SNM received, on hand and transferred," but the regulation did not prescribe detailed accounting procedures nor the type of physical protection to be given the material (Wiley, 1955 p.367). Successively the amendment of 1964 permitted private ownership of SNM. In July, 1973, private ownership of power reactor fuel becomes mandatory (AEC, 1970). At present we perceive the changing nuclear industry environment accenting the closing of this century. As such, we later examine the need and utility of safeguards in materials control. To complement this later evaluation it is helpful to summarize the changing status of weapons and personnel security controls.

Weapons Security

Weapons security control impacts upon our study to the extent in which the threat group perceives it as worth the risk of penetrating it. In part, the group would trade this risk off with quick weapons possession as opposed to the possibly lower risk, but dubious route of fabrication. Since the status of such security is the concern of another project, limited observations will be made here. Significant changes have occurred in the weapons types and deployments and the practices of weapons security since World War II. The policy level there was for some time a civil vs. military struggle over the custody of nuclear weapons. In December 1946, General Groves and General Kenneth Nichols fought to retain military possession of all weapons and weapon facilities. They were unsuccessful. In November 1947, Lilienthal received a request to transfer the weapons stockpile to the armed services. As the Berlin crisis developed in summer of 1948, this issue was still decided against military custody by President Truman. He reaffirmed that in 1949. But in July, 1950, there were some transfers of non-nuclear components to the Air Force. In April 1951, a number of complete weapons were handed over and in September 1952, the armed forces were given control of a much larger share of the stockpile. It was a clear victory for the military— who believed that nothing less would guarantee national security (Major, 1971). At present, only the President may approve nuclear deployments (Halloran, 1971). Undoubtedly some of these and later policy variations served as stimuli to variable security practices.

The National Security Council decision in the Fall of 1953 to accept tactical atomic weapons as part of the Western Europe Defense (Major, 1971) led to an eventual buildup there of some 7200 tactical nuclear weapons under the control of specialized US military units (New York Times, June 17, 1971 and Congressional Record, December 30, 1970, E10881). World-wide storage sites have been estimated at 100 (Schrader, p.49). One, Okinawa, which recently reverted to Japanese control, stimulated speculation of shipments to other possible sites such as Guam, South Korea, Taiwan and the Philippines. Aircraft carriers and other vessels augment this Pacific stockpile. The tactical nuclear weapons spectrum includes bombs, artillery shells, ground-to-ground rockets, land mines, depth charges and surface-to-air missiles. Yields range from several tons to 50 kt. An average yield is 20 kt.

> Officials concede that potential enemies have little doubt where such weapons are stored because of the odd-shaped concrete and earthen igloos protected with three barbed wire fences and manned by special troops...there are plans to cover situations in which tactical nuclear weapons are in danger either of being overrun by hostile troops or seized by dissident elements in the countries where they are stored. These plans include rushing in special airborne units to remove the weapons, destroying them in place (scattering a small amount of debris), or flying in special troops. (New York Times, June 17, 1971).

Such current security practice is significantly more intense than some of the loose weapons security practices characteristic of our European tactical and IRBM deployments in the early 1960's. Appalled observers such as Senator Symington remarked on lax storage practices and fire control authority (Larus, 1967).* Another significant outcome of such traumatic stimuli was the implementation of the permissive action link concept. The sophistication of such electronic safety fuzing (other than described by Larus (1967)) as a function of the spectrum of strategic and tactical nuclear weapons is largely unknown to us. It seems evident, though, that apart from size and weight considerations, tactical nuclear weapons would be perceived by a threat group as the more attractive weapons source. Whether they are more secure than factory assembly lines, and the initial storage and transportation to the military base is unknown.

*Senator Symington recently said he is worried about American handling of its nuclear stockpiles in the Far East. "I will only say that the nuclear stockpiles are not being handled as carefully in the Far East as they are in Europe." (Santa Barbara News-Press, January 19, 1972).

Few other unclassified references to weapons security practices or penetrations are available. There are instances of the past practice of assembled nuclear weapons transported through the streets of New York (Larus, 1967). On January 25, 1971, two young Mexicans got past the four electric fences, barbed wire, security guards and patrols at the Manzano Mountain, New Mexico stockpile. They thought it was a ranch! Details of this trespass are classified (Rapoport, 1971 p.68). In contrast, a May 1972 trespass at the Kirtland Air Force Base nuclear weapons site resulted in the electrocution of 1 of 2 youths out hiking. They had climbed two fences; the leader failed in going under the 7200 volt third fence (Santa Barbara News-Press, May 29, 1972).

Personnel Screening

Personnel security policies and practices, like those for information, SNM and weapons controls varied to fit the degree of control compatible with the environment of the times. A brief review is helpful in understanding some of the present opposition of industry and some AEC officials to the application of a personnel security practice for the civil nuclear industry as used within the AEC.

Besides the apparent inconsistency of implementing a personnel security program in a civil industry using ex-secret information, materials and processes, there are still traumatic, inhibatory rememberances of security as earlier practiced within the US.

> A national obsession with secrecy and security became the sine qua non of defense against the Soviet Union...thousands of Americans had their lives and their fortunes shattered because it was determined that their conduct matched a word or phrase in the catalogue of human misfortune known as the security risk criteria. (Green, 1964).

The case of Robert Oppenheimer typifies, for many, this period and the variability of security clearances. His vital necessity to the required success of the Manhattan Project outweighed the awareness of his pre-World War II affiliations. Recurring doubts of his loyalty were sharply refocused in 1953. This period and the subsequent trial were detailed and evaluated by John Major (1971). He concluded:

> Governments rarely admit their mistakes, particularly over issues as monentous as those raised here. Above all... (the trial) indicated that the interests of the state could not be reconciled with the freedom of the individual.

In part, Oppenheimer had spoken too pointedly against a nuclear buildup when the international environment was charged with the risks of the Soviet threat.

Personnel security clearance emphases changed during this period as well. Before April 1951, there had to be reasonable ground for belief that the person involved was disloyal to the government. After that time just a reasonable doubt as to the loyalty was sufficient. In April 1953, Eisenhower's executive order expanded the previous emphasis on government employment such that all government employees should be reliable, trustworthy, loyal and of good conduct and character. (Major, 1971) Recent hearings reaffirmed that "the AEC has determined that all AEC employees held sensitive positions." (Vinciguerra, 1971 p.886). As such, security investigations are made by the FBI.

An overview of the Q-Clearance personnel security program cited that "government security, which (was) a burning issue of public policy in the mid-fifties, has in recent years largely receded from the public conciousness." (Green, 1964). This 1964 view has again been modified in other government operations by the recent cases of the Pentagon and Kissinger papers. Green has noted that the three major aspects of effective security practice—information classification, enforcement and personnel clearance are interrelated and that personnel clearance can be loosened if the others are increased but that:

> ...in actual practice the government has regarded human talent as readily replaceable and surveillance techniques as readily fallible. Hence, clearance programs (are) the cornerstone of the security mechanism.

Of the 717,000 Q-clearance applications (1947 through 1963) about 1-1/3 percent were identified as involving substantially derogatory information. Of these (depending in part on national mood and sense of paranoia of each applicant) from 33 percent to 74 percent per year were withdrawn. The remainder experienced a 1/2 percent to 18 percent per year variation in clearance denial (Green, 1964). The 1960's were seen as years of "emancipation" from the clearance traumas of the 1950's. No doubt suggestions of personnel clearance requirements for the civil industry rekindle, for some, suppressed memories of the more difficult days. At the 1969 Safeguards Symposium, Hightower (1969) reminded his audience:

> Back when the AEC was in its infancy, our security system followed a security-in-depth principle...no one was admitted without a proper credential. And we had a system of administrative approvals for people who were permanently employed... I am not advocating a return to the old system, since to do so would unnecessarily complicate our security structure.

Personnel clearance, however, was one of the recommendations of the Lumb Panel in 1967 (Shapley, 1971) and is under consideration as part of the civil nuclear industry safeguards under AEC (Crowson, 1970).

Green (1964) made a curiously interesting observation:

> ...it may be that the probability that a person will obtain clearance varies inversely with the real security sensitivity of his agency;

claiming that:

> Some agencies such as the Department of Commerce have had notoriously savage security programs. In contrast agencies with genuine sensitive secrets to protect tend to have more objective, realistic and fair (clearance) programs.

Green summarizes:

> The problem of maintaining a level of personnel security adequate to protect national secrets is difficult and complex... (it) will never be really satisfactory to all, so long as it involves essentially subjective determinations as to the likelihood that a person will in the future commit an act detrimental to the nation's security interests.

Clarke (1972) cites that the two men responsible for the Navy's screening program (Capt. Christy and Cmdr. Rasmussen) have said that:

> The most potentially dangerous situations in the Navy have involved personnel who demonstrated no evidence of phychiatric disturbance at the time of their initial assignment to military sensitive duties.

Undoubtedly the likelihood of anti-US actions is functionally related to the antagonism of a person's view of his governmental or industrial employer. Thus, some consideration has been given by the civil nuclear industry to the possibility of sabotage at reactor installations. A review of industrial sabotage noted that "the most serious acts of sabotage have occurred during periods of discordant labor-management relations." (Turner, 1970). No data has been found to show the degree of suspected or actual sabotage within the nuclear industry.* During World War II 20,000 cases of suspected sabotage against all industries were investigated by the FBI. The majority were attributed to industrial accidents. Of the remaining sabotages, disgruntled employees rather than enemy agents were the dominant source (Turner, 1970). This concern and that of other criminal acts have resulted in some industrial employee screening practices to take on some of the aspects of a security clearance.

*On November 4, 1971, a $5 to 10 million fire was set by a 7-year maintenance employee of Con Edison at the Indian Point No. 2 reactor auxiliary building (Gravel, 1972 and New York Times, March 12, 1972).

Events of the last seven years have resensitized some within the US to the personnel security issues viz., the internal dissidents. In effect, partial field investigations were conducted in increased scope on people who had made no applications for clearance. On January 1, 1965, the US Army Intelligence Command was activated. It included all Army investigative and counterintelligence units in the US. It specifically functioned from 1968 to 1970 collecting essential elements of information pertinent to civil disorders. Popular and Congressional pressures stopped the use of the Army in the collection process. It now relies on the Department of Justice for civil disturbance, planning, threat and early warning information (Froehlke, 1971).

A pertinent exception to the collection and processing prohibition undoubtedly covers the nuclear industry re: "activities endangering facilities which have been officially designated as key defense facilities." (Froehlke, 1971). The extent to which there is any intelligence information pertinent to conspiracies of damage to, or diversion of material from, the civil or weapons nuclear industries is unknown.*

It is our considered opinion that there is a high probability of the infiltration and/or surveillance of a threat group planning criminal interaction with the nuclear industry. Although public clamor against the practice of internal intelligence (especially as performed by the Army) has subsided, undoubtedly it is still being practiced in these excepted areas. Even Secretary of Army Froehlke (1971) noted that he

*Additionally, the extent of information correlating, e.g., library book checkouts in unusual category/personnel combinations is unknown. The surfaced incident of Treasury agents seeking library records of checkouts brought affirmations that it would no longer be practiced (Congressional Record, July 16, 1970 S11561).

(at that time) could not say for certain if the vast intelligence data bank on internal dissidents had been destroyed as ordered. Recently Senator Ervin introduced bill S.3750 to prohibit the use of US armed forces to exercise surveillance of civilians except during invasion or the supression of rebellion, insurrection or domestic violence (Congressional Record, June 27, 1972, S10255). These considerations have taken us to the point where further discussion of personnel securi.., is more appropriately made in later sections.

NUCLEAR MATERIALS SAFEGUARDS

Philosophy and Objectives

The basic thrust of the safeguards* program comes from the language of the AEC authorizing legislation "to promote the common defense and security" and "protect health and minimize danger to life and property." (AEC, Security, 1970). In 1967 the AEC "took two significant steps in the interest of strengthening its ability to meet the growing need for practical and effective safeguards." (Hosmer, 1970). Established then were the Division of Nuclear Materials Safeguards, the Office of Safeguards and Material Management+ and the ad hoc Lumb panel safeguards

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*Safeguards—a collective term that comprises those measures designed to guard against the diversion of material... The measures may include, but are not limited to, (1) the maintenance and verification of records of receipt, shipments, and periodic inventories, (2) physical protection, (3) reliability standards for individuals having access to safeguarded materials, (4) inspection of nuclear facilities to provide assurance that no diversion has occurred, (5) physical methods to detect or measure loss of materials, and (6) penal provisions to deter theft and diversion. (Technical Support Organization, Brookhaven, 1971).

+Nuclear materials manager—a person qualified to develop and establish standards and requirements for a system of nuclear materials control (measures taken to check, test, and verify the existence and amounts of nuclear materials). (Technical Support Organization, Brookhaven, 1971).

advisory group.* During the December, 1971, first broad reorganization in ten years, the Director of Regulation assumed the policy and administrative responsibilities for assuring that nuclear materials possessed by licensees are safeguarded against diversion to unauthorized uses. The Division of Nuclear Materials Security is now under the National Security program area (AEC, 1972). These actions were stimulated significantly by some of the growth pangs of the private nuclear industry such as the oft-cited Numec Corporation unaccounted for loss rate of six percent on highly enriched uranium (greater than 100 kg) over a period of 6 years. Table 5-1 lists some of the SNM incidents. Another stimulus was the desire to impart safeguards expertise to countries then considering the NPT. The philosophy and objectives of a safeguard system reflected these concerns.

Delmar Crowson (1970 p.23 and Congress, J.C.A.E., 1971 p.1677) has, perhaps, best defined the term and the system purpose:

> Safeguards—a collective term that comprises those measures designed to guard against the diversion of material such as source and SNM from uses permitted by law or treaty, and to give timely indication of possible diversion or credible assurance that no diversion has occurred.

Its purpose is "to insure that we know where the material is in the (fuel) cycle, what it is being used for and ... (that) it can be accounted for." Thus, a summary statement would be: "We are y percent confident that we know the disposition of x percent of the material in the system at time t." (Kouts, 1969). The basic rationale is that the "risk of early detection" as perceived by the would-be diverter, or as it actually exists, is highly correlated with, or effects, deterrence. Timeliness is considered to enhance this relationship.

*The advisory committee is now chaired by John Palfrey of Columbia University.

Table 5-1. Some SNM Incidents

DATE	ITEM/QUANTITY	REFERENCE
ACCOUNTING		
1961-1966	About 100 kg Pu unaccounted for (~6% of throughput)	Hosmer, 1970 Willrich, 1971a p.93
1969	Few kg Pu lacking from SEFOR fuel rods	Hosmer, 1970
TRANSPORTATION		
3-5-69	UF_6 in container misrouted in intended transit from Portsmouth, Ohio to Hematite, Mo.*	Hosmer, 1970
3-69	Highly enriched uranium for West Germany arrived 5 days later than scheduled delivery date at London (offloaded in error).*	Hosmer, 1970
5-70	Drum of waste with small amount of 70% enriched uranium consigned for delivery within California was delivered to Tijuana.*	Hosmer, 1970
4-71	Two cylinders of UF_6 (2-1/2 and 14 tons) fell off RR flat car during shipment.	AEC, 1972
THREAT		
1970	Orlando, Florida threatened with destruction by a hydrogen bomb unless $1,000,000 is paid.	Crowson, 1971

*Recovered

> [O]ne way to look at progress in safeguards is not in terms of after-the-fact detection exclusively, but rather in terms of deterrence or, at the very least, in terms of detection on a close to real time basis... These have been the guiding principles in the development of the US domestic safeguards system. (Crowson, 1970 p.24).

Deterrence though is not the sole purpose of safeguards.

> The technical standard of the performance of safeguards and the accuracy and reliability of the methods used has, of course, fundamental importance for the value and credibility of the control. ... But apart from the purpose of safeguards a precise accounting of fissile materials is necessary, both because of its high economic value and for reasons of health and safety related to its toxicity and radioactivity. (Prawitz, 1969).

Some, such as Gilinsky (1970 p.51), see the purpose of safeguards as "to provide reliable early warning of diversion in order to permit at least the possibility of effective response." This statement, thus, does not necessarily admit to a deterrence capability via detection nor does it imply that an effective response is now available. And Crowson (1970, p.29) also cites the importance of response:

> What if diversion or gross negligence does occur in the future? How can the US improve its ability to react? One of the most important functions of safeguards within the domestic program is to recover the missing material should it occur.*

The safeguards objectives have been the subject of unofficial variants. Others have: (a) by implication overstated the required purpose or (b) intensified its requirement. For example, re (a),

*Crowson adds: "In addition we are considering offering rewards for information concerning diversion of materials." One reward amount rationale we offer would be to have the reward a directly related function of the amount of material recovered due to that information and/or the projected impact of threat.

"Guarantees were needed that none of this material or assistance would ever create a threat to international security... Thus, US introduced the concept of safeguards to implement such guarantees in its bilateral agreements." (Seaborg, 1971 p.307). And, re (b), a tentative speculation was that "the purpose of diversion safeguards is to avoid the first significant theft and certainly not to establish the pattern of nuclear thefts."

If these interpretations were so (even if unexpressed as official policy) the capability of safeguards would have to be significantly more protective than just deterrence by detection. Most protective measures within our social experience have been refined via a series of undesired experiences. Often there is a progressive stiffening of defensive/protective measures or possibly some oscillation about a level compatible with social risks and costs. Our contemporary experience with anti-skyjacking measures is a case in point. Protection against first occurrences is analogous to the philosophies of various "zero-defects" production programs and the exhaustive reliability engineering afforded the Apollo Program.

Another contrast with the concept of deterrence via the risk of detection is the court decision in Seagel vs. AEC in 1968 wherein the plaintiff sought to prevent the licensing of a reactor in Miami on the grounds of its vulnerability to military attack. The court ruled that AEC was not responsible for considering such vulnerability in granting licenses or in design requirements. It interpreted common defense and security as "for keeping such materials in private hands secure* against diversion." This conveys a characteristic more associated with protective

*Secure implies free from fear, care or anxiety, easy in mind, confident, not feeling doubt.

security as opposed to theft awareness only. Present regulations encompass this court ruling (10 Code of Federal Regulations, 1972 p.343).

Finally, it appears that the deterrence by detection rationale is most apropos to the international, n^{th} nation diversion case. Scoville (1970) feels that "the political and perhaps practical consequences of being detected in a violation would be great, otherwise the potential violator would merely abrogate the treaty." Obviously one reason for this is that after diversion and detection the nation remains "visible." In contrast, US internal threat groups undoubtedly would rely on low visibility after the diversion and probably could effect it even before a detection if the group has not been penetrated by US internal intelligence. Another diversion option could be taking on the risk of immediate detection via an intentional overt action to divert material (e.g., interception of a shipment) relying on concealment after the theft. We assume that study would confirm an expected low probability of determining the covert locale of the diverted SNM via existing SNM detection systems.

The Defined Threat

The most complete description of the threat for which the domestic system is designed against is given by Crowson (1970 p.24):

> We have and are instituting deterrent type action against diversion by petty thieves, organized criminal groups, disgruntled plant employees and politically motivated individuals bent on assisting a foreign power to acquire a nuclear weapon capability either with or without that foreign power's encouragement.

The threat rationale at present does not include plant management and above as a threat for the US domestic system. AEC has made it clear that if plant management was a viable threat their sampling procedures in the materials accounting surveillance function would have to be significantly intensified (Vischow, 1970 p.440). Thus, domestically, the rationale is to have each facility set up its own materials control and accounting with the AEC serving in an inspection/surveillance role.

The nature of the international threat is of interest since much of the US safeguards philosophy and development is functionally to serve as an example to other nations implementing such a program under the requirements of the NPT and as monitored by the IAEA.

The international threat includes all the domestic threat described plus the "additional theoretical national diversion threat." This requires the additional objective of an international safeguards system of "reasonable assurance to all members of the international community that diversion does not take place." (Crowson, 1970 p.24).

> Under NPT...each country is responsible for the physical security necessary to prevent the hijacking of material while in transit from one plant to another or for preventing embezzlement of material by individuals within a plant... (Scoville, 1970 p.53).

System Implementation and Performance

A rather sobering perspective, if valid, on controlling the world-wide nuclear industry is reflected in Willrich's comment about its potential wrongful sideuse:

> Despite the inadequacies of the international political system a nuclear catastrophe has been avoided thus far by a combination of skill and luck in the management and mismanagement of military and civil nuclear power in the world. (Willrich, 1969 p.6).

But the last five years, in particular, have seen significant emphasis on a system of skillful management and control. At present the system components are:

(1) materials assay for nuclear material content
(2) accounting of nuclear material and the conduct of physical inventories
(3) physical and personnel security*
(4) surveillance and inspection by a safeguards agency
(5) transportation safeguards
(6) comparisons between measurements made by shippers and receivers. (Congress, J.C.A.E., 1971).

Alternately, these components are grouped into the areas of (1) accountability and management, (2) surveillance and inspection and (3) containment and physical protection (Crowson, 1970 p.24 ff). Their relatedness to detection and deterrence is shown in Figure 5-1 which is an amplification from Bennett (1970 p.248).

Assessments of the performance of these components in fulfilling the defined threats have been of two types. These consist of:

(1) subjective assessments on the overall system or the materials accounting portion, and
(2) quantitative performance data on the materials accounting/management subsystem.

Conceptual systems structures have been defined. Bennett (1970) and Gupta (1970) are excellent examples of these. A significant amount of current research is directed toward quantifying these postulated interactions (Morgan, 1970a). Quantitative system evaluations of the cost-effectiveness of various combinations of accounting, containment, and surveillance safeguards cannot be made, however, until all categories of the system are quantified. Thus, conceptual functions have been identified to describe the probability of diversion (e.g., as in Bennett, 1970 p.251) as well as those of the probabilities of deterrence, detection and false alarm. It is readily apparent, however, that the problem is not in system

*The context here is assumed to be "under consideration."

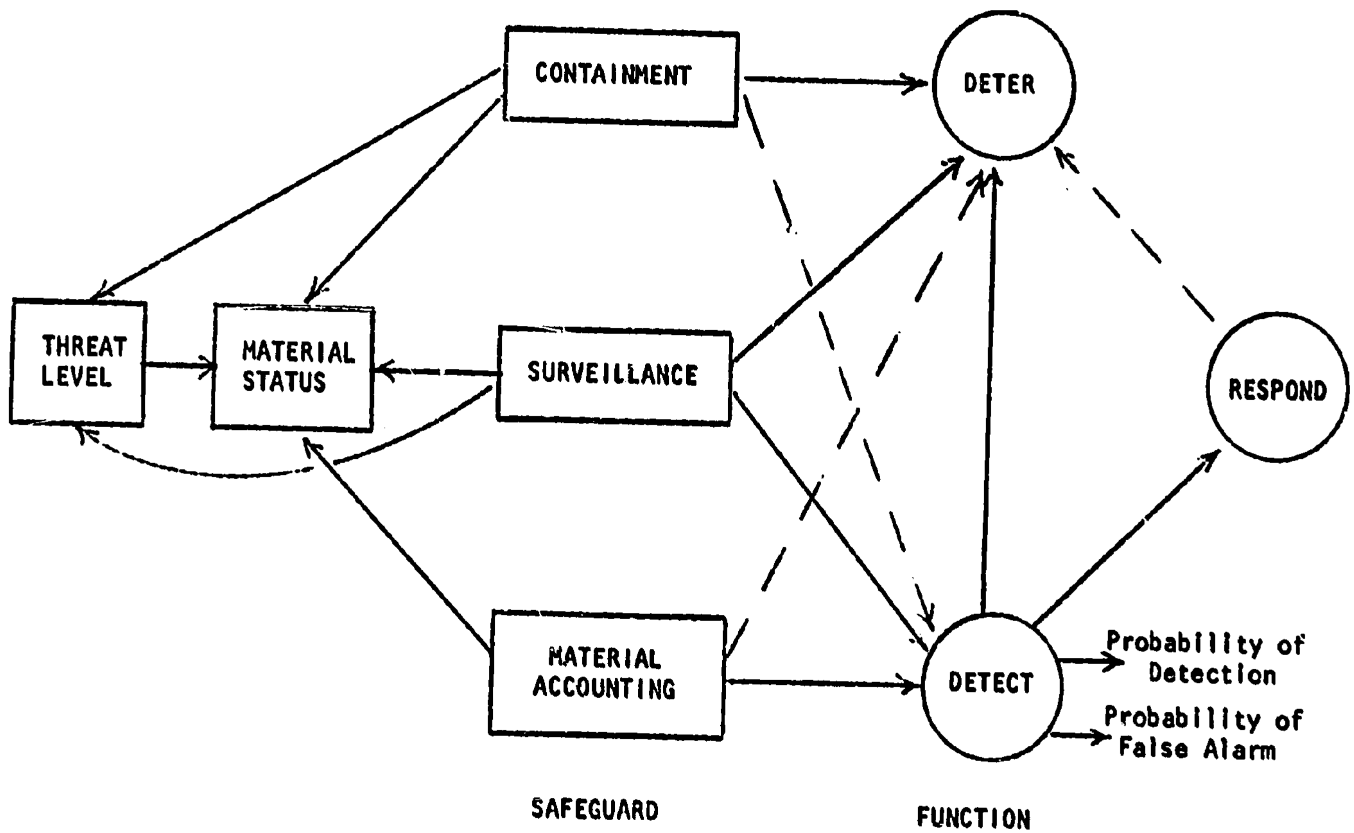

Figure 5-1. A Conceptual Safeguards System adapted from Bennett (1970).

conceptualization or modeling but in quantification of the values and correlations of the variables ranging from a priori probabilities of threats, material susceptibilities, etc., to deterrence effectiveness. Of special significance in any quantifying attempt on the system parameters would be associated ranges of uncertainty encompassing each mean, or most likely, value. The importance of such disciplined quantification is that it would indicate whether there really are discernible and distinctive decision choices within a given confidence range or if such choice categories cannot be supported on the basis of present quantification uncertainties. For example, familiar functions of containment such as guarded entries, fenced enclosures, can be used but little, if any, statistical data is available to demonstrate deterrence effectiveness as a function of the variability of these methods.

Because of this, comments which describe the relative importance of each of the system components to the system objective point to the basic reliance on materials management.

> The US has relied and continues to rely on materials balance accounting as a primary safeguard along with physical protection and surveillance. (Crowson, 1970 p.29).

> Checking records to insure they are free of mistakes and are consistent at all points is a basic starting point for preventing diversion of fissionable material. (Scoville, 1970 p.55).

There are definite statements, though, that accounting, per se, is insufficient to the task.

> I strongly believe that deterrence of diversion by the risk of early detection cannot be satisfactorily achieved for all kinds of possible diversion threats through accountibility measures alone, but must be supplemented to some extent with physical protection measures which may involve tamper-indicating devices (seals, alarms, fences, etc.) and surveillance systems (guards, TV, etc.). (Crowson, 1970 p.24).

Some description of these qualitative safeguards was given by Sastre (1970).

Further, there is a range of opinions on apportionment of intensity of safeguards as a function of material state. Some favor essentially equal safeguards. Others see that in evaluating the technical capability of safeguards, the probability that plutonium or highly enriched uranium can be diverted is of primary concern (Scoville, 1970 p.54) with source materials accounting controls as useful to the material balance through the fuel cycle. Taylor (1972) preferred a 4 to 1 range of effort.

Since we still lack quantitative system performance data, we cite several subjective appraisals of the system. Then we illustrate with some available data the characteristics of the materials accounting and diversion detection part of the safeguards system. One example which characterizes such a quantitative system deterrence dilema cited by Crowson was:

> About a month ago I was jokingly charged with a failure; a failure to disclose information on the domestic diversions that had not occurred because of the success of the USAEC safeguards effort. (Crowson, 1970 p.33).

Of the system performance experienced so far:

> To date we have had no losses that we can attribute to either theft of significant quantities of material or to any other kind of suspicious loss in the system. (Crowson, 1971 p.187).

And,

> To date, to the best of our knowledge, no strategically important shipments have been lost, no strategically important amount of material has been diverted...the number of new major problems involving strategically important quantities and types of materials appears to be on the decrease. (Crowson, 1969 p.4).

There have, of course, been diversion alarms but not necessarily from the detection system per se:

> Within any national program our experience indicates that alarms are to be expected. There probably will be safeguards incidents of this kind where, at least temporarily, materials accounting procedures or other information do not account for some material known to have been on hand or in transit. (Crowson, 1970 p.29).

Finally, it seems to us, a caution or conditional statement of safeguards system performance has been given. It is this:

> The current AEC domestic safeguards system has been effective in operating in the environment for which it was designed, namely in plants owned or operated exclusively for the government, and other plants producing materials and products that are classified for security reasons, and as a consequence, receive optimized security protection. (Crowson, 1968).

This is in sharp contrast to some of the views within industry wherein the threat is viewed as one of an economical operation. AEC security via legislation is seen as possibly even more effective than just military security in safeguarding materials.

At the materials management level there have been subjective appraisals of experience to date:

> The effectiveness of material accounting at the various levels is obviously highly dependent on the degree of independent verification of flows and inventory which is possible.

And, in recognition of level at which the threat is defined:

> A good plant material accounting system may be highly effective against diversion by an individual. On the other hand it may be an asset rather than a deterrent against diversion by plant management. (Bennett,1970 p.252).

> The operation of a reprocessing plant requires accountability of fissile material to ensure plant safety and sound financial management...our four years' experience has shown that the precision necessary...is of the same order of magnitude as that normally required for safeguards...the data requirements for safeguards and for plant management are more or less the same. The only difference being in evaluation and use of data. (Detilleux, 1970 p.467).
>
> Ideally, one should be able to account for all material within the measurement error propagated for the system. In short, we have a long way to go to get into that happy land where one can measure scrap, effluents, product, inputs and discards of all processes with a 1 percent accuracy. (Crowson, 1969 p.4).

There are comments, too, on the time delays involved in assertion/confirmation/denial of materials diversion situations. For example, in the 1969 Sefor reactor deficiency and the subsequent incident of a few kg of plutonium unaccounted for:

> The fabrication plant had been shut down since completing the Sefor rods and non-destructive and chemical assay measurements were made on essentially the entire inventory of plutonium bearing materials at the plant including feed, product and waste...the scrap and waste have not yet been dissolved and the remaining plutonium recovered. We are still, several months later, continuing the investigation. (Crowson, 1970 p.29).

Performance in the international context is also pertinent to the domestic US experience. R. Rometsch (1970 p.474) commented:

> We have sufficiently precise measuring techniques and a sufficiently developed safeguards system to detect a diversion which might lead to weapons fabrication on a militarily significant scale. On the other hand, our present techniques are such that an adversary could probably divert enough fissile material to make a single bomb for, say, blackmail purposes. The decision as to the level of diversion-proofness of a safeguards system is a political one.

And, F. Morgan (1970b p.474):

> ...a safeguards system is rather like marriage; you have to take an awful lot on trust, and if you try to quantify the degree of confidence you are heading for trouble.

These comments and others taken together point to the following general observations:

(1) Alarms re. diversion incidents have occurred but predominantly not because of criminal reasons.
(2) The alarms have not always been given by the accounting system.
(3) The early accounting systems in the civil industry were similar to those used in the military industry.
(4) The total safeguards effectiveness in the civil industry was less than that of the military industry because of the unquantifiable, significant difference of the security practiced within the military. As a result, the early civil industry was viewed by some with more concern about potential MUF incidents than did they view the military industry.
(5) To correct these perceived civil industry deficiencies, emphasis focused primarily on significantly improved materials accounting and the associated detection capability. This certainly was in keeping with the two contrasting philosophies of control: the highly secure control of the military industry and the open information of the civil industry. Control philosophies could not be crossed by implementing intense security enforcement in the civil industry. The remaining hope was that improved accounting for detection would suffice.
(6) It is evident that the system performance is dynamic; its effectiveness is a function of the changing environment.

> Because of the expected simultaneous increase in plutonium production and safeguards reliability, a fresh assessment of the capability of the techniques employed will be necessary in order to estimate the security provided by safeguards at any time and for any case where such estimate is required. (Prawitz, 1969 p.117).

Thus, at this point, projecting the safeguards performance characteristics after two successive ten-fold increases in the quantities of plutonium in circulation is dubious at best. It, indeed, bears frequent updating evaluations and, at present, a view of the limits of performance one might expect from a safeguard system is adviseable.

System Performance Limits

What limits should be expected for the safeguards system performance? The following show some of the diversity of opinion. (Some are spoken in international context.)

> Safeguards are not foolproof nor should there develop a complacent feeling that they are all that is needed to prevent or detect nuclear weapons programs...they have to be supplemented by political and legal restraints. (Seaborg, 1971 p.308).

> We can never say we have done enough to deter diversion. Any threat of diversion is a threat to national and international security. We must always be ready to respond to any future threats of diversion with firm and effective measures. (Crowson, 1970 p.33).

> The only 100 percent effective way of preventing the emergence of primitive nuclear powers seems to be to deny to non-nuclear powers the possession of highly enriched uranium and plutonium. (Olgaard, 1969).

Senator Gravel saw "The likelihood of theft of fissionable material, especially plutonium, to make private atom bombs" as one of seven of "the major unresolved problems of nuclear power." (Congressional Record, May 24, 1972 S8355).

> I will state flatly that no matter how good a physical security job is being done, it can always be done better, and ought to be done better." (Hosmer, 1971 p.3).

Herbert Scoville, Jr. (1970 p.61) was more optimistic in his conclusions, in part because they were in the context of significant (international) diversions:

> The potential capabilities of safeguards are adequate to reduce to acceptable levels the risk of significant diversion of fissionable materials—at least for many years to come.

In reality, besides one of his stated contingencies of new safeguards development, considerable hedge was left in the undefined "acceptable levels," "significant diversion" and "...at least for many years to come." In reality, too, system performance is a function of other growth constraints.

Safeguards Growth Constraints

Performance effectiveness, in the final analysis, will not even be limited by the technological assymptotes such as inferred above. There are many other pressures which constrain the decision maker. One is the degree of regulation which an expanding civil industry will tolerate. This is evident in these comments:

> The goals of the safeguards system in the US are based on identification of an effective system. There should be no new safeguards without clear proof of need. Certainly we do not intend to be capricious as far as AEC requirements are concerned. (Crowson, 1969 p.5).

> The objectives of our system are to be
> - technically effective
> - inexpensive relative to the cost of the material involved
> - depersonalized to the maximum extent possible
> - create minimum interference with normal plant operation. (Crowson, 1968 p.147).

> Safeguards has many possible solutions. Our job is to find those solutions that meet our objectives and time scales, and we must have as our primary objective the achievement of public acceptance through proven performance. (Crowson, 1969 p.5).

Similar restraints were voiced on the international scene. Paragraph 3 of Article III of the Non Proliferation Treaty says, "required safeguards shall be implemented in a manner designed to avoid hampering the economic or technological development" of the state concerned (Willrich, 1969 p.290).

> The IAEA system also provides that safeguards shall be implemented in a manner 'consistent with prudent management practices'...
>
> Fears (of interference with peaceful programs and trade secret disclosures) created tremendous difficulties in negotiating the safeguards article in the NPT and still give objections to adherence to the treaty. Therefore the application of any specific technique must be clearly justifiable as providing significant assurance against diversion and not merely information which might be nice to know. (Scoville, 1970 p.55).
>
> From an economic point of view there is a great need to develop safeguards techniques, but I am not sure that it is necessary from a political point of view... (Mitrovic, 1970).

Further, there was the reassurance and general interpretation by Sidney G. Kingsley (1969 p.37), Office of the General Counsel, AEC:

> You find partly explicit in the Atomic Energy Act already and to a greater degree...implicit in the whole act as it now stands, the basic philosophy that the regulatory function of the Commission will be carried out with as light a hand as possible consistent with the ultimate purposes to protect the health and safety of the public and the national security.

Some further reactions by industry, even after recalling a unanimous statement by transportation industry representatives that anything that organized crime wants to lay his hands on, while it's in the transportation cycle, it's going to get, were:

> I was under the impression that the whole program of the AEC was to turn things over to industry, not take it away from industry...I resent the implication that only the government is capable of doing anything correctly. (Edlow, 1969 p.37).

Also, at a symposium:

> A representative from AEC propounded the theory of physical control of plutonium by means of assay or registered, continuous monitoring. ...to many listeners the proposals sounded alarming... the real value of international safeguards was called into question...

Some safeguards were characterized as possibly becoming "a serious bar to the free development of the peaceful uses of nuclear energy in the international markets." (Nuclear Engineering International, Jan 1969 p.45)

The attitude survey conducted by D. A. Zellman and D. W. Brady found:

> At the national level government officials generally prefer a more stringent safeguards system, but generally perceive the existing system as lacking stringency, while nuclear industry officials generally prefer a less stringent safeguards system but generally perceive the existing system as too stringent. (Leachman, 1971 p.21).
>
> The nuclear industry's main concern was with safeguards interfering with their right to 'run a business,' and the AEC's prime concern was with their right to regulate. (Brady, 1971 p.14).

There are other indications of industry's chafing evidenced in:

> Tell us, just what is the threat?

Though delivered in the context of safety and industry promotion, Schlesinger's (1971) comments are still pertinent:

> A government agency has separate responsibilities, distinct from those of industry.....the first is to conduct its business in an efficient manner. The second is to avoid changing the rules of the game for other than sound reasons.
>
> I must assure you that I can see no need for abrupt change in our current system. When R&D progress dictate, cost benefit studies will begin. After the results are evaluated, the proposed modification will be openly discussed with the industrial community. Changes finally decided upon will be implemented in a progressive and gradual manner to ensure maximum effectiveness with minimum perturbation. (Crowson, 1968 p.147).

It is evident that industry is not going to move beyond those safeguards which are inimicable to and compatible with economic operation and that the accounting procedures, albeit tightened from the days of the late 50's and early 60's are still those basically consistent with the concerns of economics.

Just how effective might the accounting system be in timely detection of diverted materials? Since this is the focal point of present safeguards it is now treated in more detail.

Diversion Detection by Materials Management

One portion of the safeguards system amenable to quantitative performance data is that of nuclear materials management. This is because materials accounting is an included monitoring and control measure. Such plant management data collection has many materials processing and quality control analogies from other metals industries. The nuclear industry, however, shows a unique sensitivity to the need for highly accurate and timely measurements of all material states in the fuel cycle to effect diversions detection about or below critical amounts. This is not possible at the present state of materials monitoring technology. Accurate measurement data is best afforded by destructive chemical processes. This is not amenable, however, to all parts of the production cycle, e.g., fuel rod assemblies. The accuracies of non-destructive assay techniques are being improved in various R&D programs. Yet even some near-future limiting values have greater inaccuracies than desired (Congress J.C.A.E., 1971). While some parts of the production cycle have been accounted for "by difference" entries, development efforts seek to have all material states measured directly (Wischow, 1970 p.440). Additionally, significant attention has been given to statistical processing of the data to refine the description of each material state. These procedures are being enhanced by the accumulating historical data (Rowen, 1970 p.291 ff).

Non-detection or low-detection diversion possibilities have been cited (Taylor, 1970; Shapley, 1971). Generally the estimates are about 1 percent of throughput are marginally detectable but no associated confidence data is given. Other studies have shown inspection apportionment efforts which give 95 percent of diversion detection for greater than 10 kg (effective) diversion from a single facility (Avenhaus, Gupta, 1970 p.369). It is useful to approximate detection performance of the materials accounting system at a national level in the more complete description of detection, namely, the tradeoff of the probabilities of detection (P_d) and false alarm (P_f). These can be obtained once a statistical description of the noise environment is given. The noise in this example would be the composite of measurement and materials processing fluctuations in a given time increment which determine net MUF values.

Complete and most recent materials accounting data and quantitative systems studies have not been reviewed, but sufficient data has been cited in various recent symposia to illustrate the general quantitative detection system performance that may be experienced.

Several summaries of MUF quantities normalized to throughput (Beginning Inventory and Material Received) are available (Rowen, 1970; Crowson, 1970; Suzuki, 1969). In Figure 5-2 a summary of some of these data as a function of integration (normalizing or measurement) time is set up using, as a first approximation, aggregated MUF values of Pu-239 and U-235.

At a national level, the detection system of excessive MUF or materials diversion is essentially the equivalent of a paralleling of the many detection systems (the materials accounting procedures) of one at each facility. That is, a national alarm is an alarm from any one of the total number of measurement/inspection/surveillance operations throughout the domestic industry.

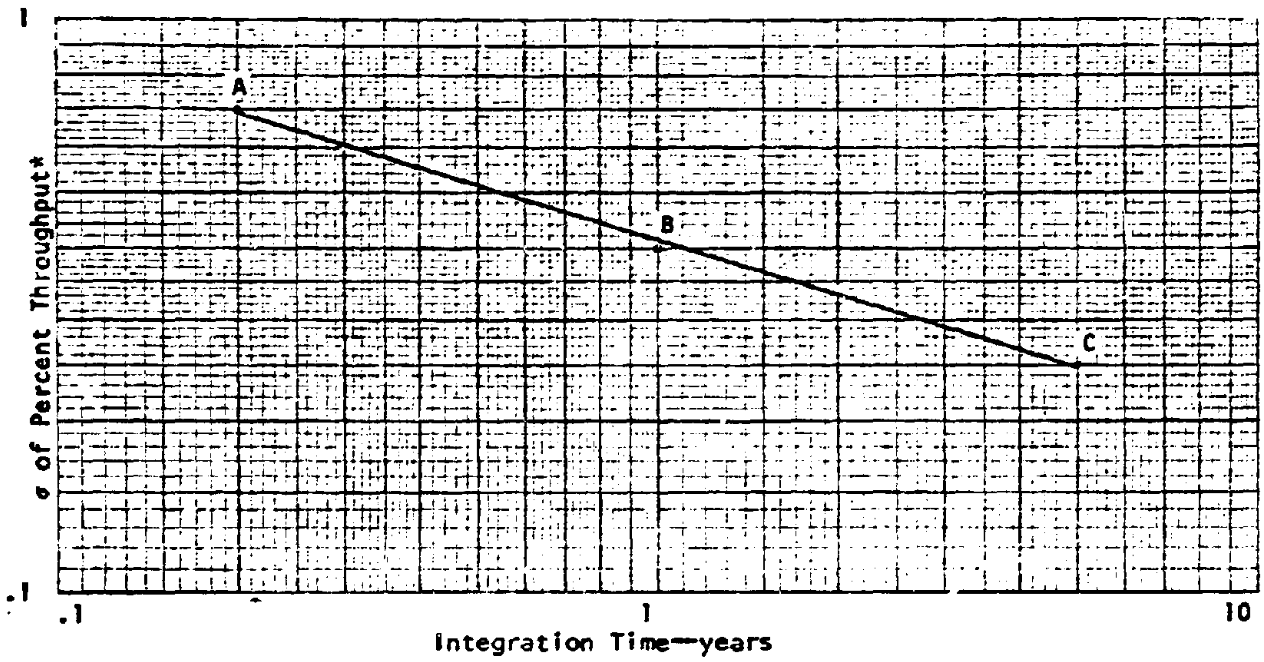

Figure 5-2. The "Noisy" Background of Diversion Detection

*Standard deviation of normalized throughput "noise":

$$\sigma \text{ of } \frac{MUF + NOL}{BI + R}$$ (except Point B for which NOL = 0).

MUF = material unaccounted for
NOL = normal operating losses
BI = beginning inventory
R = receipts

Reference	Point	
Rowen, 1970	A	26 campaigns of 1 facility (in 5 years).
	B	1 year average of 108 values of 28 facilities.
Crowson, 1970	C	5 year average of 26 facilities.

There are at least two ways of synthesizing the model representing this national detection system. These are:

(1) Determining the relationship of P_d and P_f at each facility on the basis of its own MUF historical "noise" data; then compute the net national composite probabilities, $\overline{P}_d$ and P_f, from the paralled "detectors."

(2) Alternately, assume that the aggregated historical MUF noise data is a good approximation of the effects of paralleling all facility detectors. Then examine the $\overline{P}_d$ vs. $\overline{P}_f$ tradeoff available in the context of this noise data and a selectable threshold. The former method is used here.

One method of determining optimal threshold levels for the national system assumes a rationale of the minimization of Bayes risk (Cooper, 1965) described by the following equation:

$$R = (1-P)\ C_{\bar{f}} + PC_d + P(1-P_d)(C_{\bar{d}} - C_d) + (1-P)\ P_f\ (C_f - C_{\bar{f}})$$

where

R = Bayes (average Risk)

P = A priori probability of a diversion

P_d = Probability of detection of a diversion

P_f = Probability of false alarm (i.e., false declaration of a diversion

C_d = Cost of a detection

$C_{\bar{f}}$ = Cost of no false alarm

$C_{\bar{d}}$ = Cost of a missed detection

C_f = Cost of a false alarm.

To simplify this analysis, (and also quite consistent with relative costs) let $C_{\bar{f}} = 0$. This is not to say that the costs of operating the system are nil, but only that, relative to the investigative costs and the implications to society of a detection, a credible false alarm or a missed diversion, it is significantly lower. $C_{\bar{f}}$ and C_d depend on the subsequent action, i.e., these encompass not only the cost of the detection system but also the cost of: (a) additional efforts to validate the alarm—e.g., more thorough plant inventory to verify missing material, and (b) the extent of other responses initiated, e.g., the use of mobile detectors (looking for missing materials) to the evacuation of the city after a credible threat.

It is recognized, too, that this simple model is far from reality. For example, the importance of the subjective element in evaluating the historical performance of a facility is a significant factor in qualifying an alarm. As Morgan (1970a) summarized it, "even a quantitative approach, when applied to the maximum extent, still calls for a good deal of pragmatism." And, "I am told by several experienced plant managers that they can sense whether anything is amiss in a plant merely by being there." If the latter is a credible statement, how is it factored into a systems analysis?

Then normalizing Bayes risk by the cost of a missed detection we have:

$$\frac{R}{C_{\bar{d}}} = P\frac{C_d}{C_{\bar{d}}} + P(1-P_d)\left(1-\frac{C_d}{C_{\bar{d}}}\right) + (1-P)P_f\frac{C_f}{C_{\bar{d}}}$$

which is useful because $\frac{C_f}{C_{\bar{d}}}$ and $\frac{C_d}{C_{\bar{d}}}$ are easier entry points for a decision maker (to wit, subjectively quantifying a ratio is usually easier than quantifying each variable). Implicitly one may begin to say that, at a first level of approximation, a ratio of unity seems reasonable, i.e., it is about of equal, significant impact to society and industry if an alarm is falsely declared as if an actual diversion goes undetected. This assumes that when a system alarms the alarm is treated with a significant amount of credibility. Generally, many systems in an early stage of development do not "enjoy" such a degree of alarm credibility.*

Primarily to illustrate the procedure, we have arbitrarily assumed the following characteristics for the year 1980:

- $\frac{C_f}{C_d}$ may range from .01 to 1 and $\frac{C_d}{C_d}$ from .1 to 1.
- There is an a priori probability, P, of a diversion attempt of .1 in any given year. (Taylor (1972) estimated that one credible threat in 10 years might be an acceptable social cost.)
- 24 tons of plutonium reprocessing and fuel fabrication (on a ratio of about 2 to 1) are handled in 12 facilities which each process or fabricate 2 tons of plutonium per year.
- The diversion detection and false alarm characteristics of the safeguard system are the same in each plant.
- The MUF (diversion detection) noise in each plant may be described by a normal probability density function with a mean of 0 and $1\sigma = .004$ of the throughput (i.e., an integration time of 1 year is assumed). The 1σ value is thus 8 kg.
- A diversion of 10 kg takes place in one attempt at one plant. Therefore the (diversion) signal to (MUF) noise ratio is 1.25.
- An acceptable national false alarm rate is about 1 per year, therefore, each plant has an alarm rate of about 1 alarm every 12 years.
- The national level system has a probability of detection equal to that at any one plant which is about .5 under the previous assumptions.

*National level system examples have been the DEW and BMW systems. The decision maker used other intelligence indicators to declare a seemingly valid alarm false.

Table 5-2 shows the normalized Bayes risk, $\frac{R}{C_{\bar{d}}}$, parametric in the ratios $\frac{C_d}{C_{\bar{d}}}$ and $\frac{C_f}{C_{\bar{d}}}$. The context is also expanded to consider other national alarm rates and detection capabilities. Within the range of assumed variables it is apparent that minimum risk conditions occur at either a low alarm rate (which forces a low probability of detection) or a high detection capability (which forces a high false alarm rate). Further risk domain exploration is therefore recommended.*

Table 5-2. The Normalized Bayes Risk of SNM Diversion Detection

			$\frac{C_d}{C_{\bar{d}}} = 1$			$\frac{C_d}{C_{\bar{d}}} = .1$		
	$\bar{P}_d$	$\bar{P}_f$	$\frac{C_f}{C_{\bar{d}}} = 1$	$= .1$	$= .01$	$= 1$	$= .1$	$= .01$
	1	1	1	.19	.109	.91	.1	.02
	.9	1	1	.19	.109	.92	.11	.028
Base Case	.5	.72	.75	.17	.107	.71	.12	.062
	.1	.06	.15	.11	.101	.14	.096	.092
	0	0	.1	.1	.1	.1	.1	.1

*Another evaluation procedure used in our studies on the effectiveness of intelligence collection systems would compare the fraction of information provided by the materials accounting/inspection procedure to the information available in an ideal, or noiseless, diversion detection system. This summary measure is useful because it permits information effectiveness to be compared with response action effectiveness (such as might be derived from historical data on physical surveillance and containment and response measures). A composite cost-effectiveness summary then provides a decision maker with data on all possible combinations of safeguard system components.

NUCLEAR INDUSTRY SUSCEPTIBILITIES TO DIVERSION

The susceptibility of the nuclear industry to diversion attempts by a threat group is dynamically dependent on its growth and some especially sensitive facets. The latter includes the deterrence performance of safeguards, the types and quantities of SNM, the access points to SNM and the uncertain human factor potentially exploiting this access.

Mason Willrich* (1971a) places these aspects in useful perspective. His summary of the subversive problem vis-a-vis the domestic and international safeguarded nuclear industry is therefore extensively quoted at this point:

> The availability of large quantities of fissionable materials in civilian nuclear industries will create major control and security problems within nations as well as internationally. Whether or not it is engaged in military diversion, a national government would need its own assurance that fissionable materials are not being diverted by any subnational entity. In many respects, the subnational or internal threat of theft from civilian nuclear industry will be more serious than the threat of diversion sanctioned by governmental policy.
>
> Possible motives for private theft of fissionable materials are easy to find. The materials have a high economic value—plutonium is worth more than platinum. For explosives, such materials could have an extremely high value to revolutionaries in the country where theft occurs. Moreover, either revolutionaries or governments seeking to acquire a secret stockpile of nuclear explosives would be possible customers in a world-wide nuclear black market.

*Professor of Law, University of Virginia, who has dealt in nuclear policy issues since the early 1960's in consultant and staff roles.

Finally, the horrible mischief a very few brilliant but demented minds could accomplish with a small quantity of material should give us pause at a time when bomb threats and actual bombings occur with increasing frequency in our cities. How should the major of a large city respond to a telephoned threat that the business district will be blown up with a twenty-kiloton nuclear explosion unless certain "political" prisoners are released, if he knows only one thing for sure—that the threat could be real?

Here the interests of national governments in protecting themselves from revolution and their populations from a major catastrophe reinforce the interest of the world community in assurance against military diversion. Not all nations will share the same attitudes toward the internal security problem, however, and some may be reluctant to establish the kind of domestic control system that will be adequate to handle the problem. Acceptance of international safeguards could have a salutary effect in this regard. The records, reports and inspections that international safeguards require are much the same as those required for an effective domestic system of accounting for fissionable materials.

In one major respect, however, international and national control systems would diverge. An international system cannot include physical security measures such as armed guards, even where these would be necessary to ensure against theft. If IAEA inspectors were armed, the IAEA would be converted into an international police force—a politically unacceptable result. Nor can international safeguards include a personnel security system to ensure that employees in nuclear industry are not subversive, even though such measures may be warranted as part of an adequate domestic control system. It is ironic that security may require civilian nuclear industry to be open to international surveillance while closed to certain domestic citizens.

Finally, it is important to stress the crucial role the United States will play. In 1980, almost half the world's nuclear power capacity will be located in the United States. An even larger proportion of the enrichment, fuel fabrication, and chemical reprocessing capacity will be there. It would probably be a great mistake to put all U.S. peaceful nuclear facilities under international safeguards in line with

President Johnson's offer of December, 1967. This would overburden the IAEA with safeguarding responsibilities where they do not really count. In order to place U.S. nuclear industry on the same competitive footing with nuclear industries in other countries, the objective of the offer could be met by placing under safeguards selected facilities representative of various types of nuclear technology.

Civilian nuclear industry in the United States, however, might well be viewed as the most likely source of fissionable materials on a world black market in view of the enormous quantities available and the notoriety of organized crime in America. It would be incumbent upon the U.S. Government to provide the rest of the world with assurance that its domestic controls were adequate to prevent theft.

Toward an understanding, then, of the tenuous nature of these assurances we examine the prime sources of concern: the fissile materials, the facilities and the people.

Attractive SNM Types and Quantities

Threat analysis in the field of intelligence evaluates both the intent and capability of group activity directed against the nation. For the threat to be credible a capability compatible with the perceived intent must be available to the group and/or perceived by the decision maker. The key capability requirement for INW fabrication is SNM.

The present large and increasing quantities of SNM characteristic of both the weapons and civil nuclear industries present a hazard to society implicit in the very existence of these materials. This is because it is one of the necessary conditions for a credible INW threat (whether based on actual fabrication or not). Needed are methods of materials (and other) controls (safeguards) which can keep this hazard from being converted to a viable menace (i.e., a social risk) as enabled by INW fabrication.

One direct indicator of the hazard of SNM to society and the susceptibility of the nuclear industry to diversion is the amount of various SN materials the industry uses, processes, produces and stores (Gilinsky, 1967). It is also a less related indicator of the degree of social risk of an INW threat.

Some feel that the threat increases at an even higher order than a linear relationship with the amount of weapons grade SNM.

> The latent threat to world security in civil nuclear power programs is already clear and will grow to staggering dimensions. (Willrich, 1969 p.30).

In an extremal view risk level of plutonium was equated, by some, with weapons.

> It is difficult to envisage any real distinction between a world in which plutonium is widely owned and one in which there are many nuclear weapons. (Beaton, 1966).

Similarly, the Western European Union Treaty of 1954 deems weapons-grade plutonium to be an atomic weapon in itself (Pugwash, 1969). Geesaman (1971) felt that increasing plutonium on the international scene leads (in effect) to decreasing nuclear disarmament. But these views were in the international context where sufficient national resources were basically no barrier to small weapons quantities.

The view taken here is that because of other factors such as industry susceptibility and the impact of resource requirements on small groups, a direct correlation of weapons grade materials quantities to an INW weapon threat is an overstatement. However, we do concur with Gilinsky (1970 p.41) who feels that:

> Despite the difficulty of nuclear weapons design and fabrication, the acquisition of fissile materials in suitable amounts and quality is probably the chief technical obstacle to the initial production of nuclear weapons.

One basis for that view is supplied by Hosmer (1970) who cites the availability of information on weapons design. Further, the Orlando, Florida, threat of 1970 was made sufficiently credible by a "fairly realistic" drawing of a hydrogen weapon from information available to a 14-year-old science student (Congress, Senate, 1971). Geesaman (1971) expressed it this way:

> A mystique of scientific accomplishment surrounded the development of nuclear weapons during WW II. That mystique has become illusionary. The main practical impasse to nuclear weapons manufacturing was perfecting and implementing the expensive technologies for the manufacture of fissionable materials. Gaseous diffusion enrichment of uranium and reactor breeding of plutonium were major industrial projects in their own right, but they are now implicit in the nuclear power industry.

All other factors being equal the material state closest to the final weapon desired by the threat group (i.e., requiring the least input resources) would be the most attractive. Thus, a small tactical nuclear weapon is seen as preferred over other kinds of strategic and tactical nuclear weapons. In material states, weapons grade material ready for machining is preferred over states requiring extended chemical/other processing if both are equally available. Since this is not necessarily so, we briefly consider the suitability of various SNM types for a weapon.

Because of the large number of future reactors (i.e., the significant fraction of the number of facilities), attention has been given to the relative utility of various reactor grade materials for weapons fabrication. In fact, during a recent TV interview (KTTV, 1972) the preference of obtaining weapons material from an illicit reactor fueled by natural uranium was indicated by Chauncey Starr over material from other civil industry reactors presumably because of the lesser fraction of Pu-240 in the former.

Excerpts of some of the comments on materials attractiveness convey the nature of the concerns of a variety of observers. (The perceptions which may be formed by a group based on public press stimuli are discussed later.) One example of materials adaptability from reactor to weapon without chemical processing is the plutonium fuel from zero-energy fast reactors.

> In theory at least it is even possible to build small, compact fast research reactors, the fuel of which might be used directly as the fissile charge in a nuclear weapon. (Olgaard, 1969 p.219).

"A zero energy fast reactor built to simulate the conditions in large diluted cores to be used in fast power reactors, may contain several hundred kg of plutonium." This plutonium, he says, is in a form "suitable for rapid conversion into primitive nuclear weapons."

> It may be objected that the plutonium produced in power reactors is not very suitable for weapons production because of its high Pu-240 concentration. However, there are many indications that this difficulty can be overcome if the implosion technique is mastered to a sufficiently high degree of perfection. The yields may be reduced somewhat and the chances of a fizzle yield may increase but the weapons will after all be nuclear weapons and they will be considerably cheaper than those produced from the so-called weapon grade plutonium. (Olgaard, 1969).

Gilinsky (1970 p.46) contrasts the military product reactors with Pu-240 contaminant kept down to less than a few percent by fairly frequent fuel replacement vs. "typical Pu-240 content in commercial Pu is expected to be about 30 percent. ... Since for practical purposes the Pu-240 cannot be removed, civilian plutonium is generally not suitable for simple, predictable, efficient weapons."

Willrich (1971a p.40) sees the thermal-breeder Pu-240 content as such that optimized (i.e., lowest cost) electrical production produces plutonium not very satisfactory for weapons purposes because of the contaminant. But breeder reactors operating in the most economical way produce high Pu-239 content, well-suited for weapons (Willrich, 1969 p.30).

A colleague of Dr. Prawitz of the National Research Institute of Defense in Stockholm "has become persuaded that he could produce a nuclear explosion from essentially any grade of reactor-produced plutonium that might be available." (Mark, 1971 p.137). Mark further assumes that nuclear explosion means about 10^3 times more energy per pound than from high explosives:

> I have no reason to question such a conclusion, and I would like to warn people concerned with such problems that the old notion that reactor-grade plutonium is incapable of producing nuclear explosions—or that plutonium could easily be rendered harmless by the addition of modest amounts of the isotope Pu-240, or "denatured," as the phrase used to go—that these notions have been dangerously exaggerated. ... This observation would be of (direct practical interest) to someone having no nuclear weapons at all, or no source of high-grade materials...for even weapons of inferior or primitive type.

Hall (1971) cited that a bomb can be made from nuclear reactor fuel materials. In this sense the explosion could be in the range of several tenths of a kt to 1 kt. Commercial plutonium with 10-15 percent Pu-240 was thought to be a bomb denaturant—it is not. The presence of Pu-240 makes the explosion unpredictable but not impossible. Explosion possibility with Pu-240 at 35-40 percent is more questionable but "don't lean on the crutch of Pu-240" (or Pu-238 + Pu-240 + Pu-242) to make it safe.

The fact that the weapon, if fabricated, might be militarily unpredictable and unreliable does not essentially detract from its ability to be an effective coercive instrument. Again, it is because the government, if convinced, would probably operate from a conservative, worst-case decision position. Indeed, the very aspect of unpredictability is related by some to irrationality of act and hence, may intensify the threat. (A 1/100 fizzle yield of a 20 kt design is still a significant threat. The 7 ton "Daisy Cutter" in use in Vietnam has a 1/2 mile blast kill radius (Congressional Record, March 1, 1972 E1842)). Undoubtedly classified, probabilistic data parametric in Pu-240 contamination quantity would be available to a "threat-appraisal group" to determine fizzle yield limits. Its utility, however, would depend on a credible, reliable input from the threat group.

At least three unclassified references (Gilinsky, 1970 p.43; Willrich, 1971a p.38; Mark, 1971) have identified the necessity of the implosion method when using plutonium; e.g., in the first:

> Gun-type weapons make less economic use of precious fissile material but they are easier to design... Note, however, that a plutonium gun-type weapon will not work. If two sub-critical masses of plutonium are brought together in a gun-type device... predetonation would blow the masses apart before an appreciable amount of energy was released.

Because of the significant disparity between Pu and U quantities in the civil industry, we have primarily concentrated on plutonium. However, the advantages of uranium are pointed out by Gilinsky (1970, p.52):

> When available, U-235 is particularly suitable for rapid production of simple nuclear weapons. It requires no reprocessing delay, it is not so toxic as plutonium, and it can be used in simple gun-type weapons.

In fact, even a non-sophisticated assembly may be adequate. In commenting on accidents it has been noted that "the rapid consolidation of a number of pieces of U-235...due to the collapse of shelving could yield a power release equivalent to that from the detonation of a quantity of high explosive." (Morgan and Turner, 1967 p.588).

The (implicit, even if not used) strategy of control at the uranium enrichment point must have been based on the rationale that although future plutonium quantities will be significantly greater than enriched uranium, the technology expertise increment required by the implosion method is sufficient to offset the difference between uranium enrichment under security controls as contrasted with plutonium production on an unclassified, yet safeguarded basis.

Willrich (1971a) feels that even slightly enriched uranium fuel for nuclear power reactors has considerably more weapons potential than appears at first glance when viewed in the light of several considerations. Three of these are:

1. About 80 percent of the separative work required to produce weapons-grade uranium has already been accomplished in enriching uranium for reactor fuel. Therefore, if slightly enriched fuel were used as feed instead of natural uranium, even a small enrichment plant could produce large amounts of 90 percent uranium.

2. Centrifuge technology, like porous barrier technology...is extremely sophisticated. In the 1970's and 1980's very few nations are likely to possess the capability to manufacture their own centrifuges. However, given the incentives for large-scale mass production once the technology has been perfected, the operation of normal economic forces would tend to spread centrifuges widely...

3. Gilinsky (1970 p.50) adds: "Highly enriched uranium could still become an important commercial nuclear material. High-temperature gas-cooled reactors are designed to use as fuel over 90 percent enriched U-235. If reactors of this type become commercially competitive, commercial gas centrifuge plants may be built specifically to produce highly enriched

> uranium." Undoubtedly the recent US decision to promote the fast breeder reactor for commercial use considered this an important factor against the high-temperature gas-cooled reactor.

Hosmer (1971), moreover, decried the notion that the U-235 problem is somehow different from the plutonium problem because U-235 accountability can somehow be assisted by suppression of enrichment technology.

Presently, all information in the US on the porous barriers used in the gaseous diffusion process, including their specifications and manufacturing process is classified. AEC has centralized all development and manufacturing of barriers in a single plant (Willrich, 1969 p.276). Further, since "widespread dissemination of gas centrifuge technology could contribute substantially to nuclear weapons proliferation," the AEC announced in March 21, 1967, that "national security interests would best be served if privately sponsored work on the gas centrifuge process for separation of isotopes were discontinued." (Willrich, 1969 p.14). Certain affected private firms then continued their work on a classified basis. Additionally, as plans to transfer ownership of diffusion enrichment facilities to private firms develops it has been suggested that potential entrants to the enrichment business be on a need-to-know basis and under full security protection and that they be given full access to all information developed by the AEC barrier program. After an interim 5-10 year period private firms would be permitted to engage in barrier manufacturing and R&D (Willrich, 1969 p.276).

Further inroads into this philosophy of containment/control at the uranium enrichment part of the cycle and hence of increasing susceptibility are evident with W. Germany, Netherlands and Great Britain engaged in major research work on the gas centrifuge process (Gilinsky, 1970 p.49) and the announcement of its construction in Netherlands. In South

Africa construction has begun on an enrichment plant which will operate on a "unique" process (AEC, 1971). France, Canada, Congo, India, Italy, the Soviet Union and West Germany are separately contemplating the extent and method of their future involvement in the enrichment business. There is the recent announcement that Japan is considering building a one billion dollar enrichment plant in the US to "...solve the question of secrecy, keeping in the US the technology of Uranium enrichment through gas diffusion." (Washington Post, February 5, 1972). And beyond,"...even the secrecy wraps may be discarded sometime in the future." (Seaborg, 1971 p.302). This method has probably been used by the US to forestall Japan's earlier efforts to build its own gas centrifuge enrichment facility. (Japan is highly committed to reactor energy sources.)

Seaborg (1971) has also commented on security control loosening:

> As of 1970, no full-scale gas centrifuging plant with appreciable capacity had been built. One drawback has been the reluctance of the nuclear powers to divulge enrichment technology of any kind. The reason, of course, is that enrichment technology is important in the manufacture of nuclear weapons. Although it is unlikely that enrichment technology will be made freely available to everyone, it is probable that a limited number of industrial concerns in the US and friendly nations will participate in the expansion of this technology. Uranium enrichment is big business...

And the further reason for such pressures:

> ...only with industry's participation can the great expansion in the required (enrichment) production be achieved.

And we now find that:

> ...for one thing, we must deliberately plan and scheme to capture the lion's share of the huge uranium enriching business now developing overseas. (Hosmer, 1972).

> If the gas centrifuge process is economically feasible—the cost barrier to enriched uranium will be lowered. (Willrich, 1969).

Thus, by successive steps such as the technological "end runs" of other nations and our own needs to increase U-235 enrichment facilities, a significant remaining barrier to SNM materials access will soon be removed. Finally, at the end of 1971, 22 US firms had been selected for access to the uranium enrichment process technology. The US also offered to engage in discussions to explore the possibility of sharing its gaseous diffusion technology on an international basis (AEC, 1972 pp.10,11). A separate technological development, that of the laser trigger for fusion weapons, may be of future, similar concern (Novick, 1968).

Many have spoken of the significance of the increasing quantities of SNM (e.g., Gilinsky, 1967; Willrich, 1969 and 1971a; Taylor, 1971). Projections of the apportionments of various material states within the civil industry (AEC, 1971) and internationally (Shmelev, 1970) have also appeared in the literature. We focus now on comparing the approximate total quantities of SNM in the form of weapons grade U-235 and Pu-239. Of interest is the historical buildup of these materials in both the weapons and civil industries (Pu-239 only) and the projected growth

Here we primarily emphasize Pu-239 quantities in the civil industry but similarly caution the future significance of U-235 as discussed. As presently forseen, though, the quantities of weapons grade plutonium will far surpass weapons grade uranium supplies.

Figure 5-3 contrasts the projected cumulative growth of US civil industry plutonium (Seaborg, 1971; Gilinsky, 1967; Taylor, 1970; Crowson, 1971)* with the crudely estimated cumulative growth of all SNM

*As well as converting annual nuclear generating capacity (AEC, 1971; Congressional Record, February 23, 1972 S2391 and Barfield, 1971) at .3 ton Pu per 1,000MWe per year.

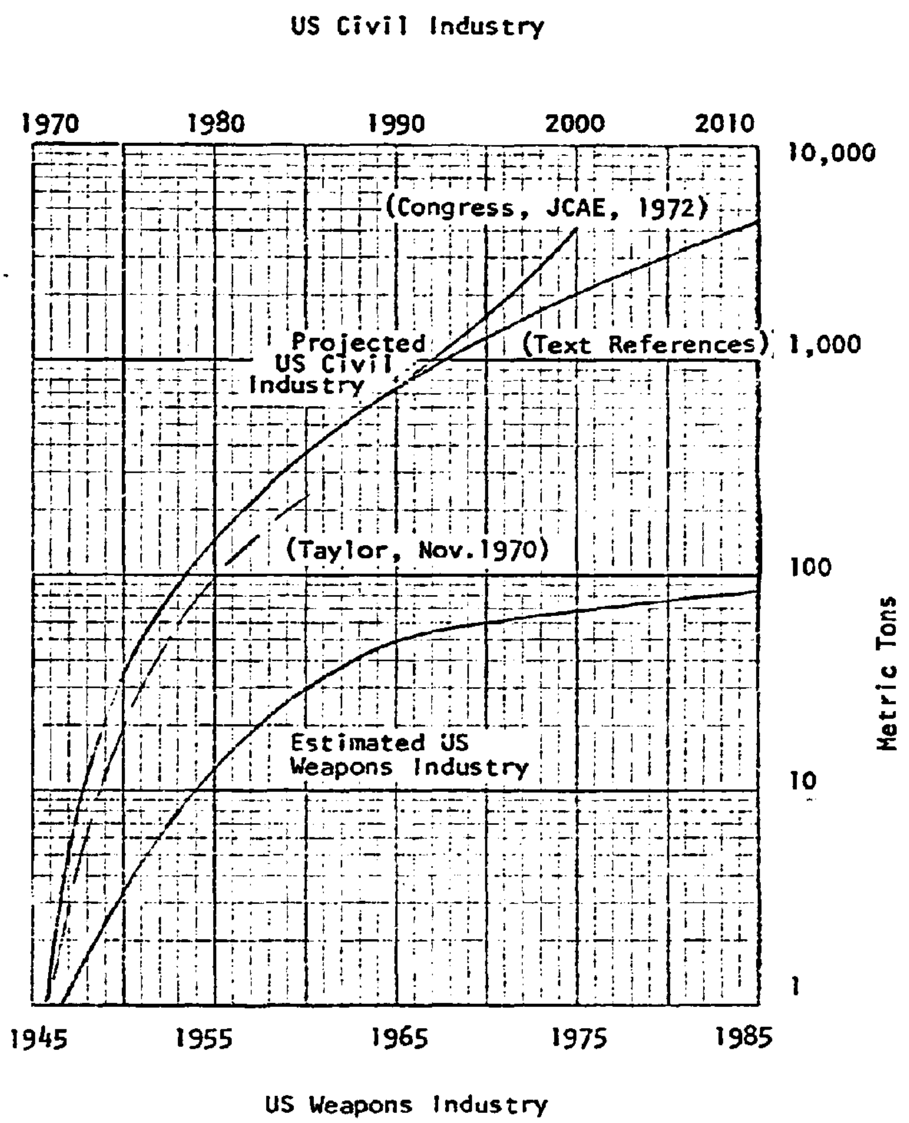

Figure 5-3. A Comparison of Cumulative Plutonium Production

within the weapons industry. Of significance is the fact that the quantities of plutonium alone in the civil industry demonstrates a faster growth in equal time than the weapons industry and that in several years the holdings of the US civil industry will surpass that of the weapons industry (Crowson, 1971) and reach a far higher assymptote of yearly production rate.

Few references are available for the weapons industries estimates. Lapp (1961, 1962) describes the factors he used in such an estimate but revealed only a few approximate points. The Yearbook of World Armaments and Disarmament (SIPRI, 1969/1970) provides additional data, and Emelyanov (1963) a comment. Separately we have estimated the number of Pu production reactors (each 1,000 MWe) as a function of time assuming 3 through 1950; a progressive increase to 14 by 1960 and a progressive cutback to 5 in 1970 starting in 1964 with a weapons grade production rate of .3 kg/year/MWe at about an .8 duty cycle. A comparison of these plutonium estimates to the total weapons SNM (Pu-239 and U-235) can be made via the published data on the buildup of strategic and tactical warheads quantity and total yield and an approximate yield to critical mass weight ratio (adapted from Berkowitz, 1970), Figure 5-4. These ratios, of course, are meaningful for conversion only in the context of fission weapons. Some, however, have used an approximation of 5 to 10 kg of SNM per nuclear warhead to relate warhead quantities of all types to the required SNM production (adapted from SIPRI, 1969/1970).

In contrasting the quantitative levels of plutonium in the civil and weapons industries we are struck by the implications of the inequalities in Table 5-3. We see that both factors, SNM quantities and security practices, are operative in a manner to aggravate the threat potential to, or the relative susceptibility of, the civil nuclear

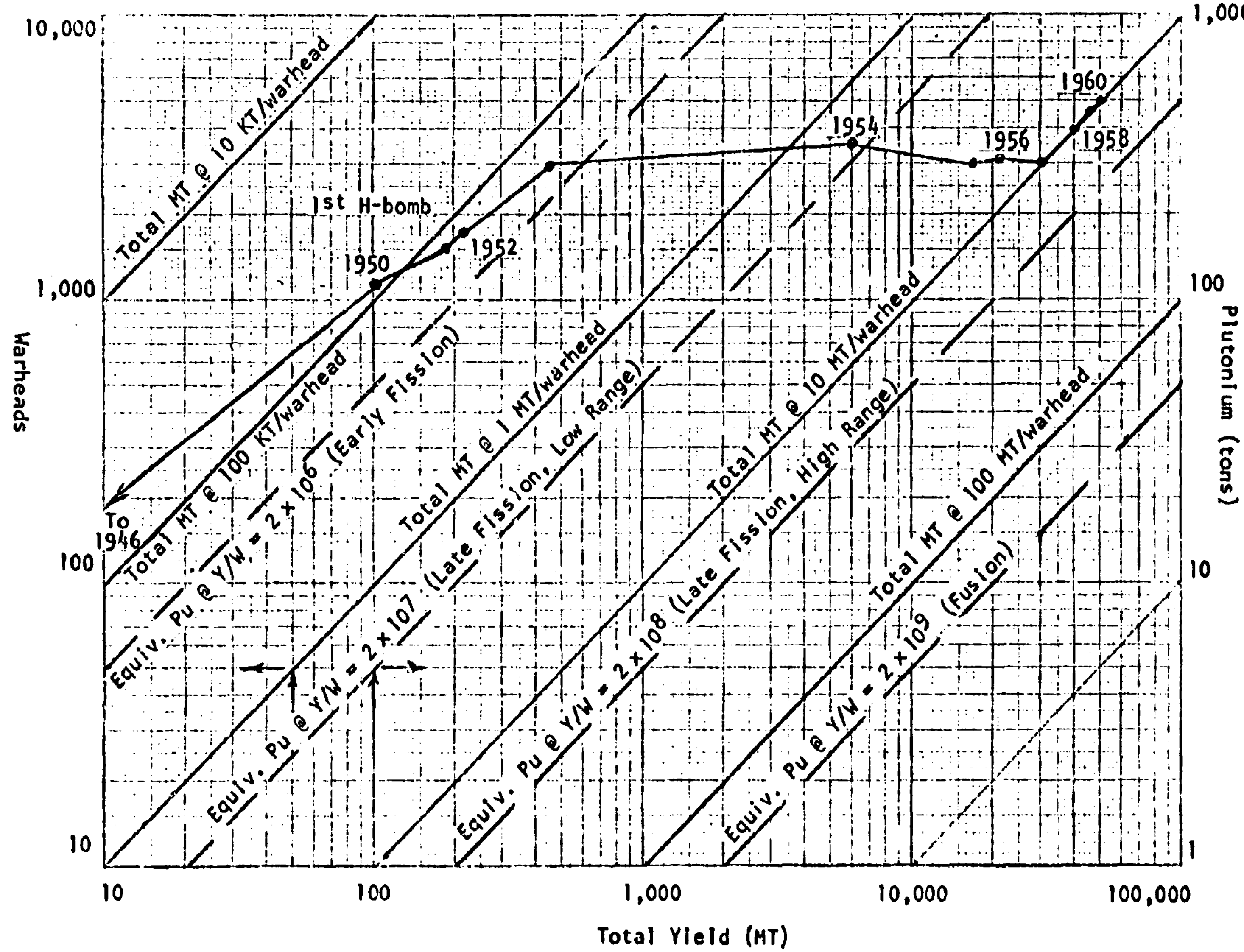

Figure 5-4. US Strategic Nuclear Weapons Inventory

[An explosive yield in the 20 KT range requires 20-30 kg of U-235 or 5-10 kg of Pu-239 (Willrich, 1971a p.38)]

Table 5-3. An Industry Comparison

Item	Weapons vs. Civil
Pu quantities (e.g., post 1975)	$<$
Accounting/material management sophistication	$\approx$
Facility security	$>$
Personnel security	$>$
Transportation security	$>$

industry rather than to be nullifying. With this in mind we next discuss some of the characteristics of the nuclear industry which may be viewed as possible, attractive routes of access to SNM by a threat group.

Facilities and People

Facilities. It is easy to conceptualize industry susceptibility indices parametric in material status (form and location) and other essential categories. Such an assessment is a necessary input to the quantitative systems study discussed earlier. However, most of the data is lacking and probably will, in the limit, be only subjectively quantified. Several Kansas State University programs closely correlated probability of diversion (of a given material type) to a subjective poll of relative concern about the type to determine safeguards apportionments (Rappoport, 1971; Costanzi, 1972), (Table 5-4).* Given a

*It seems that this table may be primarily reflecting concern about the consequences of such a theft more than the degree of vulnerability to theft, e.g., the differences expressed in the concern about UO_2 (90%) and UO_2 (5%) which we presume are about of equal theft ease.

Table 5-4. Perceived Vulnerability of Nuclear Materials to Diversion*

SNM	Concern Index	Subjective Equivalent
PuO_2 and UO_2 (90%)	3.8	greatly concerned
Pu $(NO_3)_4$	3.3	concerned +
UO_2 (5%) and UO_2 (NO_3)	2.2	somewhat concerned +
UF_6 (5%)	2.0	somewhat concerned
U_3O_8	1.8	somewhat concerned -
Liquid Waste	1.5	no to some concern

*Based on the question: "Which form is most vulnerable to diversion—Indicate degree of concern associated with the vulnerability to diversion of each substance."

Index	Subjective level of concern
1	no concern
2	somewhat concerned
3	concerned
4	greatly concerned
5	extremely concerned

[Adapted from Leachman (1971)]

distributed, quantitative a priori diversion threat it is relatively straightforward to apportion a quantifiable detection and/or deterrent capability which are functions of inspection cost. But the a priori diversion threat is essentially qualitative and subjective, rather than historical and quantitative. The following are some of the subjective comparisons.

> The most important control point is at the plutonium chemical separation plant, since plutonium does not become useful for military purposes until it has been separated from the irradiated reactor fuel. (Prawitz, 1969).

> ...we think...fuel enrichment and reprocessing...are the highly critical points in the cycle. ... The task of providing assurance that materials are not being diverted is formidable and it will become more so as the peaceful industry using nuclear materials continues to grow in size and complexity. ... The present (1971) number of about 200 facilities will grow to about 225 to 250 in 1975 depending on how many reactors come on stream, ...how many reprocessing plants are put together, and particularly how many get into the uranium fabrication business...the large number of facilities are basically reactors... the rest about 10 to 12... (Crowson, 1971 p.187).

> The other possibility of loss in the system...is in the transportation business, when the material is handled basically as an article of commerce... For the government operated facilities there is essentially an analogy to a good portion... (of civil industry), particularly reprocessing plants, plutonium and the fuel fabrication and gas diffusion plants. (Crowson, 1971 p.187).

We believe there is a significant difference in the susceptibility of the weapons and civil nuclear industries to materials diversion. This difference is primarily that effected by security controls. In one statement this difference was not emphasized much:

> The environment in government plants is somewhat different from the environment in which a nuclear power industry operates... nevertheless the experience of all types of plants in handling nuclear materials should be useful. (Crowson, 1970 p.30).

Undoubtedly a threat group would perceive a significant difference in access. Alternately, there would be a higher probability of an "inside man" within the civil industry than within the weapons industry.

Many have focused on the transportation link as the maximally susceptible aspect of the nuclear industry:

> ...anything that organized crime wants to lay his hands on, while it's in the transportation cycle, it's going to get... (AEC, 1969).

One of the anachronisms of AEC policy is that strategic nuclear materials which are to be used for military purposes are shipped under military rules. But, if the same materials are to be used for civilian purposes, although they too could fuel a bomb, they are usually shipped in the words of Crowson (1971), "like a special delivery letter." A significant amount of concern has also focused in recent Congressional hearings on the susceptibility of the transportation links for must of the rest of US industry (Bible, 1972). At J. F. Kennedy Airport:

> ...air mail, parcel post thefts of securities, cash, diamonds and other high value items were estimated at \$65 x 10^6 from 1967 through 1969. At some airports today...US Postal Service guards are "riding shotgun" on ground vehicles...the Postal Service in 1969, 1970 and 1971 levied fines against 15 of the 16 US domestic air carriers operating under mail contracts out of Kennedy Airport because of lax mail handling practices or for losses.

Current experiments relative to the pending "customer port security act" in the pilot project at J. F. Kennedy Airport reported a one year's decline of 69 percent in dollar value of stolen goods (Rossides, 1972).

Well before the end of the century an extensive and complex transportation system will be necessary to ship plutonium fuel to new plants and to move large quantities of radioactive products from light water and breeder reactors. The AEC projects about 9500 annual shipments of spent fuel from nuclear plants by the year 2000 and 20,000 by the year 2020 (Barfield, 1971). Graphic descriptions of transportation requirements are evident in the shipping container quantity projections (AEC, 1970).

One extreme proposal to reduce the susceptibility of the nationally dispersed elements of the fuel cycle considers a consolidation of practically the whole fuel cycle at the nuclear reactor site. Certainly this composite reduces or elimi--es the risk associated with the transportation link, but from a national defense viewpoint it elevates it in target importance.* Edlow and others concluded at one point that a real set of safeguards for the transportation cycle would have to be via AEC regulation of that industry (Edlow, 1969).

We have not reviewed the recent study conclusions on transportation security but decreases in susceptibility can be expected from the implementation of the updated regulations and the recommendations in other symposia.

The significance of these proliferating materials, facilities and reactors and the interconnecting transportation links which enable the SNM movement can be simply demonstrated. A probabilistic description of cumulative probability of risk as a function of the increasing number of ways that a transportation link may fail is straightforward. It can indicate, too, the required defense capability change in keeping

*The number of electrical energy generation sites in the US will decline by about 1/3 by the year 2000 despite the doubling of energy demand every 8 to 10 years.

with industry growth to maintain a constant risk of diversion. Though both present and future threat probabilities are subjectively estimated as very low, it is of significance that, using the above proliferating link/materials rationale, it seems possible that there are several orders of magnitude of risk increase projectable for the next 30 years.

People. The extent to which the civil nuclear industry clears or screens employees is unknown (some attempts to determine this were unsuccessful). There is, however, reference to the fact that Nuclear Fuel Service had 1/3 of its personnel cleared in the late 1960's and was now clearing all of them (Shapley, 1971). Pertinent to determining this aspect of industry susceptibility would be criminal conduct after clearance. The question would be if there is a significant difference in criminal behavior in the cleared and uncleared personnel groups. There are probably rather good quantitative data on the efficiency of various screening methods. To wit, the degree to which cleared or screened personnel for specific duties (such as weapons handling) either later performed and/or fantasied illicit acts. Some examples are in Larus (1967): the Air Force man who took a B-47, a classified incident, and the fantasied take-over of a Polaris submarine (Lewis, 1971). Previously we cited the 7-year Con Edison employee who caused significant reactor site arson damage, and typical rejection rates of people being screened for Q-clearance. Within the last decade various civilian industries have augmented their conventional employee screening methods with polygraph tests.* Great screening claims are made by advocates of this approach. Rejection rates as high as 30 percent to 50 percent of all and police applicants are reported (Ferguson, 1971). [See Table 5-5.] Undoubtedly this significant difference in rejection rates must be explained, in part, by the differences in initial applicant groups. A significant level of "self-screening" must deter many people from security clearance applications, regardless of reason.

Although the Lumb panel in 1967 recommended that personnel having access to significant quantities of unclassified special materials should have the lowest level security clearance (Shapley, 1971), this facet of safeguards is still under review (Crowson, 1970). There are negative reactions about personnel security clearance, of course. One AEC trucking consultant retorted that "making security checks on shipping personnel, for example, was retrogression not progression." (Edlow, 1969). Within Congress there has been considerable debate on a bill sponsored by Senator Ervin (1971) guaranteeing civil rights in government pre-employment screening. In contest is the use of the polygraph which, it is contended, should be limited only to the needs of NSA and the CIA. Recent hearings have reviewed the scope of clearance operations within the government (Congress, House, 1971).

*It is of some surprise to find the extensiveness of its use in other than government sensitive position clearances: During 1968, 3,000 polygraph examiners (in the US) conducted in excess of 500,000 pre-employment tests for private industry (Ferguson, 1971). An estimate by Franklin (1971) was 4,000 to 5,000 polygraph practitioners and about 200,000 polygraph tests in 1971. In 1963 (the last year of available data) the US government conducted some 19,000 polygraph tests (other than for CIA and NSA). AEC used it in only 1 of some 23,000 security clearances. FBI used it in only .14 percent of investigative matters.

Table 5-5. Polygraph testing cited by Ferguson (1971)

57 percent of a series of police applicants were turned down because of admissions to burglaries, robberies, auto thefts and rapes. 1/3 of a group of police applicants accepted (after all other testing) should not have been accepted. Zale Corporation (world's largest jewelry concern) uses 10 full time polygraph examiners on its staff.* A Chicago bank with annual deposits of greater than $120,000,000 gives polygraph tests to every applicant. 98 percent of the employers of a group of 4,000 thieves did not know their past histories. 70 percent of all persons tested for positions of trust with the polygraph pass it. One bank got 80 percent of its workers to admit thefts averaging greater than $2.00 per week. 13 percent of a survey group of Texas business firms use it.
Ferguson states that every employer wants to ascertain six basic factors contained in the makeup of every prospective employee. These are: 1. Are you who you say you are? 2. Are you what you say you are? 3. Will you fit in? 4. Are you physically capable? 5. Can you work in harmony with other employees? 6. Can you treat customers (and/or equipment) the way they should be treated?
*In contrast, Bonwit Teller recently announced its discontinuance of polygraph screening of its employees despite an annual 4 percent merchandise loss (Santa Barbara News-Press, July 18, 1972).

CONCLUSIONS

A very real dilema was created with the introduction of the "Atoms for Peace" concept. Formerly classified information and material was declassified to implement the concept. That very process changed the use and availability of the information and hence changed its character. This, however, was and is not true for the SNM. The SNM declassification process which made it available to the civil industry, in effect, created a "cognitive dissonance" which is at the very core of our current problem. That is, the SNM was (after the declassification) what it always had been—the direct or prototype resource for a nuclear weapon. We are aware of this fact as a nation and yet are seemingly unaware, i.e., there is a desire for us to reconcile this dissonance. If it cannot be done logically, it is done emotionally. In one sense the two response examples we used (Eisenhower and Lodge) follow this pattern. Both were able to reconcile the coexistence of the weapons—peaceful nature of the same material. To wit:

> ...the scientists will find a means of control.

and,

> The future proliferation of plutonium is not necessarily so.

The civil industry can override this conflict with pragmatism: "We have a business to conduct." Other decision makers may find the emotional outlet in the logic that solves the problem, variously: "The risk of detection will deter" or "The threat group has an almost zero probability of success" or similar rationales.

In contrast, a very real and credible reason for no further safeguards might be that other sources of mass threat risks within our society already exist and surpass this one of consideration. If this is not so, we feel that prudent action would seek to remove as much of the preemptive initiative from a threat group as is possible; i.e., by handling the SNM for what it actually is—and as handled within the weapons industry. We recognize that the logic of the pragmatic world also dictates this cannot be done. We cannot really retreat. Other demands presently burden the growing nuclear industry as well. These include issues of reactor safety and development and environmental protection.

Our government sought to compensate for the removal of security controls via materials accounting, licensing and regulatory action and what was considered to be prudent controls. However, much of the thrust for the deterrence of materials theft was relegated to the detailed awareness of nation-wide (and world-wide) SNM residency. It is evident, though, that significant quantities of SNM can be diverted with low risk of detection. Further, the rationale of deterrence by detection is open to question.* There is uncertainty about the functional relationship between deterrence, detection probability and time lag and the response system cued by the detection system. Additionally, the level of performance of each of these variables is less than needed, even if they were highly correlated with deterrence.

Consistent with our view of the questionable ability of the deterrence by risk of early detection and of the inadequate detection performance at "one-weapon" diversion levels of interest we conclude that increased emphasis be placed on the containment and surveillance aspects of the safeguards triad. We also recommend continued improvement of the materials accountability and management systems.

*A current, powerful example of the inability of detection systems to deter is that of hijacked aircraft. Too many weapons have still been secreted on the person or in the carry-on luggage of the skyjacker, despite publicity on the screening/detection policy and the implied risk. There are other examples.

The risk of personnel access to SNM lies within a spectrum of potential societal impact bounded on one end by decaying, sensitive information and at the other end by the controllers of nuclear weapons. To make the personnel screening even more selective at this extreme end the military uses the "two-man rule." In the misused limit, however, such scrutiny of one another's behavior leads to "small-group police states."* Have we thus posed ourselves the dilema of wanting the "fruits" of a clearance process without sanctioning its use? We feel that the logic of the situation calls for equal screening for persons with equal scope of SNM access regardless of which of the two (weapons or civil) industries provide this environment. We recognize, again, however, that the pragmatics of social and political change can and do effect a different resolution. We are left with merely arguing the degree of a significantly different kind of security for SNM whose only difference is a label marked: "for peaceful use only."

Therefore, we conclude that in the area of personnel it is not necessary to identify or implement the screening program as one that is identical to obtaining Q-clearance. What is important, however, is that some effective employee screening and review program be consistently maintained that selects persons of trust who are sensitive to the implications to society of any potential malpractices. Many other civil

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*Dr. Paul Eggertson, member of the Human Resources committee has said, "neither that committee nor any other group would ensure that only 'safe' people could deal with nuclear weapons. ... We begin to perceive our bombs may not always be in safe hands." (Clarke, 1972) Professor John Raser identified two basic assumptions of such screening:

(1) carefully selected men will retain cool judgement in an intense crisis.

(2) if one (man) fails, others will act as a fail-safe device;

and added, "Behavioral science research shows that both assumptions are almost certainly false." (Clarke, 1972) industries where an employee criminal act primarily affects only that industry find themselves accepting, as a condition of employment, extremely rigorous screening and analysis requirements. It would be highly remiss to ask less of persons within the nuclear industry who have access to materials, information and equipment whose misuse can have still unexperienced, but harsh, societal impact.

Possibly such a screening is even more vital than that accorded people who are to have access to highly classified and sensitive information. By its very nature, and as evidenced by the information security practices of the US, almost all such sensitive information is of temporal nature—decaying usually within a decade or so to much lower status. Diverted SNM has, of course, a far longer half-life. Within a small fraction of that time one can find the tolerance for many abortive attempts to fabricate an illicit nuclear weapon.

CHAPTER 6

EXTRAPOLATION TO SUPERVIOLENCE

This short chapter serves as a transition between the background material presented and the balance of the report. More importantly, however, it formulates a hypothesis associated with the concept of superviolence, and raises some fundamental questions regarding the appraisal of unquantifiable issues which, we believe, each reader must answer for himself. The background and motives thought to underlie past political violence and the insights drawn from the fields of psychopathology and criminal behavior are brought to bear on the question of superviolence. The review of the nuclear industry identifies policies and practices which affect the opportunity for acquiring supplies of special nuclear material. The chapters to follow address the technological and human aspects of efforts to acquire and use exotic weaponry illegitimately. Before moving into these latter areas, however, we pause to raise the question whether the possibility of illicit use of mass destruction weapons is simply a logical extension of these background elements, or whether it is a concept different in kind. We advance the hypothesis that the latter is indeed the case on the grounds set forth in the balance of this study. In short, we postulate that there is a gap between the forms of "ordinary" violence that have been experienced and the forms of superviolence about to be described, and ask the question: How does one extrapolate across this gap?

THE CONCEPT OF SUPERVIOLENCE

Having used the term "superviolence" previously in an implicit sense, an explicit statement of the key elements which it has come to convey during the course of this research is attempted here. Three elements are involved: the occurrence of civil violence unsanctioned by legitimate authority, the magnitude and impact of death or destruction produced, and the involvement of an exotic instrumentality: nuclear, chemical or biological weapons. Situations in which each element is clearly defined and easily recognized present no problems of inclusion in the defined set. Marginal cases, however, can arise. How widespread, and within what community, might violence be condoned to the extent that it can be considered legitimatized? How massive must the "mass destruction" be to qualify? How selective or indiscriminate must be the attack, what mode of use might be contemplated and by whom, what degree of technical sophistication must be involved before an act can be termed one of superviolence? The boundaries of the concept are hazy; we cannot answer these questions because no historical cases satisfying the essential elements of the definition exist. Consequently, what is said here must be considered highly speculative.

From Carthage to Hiroshima, history affords many examples of mass destruction under wartime conditions; from the slave raids of the ancient world to the revolutionary birth of many modern nations, the same is true under ostensibly peacetime conditions. In the past, technological limitations required the destroyers to be much more militarily, psychologically, or economically powerful than their victims. The technological achievement that made possible the atomic bombing of Japan stemmed fundamentally from the economic ability of the United States to engage in a world war and a Manhattan Project at the same time. Today this is no longer true. Progress in the technology of death and destruction has advanced to the point where a few qualified individuals, with significant but not unreasonably great resources at their disposal, can accomplish the necessary technical action. But technical capability by itself is not the sole determinant of the superviolent act. Motivation and psychopathology sufficiently potent to overcome normal restraints and the impetus of a situation which can evoke the need for superviolence are ingredients as essential as technical capability. All must be combined to produce the act.

THE EXTRAPOLATION PROBLEM

Conventional, politically motivated violence provides a baseline from which to measure the gap to superviolence. Confrontation tactics, shooting, bombing and arson, aircraft hijackings, and kidnapping of politically important individuals are comprehended as familiar forms. Bank robberies to finance the activities of militant groups, accumulations of firearms of all types, and the psychological warfare of verbal threats and furious rhetoric add to the violent tenor of our times. To account for this level of violence, it must be assumed that dissident groups in the US comprise a sufficient number of persons willing to commit such acts and having the necessary financial support.

In a society as wealthy, technologically developed, and mobile as the US, the availability of varied resources for troublemaking is beyond question. The combination in modern cities of high population concentrations and important economic and political resources, coupled with the vulnerability of many critical services on which the life of those cities depends, offers many new opportunities for the escalation of violence. If damage to the civil sector were the terrorist's intent, how many better targets than an Army-supported mathematics center on a university campus might he think of? Consider the chaos and loss that would result from the same size explosion at a major telephone exchange in a large city, an electric power plant and its grid connections, a vehicular tunnel beneath a river during rush hour, a water supply pumping station or purification plant serving a large community, or for that matter its sewage disposal plant. All these targets can be effectively attacked by conventional means. Consider the ease with which a relatively small number of people could (and do!) set massive forest fires by choosing an opportune time and place. Consider even the special impact which would result from the coordinated occurrence of violent acts which, individually, are all but ignored by the general population. Each of these types of acts could easily transcend what has been experienced without invoking anything in the way of novel technology, yet each represents a further step into the gap.

Further steps, however, can be taken. There are a handful of examples of planned or accomplished acts which point in the direction of superviolence by virtue of their technical innovation or potential impact. Although too few to warrant generalization, they do suggest some of the steps through the gap. In the recent bank vault bomb plot, time bombs were placed in safe deposit boxes in nine separate banks, three each in New York, Chicago and San Francisco. The novel element in this case was the use of an inexpensive, day-date, battery powered clock for the timing mechanism. (San Francisco Chronicle, January 8, 1972, pp.1-3). The combination of seven day week and thirty-one day month allowed the perpetrator to preset these bombs to detonate at a selected time up to 217 days from their activation. The fact that one of the nine appears to have accidentally detonated in advance (Bank of America, San Francisco), that they contained only a small, black powder charge, and that the individual who constructed or emplaced them divulged their location are immaterial to our thesis. What is important is the fact that a product of our technological society was used in a novel manner to underscore the threat of similar violence to come. Another, more recent example of unbridled terrorism on the international scene was, of course, the Lod airport massacre in Tel Aviv.

There is some evidence that a fascination with chemical and biological agents exists among militant and dissident groups. Minutemen leader Robert De Pugh has been quoted as saying:

> The first batch of nerve gas I ever made—of course it's a liquid, not a gas—I figured what I thought would be the minimum lethal dose, a minimum effective dose for this dog. I just wanted to see if I had the thing right, you know, and I figured the minimum effective dose and then I cut that by ten, and I put it on the dog's nose, and the dog walked six steps and dropped dead. (Jones, 1968 p.37).

Operating from the Biolab Corporation, a veterinary drug firm he ownes in Norborne, Missouri, De Pugh claimed to have developed a virus which he would spread by sprinkling it on the floors of major airline terminals. Although the details are somewhat ambiguous, a group within the Minutemen organization were allegedly involved in a plot to introduce hydrogen cyanide gas into the air conditioning system of the United Nations building in New York. Nor is interest in biological warfare confined to the militant right: the Army reported having been alerted to a plot to steal biological weapons from Fort Detrick for use in poisoning a city water supply. Several newspapers indicated that the Weatherman organization was involved, and that it planned to obtain the weapons by blackmailing a homosexual officer at Fort Detrick. (New York Times, November 21, 1970).

The biological plot which has perhaps come closest to fruition was that disclosed in January 1972 when Allen Schwander, 19, and Steven Pera, 18, were charged with conspiracy to commit murder by introducing cultures of typhoid fever bacteria into the Chicago water supply.

Although the scheme was uncovered before the final act, the State Attorney's office told the court that Pera, a Chicago City College student, had apparently developed a culture in a school laboratory where a quantity of it was found. Pera had worked as a volunteer at a Chicago hospital medical center, but was ordered off the premises when it was learned that he had grown bacterial cultures there and had attempted to obtain chemicals without the proper authority. The motive in this case was associated with an organization named RISE which Schwander and Pera had formed. State's attorney E. V. Hanrahan reported that they had "planned poisoning water supplies and spreading deadly diseases in Illinois and elsewhere. Members of RISE were allegedly to be inoculated and immunized enabling them to survive poisonings and diseases to form the basis of a new master race. Water filtration plants in the Midwest were allegedly to be infected with typhoid and other deadly bacteria." (Los Angeles Times, January 19, 1972). What little information is available indicates that RISE was poorly conceived. Not only was it discovered in time, but the choice of Salmonella typhi as the organism poses only a moderate threat; they are destroyed readily in water by the routine methods of chlorination (Smith, et al., 1960 p.381).

At least one extortion attempt based on an illicit nuclear weapon threat is known to have occurred, but this proved to be a sham. In this case, the city of Orlando, Florida, was threatened with destruction by a thermonuclear weapon unless a ransom of one million dollars was paid. For validation of the threat, a drawing of a nuclear device and a small sample of uranium metal were supplied along with a claim that the material was obtained from an AEC shipment. Evaluation of the drawing was accomplished on an ad hoc basis by an armament officer at McCoy AFB at the request of the Orlando police department; the drawing has been termed "fairly realistic." The Orlando authorities involved the FBI in the case, and they checked with AEC to ascertain whether any SNM was known to be missing. A negative response from AEC notwithstanding, the ransom money was collected and made ready for delivery over the course of the next few days while negotiations with the threatener and a regular police investigation were being conducted. Police surveillance of a vacant house indicated in one of the ransom notes finally resulted in the apprehension of a suspect: a 14-year-old boy with a particular interest in "science;" comparison of his handwriting with one of the ransom notes confirmed the boy's confession. The uranium sample turned out to be the kind of material sold as a souvenir at Oak Ridge and other places. What is important about the Orlando case is its evidence of the great potency of the superviolent threat, even though based on the flimsiest kind of validation. As summed up by Senator Stennis: "He got closer to the million dollars than he did to the actual bomb. He did rather well in both." (Congress, Senate, 1971 pp.188-190).

The extent of technological vulnerability in modern society is humorously illustrated by a cartoon depicting a bank robber riding a crane-suspended electromagnet that has just broken through the skylight of a bank computer center; the bank employees in the room are covered by the robber's hand gun. The caption reads: "Hand over the money or we degauss your master file!" (DATAMATION, March 1972).

The half dozen incidents cited illustrate new techniques of terrorism, although at fairly low levels of technical sophistication. They include a demonstration, several conjectures, two aborted plots, and a sham threat. None really materializes as an example of superviolence as we have defined it. Given the extensive resources available in our society, mature efforts at superviolence are largely dependent on whether individuals with appropriate scientific training are motivated to these acts. In dealing with the rare and specialized kinds of motivation and behavior on the part of qualified scientists required for superviolent plots, it is difficult to determine whether general trends are at all relevant. In recent years there has been an increased politicization among American scientists, a group traditionally considered to be as apolitical as any. An example of this trend carried to the point of incipient action was disclosed during the conspiracy trial of the "Chicago seven" when undercover agent William Frapolly testified.

> Froines talked about setting up an underground chemist network. He says there has to be a need for a biochemist in the movement, and then he started talking about how tear gas was made. He said they could get together and they could have the formula for making tear gas, Molotov cocktails, mace, and other devices. He thought it was a very good idea. (Clavir and Spitzer, 1970 p.146).

More interesting than the radical character of this idea is its innocuousness; not superviolence, but tear gas and incendiaries are the tools of the movement. While the extent to which scientists have been radicalized is not known quantitatively and is virtually impossible to interpret, the impression given by the mass media certainly tends toward exaggeration. For example, the newspaper coverage given the 1971 meeting of the American Association for the Advancement of Science emphasized the "newsworthy" demonstrations which occurred, yet only a few talks were disrupted and only one session cancelled because of them, while more than 1,500 scientific papers were presented and 120 symposia conducted.

> The impression created—though undoubtedly not intended—was that this was one hell of a volatile meeting when, in fact, it was generally calm.
>
> The demonstrations were not carried out spontaneously by angered scientists, indicating a great wave of discontent in the

scientific establishment, which would have been significant. They were organized and executed by a handful of radical scientists—no more than 35—loosely affiliated in an anti-establishment group called Science for the People, or more formerly Scientists and Engineers for Social and Political Action (SESPA). They came to Philadelphia for no other reason than to conduct these confrontations just as they did the year before in Chicago and the year before that in Boston.

By the demonstrators' own admission, they wanted to get their message to the people through the media. We graciously obliged. (Drake, 1972).

To return to the question of extrapolating through the gap between conventional violence and superviolence, we have found a few cases which map some of the steps but none which demonstrates the necessary combination of motive, overcoming of restraints, intent, and adequacy of resources. In the following chapters, these questions will be examined specifically for nuclear, chemical, and biological weapons, with particular reference to the requirements for skilled and committed individuals, and the information, time, facilities, equipment, supplies, and security needed. It will be shown that the requirements for mounting significant chemical or biological threats are significantly smaller than those required for illicit nuclear weapon threats. Whether the increased quantities of special nuclear material envisioned for the near future alter this observation is a moot point; the problems of nuclear weapon fabrication are only partially alleviated by greater availability of SNM. While particular techniques of violence have shown a degree of contagiousness in that they are copied and frequently improved upon after their first occurrence, it does not seem possible to decide whether the gap to superviolence will be closed by an evolutionary process of increasingly threatening steps of crossed suddenly in a single massive act of terror.

In summary, we conclude that superviolence is an extraordinary act, rather than an extension of present forms of violence; that it is neither specifically nor uniquely related to the motives which have impelled conventional violence in the past; and that its occurrence is essentially unpredictable.

LEVELS OF BELIEF

As a prelude to the terror techniques and scenarios yet to be described, the reader is asked to consider the following sequence of belief levels relative to the intrinsic nature of the plot: conceivable, possible, plausible, feasible, and practicable. Without indulging in the pedantry of dictionary definitions, we contend that distinctions among the steps of this scale are significantly important in assessing superviolent plots. Explosive fusion devices in which the thermonuclear reaction is initiated by a laser are conceivable, but not yet known to be possible. What is possible is not contrary to the nature of things; this is certainly true of the terror techniques to be examined. What is plausible is superficially worthy of belief. Further investigation may show the proposition to be feasible or readily carried out, but with only an indefinite suggestion as to concrete ways and means. It is only when a scheme is demonstrably practicable, capable of being accomplished by available means, does it become sufficiently likely to warrant serious concern. In all that follows, our assessment of the superviolent threat is predicated on the agent's ability to start with what is at least feasible and, by making definite the ways and means in which it could be brought to fruition, converting it to a practicable scheme. This is not to say that unless a terrorist group has the requisite means available to it initially, its attempts at superviolent acts are not practicable; but rather that the totality of those requirements must be jointly and simultaneously achieved before a plot can be considered to pose a real threat.

Finally, we wish also to suggest the distinction between credible and probable. The fact that practicable, superviolent plots may be credible does not, in itself, make them probable. We know of no objective basis on which the probability of occurrence of superviolence can be estimated. Nonetheless, this is the crux of the matter, the key issue, on which decision making with regard to responses must rest. This question is addressed in the final chapter of the report on the basis of the findings of the threat evaluation.

CHAPTER 7

THE ILLICIT NUCLEAR WEAPON THREAT

THREAT PROCESS: CONCEPT TO CAPABILITY

We consider here the processes implicit in the transformation of group intent to group capability. There are a number of factors involved in carrying the threat process from original concept to final capability. Many of these factors appear most clearly in the nuclear threat case, rather than for chemical and biological weapons or escalated conventional cases, because the former imposes the greatest time, resource and skill demands. Therefore, the flavor of this discussion applies most directly to the nuclear case, but since some of the factors are common to all the cases, this chapter also serves as an introduction to all forms of the threat.

What we have attempted to describe here are the originating, motivating, planning and supporting and implementing steps which the agent group must execute successfully, rather than the detailed technical production steps. (For the nuclear threat, these latter have been the subject of a number of prior studies; some material which we feel warrants emphasis is presented at this point. For the CBW threats, the technical material is contained in Chapter 8.) As a counterpoint we identify dissuasive factors which test the group resolve.

A point which we feel is crucial in examining the illicit nuclear threat is that the characteristics of the INW threat are sufficiently different from conventional bombings and other forms of political violence such that uncritical argument by analogy to lesser threats is more likely to be in error than not. To support this hypothesis, then, we wish to discuss in detail the stages of a nuclear plot.

The process of initiating, planning and implementing those actions necessary for a real threat capability requires: personnel, skills, information, money, facilities, equipment, supplies, security, special nuclear material or weapons and, usually, other specialized and hard-to-obtain material. In contrast, a credible sham threat requires primarily the resources of an effective communication.

The conversion process of intent to capability in each case must coalesce via the perceptions, decisions and subsequent actions of the group in the context of many dissuasive or inhibitory factors and modes of failure. There is undoubtedly a range of wrong perceptions, decisions and actions which can occur and yet permit group success. Often it is because subsequent steps provide corrective "feed-back." Less seldom is it because of compensating errors or the inherent level of tolerance in weapon performance vis-a-vis weapon synthesis.

The basic steps of the process of implementing the threat capability are shown in Figure 7-1. For continuity, some of the use options and subsequent activity are included. Enrichment of each step is typified by the detail of Figure 7-2. Some further explanation of the implications and symbolism of the concept-to-capability conversion process, summarized by Figure 7-2 is in order. The basic, sequential thrust of the activity is represented and categorized by each implementation step. As with all morphologies describing a process, a concern here is toward that level of abstraction which conveys some information of the process while stopping far short of the exhaustive detail characteristic of real life implementation. Thus the next level of significant detail in the fabrication is to be found in the treatment by Taylor and Humpstone (1970), some of which is summarized later. We have categorized

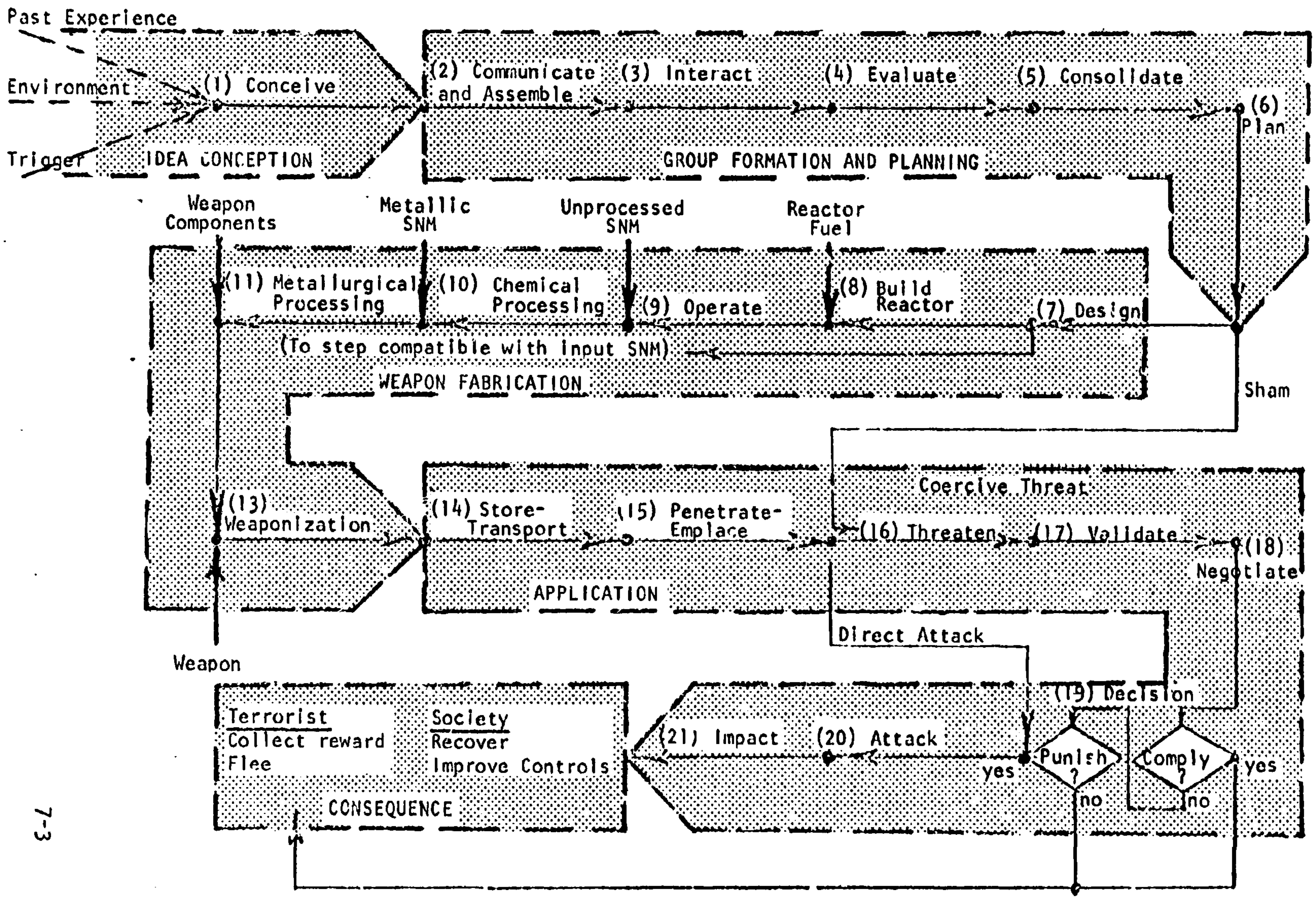
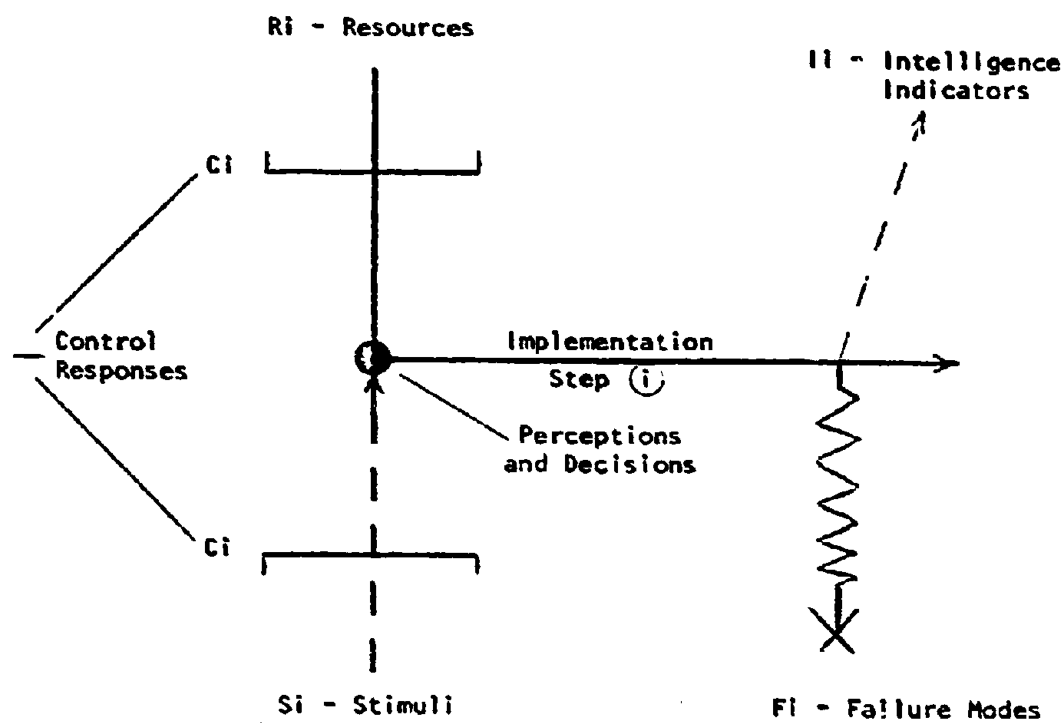


Figure 7-1. Threat Implementation Steps



See Tables Si, Ri, Fi, Ci, Ii.

Figure 7-2. Implementation Step Enrichment the remaining factors to be taken into account for each implementation step into resources and intent stimuli (represented by input arrows), perception and decision making (a node), and intelligence indicators and failure modes (represented by output arrows). Control responses are represented by the "gates" superimposed on the inward flow of resources and stimuli and, presumably, become operative because of: (a) the evidence available from the intelligence indicators of at least one step, or (b) the hypothesized susceptibility of our environment to the threat of INW.

It is obvious that an implementation step cannot exist in vacuo. The stimuli S_i (where i is the related step number), and the resources, R_i, provide these vital input links from the existent environment. And, of course, if the INW process needs these inputs to incubate, it is logical that the control responses, C_i, seek to cut off or inhibit these inputs. Thus, safeguards efforts seek to confront the would-be diverter with physical inaccessibility to SNM and an intellectual repression of the illicit diversion desire, to wit: "I will be found out and punished." This myriad of stimuli and resources is perceived and considered at each point preceding an implementation step as represented by the decision nodes. The essence of the human factors study of Chapter 3 is, of course, that the threat group decision process is warped enough to result in implementing the successive (il)logical action step rather than not. Once the implementation is functioning, intelligence indicators, I_i, of some sort may "emanate;" additionally, the perils of any sort of human endeavor bring with them the spectre of failure, F_i.

In this treatment we have relied essentially on lists of phrases to characterize each appropriate i^{th} group. The extended discussion is usually omitted. The reason for this is that credibility and viability of the INW process is examined, at this point, primarily by an identification of enough of the characteristics of each implementation step to assist a reader-subjective test of the credibility of step fulfillment. By this process one seeks to surface and resolve the discrete factors of disagreement between decision makers and critics as to whether the mass threat, concept-to-capability process is credible and possible. An appropriate concluding detail of such examination is the comparison of the five alternate sources of input nuclear materials (inputting steps 9, 10, 11, 12 and 13), the possibility of group access to each source and the implementation steps necessitated by each alternate.

Idea Stimuli

For some undetermined time prior to the concept of mass threat society interacts with the members of an existent or subsequent threat group to provide the stimuli for it. Certainly the latent threat group is aware of the many past implementations of social threat, Table 7-1. Curiously enough, the mass threat level of our focus has existed only as a sham or as the postulate of some observer or fictional plot. In a different sense, it exists as part of the milieu of social or industrial risk. In the context of war, the mass threat of one nuclear weapon scope has usually been within a larger scope of national threat. Nuclear technology, however, has within the last decade been coupled closer to the criminal mind and talent and afforded small groups the potential of mass threat. This future coupling seems likely to increase. If a person or threat group has seriously contemplated the mass nuclear weapon threat, he must have been constrained more by the dissuasive factors than inclined by the provocative stimuli. To our knowledge there has been only one exception to that statement. The extent to which stimuli, S_1, of the type in Table 7-2 motivated the 14 year old

Table 7-1. Extensiveness of Social Threat

Social Extent	Perceived Image (example)	Criminal Action (example)
Individual	The person as a hostage or target.	Kidnapping, murder
Small Group	The fragile, susceptible, valuable environment of the aircraft and passengers as a hostage.	A hijacked aircraft
Mass Threat (e.g., city)	Macro-society as hostage.	INW threat
Nation	National entity as hostage.	Pre-emptive war

Table 7-2. Some INW Plot Stimuli, S_1

Brain storming
A "lark"
Bring self attention
Revenge
Past failures and frustrations (in context of other weapons and threats)
Goal (target) and incompatibility of present weapons
Nuclear weapons knowledge—and a desire to use skills for the movement
Books, periodicals, movies, TV, drug trips, dreams, brainwashing, post-hypnotic suggestion
Untried neophytes' "leap in dark," i.e., 'why don't we..."
Increasing awareness of characteristics and susceptibilities of the civil nuclear industry
Awareness and comprehension that the concept of INW fabrication or threat is not an absurdity

science student to threaten Orlando, Florida, is unknown to us. (Congress, Senate, 1971). But such may serve as a source to others. In the future, an inordinate or selective emphasis of increasing-context stimuli may motivate an individual or group to initiate the sequence of actions converting intent to capability. The net result may be an abort, a credible sham or a real INW threat.

To what extent does the nuclear industry itself provide INW threat provocation besides being a residence of the hazard? If it does serve as a threat stimulus, what safeguards or other responses would nullify these to render such a threat incredible? Or, alternately, are there still sufficient risks of failure, penalties of required resources and alerting intelligence indicators which provide the needed buffer for society and essentially confirm the adequacy of the planned safeguards? We consider the first question and comment on the last two entries of Table 7-2. The civil nuclear industry may be perceived as susceptible to penetration via a sympathetic or coerced employee. The transportation links which interface with industry and society in a diversity of people, packages, vehicles and routes may be viewed as the access to SNM.

The past (and expected future) publicity speculating on INW fabrication may be another form of this environmental provocation.* It is difficult to evaluate the extent to which statements intending to raise the sensitivity of officials to the need for safeguards improvement or speculating on potential future threats are themselves provocateurs of an INW threat.

*Dr. David Hubbard (Life, August 11, 1972) has cited "several cases where hijackers made their plans by consulting newspapers and magazines and watching television."

In a somewhat analogous manner it is conceiveable that a threat group may be sensitized to exploit the latent radiological hazards of SNM and waste materials movements throughout the country. In this concept of a radiological threat they may see as sufficiently coercive or destructive the intentional creation, manipulation or intensification of transportation and handling accidents and incidents.

There are many current and painful examples in society of the epidemic effect or "learning curve" exhibited by criminals after first incidents or other key stimuli such as books, TV and movie plots.* Certainly hijacking patterns have evidenced this trait, e.g., destination similarities, modus operandi (the parachuting variant), and the appreciation of the vulnerable hostage symbol. Assassination attempts, White House crank calls, bomb threats and bombings are more evidences of the communication impact which such actions have than they are the indicators of coordinated conspiracy. The sensitivities of contemporary culture are variable as well. Demonstrations that the assymptotes of the four minute mile, the 17-foot pole vault and the earth-bound traveler could be crossed changed us from awed to blase observers of the repeated performances. The spoken and written word may motivate one less, perhaps, but the new message: "the n^{th} group nuclear threat" may strike responsive chords in stressed minds.

Our society appears to be in a transitional or learning stage with respect to who may possess mass threat or nuclear weapons. The future period, of possibly the next 5 to 10 years, will find a shift in awareness from the image of nuclear weapons as unattainable

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*The recent Queen Elizabeth II bomb threat was revealed to closely parallel a story (Santa Barbara News-Press, 1972) and Agatha Christie wondered if a multi-poisoner had learned from her book (Time, July 17, 1972. p.31).

to any group without national resources.* The INW early warning information provided by spokesmen such as Taylor (1971) has a sound rationale. It is that in response to his message, defenses can be raised sufficiently and in a timely sense to override any concurrent sensitizing of threat-minded groups.+

The following are examples of "early warning statements" given in a variety of public contexts which may be or have been provocative stimuli. Alternately, they may be viewed as only one of many subjective assessments of a possible future.

> There is no longer any secret of the "poor man's atomic bomb." (Taylor, 1971).

> The fact of the matter is that nuclear weapons are becoming cheaper and more accessible. If we hope to find ways of keeping them under control, we will have to publicize the fact, not hide it. (Taylor, 1971).

> Published data is now so thorough and extensive that a completely reliable A-bomb can be built without any need for testing. (Ponte, 1972).

> ...the fear is justified that such a dangerous material may be diverted for use by unauthorized parties. Just a small amount is enough to construct a nuclear bomb. (Dow, 1972).

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*This has also been postulated by Willrich (1971a): "Beyond 1975 and especially in the 1980's, public opinion in many nations will become generally aware of the security implications of civilian nuclear industries. The international political problems may then be translated into a domestic political issue. If a sixth nation acquires nuclear weapons in these circumstances, it is probable that many of the other nations will cross it rapidly."

+In an information theory model, the effectiveness of the warning message could be evaluated considering the probabilities of consequent, desired results and of the spurious, unwanted motivations in the context of an a priori probability of INW threat.

> During the 1970's, the use of nuclear energy to generate electric power will result in the widespread availability of fissionable materials in civilian nuclear industries around the world. The ramifications of this development for the security of the entire world community are immense. However, many government policy makers have not yet grasped the issues and stakes involved, and the general public remains largely unaware that a problem exists. (Willrich, 1971b).

> When plutonium commonly exists, the possibility of theft will exist, and accountability will be difficult and the technology needed to make an explosive device will be available in text-books, as it already is. (Geesaman, 1971).

> A potential proliferor enterprising enough to lay hands on illicit supplies of fissionable material is certain to be smart enough to know how to weaponize them. (Hosmer, 1971).

> A-bombs are so simple in their fundamentals that any good physicist with an up-to-date encyclopedia would know how to make one. (Ponte, 1972).

> Aspiring nuclear scientists from all over the world can now find most of the information they need to build a bomb in their public library. This fact, together with the great reduction in costs of equipment and raw materials, has taken away most of the difficulty of A-bomb construction. (Ponte, 1972).

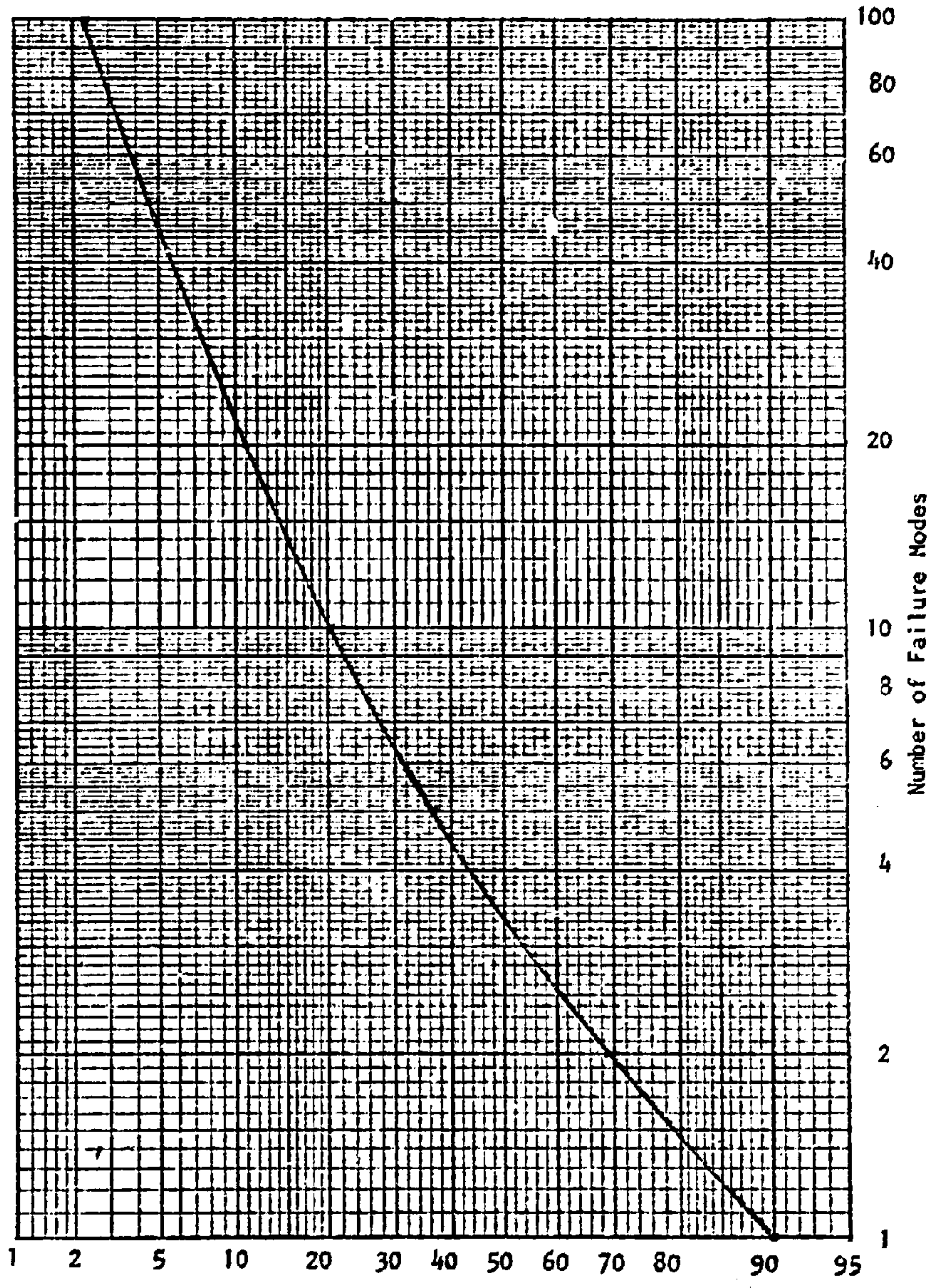
These are, of course, our selective emphases from the sea of issues battering the public, most of which are receiving much more attention and debate. Thus, such messages may be received with apathy from the general public. The question of whether such stimuli supply a "missing link concept" at the time of need or are mentally filed for future reference is difficult to answer. The subjective assessment here is that these communications will increase the likelihood of an INW credible sham threat but will have a minor, if any, impact on the probability of successful INW manufacture, once started. They will, however, increase the probability of intent of

INW fabrication and start. It is considered, in balance, that the risks inherent in providing some sensitive context to open debate on issues of social impact are significantly less than the penalties associated with a government functioning under non-openness.

The required threat group resources at this stage are the perceptive, imaginative, uninhibited, perhaps imbalanced mind. A lack of these resources is our first instance of a mode of failure which can terminate the threat. (Generally, we will not separately identify lack of inputs as failures.) At this first encounter of a failure mode we discuss its significance further. This is because considerable emphasis is placed here on the logic of failure modes. Quantitative failure modes analysis has matured to enable disciplined evaluation of high social impact events. The Apollo program, the Poseidon missile fleet, and others are examples where a prime concern is on the reliability assessment. We do not pretend to be either exhaustive or quantitative in analysis. Nor do we suggest that an increasing number of identified failure modes raises the overall threat group failure probability in close correlation. We prefer instead to use the failure modes approach to give a sober perspective to unreserved comments of INW fabrication "ease" and as a method of introducing the available quantitative data that is pertinent.

To appreciate the effects of proliferating failure modes, Figure 7-3 indicates the required probability of failure of each of a total of n independent failure modes for a .9 total probability of failure. Obviously, most failures will have widely differing probabilities; some will be highly correlated with preceding failures. Subjective impression of the significance of aggregate failures may be aided, however, by assuming that all failure modes are of equal and lowest (or some average value) probability. A further caution is that such computations

Figure 7-3. The Effect of Cumulative, Independent Failure Modes (Total Probability of Failure = .9)



should be made for specific time intervals of potentially operative failures. Conceptually, successive evaluations of the cumulative probability of failure as a function of time after idea inception would follow.

The classes of failure modes considered here are those of environmental, technological and personnel failures. The first encompasses the general risks of contemporary society and are discussed in Chapter 10. The technological failures include those characteristic of many industrial efforts as well as the additional risks of a nuclear industry conducted under "primitive" conditions and safety measures. The personnel failures which may first be encountered are those which relate to idea generation or communication. These failures may be logical, emotional or some combination of both, especially as aggravated by the context of "super criminal" activity. Some of these are listed in Table 7-3.

Some Mechanics of Communication

The concept of mass threat (regardless of stimuli, source and character at this point) may be the product of individual contemplation, or the synergistic result of "idea generation" with two or more individuals. Most generally it will be an idea to be communicated, for confirmation or dissuasion, and further planning. Unless the idea is retained solely by the initiating individual, the communication process initiates other potential failure modes. Presumably the risk "taken on" by the idea source will be minimized via the procedure of progressive stages of revelation. Alternately, the communication may be phrased in a "light vein." Undoubtedly it will be given only to trusted individuals. Patterns of trust (i.e., how they become established and the criteria used by one in making himself vulnerable) would be useful to evaluate,

Table 7-3. Some Early Failure Modes

Idea Generation Failure Modes, F_1
No Event Stimuli
No Idea
Unawareness of Concept
Lack of Concensus
Alternative Chosen
Communication Failure Modes, F_2
Information Leak
Defector motivated by: reward, patriotism
Infiltrator
Information not received by those needed
No response from recipient: not understood; understood — too risky; no (insufficient) attraction
No charismatic leader

especially if sufficient sociological data is available to illustrate the frequency and consequences of false or misplaced trust. In this context it would be plausible for serious threat groups to progressively reveal its true intent and capability as it prepares for an INW fabrication.

The emotional impact of such proposed weaponeering and its intended or implied mass use would undoubtedly test the will of even the most dedicated. Thus, helps that might be used by the group would include: sequential, increasing threat group recruitment stories, and the use of a polygraphist and instrument* to "professionally determine" the possible group security risks.+ A rationale which lends "high purpose" to the effort could be used. This might include escape (if discovered) clauses such as given in Table 7-4. It is important to note the extent to which this resume emphasizes the "high purpose" test. From the viewpoint of the threat group the contemplated action itself against society may not be so difficult to resolve. An "escape" rationale for some, if eventually exposed, might be the proclaimed desire to be a self-appointed intelligence agent with intent to notify/cooperate with authorities at an opportune time. This claim might even be validated with a boast to

*Another device recently cited in the press analyzes voice patterns for the absence of variations which indicate throat muscle tenseness and, hence, an untruthful statement.

+It would be expected that the security risk would increase more than as a linear function of the number of confidants exposed to the full plot (on the basis of personal knowledge of the individual's reliability). Just as management discernment ability dissipates with an increasing number of directly responsible subordinates, adequate (i.e., required) confidents, in acquaintance, would drop. Moreover, mutually shared, past law breaking or law defying involvements may have been below the threshold of this more stringent test.

Table 7-4. Communication Resources, R_2

Limited dissemination of full story
High purpose cover stories
A demonstration (or official test) of weaknesses within the safeguard system
An officially sanctioned effort to collect data on the viability of INW manufacture by a dissident group
An intentionally developed context for the forthcoming book, "How We Clandestinely Built a Nuclear Weapon."
There is US sanction—but don't reveal that "fact."

undergo a polygraph test. Alternately, some "anti-conspiracy" protection may be derived by allowing sufficient time to elapse to detect an unwanted response to the communication. If one is subsequently charged he might use the rationale of the Kissinger kidnap plot: This so-called conspiracy was in the form of casual "what if" conversation. (This is not to suggest that the Berrigan, et al. trial verdict was incorrect.)

Group Formation, Evaluation and Integrity

Whatever the processes of communication it is expected that at some point the group must physically assemble to begin planning and/or receive detailed instructions and test one another's resolve (regardless of the leader's charisma). There may be some attempt at compartmentalization of effort and the use of selected information sets to prohibit total group assembly. It is doubtful that such an approach would enable a successful group effort. Therefore, we assume total group interaction.

There is a high probability that the group will select the credible, sham threat option at this early interaction stage for several reasons. These include: (1) Obvious and significant resource differences between the communication of a credible threat and the actual INW fabrication. Even if this option is not clearly evident at the early stages, subsequent frustrations will surface this possibility. Further, the group will become aware that communication of a threat per se to illicit the desired response is a significant limiting factor to the whole operation if the intent is coercion; (2) The personal and group risk may be readily assessed as much less for a threat-only effort; and (3) It seems likely that a threat group will see the advisability of testing official response prior to INW fabrication. Indeed, preliminary negotiations may seek to explore or identify weaknesses in their communication and in their documentation of credibility. This consideration is, however, balanced by Aesop's boy who cried "wolf."

During the group formation stage various selection and integrity factors may be employed to test their resolve and to serve as mental resources. Table 7-5 lists some of these.

INW fabrication

Once the group has been formed, the effort focuses either on issuing a sham threat or fabricating the weapon. We consider the latter here. The most extensive references we have reviewed on the group resource requirements for INW fabrication are those of Taylor (1970) and Kinderman (1969) and we shall only summarize some of their extensive detailing which mainly encompasses steps 7, 10 and 11 of Figure 7-1. We concur with Taylor's (1971) findings:

> ...(a low yield nuclear explosive) could be assembled by groups of people with resources available to practically any country in the world.

We consider INW fabrication to be both plausible and feasible. Some observers, however, may erroneously perceive a description such as "relatively easy" when applied to a nuclear weapon design and fabrication. Dr. Taylor has no such misperceptions, but his communication and those of others concerned about safeguards may be taken out of the objective context they detail. Figure 7-4 attempts to portray the discrepancies between the factual communication and the perception.

The purpose of this discussion is, in part, to focus on some of the significant difficulties that still serve to confine the probability of successful INW fabrication to a relatively low value. There are constraints to the conversion of "the feasible and possible" to an actual capability. For us, a most frequently recurring thought that cannot be

Table 7-5. Some Group Integrity Factors (essentially all R steps; especially R_3 - R_5)

Internal testing procedures/periodic (own psychologist/lie detector)
High purpose/sanction rationales: to save the US to test the safeguards system
Charismatic leaders
Revenge Individual Group Company Country
Coercion
Love/Sexual drive
Hypnosis
Brain washing—behavior control via drugs or electrical stimulation
Religious fervor/cult
"Patriotic" fervor
Participatory democrary!
Reenforcements of intent
"Soul-sessions", pledges, rituals
Pooled group reward
Challenge of the "unknown" (also a negative factor)
Analogies of other small-group sustained efforts legal—threats to survival disasters—prison—POW extra-legal—tunneling to gain access to freedom/money/...
Compartmentalization of workers (esp. R_7—R_{12})
Fraternal vows; Mafia/kiss of death
Pledges/initiations, rituals
Security bonds/renewals
Early successes
Adequate financial backing, expertise, inside contacts

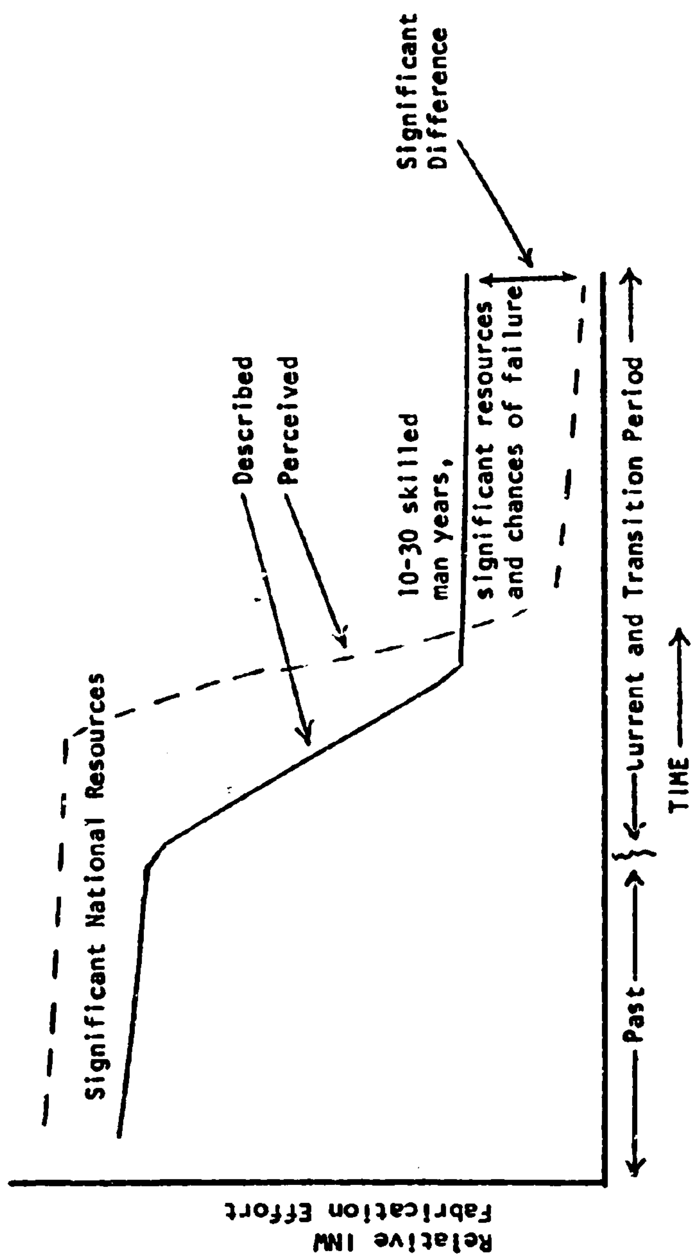


Figure 7-4. Communicated and Perceived Discrepancies on INW Fabrication.

documented is the low probability that a group will possess the simultaneous composite of skills and motivations to initiate and see such a threat through to fruition. This thought is similarly voiced in an evaluation of potential sabotage against nuclear power plants:

> The probability of a saboteur having the required prerequisites—motivation sufficiently strong to deliberately endanger the public, the knowledge and the technical skill to accomplish catastrophic damage and the opportunity and necessary logistic support—is believed to be so low that sabotage of a magnitude capable of endangering the public is virtually incredible. (Turner, 1970).

(The validity of such a conclusion is, of course, still open to question.) This aspect of personality and skill is discussed in Chapter 3.

There are also significant resources to aggregate and skillfully use. Table 7-6 lists these, some of which will shortly be discussed. Taylor details both materials and procedural requirements. He estimates a typical materials quantity (for those pursuing the chemical processing route) of about .1 kg per batch (per day).

The following further identifies some equipments, materials and costs to convey the general scope of resources required (Taylor, 1970).

A. Plutonium weapons fabrication

20' x 40' room; chemistry/chemical engineer/experience (chemist); metallurgical engineering experience (metallurgical engineer); books (Plutonium Handbook, Reactor Handbook); delta phase plutonium or with $Pu(NO_3)_4$ input material: Chemical Processing (.1 kg batches): standard lab equipment and glassware, nickel furnace, hydrogen fluoride gas, H_2O_2, tray shaker-$1,000, glove box 4'x4'x8'-$5,000; Reduction: calcium and iodine, magnesia-lined, cold rolled reduction bomb, induction furnace (5-10 kw)-$5,000, induction heater-$15,000, thermocouple, glove box 4'x4'x8'-$5,000; Metal Batch Combination/Casting: vacuum furnace and separation vacuum pumps, magnesia or graphite crucible, gallium (.2kg),graphite

Table 7-6. Some Resource Requiremnts, R_7—R_{13}

Facility Location

- isolated barn
- urban industrial area
- suburban outskirts
- commune
- artisan culture
- urban industrial area (clandestine or cover)
- university laboratory
- AEC facility
- other nation
- isolated island
- ship

Personnel

Time

Money

SNM

Other Materials

Procedures

Weapons

- US/other stockpiles (e.g., NATO, Pacific)
- tactical types (land mines ground-to-ground rockets, bombs, artillery shells, depth charges, surface-to-air missile, air-to-air missiles)
- sources (arsenals, aircraft carriers, tactical aircraft labs, factories)
- Plowshare
- other nations
- weapons resupply/other movements

mold, inert atmosphere furnace-$1,600. (use reduction glove box); Machining: radiograph to examine casting, lathe/cutting oil, carballoy grade 999s tools, glove box (w/inert gas atm) 6'x6'x12'-$10,000. Waste Disposal: plaster of paris, containers for 60 gal of waste solution, barrels, waste evaporation and casting equipment, glove box 4'x6'x6'-$5,000. Miscellaneous: Mg oxide powder fire extinguisher, portable α counter (survey meter)-$700, air sampling device-$500, beryllium oxide tamper, glove box to load powder 4'x4'x8'-$5,000, filtered, secondary exhaust system-$3,000, 220V or 440V utility, water aspirator vacuum device. Processing time: approximately .1 kg per day.

8. Uranium Weapons Fabrication

Conversion: UF_6, fluorine gas, hydrogen gas or ammonium hydroxide, 2 each 4'x6'x8' glove boxes-$10,000; Reduction: 4'x10'x6' glove box, flowing hydrogen, vibrating tray reactor, power supply for vibrating tray; Hydro-Fluorination: 4'x10'x6' glove box, vibrating tray reactor, temperature control; Conversion to Metal: steel reactor with magnesia liner, calcium with iodine booster reductant, argon, induction coil heater, thermocouple, vacuum furnace with heater, graphite mold (orange peel segment-1/8 sphere), dry box 4'x8'x8', natural or depleted U, high voltage (1-2MeV) Xray machine or Ra^{226} or Co^{60} sources for radiographic examination of casting; Machining: milling machine, hood enclosure; General Utility Requirements (as in Pu): floor space (30'x60'), lab area with hood for chem analyses, air exhausts, power, vacuum as in Pu fabrication; Personnel: Chemist, metallurgist, machinist, 2 chemical technicians.

The problem of resource assembly is no small one. For example, the need for radioactivity monitoring equipment may not be solved by a theft without that act being an obvious intelligence indicator leading one to question the reason behind the act. Nor does one casually sub-contract to a machine shop for suspicious-looking assemblies. Undoubtedly machine fabrication will be part of the group's expertise.

A sufficiently covert facility does not seem too incompatible with the present environment. There is, for example, an interesting reference to contemporary experience in illegal, flourishing narcotics production in France by John Cusock, US Bureau of Narcotics:

> ...in five years not a single illegal heroin laboratory... supposed to exist in Southern France...had been located. (Congressional Record, November 29, 1971 S19673).

Efforts such as warhead design and fuzing simultaneity might perhaps be carried out under the guise of another industry (for example, developments of explosions for underwater sounding).

Separately, Taylor (Kinderman, 1969 p.59) identifies the highly useful unclassified reference sources available, e.g., the "Los Alamos Primer" which "includes all things to think about and how to think about them," and that "a moderately experienced reactor engineer could easily understand (it)."

There is a significant discussion on design and production details and the factors involved in assessing if the produced INW will detonate and the range of probable yields. In the limit, probabilistic evaluations could be assigned to each function and yield probabilities determined. Indeed this must be available in classified form.

Kinderman (1969 p.91) estimates a total investment of about $150,000 in the first year. The fabrication resources are:

	Low		High	
Minor equipment	10,000	to	25,000	
Supplies & chemicals	10,000	to	15,000	(first 1/2 yr)
Supplies & chemicals	10,000	to	10,000	(per year)
Hoods & glove boxes, filters, fans	20,000	to	50,000	
Process equipment	1,000	to	20,000	
20' x 50' building & lot	30,000	to	30,000	
	$81,000		$150,000	

This detail should not restrict one's thinking to this SNM access route and fabrication. For example, Starr postulated that a group would possibly rather construct their own small, naturally-fueled reactor for a plutonium source (KTTV, 1972). This action would avoid the diversion of the presumably more protected SNM. There are also indications that ch^mical processing may be avoided. Some suggest that reactor fuel or high grade scrap may be used for at least fizzle yield weapons. (See Chapter 5.) There are other not so well known or, perhaps, as well protected or desireable sources such as the 1800 cubic foot closed trench which contains 100 kg of plutonium dumped there as contaminated liquid during 7 years (1955-1962) operation of the plutonium finishing plant at Hanford (Congressional Record, May 10, 1972 E4934). These aspects are offered primarily to sensitize us to other routes of SNM access or fabrication. The last section of this chapter will provide some further perspective on this.

The general threat group philosophy would parallel that of a nation trading off: (a) a risk of detection (of group efforts) in favor of the decreased INW fabrication time realized from the supply of material or the theft of the object closest to the end result, i.e., the weapon, vs. (b) minimize detection by long term access/diversion at the best point of materials access. This increases the risks and problems due to the increased manufacturing and time requirements (Gilinsky, 1970 p.51).

It would seem that materials access and group capability would be the basic defining elements for modus operandi. Unless members of the group have actually performed key design, planning and production tasks associated with nuclear weapons it should be expected that the group will optimistically misjudge their capability. Later they will undoubtedly find themselves frustrated due to insufficient performance, skills, time and other resources. The extent of the discrepancy between their earlier anticipated performance and that which has been experienced, will accordingly determine the chance of an abort. There are several studies which portray the differences in physiological responses and physical skills between the non-skilled and skilled individuals (Crider, 1970).

It would be highly desireable to have statistical data on a controlled study of fabrication attempts, parametric in resources and expertise. We are aware of one study (but not its contents) that uses a small group to describe their successive moves, given a set of resources. It appears, however, that the environment surrounding this psuedo-threat group was sufficiently artificial (e.g., the lack of penalty and mental duress) to render the study of questionable extrapolation.

Our dominant source of critique on INW fabrication has been Taylor (1970) and Kinderman (1969). We must point out here that Dr. Taylor's expertise in weapons design and fabrication enables him to successively follow many correct logic paths at each decision node in an immense logic tree. He knows what he is looking for when he describes how to design and fabricate the INW weapon.* The weapons neophyte might see the logic tree branches as the end of a massive telephone cable, all one-color coded and equally likely of being the only correct path.

For those who are unsatisfied without an overall probabilistic estimate of fabrication success, we have attempted to convert available subjective estimates of manpower-time for INW fabrication to a quantitative summary. First, the statements:

*A case in point: One of the authors has participated in the design and test of an equipment to seriously harass, if not disrupt, the warning portion of the US air defense net. But, despite good aerospace reporting in this area, successful design and fabrication of such electronic equipment would frustrate many engineers. It seems we would feel frustrated, as well as queasy, in "our INW fabrication attempt."

(1) At the 1972 appropriations authorization hearings (Congress, Senate, 1971)

> Senator Pastore: You would have to have quite a bit of people involved and quite a bit of equipment in order to put a bomb together, wouldn't you?...
> Senator Pastore: I mean you couldn't do a thing like this clandestinely unless it is a big operation.
> Mr. Crowson. We figure you are going to need a dozen people, a very good set of metallurgists and a very good set of physicists in order not to blow yourselves up and it is not just a one-man type operation.

(Elsewhere it is noted that an engineer/physicist skilled in fast-breeder reactor technology is well attuned to many aspects of the weapons design.) (Taylor, 1970).

(2) The Taylor summary:

> We believe the designs outlined here might be produced by some determined/talented individual. It is clear that these individuals, a physicist, a hydrodynamicist and an explosives engineer would have a good chance to produce at least one useful design* .. and a group 2 or 3 times as large could certainly succeed in a period of a few years. (Kinderman, 1969 p.71).

If a subjective probability assessment arbitrarily equates words to numbers, the following may result:

	Optimistic+	Pessimistic
might be	.19	.1
good chance	.75	.5
certainly	.9999	.99

If one furthe- assumes one year of effort for the lower time limit of the 1 to 3 men and the "few years" as 2 to 3 years for a group of

*We assume this phrase means design and produce or manufacture.
+The optimistic limit (O) is determined from the pessimistic base (P) by $O=1-(1-P)^2$.

6 to 9 men the pessimistic and optimistic estimates of Figure 7-5 result.

The Olgaard (1969) estimate is that of a significantly long development period for just the implosion technique:

> It is...very likely that any reasonably industrial country will be able to master the technique...after a development period of some years.

Other gross estimates of resources for weapon fabrication have been translated to one variable: cost. The frequently cited UN (1968) study estimated costs of $\$1 \times 10^6$ per 20 KT weapon for an annual production of 10. Kosters (Kinderman, 1969) estimates $\$.8$ to $.2 \times 10^6$ per weapon for rates of 5 to 30 per year respectively. The Plowshare program rates are $350,000 for 10 KT and $600,000 for 2 MT (Willrich, 1971a). Plowshare rates must be essentially for materials and production costs and no prorated R&D costs. These examples, though, are possibly too removed from the desired context to be applicable for an aggregate INW cost estimate.

Some analogies of effort success may be sought from the present status of the "future n^{th} nation." In comparison, an n^{th} nation, of course, is more likely to achieve successful fabrication because of its: (a) national (albeit covert) sanction; (b) significantly larger resources; and (c) adequate secure/cover industries. The apparent fact that no n^{th} nation (which would have a higher probability of success) has yet announced nuclear weapons manufacture should not, therefore, make us treat the INW threat as no greater than that zero. Speculations such as: (a) the result is still secret, or (b) it makes even less sense for a small nation to try it than an internal group are possible. Further, there is some evidence* and some

*India recently announced its interest in "studying a program of underground nuclear blasts for peaceful purposes." (Santa Barbara News-Press, May 2, 1972). "The Indians have been operating a natural uranium fueled, materials test reactor so as to produce a maximum amount of plutonium. This has raised suspicions in Pakistan and doubts in Canada, the reactor and fuel supplier, and the United States, which supplied the heavy water used as moderator. (Willrich, 1971a).

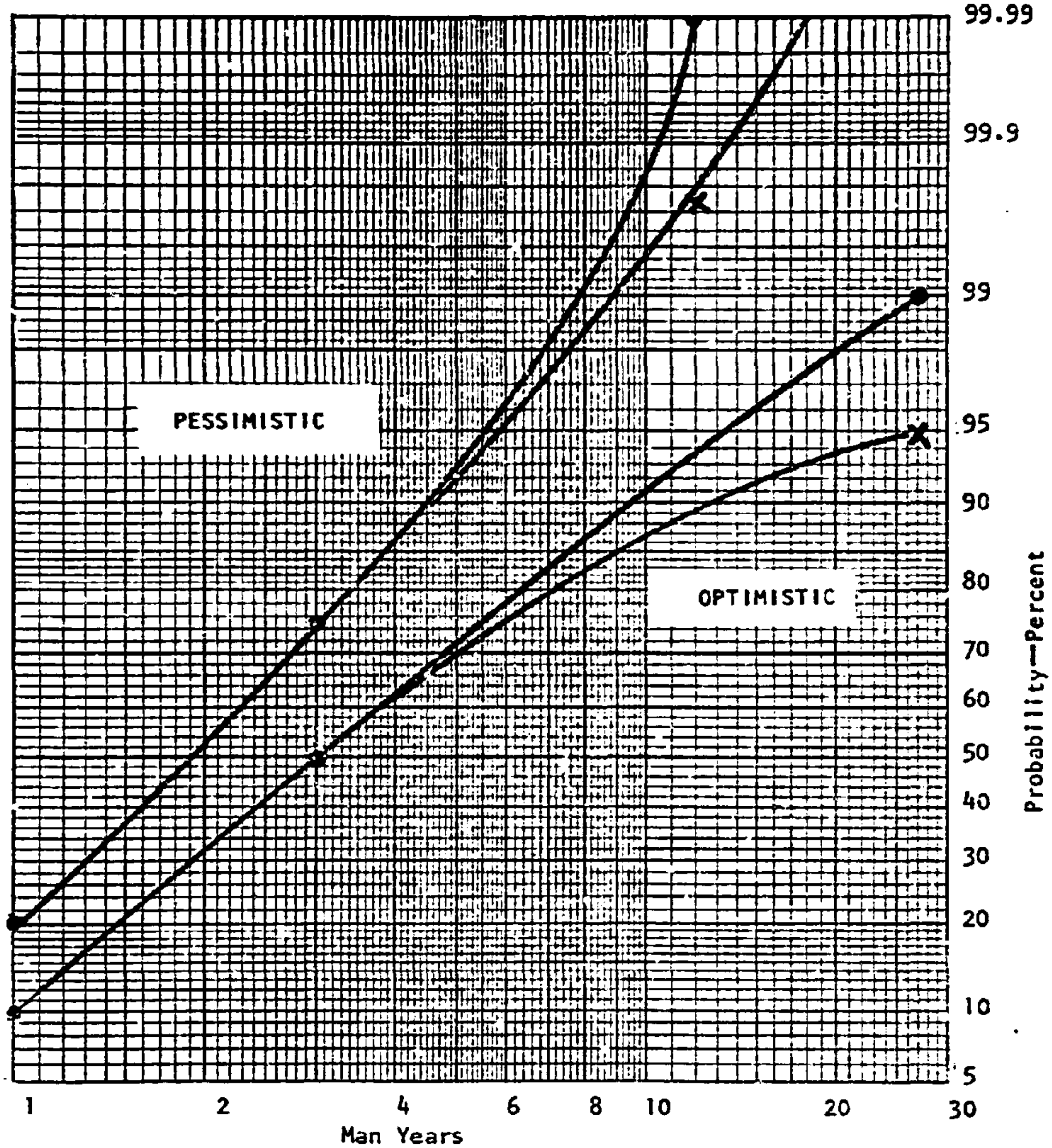


Figure 7-5. A Subjective Assessment of Successful INW Fabrication (No Failure Modes)

Adapted from Kinderman et al., 1969.

informed spe..ulation* that other nations will reveal their true capabilit- ~ventually. Current US estimates are that India has 95 kg and Israel has 40 kg of unsafeguarded plutonium (Time, July 31, 1972).

Failure Modes

It is apparent that, fabrication ease statements notwithstanding, any threat group engaging in the fissile materials processing and weapon fabrication makes itself vulnerable to a significant set of failure modes. It is, then, not too surprising that the Lumb panel considered the probability of nuclear weapons (or components) theft by a threat group higher than that of illicit manufacture (Lapp, 1968 p.115). But, we conclude that the probability of successful illicit manufacture is about the same as the probability of theft of a tactical nuclear weapon. We conclude that the probability of theft of a strategic nuclear weapon is significantly lower.

What, then, are some of these sources of failure which confront the group and its efforts and, indeed, also serve to increase the probability of the group eventually choosing the credible, sham threat route? The products of the abortive effort may still serve the group in good stead

*A 24 Mw materials test reactor in Israel, which was obtained secretly from France, and secret purchases of uranium abroad have been a source of concern not only to Arab nations but also to the US. The uranium used as fuel...has been reportedly purchased in Argentina and South Africa. The reactor is capable of producing enough plutonium for about one bomb per year (Willrich, 1971a). The nuclear alternative will remain the subject of serious scrutiny and consideration in Israel for as long as a truly final settlement of the Palestine conflict remains unachieved (Jabber, 1971).

in validating the credibility of their threat and "successful" manufacture. The criminal act goes through "visibility" stages. First, it is only conceptually criminal, i.e., it is primarily intellectual and consequently is perceived as non-criminal. Eventually criminal communications or acts occur which are either perceived as such or are non-detected depending on the overt intelligence indicators. Table 7-7 lists some personnel, social risk and business failure modes operative during these phases.

Some amplification of the failure modes which overshadow a fabrication effort may be sought from extrapolations of the experiences within the US nuclear industry. The industrial safety record per se has been documented as outperforming many other more conventional, less hazardous industries (AEC, 1968; Gordon, 1971). One reason for this is the considerable emphasis on safety practices from the inception of the industry—in part stimulated by the extreme uncertainties of this technological field. Another is the particular mechanics of data compilation and reporting and the delayed impact of effects (Gofman, 1971). Nevertheless, significant industry-unique accidents occur even in the safety-concious environment. It seems fair to speculate that a primitive laboratory (by this we mean lacking the full panoply of radioactivity monitoring instruments or not intensely practicing safety) would experience risks greatly amplified beyond the legitimate nuclear or other industry and beyond many illegitimate industries.

Criticality accidents are probable the popular impage of what can happen in the nuclear industry. One of the most spectacular types and, hence, fulfilling that image is that of the manually conducted criticality experiments of Louis Slotin. "These tests must be made for each new weapon design." (Rapoport, 1971). (Today they are performed remotely at critical assembly machines by operators 1/4 mile away.) "For 40 times previous, Slotin had successfully pushed the hemispherical components

Table 7-7. Some Failure Modes

General Group Dissuasive Factors and Tests of Resolve, F-all

Effects of Time, Effort, Resource Depletion

Mental Duress
    The conversion of the conceptual idea to a capability to eventual threat is beyond the tolerable threshold of some in group. Results: work delay/abort/design defects.

Key "hang up" Areas/Social Quirks

Dilema of what to do with subsequent misfits or would-be defectors.

Mental duress of secrecy cover.

Cover Blown
    Infiltrator, attitude change

Failure of Pledges, Initiations, Rituals, Secrecy
    Change of intents (what is the half-life of unchanged attitudes/behavior/life styles?)

Mistrust

Effects of Inter-personal Relations

Infiltrators

Frustration at working conditions, environment, uncertainties, time delays, resources, people, schedules, hazardous duty.

Dual-life complexities

Incompatibilities

Degree of contact with non-involved and/or non-informed people.

Desire to confide in others
    self-esteem
    press/law

CONTINUED

Table 7-7. Some Failure Modes (Continued)

Poor controls of memos, notes, effluents
Events which lead to a mutually agreed abort
Motivations/goals that brought them together are insufficient to maintain them.
Intra-group informers
Uncertainty of Payoff
Social Risk Failure Modes, F-all
Illness, Death, Suicide
Natural hazards—earthquake, flood, tornado...
Personal accidents—home, auto
"Business" Failure Modes, F-7 to 14 (especially)
Insufficient funds/other resources (people/time/facilities/material)
General Small Business Failure Rates
Industrial accidents (machine, fire, other)
Fabrication/test accidents (radioactive, fire, criticality, weapons tests, experimentation)
Insufficient information/expertise (recognized/not recognized)
Intentional design/fabrication flaws via coerced expert.
Poor product marketing: the incredible threat.

together with a screwdriver and measured the radiation with a Geiger counter and a neutron monitor. The 41^{st} time he slipped and failed. There was a blue ionizing glow. He pulled the masses apart before they became overcritical but he had been exposed to 880 rads and died 9 days later." This data set provides a failure mode rate of .025 for the criticality experiment. A .95 confidence conservative estimate based on data sample size increases the failure rate to .075. Another reference describes this death and that of another experimenter as due to "errors in judgement during the manipulation by hand of components of the (supercritical) (sic) assemblies." (Morgan, Turner, 1967 p.591).

One summary identifies that some fifteen or more nuclear accidents have occurred in the performance of critical experiments. Six nuclear accidents are recorded as having occurred in chemical plant operations. These are discussed by Morgan, Turner (1967) and include:

- o A first recorded fatality in a plutonium recovery operation at Los Alamos in December 1958.
- o A fatality in a uranium-scrap recovery plant operated by United Nuclear Corporation in July 1964.
- o A U-235 salvage process accident (500 rem dose) at the Oak Ridge Y-12 plant in 1958.
- o An accidental excursion (50 rem dose) in the transfer of an enriched Uranium solution at the Idaho Chemical Processing Plant in October 1959.
- o Another Uranium solution accident at Idaho in January 1961.
- o An accidental criticality in unshielded plutonium recovery equipment at Hanford in April 1962.

A more complete list of radiation accidents is found in the AEC (1968) summary. It cites only 6 deaths due to nuclear causes (the two criticality experimenters, the plutonium recovery fatality plus the three killed in the SL-1 reactor excursion in 1961). It cites only 35 workers involved in lost-time radiation non-fatality accidents. Yet the tabular listing of the distribution of the worker population and radiation exposure levels is more descriptive of the scope of industrial risk. Radiation accidents have been caused by: human error, faulty manipulation of controls, deviation from standard operating procedures and faulty mechanical equipment. About .2 percent of the radiation exposures have been the result of accidents. These have exceeded 5 rem.

The conventional type accident rate within the nuclear industry has been frequently cited as better than that of US industries as a whole. However, criticism has been directed against both sets of data. A critical appraisal of industrial safety statistics prepared for the US Department of Labor (which cites 14,500 lives/year lost due to occupational accidents and a disabling accident extent of 2,500,000 per year) found that accident reporting in the US does not give an adequate picture of what actually exists (Gordon, 1971). Thus, the Oil, Chemical and Atomic workers Union has, for example, initiated survey programs to capture informal counts of accident data (Congressional Record, April 13, 1972).

We expect that several factors of the INW fabrication effort would significantly increase the death/accident rates beyond that actually experienced by both the nuclear and other industries. These include:

- lack of or no focus on safety programs and training, e.g., safety directors;
- the lack of physicians and industrial nurses as part of the team (a cover operation could easily be "blown" by being treated outside for a plutonium burn).

- o We would expect it more likely that youth comprised most of the threat group. The disabling injury frequency rate for labor force males in the 20's age group* is almost twice that of older workers (Gordon, 1971).
- o Small industries generally have higher accident rates than similar large industries.

And, there is always a chance of a fire. "Plutonium and its compounds are highly pyrophoric and account for many glove box fires. Uranium and metal fires are extremely difficult to estinguish." (Wick, 1967 pp.831, 861, 873). The fire hazard in plutonium fabrication facilities has, of course, been graphically demonstrated by the Rocky Flats Plant fire of May 11,1969, identified as the single most costly industrial fire in the US history (some $45,000,000 damage and subsequent clean-up operations). The suspected source was plutonium briquettes (discs 3" in diameter by 1" thick) of pressed scrap metal or lathe turnings and some loose scrap stored in uncovered cans in a cabinet. The exact cause was unknown but plutonium chips or lathe turnings are a pyrophoric material + (Congress, JCAE, 1970). Subsequent events have seen controversy over the amounts of consequent deposition of plutonium oxides over the adjacent area.** This has been evidenced in the publication of safety considerations of the Rocky Flats plant (Congress, JCAE, 1970 pp.1955-1997), a later symposium on safety in plutonium handling facilities (AEC, 1971) and a request for an additional 4600 acre buffer zone around the 2500 acre site of the 400 acre industrialized area (Congressional Record, May 10, 1972).

*about .5 per 10^5

+Some additional data for Rocky Flats: 24 x 10^6 manhours without a disabling injury over the first 13 months period but there was an average of 1 spill, contamination incident, fire or explosion every 20 days (Rapoport, 1971 p.31).

**A Martell study estimated some 10^{12} PuO_2 particles escaped (Rapoport, 1971 p.42).

Seaborg (1971) noted that the permissable body burden of Pu-239 is .04 μ curies (about .6 μ gm). In commenting on plutonium plant design and location he said:

> Gram quantities of plutonium released to the atmosphere may cause extensive surface contamination. A sound and reasonable method of contamination control is complete containment...

Miner's (1966) comments on plutonium contamination control and safety indicated that:

> Strict control of radioactive contamination is imperative in plutonium operation. In some laboratories all forms of Pu are kept in hermetically sealed enclosures, the atmospheres within these enclosures never being allowed to come in contact with the atmosphere breathed by workers in the open laboratory... In other labs the importance of convenience may outweigh the reliability of total containment... Scrupulous attention must be paid to cleanliness and to maintaining all surfaces in the lab as free from contamination as possible...air samplers, alpha counters, beta-gamma survey meters, neutron counters are used routinely to reveal any Pu contamination. In spite of Pu's unusually dangerous properties, people routinely work safely with it by paying careful attention to safety precautions... Experience records show fewer accidents...than in hospitals, hotels, stores... chemical plants...home.

Despite the citation of many possible failure modes, the quantitative support of a sufficiently low probability of threat with adequate confidence will not be available. Consequently only the decision maker's subjective impression will be available as to whether the threat is improbable enough to warrant no further safeguards implementation.*

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*But we cannot affirm that it will have the assessed zero that confronted the boy in Wright's novel: "...I could fly a plane if I had the chance," Bigger said. "If you wasn't black and if you had some money and if they'd let you go to that aviation school, you could fly a plane," Gus said. For a moment Bigger contemplated all the "ifs" that Gus had mentioned. Then both boys broke into hard laughter... (Wright, 1941).

Conservative decision making should be aware of the impact of the INW threat to society and structure responses and containment in consonance with even this highly unlikely event. These considerations are discussed in Chapter 10. Given a sensitization of the decision maker to the INW threat, it is of concern to him if any conclusions can be reached on the most likely route a threat group would follow in the context of the implementation variables just discussed. Thus, we now compare some alternate routes to a weapon capability with the rather extended sequence discussed earlier which started with unprocessed SNM as an input from a successful diversion.

ALTERNATIVE ROUTES TO A WEAPON CAPABILITY

We have already identified the potential threat capability of the sham threat. The selection of this alternative bypasses a significant amount of resource requirements, time, failure modes and control responses. It focuses instead on optimizing the effectiveness of the threat communication which is still a significant factor even when bolstered by an available weapon and used in the coercive role.

Here we examine some of the SNM access possibilities and the resultant implementation implications which combine to provide alternate paths to a weapon capability. The five SNM input forms considered here are:

1. Natural uranium reactor fuel
2. Unprocessed forms requiring chemical processing such as:

    plutonium nitrate
    uranium nitrate
    uranium oxides
    plutonium oxides — See 3. below
    uranium-aluminum alloys
    uranium hexafluoride

3. Metallic or ceramic forms requiring no chemical processing

    plutonium
    uranium
    possibly oxide forms for sufficient fizzle yield

4. Near critical mass quantities and shapes or weapons components

5. A nuclear weapon

Obviously each input forces significantly different implementation steps upon the threat group. To compare the alternatives we use factors of: (1) a systems analysis method, (2) an operative rationale and (3) a point of view, as follows:

1. Systems analysis method (in the context of the uranium or plutonium based weapon)
    a. The susceptibility* of SNM to diversion
    b. The weapons implementation ease
    c. The combination of a. and b.

2. Operative rationale
    a. Implement the optimal systems analysis solution from the method of 1. above.
    b. Exploit what is available in materials and/or skills and adapt through innovation.

3. Point of view
    a. The threat group
    b. The external observer striving to assume the perceptions of the threat group.

Although our evaluator role is 3b. we still make the presumption that if we were part of a threat group we would adopt the exploitive point of view, 2b, as an operative rationale. This indeed may be equivalent to the optimal systems solution 2a as based on real life exigencies rather than the hypothetical preferred solution. We thus expect the threat

*We prefer the term susceptibility rather than vulnerability since, for some readers, the former term refers basically to its inherent nature and the surrounding environment wherein the latter encompasses susceptibility as statistically documented by acts carried out.

implementation to arise basically because of some future awareness of an exploitative avenue available for the traveling. As such we feel that the weapon type would be resolved essentially by what is available rather than by the fact that a uranium type weapon would be the easier to construct.* It is, of course, this reasoning which identifies some with the concern for the burgeoning plutonium economy as opposed to what (we feel) must have been a dominant decision maker consideration of the past:

> The plutonium type weapon is significantly more difficult to implement such that a civil economy based even on weapons grade plutonium rather than weapons grade uranium is a less threatening environment of the two.

Other parts of that rationale have already been treated in Chapter 5.

We pursue this discussion now using comments pertinent to the systems analysis method and then modify the results by the other evaluative factors. We have liberally incorporated the evaluations of Taylor and Humpstone (1970). Their attempt to develop a rank ordering rationale for each of the four input material alternatives (which excluded the reactor fabrication route) concluded:

> We have not found it possible to argue, in general, that anyone of the four (alternates) represents, overall, the easiest way for unauthorized people to acquire nuclear explosives. (Taylor, 1970 p.7).

SNM Access

Table 5-4 summarized the perceived vulnerability (susceptibility) of nuclear materials to diversion which, we feel, probably also incorporated

*Perhaps the best illustration of the exploitative possibilities is the availability of an inside man who can provide, at least, information on SNM locale, movement, protection, etc., and beyond that the involvement in the diversion action.

a subjective concern about the relative consequences of such a theft. Our subjective evaluation is summarized in Table 7-8. It uses four levels of "theft effort x risk" assessment with a numerical interval of 10. These factors will later be used in the combination assessment of susceptibility and implementation ease. It is readily apparent, however, that if unprocessed SNM is about as accessible as the metallic form (e.g., scrap), then the utility of the right kind of middle man and access can bypass a lengthly materials conversion process.

Taylor and Humpstone (Nov., 1970, pp.61,62) characterize SNM or weapons susceptibility to theft in terms of the force size necessary to acquire it.

> Of materials access from the civilian industry, we state categorically that strategic quantities of SSNM could be stolen from any part of the civilian fuel cycles where they exist, by armed groups that, in many cases could be substantially smaller and less experienced than those required for successful thefts from banks, security vaults or armored cars. The majority of AEC licensee employees that we have informally talked to (12) have stated that they thought they could illegally acquire at least several kilograms of plutonium or highly enriched uranium without detection for at least a few weeks.

In the limit one also views the access route to already fabricated nuclear weapons. For example, for weapons access:

> We would expect that a force of several dozen, or perhaps less, armed men equipped with at least one motor vehicle, and with high explosives, could gain access to nuclear weapons within less than 1/2 hour of the time of forced entry of the perimeter.

Rail and truck shipment convoys of nuclear weapons are seen as vulnerable to "in transit hijackings by forces of the same order of size and strength as the protective forces,"—(2 to 8 armed guards).

Table 7-8. A Subjective Assessment of the Susceptibility of SNM to Diversion (Theft Effort x Risk)

SNM	Civil Industry	Weapons Industry
natural uranium	low	low
unprocessed forms	medium	high
metallic or ceramic forms	medium	high
weapon components		high to very high
weapon		very high

KEY: Theft Effort x Risk	Relative Number
very high	1,000
high	100
medium	10
low	1

Item	Access Modifier of Susceptibility	
Access contact in covert action		
inside men		
information only	$1/\sqrt{10}$	assume a 1/5 average
information plus action involvement	1/10	
no internal contact	1	
Material production cycle locale in overt action		
fabrication/processing plants, etc.	$1/\sqrt{10}$	
transportation link	1/10	
ultimate user custody (e.g., reactor use in the civil industry or military user for the weapons industry).	1	

A related valuing attempt could seek to determine the cost to respectively collect, equip and motivate such a "strike force" or to buy a trusted employee. However, it seems unreasonable that $500,000 is sufficient inducement for a group to pursue an armed assault against a weapons storage or weapons transport security ring. This is especially true in these days when it is akin to the "takeaway" for a 1 man skyjacking effort with still a "reasonable" probability of success. Recent official statements, though (and ~~some~~ events), seek to convey that skyjacking is a "no-win" way to high monetary amounts. Further discussion on the industry susceptibility, per se, may be found in Chapter 5.

Implementation

Apparently the highest implementation effort would be that forced by the inputting of natural grade uranium (19). The natural reactor route was preferred by Chauncey Starr (KTTV, 1972) once one became involved in the necessity for chemical processing, e.g.,

> If you're going to do all that then you're not going to want to make the bomb this way. It's much easier to build your own reactor and make it out of natural uranium which is easily available.

It seems, though, that the additional effort of reactor construction and operation would more than offset the aspect of easier materials access and less risk. Therefore, we consider only the remaining four input SNM types.

Taylor and Humpstone (1970) have dealt at length with a description of the technology required for the fabrication of an INW commencing with unprocessed SNM forms (input I_{10}) and the chemical conversion process. Part of the thesis developed is the analogy of the effort to other criminal-industrial processes such as the illicit drug industry. Thus, the argument for the credibility of clandestine weapon manufacture describes the steps of the chemical and metallurgical processing which yield the metallic-form, end product. At this point we observe that either each described process has been performed by an individual in the threat group and that he is intimately familiar with the logic and mechanical manipulations of the step, or, by making a liberal equality, at least he is familiar with what he perceives as analogous laboratory procedures. At worst, he is uninformed and unaware of this state. Thus, one of the phrases: "Any possibility of criticality accident can be avoided by making sure that the total amounts of plutonium (or highly enriched uranium) in solution in any particular compact container, are less than about 200 grams..." (Taylor and Humpstone, January 1970 p.3-41). must invariably be viewed by the cautious, intelligent neophyte as requiring significantly more "cook-book" detail or, by the expert as automatically appended with his own ensemble of detail which carries him unerringly through the process.

Understandably, parts of the discussion lack a similar level of detail. These are the fabrication and machining steps which produce the correct dimensional configuration of the weapon. If these details are not specifically known, either independent research and experimentation is required or there is an awareness of the tolerance range of the design (as we presume is illustrated by the weapon which brings two blocks of subcritical, highly enriched uranium together). Postulated manpower estimates, total cost and some details of required materials for the chemical processing implementation have already been cited in this chapter. We shall consider some of the other implementation options and then summarize and compare the available estimates.

The lower limit of the implementation requirement is probably that associated with the input of close to a well tamped critical mass of highly enriched uranium plutonium 239 or U-233 (Input 112). The implementation effort requires an innovative person experienced in "nuclear reactor engineering and high explosives handling plus a few weeks labor plus a few hundred dollars material or up to a few thousand dollars with an auxiliary neutron source. An alternative effort-resource comparison is that of a National Science Fair high school winner's project (Taylor, November 1970 p.6). Appropriate to that description is a reemphasis of the worth of an innovative, resourceful individual. Short cut, gross equivalent designs have consistently appeared in other physical devices under circumstances of high motivation and limited resources within, of course, the constraints of physical feasibility.

Given an input weapon (113) rather than the near critical mass we assume that the required implementation effort might actually increase over the previous example. An estimate has been made that one knowledgeable of explosive ordnance or fuzing working for a few minutes to two days could fuze and detonate stolen weapons not designed to prevent use or by-passing of the normal detonation chain (Taylor, November 1970, p.5). Yet we consider it about equally likely that a stolen weapon would have some type of permissive action link. (Whether Plowshare or tactical air intercept weapons, for example, have this "safety" is unknown to us.) We assume that a resourceful fuzing, electronics expert might need several weeks to several months to bypass a more sophisticated chain of detonation fuzing.

Given an input of processed metal (111), the implementation requirements are seen as 2 to 3 people working a few weeks with a few thousand dollars of materials and access to glove boxes, casting and machining equipment (Taylor, November 1970 p.6). We add another several thousand dollars for this equipment—some of which may be acquired through leasing.

We summarize now the implementation requirements in Table 7-9 using an arbitrary conversion of man-months to dollars at a $2,000/month rate. This is an extremely tenuous equality of expertise to cost. Either of the following extremes appears possible with the first more likely: the disgruntled employee or cause-motivated individual satisfied with little monetary gain or the induced expert—a very unlikely situation—at a perhaps 2 to 10 times normal income rate.

Table 7-9. INW Implementation Estimates

SNM Input	Equipment $ \times 10^3$	MM*	Total Cost $ \times 10^3$
Unprocessed	100-150	50-150	200-450
Processed	3-6	2-5	7-16
Near critical mass	.3-3	1	2.3-5
Weapon	.1-.2	.1-3	.3-6.2

*Convert @ $2000/MM rate.

For comparison, the differences of the cost estimates of illicit input SNM summarize, in gross form, the implied implementation cost equivalent of parts of the illicit industry. To date, SNM prices on the legitimate market have been established by the weapons industry supply and demand. Taylor and Humpstone (November 1970 p.35) assume that the value of SNM in an illicit market will similarly be associated with its use in illicit nuclear explosives. We use this evaluation of the hypothetical illicit market in progressively processed SNM as another measure of the cost of the incremental illicit efforts within the fabrication process. This is summarized in Table 7-10 assuming a 7 kg and a 10 kg SNM requirement.

Table 7-10. An Implied Valuing of INW Activity*

SNM	Source	Price $\$ \times 10^3$	INW Effort	INW Effort Value $\$ \times 10^3$
Unprocessed	licit, unavailable	$70-100	theft	35-50
Unprocessed	illicit, available	105-150	processing	175-250
Processed	illicit, available	280-400	fabrication	100-220
Weapon-fabricated	illicit, available	500 (1 kt)		

*Adapted from Taylor and Humpstone, November 1970 p.42.

It seems that the cost of each illicit activity is most properly thought of as a minimal cost for relative comparison rather than the expected level of monetary inducement to get such illicit market operation going to "service" a threat group. Sheer subjective speculation suggests perhaps figures ten times the value shown as the necessary threshold inducements to such illicit activity. This table also shows the vast discrepancy between the previously estimated processing and fabrication costs and the implied value of that form of illicit material which permits a threat group buyer to avoid the risks of implementation required by input SNM more removed from the final weapon state.

Likelihood of Total Access and Implementation Effort

Table 7-11 summarizes the extremal ranges of the composite theft (effort x risk and access) implementation estimates from the previous details.

Table 7-11. Relative Extremal Threat Group Efforts for Alternate Weapon Implementation

	High Estimate (1)			Low Estimate (2)		
SNM	$\$ \times 10^3$	Overt Theft	π	$\$ \times 10^3$	Covert Theft	π
Unprocessed*	450	10	4500	200	10 x 1/10=1	200
Metal or Ceramic*	16	10	160	7	10 x 1/10=1	7
Components+	2	1000	2000	2.3	1000 x 1/10=100	230
Weapon+	6	1000	6000	.3	1000 x 1/10=100	30

(1) Highest implementation costs and no overt theft exploitative possibility.
(2) Lowest implementation and maximal covert theft exploitation.
*Civil industry source assumed.
+Military industry source.

If we assume that somehow these numerical products (π) are related to relative overall energies and trauma to achieve a weapons capability, we can make some comments on the alternate routes. We might simply assume that any SNM state-energy estimate is equally likely in the discussion described by the high and low estimates, but this does not sound reasonable. Therefore, one further assumption is made about the relative likelihood of various access or exploitative possibilities. It seems that an overt theft or access would be about 10 times more likely than having an available covert contact.* It also seems that a theft directed against the civil industry is about 10 times more likely than a theft directed against the military industry. A matrix of such postulated likelihoods of occurrence is:

Likelihood of Theft Type:

	Overt	Covert
Civil	100	10
Military	10	1

It further seems that overt, civil thefts would be about 10 times more likely to be directed against the transportation links than against the nuclear reactor sites, and about 3 times as likely against the fabrication and processing plants. Similarly, overt thefts against the military industry would most likely be directed against transportation links or fabrication plants rather than user or storage facilities, by a likelihood ratio of perhaps 10:3:1, respectively.

The composite result of the considerations of likelihood and access effort as a function of access mode and SNM form in conjunction with the reuqired implementation effort may be detailed in matrix form, as per Table 7-12.

*This seems compatible with the approximate 1 percent clearance screening rejection rate since perhaps about 90 percent of the average population self screen and hence do not apply for sensitive positions.

Table 7-12. Alternate INW Routes

		Overt Theft			Covert Theft		
Implementation Cost $\$ \times 10^3$	SNM* Form	Trans.	Fab./ Procc.	User	Trans.	Fab./ Procc.	User
Civil							
200-450	U	100(1)+	30(3)	10(10)	10(1/5)	3(3/5)	1(2)
7-16	M	100(1)	30(3)	10(10)	10(1/5)	3(3/5)	1(2)
Military							
200-450	U	10(10)	3(30)	1(100)	1(2)	.3(6)	.1(20)
7-16	M	10(10)	3(30)	1(100)	1(2)	.3(6)	.1(20)
2.3-5	C	10(30)	3(90)	1(300)	1(6)	.3(18)	.1(60)
.3-6.2	W	10(100)	3(300)	1(1000)	1(20)	.3(60)	.1(200)

KEY:
*SNM Forms: U=unprocessed; M=metal or ceramic; C=weapon component; W=weapon
+Likelihood(access risk x access effort modifier)

These details are then compressed into a summary form on the basis of a weighted average of relative likelihood, the access mode and access effort. The results are shown in Figure 7-6; the relative access and implementation effort may possibly be considered to have units of equivalent dollars. The visual impact of the relative spread of the alternates would be far more apparent if this summary were plotted on a linear scale. On the basis of the predominantly subjective assumptions presented in this chapter, the graph

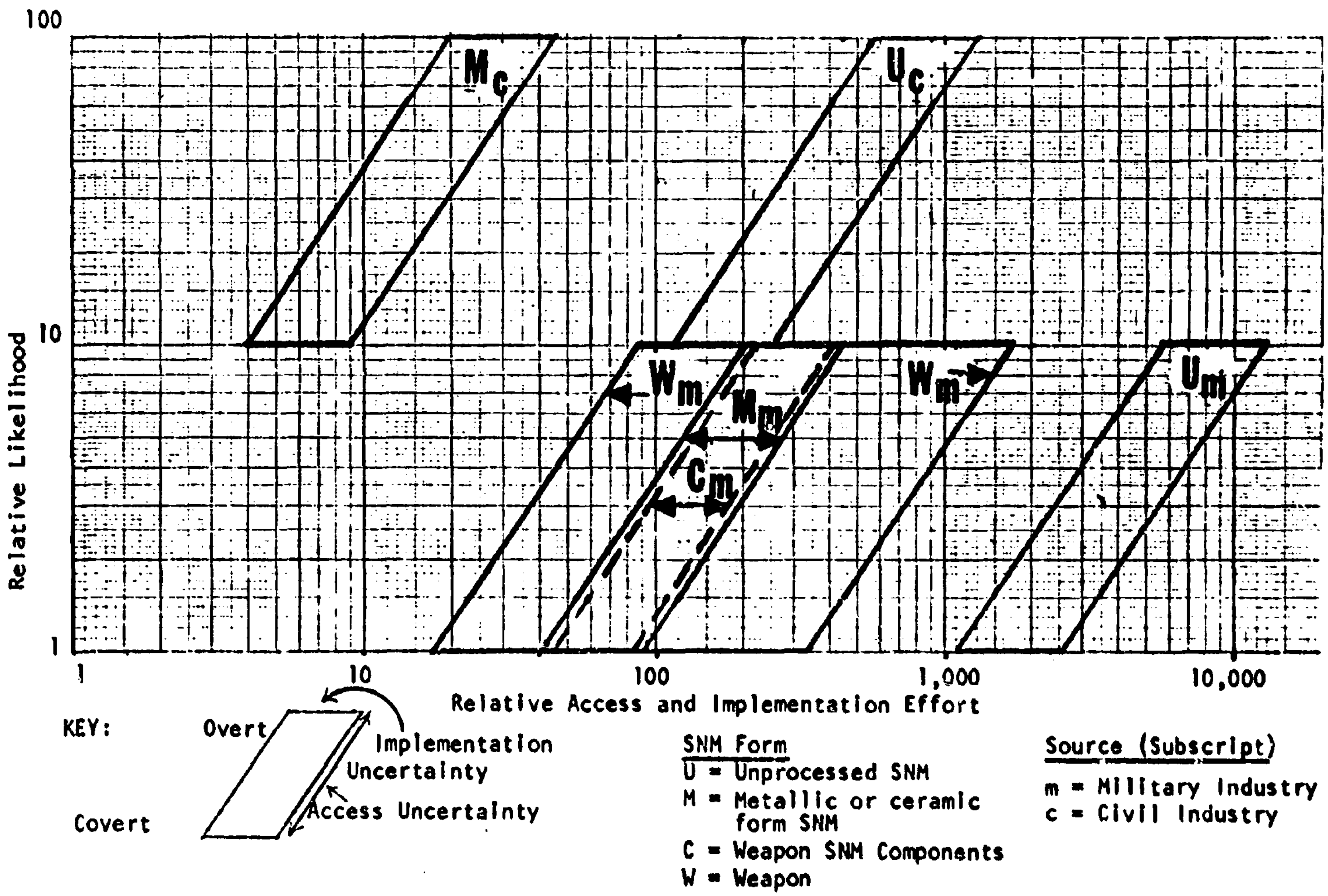


Figure 7-6. A Comparison of Alternate Ways to an INW Capability

indicates that SNM in the metallic or ceramic form, obtained from the civil industry, is the most likely, least effort alternative of a threat group to achieve an INW capability.

CHAPTER 8

THE CHEMICAL AND BIOLOGICAL THREAT

From a military viewpoint, chemical and biological (CB) materials have been treated as mass destruction weapons (Rothschild, 1964; Rose, 1968; UN, 1970). As such, they are properly included in this study. This chapter assesses the threat potential of these materials in the hands of political dissidents, terrorists, and psychopaths in the context established by the study as a whole. The CB threat is compared with that presented by the INW in Chapter 9.

The characteristics and utility of weapons involving toxic or pathogenic materials are described in considerable detail because, unlike the INW, we know of no other study of terrorist use of these weapons. Because of important differences between the chemical and biological agents, however, the problems of acquiring and disseminating them are treated separately.

UTILITY OF CB MATERIALS

Anti-Personnel Characteristics

By utility is meant the effectiveness with which dissidents, terrorists or psychopaths can achieve their goals through the use of CB materials. Since the outstanding characteristic of these substances is that they are uniquely anti-personnel agents, there are only two purposes served by their actual use: production of casualties and restriction of personnel activity in a contaminated area for as long as the material remains active. An ancillary factor of possible significance is that physical damage can be minimized with these materials. The second major characteristic of CB materials is that the physical extent of their effects depends more on the mode of dissemination than on the material used (with the possible exception of high epidemicity pathogens). While agent dissemination will be considered as a determinant of the practicability and mechanics of CB plots, it is important here to draw attention to the difference between the CB substances themselves and the standard military concepts of their use.

Relation to Total Weapon System

The utility of CB materials as mass destruction weapons depends on the ability to disseminate them in casualty-producing amounts over large areas, as well as in their intrinsic toxicity or virulence; their mass destruction character derives from the total weapon system rather than the active ingredient alone. The dissemination methods used in weapon system include aerosolization from moving or fixed sources (utilizing wind drift of the agent cloud where appropriate), generators, and exploding munitions in the form of grenades, artillery shells, bombs and rockets, with the larger packages achieving agent dispersal by means of cluster bomblets. It is the delivery system which brings the agent into contact with its personnel target that determines the extent of its effect; to develop lethal concentrations of chemical agents by artificial dispersal methods requires all the components of a weapon system in addition to a supply of the toxic fill. In the case of rocket or artillery delivery, it is self-evident that the major military hardware needed is inconsistent with the civil threat context, and we reject further consideration of these delivery means.

The use of aerosol delivery systems from light aircraft, small watercraft, moving vehicles or pre-emplaced sources does represent a practicable delivery mode for a civil threat. For an area attack, the quantity of chemical agent to be dispersed is so great that effective spraying would constitute an obvious and overt act. In contrast, biological agents are effective in sufficiently small quantities for covert area attack. The standard concept of releasing an aerosolized biological agent from a vehicle moving across the wind upwind of the target requires only limited resources and therefore represents a practicable civil threat.

Finally, delivery may be effected by taking advantage of the material transport systems which penetrate society. Chief among these are water and food distribution systems covering large segments of society and ventilating or air-conditioning systems serving societal units characterized by high personnel densities such as major office buildings, large auditoriums, and the like. These distribution systems make a covert CB attack somewhat easier than it would be otherwise. Unlike the INW attack, the terrorist considering CB materials for a civil threat must be concerned with the problems of acquiring the material and, more importantly, the means for disseminating it effectively to the target. In many cases, the latter problem is more difficult than the former.

TOXIC CHEMICAL MATERIALS

Introduction

Because of the difficulties associated with widespread dissemination of chemical agents, we confine our attention to the acquisition of extremely toxic materials for selective use in small scale attacks.

Consequently, we first examine the candidate materials in the context of mass poisoning threats rather than as military weapons.

Both murderers and criminologists are continually alert for new poisons. The criteria for poisons as good murder instruments are that they be of high toxicity, inconspicuous with respect to odor and taste, and stable as required in their use; that they operate with delayed action to allow the poisoner to escape or cover his tracks; that they induce no obvious pathological changes which would provide evidence on postmortem examination or that no reliable means of analyzing for residual traces exist; and that no antidote is effective once the symptoms have developed (Pattison, 1959 p.1). Obviously, the criteria are not all of equal importance, and some are dependent on the anticipated mode of use; the toxicity and stability criteria must be satisfied in any case, and the inconspicuousness and delayed action criteria apply if a covert attack is contemplated. The toxicology literature is replete with information and lists of substances which, properly disseminated, can serve as murder weapons; most any library can supply such information. For example, "Poisoning: Toxicology, Symptoms, Treatment" (Arena, 1970) discusses hundreds of poisons of which at least 50 fall in the "very toxic" category, having a minimum lethal dose (MLD) for a 70 kg (155 lb) man of one gram (0.035 oz) or less. Included among these are 20 "extremely toxic" substances with MLDs of 0.1 g or less, most of which are either well known poisonous chemicals (hydrogen cyanide, arsenic trioxide, sodium fluoroacetate), potent drugs (digitoxin, curare, strychnine), or commercially available materials such as the organophosphorous insecticides (Parathion, Systox, TEPP). Thus, there are many highly toxic substances usable for mass poisoning attacks and commercially available to an apparently legitimate "front" operation (medical or veterinary laboratory or supplier, biological or chemical small manufacturer, exterminator, etc.). There is little technical sophistication analogous to INW fabrication in mass poisoning plots involving such mundane materials as these. Consequently, we investigate several much more toxic substances.

While a technically naive terrorist may speculate on the use of these more toxic chemicals as a result of reading about chemical warfare, he would quickly recognize the need for the technical assistance of a trained chemist. On the other hand, the terrorist's attraction to a chemical attack may stem from his own possession of these skills. In either event, a degree of technical competence must be assumed. Thus, this threat becomes analogous to the nuclear weapon case, although with appreciably smaller resource requirements. The two most important reasons for this are the absence of any meaningful restrictions on the availability of materials required and the accessibility of all the information needed in the unclassified, technical literature. This last point bears some elucidation. Although the proper combination of scientifically trained people can assemble information bearing on the design of an effective nuclear explosive from unclassified sources, it is also true that specific data, design parameters, and fabrication techniques are not directly available; difficult calculations (e.g., hydrodynamic computer codes), estimates, and possibly some experimentation are required (Taylor and Humpstone, 1970). This is not so in the case of chemical weapons. Detailed descriptions of the preparation of toxic materials and information directly relevant to various dissemination methods are readily available. In the case of the toxic chemicals, "readily available" must be construed to mean literally tens of thousands of original papers, reviews, and monographs, written by and for organic chemists, biochemists, physicians, toxicologists, pharmacologists, physiologists and other specialists whose professional interests relate to this material. Therefore, as soon as some technical competence is postulated for the threat group, this extensive information base becomes accessible.

In his initial search, the terrorist-chemist will find a number of papers originating from the American, British, Canadian and Swedish chemical warfare laboratories. A typical starting point might be the review article "New Developments in the Chemistry of War Gases" (Sartori, 1951) which describes three classes of chemical warfare agents: the nitrogen mustards, the fluoroacetates and the organophosphorous cholinesterase inhibitors or "nerve gases."

As for the quantity required, assuming appropriate dissemination modes available, the terrorist will discover that even the most toxic of these synthetic compounds show MLDs of the order of 2-3 mg per target individual. Taking target size and dissemination losses into account, even this small MLD may require the preparation of an uncomfortably large quantity of toxic agent. As he continues his search, however, the terrorist will find much information about the preparation of botulinum toxin, probably the most deadly poison known. With its MLD for a healthy adult of approximately 1 μg, this substance reduces the quantity required by three orders of magnitude. The preparation of botulinum toxin depends more on micro-biological than on chemical skills.

To exemplify the problems facing the terrorist contemplating a toxic chemical attack, we investigate in detail the three substances mentioned: the fluoroacetates, because of their relative ease of preparation; the nerve gases, because they are so widely known; and botulinum toxin, because of its extreme lethality. In each case we are primarily concerned with the practicability with which the terrorist can prepare and use the compound in question.

Fluoroacetates and Related Compounds

General. Fluoroacetic acid (FCH_2COOH) was originally prepared in 1896 (Swarts, 1896), but the toxicity of its methyl ester was first reported by three Polish chemists who escaped to England with that information early in World War II (Gryszkiewicz-Trochimowski et al., 1947). For a time, methyl fluoroacetate was under consideration as a chemical warfare agent, especially for clandestine attacks involving the poisoning of water supplies (Sartori, 1951). While fluoroacetic acid is a powerful poison itself, it may also be considered as the parent compound of a large series of monofluoro aliphatic compounds, many of which are considerably more toxic than the parent substance (Pattison, 1959 p.4ff). Fluoroacetic acid has been recognized as the toxic principle of the very poisonous South African plant Dichapetalum cymosum, a hazard to browsing cattle and a source of arrow poison; and one of the higher members of the series, a monofluoro unsaturated fatty acid, probably ω-fluorooleic acid, occurs naturally in the plant D. toxicarium found in Sierra Leone and known as "ratsbane" since the dried and powdered fruit is an effective rodenticide. The sodium salt of fluoroacetic acid, sodium fluoroacetate, is a commercial rodenticide known as Compound 1080.

Information Sources. A small, 229 page volume entitled "Toxic Aliphatic Fluorine Compounds" (Pattison, 1959) provides an entry to practically the entire literature of the fluoroacetates and related compounds through the late 1950's, and summarizes their chemistry, toxicology, pharmacology, biochemistry and medical aspects. The properties, including MLDs, of hundreds of fluorine-containing compounds are tabulated, with references to the original papers describing preparation and toxicity studies.

Toxicity. Before presenting specific toxicity data, some general observations fundamental to the science of toxicology are in order (Polson and Tattersall, 1969; Thompson and Schuster, 1968). The first concerns the determination of lethal dose. Experimental toxicity determinations are ideally based on the exposure of statistically significant numbers of laboratory animals to graded doses of the poison under investigation. The number of animals which succumb to the poison after a fixed time period provides the data from which a dose-mortality curve is constructed. It is evident that statistical variation in the results of these experiments is expected due to variations in age, weight, sex, physical condition, handling, etc., of the experimental animals. Standard statistical methods are used to determine the most probable dose-response curve and its confidence limits. The single most frequently cited datum is the LD_{50}, the dose which is lethal to 50 percent of the sample population. In few cases are toxicity data obtained over a sufficiently wide range to demonstrate the shape of the full dose-response curve. Without this, it is impossible to be quantitative about the magnitude of the threshold lethal dose, say LD_{10}, or the dose required to produce death in almost all the sample, say LD_{90}.

This statistical uncertainty in the dose-response curve is of minor significance in comparison to two more practical problems: the species of experimental animal used and the route of entry of the poison. The white mouse, weighing about 20 g, is by far the commonest experimental animal for toxicity studies; investigations with other animals are more difficult and more expensive. What is important, however, is that they invariably show large interspecific differences in LD_{50}, even when that parameter is normalized for body weight. For example, Pattison (1959, p.3) reports more than a two order of magnitude variation in sodium fluoroacetate LD_{50}, on a mg/kg basis, for eight mammalian species, the toxic doses increasing in the sequence dog, cat, sheep, guinea pig, rabbit, horse, rat and mouse. Extrapolation to other vertebrate classes can, of course, lead to even greater variation: the toxicity of fluoroacetate for the South African clawed toad is some 10,000 times less than that for the dog (species unidentified).

Since man is the primary target for terrorist attack, what should interest us are human toxicity data. At least three methods are available for estimating human LD_{50}s: interpretation of animal data (taking known physiological differences into account), extrapolation of sublethal doses on human volunteers in clinical situations, and investigation of both fatal and non-fatal, accidental poisonings and suicides. In the last case, only fatal outcomes in which postmortem analyses are conducted provide quantitative indication of the dose received; it is rarely possible to acquire this data in non-fatal cases. Taken together, these information sources provide a rough indication of human toxicities, but when the potential variability of a mass target group (young and old, male and female, healthy and ill, robust and weak, etc.) is considered, it becomes apparent that human LD_{50} estimates can only be used as crude estimates of potential impact. Faced with both dissemination losses and dose-response uncertainties, a malevolent terrorist would probably attempt to deliver toxic concentrations much in excess of published human LD_{50} estimates.

There are many routes by which toxic materials can gain access to their site of action within the human body. Because each route depends on different characteristics of the poison and subjects it to different effects by the body's defense mechanisms, LD_{50}s may be markedly dependent on entry route. For a given poison, the highest toxicities are usually obtained by intravenous or intraperitoneal injection since this route bypasses most defense mechanisms and delivers the poison directly into the body fluids which distribute it to its action sites. For certain compounds, perocular or subcutaneous administration is about as effective as intravenous injection. Because of their controllability and reproducibility, these four artificial routes are the ones used in experimental work, intraperitoneal injection in mice being by far the most common.

The entry routes of practical importance are ingestion, inhalation, and percutaneous absorption. On ingestion, the poison is subjected to the normal activity of the digestive system. Many substances which are toxic by injection are ineffective when taken by mouth. The fluoroacetates, on the other hand, show enhanced toxicity when ingested; much of the nominal oral LD_{50} can be recovered unchanged from the stomach while the balance to which the lethal effect is attributed, is rapidly brought to the site of action. The variety of structures found in the respiratory system provide diverse defensive mechanisms against particulate or vapor poisons. For the proper kinds of materials, however, inhalation LD_{50}s are frequently smaller than the corresponding ingestion values. Percutaneous absorption is highly dependent on the ability of the poison to penetrate the skin and on skin condition; lacerated, abraded, burned, or otherwise injured skin providing less protection than normal skin.

For fluoroacetate (either the free acid or its sodium salt), the estimated human LD_{50} by ingestion lies in the range 2-10 mg/kg, corresponding to 140 to 700 mg for a normal adult. The intraperitoneal LD_{50} of fluoroacetic acid against the mouse has been repeatedly established at a value of 6.6 mg/kg (Chenowith, 1949). Since this falls midway in the range estimated for man, we shall use intraperitoneal mouse data for the fluoro-aliphatic compounds generally as indicative of their human oral toxicity. On this basis, the most toxic compounds reported are

8-fluorooctanol (LD_{50} 0.60 mg/kg) and 4-fluorobutyric and 8-fluorooctanoic acid (LD_{50} 0.65 mg/kg) or about 42 and 46 mg, respectively, for normal adults (Pattison, 1959 pp.104,128). The preparation of these three compounds and of fluoroacetic acid itself is described later.

Mechanism of Action. The mechanism of poisoning by fluoroacetic acid and related compounds depends upon their conversion to a form which reacts irreversibly with an enzyme involved in a critical metabolic process. In a general sense, this statement applies to most of the extremely toxic substances known. Enzymes are biochemical catalysts, substances which accelerate metabolic reactions without themselves being consumed in the process. They are highly specific with regard to the nature of the substrate on which they act and the reactions which they bring about. In normal function, an enzyme molecule complexes with a substrate molecule, facilitates a particular reaction on the part of the substrate, releases the altered substrate, and regenerates itself unchanged. If the enzyme encounters an "unnatural" substrate, a substance sufficiently similar to its natural one to permit complex formation but dissimilar in the sense that the normal reaction doesn't occur and the enzyme-substrate complex fails to decompose, then the available enzyme molecules are rapidly removed from the system. The reaction which they catalyze ceases to ~~take place,~~ and the biochemical process ~~in which~~ that reaction appears suffers as a result. The general phenomenon is referred to as "enzyme inhibition."

Fluoroacetate poisoning illustrates this mechanism well. Ordinary acetates and carbohydrates in general are metabolized by oxidation to carbon dioxide and water with the release of energy to other cellular functions through a series of reactions known as the Krebs cycle or the tricarboxylic acid cycle (Bourne, 1962 pp.84-112). In this cycle, acetate to be metabolized is first activated by formation of a complex known as acetyl-coenzyme A which is then converted to citric acid. The first step in the oxidative degradation of citric acid, conversion to aconitic acid, is accomplished by the enzyme aconitase. The presence of the single fluorine atom in the poison permits it to mimic normal acetate through its conversion to fluorocitric acid, but then results in the irreversible formation of a fluorocitrate-aconitase complex. The available supply of aconitase is consumed, and the balance of the metabolic cycle is blocked. The resultant energy deprivation leads to general impairment of cellular functions, destruction of permeability barriers, and eventually, to cellular death.

It is of interest to note that in homologous series of ω-fluoro aliphatic compounds, i.e., the series of compounds obtained by successive insertions of a single carbon atom in the chain, the toxicity of the members alternates by one to two orders of magnitude. This is attributed to the fact that compounds with an even total number of carbon atoms in the molecule are degraded and eventually metabolized as described for fluoroacetic acid, while those with an odd total number of carbon atoms are metabolized by a different route (Pattison, 1959 p.90). The compounds mentioned previously (8-fluorooctanol and the two fluorocarboxylic acids) have an even total number of carbon atoms, and exemplify the toxic members of the series. Their enhanced toxicity compared with fluoroacetic acid is due to their greater lipid solubility and cell permeability, permitting more rapid establishment of effective intracellular concentrations than in the case of fluoroacetic acid itself.

<u>Symptoms and Therapy</u>. Fluoroacetate poisoning in man shows wide variation in observed symptoms. The symptoms may be divided into two stages following a relatively long (up to six hours) and irreducible latent period. In the first stage, excessive salivation, nausea, vomiting, numbness, tingling sensations, epigastric pain, and mental apprehension

occur. Muscular twitching, epileptiform convulsions, low blood pressure, elevated temperature and blurred vision may follow. The second or terminal phase manifests itself by progressive depression of central nervous system functioning leading to death. Severe convulsions alternating with periods of coma may culminate in respiratory arrest, or gradually increasing cardiac irregularities may precede cardiac failure. Although the major points of attack are the central nervous system and the heart, the latter is generally taken to be the primary failure site leading to death (Pattison, 1959 p.47ff).

No specific or highly effective antidote for fluoroacetate poisoning has yet been found. Therapy consists of gastric lavage and general supportive measures designed to ease respiration (administration of oxygen by nasal catheter, suctioning of excess mucous from the trachea, tracheotomy if indicated) and to control convulsions if they occur (intravenous or intramuscular administration of barbiturates). There is evidence that intramuscular administration of excess acetate in the form of monoacetin (glycerol monoacetate) in large doses (35 ml every half hour for a normal adult) may be of assistance. While it is a specific antagonist to fluoroacetate, the stability of the fluoro-citrate-aconitase complex, once formed, limits its utility (Chenowith, 1959 p.208).

<u>Preparation of Monofluoro Aliphatic Compounds</u>. The problems of acquiring monofluoro aliphatic compounds for a mass poisoning attempt represent no serious deterrent to the terrorist who selects this form of attack. The larger problem is arranging to administer the poison to the target group. The acquisition of the necessary materials is discussed here; the matter of delivery and dissemination is left for later consideration.

One option open to the terrorist is the use of Compound 1080, technical grade material containing about 90 percent sodium fluoroacetate. It could be argued that suspicious attempts to purchase Compound 1080, or thefts of it from manufacturer's or exterminator's stocks, might alert the authorities to the possibility of attack. Furthermore, covert administration of any poison is aided by minimizing the quantity of material needed. For both reasons, we suggest that preparation of the more toxic monofluoro compounds better serves the terrorist's intent and can be undertaken using materials which hardly suggest the ultimate purpose to which they are to be put.

There is a more basic reason for describing the synthesis of a poisonous organic chemical at this point, namely to clarify some possible misconceptions about the difficulties and resource requirements of this kind of activity, and to lay the groundwork for comparing this process to the clandestine fabrication of an INW as far as the laboratory operations are concerned. It has been suggested by others that the difficulties and dangers involved in the illicit production of narcotics and other drugs are analogous to those encountered in the chemical processing of SNM, and that therefore the technical skills, resources, and facilities available to the illicit drug industry constitute evidence that the capabilities required for INW production are similarly available (Taylor and Humpstone, 1970). In contrast to this position, we contend that the laboratory operations involved in heroin production, for example, are simpler, easier, and less demanding of resources than are those involved in the fluoroaliphatic compound syntheses described below, and that those operations are, in turn, very much less demanding than the problems encountered in the nuclear weapon case.

This is the appropriate place to make another observation about the assessment of problems encountered by the presumed terrorist in preparing a mass destruction weapon, be it chemical poison or nuclear device. The author of this chapter is a Ph.D. physical chemist with a little experience in organic synthesis work. It is his considered and informed judgement that the holder of an M.S. degree in chemistry, with organic chemistry as his specialty, has received the training necessary to comprehend and perform the operations described with no particular difficulty; and further, that anyone with aptitude for the task could train himself to carry out this process in a relatively short period of time, say 2-3 months. On the other hand, the author's opinion regarding the difficulties and uncertainties of designing, procuring the materials, and fabricating a nuclear device is less informed. Yet some nuclear weapon experts have argued that the difficulties and dangers in what this author considers to be simple, controllable, and certain chemical processes provide analogical evidence for the practicability of the INW threat. It is precisely here that the point lies. The assessment of the difficulty of a process must depend on the experience of the assessor; to a chemist, a simple organic synthesis is straightforward; to an experienced nuclear weapon designer, the fabrication of a nuclear weapon may well be a straightforward task. But neither expert is in a position to evaluate the subjective sense of difficulty and uncertainty confronting the neophyte in these areas. All that the expert can do is tabulate completely and objectively the skills, resources, and information needed for each job, without implying the transferability of one set of capabilities to a task requiring a different set. In other words, we recognize that the inclusion of a nuclear weapon expert who has had access to design information on the terrorist team greatly enhances their success probability; but we deny that in his absence the team can generate an equivalent expertise without an impracticably great expenditure of effort. Left with massive uncertainties in their process and product which are not subject to experimental testing, the threat team's chance of success must be markedly reduced.

We return now to the problem of synthesizing poisonous organic compounds. The ω-fluoro compounds of interest are relatively simple ones, a variety of preparative methods are reported in the literature. The selection of a particular method is generally based on the expected product yield, the cost or availability of the starting materials, and the desire to avoid methods which require special laboratory equipment or difficult process conditions. These simple, laboratory syntheses are typically carried out in mole quantities, that is, the molecular weight of the compound expressed in grams. For 4-fluorobutyric acid, $F(CH_2)_3COOH$, the molecular weight is 106.0; if the yield is 50 percent overall, about 53 g of product are obtained. Using a human, oral LD_{50} for this compound of 0.65 mg/kg (46 mg for a 70 kg adult), 53 g of product provides over 1100 LD_{50}s. Ideally distributed to the target group, this would produce 1100 very ill victims, about 500 of whom would become fatalities. The important point, however, is that mole quantity syntheses usually present no serious problems if scaled up by a factor of three to five, or perhaps even ten; this is still laboratory rather than pilot plant scale. If the product is stable, successive batches can be prepared and accumulated until the quantity needed for attack is at hand.

The fluoroacetates (either fluoroacetic acid, its sodium salt, or its methyl and ethyl esters, all of which have LD_{50}s in the 6-10 mg/kg range) are prepared by treating methyl or ethyl chloroacetate (I) with anhydrous potassium fluoride at an elevated temperature, either in an autoclave (Saunders and Stacey, 1948), at normal pressure in molten acetamide (m.p. 81°C) as solvent (Bergman and Blank, 1953), or without a solvent (Nozu, et al., 1955):

$$ClCH_2COOCH_3 \text{ (or } C_2H_5) + KF \xrightarrow[12\ hrs.]{200°C} FCH_2COOCH_3 \text{ (or } C_2H_5) + KCl$$
$$\text{(I)} \qquad\qquad\qquad\qquad \text{(II)}$$

The fluoroacetate ester (II) may be used directly as a poison, or hydrolyzed to the sodium salt (III) with cold, aqueous sodium hydroxide:

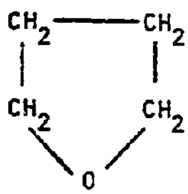
$$FCH_2COOCH_3 + NaOH \xrightarrow[H_2O]{} FCH_2COONa + CH_3OH$$
$$\text{(II)} \qquad\qquad\qquad\qquad \text{(III)}$$

A more convenient method since it can be carried out in laboratory glassware uses cyclohexylbromoacetate (IV) and potassium fluoride as the starting materials and produces cyclohexylfluoroacetate (V) in 74 percent yield (Gryszkiewicz-Trochimowski, 1953):

$$BrCH_2COOC_6H_{11} + KF \xrightarrow[48\ hrs]{200°C} FCH_2COOC_6H_{11} + KBr.$$
$$\text{(IV)} \qquad\qquad\qquad\qquad \text{(V)}$$

This is followed by quantitative hydrolysis to sodium fluoroacetate (III).

The fluoro compounds with LD_{50}s an order of magnitude smaller than the fluoroacetates are prepared differently. To obtain 4-fluorobutyric acid, the corresponding fluoroalcohol is first synthesized (Pattison, et al., 1956a) and then oxidized to the desired acid. To an ether solution of 250 g of tetrahydrofuran (I) and 7.5 g of zinc chloride in a 3-necked flask equipped with dropping funnel, reflux condenser, and stirrer, is added 290 g of acetyl chloride (II); 413 g of 4-chlorobutylacetate (III) is obtained after stripping the solvent on a steam bath (yield 80%). Halogen exchange is accomplished by treating (III) with anhydrous potassium fluoride in an autoclave for 48 hours; 242 g of 4-fluorobutylacetate (IV) is recovered (yield 66%):



$$\text{(I)} + \underset{\text{(II)}}{CH_3COCl} \xrightarrow[\text{in ether}]{ZnCl_2} \underset{\text{(III)}}{Cl(CH_2)_4OCOCH_3}$$

(I)

$$\text{(III)} + KF \xrightarrow[\substack{230\text{-}260°C \\ 48\ \text{hrs.}}]{\text{autoclave}} \underset{\text{(IV)}}{F(CH_2)_4OCOCH_3} + KCl$$

The desired 4-fluorobutanol (V) is obtained by refluxing (IV) with 3.5 times its volume of 5% sulfuric acid for 30 minutes:

$$\underset{\text{(IV)}}{F(CH_2)_4OCOCH_3} \xrightarrow[H_2O]{H_2SO_4} \underset{\text{(V)}}{F(CH_2)_4OH} + CH_3COOH.$$

The solution is neutralized and the product (V) is extracted with ether, dried over anhydrous sodium sulfate and potassium fluoride, and purified by distillation (b.p. 57.5-58°C/15mm); 142 g of purified (V) is recovered (85.6% yield). Since (V) has an LD_{50} of 0.9 mg/kg, 2260 LD_{50}s are at hand.

The fluoroalcohol (V) is now oxidized by adding it dropwise to a vigorously stirred solution of 455 g of potassium dichromate ($K_2Cr_2O_7$) in sulfuric acid prepared by adding 835 g of concentrated H_2SO_4 to 2.3 liters of water. The reaction mixture is kept below 5°C by an ice bath. After all the alcohol has been added, the mixture is diluted with an equal volume of water and the product, 4-fluorobutyric acid, $F(CH_2)_3COOH$ (VI), is recovered by continuous ether extraction for 24 hours. The ether solution is dried over anhydrous sodium sulfate and fractionally distilled, the acid (VI) boiling at 76-78°C/5mm; 111 g of (VI) are obtained for a 68% yield in the oxidation (Pattison, et al., 1956b) and 30.7%

yield for the overall synthesis. With its LD_{50} of 0.65 mg/kg, this provides almost 2500 such doses against normal adults. The acid is a colorless liquid; if a dry solid is desired, it can be quantitatively converted to its sodium salt with no l ss of toxicity.

The preparation of 8-fluorooctanoic acid follows a different procedure, using dimethyl suberate (I) as the starting material (Pattison, et al., 1956a). This is reduced to a glycol (II) by lithium aluminum hydride in 93% yield, converted to the corresponding chlorohydrin (III) by hydrochloric acid and cuprous chloride in 75% yield, and fluorinated by halogen exchange with potassium fluoride in 69% yield. The 8-fluorooctanol (IV, b.p. 111.5-112°C/12mm) obtained in 48% yield overall has an LD_{50} of 0.6 mg/kg; a one mole preparation starting with 203 g of (I) produces 71 g of (IV), enough for almost 1700 human LD_{50}s.

$$\underset{203\text{ g (I)}}{CH_3OCC(CH_2)_6COOCH_3} + \underset{47\text{ g}}{LiAlH_4} \xrightarrow[\text{ether}]{} \underset{\text{(II)}}{HO(CH_2)_8OH}$$

$$\text{(II)} + HCl \xrightarrow[\text{ether}]{CuCl} \underset{\text{(III)}}{Cl(CH_2)_8OH}$$

$$\text{(III)} + KF \xrightarrow[\substack{\text{diethylene glycol} \\ 120\text{-}125^\circ\text{C, 13 hrs.}}]{} \underset{71\text{ g (IV)}}{F(CH_2)_8OH}$$

If the poison is desired as a crystalline solid rather than a liquid, the alcohol (IV) may be oxidized to 8-fluorooctanoic acid by the procedure described previously, but the reduced quantity (68% yield in the oxidation) and lowered toxicity (LD_{50} 0.65 mg/kg) make this a counterproductive step.

Utility to the Terrorist. For this report, the detailed discussion of the previous section may have been unnecessary or even inappropriate. To the lay reader the chemistry may still be obscure, while a chemist or toxicologist would recognize the presentation as over-simplified. Our purpose was to illustrate both the availability of information and the fact that the processes involved in making toxic compounds are the standard ones of practicing organic chemists; the ultimate terrorist intent has no bearing on the problem. Aside from the special care needed in handling toxic materials and in cleaning-up after each batch synthesis is completed, the operation would look no different than those which are conducted daily in thousands of industrial, government and university chemical laboratories. If such facilities are available to the terrorist, his problems are minimized. If not, he might set himself up as an apparently legitimate, small business; rent himself a shop provided with water, sewage, and electricity; and set up a laboratory scale operation. Aside from salary, his annual expenses, including laboratory equipment and supplies, would undoubtedly be less than $10,000, and would permit him to easily produce tens of kilograms of toxic material per year working a leisurely 40-hour week. It should be emphasized that this could easily be a one-man operation, and that the estimate takes into account the usual kinds of minor laboratory accidents, breakage, and lost batches.

As to the utility of the fluoro aliphatic compounds for a poison plot, Pattison (1959 p.34) indicates that:

> they are readily absorbed by all common routes of administration; these include inhalation, injection, ...oral administration, percutaneous application, and introduction into the eyes. More recently, some doubt has been cast upon the ready percutaneous absorption of the low members, particularly of solids such as sodium fluoroacetate, although longer chain compounds, on account of their enhanced lipid solubility, are unquestionably absorbed by this route... Even solid

> fluoroacetates, in the form of dust, are effective by inhalation due to efficient absorption through the pulmonary epithelium, although most work has been carried out with volatile members. The compounds may be administered in any of the common non-toxic solvents with equal effectiveness.

Thus, all that remains is for the terrorist to appropriately expose his target group and the job is done.

Organophosphorous Anticholinesterases

General. No investigation of the substances which could be used for large scale chemical poisoning would be complete without consideration of the "nerve gases" and the thousands of other organic compounds to which they are related, the organophosphorous anticholinesterases or OPAs. This group includes the most toxic synthetic chemicals yet prepared. Many, with high human toxicity, are commercially available as insecticides; others, including the nerve gases, can be prepared from easily available starting materials in a few steps and with relatively high yields. Tens of thousands of scientific papers in the open technical literature deal with their preparation, properties, physiology and pharmacology.

Although the first of the OPAs, tetraethyl pyrophosphate, or TEPP, was prepared (and tasted without ill effect!) as early as 1854, it was not until 1932 that German chemists became fully aware of their toxic properties (Holmstedt, 1963 p.428ff). Four years later, Gerhard Schrader at I. G. Farbenindustrie synthesized a series of organophosphates with insecticidal properties, and in March 1937 patented the general formula for contact insecticides of this type. Since the German Government at that time required that new toxic products be submitted for investigation, the organophosphates were quickly incorporated into the German war effort. In 1937, both Tabun (GA) and Sarin (GB) were turned over to German Ministry of Defense, and by January 1940, a factory for their production was under construction at Dühernfurt, near Breslau, camouflaged against air raids by trees planted on the roofs of its buildings. Although some 10,000 to 12,000 tons of Tabun and 600 tons of Sarin were manufactured at Dühernfurt, the Allies apparently did not know about the factory. It was eventually captured by the Russians and presumably dismantled and moved deep into Russia.

Independently of the German effort, British research teams at Cambridge and American investigators at Edgewood Arsenal became interested in these compounds during WW II. The first candidate examined—diisopropyl phosphorofluoridate (DFP), prepared at Cambridge in 1941—demonstrated a toxicity only slightly greater than that of the long standardized mustard agents and, consequently, excited little official interest in these substances. The results of Schrader's work became known to the Allies in 1946 through the efforts of a British Intelligence Objectives Subcommittee (BIOS) under Hubert Martin; its reports indicate that an astonishingly large number of OPAs had been prepared and studied in Germany during the war. Of the insecticides which have subsequently received extensive use, Dimefox was made in 1940, Schradan in 1942, and Parathion in 1944 (O'Brien, 1960 p.5).

The continued interest in these compounds as chemical warfare agents is manifested by the number of publications dealing with them from the US Army Chemical Center at Edgewood Arsenal, Maryland; its British equivalent at Porton, Wiltshire; the Canadian Research Station at Suffield, Alberta; and both the Research Institute of National Defense and the Karolinska Institute in Sweden. Starting in the late 1950s, an enormous amount of Russian work on organophosphates began to appear in the open literature.

Since World War II, research activity in the field of organophosphorous compounds has increased to a very high level for reasons other than their military value: advances in the long neglected area of organophosphorous chemistry, their economic effectiveness as insecticides (O'Brien, 1967), their utility in basic research studies of nerve physiology and synaptic transmission (O'Brien, 1969 p.2), and in the elucidation of the structure and action of the enzyme cholinesterase (Koelle, 1963). These compounds have shown medical utility in the treatment of myasthenia gravis and similar neuromuscular diseases and in ocular therapy for glaucoma (Leopold and Krishna, 1963 p.1051). It has been estimated that well over 50,000 compounds of this general type have been prepared and described, and that insect or mammalian toxicities have been determined for a majority of them (Chadwick, 1963 p.742).

Information Sources. The recent debate over US chemical warfare policy, the Army's problems in disposing of CW munitions, and the earlier Dugway Proving Grounds accident would certainly be expected to direct the attention of anyone seeking a chemical weapon to these materials. In searching the technical literature, the potential terrorist would soon find a number of reviews and monographs which provide a complete survey of the field. Outstanding among these are "Organophosphorous Poisons" (Heath, 1961), the review article "Pharmacology of Organophosphorous Cholinesterase Inhibitors" (Holmstedt, 1959), and Volume 15 of the Handbuch der Experimentellen Pharmakologie, "Cholinesterases and Anticholinesterase Agents" (Koelle, 1963). Each of these provides data on the properties and toxicities of many OPAs and directs the reader to methods of preparation in the original literature.

In order to impose reasonable limits on this section, we confine our attention to a select few of the OPA poisons which might interest a terrorist. These, and the reasons for their selection, are: TEPP, because it is the most toxic of the commercially available insecticides; Sarin (GB), because its standardization as a US chemical weapon vouches for its effectiveness; and certain organophosphorous choline derivatives, because their published toxicity levels make them the most potent synthetic poisons known. Although we have not specifically attempted to identify the chemical composition of the V-series nerve gases, there is repeated speculation in the literature to the effect that their structure is that of the choline-like compounds last mentioned (Rose, 1968; Cookson and Nottingham, 1969; SIPRI, 1971). Whatever the case, the open literature description of these materials leaves no doubt as to their potency, and is more than adequate for the terrorists needs.

Toxicity. Toxic organophosphorous compounds may be had as more or less volatile, colorless liquids and as crystalline solids. They are poisonous by injection, ingestion, percutaneous absorption and inhalation as vapors, aerosols, or dusts. If the skin is broken or abraded, the percutaneous route becomes even more effective. Extremely small lethal doses result from droplets which lodge in the eye (DuBois, 1963, p.833ff; Grob, 1963 p.989ff). Other than for ingestion, the choice of entry route is, of course, associated with the physical form of the particular compound chosen. Volatile liquids may be vaporized to take advantage of the inhalation route, less volatile liquids may be sprayed or splashed, and solids may be disseminated as a dust.

Even for the few compounds discussed here, there is a bewildering variety of (and discouraging inconsistencies in) toxicity data resulting from variations in test animals, routes and techniques of administration, biochemical purity of the poison (difficult to assure for some of these compounds), experimental technique, etc. Mouse intraperitoneal (i.p.)

injection toxicities are most frequently cited, but their extrapolation to human toxicity is uncertain as different kinds of OPA poisons are considered.

The LD_{50} (mg/kg) of TEPP is reported as 0.7-0.85 for mice (i.p.) (Holmstedt, 1959), 1.05-1.70 for humans (oral) (Heath, 1961), and 2.4-7.0 for humans (dermal) (HEW, 1967). For Sarin (GB), the LD_{50} is 0.42 mg/kg for mice (i.p.) (Holmstedt, 1959), 0.03 for rabbits (intravenous) (DuBois, 1963), 0.03 for humans (intramuscular) and 0.14-0.28 for humans (oral) (Heath, 1961; Grob, 1963). The human dermal LD_{50} is given as 29 mg/kg, but the inhalation toxicity [$L(Ct)_{50}$, the concentration-time product which is lethal in half the exposures] is 70 mg min/m^3 (SIPRI, 1971); for mild activity breathing rates (0.015 m^3/min), this corresponds to an inhalation toxicity of 0.015 mg/kg, half the human intramuscular dose. Compared to TEPP, Sarin is twice as toxic for mice by injection, and ten times as toxic for humans by mouth. Its relatively low dermal toxicity may well be due to its high volatility; in a practical sense, a small quantity of Sarin splashed on the skin is likely to produce a vapor concentration high enough to exceed the inhalation LD_{50} with a single breath. In the open, six pounds of Sarin distributed by a three pound burster charge at a height of 15 feet creates a dosage of 3500 mg min/m^3 20 yards from the burst within ten seconds; in 25 seconds, the cloud expands to a 50 yard radius with a minimum dosage of 100 mg min/m^3 (Robinson, 1967). A minute after the burst, anyone in an area of over 70,000 square feet around the burst will have received at least a median lethal dose, and probably much more than that. In a confined space (banquet hall, auditorium), the effects will be even greater.

The quaternary choline, thiocholine and selenocholine OPAs, characterized as the most toxic synthetic compounds known, show mouse (i.p.) LD_{50} values ranging downward from 0.17 mg/kg. In particular, the quaternary ethoxy methylphosphono derivative of thiocholine is reported at 0.03 mg/kg (mouse, i.p.) (Holmstedt, 1959), and the equivalent selenocholine compound at 0.02 mg/kg (Cookson and Nottingham, 1969). We estimate the total human lethal dose by ingestion of these compounds to be no more than a few milligrams at most. The thiocholine free base is a relatively involatile liquid thought to have a human dermal toxicity of less than 10 mg total (UN, 1970) or 0.14 mg/kg making it 20-50 times more effective than TEPP by this route.

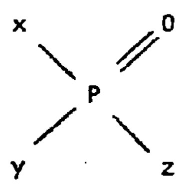
Mechanism of Action. Fundamentally, the mechanism by which the OPAs exert their effect is analogous to that described for the fluoroacetates: the poison mimics the natural substrate of an enzyme sufficiently for the substrate-enzyme complex to be formed, but the complex then reacts abnormally, either binding-up or changing the enzyme, thereby inhibiting its activity. In the present case, the normal substrate is acetylcholine ($CH_3COOCH_2CH_2N^+(CH_3)_3$) and the enzyme, cholinesterase; both are critically important substances in the biochemical behavior of the nervous system. Because of the special sensitivity of that system, substances which produce even transient interference with its functioning tend to act as poisons and kill by virtue of their effect (O'Brien, 1960; Heath, 1961).

The transmission of impulses through the nervous system occurs in two ways: by electric potential changes which travel along the extended portion (axon) of the nerve cell, and by the release of chemical transmitter substances at the junction (synapse) of nerve cells or the organs which they control. Acetylcholine is the most important of these transmitter substances; the cholinergic junctions in which it functions are found in the motor nerves of the somatic system which control voluntary muscles and in both the sympathetic and parasympathetic nerves of the autonomic nervous system. The concentration of acetylcholine at these synapses is controlled by the action of cholinesterase, the enzyme which chemically deactivates the acetylcholine by splitting its ester linkage to form acetic acid (CH_3COOH) and choline ($HOCH_2CH_2\overset{+}{N}(CH_3)_3$). The choline is eventually reacetylated to renew the supply of available transmitter substance. The overall, normal reaction can be represented as:

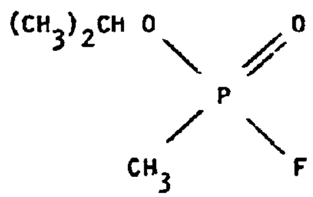
$$\underset{\text{acetyl-}\atop\text{choline}}{AcCh} + H_2O + \underset{\text{cholin-}\atop\text{esterase}}{(ChE)H} \longrightarrow \begin{bmatrix}\text{normal}\\ \text{complex}\end{bmatrix} \longrightarrow \underset{\text{acetic}\atop\text{acid}}{AcOH} + \underset{\text{choline}}{ChH} + \underset{\text{cholin-}\atop\text{esterase}}{(ChE)H}$$

where $Ac = CH_3CO—$, $Ch = —OCH_2CH_2\overset{+}{N}(CH_3)_3$, and $(ChE)H$ is the active form of the enzyme. Note that, as a true catalyst, the enzyme remains unchanged by the reaction.

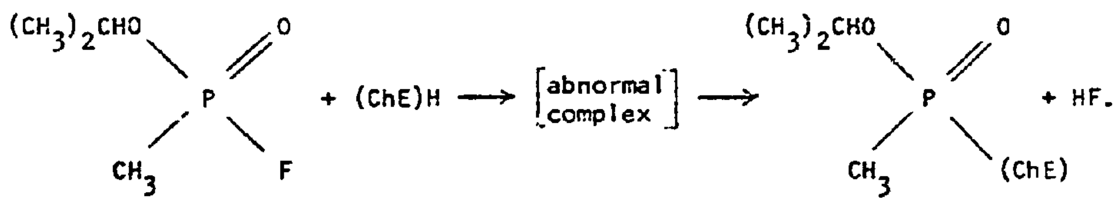
The important biochemical property of the organophosphates lies in their ability to react with cholinesterase. The phosphate linkage simulates the normal substrate's ester linkage, but instead of being split and released from the enzyme a group attached to the phosphorous atom leaves and the remainder of the poison molecule becomes chemically bonded to the enzyme, phosphorylating it. The general structure of the OPAs is:



where x and y are organic groups and z is any of a wide variety of "leaving groups." Sarin, for example, has the structure:



where x is the isopropoxy group ($(CH_3)_2CHO—$); y, the methyl group ($CH_3—$); and z, a fluorine atom (F). The reaction of Sarin with cholinesterase may be represented as:



Note that the poison is now chemically linked to the enzyme, the enzyme is not released to continue functioning as a catalyst, and the leaving group, the fluorine, has split off with a hydrogen atom from the enzyme. The phosphorylation reaction shown is essentially irreversible, that is, it occurs very rapidly in the direction shown and very slowly or not at all in the reverse sense. With some OPAs, the reaction is truly irreversible; with others, certain compounds are effective in displacing the phosphorous-containing residue and can reactivate the enzyme.

The consequence of cholinesterase inhibition is the accumulation of acetylcholine in the synapse and continued stimulation of the adjacent organ or nerve cell. As the acetylcholine concentration increases, the excessive stimulation causes saturation of the ability to respond, and the cholinergic synapses block completely, giving rise to a variety of symptoms.

Symptoms and Therapy. Intoxication by OPAs shows a wide but characteristic set of symptoms depending on the amount of poison received. Regardless of entry route, local effects are observed first and, if the absorbed dose is sufficiently great, generalized systemic effects appear later. On local exposure, small accumulations of acetylcholine in the sympathetic and parasympathetic nerves give rise to muscarinic symptoms: miosis (constriction of the pupil), dimness of vision, tightness in the chest with bronchoconstriction or increased secretion, nausea, sweating and excess salivation. In addition, nicotinic symptoms (muscular twitching and cramps) result from the effect on the motor nerves controlling voluntary muscles and on the autonomic nervous system.

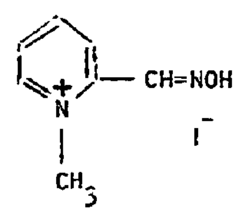
Following systemic absorption, both classes of effects are intensified. Intense muscarinic symptoms are excessive bronchial secretion, pulmonary edema, cyanosis, drooling, vomiting, diarrhea, urinary and fecal incontinence, increased sweating, and bradycardia. Corresponding nicotinic effects are easy fatigue, muscular cramps, and generalized weakness, especially of the muscles of respiration. Lipid soluble OPAs like Sarin penetrate the central nervous system and give rise to tension, anxiety, tremors, confusion, slurred speech, ataxia, coma, convulsions, and respiratory and circulatory depression; those of low lipid solubility (TEPP, quaternary choline salts) have less effect on the central nervous system (Grob, 1963 pp.989-1027).

The rate of appearance of symptoms depends strongly on the quantity of poison received and its entry path: inhalation and ocular exposure produce the most rapid response (minutes); ingestion, a slower response (one fourth to two hours); and cutaneous exposure, the slowest. Massive exposure by any route, however, results in the appearance of symptoms within minutes. For sub-lethal doses, recovery times also vary markedly. Durations to death resulting from accidental exposure to OPAs (typically Parathion or TEPP) average 9 hours, but overwhelming exposure may be fatal within 5 minutes.

In fatal intoxications, collapse and paralysis generally precede death. The immediate cause of death is usually respiratory failure due to either airway obstruction by bronchial secretions, paralysis of the respiratory muscles or depression of the respiratory center. When exposure is less acute and death delayed, circulatory failure may become involved. On postmortem examination, blood cholinesterase levels are found to range from zero to 20 percent of normal, and brain and muscle tissue show levels below 30 percent of normal.

Treatment of OPA poisoning is critically dependent on the rapidity with which therapeutic measures are instituted. The victim must first be removed from further contact with the toxic agent; this may involve removal of contaminated clothing, washing of the body, and gastric lavage with water if the poison was ingested. If symptoms have appeared, atropine must be administered, preferably by intramuscular or intravenous injection: 2 mg every 5 minutes until atropinization occurs (dry mouth, rapid pulse, hot dry skin). As much as 100 mg of atropine may be required to maintain this condition during the first 24 hours of treatment. Atropine functions by inhibiting the action of acetylcholine at all cholinergic sites except those in the voluntary muscle motor system. Consequently, it is effective against the muscarinic and central nervous system effects of the poison. It is reported that more than five million doses of atropine in single dose, pressurized injection ampules, have been stockpiled as part of the US civil defense program (Lieberman, 1962 p.12). Oral administration of atropine sulfate is advised by one manufacturer of organophosphate insecticides, but this is held to be too slow working to be effective (Meidl, 1970).

Even if the muscarinic symptoms of OPA poisoning are controlled by atropine, death may still result from respiratory paralysis, one of the nicotinic effects. Certain oximes, especially pyridine-2-aldoxime methiodide (P-2-AM, 2-PAM)



have been found effective in reactivating phosphorylated cholinesterase, thus relieving the neuromuscular block and the consequent muscular weakness or paralysis. In severe intoxications, up to 2000 mg of P-2-AM is administered intravenously at a rate of 500 mg/min, repeated every 20 minutes if weakness is not relieved. Throughout treatment, the patient's airway must be kept open and artificial respiration applied if necessary. If convulsions occur (even after atropinization), muscle relaxants which do not depress respiration (trimethadione, sodium pentothal) may be given (Grob, 1963 pp.989-1027).

It should be apparent from the foregoing that effective, simultaneous treatment of a number of acute, organophosphate intoxications will severely tax any normal medical facility, assuming the victims can be reached in time.

<u>Acquisition of Selected Organophosphorous Compounds</u>. There are two methods by which a potential terrorist can acquire organophosphorous compounds: purchase of commercial insecticides such as Parathion or TEPP and laboratory scale synthesis of the more potent compounds. Parathion ($(C_2H_5O)_2P(S)OC_6H_4$-4-NO_2) is manufactured by American Cyanamid Company under the proprietary name "Thiophos" and by Monsanto Chemical Company

as "Niran;" the technical grade material is a yellow to brown liquid containing 95 to 98 percent of the nominal compound or its thiolate isomer $((C_2H_5O)_2P(O)SC_6H_4\text{-}4\text{-}NO_2)$ and has a human, oral LD_{50} of "nine drops." Truckload quantities of Parathion are on the highways daily. It is also available in a variety of other preparations at lower concentrations (50 percent liquids, 15 to 25 percent wettable powders, 10 percent aerosols, etc.).

TEPP $([(C_2H_5O)_2P(O)]_2O)$ is manufactured by California Chemical Company, Richmond, California, as "Vapotone" and by American Potash and Chemical Company, Los Angeles, as "Tetron." It is a hygroscopic, water-white to amber liquid, about three times as toxic as Parathion orally or on skin contact. The technical grade is 60 percent TEPP and 40 percent other active organophosphates; less concentrated grades are also marketed (Meidl, 1970 pp.219-223).

An accident or fire involving a truckload of either of these substances represents a hazard, and a hijacked truckload certainly poses a potential threat. A greater threat, however, lies in the ease with which the more toxic OPAs can be synthesized in the laboratory. The general comments about synthetic methods and problems made in discussing the fluoroacetates apply here, with the added stipulation that the OPAs are more dangerous because of their greater toxicity and, in some cases, greater volatility. Still, the function of the technical literature is to communicate among competent workers; both the cautions (to prevent accidental intoxication) and the precautions (to ensure successful conduct of the syntheses) are stated.

A convenient but low yield (7% overall), two-step synthesis of TEPP was published by Holmstedt (1951); this paper also describes the synthesis of Tabun or GA. In the first step:

$$POCl_3 + 2C_2H_5OH \xrightarrow[\text{ether}]{} (C_2H_5O)_2P(O)Cl + 2HCl,$$

the alcohol is added dropwise to an ether solution of the phosphoryl chloride, with cooling and vigorous stirring. The ether and hydrogen chloride evolved is removed by a suction pump, and the residue fractionated (b.p. 62-68°/5mm). The diethoxyphosphoryl chloride obtained is condensed with water and pyridine in step two:

$$2(C_2H_5O)_2P(O)Cl + H_2O + 2C_5H_5N \xrightarrow[0-3°C]{} [(C_2H_5O)_2P(O)]_2O + 2C_5H_5N{\cdot}HCl.$$

The mixture is allowed to stand overnight, heated at 35°C for 30 minutes the next day, filtered and washed, and the filtrate is distilled to separate the product (b.p. 132°C/1.3mm). About 50 g of TEPP (perhaps 500 human oral LD_{50}s) is obtained from 450 g of phosphoryl chloride.

Two methods for the laboratory synthesis of Sarin are described by Bryant and co-workers (1960). The starting material for the first method is methylphosphonodichloridate (IV), prepared as follows (Kinnear and Perren, 1952):

$$\underset{(I)}{CH_3Cl} + \underset{(II)}{PCl_3} \xrightarrow{AlCl_3} \underset{(III)}{[\text{addition complex}]}$$

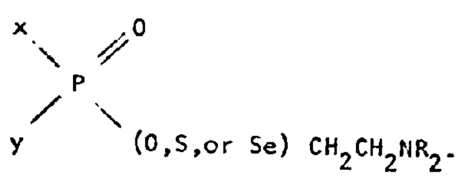
$$(III) + H_2O \xrightarrow[CH_2Cl_2]{} \underset{(IV)}{CH_3P(O)Cl_2}$$

The starting materials, methyl chloride (I) and phosphorous trichloride (II), and the catalyst, aluminum chloride, are combined with shaking to

expensive quantities—for a one mole batch preparation (137.4 g PCl_3, 50 5 g CH_3Cl, 133.3 g $AlCl_3$, etc.) is \$6.83; this produces 0.5 mole or 70 g of Sarin. Five iterations of a 3 mole preparation would provide over a kilogram of Sarin; even at small quantity prices the materials would cost less than \$100. If a laboratory were not available to the terrorist-chemist, a total investment of \$600 would suffice for the necessary equipment (assorted, standard-taper glassware, \$100; distilling column with variable reflux head, \$165; heating mantle and autotransformer, \$60; vacuum pump, McLoed gage and trap, \$200; supports, clamps, miscellaneous hardware, etc., \$75). No unusual equipment is required, and only the hydrofluorination step might be expected to cause problems until the technique is mastered.

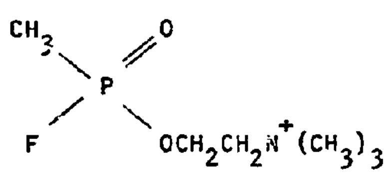
The second Sarin synthesis requires the preparation of diisopropyl methylphosphonate; this material is treated with carbonyl chloride for ten hours, after which halogen exchange with sodium fluoride produces Sarin. The yield of the last step is not reported (Bryant, et al., 1960). Assuming even a 50% overall yield as in the first synthesis, the cost of materials for this process is about 1.5 times greater, and there appear to be no compensating advantages. The physical properties of Sarin prepared by both methods and carefully purified are reported in the Bryant paper. Density, refractive index, surface tension and viscosity are tabulated from 10° to 40°C; vapor pressure, from 45° to 80°C.

In 1955, the first of a new class of OPAs in which one of the groups attached to the phosphorous atom possesses a choline-like structure was reported (Ghosh and Newmann, 1955). These compounds have the general formula:



Many such compounds are known in which x and y are alkyl, alkoxy or other groups such as fluorine; with oxygen, sulfur, or selenium linkages to the side chain; with variations in side chain structure; and with R being any of several alkyl groups.

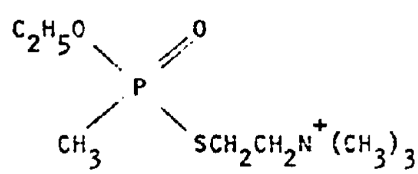
Among this class are some poor cholinesterase inhibitors (x and y both alkoxy or methyl alkoxy derivatives), as well as the most potent ones known (the methylfluorophosphoryl cholines and the methylethoxyphosphoryl thiocholines). It is believed that in the case of the poor inhibitors, the choline chain constitutes the leaving group, with the result that the cholinesterase actually performs its normal function or, if phosphorylated, the reaction is easily reversed and the enzyme restored. For the potent inhibitors, however, either x or y becomes the leaving group and the enzyme is not only extensively but irreversibly inhibited; neither P-2-AM nor any other known reactivator is effective in restoring enzyme activity. Quaternization of the amine nitrogen enhances anticholinesterase activity, possibly by providing a site for ionic bonding of the inhibitor to the enzyme. Specifically, two of the most toxic compounds found in the technical literature (Holmstedt, 1963) are:



methylfluorophosphoryl choline (I)

LD_{50} = 0.10 mg/kg (mouse, i.p.)

and

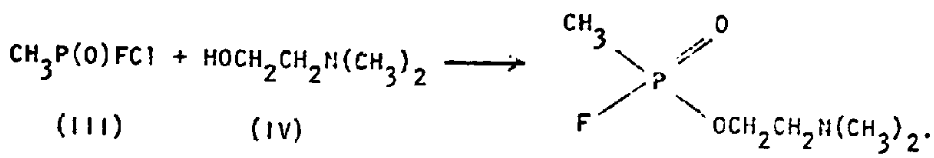


methylethoxyphosphoryl thiocholine (II)

LD_{50} = 0.03 mg/kg (mouse, i.p.)

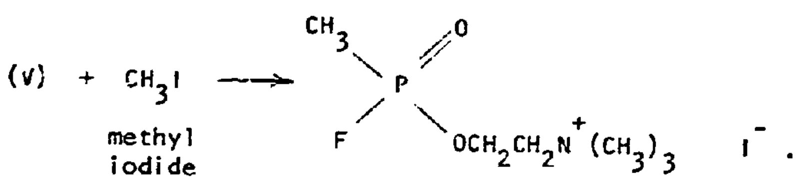
The alkyl alkoxy thiocholines analogous to (II) comprise the V-series nerve gases; at least 16 of these compounds are described in the open literature from US, British, German, Belgian, Swedish ("F-gas"), Dutch, USSR, Yugoslav, and Romanian laboratories, and have been tabulated with their original publication citations (SIPRI, 1971 p.76).

Preparatory methods for compounds of type (I) and (II) are reported from the Swedish Research Institute for National Defense (Tammelin, 1957a; 1957b). They are not difficult to prepare. The methylfluorophosphoryl compounds (Type I) are formed by combining methylfluorophosphoryl chloride (III) with 2-dimethylamino ethanol (IV):



(III) (IV) (V)

Compound (III) is prepared as described in the Sarin synthesis, and the amino alcohol can be purchased directly ($7.07 per kg) or made in one step from diethylamine and ethylene chlorohydrin (Hartman, 1943). To form the fluorophosphoryl choline (V), the alcohol is slowly added to the phosphoryl chloride in a mixture of anhydrous ether and aniline, which neutralizes the HCl evolved. The mixture is refluxed, cooled and filtered, and the filtrate distilled. The product is obtained at 40°C/0.2mm in 60% yield. Because the free base (V) rearranges spontaneously on standing over the course of a few days, it is advisable to continue directly with the quaternization step:



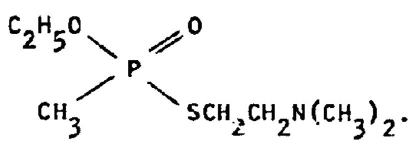
methyl iodide

(I)

The free base is treated with a 10% excess of methyl iodide in ether solution at 25°C and allowed to stand for 6 days. The solid product (I) is then obtained by filtration in 75% yield as a crystalline material (m.p. 152°C).

The V-agents, the methylethoxy thiocholine esters (Type II), are prepared by essentially the same technique as described for the Type I compounds, using methylethoxyphosphoryl chloride (VI) in place of (III) and 2-dimethylaminoethanthiol (VII) in place of (IV):

$$\underset{(VI)}{(C_2H_5O)(CH_3)P(O)Cl} + \underset{(VII)}{HSCH_2CH_2N(CH_3)_2} \longrightarrow$$



(II)

The synthesis of (VI) involves three steps. In step one, phosphorous trichloride is slowly added to a stirred, cooled mixture of ethanol and aniline in petroleum ether. After refluxing for one hour, cooling, filtering, and fractionating, triethyl phosphite (VIII) is obtained in 83% yield (b.p. 57-58°C/16 mm) (Ford-Moore and Perry, 1951a):

$$PCl_3 + 3C_2H_5OH + 3C_6H_5N(C_2H_5)_2 \longrightarrow \underset{(VIII)}{(C_2H_5O)_3P} + 3C_6H_5N(C_2H_5)_2 \cdot HCl.$$

Step two, the Michaelis-Arbusov rearrangement, is accomplished by combining (VIII) with methyl iodide; the reaction is exothermic and self-sustaining, but may require gentle heating to start (Ford-Moore and Perry, 1951b):

$$(VIII) + CH_3I \longrightarrow \underset{(IX)}{(C_2H_5O)_2(CH_3)P(O)} + C_2H_5I.$$

The diethyl methylphosphonate (IX) is isolated in 85-90% yield. Treatment of (IX) with a stream of carbonyl chloride at room temperature is the third step; the desired product (VI) is formed in greater than 90% yield (Bryant, et al., 1960):

$$(IX) + COCl_2 \longrightarrow \underset{(VI)}{(C_2H_5O)(CH_3)P(O)Cl} + CO_2 + C_2H_5Cl.$$

The other ingredient for the main reaction the aminothiol (VII), is quite expensive to purchase ($37.26 per 100 g) but can be prepared by treating the corresponding alcohol (compound (IV) in the previous synthesis) with thionyl chloride (Breslow, 1944) and then converting that to the thiol by means of an alkaline hydrosulfide solution in a nitrogen atmosphere to exclude air (Gilman, et al., 1945):

$$(IV) \xrightarrow{SOCl_2} (CH_3)_2NCH_2CH_2Cl \xrightarrow[N_2\ atm.]{HS^-} \underset{(VII)}{(CH_3)_2NCH_2CH_2SH}.$$

Finally, with both starting ingredients at hand, the main reaction between (VI) and (VII) is carried out by mixing them in equimolar quantities with a 5% mole excess of triethylamine in ether solution. The reaction mixture is refluxed for one hour, triethylammonium chloride is filtered off, and the filtrate is fractionated. The thiocholine free base (II) distills at 80°C/0.06 mm, and is recovered in about 60% yield (Tammelin, 1957b). If a solid compound is desired, (II) may be quaternized with a 50% excess of methyl iodide; the thiocholine salt precipitates in 85% yield within five hours.

Utility to the Terrorist. The utility of the OPA poisons to a terrorist group planning a mass attack depends upon a number of factors: the target characteristics, especially its accessibility; the availability of the poisons; and the need for an effective means of delivering and disseminating it can be more important than intrinsic toxicity. The difficulty in generating lethal concentrations of chemical agents over large open areas has been discussed. To avoid the requirement for large quantities and major delivery systems, effective chemical attacks by terrorists would probably be limited to confined groups such as the occupants of a building, passenger terminal, auditorium, banquet room, convention center, etc. A few, small to medium scale weaponization concepts are presented in the following chapter. Since humans are vulnerable to the effects of OPAs by all entry routes, the volatility of Sarin and the extreme toxicity of the V-agents suggest vapor or aerosol dissemination as a preferred method. Additionally, these compounds have no characteristic taste or odor, so their presence in liquid or solid foodstuffs would not be evident. They are, however, hydrolyzed in water, especially under basic conditions, and would be ineffectively administered by this route unless the poisoned drink were consumed quite rapidly.

Botulinum Toxin

General. The neurotoxins produced by the bacterium *Clostridium botulinum* are the most potent poisons known. Although the poison is produced by a living organism, it is treated as a toxic chemical because its use by a terrorist would be similar to that described for the fluoroacetates and OPAs. This classification is consistent with the identification of botulinum toxin (BTX) as a mass weapon (UN, 1970; SIPRI, 1971). It is important to recognize that the use of BTX does not depend on infecting the victim with the living organism, but on causing him to ingest or inhale the preformed chemical substance, a protein, isolated from a growth culture of the bacteria. BTX is important as a potential weapon of mass destruction because of its tremendous toxicity; the adult LD_{50} is of the order of a millionth of a gram, making this material two or three orders of magnitude more toxic than the V-agent nerve gases.

Botulism ("Sausage poisoning") was recognized as a disease entity in Europe early in the nineteenth century, and about 2000 cases with a case mortality rate of 30 percent were recorded during the latter half of that century. In 1895, Van Ermengen isolated and described the causative organism on the basis of his investigation of three deaths and 23 illnesses which occurred among a group that had eaten a raw, salted ham in Ellezelles, Belgium. The organism isolated from the ham and from the body of one of the victims was originally named Bacillus botulinus, "botulinus" being the Latin word for "sausage."

In contrast to the European experience, the period from 1898 to 1963 saw 1,561 cases of human botulism in the United States with a case mortality rate of 65 percent. By 1960, six serologic types of C. botulinum had been identified; man is vulnerable to types A, B, E and F. The mortality rate difference between the European and American experience proved due to the fact that type A, the most toxic, was implicated in over 80 percent of the American cases while the significantly less lethal type B accounted for between 50 and 90 percent of the European cases (Riemann, 1969 p.293). Separated by type, these natural outbreaks suggest a mortality rate of over 70 percent for type A toxin. For this reason, the present discussion will be confined to it.

Information Sources. Even though botulism is a relatively rare disease, the fact that C. botulinum spores are ubiquitously distributed worldwide and can contaminate and grow in a variety of foodstuffs intended for human consumption is sufficient to justify widespread interest in botulism as a public health problem. In addition, the processed food industry is properly sensitive to the violent public reaction engendered by actual or suspected outbreaks of the disease (Riemann, 1969, p.294). Research interest is maintained by the fascinating properties of these superbly potent bacterial toxins and the fact that their mode of action is yet but poorly understood (Boroff, et al., 1967). International cooperation in the development of toxoids and antitoxin sera for protection and therapy of exposed subjects has recently reached a high level. For these reasons, and because there is no national security basis for the control of BTX information, the open technical literature dealing with identification, culture, spore formation, toxin production, and other properties of C. botulinum, and with the preparation of concentrated and purified toxin itself, is profuse. The textbook and monograph references cited in this section provide adequate starting points for a literature search which would produce all the information necessary to support the production of BTX for terrorist purposes (Riemann, 1969; Ingram and Roberts, 1967; Smith and Holdeman, 1968; Bailey and Scott, 1970). The primary skills required are those of a microbiologist rather than a chemist as a member of the threat group; this theme will be developed further in connection with the use of biological pathogens as mass destruction agents. For the present, let the reader be assured that there is no dearth of open information regarding the technical requirements for developing a BTX threat.

Toxicity. There are many reasons why the human LD_{50} for BTX is not known with precision, but there is no doubt that it is extremely small. Most certainly, not more than a few micrograms—perhaps even a fraction of a microgram—of pure type A toxin is sufficient to produce at least serious illness and slow convalescense; more probably, death. Among the reasons for this uncertainty are the extremely small dose, the difficulties of quantitative assay in postmortem investigation of accidental intoxications, and the complications arising from possible ingestion of live microorganisms or their spores with subsequent growth and additional toxin production in the victim's body.

In the case of BTX, the problem of estimating the human LD_{50} from animal data is compounded by an unusual effect. The experimental animal used for standardized BTX assay is the white mouse. With the mouse, the LD_{50} and time to death by intraperitoneal injection are essentially independent of body weight, sex, and age. This is in contrast to results obtained with rats, where the LD_{50} is proportional to body weight; and to results with toxic synthetic compounds in mice, where LD_{50}s are also proportional to body weight (Lamanna and Hart, 1967). The reason for this effect is unknown.

These problems notwithstanding, the original report of the isolation of crystalline, type A BTX indicated a titer of 240 million mouse LD_{50}s (i.p.) per mg nitrogen (Lamanna, et al., 1946). Since the toxin assays 14.1% nitrogen, this corresponds to 34 million mouse LD_{50}s per mg toxin, equivalent to an LD_{50} of 0.0016 μg/kg for the mouse. If this figure were applicable to humans, the total LD_{50} for a 70 kg adult would be about 0.1 μg. The open CW literature reports a human inhalation toxicity, $L(Ct)_{50}$, of 0.02 mg min/m^3; this figure is 0.002 times the corresponding value for VX and 0.0002 times that for Sarin (SIPRI, 1971 p.86). If a mild activity breathing rate of 0.015 m^3/min is assumed, the equivalent LD_{50} is 0.3 μg. Adoption of a nominal value of 1 μg as the human LD_{50} of purified BTX is consistent with the available information.

Mechanism of Action. Ingested BTX is primarily absorbed from the small intestine and distributed through the body via the circulatory and lymphatic flows. Like the nerve gases, BTX acts on the cholinergic neuromuscular synapses of the peripheral nervous system, but here the similarity ends. BTX is unique in that it causes pre-synaptic block by preventing the release of acetylcholine; the impulse conductivity of the nerves and the excitability of the muscle fibers remain unimpaired. There is evidence that the acetylcholine release mechanism is not damaged by the block; it simply ceases to function, but the manner in which this occurs is unknown (Boroff, et al., 1967). Large doses of BTX apparently have some blocking effect on the adrenergic synapses of the sympathetic nervous system, but the effect is transient. There is also clinical evidence of central nervous system involvement. In any event, the important neurological impact is paralysis, and the usual cause of death is paralysis of the respiratory musculature (Riemann, 1969 p.321).

Symptoms and Therapy. The symptoms of botulism typically appear within 12 to 36 hours after ingestion of the toxin, although delays as short as 4 hours and as long as 4 days have been reported. Both gastro-intestinal and neurological symptoms appear, but with great variability in their sequence. Weakness, lassitude, and headache, possibly accompanied by nausea and vertigo occur early; double or blurred vision, mydriasis, nystagmus, and a degree of paralysis of the pharyngeal muscles resulting in thickness of speech and difficulty in swallowing usually follow. Vomiting, constipation, or occasionally diarrhea may occur. Conciousness is maintained until near the end, and temperatures are normal or slightly reduced (Smith, et al., 1960 p.502). The non-specific character of the early symptoms makes botulism difficult to recognize; cases have been initially diagnosed as gastroenteritis, intestinal obstruction, muscular dystrophy, poliomyelitis, cardio-vascular accident, chronic alcoholism, and streptococcal sore throat (Smith and Holdeman, 1968). In a review of 173 fatal cases, 15 percent were found to terminate within 48 hours, 60 percent between 3 and 6 days, and one case after 26 days (Riemann, 1969 p.299).

The only specific therapeutic agent for botulism is polyvalent horse serum antitoxin, but it must be administered before symptoms have developed or little or no effect can be expected. Antitoxin is used in any event, and some success has been reported with parenteral administration in addition to injection (Minervin, 1967). General supportive measures are employed, but the treatment is unsatisfactory at best. In non-fatal cases, convalescence is typically difficult and prolonged, and many cases of recurrence of acute symptoms are known.

Effective protection of laboratory workers exposed to BTX is achieved by the use of formalin-deactivated toxin (toxoid); three injections from different lots of pentavalent toxoid produce an immune response in almost all cases and can be serologically verified.

Preparation of BTX. Military stockpiles of BTX, and possibly BTX-poisoned ammunition (bullets, flechettes, etc.), have been reported. Their present status, however, may be somewhat ambiguous. Because BTX is a product of bacterial growth, it is unlike the synthetically produced CW agents; because it does not reproduce in the host, it fails to satisfy the definition of biological agents. President Nixon's executive order of November 1969 banning US production and use of biological weapons led to a controversy over the toxins which was resolved by a further order issued in February 1970 extending the ban to include toxins (New York Times, February 15, 1970,1:8). The publicity given the Army's destruction of biological agents notwithstanding, stockpiles of BTX may still exist. If so, they provide a possible source of supply for terrorists seeking this material.

Some BTX is produced by the pharmaceutical industry for the manufacture of protective toxoid and therapeutic anti-toxin. Illicit attempts to acquire this material might arouse suspicion and possible disclose a plot before it got very far. The remaining option, and the one examined here, would be for the terrorist to acquire BTX from scratch. In general, the steps to be accomplished in order to acquire an adequate supply of the toxin are: obtain, culture, and isolate samples of C. botulinum; characterize the cultures as to type, seeking a type A culture showing high toxicity on animal tests; grow this strain in quantity; and finally, concentrate and purify the toxin produced to minimize the total amount of material needed for the attack. The essential features of each step are now described.

Clostridium botulinum is a large, gram-positive, anaerobic bacillus which forms subterminal spores. The organism or its spores are widely distributed throughout the world, being found in soil from sea-bottom to layers of glacial origin at altitudes of 11,000 feet. It has been isolated from river and lake sediments and from both virgin and cultivated terrestrial soil, and is more frequently found in silty rather than sandy soils. Within the US, type A is the predominant type found in the Pacific coast states, in the Rocky Mountains, and in Maine, New York and Pennsylvania. Because the procedures for isolating, culturing and characterizing the Clostridia are so important in both the processed food and medical areas (other Clostridia being the causative agents of tetanus and gas gangrene), they have become more or less standardized and are widely documented (McClung, 1967; Smith and Holdeman, 1968; Bailey and Scott, 1970; Collins and Lyne, 1970; Hobbs, et al., 1971).

Using these standard techniques, a variety of soil samples would be processed until colonies showing the appropriate macroscopic appearance and microscopic form of the individual cells are found. In this search for a starting culture, the terrorist might even enjoy the serendipitous discovery of a new serologic type as occurred during a study of C. botulinum prevelance in Argentina (Gimenez and Ciccarelli, 1967). The advantage derives from the difficulties that would be experienced in attempting to diagnose and treat the illness once the attack is made; standard anti-toxins do not neutralize the toxin produced by this new "type 84" strain.

Specifically, samples to be cultured for C. botulinum are innoculated into enriched, glucose-containing media. The tubes are incubated between 10° and 37°C, and when growth is observed, the organisms are examined microscopically and tested for gram-positive reaction. If these tests are satisfied, streak cultures are transferred to egg yolk agar plates and incubated anaerobically for two days. Under these conditions, strains of all toxic types of C. botulinum produce lipase, causing the appearance of a dense, opaque zone in the agar under the irridescent sheen over the surface of and around the colonies. Samples from these lipase-positive colonies are transferred to meat-dextrose medium, incubated at 24° to 30°C for two to five days, and tested for BTX in the culture fluid. This test and the determination of type can be made by ascertaining whether the toxin is neutralized by the appropriate anti-toxin. If the acquisition of pharmaceutical anti-toxin is undesirable from the terrorist's point of view, an alternative typing process based on identifying the chemical substances digested and the metabolic products produced may be used. This is a tedious process complicated by the need to maintain anaerobic culture conditions, but it uses only standard microbiological techniques, equipment and materials.

C. botulinum is identified by its digestion of gelatin, milk, meat, and coagulated egg or serum; by reduction of nitrate with production of indole; and by production of acid from glucose, maltose, sucrose, lactose, and mannitol. Identification of type A organisms is made by analyzing the fermentation products of cultures grown in a peptone and yeast extract medium containing pyruvate and lactate. Production of isobutyric acid, isovaleric acid and isocaproic acid, coupled with failure to produce lactic acid, is determinative (Smith and Holdeman, 1968 p.198). This description must be qualified, however, by the requirement for specialized technical competence:

> The difficulty in recognition and identification of the botulinal organisms, particularly of the proteolytic types, is compounded by several factors. Perhaps first it should be mentioned that unless the laboratory worker has had special training in anaerobic methodology, the isolation and identification of any anaerobic species is likely to be a considerable problem. Further, especially the nonproteolytic botulinal types are not easily grown even by the experienced bacteriologist on many media, and reports of loss of toxicity are not unusual. With the proteolytic types, the very close similarity to the non-toxic C. sporogenes adds additional problems (McClung, 1967).

BTX is referred to as a "protoplasmic" toxin since it is produced within the cells of the microorganism and released into the medium as a result of autolysis or mechanical rupture of the cell wall. There is evidence that the intracellular material is actually a non-toxic proto-toxin which is activated by proteolytic enzymes such as trypsin. These enzymes are present in cultures of proteolytic strains, so activation occurs spontaneously as the culture ages.

Various methods for the production, concentration, and purification of type A toxin are described in the literature. In one method, five gallon carboys containing corn-steep liquor medium enriched with casein and glucose at pH 7.2 are innoculated and held at 34°C for 72 to 80 hours. From this, an eight step purification and crystallization procedure permits "isolation at will of highly toxic needle-shaped crystalline protein material" by acid precipitation from the culture medium (Lamanna et al., 1946). Abrams and co-workers (1946) describe methods for handling the large volumes of fluid involved, since only 20 mg of toxin is developed per liter of original culture; their procedures permit 70% recovery of the total toxicity in purified form. On this basis, ignoring for the moment the problem of disseminating the toxin, approximately 150,000 adult LD_{50}s can be obtained from a single carboy containing a 3 gallon culture batch. By avoiding aeration of the culture, toxin yields up to 30 mg per liter can be obtained regularly in 48 hours or less (Lewis and Hill, 1947). This raises the productivity of the process to almost a quarter million human LD_{50}s per three gallon batch.

If three gallons is an uncomfortably large quantity for the terrorist's intended use, the toxin can be concentrated and purified by acidifying the whole culture to pH 3.5, precipitating the toxin-containing fraction in 1/40 of the original volume. The precipitate is washed and then redissolved by adding calcium chloride solution and reducing the acidity to pH 6.5. The solution is filtered, the solid material discarded, and the filtrate re-acidified (pH 3.7) to again precipitate the toxin. At this point, the volume of solid material is less than 10 ml and represents recovery of half the BTX in the original culture; based on its LD_{50} assay compared with that of the crystalline toxin, it is 66 percent pure (Duff et al., 1957). Only simple, aqueous solution processes are involved and all steps are carried out either at room temperature or at 4°C. There are three more steps involved in obtaining the pure, crystalline toxin; since they are more difficult and result in only 16 percent recovery of BTX, they seem to have little practical utility for a terrorist.

In summary, once a satisfactory seed culture is obtained and the necessary technique developed one person should be able to handle the set-up, cultivation, partial purification, and clean-up of two 3-gallon batches per week, producing about 350 mg of 66% pure BTX weekly. If a greater production rate is desired, parallel batches may be processed or continuous cultivation techniques used (Cf BW section of this chapter; Holme, 1969). To isolate the seed culture, a competent microbiologist and a small bacteriology laboratory are needed; the requisite equipment can be assembled for less than $3,000. Alternatively, access to an existing laboratory would be adequate for the early steps (acquiring and characterizing the seed culture), leaving only the production steps to be conducted clandestinely. Experimental animal requirements can be minimized if the terrorist is primarily interested in a practical, rather than a scientifically elegant, threat.

Weapon Formulation. The usefulness of BTX as a mass destruction weapon depends on its toxicity, its method of dissemination, and the risks experienced in preparing it. The risks are primarily associated with accidental ingestion or inhalation of droplets of the material, and are normally guarded against by careful laboratory technique and the use of protective equipment such as masks and goggles. In addition, a technically sophisticated operation would include toxoid preparation for self-immunization.

BTX is physiologically effective by all entry routes to the body and its great toxicity makes some modes of dissemination more attractive than they would be with less potent agents. Perhaps its major drawback is that it is heat labile; the toxin is denatured and deactivated in six minutes at 80°C, 18 minutes at 74°C, and 1-1/2 hours at 65°C. It is soluble in water and quite stable under slightly acid conditions, but the combination of heat and basic conditions deactivates it rapidly. At pH 6.5 and room temperature, 10 percent of the toxicity is lost in three days; at pH 7.5, 80 percent is lost in the same time period. At pH 6.9 and 50°C, BTX becomes inactive in a few minutes; but at 40°C, it shows no toxicity decrease within an hour (Riemann, 1969). If dissemination is via water and the water conditions are or can be made cold (10°-15°C) and slightly acid (pH 6.5), the toxin is effective for a reasonable length of time, more than 60 percent remaining active after two weeks have elapsed. If the water is neutral or slightly basic and warm, then the time period between application of the poison and its ingestion by the target group is more critical. The small quantities involved allow BTX to be covertly administered for ingestion in a variety of ways, as long as prolonged basic or elevated temperature conditions are avoided. Like all proteins, BTX is denatured by treatment with strong chemical agents, especially oxidants, but these are not likely to be encountered in a covert attack.

Because of its toxicity, aerosol dissemination of a BTX solution is a feasible means of attack, but in the open and during daylight hours some photo-oxidation of the toxin is to be expected. Since the toxin is involitile, aerosolization is necessary; this is discussed in the following section dealing with biological pathog·ns. There has also been some speculation with regard to adsorbing BTX on inert dust particles which could produce intoxication on inhalation. The production and dispersal of a solid aerosol of this type, however, presents some severe technical problems. Considering the sheer terror that a group of terrorists could produce by indiscriminate, repeated, small scale distribution of BTX in places that provide food for consumption without cooking (injections into supermarket produce such as melons or apples, soda fountain ice cream supplies, dairy or bottling plant output, etc.), the potentialities appear quite awesome. But this would hardly be considered mass destruction.

PATHOGENIC BIOLOGICAL MATERIALS

Introduction

The biological pathogens comprise the third major type of mass destruction weapon potentially available as the basis for a civil threat. In this section, the conditions under which these materials might be chosen and the practicability and effectiveness of such an attack are described. Unlike the chemical poisons which, for mass dissemination, require complete weapon systems of a type not likely to be available to terrorist organizations, use of biological pathogens is virtually identical with certain BW applications which do not require massive weaponry. Consequently, we first undertake a brief review of the applicable concepts of BW, but reserve for later discussion the specific details which bear on terrorist practicability of this form of attack. It is both unnecessary and undesirable to attempt an extensive description of military BW here. Many unclassified analyses, at various levels of technical detail, are available; some represent proponent's viewpoints (Rothschild, 1964); others are those of critics (Caldor, 1968; Rose, 1968; McCarthy, 1969); and still others have been prepared by objective observers called upon to advise national and international policy making bodies (UN, 1970; Cookson and Nottingham, 1969; SIPRI, 1971).

To introduce the relevance of BW attack to the terrorist scene, an extract from testimony given by Dr. Ivan L. Bennett (1970) before a Congressional subcommittee is cited:

> Both chemical and biological agents lend themselves to covert use and sabotage against which it is exceedingly difficult to visualize any really effective defense.
>
> For example, a relatively small quantity of a culture of virulent bacteria introduced into the ventilation system of the New York subway or sprayed upon unsuspecting passengers at an airport could certainly play havoc with our public health system...

> I will not dwell upon misuse of CBW further because, as one pursues the possibilities of such covert uses, one discovers that the scenarios resemble that in which the components of a nuclear weapon are smuggled into New York City and assembled in the basement of the Empire State Building.
>
> In other words, once the possibility is recognized to exist, about all that one can do is worry about it.

. Concepts of Biological Warfare

Background. The UN (1970) report defines biological warfare agents as "living organisms, whatever their nature, or infective material derived from them which are intended to cause disease or death in man, animals or plants, and which depend for their effect on their ability to multiply in the person, animal or plant attacked." More than 150 pathogens, including bacteria, rickettsiae, viruses, and fungi, are believed to have been investigated as potential BW agents (Laurie, 1970).

The BW program spans an active period of almost 30 years, from late in 1941 when the possible need for retaliation to Axis use of pathogens was perceived to President Nixon's renunciation of BW use in 1969 (New York Times, November 26, 1969, 1:8). During this period, US activities centered at Fort Detrick, Maryland, were closely coordinated with similar activities at the British Microbiological Research Establishment at Porton Down, Wiltshire. These laboratories, together with non-military research in microbiology, medicine, public health, epidemiology and aerosol physics, resulted in three major breakthroughs of importance to BW: the continuous culture of microorganisms, the stabilization of viable cultures of those organisms, and the production of monodisperse aerosols (Heden, 1967). Taken together, these permit the mass production, storage, and effective dissemination of pathogenic materials. The "search" capability of the aerosol cloud (it "seeks out" its victims); its potential for large area coverage; and the fact that the respiratory form of most diseases, the form resulting from aerosol particle inhalation, is usually the most severe form, are the factors which make BW aerosols truly mass destruction weapons.

Characteristics of Biological Weapons. Aside from its anti-personnel (animal, plant) character, the outstanding characteristic of biological pathogens "is the variability, amounting under some circumstances to unpredictability, of their effects. Depending on environmental and meteorological conditions, and depending on the particular agent used, the effects might be devastating or negligible " (UN, 1970, para. 10). The potency of the pathogens on a weight basis exceeds that of the most toxic chemicals; between a few and a few thousand viable organisms is all that is required to produce infection in many cases. Since pathogens can be prepared in concentrations of the order of 10^{10} micro-organisms per gram, infectious doses range downward from 0.1 microgram per target individual. The search capability of the aerosol cloud and the fact that infectious doses are independent of victim body weight (because the pathogen reproduces in the host), make the quantity of BW material needed for mass attack quite small indeed.

Criteria for Agent Selection. In 1942, three civilian scientists prepared a paper on the threat of bacterial warfare for submission to the National Research Council. This paper, based on open technical sources, was published after the War (Rosebury, et al., 1947a); it remains today a definitive statement of the criteria for BW agents even though sub-sequent research has made its evaluation of particular pathogens some-what dated. Briefly stated, the criteria are:

1. Infectivity: the magnitude of the dose (number of organisms) necessary to produce the disease in a host. The statistical nature of the infection problem leads to the usual, sigmoid dose-response curve from which median effective or lethal doses (ED_{50}, LD_{50}) can be determined. The virulence of an agent is a measure of its capacity to infect.

2. Casualty effectiveness: the nature of the effects resulting from infection, the length of the incubation period, the duration of the acute stage, and either the expected mortality or the duration of convalescence. While biological pathogens can be generally characterized as more or less severely incapacitating or lethal, statistical variations in age, sex, state of health, and resistance of the target population can result in significant mortality levels even when a nominally incapacitating agent is used.

3. Availability: a joint criterion combining the acquisition of a viable, virulent sample of the desired organism, and the practicability of cultivating it to produce the required quantity of agent.

4. Resistance: another joint criterion reflecting the organism's ability to withstand environmental stresses experienced in dissemination as well as to retain its virulence.

5. Transmissibility: the modes of dissemination and routes of entry by which primary infection of the host can be achieved.

6. Epidemicity: the degree to which an infected primary host can induce secondary infection by transmitting the disease to others. Given proper conditions, some agents are much more likely than others to produce epidemic spread, and possibly lead to a disease becoming endemic to an area in which it was previously unknown.

7. Specific immunization: the existing resistance of the target population to the disease, or the effectiveness with which immunological protection of the population before, during or just after attack can be conducted.

8. Therapy: the effectiveness with which symptomatic occurrences of the disease can be treated. The problems of therapy in response to BW attack must be viewed in the context of widespread, simultaneous appearance of acute cases rather than the localized and irregular demands usually made on medical facilities.

9. Detection: the ease with which the attack or the symptoms of the disease can be identified. For many diseases of BW interest, the respiratory form is atypical and unfamiliar to the medical profession generally and can result in diagnostic delays, precluding an effective, rapid response.

10. Retroactivity: the likelihood with which the agent might infect those responsible for its use. For transmissible and potentially epidemic diseases, BW doctrine guards against retroactivity by relying on large geographic separation or by immunizing the attacker's population against the agent used.

A large, national BW program would undoubtedly take advantage of the many advances made in microbiology over the past years such as the development of highly resistant or highly virulent strains, the discovery of previously unknown kinds of pathogens, and the production of new pathogens by artificially induced mutation utilizing the techniques of microbial genetics. The existence of such agents would be among the highly classified secrets of any nation engaged in a BW program. These particularly sophisticated approaches, therefore, will not be considered since our ultimate interest is in the more practicable terrorist context (but recall the discussion of the Strain 84 subtype of *Clostridium botulinum*).

Pathogens which generally satisfy the ten criteria are identified in the Rosebury (1947a) paper and in most of the general references cited; Rothschild (1964, App. D,E) describes 32 such agents and the diseases they cause: anthrax, North and South American blastomycosis, botulism, brucellosis, cholera, coccidioidomycosis (Desert or San Joaquin Valley fever), cryptococcosis, dengue fever, bacillary dysentery, three forms of encephalitis, three forms of encephalomyelitis, glanders, influenza, melioidosis, plague, psittacosis, Q-fever, Rift Valley fever, Rocky Mountain spotted fever, Salmonella gastroenteritis, smallpox, tularemia, typhoid fever, three types of typhus, and yellow fever. More detailed descriptions of these diseases are found in the standard medical microbiology texts (Cruikshank, 1968; Smith et al., 1960) and specialized monographs, symposium proceedings, etc., are available. In Table 8-1, data for some of these diseases are presented. The choice is not arbitrary; we believe these include the likely terrorist selections for reasons yet to be discussed. Such potential BW diseases as glanders, melioidosis, bacillary dysentery, Q-fever, the various kinds of encephalitis and encephalomyelitis do not appear in Table 8-1 for combinations of reasons related to the terrorist context: low availability, difficulty of cultivation, low resistance to dissemination stresses, problems of self-protection, redundancy of effects with diseases listed, etc. They will not be considered further in this study even though they might be chosen for an illicit BW attack; the diseases listed include a sufficiently wide range of characteristics for illustrative purposes.

Table 8-1. Characteristics of Selected BW Diseases.

DISEASE AND ORGANISM	INFECTIVITY	CASUALTY EFFECTIVENESS INCUB. PERIOD	DISAB.[1] PERIOD	MAXIMUM LETHALITY TREATED	UNTREATED
ANTHRAX [3]					
Bacillus anthracis	20,000 spores	1-5 days	7-14 days	High	~100%
BRUCELLOSIS [4]					
Brucella suis melitensis, abortus	1,300 cells	3-21 days	1-4 months	2%	10%
PNEUMONIC PLAGUE [5]					
Yersinia pestis	3,000 cells	2-6 days	1-2 weeks	10%	~100%
TULAREMIA					
Francisella tularensis	25-50 cells	2-7 days	2-4 weeks	1%	8%
COCCIDIOIDOMYCOSIS [6]					
Coccidioides immitis	1,350 spores	1-3 weeks	2-13 weeks	Low	Low
CRYPTOCOCCOSIS [7]					
Cryptococcus neoformans	High	Unknown	3-6 months	Very High	Very High
ROCKY MOUNTAIN SPOTTED FEVER					
Rickettsia rickettsii	High	3-10 days	2-3 weeks	28% in west; 18% in east	80%
PSITTACOSIS					
Chlamydiaceae virus	High	5-15 days	2-3 weeks	2-10% (strain dependent)	10-90%

Table 8-1. Characteristics of Selected BW Diseases. (Cont'd.)

TRANSMISSION TO MAN		EPIDEMICITY	IMMUNITY		THERAPY[2]
NATURAL	ARTIFICIAL		NATURAL	VACCINE	
From infected sheep and cattle by inhalation, ingestion, and skin trauma.	Aerosol Food Fomites	None (Resp. form)	Limited, variable	Available for high risk personnel	P,TC, CA
From infected sheep, cattle, goats by inhalation, milk, water, and skin trauma.	Aerosol Food Water Vector	None	10-30%	Under development	TC,S
Infected rodent to flea to man; man-to-man by droplet infection.	Aerosol Food Water Fomites Vector	High	Duration, quality uncertain	Short term vaccine available	S,CA, TC,SU
From infected rabbits by contact, tick or deer-fly vector bite.	Aerosol Food Water Vector	None	Yes	Short term vaccine available	S,CA, TC
Inhalation of dust-borne spores, desert soil contact with abraded skin.	Aerosol	None	50-80% locally	None	AMB, Surgery
Ingestion or inhalation of budding cells.	Aerosol Food Water	None	None known	None	AMB, Surgery
Via tick bite (imbedded more than two hours)	Aerosol Vector	None	Yes	Available for high risk personnel	CA,TC, PAB
From infected bird excreta by inhalation, man-to-man by droplet infection.	Aerosol Food Water Vector	Mod. High	Duration, quality uncertain	None	TC,CA

(Notes to Table 8-1 appear overleaf.)

Notes to Table 8-1

1. Disability period is indicated for treated conditions.
2. P, penicillin; TC, tetracycline; CA, chloramphenicol; S, streptomycin; SU, sulfonamides; AMB, amphotericine-B; PAB, p-aminobenzoic acid.
3. ANTHRAX (respiratory form), "wool-gatherers disease;" spores less than 2 μ diameter. Treatment of respiratory anthrax should start when symptoms are still vague; otherwise nearly every case is fatal in 2 to 3 days.
4. BRUCELLOSIS (undulant fever). Non-lethal, untreated cases may have intermittent disability periods for months or years.
5. PNEUMONIC PLAGUE. Particles of 1 μ diameter (single cells) deposit in lungs causing primary pneumonia; 5-10 μ particles deposit in upper respiratory tract, infect lymph nodes, and produce general septicemia. Disease is nearly 100 percent fatal unless treatment starts within 24 hours of exposure.
6. COCCIDIOIDOMYCOSIS (Desert or San Joaquin Valley fever); arthrospores 3-4 μ diameter. Primary form is an acute, self-limiting, respiratory infection; progressive form is a chronic, malignant, deep mycosis of all body tissues.
7. CRYPTOCOCCOSIS (torulosis); 5-15 μ bud cells in thick, gelatinous capsule. Skin lesions or lungs provide primary focus from which organism invades all other body tissues; terminal meningitis is the usual cause of death.

(References: Rothschild, 1964; Rose, 1968; UN, 1970; Smith et al., 1960; Heden, 1967)

Attack Concepts. Because of their effect variability and lengthy incubation periods, biological pathogens are not considered as tactical weapons. For example, McCarthy (1969 p.62) reports that incapacitating pathogens were considered in contingency planning for a hypothetical invasion of Cuba following the missile crisis. The BW planners believed that incapacitation of the defenders would result in a significant saving of American soldiers' lives and that mortality would be less than 3 percent among those Cuban civilians affected. Operations planners, it is reported, took another view: the Cuban soldiers, unable to withdraw under the combined effects of illness, air and artillery attack, would "feel so rotten that they would probably man their guns to the last man and be willing to die at their post," resulting in higher US casualties than if the BW agent had not been used at all.

For reasons like these, BW is generally considered as a strategic weapon. It can be used in large or small scale attack, overtly or covertly, and in such a way as to produce indiscriminate or selectively specific effects. Aerosol dissemination is the method of choice for large scale attacks, but the introduction of pathogens into water and food supplies is also effective. Fomites (articles for personal use as carriers of pathogens, as in the classic case of American colonists providing neighboring Indians with blankets from smallpox victims) and insect or arthropod vectors (Aedes aegypti mosquito as a yellow fever vector; Dermacentor andersoni, the wood tick, and D. variabilis, the dog tick as vectors for Rocky Mountain spotted fever) are other techniques for disease dissemination.

The vulnerability of modern society to BW "sabotage acts" is attested to by several increasing tendencies:

1. Extensive and rapid communications, increasing the "coverage;" 2. urbanization, concentrating people and production units in small areas; 3. increasing the size of slaughter houses, dairies, food processing industries and waterworks; 4. more efficient agriculture, i.e., extensive use of monocultures, large herds, and centralized fodder manufacture; 5. central ventilation systems in command centers, subways, cinemas, theaters, restaurants, etc.; 6. increased dependence on key personnel: radar and missile operators and the people in power, communications, and transport centers. Such individuals are frequently confined to environments (shelters, submarines, and other navy units) in which conventional sabotage acts might be more difficult to carry out than the introduction of a biological agent with an incubation time giving a saboteur many days lead time (Heden, 1967 p.643).

For other than extensive, strategic attacks, there is only a small distance from laboratory techniques in microbiology and aerosol physics to an operational weapon capability; development of a large, sophisticated weapon system is not required. The intrinsic nature of BW precludes achieving the standardized effectiveness and reliability characteristics sought for military weapons systems. Even if the agent fill is standardized, complex environmental and target dependent factors made prediction of the effects of BW attacks highly uncertain.

Responses. The ability to initiate effective responses to BW attacks in warfare depends on intelligence, strategic or tactical warning, and a high degree of informed alertness on the part of the medical profession. The detection and identification of BW agents is an extremely difficult task; military R&D on a reasonably large scale is being devoted to this problem, but an operational network of effective sensors lies in the future. If intelligence about intended use of a BW agent is at hand, prophylactic and therapeutic anticipatory measures can be taken: existing stocks of vaccine can be administered rapidly (jet gun vaccination or orally, if appropriate) and aerogenic immunization using aerosols of attenuated organisms can be undertaken. (Soviet research with aerogenic tularemia vaccines, for example, is reviewed by Tigertt, 1962.) Emergency medical facilities ("Packaged Disaster Hospitals"), each able to care for about 200 patients for 30 days, are reportedly available in the US to supplement normal medical facilities (Heden, 1967 p.648,655).

To bridge the concepts of BW in the military context to those of its elements relevant to the terrorist context, it is instructive to examine what Heden (1967 p.663) has characterized as "the inhibitory forces which influence biological warfare development":

1. that critical problems in the production, storage and delivery of some agents...have not yet been solved;
2. that the attacking country's own BW defense is not adequate or has not been fully tested,...
3. that the popular conception of biological weapons as terror agents makes their use most distasteful, at least in countries with a free press and a democratic system of government;
4. that the value of such weapons is relatively less to the nuclear armed powers, which have a great BW development potential, than to the smaller nations which have a limited BW capability;
5. that all of the tactical/strategic implications, for example, the opportunities for small groups to bring about devastating reprisals, have not yet been given serious attention in military-political discussions;
6. that the exact target area and the long-range ecological consequences are very difficult and occasionally impossible to predict;
7. that there exists a sort of <u>pactum turpae</u> based upon the unpredictability and complicated consequences of BW. These must introduce very disturbing elements in the mathematical mode of military thinking.

Item 5 calls attention to the possibility of BW use by anonymous terrorist groups. Of the remaining items, only item 1 bears on the technical practicability of the threat, a point to be discussed below. Item 2 is irrelevant to the domestic terrorist; items 3, 6 and 7 appear to be desirable attributes from the terrorist's viewpoint, and item 4 is the crux of the matter if the biological pathogens are useful to the terrorist in achieving his aims and more practicably procured than an illicit nuclear weapon. In our investigation of BW agents as the basis for a terrorist plot, these questions of practicability and utility will be the primary factors considered.

Use of Pathogens for Civil Threats

All the clusters of motives identified for the political, psychopathic or criminal terrorist can underlie BW attack as long as a personnel target is designated. This is especially true because even limited or selective dissemination to a particular target group maintains the implicit potential for a widespread attack with its powerful psychological effect. Although the details and problems of BW are poorly understood by the general public, it elicits strongly negative attitudes. In light of the recent US renunciation of BW as an offensive military capability, these public attitudes have undoubtedly been reinforced, so that the threat of a terrorist BW attack would result in much sensationalism, exaggeration, and emotional distress.

Unlike the INW case with its reasonable limitation to one or, at most, a few weapons and unlike the CW case with its dependence on fairly large delivery systems for a widespread attack, the biological pathogens are well adapted to demonstration attacks on small, isolated targets without significantly impairing the terrorist's capability for large-scale attack. Consequently, they seem to offer a unique effectiveness as the basis of a coercive threat or extortion plot. Providing samples of stable, virulent materials and drawings or photographs of effective dissemination devices to the authorities would make such a threat highly credible; this problem is investigated further in Chapter 9. Finally, the large effect to weight ratio and the relatively low cost of developing a BW threat make this particularly appropriate for covert attack. (Heden, 1967 p.644). There are few if any reasons why complete secrecy cannot be maintained during the development of this capability.

Resources. The process of developing a pathogen threat involves selection and acquisition of an appropriate seed culture, its cultivation in adequate quantity, its maintenance in a viable or virulent state, and the ability to disseminate it effectively against the target population. Each step will be considered in detail, including two fundamentally different methods of dissemination: the contamination of food, water or fomites and the production of aerosol clouds. The terrorist's safety problems must also be solved; this is a standard problem when working with pathogenic materials. A variety of techniques have been developed to prevent exposure; vaccines for the immunization of high-risk personnel are available for certain of the agents (Table 8-1); and at the worst, the terrorist contracts the disease, temporarily(?) aborts his plan, and appears as a medical statistic who contracted the disease in an unexplained manner.

It is obvious that the key resources needed are trained and skilled personnel. An experimental microbiologist and a pathologist, or someone who combines these capabilities, would be crucial to the threat group. In fact, their presence would be largely determinant in directing the group toward the biological pathogens. Supplemented with a little help and advice from an aerosol physicist and a meteorologist, a completely adequate set of capabilities would be at hand. At that, the contribution expected of these latter two specialists is not particularly advanced, and could probably be provided by another scientifically trained team member. The information needed is readily available in the technical literature; extensive investigations from the fields of medicine, public health, epidemiology, aerobiology, immunology and others is widely reported and directly relevant to the threat. The choice of agent and attack form would have some bearing on the time, money and facilities needed. The cost of equipment and facilities is somewhat greater than that described for synthesizing the chemical poisons but appreciably smaller than that involved in INW development, and the problems associated with obtaining a seed culture are trivial compared with those to be surmounted in acquiring a supply of SNM.

> Add to this the great advances made in microbiological laboratory personnel protection and the fact that equipment ranging from elaborate protection hoods to fermentors suitable for the propagation of pathogens are now commercially available, and it should become obvious that it is increasingly difficult to neglect the BW defense problems. (Heden, 1967 p.641).

Should the terrorists' plan require larger than laboratory scale quantities of pathogens, someone with experience in the fermentation or vaccine industries would make a strong contribution to the group.

Selection and Acquisition. Of the ten criteria for the selection of BW agents, the terrorist would be more concerned with the first seven than with the problems of therapy, detection, and retroactivity. The first criterion, infectivity, is clearly important; agents known to have caused numerous infections in BW research laboratories where the most stringent precautions are in effect would be good first choices.

> Despite elaborate safety measures, [Fort] Detrick's Assistant Research Director, Dr. Harold Glassman, told Washington Post Reporter John Hanrahan in 1969 that two Detrick personnel contracted anthrax and died in the late 1950's and another caught Venezuelan equine encephalitis and died in 1964. The latter disease is one that is categorized by CBW officials as not a lethal but an incapacitating agent. An earlier accident with brucellosis took the life of a young woman working on the base.

> In addition to the Detrick deaths reported by Dr. Glassman, Dr. Arnold G. Wedum, Detrick's Industrial Health and Safety Director, told the Post about some 400 other cases over a 25 year period where the victims did not die.
>
> Included in Wedum's list were 31 cases of anthrax, 50 of Q-fever, 146 of tularemia, 90 of Venezuelan equine encephalitis, 18 of psittacosis, 5 of Rocky Mountain spotted fever, and one of the plague. (McCarthy, 1969 p.28).

Casualty effectiveness and epidemicity, criteria two and six, provide three different patterns of importance: plague and psittacosis are potential epidemic agents; anthrax, plague, and Rocky Mountain spotted fever are highly lethal to infected victims; and the remaining diseases are, ideally, non-epidemic incapacitators. The effects desired by the terrorist may therefore be reflected in his choice.

Resistance and mode of transmission, criteria four and five, are related through the anticipated method of attack. For small-scale, direct contamination attacks in which the agent is brought directly into contact with the victim, thereby avoiding such stressful processes as desiccation or aerosolization, the resistance criterion is of little importance and delicate organisms such as that responsible for tularemia can be employed. If, on the other hand, a large-scale, aerosol cloud attack is contemplated, more resistant organisms would be preferred. Outstanding among these are the spore formers such as the anthrax bacterium and the fungi, but the viability of less rugged pathogens can be enhanced by various stabilizing processes. Given that the organism can be adequately stabilized for aerosol dissemination, stability-infectivity and stability-lethality effectiveness indexes can be measured against various experimental animals (Rosebury, 1947b p.201ff).

Regarding immunological safety, criterion seven, vaccines which might be used to protect members of the terrorist team are available for anthrax, plague, tularemia and Rocky Mountain spotted fever. None of these have been extensively used for the population at large. Anthrax and spotted fever vaccines are normally given only to high-risk personnel, and plague and tularemia vaccines confer only short-term protection. If the threat team has access to these vaccines, the safety problem is largely solved; if not, attenuated cultures or vaccines can be prepared for self-immunization or operating procedures may be designed with extreme care (filter masks, glove boxes, etc.) in an attempt to avoid exposure.

In the final analysis, the practicability of the process depends on the availability of the chosen organisms. There are two components to availability: acquisition of the seed culture and its requirements for quantity cultivation. The research environment, the medical pathology environment, and natural reservoirs constitute the three sources of supply for the seed culture. The American Type Culture Collection, an independent, non-profit corporation whose mission is to collect, propagate, preserve, and distribute authentic cultures, is an example of the first category. ATCC maintains most of its cultures in a freeze-dried state, and publishes a catalog listing the organism, strain, literature references, source, and recommended culture conditions for the organisms which it provides (ATCC, 1968). Pellets of these standardized cultures, sealed in double glass ampules, are provided at trivial cost and sent by first class mail; the recommended procedures for developing laboratory cultures from the pellets are described in the "Manual of Microbiological Methods " (SAB, 1957). Orders for pathogenic organisms are restricted to "qualified professional investigators" as evidenced by the signature of the institute or laboratory head or the principal investigator on the order blank. Restricted organisms are those of anthrax, brucellosis, botulism, tuberculosis, meningitis, plague, tularemia, glanders, melioidosis, typhoid fever, cholera, blastomycosis, coccidioidomycosis, cryptococcosis, histoplasmosis and South American blastomycosis. Assuming the terrorist is not a "qualified professional investigator," a clandestine visit to a research laboratory in which the desired organism is being used could provide sufficient inoculum for a seed culture; so little is needed that the theft, if carefully carried out, would likely never be noticed. This method of acquisition has the advantage that pure strains of known virulence can be obtained.

Access to a hospital or public health service laboratory where pathogens are cultured from clinical samples for diagnostic purposes is the second potential supply source. With this material, the terrorist might wish to determine the virulence or identify the strain of organism acquired. This could be done by comparing the results of tests on laboratory animals with equivalent published data or by standard immunological assay methods. As his third and possibly most secure source of supply, the terrorist might resort to sampling the natural reservoirs of the organism desired. Sampling, isolation, and identification techniques appropriate to this method of acquisition are described in all the microbiological procedure manuals (SAB, 1957; Bailey and Scott, 1970; Collins and Lyne, 1970). Table 8-2 summarizes data bearing on the last two of these acquisition sources, the medical environment and natural reservoirs, and provides basic information on the culture characteristics (criterion three) and the resistance (criterion four) of the organisms listed in Table 8-1.

Table 8-2. Availability and Resistance of Selected Organisms.

CAUSATIVE ORGANISM (DISEASE)	AVAILABILITY: NATURAL RESERVOIR (LOCALE AND AFFECTED SPECIES)	AVAILABILITY: CLINICAL FREQUENCY IN US
Bacillus anthracis[1] (Anthrax)	US-Annual minor cattle epidemic. A "scourge" in Austria, Hungary, Germany, France. Affects cattle, sheep.	80/yr (avg) (2,447 cases, 1919-1949)
Brucella[2] species (Brucellosis)	Texas, New Mexico, Arizona. Affects goats, cows, swine.	4,000/yr (may be 10 times that frequent.)
Yersinia[3] pestis (Plague)	Human, endemic: Africa, Indochina, South America. Sylvatic (wild rodent),endemic: NW.US, Afr, India, Malaysia, Manchuria	10/yr (avg) (Western states plus Texas, La, Florida)
Francisella[4] tularensis (Tularemia)	North America (disc. in Tulare County, Ca.,1912), Europe, Russia, Japan. Affects rabbits, hares, rodents, birds.	2,000-3,000/yr
Coccidioides immitis (Desert fever)	Southwest US deserts (Delano and San Benito Counties, Ca., San Carlos County, Ariz.) Cattle, sheep, dogs, rodents.	Primary form very common
Cryptococcus[5] neoformans (Cryptococcosis)	Worldwide distribution, sporadic outbreaks. Isolated from soil, pigeon excreta, fruit bloom, etc.	(Human males more susceptible than females.)
Rickettsia rickettsii[6] (Rocky Mountain spotted fever)	All states (foci on Long Is., Rocky Mountain area), Canada, Brazil, So. Africa. Inapparent in many animal hosts.	480/yr (probably more)
Psittacosis[7] virus (Psittacosis)	Endemic in So. American and Australian parrots, their aviaries in US, turkey farms. Psittacine birds (parrots, parakeets).	28/yr (avg.1945-1951). Increasing (444 cases in 1954)

Table 8-2. Availability and Resistance of Selected Organisms. (Cont'd.)

CULTURE CHARACTERISTICS			
TYPE	TEMPERATURE, pH, MEDIUM	DIFFICULTY	RESISTANCE
Spore-forming, aerobic bacillus	12-45°C, 37°C opt.; pH 7.2-7.4; grows well on many simple laboratory media.	Grows easily and rapidly	Very stable spores
Small, Gram neg., aerobic bacillus	Cultivate at 37°C pH 6.6-6.8; blood, meat or liver infusion broths.	Moderate; grows slowly	Moderately stable as aerosol
Small Gram neg., aerobic bacillus	0°-43°C, 28°-29°C opt.; pH 6.6-8.0, 7.2-7.4 opt.; blood agar with NaCl.	Grows easily in broth	Moderately delicate as aerosol
Small Gram neg., aerobic bacillus	24°-39°C, 37°C opt.; pH 6.9 opt.; blood-glucose-cystine or embryonated egg.	Moderate; frequent transfers necessary	Delicate as aerosol
Spore-forming fungus	Grows well over wide temperature range on Sabouraud's glucose agar and other common laboratory media.	Grows readily	Very stable spores
Budding yeast (fungus)	25°-37°C; grows on all usual laboratory media and synthetic media containing thiamine.	Grows readily; may start slowly	Moderately delicate bud cells
Small cocco-bacillus	Grow in yolk sac of embryonated egg, slow growing tissue cultures, laboratory-reared lice and ticks.	Difficult; special techniques required	Delicate as aerosol
Large, coccoid virus	Grow in yolk sac of embryonated egg, rapidly growing tissue cultures.	Grows well under proper conditions	Moderately stable

(Notes to Table 8-2 appear overleaf.)

Notes to Table 8-2

1. B. anthracis. Virulence increased by animal passage. Continuous cultivation methods produce luxuriant growth; sporulation is induced by reducing Ca^{++} concentration and oxygenating.
2. Br. melitensis, abortus, and suis. Survives for weeks to months in refrigerated dairy products.
3. Yers. pestis. Characteristic "stalactite" growth in broth.
4. F. tularensis. Will not grow on nutrient agar, poor growth on blood agar.

5. Cr. neoformans. The large, gelatinous capsule distinguishes this fungus from other yeasts.
6. The rickettsia are very small, Gram-negative coccobacilli always found in association with arthropod vectors. They are obligate, intracellular parasites, best grown in the cells lining the yolk sac of fertile eggs; the eggs are first incubated (39°C, 5-6 days), innoculated, and then incubated (32°C, 3-7 days) to allow growth of microorganisms.
7. In contrast to the rickettsia, the chlamydiaceae viruses are best cultivated in vigorously metabolizing cells. Many strains of highly variable virulence are known.

What constitutes a "good" terrorist choice from the diseases listed? First, it is reasonable to consider the treated lethality as the principal factor; the terrorist's intent is most clearly indicated in this choice. The highly lethal agents are those of anthrax, plague and cryptococcosis in their respiratory forms; among these, only plague has high epidemic potential. The factors impinging on practicability are seed culture acquisition, cultivation and dissemination. The anthrax bacillus is not uncommon in the medical environment; can be reliably obtained from its natural reservoirs; is easily grown in quantity; and, by virtue of spore formation, leads to a stable agent for dissemination which offsets its somewhat lower infectivity. Plague bacteria are less common in the medical environment, but perhaps more available in their natural reservoirs than anthrax bacteria; they are also more difficult to cultivate and more subject to aerosolization stresses, but highly infective by both primary and secondary dissemination. The causative agent of cryptococcosis is a yeast isolable from the localized lesions or the cerebrospinal fluid of its victims (Buckley, et al., 1969), but both its clinical and natural occurrence is limited which may produce an acquisition problem for the terrorist. It grows easily but slowly, and may be difficult to disseminate effectively. As regards self-protection by the terrorist, anthrax can be considered relatively safe; Pasteur immunized himself and his assistants while studying the disease in 1850 by the simple expedient of injecting avirulent cultures which had been attenuated by incubation at 42-43°C. Plague vaccine can be prepared, and prophylactic treatment of exposed individuals with 3 g of sulfonamide daily for 7-10 days suppresses the disease until active immunization becomes apparent. (Smith, et al., 1960 pp.470,465). No immunological protection for cryptococcus infection is known; this organism would present a serious hazard to the attacker.

Among the incapacitating or low lethality diseases listed in the tables, the organisms of brucellosis (undulant fever) are difficult to grow and to immunize against; but are highly infective, readily available from both clinical and natural sources, and relatively stable to aerosolization from a dextrin-stabilized, tryptose-saline medium (Rosebury, 1947b). The tularemia organism is extremely infectious and readily available; it is also difficult to grow and is quite delicate when disseminated. The spores of Coccidioides immitis, the desert fever agent, are easily obtained and grown, very stable, and very effective as long as the attack is not made in endemic areas where natural immunity runs as high as 80 percent in some locations. Since there is no vaccine for desert fever, a naturally immune microbiologist would be ideal for preparing this agent. The rickettsia responsible for Rocky Mountain spotted fever is easily obtained and can be protected against, but specialized virological technique is necessary for its production and it is difficult to disseminate effectively while maintaining virulence. Concentrated preparations of psittacosis virus are extremely dangerous and no effective vaccine is available. While the virus could be obtained from an infected turkey farm, the search might be a long one; additionally, quantity production of the virus would be a demanding job. While the mortality rate of treated cases of psittacosis is quite low, untreated cases are frequently fatal; the literature is quite inconsistent on this point, 10 to 90 percent fatality rates being reported possibly as a result of the difficulty of diagnosing untreated cases. Since the disease can be spread by secondary infection, it is difficult to predict whether widespread primary dissemination would oversaturate available medical resources and result in a large number of fatalities.

It is evident from the foregoing that many options lie open to the BW-oriented terrorist. Since we are unable to suggest any particular reasons for choosing among them, we adopt anthrax as a not unreasonable choice, and refer to it in later discussions of civil BW plots. It is of further interest with respect to anthrax that there are some ancillary factors in its favor: it is well adapted to continuous cultivation; sporulation is easily induced leading to a very stable infective agent; and B. anthracis is closely related to another microorganism, B. cereus, an abundant, aerobic, non-pathogenic spore former found in soil (Stanier, et al., 1970 p.637). The use of B. cereus would permit the terrorist group to develop the necessary cultivation, sporulation inducing, and agent preparation techniques; to test for spore viability; and to essay the safety of its procedures by attempting to cultivate B. cereus from the laboratory environment before beginning work on its pathogenic cousin.

Cultivation and Accumulation of Biological Pathogens. There are basically two methods for cultivating microorganisms: the batch process and continuous culture. Bacterial growth in the batch process passes dynamically through various stages: an induction phase during which the inoculum is activated and begins to reproduce, an exponential growth phase in which the rate of reproduction is maximal, a transient stable phase achieved when the bacterial population is just in balance with both the increased concentration of metabolic wastes and the remaining food supply, and a death phase in which the bacterial titer decreases as the surviving individuals consume the residual nutrients. To achieve high productivity, growth must be arrested toward the end of the exponential stage by methods which do not reduce the viability of the organism; these are discussed below.

The continuous culture method is based on establishing a kinetic system in which the input rate of flow of fresh nutrients to the growth chamber matches the rate at which they are consumed by a bacterial population whose concentration is essentially that reached at the end of the exponential growth stage in batch culture (Malek, et al., 1964 and 1969; Dixon, 1966) This high concentration culture is drawn off at the same volume rate at which nutrients are provided, thus maintaining a constant volume in the growth chamber. The development of continuous cultivation techniques has been a major field of activity over the past 15 years in experimental, biochemical, and genetic research and because of its practical applications in the production of biomass (baker's yeast, for example), alcohol, beer, and in the decontamination or recovery of various industrial wastes and effluents (Malek, et al., 1964 p.14). Continuous cultivation involving induced sporulation of B. subtilis and B. cereus (Dawes and Mandelstam, 1969; Ricica, 1969), organisms related to B. anthracis, and antigen production systems involving Yers. pestis (Pirt, et al., 1961) have been described. Steel and Miller (1970) describe the elements of culture chamber (fermentor) design appropriate to laboratory-built systems or the selection of commercially available items. Continuous culture methods not only avoid the inhibitory influence of high nutrient concentrations and the accumulation of metabolic products, they also maintain the purity of the culture by providing optimum temperature and pH conditions for the desired organism thereby placing any other species present at a competitive disadvantage.

Whether batch or continuous processes are used, the product must be accumulated until the quantity needed is at hand. For attacks in which the material can be produced within about two weeks, simply separating the cells or spores from the culture broth by centrifugation, washing them, and resuspending them in a stabilizing medium will generally permit storage at refrigerator temperatures without significant loss of viability or virulence. For dry agents from sporulating organisms, the spores are separated from the growth medium, washed, dried by desiccation, and stored in sealed vials kept in the dark. Spore stability allows storage under these conditions for periods of months to years without loss of virulence, so small installations are sufficient to produce large quantities of these agents given enough time. For dry preparations of vegetative cells, the technique of lyophilization (freeze-drying) may be used. Because this sometimes kills a highly variable but quite large fraction of the cells, the procedure is usually carried out on the most concentrated cell preparations that can be obtained. Protective substances (milk, serum, sugar, sodium glutamate, etc.) are added and the preparations are slowly frozen. Water is then sublimed from the frozen sample under reduced pressure, the moisture being condensed on a cold surface between the sample and the vacuum pump, or the water may be removed by exposing the sample to desiccants. For small samples, the heat required to sublime the water is supplied by conduction and radiation from the environment. Although commercial lyophilizers are available, the construction of simple laboratory versions presents no problems.

Lyophilized samples of vegetative microorganisms are sealed in glass ampoules and stored in the dark at normal refrigeration temperatures. The viability and virulence of cultures from freeze-dried pellets depends on the organism, its state of nutrition, its concentration, the suspending medium, and the methods by which it was frozen, dried, and reconstituted. For example, Brucella organisms lyophilized from equal volumes of cell suspension and 6 percent sucrose solution stored at 0°C for seven months showed 50 percent viability. Similar preparations of Yersinia pestis, with lactose in place of sucrose, have been stored at 4°C for three years and show 70 to 80 percent viability (Heckley, 1961; Nei, 1969). As a component of a terrorist plot, lyophilization can serve two purposes: preparation of an easily concealed seed culture pellet which can be kept until the production of large amounts of pathogenic agent is initiated, or more importantly, the production of dry, powdered material for use as a direct contaminant or an aerosol dust. As a contaminant, the dried agent might be introduced into foodstuffs which would provide both a reconstitution medium and a vehicle for infection by ingestion. The use of lyophilized agent as a dust, however, depends strongly on its inhalation infectivity in that form.

One other type of biological pathogen threat should be mentioned, even if only briefly: the use of the highly incapacitating Shigella microorganisms responsible for a variety of forms of bacillary dysentery. Shigellosis manifests itself by a variety of symptoms ranging from mild enteritis to rapidly fatal septicemia, and has received as much credit as has generalship in determining the outcome of the "famous battles of history." (Smith, et al., 1960 p.403) Although the control of Shigella infection remains a continuous public health problem, and although the preparation of massive virulent cultures of this organism presents few difficulties, it is unlikely that its use has a significant bearing on the terrorist context.

Aerosol Dissemination. Probably the most important aspect of a large-scale terrorist attack with biological pathogens is the practicability of employing aerosol dissemination. To review the thesis up to this point, we have identified ways in which a terrorist group would acquire seed cultures and cultivate the organisms of several lethal diseases, and have mentioned various forms of dissemination which might be employed in an attack. The repeated observation that these diseases are transmissible by airborne infection and the fact that the respiratory or pneumonic forms induced are their most acute and severe lead inescapably to the conclusion that if aerosol dissemination is a practicable terrorist capability, it must constitute a major civil threat. This is accentuated by the fact that for almost all these diseases artificial transmission via airborne pathogens is <u>more</u> effective than the process of natural spread.

The study of airborne infection draws on the fields of aerosol physics, aerobiology, and meteorology. This section addresses the production of pathogenic aerosol clouds and identifies the relevant literature. Three volumes of inestimable value to the terrorist contemplating this form of attack are Rosebury's "Experimental Air-Borne Infection" (1947b). Green and Lane's "Particulate Clouds" (1964), and the symposium proceedings "Airborne Microbes" edited by Gregory and Monteith (1967). Not only do these volumes provide a review of the field which justifies its practicability for terrorist use, they also direct the reader to the original papers for detailed information as to technique. Two such collections are the proceedings of the First (1961) and Second (1966) International Conferences on Aerobiology (McDermott, 1961; Lepper and Wolfe, 1966). Drawing on these sources, this section comprises a general description of the physical behavior of aerosol clouds, the production of pathogenic aerosols, the survival of pathogens in aerosolized form, their ability to produce infection, and an indication of the magnitude of the effects that can be expected.

Clouds of particulate matter dispersed in gases are classified as dusts, smokes, or mists. Dusts are heterogeneous collections of solid particles of widely variable size with the larger values predominant. They are generally of poor stability, tend to settle rapidly, and are easily redispersed into the atmosphere. Smokes are disperse systems of low vapor pressure which settle slowly under the influence of gravity, their main criterion being particle sizes less than about 5μ diameter. Mists contain relatively large particles (10μ and above) consisting of droplets formed by the condensation of vapor or the atomization of liquid. The generic term "aerosol" is intended to relate these systems to liquid colloidal suspensions (hydrosols), but the analogy is a poor one due to the inherent instability of the former. Although smokes and fine mists show a tendency toward sedimentation, they can usefully be discussed as aerosols; their ability to scatter visible radiation is diagnostic.

Aerosols are formed by two processes: condensation onto nuclei and dispersion of bulk material. The terms "polydisperse" and "monodisperse" refer to the range of particle sizes found in the aerosol; the latter designating systems in which all particles are within about ± 10 percent of the mean. Five fundamentally different methods are used for production of aerosols: aerodynamic (air blast used to produce liquid breakup), centrifugal action (liquid fed to the center of a rotating disc is centrifuged off its edge), hydraulic (liquid forced under pressure through a nozzle), vibratory (sonic or ultrasonic energy or vibrating reed used for liquid breakup), and electrostatic (charge separation used for liquid breakup). Aerodynamic dispersion (atomization) is the method most widely used for producing biological aerosols, but special designs are required to avoid the formation of polydisperse systems. Once formed, the dynamic behavior of aerosol clouds is affected by their rates of sedimentation, condensation, evaporation, growth, absorption, diffusion, aggregation, and other physical processes (Green and Lane, 1964).

After the aerosol cloud is released, its transport depends on air circulation whether this be due to indoor airstream (Daws, 1967) or circulation in the lower atmosphere and troposphere (Tyldesley, 1967). Long range transport of dusts, pollens and spores depends on their achieving a large height distribution, a low deposition velocity, and a high transport velocity (Ludlam, 1967). The fluorescent particle (zinc sulfide-cadmium sulfide) tracer technique has been used to map the deposition of monodisperse aerosols. In one experiment, a ground based, point source generator with an output of 3×10^{10} particles/sec of 1μ diameter was used. In a 25 mph wind, the average concentration across the plume was found to be 100 particles/m^3 25 miles from the source and 50 particles/m^3 at a point almost 100 miles from the source (Malone, 1952).

The primary problem in the production of pathogenic aerosols is the survival of the pathogen to the extent that it remains sufficiently virulent to infect its ultimate host. Most pathogenic microorganisms are quite vulnerable outside their normal host. The hazards of desiccation, sunlight irradiation and high temperatures are experienced after aerosolization, the most destructive process of all. Microbial aerosols generated as small monodisperse droplets from dilute aqueous suspensions are not only the most infectious, but there is some evidence that particles containing a single microbe survive longer than those containing clusters (Anderson and Cox, 1967).

Now twenty-five years old, the detailed description of the Fort Detrick cloud chamber project for studying infectious aerosols (Rosebury, 1947b) is still cited as a primary reference. It describes a variety of atomizer designs, the criteria by which preferred designs were selected, and the procedures for fabricating them. Paint spray devices are rejected because of their large particle size, but artist's air brushes are found to be possibly applicable where small output is sufficient. For limited terrorist or sabotage use, they may be perfectly adequate.

For somewhat larger but still quite limited output the common, self-contained, aerosol dispenser is available. This would be appropriate for attacks in virtually any small to medium size enclosed space such as a command center, submarine, aircraft, legislative chamber, banquet hall, etc. Conventional aerosol cans are simply tinplate containers charged with a mixture of active ingredient, appropriate solvent, and a propellant gas, typically one of the Freons. (Some half dozen different Freons are in common use; they are volatile, low molecular weight, polyfluorochlorohydrocarbons.) A dip tube reaching to the bottom of the can connects with the spray orifice through a pressure actuated valve. Depressing the valve allows the pressurized contents to ascend the dip tube to the orifice where the sudden reduction to atmospheric pressure results in vaporization of the remaining propellant, converting the fill to aerosol form by the aerodynamic mechanism. Ordinary aerosol packages produce a spray in which all the particles are of less than 50μ diameter and 80 percent less than 30μ; higher pressures and special valve-orifice assemblies, however, can be obtained and produce finer aerosols. Simple equipment for sampling from pressurized dispenser cans is available; it could be modified to permit replacement of the fill under pressure without significant loss of the original propellant.

For products which are adversely affected by contact with the propellant, there are "bag-in-can" systems in which an inner plastic bag contains the product and separates it from the propellant: the "Sepro" can (Continental Can Company) and the "Sterigard" dispenser (Sterigard Company). Another method of separating the propellant from the fill utilizes the aspirator or venturi system; the propellant cylinder and valve assembly are provided as a unit with a projecting dip tube. In the "Preval Spraymaker" (Precision Valve Corporation), the base of the propellant cylinder comprises a screw cap that fits a removable glass container. This unit can be used to spray different liquids by simply changing the material in the container. The "Innovair" system (Geigy Chemical Corporation) differs from the Preval unit in that the product container is not pressurized during use. The dip tube which projects from the side of the pressure cylinder is simply immersed in an open container of the liquid to be sprayed. When the valve is actuated, the product is drawn up the dip tube, mixed with the propellant, and dispersed through the orifice as an aerosol (Sanders, 1970). The applicability of these devices in the present context requires no comment.

Rosebury (1947b) describes the construction of two atomizer jets specifically adapted to the production of pathogenic aerosols. In the first the microbe suspension is drawn by suction feed through a fine (24-gage) stainless steel hypodermic needle. Atomization is accomplished by the focused air blast from three larger (18-gage) needles arranged around and focused at the tip of the fluid jet. In preliminary measurements, this atomizer produced a cloud of Serratia marcescens from water suspension with about 90 percent of the particles having diameters of 4μ or less. The second, the "Chicago atomizer," is made of two concentric tubes of Pyrex glass. The inner tube, drawn to a fine tip, carries the fluid medium; the outer, drawn down so that only a small annular space exists between the two orifices, supplies the pressurized air flow. A 1-inch diameter mixing chamber concentric with the double nozzle provides a secondary air supply of controlled humidity to improve microbe viability. Microbe destruction under the stresses of atomization has been attributed to shearing action, impaction, concentration, agitation, desiccation, oxidation, and bacteriostatic effects due to use of metal in the system. While the design of the Chicago atomizer minimizes or obviates the second, third, fourth and last of these, shearing action, desiccation, and oxidation still result in significant microbe kill during atomization. Using the Chicago atomizer and a gelatin stabilized suspension of S. marcescens, 50 percent recovery of the microbe (not necessarily viable) was achieved with primary air pressures in the range 11 to 17 psi and flow rates in the range 16 to 19 liters/min, secondary air flows between 60 and 80 liters/min, and fluid flows of 1.0 to 1.5 g/min at relative humidities between 60 and 75 percent (Rosebury, 1947b p.99). In contrast, spores of Bacillus globigii (B. subtilis var. niger) showed over 73 percent viable recovery, and Brucella suis organisms suspended in tryptose-saline showed over 16 percent viable recovery. For the four pathogens investigated (brucellosis, glanders, melioidosis, and tularemia), initial suspension concentrations between 10^6 and 10^9 organisms/ml produced initial aerosol clouds with concentrations between 10^4 and 10^7 organisms/liter. Recovered clouds showed concentrations about one order of magnitude smaller, except in the case of Franciseila tularensis which is so susceptible to desiccation that recoveries another one to three orders of magnitude smaller were found.

Once the aerosol cloud is released, the viability of a particular organism depends on relative humidity, atmospheric composition, temperature, and radiation. At this point, a little meteorological expertise would contribute to the effectiveness of a terrorist attack. From what has been said, it is evident that evening release of the aerosol on cool, humid days would prove most effective. A cloud released to drift over crowded, large cities during the wintertime, when resistance to respiratory infection is generally low, would probably be most effective. A moderate wind, some turbulence (to prevent the aerosol from settling), and an inversion layer (to confine the cloud to lower altitudes where the target population is found) are other desirable meteorological conditions. In one experiment with spores:

> 130 gallons of a suspension of B. subtilis var. niger was aerosolized from the deck of a ship running on a two mile course about two miles off shore. The dissemination line was at right angles to an onshore wind, and meteorologically the situation was characterized by a certain tendency to vertical dilution. In

> spite of this, the cloud could be followed for about 23 miles, giving viable cell densities inside buildings corresponding to "infectious doses" over some 100 square miles. Of course a test of this sort can be downgraded insofar as it concerned a spore, but guinea pigs have actually been infected with vegetative bacteria which had traveled in an aerosol nearly 15 miles (Heden, 1967 p.642).

The author fails to point out the close taxonomic relationship between B. subtilis used in this experiment and B. anthracis (Cf UN, 1970, para. 54). The stability of anthrax spores is attested to by recent samples from the small island of Gruinard off the northwest coast of Scotland which was used as a BW test range during World War II. In his report, Dr. G. E. Gordon-Smith stated that the island may remain infected for a hundred years (Langer, 1967).

Given the survival of some fraction of the microbes or spores in the aerosol cloud, the last step in the process is infection of the target group. The human respiratory system discriminates between particles of different sizes: particles larger than 10 or 12 μ are retained in the upper respiratory system (naso-pharynx or upper bronchi), intermediate particles of about 5 μ diameter are trapped by sedimentation in the trachea and bronchioles, and 0.8 to 1.6 μ particles account for maximum deposition in the fine bronchioles and alveoli; smaller particles (less than 0.5 μ) are exhaled. More than 50 percent of the 0.8 μ particles are retained in the lungs as compared with only 26 percent of the 2 μ particles. In typical microbiological aerosols, vegetative bacterial cells are 1 to 2 μ in diameter and spores range from 2 or 3 μ upward. Thus, these particles are ideal for lung deposition.

> Retention of the invading organism within the respiratory system is a necessary, but by no means sufficient, condition for the infection of the host. Many bacteria and their spores are well adapted by their size to reach the respiratory

> portion of the lung, but invasion is fortunately uncommon. This is due in part to the inefficiency of natural processes in generating finely dispersed bacterial aerosols and to the limited life of many airborne pathogens. ... If the respiratory portion of the lung is the susceptible region, spectacular increases in the number of inhaled organisms required to initiate infection may occur with increasing particle size. If the susceptible region lies in the upper respiratory system, particles of all inhalable sizes may be deposited in it with varying efficiency and particle size effects will be less marked. (Druett, 1967).

In the case of anthrax spores, respiratory infection is highest with single spores, but only slightly reduced with clumps up to 5μ in diameter. Above this value, infectivity falls off (Green and Lane, 1964 p.380). Five cases of pulmonary anthrax occurred among mill-workers processing goat hair in New Hampshire in 1957. Air sampling carried out some months after the epidemic indicated that between 600 and 2150 particles containing B. anthracis might be inhaled during an 8-hour shift by a worker in the mill; 25 to 30 percent of the particles were less than 5μ in diameter (Williams, 1967). Depending on the deposition site, certain pathogens can produce different, if equally serious, effects: one micron particles containing single cells of Y. pestis (the plague organism) lead to primary pneumonia, while 5 to 10μ particles which deposit in the upper respiratory tract propagate to the lymph nodes from which a generalized septicemia develops (Smith, et al., 1960 p.462).

Other evidence of the infectivity of airborne particles is provided by the many cases of laboratory infection resulting from procedures in which infectious material is dropped, splashed, shaken, homogenized in blenders, injected into animals, and even as a result of opening screw top bottles or ampoules of lyophilized culture pellets (Chatigny, 1961 p.139ff). Sneezing, coughing and talking expel 1 to 100 μ droplets of microbe-containing saliva with considerable velocity. While the large particles drop rapidly, the small ones evaporate quickly leaving suspended organisms which can remain airborne for a long time and subsequently be raised as a dust. The ability to demonstrate fecal bacteria in the depths of the respiratory tract is attributed to the production of high concentration aerosols resulting from toilet flushing (Green and Lane, 1964 p.375-76). Even a delicate organism like F. tularensis shows an infectious dose increase for guinea pigs of not more than 1 order of magnitude after the aerosol cloud has aged for 5-1/2 hours (Rosebury, 1947b).

To underscore the capabilities of an entirely practicable terrorist act, the following is offered:

> Theoretical calculations clearly indicate the possibilities for large scale coverage. A midnight dispersion of five liters per kilometer of a suspension holding 10^{10} perticles per milliliter at an altitude of 100 meters along a 50 km line would—given a reasonable generator efficiency, certain meteorological conditions, and a wind speed of 20 km per hour—set up a cylindrical cloud which would pass a downwind point in less than a minute. A person breathing at a rate of 10 liters per minute would be exposed to about 150,000 particles. If this happened at 2 o'clock in the morning and if the relative humidity had been appropriate for the selected agent (decay: 2 percent per minute), an aerosol with an infectious dose of 150 viable particles would be enough to cause disease. An individual exposed at 6 o'clock would, on the other hand, only contract the disease if the agent used had an infectious dose of 1.5 particles. At this time the coverage would be 6,000 square km. (Heden, 1967 p.655).

As a closing note with a strange touch of irony, workers at the Microbiological Research Establishment at Porton report that microbial aerosols which show high viability in the laboratory deteriorate rapidly when exposed to the night air on the laboratory roof; the effect is attributed to the phytotoxicants in urban smog (Druett and May, 1969).

It is a strange commentary on our culture that atmospheric pollution may provide a degree of protection against bacteriological attack whether of international or terrorist instigation.

While the terrorist may be incapable of mounting continent-wide strategic attacks with BW agents, smaller attacks on cities are not impracticable. An example is given in the following chapter. The problem of defense against the threat of BW in warfare and its use by terrorists differs only in degree and extent.

> A psychiatrist once claimed that the common reaction to BW is similar to that of the medical student who enters the postmortem theater for the first time; he can learn no anatomy until he has become accustomed to death. Such an adaptation process is important for the defense planner who must be able to create imaginatively a proper picture of conceivable BW situations.
>
> In the protection of a nation's water resources and its food and drug production against BW, security checks and special training of all personnel holding key positions in sabotage-vulnerable establishments are essential. Food processing industries, dairies, ice cream factories, and water works are at the head of a long list of vulnerable establishments.
>
> Considering modern water purification methods and the close supervision of the water supply which is the rule with military units, the water contamination problem is primarily one for civilian authorities to consider.
>
> In addition to an effective system for a nationwide reporting of infectious diseases, the planning of BW defense should involve the preparation of standby legislation for compulsory immunization, stockpiling of therapeutics, preparation for extra protection of broad spectrum antibiotics, microbiological research and finally, the spread of knowledge about unusual infections.
>
> Control and inspection in the BW area is hardly possible with regard to "sabotage" quantities, but large scale military efforts are probably not easy to hide. (Heden, 1967 p.645).

This rather extensive, and hopefully not too superficial, discussion of chemical and biological materials which could be used by terrorists, psychopaths, or criminals as civil threats has been prompted by the fact that even more extensive investigations of the manufacture of illicit nuclear weapons have appeared (Kinderman et al., 1969). A threat-oriented comparison of these three mass destruction weapons is presented in Chapter 9 in the context of the differential utilities which they confer on the terrorist for direct attack or coercive use. In approaching this material, the reader should be aware of our bias to the effect that chemical poisons represent a relatively ineffectual threat, but that the nuclear weapon and the biological pathogens constitute threats of comparable seriousness with the latter the more practicable of the two.

CHAPTER 9
SUPERVIOLENCE APPLIED

This chapter deals with the application phase of the superviolent plot by combining its mechanics and its motive in an internally consistent fashion. The weapons of superviolence are first compared in terms of their resource requirements, appropriate targets, modes of employment, and potential impact, with emphasis on the terrorist's selection of possible weapon-target combinations. We adopt the premise that the terrorist can complete his preparatory activities without disclosure to the authorities and without the occurrence of countervening events which cause him to abandon further action. Following these objective aspects, we examine the terrorist's motives and contingent options.

A critically important distinction is made between motives leading to direct attack and the coercive motive based on the threat of attack. Recent examples of politically motivated coercion and contributions from the formal theory of threats are brought together in a meta-scenario describing the elements of the coercive threat. The possibility of mass panic resulting from public disclosure and the problem of determining whether a threat is real or a sham are explored. Finally, the relative likelihoods of various forms of superviolent plots are assessed.

Some preliminary notions are important. Throughout this report, the INW threat and its chemical and biological analogues have been viewed as conspiratorial by nature; in the context of political violence, these are pre-planned actions carried out by elite groups. The violence contemplated is instrumental rather than expressive: its essential nature is derived from the weapon, the instrument, rather than from the eruption of anger or frustration. The threat is not considered in the context of internal war. The dissident's rhetoric to the effect that he is at war with society notwithstanding, the conditions of true internal war (sustained and overt guerrilla or revolutionary operations) are of sufficient magnitude to be recognized as such by the authorities. While mass destruction weapon threats are certainly germane to this case, a state of actual or impending internal war would certainly lead to stringent controls over fissionable materials, protective responses, and general counterinsurgency operations designed to foil attempts at violent attacks. Therefore, for the present and near-term future, it is reasonable to limit the plots examined to the elite, conspiratorial character described.

Because of the almost complete absence of experience with superviolent plots, much of this material is speculative. Analogical evidence is brought to bear where it exists, but its relevance must be subjectively determined. We have attempted to be analytic where possible; this is most clearly recognized in the identification of alternative options at each stage of the plot. Without the ability to rely on historical data, the problem of relevance is especially severe; too many cases are partially relevant for detailed exploration, and too few directly relevant to shed objectivity on these matters.

THE WEAPONS OF SUPERVIOLENCE

Although we have not conducted a design and production engineering study of weaponizing illicit nuclear, chemical, or biological devices, we present reasonable estimates of their complexity, cost, and the specific ways they might be employed. Because there are no examples of successful superviolent plots, we rely on speculation and imagination, tempered by reason. The wide range of alternatives resulting from the diversity of individuals who may motivate superviolent plots; their skills, backgrounds, and consequent choice of weapons; their objectives which dictate the target to be attacked and the possibility of inside assistance or specialized knowledge for penetration of that target; the impact they wish to achieve; their security during and after the attack; all these factors make it presumptive to suggest that a few "standardized" plots could represent the entire problem. Yet there are obvious and limiting capabilities which characterize appropriate plots for each of the three weapon types.

Weapon Forms, Resources, and Modes of Employment

Nuclear. Technical analysis of the problem of INW fabrication (Chapter 7; Kinderman et al., 1969) indicates that devices weighing about 1,000 pounds and capable of producing yields between 0.1 and 10 kilotons represent typical threats. In Chapter 7, we suggest that the most likely route to such a device is by diverting metallic or ceramic SNM from civil industry sources. Given a successful diversion effort, weapon fabrication within the stipulated $7,000 to $16,000 (including two to five man-months of effort) is predicated on a most austere cost basis, involving purchase of only minimal and most specialized materials and equipment, and assuming that an adequate working facility is available at no additional expense. The most crucial requirement is significant inside assistance for the diversion to be carried out covertly. Otherwise, overt acquisition of the required SNM becomes necessary, and leads to a massive recovery effort by the authorities which certainly increases the security problems of the threat group.

Although numerous methods for the surreptitious delivery of an INW can be imagined, perhaps the simplest and most flexible is a small, enclosed-body van of the kind typically used for delivering a variety of products and services. The innocuous appearance of this ubiquitous vehicle, its sides painted to identify it as a provider of TV service, air conditioner maintenance, clean linens, catered food, etc., would be unlikely to invite suspicion. With only a modicum of inside connivance, it might even permit entry to otherwise restricted areas. While the virtue of the INW to the terrorist may arise from its utility in destroying targets of high value, physically large targets, or physically hard targets, the case of small but inaccessible targets in which the weapon effect radius compensates for the imposed standoff may also be important. With the exception of a few special targets, all these classes can be effectively approached by the small delivery van described. Once parked at the desired location, the operator could leave the area and the device be detonated by a time delay or remote control mechanism.

For a 1 KT surface burst, the 3 psi contour lies at a radius of about one-third mile from the point of detonation. The impact of prompt blast destruction within this area may be crudely approximated by an overlay on a map of the target area. For sheer destruction, the downtown areas of major cities probably represent the largest values that can be obtained. Prompt fatalities of the order of a few hundred thousand individuals and immediate destruction of the order of a few billion dollars appear achievable; Rockefeller Center in New York City, with 18 buildings on a 20 acre plot, encompasses a working population of 160,000. Adding the transient population, delayed effects due to fall-out, disruption of services, and damage extending another few tenths of a mile beyond the boundaries of the Center itself, all contribute to the total impact. Were we to adopt a figure such as $300,000 for the economic value of a working individual, the total loss in this attack would be at least $60 billion and probably closer to twice that amount. On the other hand, it is highly unlikely that the survival of the US national entity would be jeopardized, or even that a local or state government would fall as a direct consequence of the attack.

Chemical. Attack with toxic chemicals offers the terrorist many options with only small resource requirements, but coupled with this is strong dependence on specific target vulnerabilities, severe problems associated with agent dissemination, and a net impact very much less than can be achieved with a nuclear weapon even in the best situations. While it is true that $100 worth of materials and less than $1,000 of lab equipment would permit the preparation of at least 10,000 LD_{50}s of any of the toxic chemicals described in Chapter 8, from a practical point of view, this quantity must be increased to account for dissemination loss factors between 10^1 and 10^6 depending on the method of attack chosen.

Four methods of dissemination should be considered: (1) covert contamination with bulk agent of foodstuffs or beverages selected to avoid conditions which would destroy the poison; (2) covert generation in enclosed spaces of lethal vapor concentrations from volatile agents; (3) covert dissemination in enclosed spaces of aerosols of non-volatile agents; and (4) overt attack with bursting munitions or thermogenerators. Examples of each dissemination method can be imagined. A 10-pound sack of ground coffee for institutional use prepares approximately 800 cups of coffee. Injection of 35 ml of 8-fluorooctanol into the sack before delivery to the user results in one LD_{50} per cup. The ground coffee would probably not appear abnormal; the brewing process will not destroy the poison; and its presence in the finished brew will not be apparent by taste, odor, or appearance. The use of BTX must be limited to dissemination paths which would not denature the protein. With the BTX concentrate described in Chapter 8, 0.3 mg in a 10 gallon milk dispensing container results in a lethal dose in each 8-ounce glass. Normal refrigeration and rapid consumption of this product insure that the toxin remains active during the period of use. Dissemination loss factors by this avenue are greater than unity only to the extent of spillage, overdose, or cooking use; a loss factor of 10 is therefore a conservative estimate.

For vapor dissemination, of the agents investigated only Sarin is sufficiently volatile. A small, self-powered boiler unit charged with the required amount of this agent and hidden in an assembly room, would rapidly produce a lethal concentration. A simple calculation involving the room volume and desired exposure time determines the quantity of agent required. Hiding the boiler just inside a ventilating system outlet would enhance vapor distribution through the room. Vaporizing 30 g of Sarin in a 100' by 50' by 20' room produces a concentration just in excess of 10 mg/m^3; exposure to this vapor for 10 minutes delivers 1.0 to 1.4 times the inhalation $L(Ct)_{50}$. Used in a similar situation, the involatility of the V-agents and BTX require that they be disseminated as aerosols. Since the inhalation toxicity of the V-agents is about an order of magnitude greater than that of Sarin, 3 g of agent is needed to produce the same effects. Any reasonably effective spray device should be adequate. Only 12 mg of BTX concentrate would be required.

All the agents except BTX could be effectively incorporated into either bursting munitions or thermogenerators. It is doubtful that an unwarned and untrained target group would comprehend the nature of the threat to which it is exposed; its first reaction would likely be to interpret the explosion as a conventional bomb and attempt to render aid to the nearby victims. The conditions under which overt attack might be chosen are so numerous and varied that there is little point in estimating agent quantity or impact.

Dissemination loss factors of the order of a million or more indicate poor selection of employment method for chemical agents. Loss factors of this order are typical of the popular "dump it in the reservoir" attack, and are analyzed later.

It is apparent that even with the best chemical agents available, if the attack effort is kept within the bounds of reason, its impact probably cannot exceed exposure of a few thousand target individuals at one time. Therefore, this is one of the lesser superviolent threats, but its small resource requirements and the great availability of necessary skills must be kept in mind.

Biological. The difficulties of describing alternative biological attacks arise from the large number of options that these weapons provide and the great uncertainties in calculating their impact. There is little doubt, however, that with a degree of technical expertise equivalent to that assumed for the INW, the mortality levels resulting from a biological attack could exceed those from a nuclear attack. With no intent to downgrade the effectiveness of the other seven diseases suggested in Chapter 8 as reasonable selections for the terrorist, the exemplar attack chosen assumes the selection of anthrax because of the high resistance of the spores (minimizing biological decay of the aerosol) and the ease of self-protection.

An attack designed to subject the five million residents of Manhattan, the Bronx, and New Jersey (from Jersey City to Englewood) to infectious doses of anthrax spores might be conducted as follows. Under good meteorological conditions and with a light wind (12 km/h) from the southeast, a small boat could make the 32 km run from Battery Park (the southern tip of Manhattan) to City Island (the entrance to Long Island Sound) in about 3 hours at 6 knots. With a culture containing 10^9 spores/ml and producing aerosol at the rate of about 500 ml/min, a total of 90 liters (24 gallons) of agent are required. The initial aerosol cloud contains about 10^7 spores/liter. As it drifts over the densely populated area to a distance of not more than 8 km during the 40 minutes following release, it is subjected to loss primarily by deposition. The dilution effect is of secondary importance because, as the aerosol concentration decreases due to mixing, the time of cloud passage increases, so that the total dose received by continuously exposed personnel remains essentially constant. Even if physical and biological decay reduces the effective aerosol concentration to 10^3 spores/liter (a decay factor of 10^4) and that target personnel are all resting (quiescent breathing rate of 10 liters/min), two minutes of exposure to the cloud is sufficient to inhale the nominal infective dose of 20,000 spores. If only half the target personnel are actually exposed; if only half of those develop pulmonary anthrax; if only half the cases result in mortalities (all conservative assumptions), more than 600,000 deaths will ensue.

The 90 liters of spore suspension aerosolized for this attack can be produced in eight 5-gallon carboys in an aqueous solution containing a few dollars worth of tryptone, yeast extract, and dextrose; the procedures have been described. To produce an aerosol cloud at the rate contemplated above requires 500 times the output of the laboratory aerosolizers discussed earlier. Such a device would consist of a number of nozzles, parallel-fed from the culture carboys, with atomization accomplished by a primary compressed air flow equivalent to 10^4 liters/min at atmospheric pressure. With an overall efficiency of 25 percent, a compressor driven by a 100 hp engine is required; an installation of this size would be driven from the boat engine itself. As stated several times before, it is the dissemination process which poses the greatest difficulties, and these are not too severe; the skills and resources required up to the point of attack are small indeed, and the entire effort requires but a small fraction of the resources and skills needed for the INW attack.

Smaller biological attacks than that described are easily conceptualized. Without entering into great detail, an anthrax aerosol attack an order of magnitude smaller (60,000 fatalities) can be effectuated by a truck-mounted dispenser driven around and through a city. Large crowds which remain in enclosed spaces for moderate lengths of time are ideal targets. The Houston Astrodome (floor area 9-1/2 acres, dome height 208' at the center) encloses approximately 3.2 million cubic meters. Aerosolization of 15 ml of anthrax spore culture in this volume results in the inhalation of an infective dose in 30 minutes. Using the small Chicago atomizer, this culture volume can be aerosolized in 15 minutes with a primary air flow supplied by one 9" by 55" compressed nitrogen tank. For basketball and boxing, the Astrodome seats as many as 75,000 people.

It is not our intent to leave the reader with the impression that the chemical and biological attacks described here are "easy" in an absolute sense; however, they are appreciably easier than the INW attack. Only enough attention has been given the design and engineering problems involved in CB weaponization to indicate that the threat is entirely practicable for terrorist employment. Specialists who have developed chemical and biological weapons for the military services know what can be done and what is required. Their judgement as to the costs, problems and effectiveness of the approaches proposed here should be solicited, and compared with the statements of the nuclear weapon experts whose sole concern has been with the INW. In summary, the chief advantages of CB weapons are the unrestricted availability of the necessary information, the relatively small resources needed, and the ability to test the product. There are no meaningful controls on the availability of chemicals, and what little control exists over pathogenic cultures can be overcome in a variety of ways. Perhaps most important is the fact that the chemical and biological materials can be produced under the cover of an apparently legitimate commercial venture such as a small research company, fine chemical manufacturer, or bio-medical laboratory. Once the agent fill has been produced (only short time requirements are involved), the material could be delivered to the clandestine arm of the threat group for weaponization and attack use, while the producing location struggles on in a valiant attempt to make its "small business" profitable. Needless to say, there is no necessary relation between the location of the production facility and that of the target.

Targets and Weapons

Throughout this study, we have sought to identify and classify the kinds of targets that might be closely related, through motive or issues, to the concept of superviolent attacks. This effort has invariably degenerated to an exercise of making lists of more or less important facilities and people, but the lists are not very edifying. For most generic targets (power stations, communications centers, bridges, tunnels, dams, rapid transit systems, police offices, fire stations, etc.), it is immediately apparent that well conceived attacks with moderate or large quantities of conventional explosive are perfectly adequate to the task. Even medium size buildings (King David Hotel in Jerusalem, Los Angeles Times Building) have been destroyed by this technique. Nor is it inconceivable that a terrorist group might purchase a shipload of ammonium nitrate, rig it for reliable detonation, and sail it to a port target in replication of the Texas City disaster. One must look further for real or symbolic targets which appear to justify the acquisition of mass destruction weapons. Nonetheless, we offer our list of "interesting" targets for what it may be worth, fully recognizing that these or others could be the center of a major, motive-providing issue. To reflect the important difference in weapon class characteristics, these are divided into property and personnel categories.

Primarily Property. A number of large, hard, or inaccessible facilities which are unique or highly specialized can be identified. Since questions of motivation are discussed in the next section, the target list is offered without comment: convention center complexes, university campuses, hospital complexes, highway and railway interchanges, large airports, the Pentagon, CIA headquarters, other military installations (SAC bases, large supply depots), the Capitol Hill complex, the White House, Internal Revenue Service data centers, the United Nations complex, major AEC installations (Hanford, Oak Ridge, Savannah River), major NASA installations (VAB at Cape Kennedy, Manned Space Flight Center at Houston), large manufacturing installations (U.S. Steel, General Motors, Dupont, Dow), state capital complexes, large hydroelectric dams; the list goes on interminably. Some property targets offer the opportunity for interesting side effects: an INW detonated near a large power reactor would certainly produce an enhanced fallout problem, and possibly set back the rate of development of the civilian nuclear power industry. A similar explosion near the first operational BMD site might generate political pressures sufficient to put an end to that program. In an even more speculative vein, an INW detonated sufficiently near the gold bullion reserves at Fort Knox might literally remove them from the economic picture, economists whom we have queried regarding the consequences of this are by no means unanimous in their opinions, some holding that a significant decrease in world trade would ensue, while others believe that the international currency market would become more rational on the basis of the real productivity of nations.

Primarily People. The specifically anti-personnel character of chemical and biological weapons does not necessarily exclude the nuclear weapon from consideration as the means for a superviolent attack on people. In general, high value personnel targets are presented by high density residential areas, but much higher densities occur during peak, downtown, working and shopping hours. The highest densities over moderately large areas result from transient crowds as at presidential inaugurations, Times Square on New Year's Eve, and big league spectator sports. There are five open stadiums in the United States which seat 100,000 or more people several times a year: the Los Angeles Coliseum, the University of Michigan Stadium at Ann Arbor, the Rose Bowl in Pasadena, Soldier's Field in Chicago, and John F. Kennedy Stadium in Philadelphia. Another dozen or so can accommodate more than 60,000 people. Both nuclear and biological attacks are appropriate for these targets. As personnel targets become physically smaller, but at the same high densities, the nuclear weapon becomes less appropriate and chemical agents moreso. The vulnerability of enclosed spaces to CBW attack has been mentioned several times. Access to lobbies of large business and public buildings, airport and train terminal waiting areas, subway systems, etc., is certainly within the terrorists' capability. In these crowded, enclosed areas, dissemination of epidemic pathogens such as plague would eventually affect many more individuals than originally exposed.

Since anti-personnel attacks based on contaminating reservoirs or other components of the water supply system are repeatedly alluded to, they should be evaluated. Few modes of attack are less effective than "dumping something" into a reservoir. To begin with, the capacity of reservoirs serving as impoundment basins for a community bears no necessary relationship to the water consumption of that community. Major reservoirs hold anything from a few months to a ten year supply, and the water produced is frequently supplemented by ground water infiltration and well pumping. Secondly, the great bulk of water drawn from an urban water supply never comes into physical contact with the population; it waters lawns, washes clothes and cars, flushes toilets, cools industrial equipment, etc. Assuming a liberal, "typical" per capita daily consumption of 250 gallons (the figure varies widely among communities), a reservoir which is the sole source of water for a community of 10,000 and holds only a two year supply, contains 1.8 billion gallons. If each member of the community were to drink a quart of water a day, seven billion lethal doses would be needed in the reservoir to deliver one dose per victim. For this kind of attack, the agent production problems would require a large manufacturing effort. Of the chemical poisons described, 8-fluorooctanol would be most appropriate on the grounds of its stability, but 300 metric tons would be needed. If BTX were equally stable, 7 kg of pure toxin would be required. The OPAs are hydrolyzed rapidly enough to make their effectiveness quite dubious. Nor is the reservoir attack problem easier using biological agents. The preferred organisms for water distribution are not ideal BW agents; those effectively transmitted by water are: Shigella species (bacillary dysentery), Salmonella typhi (typhoid fever), and Vibrio cholerae (cholera). While they remain viable and virulent in water, their dissemination represents a poor choice by the terrorist for precisely the reason that these diseases no longer pose a major public health problem: standard methods of water purification (coagulation, flocculation, sedimentation, filtration, chlorination and aeration) serve to remove or destroy pathogenic bacteria as well as improve taste, odor, and clarity (Steel, 1960). The terrorist could inject pathogenic organisms directly into the mains past the treatment and quality control stations, but this is still an attack of questionable effectiveness.

Another water supply attack concept frequently encountered involves the use of psychochemicals. Both the military agent BZ and the well known hallucinogen LSD are effective against humans in doses of a few tens of micrograms. If an effective dose of LSD cost only $.25, if the reservoir-to-ingestion dilution factor were no larger than 10^6, and if only a thousand people were to be affected, $250 million worth of LSD would be needed. This is a rather large investment for producing a 6 to 24 hour period of bizarre and unpredictable behavior in a small community.

> Contamination of a major water supply has often been discussed, and dismissed as too crude, too unpredictable in its effects, because of the variable affinity for water of different human beings—especially, perhaps, the decision-makers who are the main targets. Air conditioning system, pepper-pots, a prepared cigarette are progressively more selective and hence more suitable for use in small groups (Joyce, 1968).

If there is any logic to the primarily anti-personnel attack at all, it must depend on the fact that the target individuals are members of some meaningful group (legislators, labor leaders, prison inmates, blacks, Jews, etc.) rather than people who are accidentially caught up in the transient crowds as at football games or in the theater. But assemblages of the first type tend not to be large in terms of the effect radius of even a sub-kiloton weapon. We conclude, then, that an INW is inappropriate against primarily personnel targets except, perhaps, where the terrorist is a sadistic megalomaniac.

Having established the characteristics of the weapons and identified some possible targets—subject to the qualification that little additional insight is obtained by examining target lists—the question of drawing together weapon, target, and motive into a consistent and credible scenario can now be examined.

DIRECT SUPERVIOLENT ATTACKS

The concept of direct attack signifies that when the threat group has completed its preparations, it proceeds directly to the attack with little or no warning. The function of warning in an anti-property attack may be to allow personnel to clear the area. Thus, warning is consistent with the use of a nuclear weapon. In a CB, anti-personnel attack, issuing a warning is counterproductive, unless the attacker's real interest lies in forcing the target group away from its normal location, either for harassment or to prevent some action from being taken. Even for these reasons, the situation would have to be highly specialized since the effects of chemical and biological agents are both temporary and subject to neutralization. The question of warning, however, is secondary; the important distinction to be made is between direct attacks in which the threat group's purpose is actually served by use of the weapon and coercive threats in which the real purpose is to compel some action the threatener desires under pain of the superviolent attack. Conceivable grounds for direct attack are examined here; the coercive threat is treated later.

Issues and Objectives

By extension of the political, psychological, and criminal motives for violence presented earlier, it is possible to construct scenarios for direct superviolent attacks. Basic plots can be developed around virtually any issue: foreign policy, race. poverty, despoliation of the environment, religious intolerance, etc. It is simply necessary to flavor the issue with that degree of fanaticism needed to override normal inhibitions and to postulate the existence of a technically qualified group which, swept along in this fanatic fervor, becomes willing or compelled to apply its skills to the production and use of a mass destruction weapon. Such plots are the stuff of which thriller fiction is made: producing disease among units slated for deployment to an unpopular war; killing all those *@#+!*#@s; destroying a ghetto area or an exploitative industrial installation; blowing up a dam which is about to inundate a scenic valley: the list goes on and on. Each controversial issue—and there are many in modern society—offers some promise of resolution by violence to those whose proclivities run in this direction. If their objectives are not actually achieved by direct attack, they may believe that the symbolic or demonstration value of attacks on appropriate targets will aid their cause. But something is missing from this impersonal catalogue of issues, targets and weapons: the evidence that human motivation, commitment, and skills might come together to give life to this otherwise hypothetical story.

Motives

The emphasis of this study is on the threat of superviolent attacks against the US civil apparatus by domestic organizations. This is consistent with the findings of the <u>ad hoc</u> Lumb report which identified three general groups as potentially having interest in diverting nuclear materials: political dissident, organized crime, and non-nuclear nations. The implicit thesis is that political dissidents desire nuclear weapons for their own use, that organized crime will find or create a lucrative black market in diverted plutonium, and that n^{th} nations might wish to acquire small, secret stockpiles of nuclear weapons to enhance their military capability. Organized crime presumably acts as the supplier to domestic dissidents or foreign interests as users, in furtherance of its profit motive. The ultimate uses of stolen plutonium or other SNM are power production or weapon manufacture. Only domestic occurrence of weapon manufacture lead to the threat of superviolence as defined.

Attacks within the United States may be motivated by policies having their roots in the international scene. Many such scenarios have been constructed (Kinderman et al., 1969; Taylor and Humpstone, 1970), but all boil down to either sabotage or assistance to pre-emptive first strike themes, and as such imply the possible identification of an enemy and consequent US responses. There is no doubt that the legitimation of a superviolent plot by a foreign nation would provide not only adequate motivation but the skills, monetary resources, security, and cover required as well. Even if we assume that a nuclear attack (rather than conventional or CBW sabotage) is desired, it is not immediately apparent that the plot need involve diversion of SNM from US sources. Providing a weapon or its core acquired elsewhere in the world to the US attack group would, at least, preclude the failure of the plot by detection of the diversion or fabrication activities. While it is patently impossible to prove that foreign-motivated, domestically implemented scenarios cannot occur, they appear quite incredible if one considers their post-attack consequences.

In Chapter 2, six motive clusters derived from the literature of political violence were set forth. Of these, the coercive motive is discussed later in considerable detail, and so-called irrational motives were found to blend imperceptibly into the severe mental disturbances described in Chapter 3. Any of the four remaining motive clusters—rational, retributive, manipulative, and self-assertive—can be joined with the issue-target-weapon triad to produce an internally self-consistent, superviolent plot. If we assume that these motives actually provide the potential basis for superviolence, then the unavailability of SNM in the past must be taken as the primary inhibiting factor accounting for the absence of superviolent incidents. It follows that increased SNM availability in the future will signal the occurrence of such incidents. On the other hand, the capability of mounting an anthrax spore cloud attack has been a clear and present danger for the last 25 years, to say nothing of the opportunities for escalated, conventional violence.

What, then, are the inhibiting factors which prevent superviolent attacks from occurring? We suggest that they stem from the very low likelihood of combining comprehensible motivation with the necessary degree of severe mental illness. To give credence to the threat, we are brought back to the most fundamental question of all: the coalescense in a single individual of (1) the very rare psychosis, organized paranoia; (2) the charismatic leadership able to motivate a threat group; (3) the technical sophistication needed to conceptualize and direct the effort; and (4) the ability to sustain group commitment for an extended period focused on a difficult and risky task. It is incorrect to argue the likelihood of superviolence on the basis of technical practicability or availability of materials; the essential element is the threat group leader. At whatever time or place such people exist, they exert their influence and society suffers the effect, but the likelihood that they can do so successfully is certainly related to the demands of the task in a strongly negative, exponential fashion. It is important to remember that not only has this kind of individual left a lifelong trail of crimes or near-crimes behind him, but, most significantly, that he is not an "all-around" individual; he suffers from perceptual gaps and delusions which offer good promise for either the failure or the disclosure of a mass threat operation.

COERCIVE SUPERVIOLENT THREATS

Because the coercive motive offers achievement of objectives other than death and destruction and allows deferring the decision to actually deliver the attack, it is offered as the most likely motive for the highly unlikely act of superviolence. For this reason and because it provides the basis for the problem of sham threats, the characteristics of coercive plots are examined in considerable detail.

Briefly stated, the coercive plot involves three players: the coercer or threatener; the coercee, the individual or agency in a position to acceed to the threatener's demands; and the hostage, the value placed at risk by the threat. The mechanics of the coercive plot necessarily involve: (1) an actual or implicit threat to the hostage; (2) a communication of demands imposed; (3) validation of the threat by the coercer and verification by the coercee; (4) the latter's decision problem; (5) his opportunity to signal his compliance (with the possibility of two-way communication for negotiations) or his refusal; and (6) the resolution of the threat, including delivery of the payoff and the threatener's decision to punish or not. Although extortion (the profit-motivated, criminal analogue of coercion) is not uncommon, there are very few examples of large-scale attempts at coercion of governments by conspiratorial groups. Cases that have occurred in recent history involve some form of kidnapping rather than the threat of technically sophisticated hostaging by mass destruction.

Historical Cases

Two recent examples of politically motivated coercion are presented to illustrate the operation of such plots.

FLQ Kidnapping of James Cross. The plot is described with minimum detail and emphasis on aspects pertaining to coercive threats. "The Revolution Script" (Moore, 1971) and "Terror in Quebec" (Morf, 1970) provide the basic data. The former is an accurate but fictionalized treatment in which the author demonstrates his sympathies with the French-Canadian separatist movement and casts the terrorists in a romantic light; the latter, by a Canadian psychiatrist who has worked extensively with jailed terrorists, provides a better background for understanding the movement and the FLQ, and shows the kidnapping for the shabbily planned and easily executed plot that it was.

The story begins with the arrest of two, known FLQ activists, Jaques Lanctot and Pierre Marcil, in June 1970. The draft of an FLQ communique announcing the kidnapping of the Israeli consul in Quebec was found in Lanctot's possession. The men were charged merely with possession of an illegal weapon, and released on bail. On June 21, a tip dealing with a $58,000 robbery from the University of Montreal directed the police to a summer home at Prevost (north of Montreal) where some of the money, arms, explosives, and mimeographed copies of an FLQ communique announcing the kidnapping of US consul Harrison Burgess were found. Among those arrested in that raid was Francois Lanctot, Jacques' younger brother. The Burgess kidnap communique demanded the liberation of specified "political prisoners," payment of $500,000 as ransom, and publicity for FLQ communiques via the mass media. It further indicated that police action against the kidnappers would threaten the life of the hostage. As a result of this find, security measures to protect US personnel were placed in effect, but no general alert of diplomatic personnel was issued by Canadian authorities. Apparently the tactics of Latin American guerrillas (who had kidnapped 13 people—mostly foreign diplomats—between September 1969 and July 1970) were not accepted as a model for the FLQ.

At 8:15 a.m. on October 5, 1970, members of "Liberation Cell" posing as delivery men gained entry to the home of James Cross, senior British trade commissioner in Montreal, and abducted him at gunpoint. Among the five Liberation Cell kidnappers was Jacques Lanctot. Within half an hour of his abduction, Cross was imprisoned in an apartment in the French section of Montreal. Police surveillance of egress routes from the city which was in effect by 9:00 a.m. was, therefore, ineffective. By noon, Communique No. 1 was delivered; the technique used for this and subsequent communiques was for a cell member to drop the document in a short-term secure location and then notify a radio or newspaper reporter sympathetic to the movement of its location from a public phone. Communique No. 1 followed the pattern of the never-attempted Burgess plot in calling for publication of an FLQ political manifesto, release of certain "political prisoners" and their conveyance to Cuba or Algeria with $500,000 in gold as a "voluntary tax," publication of the name and photograph of the informer responsible for the Prevost raid, and cancellation of the police manhunt for Cross. (An additional demand dealt with re-employment of drivers for a private postal firm who had lost their jobs in a dispute with the post office.) A period of 48 hours was offered "the authorities" to accede to the demands; otherwise, Cross would be assassinated.

Two communiques were issued on October 6 in response to early and inconsistent statements by Quebec provincial officials and others at TV news conferences. In Communique No. 4 on October 7, the kidnappers extended their deadline for 24 hours and emphasized two of the original seven demands: the reading of their manifesto on Radio Canada during prime time and the cessation of police efforts to find Cross. A handwritten letter by the captive provided evidence that he was still alive. The following day, Communique No. 5 extended the deadline for an additional 12 hours and restated the broadcast and cessation of police activity demands, but withdrew the ransom demand and stipulated that Cross would be released within 24 hours of the freeing of the "political prisoners." Apparently a negotiation phase had begun at this point. That night (October 8) the FLQ manifesto was read over Canadian Radio and TV with minimum editorial comment. The next morning, Communique No. 6 temporarily suspended the threat to kill Cross and again demanded liberation of the prisoners and termination of police action. In the absence of any official response by the government, Communique No. 7 was issued that night (October 9) establishing 6:00 p.m. the following day as the new deadline for compliance. Thirty minutes before the deadline, the Quebec Minister of Justice appeared on TV and, speaking for the Canadian Federal government, offered the kidnappers safe conduct out of the country in return for Cross.

Less than half an hour after the government's refusal to fully accede to the demands of the Cross kidnappers, Pierre Laporte, Quebec Minister of Labor and Immigration, was abducted at gunpoint by another group of FLQ terrorists calling itself Chenier Cell. It is generally accepted that the Chenier group's activities were neither known to or coordinated with Liberation Cell, and that the Laporte kidnapping was an independent effort triggered by the government's refusal to comply. This is borne out by the Chenier Cell communique on Sunday morning, October 11, reinstating all the demands originally made by the Cross kidnappers and setting 10:00 p.m. that night, only 12 hours off, as the deadline for executing Laporte. Five minutes before that deadline, Quebec Premier Bourassa appeared on TV, identified the conflicting demands of the two FLQ groups, and offered to negotiate by stating "that we want, before we discuss the demands that have been made, to have some machinery which would guarantee...that the release of political prisoners would result in the certain safety of the lives of the two hostages."

Beyond this point, the events are less pertinent to the mechanics of coercive plots, so are summarized briefly. The kidnappers' inability to establish a consistent position or to provide an acceptable mediator, coupled with the Federal government's deployment of troops and its October 16 proclamation of the War Measures Act outlawing the FLQ and prohibiting cooperation with them by the mass media, consumed the balance of that week. On October 17, a week after he had been kidnapped, Laporte was strangled to death and his body left in the trunk of an automobile. Chenier Cell's final communique identified the location of the body.

Following Laporte's murder and faced with an intensive manhunt, the Cross kidnappers remained quiet. On November 2, they provided evidence that Cross was still alive, but no further demands or offers were made. By the very end of November, astute police work had located the apartment where Cross was being held, and on December 2, city and provincial police forces took up positions throughout the area. The following day was one of confrontation and negotiation between the kidnappers and the authorities. At their successful conclusion, a police escorted motorcade carried the kidnappers, still holding their prisoner, to a temporary Cuban consulate set up in a vacant building on the site of Expo 67. There Cross was turned over to the Consulate first secretary. Lanctot, joined by his wife and son, and the four other kidnappers, two of whom had been released from jail after being apprehended on December 2, were taken by helicopter to Montreal International Airport where they boarded a military flight for Havana. On receiving word that the aircraft had landed in Havana, James Cross was released from Cuban custody. It was 2:30 a.m. on December 4; he had been captive for 59 days.

Aircraft Hijacking. The most widespread coercive threat presently affecting civil society is aircraft hijacking. Since July 1947, about 400 air carrier flights have been "skyjacked" throughout the world. In this section, we review the patterns of this activity, and investigate the politically-motivated, and the coordinated hijacking of five international flights by Arab guerrillas in September 1970.

The master list of hijacking attempts and the analysis of cases in which the skyjacker was eventually captured and examined identify four distinct phases of this activity. The first phase (1947—1952) consisted of 14 attempts by groups of people to escape from communist countries. The group typically commandeered the aircraft and supplied its own pilot. At this time, the concept of granting political asylum to escapees gave a degree of sanction to the activity.

After a few years of infrequent incidents with no recognizable pattern, the ascendency of Castro initiated a wave of Cuba to US aircraft thefts in which the pilot himself was usually the hijacker. Only ten such attempts appear on the master list to March 1966, but these Cuban pilots were again granted political asylum and offered immunity from prosecution. Thus, phases one and two appear to be legitimate attempts to escape from communist domination.

Phase three began in 1961 with the first hijacking of a US commercial to Cuba and a new innovation: the take-over of the aircraft by an armed passenger, not himself qualified as a pilot.

> That completely changed the nature of the game by at least ten-thousand fold. Up to this point, such a theft had demanded an aviation competence sufficiently adequate to manage a multi-engine plane. Only limited numbers could participate. Beyond this point, "anybody could play" provided he had a dollar and a half to buy a pocket knife, or fifty-nine cents to buy a can of insect repellent, or provided he was clever enough to look into the nearest garbage can for some strange object that he could call a bomb. (Hubbard, 1971 p.211).

In contrast to the motives impelling the earlier incidents, the diversions of US commercial aircraft to Cuba (comprising 47 percent of all world-wide hijackings during the eight and one half years through October 1969) were carried out by hijackers predominantly motivated by psychological rather than political factors. Psychiatrist David Hubbard has studied 48 apprehended skyjackers; twenty of those case histories are presented and analyzed in his book "The Skyjacker: His Flights of Fancy." He finds a remarkably consistent psychiatric profile of "mentally unstable, suicidal and belligerent losers...[who]...share dreams and fantasies of being able to fly. ... The few who talk about political motivation, left or right, are in fact only voicing warped rationalizations. Beneath it all are the same psychological motivations" (Hubbard interview, Life Magazine, August 11, 1972, p.29). Technical sophistication in planning is coupled with naive execution, suggesting that these skyjackers have little in common with the successful builders of superviolent weapons. Rather than strong, politically motivated idealists, skyjackers are typically the offspring of violent, alcoholic fathers and religious zealot mothers, and whose psychic development has left them emotionally weak and sexually confused. The act of hijacking, the control of flight, represents the culminating act for them, for which punishment must be suffered (Hubbard, 1971).

The fourth phase of hijackings started after the September 1970 Arab guerrilla action to be described shortly. These are the overt extortion attempts in which large ransom sums are demanded for the release of passengers, crew, or aircraft, and which appear to be of rapidly increasing incidence. In recent cases, the necessity for the skyjacker-extortionist to get away with his loot requires at least his ability to leave the aircraft by parachute. The record of success in these attempts has certainly not been outstanding, but the arrest of more than 250 armed, would-be passengers and the discovery of thousands of weapons discarded around terminals during the first quarter of 1972 suggest that the intent may be a common one.

Based on the foregoing, hijacking appears to offer little insight into the motives and methods for mass civil threats. The possible exception is the series of events which began on September 6, 1970, when four New York bound flights were almost simultaneously hijacked on departures from Frankfort, Amsterdam and Zurich with a total of more than 600 passengers and crew members aboard. One, a Pan American 747, was hijacked from Amsterdam to Cairo via Beirut. In Cairo, the passengers were released and the aircraft destroyed; the act was announced as a symbolic protest against the US-supported Middle East peace plan. The next two, a TWA flight from Frankfort and a Swissair flight from Zurich, were hijacked to Dawson's Field, an abandoned R.A.F. strip in the desert about 25 miles from Amman, Jordan. Aboard the fourth plane, an El Al flight from Amsterdam, Israeli security agents engaged in an airborne gunfight with the hijackers, and killed one (P. J. Anguello), captured his female accomplice (Leliah Kahled, who had come aboard with hand grenades in her brassiere), and wounded the steward and two passengers. The El Al flight landed in London; Kahled was taken into custody by British authorities, who ascertained that she had participated in an earlier hijacking of a TWA flight to Syria. It is also of interest that Anguello, a US citizen who had been living in Nicaragua, had two false passports with him in addition to his US passport.

Immediately after the hijackings, the Popular Front for the Liberation of Palestine (PFLP), the most militant left-wing group of the Arab guerrilla movement, acknowledged conducting the operation. In its statement, PFLP asserted that the Pan Am and TWA planes were taken to teach the US a lesson for supporting Israel and to retaliate for the US peace plan (retributive motive), and that the Swissair plane was taken to compel the release of three Arab guerrillas held by the Swiss for their attack on an Israeli aircraft at the Zurich airport in 1969 (coercive motive). The unsuccessful El Al attempt was likewise intended to force Israeli authorities to release two Algerians and possibly other guerrillas detained in Israel (coercive motive).

It is of no particular value to our purpose to detail the confused events of the days. They involved national decision making and international coordination of the decision to comply with or reject the PFLP demands, activities of the International Red Cross attempts to rescue or succor the hostages, the threat of civil war in Jordan, and a host of other actions and declarations. The most frequent PFLP demand was addressed to Great Britain, however, for the release of Kahled. Since there were then no British subjects among the hostages, it may have appeared to the guerrillas that they could do little to enforce this demand. Presumably to increase their leverage over the British, what might have been expected, occurred: on September 9, a London-bound BOAC flight out of Bombay was hijacked to Dawson's field with 117 passengers aboard. This was the fifth and last of the hijackings involved, and it is difficult not to attribute a direct coercive motive to it.

Although a few hostages had been released as early as September 11, negotiations relative to the PFLP demands were not proceeding effectively. On September 12, the guerrillas destroyed the three aircraft at Dawson's field (TWA, Swissair and BOAC), selected more than 50 hostages as prisoners of war, and released the remainder; more than 30 US citizens, as well as British, West German, Swiss and Israeli nationals were held. On September 14, the PFLP announced that the US hostages would be treated on the same basis as the Israelis and would be released at the same time, but the conditions for such release had not been clearly communicated to either government. The inability of the International Red Cross negotiators to obtain release of the hostages and the failure of the PFLP to set forth a clear and consistent set of demands had provided over a week for the Western nations and Israel to finally develop a consistent position for the release of all hostages. In return, the three European countries and Israel would release seven Arab guerrillas.

By September 16, small scale warfare had broken out between the Jordanian army and the PFLP guerrillas in the desert. The delays in negotiation had allowed the situation to build almost to a crisis point: US and British military forces were deploying to the eastern Mediterranean area and relations between some of the Arab states had deteriorated. Dissension among the various groups comprising the Arab guerrilla movement increased as a result of the intransigence of the PFLP and the lack of any authoritative means of communicating with them. By September 25, the PFLP guerrillas had lost control of the situation; small groups of hostages were being freed or abandoned as food became unavailable, and others were freed by Jordanian army units as the scattered locations in which they had been held were discovered. The last of the hostages were relased by the end of September, and on October 1, the seven Arab terrorists from Great Britain, Switzerland and West Germany were returned to Cairo by an R.A.F. aircraft.

All told, from no point of view could this operation be characterized as successful. The costs to all were considerable, and whatever gain the PFLP may have felt it achieved was largely offset by stresses generated within the Palestine Liberation Movement and by the military action with the Jordanians. It must be concluded that successful coercion of powerful governments requires more leverage and better organization than was demonstrated by this particular operation. (Summary reconstructed from extensive N.Y. Times coverage of these events, September 7—October 1, 1970.)

Formal Theory of Coercion

To recapitulate, the purpose of this chapter is to examine the application of superviolence: weapons, targets and motives for direct attack have been discussed. We have argued that the threat of superviolence for coercive purposes is more credible than direct attack, and that pre-attack communication implies the existence of a coercive motive on the part of the threatener. We now investigate the problem of coercion further, recognizing the crucial importance of the idea that the threatener's goals are not achieved by execution of the threat, but by using the threat to influence the behavior of its recipient.

The effect and coerciveness of threats have been examined in a variety of contexts. The theory of games of strategy provides concepts and structures for studying conflict situations in behavioral psychology, economic bargaining, international relations (including coercive diplomacy and the conduct of negotiations), and blackmail. Consequently, we review some basic game theoretic ideas, and attempt to draw from them the beginnings of an analysis of small group coercion of governments by means of mass destruction threats.

For convenience of expression, let T denote the threatener (or terrorist) and V, the victim. Following standard game theory practice, all victim roles are coalesced to emphasize the two-party nature of the conflict. The actual threat recipient may not himself be the intended victim nor may he (or the victim) have the power to grant T's demands, but the relationship among recipient, victim and coercee must place them in the same camp in opposition to T. For example, in the FLQ kidnapping, the threat recipients were the journalists to whom communiques were delivered, the victim was James Cross, and the coercee was the Canadian government. A threat is an attempt by T to influence V's behavior by indicating the action T will take to induce a loss to V unless T's demands are met. (A distinction is sometimes made between deterrent and compellant threats on the basis of whether the influence attempt is designed to prevent V from acting (deterrence) or to induce V to act as T wants (compellance). Either situation could underlie the threat of superviolence, but the distinction is not of primary importance.) In formal theory, threats are assigned the attributes of coerciveness, cost, degree of ambiguity, and relationship to promise. The last, threat vs. promise, distinguishes between punishments and rewards (Baldwin, 1971). Since T's refraining from an act of superviolence against V is hardly to be considered the granting of a reward, this attribute will not be considered further.

As for the remaining attributes, all theoreticians agree that two factors contribute to the degree of coerciveness, compliance potential, of a threat: its potency (impact, magnitude of punishment) and its credibility. V's assessment of these factors depend on his perceptions of T's capability and intent, as well as on his own capability and intent to counter the threat by retaliation or neutralization. The second threat attribute, cost, consists of two additive components: the cost of preparing and issuing the threat and the cost of executing it. It is through the concept of threat cost that the logic of bluffing is developed: the greater the threat, the greater its probability of success; the greater the probability of success, the less the probability of having to implement it; the less the probability of implementation, the cheaper it is to make big threats. From T's point of view, threats which fail are more costly than those which succeed, and real threats are more costly than shams; consequently, big sham threats can look very attractive to T. The third attribute, the ambiguity of the threat, directs attention to V's ability to answer three questions: What does T want me to do? What will he do if I do not comply? What will he do if I do comply? At a minimum, V must have a specific idea of the answer to the first and a basis for distinguishing between the latter two. The more certain T is about his demands and his capabilities, the less ambiguously can he provide this information to V. While T may gain some advantage from a degree of uncertainty on V's part, this does not extend to the point where V becomes unable to answer for himself the three questions posed (Baldwin, 1971). (Compare the absence of adequate communication and the consequent confusion in the PFLP hijackings.)

Formally, the coercive threat is represented as a two person (V, T), non-zero sum game. Each player has two strategies or options available: for the victim, to comply or not; for the threatener, to punish or not. In the game matrix, V's options are represented by the two rows, and T's by the two columns. Each of the four elements of this two by two matrix consists of two entries: the row player's (V's) payoff followed by the column player's (T's) payoff. The non-zero sum character of the game is indicated by the fact that the two payoffs in each element are not necessarily equal in magnitude and opposite in sign. An additional feature of the coercive threat game lies in the fact that T choses his strategy (punish or not punish) after V has chosen his (comply or not comply); that is, the moves are sequential rather than simultaneous, V choosing first. In a sense, this provides a limited form of communications between the players.

Coercive threat structures are strongly dependent on their opportunities for communication. With no communication (and the appropriate relationships among the payoffs), a game known as the Prisoner's Dilemma is developed. This game has been used extensively for behavioral studies (Rapoport and Chammah, 1965; Tedeschi, 1971). It provides the opportunity for the two players to cooperate (resulting in mutual gain or loss) or to compete (resulting in one player's gain at the expense of the other). Coercive threat games with unrestricted communication move directly into the area of bargaining and negotiation (Ikle, 1964; Karrass, 1970; George et al., 1971). Subject to assumptions of perfect resolve, credibility, and explicitness (i.e., complete and unambiguous information), and with pure self-interest as the criterion, the effect of threats on negotiations does not preclude solving the game; it does, however, change the payoffs from those which comprise the solution without threat (Kent, 1967). We are not yet prepared to consider the desirability of negotiations in the context of the superviolent threat; this point will be examined later.

The matrix of a coercive threat game is constructed by identifying the factors which contribute to the two players' payoffs. Following conventional game theory techniques, these are expressed as utilities (and disutilities) to emphasize the fact that they represent an otherwise unspecified combination of dollar losses or gains, deaths and injuries, property damage, loss of face, emotional satisfactions, etc. In the simplest version of the threat situation, there are three independent factors for each player. The victim, V, is concerned with:

- d, the damage associated with punishment,
- c, the cost of compliance, and
- r, the result of removing or resolving the threat.

The threatener, T, consideres:

- s, the value resulting from success of the threat,
- p, the cost of preparing the threat, and
- e, the cost of executing the threat, including the effect of V's subsequent retaliation.

The utilities are shown as absolute values; obviously d, c, p, and e represent disutilities to their respective players, while r and s represent positive utilities or gains. This is indicated by the appropriate algebraic sign in the game matrix, Table 9-1.

To clarify the matrix representation, consider first the two payoff entries in the upper left-hand element which result from V's decision to comply and T's subsequent, perhaps illogical, decision to punish. (This case is not only required by the formalism of game theory; it also represents a possible outcome as a result of error, misunderstanding, confusion, or pure perversity.) Recall that V's payoff is shown first: he suffers the cost of the damage sustained as well as the cost of having complied, and is benefitted by the resolution of the threat. T's payoff indicates his gain resulting from the success of the threat (V's compliance), but this is reduced by his cost of preparing the threat and his anticipation of V's retaliation. One more assumption is made in the case of V's compliance and T's not punishing (upper right element): T's disutility for executing the threat,

		T's Strategies	
		P (punish)	$\overline{P}$ (not punish)
V's Strategies	C (comply)	-d-c+r, s-p-e	-c+r, s-p
	$\overline{C}$ (not comply)	-d+r, -p-e	r, -p-e

Table 9-1. General Threat Game Matrix

e, is omitted on the presumption that one of the demands to which V has complied is that of T's own future safety, e.g., safe conduct out of the country, etc.

There are several, obvious relations among the utilities which must be satisfied to make this structure reasonable. V's utilities are related as:

$$d > c > r.$$

Clearly the threatened damage, d, must be greater than the cost of compliance, c, to induce V to comply rather than resist and suffer. Since these are disutilities, they are obviously greater than the positive utility, r. T's utilities are related as:

$$s > p \sim e.$$

Obviously, T's utility of success, s, must be greater than his cost of preparing the threat, p. There is no necessary relation between p and e, but their sum must still be less than s; consequently, we indicate the value of e to be of the same order as that of p. Finally we suggest the relation

$$c \sim s,$$

that is, V's cost of compliance is of the same order as T's gain by success. This is not a necessary condition, and perhaps not even a desirable one since it suggests a zero-sum character; it is proposed on an intuitive basis to simplify thinking about the problem. It does no damage to the analysis while making it easier to conceptualize.

To examine the characteristics of this game in a more concise form, consider an arbitrary set of (absolute) utilities satisfying the given relations:

$d = 2{,}000$	$s = 1{,}000$
$c = 1{,}000$	$p = 100$
$r = 200$	$e = 100.$

Combined as shown in the general form of the matrix, these values lead to Table 9-2. (The conclusions to be drawn are not dependent on the particular values selected for this example. This can be verified by expressing the utilities in general form.)

The first observation is that V's non-compliance strategy (bottom row) dominates his compliance strategy. This means that for V, either of his bottom row payoffs is preferred to the corresponding top row payoff. Similarly, T's non-punishment strategy (right column) dominates his punish strategy since T's payoffs for the former are preferred regardless of V's choice. This leads us to the essential paradox of the coercive threat game: were each side to adopt his dominant strategy as game theory dictates, the solution is the "do not comply, do not punish" outcome, the lower right-hand element of the matrix. But if this is to be the outcome, what is the point to T's threat in the first place? He would be 200 units to the good had he not invested in the threat and, by issuing it, invoked V's ire and retaliation.

		T's Strategies	
		P (punish)	$\overline{P}$ (not punish)
V's Strategies	C (comply)	-2800, 800	-800, 900
	$\overline{C}$ (not comply)	-1800, -200	200, -200

Table 9-2. Threat Game Example

Game theory points to this paradox, but cannot resolve it. It does, however, indicate some of the actions that T might take to improve his likelihood of obtaining compliance and ending at the "comply, not punish" outcome in the upper right corner of the matrix. Fundamentally, there are three kinds of actions which T, having the initiative, might take. The first is for him to increase the magnitude of d, the damage disutility to V, to such an extent that it would strongly outweigh the disutility of compliance. T accomplishes this by moving to the most massive (superviolent) threat of which he is capable and by making every effort to convince V of its credibility. The second enticement which T might offer is to reduce V's disutility of compliance, c, at least to the extent that it does not seriously affect his own utility of success, s. Specifically, we identify this idea in the superviolent threat context with T's use of a confidential threat communication directly to those whose position or authority can lead to the choice of compliance. For example, an attempt to induce public panic by utilizing the mass media to disseminate the threat would tend to increase V's compliance loss rather than decrease it, thereby reducing T's likelihood of obtaining his desired outcome. Finally, there is a class of actions for T to take which reduce his utilities for not punishing, and thus increase V's estimate of his readiness to punish. Stated differently, T attempts to show that his "not punish" strategy does not dominate his "punish" strategy. This may be accomplished by T's putting forth minimum, highly specific demands, by attempting to convince V that he is ready to die with his threat (martyr complex), or by claiming that his hands are tied: the time fuse has been ignited and only V's compliance can induce T to extinguish it.

Since its inception, game theory has provided a rich mother lode of concepts and structures for studying conflict situations in many fields.

It has deficiencies, however: the inability to quantify utilities, the appearance of paradoxes in non-zero sum situations, and above all, the insistence on a particular kind of objective rationality most uncharacteristic of human beings in stress situations reduces its applicability to practical problems. Analysis of the coercive threat suggests that a rational basis for superviolence is the leverage it can confer on a small group, allowing it to impose its demands on a large and powerful nation. This is in sharp contrast with the use of superviolence for imposing intrinsically large demands. Not all superviolent coercive threats necessarily partake of this rational character; the basically irrational threat can exist. If a rational justification for civil threats of superviolence is sought, however, the game theory formulation set forth can provide its basis.

Meta-Scenario for the Coercive Threat

The information and ideas relevant to the coercive threat developed through this study can now be drawn together. No attempt at an exhaustive or morphological approach is made; the infinite variety of alternatives make this an exercise in futility. Instead, the more important aspects of the plot are discussed and freely illustrated with hypothetical or speculative examples. If there is a single unifying criterion, it is to maintain self-consistency: a threat group with the skills and resources to prepare for a superviolent attack must be assumed to command the additional skills and lesser resources needed to manage a coercive threat. For clarity at this point, we assume that the threat group does, in fact, possess the weapon capability it claims. The sham threat, investigated later, is predicated on its ability to simulate the real threat discussed here.

Our starting assumption is that a group of individuals who share an overriding commitment to some objective which cannot be achieved by spreading death or destruction have banded together to fabricate the instruments of a superviolent coercive threat. Having succeeded in their preparatory tasks without their activities being disclosed to the authorities, they are now engaged in setting forth their demands, issuing their threat, and establishing its validity. It is not important to characterize these threateners other than to reiterate the unprovable premise that the scientific rationality they show in acquiring their weapon is paralleled by a reasonable degree of rationality in the demands they make and how they are communicated. The demands, then, will be achievable ones (in a practical sense), and the function of the weapon will be to enable the imposition of these demands at high levels of political power. Consequently, the national government, more specifically the Office of the President, is envisioned as the recipient of the coercive superviolent threat. But there is a much better justification for this choice: it must be obvious to the threatener that even the least credible of superviolent threats will provoke a massive response by police and investigative agencies. To threaten the mayor of Oshkosh with an attack on Oshkosh is to suggest strongly that the official response should focus on Oshkosh. On the other hand, to convey to the President of the United States a credible threat which can be directed against any one of thousands of targets will obviously hamper the official response. The fact that the demands themselves may not be relevant to the national level is of no concern: if, for example, the President can be convinced that 100,000 deaths will be avoided by a telephone call to a governor "requesting" him to release specified "political" prisoners, it is difficult to comprehend why the threatener should address himself to the prison warden directly or even to the governor. For such reasons, we believe that superviolence (as the concept has been defined here) is properly viewed as a national level problem, regardless of the nature of the demands or their recipient. (Other evidence for this position is given in Chapter 10.)

With the reader's indulgence, a fictionalized account of the delivery of a coercive superviolent threat is presented. A package mailed from some large city arrives at the Office of the President. It contains a number of items prepared with the same skill and professionalism as is presumed for acquiring the weapon capability. One item is a letter setting forth demands (possibly in the form of an ultimatum, but more likely as the first step in a hoped-for negotiation process) and stating the punishment envisioned should the demands be rejected. The second item describes the mass destruction weapon involved; detailed design drawings, calculations, photographs, and documentary evidence such as shipping invoices for component parts are included. Item three establishes specific directions for complying with the demands, including provisions for communicating with the threatener if necessary. A small dictionary of code word replies for use in classified ads to be inserted in a widely distributed newspaper might convey the threatener's intent to limit at least the early stages of the threat to responsible government authorities, thereby avoiding the pressures and complications bound to ensue from public disclosure. A small, opaque envelope labeled "For the President's Eyes Only" is an extra gimmick. When opened by the Secret Service, it is found to contain simply a set of authentication codes whose function would presumably be Presidential authorization of whatever response communication is selected. The prize item in the package would, of course, be the sample: a container of physical evidence supporting the claimed capability. Whether the evidence consists of lathe turnings of plutonium, a biomass of anthrax spores, or a few milliliters of BTX concentrate, it would certainly elevate the credibility of the claim in the eyes of the investigators and special advisors called upon to study it. As a final touch, the safe return of an expert put forth by the government to verify the threat capability is promised.

In a sense, the very incredibility of the superviolent threat requires that the threatener make some special effort to validate his claim. This need not be specific to the n^{th} degree; a bit of residual uncertainty, a hint of irrationality, and a foxy preoccupation with his own security during the threat phase and after its resolution would all be confirmatory ingredients. We will not dwell on the obvious question of the threatener's security. Receiving such a package would, of course, trigger a most extensive investigation. Suppose the investigation discloses no fingerprints, the use of untraceable five-and-dime store stationery and wrapping, photographs and drawings from which no clues can be obtained, physical evidence which proves to be as billed; an effective communication job has credibly conveyed an unlocalizable mass destruction threat. The buck ends here: a decision must be made.

Based on the available information, the credibility of the threat and the resolve of the threatener to carry it out must be assessed, and the appropriate actions taken. In a study of coercive diplomacy, eight preconditions for success with the strong (ultimatum) form of the strategy are set forth (George et al., 1971 p.216). Paraphrasing slightly, as appropriate for the superviolent threat, these are:

1. strength of the coercer's motivation;
2. asymmetry of motivation favoring the coercer;
3. clarity of the coercer's objectives;
4. the sense of urgency to achieve his objectives conveyed by the coercer;

5. adequacy of support;
6. usable force options;
7. the opponent's fear of unacceptable escalation; and
8. clarity concerning the precise terms of settlement.

Each precondition is interpretable in the present context, even item 5 if the threat is politically motivated and consonant with the desires of a larger group. The central task of a coercive strategy is to create in the victim the expectation of unacceptable cost in order to erode his motivation to resist the threatener's demands. If the ingredients of the superviolent threat indeed exist, and if they have not been controlled during the preparatory phase, the chance of avoiding damage appears to lie either in compliance or in the threatener's option to not punish. Should the threatener be possessed of high resolve and the ability to levy more than one attack, his continued restraint is highly unlikely.

A second major scenario option might be built around the terrorists' attempts to use the mass media for public dissemination of the threat. We believe this is highly unlikely in the real, coercive threat case. To have strong public impact, the threat must be localized in place and immediate in time; hence more subject to forceful, official responses. Public reactions might range from complete disbelief to panicky flight. What the threatener's motive for a public pronouncement might be is difficult to conceive. Whether he could validate his threat to the populace at large and whether he could compel responsible mass media to promulgate the threat (rather than suppress it until an official government response has been formulated) are unanswerable questions which present unnecessary chances of loss of control to a terrorist whose real objectives can be served by a confidential communication. Nonetheless, the possibility of a credible, superviolent threat becoming public knowledge exists. Among the public reactions which should concern those in authority is the possibility of widespread, uncontrollable panic, itself leading to damage and death.

The Question of Panic

Whether as a result of direct, superviolent attack or the issuance of a superviolent threat, the conditions, characteristics, and likelihood of mass panic warrant understanding. The major discoveries of panic research, largely derived from the more general field of disaster research, are summarized and interpreted in the context of superviolence.

Panic Defined. The dramatic connotations and multiple uses of the term panic have created an ambiguous concept of what the phenomenon actually is. An effort to develop an operational definition distinguishes between two dominant themes prevalent in the psychological and sociological literature: one, represented by the work of Meerloo, Cantril, and Janis emphasizes " the covert emotional state of a terrorized individual; a person who is distraught and demoralized and in an intense state of fear. Panic, according to this view, is primarily an internal state which may or may not lead to overt flight behavior." (Schultz, 1964, p.6). The second view defines panic as "an acute fear reaction marked by a loss of self-control which is followed by a non-social and non-rational flight behavior." (Quarantelli, 1954). While headlong, fear-motivated flight from danger is the most common form of panic behavior, it is insufficient to account for the most important characteristics of panic. Precipitate removal of oneself from the immediate vicinity of danger is a highly adaptive and useful form of behavior in many potentially panic-producing situations. Implicit in both definitions of panic is the presumption that non-adaptive or maladaptive behavior, typically flight, occurs which results in greater death or destruction than that posed by the original danger itself. There are, in fact, only a few cases of mass panic satisfying these definitions. Four of the five outstanding examples involve immediate threats of death coupled with restricted egress from the threatened area; two due to fire (the Irocuois Theater fire of 1903 and the Cocoanut Grove fire of 1942) and two due to drowning (the sinking of the Luisitania and the Titanic). The fifth classic case is the 1938 panic produced by the Halloween broadcast of a dramatization of H. G. Wells' fantasy "The War of the Worlds" by Orson Welles and the Mercury Theater.

Lest the reader feel that this limited set constitutes a highly biased selection of what should properly be considered mass panic, we hasten to point out that objective investigation of natural and accidental disasters, extensive wartime bombings, and even the atomic bombing of Hiroshima evidence only small and infrequent manifestations of behavior which are usefully called panics. (The term is also used to describe certain forms of economic behavior, but this kind of panic is not relevant to the present issue even though some self-destruction occurs, as during the 1929 stock market crash.)

<u>Disaster Research</u>. If panic necessarily involves the presence or imminence of intense personal danger, large disasters must provide examples of mass panics for study. Failing that, disaster research should provide insight into the conditions under which panic does not occur even though it might be expected.

Since the early 1950s, intensive disaster research programs have been conducted at the Universities of Chicago, Oklahoma, and Michigan and at Ohio State University. The Disaster Research Group of the National Academy of Sciences-National Research Council has carried out a large number of investigations in support of the military medical services and the Federal Civil Defense Administration. By 1969, 110 field studies had been conducted of tornados, fires, explosions, floods, hurricanes, typhoons, earthquakes, incidents involving poisonous or asphyxiating chemicals, false civil defense alerts, actual or threatened epidemics, air crashes, blizzards, mine disasters, civil defense exercises, and other miscellaneous emergencies. Almost 1,500 interviews were recorded during these studies, to supplement the almost 7,000 interviews obtained in World War II bombing effects research (Chapman, 1962 p.5).

Disasters are defined as collective stress situations in which many members of a social system fail to receive the expected conditions of life from the system (Barton, 1969 p.38). Seven time phases are recognized in the evolution of a disaster: warning, threat, impact, inventory, rescue, remedy, and recovery. Potential panic conditions are present during the warning, threat, and impact stages; if the danger is not a continuing or repetitive one, social behavior is found to be remarkably adaptive and effective once the impact has passed and the inventory phase begun (Chapman, 1962 p.7). A four-factor typology for classifying disasters recognizes: scope of the impact (geographical, numbers of people), speed of onset (sudden, gradual, chronic), duration of impact (short or long), and social preparedness (low or high) (Barton, 1969 p.41). From these studies, the special conditions conducive to the appearance of mass panic can be derived.

Conceptual Structures. Among unorganized social groups, the elements thought to affect the occurrence of panic are: predisposing and antecedent factors, threat perceptions held by the group, the nature of the immediate danger, and the forms of behavior observed among group members. Typical antecedent and background factors contributing to panic are tension, insecurity, fatigue, and, in the absence of reliable information channels, dependence on rumor (California OCD, undated, pp.12-17).

Foreman (1953) advances a series of nineteen propositions and hypotheses dealing with panic; the first four relate to background factors and state that deliberate attempts to induce panic or terror can take advantage of known predisposing conditions, but the more atypical or incomprehensible the threatened disaster is, the less it is dependent on background factors. Anxiety, social unrest, and impoverished group identification also contribute to panic-proneness (Schultz, 1964 p.29ff).

The perception of a threat "Which confronts individuals in a target population with an acute sense of danger...is a likely prelude to terror and panic, provided that responses to it have not been conventionalized, that is shatters immediately antecedent forms of behavior, and that is has sufficient duration, sequence or repetition for the compounding of terror responses." (Foreman, 1953, Proposition 5). A highly and personally dangerous anticipatory perception of the crisis is necessary. If the most typical form of panic behavior, mass flight, is to be realized, participants must be able to associate the threat with a definite place. "Individuals will continue to flee in panic only to the extent to which they believe themselves within a danger area and still exposed to the consequences of the threat." (Quarantelli, 1954). Once the crisis perception has crystallized, fear rather than anxiety becomes the driving force. But fear-motivated flight from danger is not in itself panic; for panic behavior to emerge, the degree of fear must be sufficiently great to inhibit the self-control needed to make flight a properly adaptive response. It is of particular interest that linguistic cues can induce panic. "Any stimulus which, prior to its appearance, has been linguistically defined as acutely terrifying and unmanageable, may induce immediate terror and guide actions directly to flight." (Foreman, 1953, Proposition 6). The response to the "War of the Worlds" is the outstanding example of this effect, although cries of "Gas!" during World War I are reported to have occasioned panic behavior on the part of organized military units (Schultz, 1964 p.26).

Once the threat is perceived, the immediate cause of panic appears to be the occurrence of a shock stimulus associated with a number of special side conditions. The shock stimulus interrupts ongoing behavior, commands the full attention of the target group, produces fear and terror by its very nature, and leads to confusion occasioned by an initial inability of the victim to select a satisfying response. The shock is maximized where surprise is most complete, where normal sensory functioning is inhibited, and where the affected individuals fail to respond to institutionalized controls should they exist. Inconsistent or contradictory suggestions as to the proper response tend to compound the confusion (Foreman, 1953, Propositions 7,8). Virtually all investigators agree that the facilitating side conditions in producing panic are a lack of preparedness for the threat, a feeling of entrapment associated with absent or limited escape routes, and a sense of helplessness on the part of the target group (Schultz, 1964, pp.49-50).

Given the shock stimulus and facilitating conditions, the development of mass panic depends on the emergence of overt panic behavior by a few individuals followed by its spread throughout the target group by contagious, imitative behavior. There is much evidence that, in panic provoking situations, individuals vary markedly in handling their fear, some tending to over-repression and denial of threat while others show over-reactivity and panic proneness. Although these extremes are in contrast to the majority, whose behavior would be characterized as showing reasonable courage and prudence, the perceived rate of development of the danger and the intensity of the other facilitating conditions lead to eruptions of panicky behavior by emotionally unstable individuals at both extremes (Wolfenstein, 1957). Once this has happened, increasing numbers of individuals undergo a transition to immediately personal, egocentric motivation characterized by flight toward available avenues of escape. The process becomes a chain reaction in which flight stimuli augment the original danger stimulus causing the panic to extend in time and space (Foreman, 1953, Propositions 12-16). Interview data obtained from those who participated in the panic flight from the Martian invasion, identifies four types of high suggestibility levels on their part:

1. a pre-existing mental set that makes the stimulus understandable;
2. uncertainty as to the proper interpretation to be placed on the crisis coupled with a lack of standards of judgement for reliably checking the information;
3. more generally, an attempt at interpretation which leads the individual to the conclusion that none of his standards of judgement is adequate to the task; or
4. a lack of both standards of judgement and even the realization that any interpretation is possible other than the one originally presented (Cantril, 1966 p.189).

Once the terror-driven, non-adaptive, mass flight characterized by breakdowns in mutual cooperation has occurred, the generative phase of the panic is over and the panic itself well underway. Quarantelli (1957) describes seven aspects of behavior at this stage. The panic participant:

1. perceives a specifically known, localizable, personal threat to his physical survival;

2. is future-threat rather than past-danger oriented;
3. is acutely self-conscious and fearful, with the idea of escape dominant;
4. is relatively aware of his activities, directing his flight with but one thought in mind;
5. is non-rational in his flight behavior (in the sense that other activities designed to cope with the threat are blocked from his thought);
6. is not necessarily non-functional or maladaptive in his flight although his non-rational nature may lead to this result; and
7. acts in a non-social manner in his flight behavior, possibly breaking even the strongest primary group ties in his highly individualistic effort to save himself.

> This non-social aspect may be short-lived, but it is one of the major characteristics which distinguish panic flight from non-panic withdrawal behavior. In the case of non-panic withdrawal, confused and ill-coordinated activities may be manifested but the conventional social roles and the normal interactional patterns are not totally disregarded. ... The non-social aspect of the panicky reaction is primarily in regard to failures to play conventional social roles and to follow the expected interactional patterns. (Quarantelli, 1957).

The Likelihood of Panic. Although an avowed fascination with the problem of panic underlies much of this research, the investigators take pains to circumscribe its applicability.

> The problem of mass panic and shock is discussed at length in the disaster literature. Janis examines the data from World War II air raids, and Quarantelli and others (Janis, Chapman, Gillin, and Spiegel) the evidence of many natural disasters. All these authors come to the conclusion that the rate of extreme non-adaptive behavior in disaster is generally very low, even in impacts as intense as the Hiroshima atom bombing. Primary group roles

> appear to provide people with strong motivation to act rationally; borrowed skills help many people to accomplish their goals, even if not very efficiently. (Barton, 1969, p.146).
>
> The frequency of panic has been over-exaggerated. In the literature of disasters, for example, so much emphasis has been placed on it that one easily gets the impression that it is the most common and immediate reaction to such crisis situations. This is not the case. Compared with other reactions, panic is a relatively uncommon phenomenon. (Quarantelli, 1954).

A statement dealing with the likelihood of panic in the event of mass nuclear attack, prepared at the request of the Office of Civil Defense by the NRC Committee on Disaster Studies reaches the following conclusion:

> Many of the forecasts and discussions concerning panic which have received wide publicity assume that it will not be too difficult for an enemy to strike terror into the hearts of Americans, especially through the use of atomic and thermonuclear bombs. To the enormous loss of life and property—so runs the theme—panic or mass hysteria will add devastating disorganization and paralysis, a weapon more horrible in its effect than any known to man.
>
> An assessment of the fact shows that the existing evidence falls far short of supporting such a vivid and dramatic prediction. The authenticated instances of mass panic known to have occurred in the last 50 years have been few in number and have been very restrictive in their effects. (Janis et al., 1955).

In the foreword to the 1966 edition of his study of the Martian invasion panic, Cantril writes:

> Since the publication of "The Invasion from Mars" in 1940, I have often been asked whether I thought such a thing could happen again. The questioners truly imply that we are now somehow too sophisticated to be taken in by anything so fanciful. Unfortunately, I have always had to reply that of course it could

happen again today and even on a much more extensive scale.

> In this study of the most widespread panic of recent times, we are not dealing with just a bit of isolated science fiction pertinent only to one particular time and place. As this little book shows, we are, on the contrary, dealing with an episode of human behavior brought about by a pattern of circumstances providing a matrix for high suggestibility. Such a pattern is by no means absent today, though it would now be fashioned out of new and different ingredients. (Cantril, 1966).

Given these cautions and qualifications, what can be said about the likelihood of panic resulting from the threat of terrorist superviolence? To induce mass panic, the threat must be sudden and unexpected, and the danger it poses must be sufficiently massive to produce immediate and intense fear on the part of the target group. This is enhanced by elements of novelty or incomprehensibility associated with the threat. It must be directly personal and localizable. Its victims must truly believe that they are in danger and without preparation or conventionalized behavioral responses adequate to deal with the crisis. They must be confused as to what to do, especially as regards escape, avoidance, or counter-action of the threat. They must be aware of their helplessness, and faced with no escape routes, no leadership, no authoritative information, and no rapid or effective official response.

We doubt that most, or even many, of these conditions can be achieved by the terrorist even granting his initiative in choosing the time, place, and circumstances for issuing the threat. In particular, the requirement for localizability is at variance with the terrorist's need for security; by announcing the specific target, he could certainly provoke flight from that locality, but probably not panicky flight and even less likely, mass panic. A further requirement is that his issued threat carry with it the degree of public credibility needed; this may be very difficult to achieve. Some evidence of panic would probably follow the unannounced detonation of a nuclear weapon, especially since this could easily be interpreted as evidence of the outbreak of general war. But this does not apply to the coercive threat case, and without a heightened state of international tension other explanations come to mind (accidental attack, "mad commander," accidental detonation of one of our own weapons, etc.). A high degree of public anxiety would undoubtedly be generated by widespread knowledge of the issuance of a credible threat. While this anxiety would most likely manifest itself in demands on the authorities to "do something," it is difficult to conceive of the concatenation of circumstances that would have a high probability of leading to mass panic. Because the threat of chemical or biological attack immediately offers a variety of counteracting or compensatory behaviors (therapy, avoidance, etc.) to those who consider themselves its potential victims, coercive threats involving these instruments are most unlikely to lead to mass panic.

The Sham Threat

Since a non-existent weapon cannot give rise to a direct attack, the sham threat is clearly a sub-category of the coercive threat, but determining whether the claim is real or sham raises what is perhaps the most difficult question in this whole matter. The technical and human factors discussed in this report can be interpreted as evidence of the practicability of the threat on one hand, or as evidence of its difficulty and low likelihood of occurrence on the other. Neither interpretation is provable, nor are they necessarily inconsistent. Even the proponents of the strongest controls would concur in the relative difficulty of fabricating an illicit nuclear weapon. What is crucial in assessing the sham threat, however, is the realization that if made sufficiently credible, its payoff becomes identical with that of the real threat. If the consequences of having a real weapon are sufficient to compel the action the threatener seeks, then the ability to convince the authorities that he has a real weapon is likewise sufficient, and this ability stems from the overall, integrated credibility of the process by which the threatener's demands are made.

The sham threat can arise in two fundamentally different ways: the coercive plot may have been predicated on sham from the start or it may have come about in an attempt to recover from the failure of a real threat effort. (It is of interest that partial success of what started as a real effort would probably provide the threatener with physical evidence which would add to the credibility of his claim.) Whatever its genesis, an effective sham threat must be made to appear as credible as the real threat it is intended to simulate. This should, in fact, be the terrorist's goal. The hypothetical package to the President can be prepared with a much smaller expenditure of time and resources than are required to create the real weapon it is meant to imply.

By giving appropriate attention to his own security, the sham threatener may even feel confident about covering his tracks should his demands be rejected. Unlike the hijacker who exposes himself to carry out his crime, the superviolent extortionist can arrange his plot so that either his objectives are gained or his personal security is ensured. Should the threat be disclosed as a sham, the threatener would be faced with the consequences of his criminal act. Without the coercive power of a real weapon to hide behind, the sham threat places its perpetrator in great risk; his act will elicit a large investigative response and, consequently, a higher than average chance of his being caught. It stands to reason then, that in a credible sham threat, the threatener will attempt to make his initial communication as effective as possible. The degree of technical expertise in design and planning needed to mount a credible sham may be almost as great as that required by a real threat. Otherwise, the sham identifies itself for what it is.

The highly specialized combination of skills, resources, and motives needed to generate a real threat make it apparent that actual superviolent acts are quite unlikely. Therefore, the threatener is faced with the problem of attempting to simulate something which, practically, cannot be. To reflect this dilemma and to provide a hypothesis for further evaluation of the sham threat, we advance the proposition that superviolent threats are shams until proven otherwise. Even the most prudent decision maker can afford to operate on the basis of this hypothesis while seeking to verify the threatener's claim; the burden of proof, however, must lie with the threatener. If both the weapon and the threatener's urgency to see his demands satisfied are valid (real coercive threat), the threatener will make reasonable efforts to substantiate his claims and allow the authorities reasonable opportunities to comply with his demands because executing the threat does not achieve the desired objectives. Keeping open the channels of communication and initiating negotiations serves two purposes for the authorities: if the threat is a sham, it calls the threatener's bluff; if the threat is real, it buys time for either a compromise resolution of the demands or for investigative and public safety agencies to neutralize the threat. (The Cross kidnapping illustrates this point well, even though the story includes LaPorte's murder.) We conclude, therefore, that the threatener's failure to cooperate with the authorities in preliminary negotiations is presumptive of the sham nature of the threat. Yet we recognize that an element of uncertainty remains. No amount of analysis or argument can unequivocally settle the question whether—a set of demands having been made and rejected—a city will be subjected to a nuclear burst, several hundred thousand people will contract anthrax, or the members of a legislative assembly will be exposed to a nerve gas attack.

RELATIVE LIKELIHOODS

Much of the study, discussion, disputation and soul searching which this research has engendered is summarized in the following informed but subjective statement of the likelihoods of various aspects of the superviolent threat. The key components in this assessment are four properties of the threatener: intent, personal motivation, skill, and lack of restraint; and one property of the external environment: the knowledge and resources that make mass destruction physically possible.

Volumes have been written (and more will be) which purport to interpret the concept of probability and the estimation of probability values in applications other than those which permit experimental observation of statistical occurrence frequencies. Small sizes, uncontrolled experiments, even unperformable experiments—if they can be fully conceptualized—have been subjected to theoretical investigation with more or less rigor because, as humans, we require and persist in efforts to obtain improved bases for making decisions bearing on future events.

There are several kinds of probability. There is physical probability, an intrinsic property of the material world; tautological probability, created by the process of mathematical definition; and psychological probability, the "degree of belief or intensity of conviction" by which people dictate their actions. Psychological probability may be subjective ("personal") or multisubjective ("multi-personal"), consistent or inconsistent. Logical probability (credibility) is a psychological probability stemming from "a rational intensity of conviction, implicit in the given information, and such that if a person does not agree with it he is wrong." (Good, 1965 p.7). Intuitive probability may be either subjective or logical, but the fact that people attempt to order such probabilities suggests that numerical values might be associated with them; value assignment, however, does not alter their intuitive nature.

Those who regard it as "meaningful to talk about the probability $P(H|E)$ of a hypothesis H, given evidence E" are referred to as Bayesians, and are characterized by:

> a readiness to incorporate intuitive probability into statistical theory and practice, and into the philosophy of science and of the behavior of humans, animals, and automata, and in an understanding of all forms of communication, and everything.
>
> If the Bayesian prefers, he can think of a credibility [intuitive, logical probability] distribution as a hypothetical physical distribution, since he can, with some boggle, imagine an infinite sequence of distinct universes selected at random and define a credibility as an (almost certain) limit of proportional frequencies in these universes. The notion of a random selection of universes is of course purely metaphysical, but not, I think, self-contradictory; and any crutch to one's judgment can be used unofficially. It might be inexpedient to mention to one's customers that one had such naughty unscientific private thoughts. (Good, 1965 pp.8,35).

Inexpedient perhaps, but necessary nonetheless. Estimates of the likelihood of superviolence are certainly intuitive probabilities, subjective ones at the least and—to the extent that they are rational convictions based on given information—logical ones at the most. A greater degree of objectivity is not possible.

The implicit disclaimers and qualifications of the foregoing notwithstanding, we summarize our conclusions regarding the occurrence of superviolence in the following eight propositions, arranged generally in order of decreasing intuitive probability.

1. Threats and attacks with conventional means are far more likely than those involving weapons of superviolence.
2. Statements and rhetoric alluding to instruments of superviolence are more likely than the occurrence of superviolent incidents (direct attack, real threat or sham).
3. Coercive threats based on superviolence are more likely than direct superviolent attacks.
4. Sham threats of superviolence are more likely than real ones.
5. Threats of superviolence involving chemical or biological weapons are more likely than those involving nuclear weapons.
6. The likelihood that a serious attempt to acquire instruments of superviolence will be initiated is greater than the likelihood that it will prove successful. In particular, the probability of an INW start is much greater than the probability of its successful completion, while the probability of successfully concluding a CB effort, given a serious start, is greater than 0.5.
7. The probability of successfully fabricating an INW is of the same order as that of successfully stealing a tactical nuclear weapon and greater than the probability of stealing a strategic nuclear weapon.
8. The probability that some community in the United States will be exposed to a real, superviolent threat or attack in a given time period is greater than zero.

We are fully aware of the fact that this investigation of what we have chosen to call superviolence was stimulated by the desire for an unbiased examination of that threat. A number of nuclear weapons experts believe that threat presents a very real danger. We can neither prove them wrong nor can we find the evidence which supports their fears, but we do not concur in their assessment of the "ease" of producing an illicit nuclear weapon. We find that an illicit biological attack can have as great (or greater) an anti-personnel impact as a nuclear attack, and that it could have been mounted any time during the past 25 years with a lesser expenditure of resources. The purpose of this observation is to suggest that the technical capability for superviolence is not new; had the motive and intent existed, the event would have occurred. We believe that those who perceive a real superviolent threat must offer more than a catalogue of opportunities for trouble-making based on scientific and technical feasibility if their warnings are to be heeded.

CHAPTER 10

THE CONTROL OF SUPERVIOLENCE

However fascinating may be the subjects discussed to this point, the utility of this study lies in its implications for controlling and responding to superviolent incidents. Superviolence is defined by three attributes: domestic character, extensive impact, and exotic weapons; the study context assumes that each characteristic is satisfied. Situations involving the diversion of SNM to n^{th} nation weapon programs or the provision by a present nuclear nation of weapons or weapon components to domestic terrorists are excluded. Subject to these qualifications, Chapters 2 through 9 constitute a superviolent threat-and-attack system analysis. Possible bases, motives, techniques, requirements, problems, and payoffs have been described.

The control and response concepts investigated in this chapter are based on generalizing the threat and attack system description, and generating the requirements for potential countersystems from it. A fundamental guideline arises from the recognition that there exists in the United States an extensive control and response system for the management of ordinary violence. Our primary concerns, therefore, are to assess the effectiveness of that system in controlling superviolence, to determine whether there are specific responses to superviolence which that system does not provide, and to ascertain the relative effectiveness of the types of control it does provide. In short, this constitutes a differential analysis to identify unique or specialized superviolence controls beyond those required by conventional terrorism and extortion.

The next section describes a general systems approach in which the logical pattern of the threat and attack system is identified. Following that, the full, superviolent threat process which must be accomplished is described by its necessary sequence of steps. Controls germane to each step are postulated. Then an inquiry into the topic of social risk places the low-likelihood, high-impact problem of superviolence and decisions related to it in the context of the other types of risks to which society is hostage. Finally the problems of evaluating proposed control and response systems for superviolence are summarized.

CONTROLS: A SYSTEMS APPROACH

The primary objective of any system designed to control or respond to the threat of superviolence is breaking the chain of steps that constitutes the threat process. Alternative system configurations to serve this purpose can be postulated. The variety of superviolent threat systems, however, precludes the standard cost-effectiveness approach, and necessitates use of lower-order criteria. Accordingly, for each threat process step, responses are considered as either inhibiting its success, providing threat intelligence, or exerting positive control over its completion.

Structure of the Threat System

The superviolent threat process can be meaningfully divided into a sequence of five phases:

I. Idea Conception
II. Group Formation and Planning
III. Weapon Fabrication
IV. Application
V. Consequences

Each phase is subdivided into steps.

At each step, the analysis identifies the stimuli which motivate the step, the major options it affords, its required resources, and the actions taken; this information is derived from the background and threat analysis part of this study. Among the motivating stimuli for each step are: successful completion of the preceding step, maintenance of the original intent for undertaking the process, and the absence of contraindications leading to abandonment of the effort. At many steps, major decision points arise which afford a choice of options for the balance of the process. The network of possible paths to superviolence arising from these options precludes designing a single, highly adapted response system. Included as resources are the human factors, material items, and infrastructure elements (time, security, and other supports which permit the threat group to function with a reasonable chance of success). The most important elements of each step are the actions to be taken. Subject to resource and other constraints, each action may be repeated until successful, except that several repeated failures may lead to the decision to abandon the effort. For the response and control analysis, however, it is assumed that the threat process avoids the terminal failure modes such as those identified in Chapter 7.

Control Aspects

Each step in the threat process affords an opportunity for examining potential intelligence indicators and controls. Ideally, one seeks the vital or unique points at which effective control can terminate the process. If such points cannot be found, two other control concepts warrant consideration: (1) general, continuously operating controls to deter, protect, detect, alarm, and provide information should a process step be undertaken; and (2) specific, reactive controls (responses) to recover material, neutralize the threat effort, apprehend the perpetrators, reduce the threat effectiveness, or otherwise moderate the threat and its impact. Both classes of controls apply to the flow of stimuli, resources, and actions of each process step along the paths emenating from every decision point.

At the level of response and control system conceptual design, the relationships of these elements in the form of a logic checklist is useful.

Threat Process and Control Checklist

For each step of each phase of the threat process:

1. Identify all relevant stimuli.
2. Assess control effectiveness.
3. Identify all requisite resources.
4. Assess control effectiveness.
5. Identify all actions to be taken.
6. For each action:
   a. Determine probability of its successful completion.
   b. Determine whether threat process is abandoned.
   c. Assess control effectiveness.

The significance of this structure is that every step of the selected path must be successfully accomplished for the superviolent threat or attack to manifest itself. From the threatener's viewpoint, there are three exits from the process: success; fail-safe abort (FSA) in response to repeated failures, inadequate resources, or the decision to abandon (item 6b); and getting caught ("jail").

The logical character of items 2, 4, and 6c (assess control effectiveness) is displayed by a second checklist which differentiates between the <u>general</u>, continuous controls and the <u>specific</u>, reactive controls (responses).

Control and Response Checklist

For the flow of stimuli, resources, and actions comprising each step of each phase of the threat process:

1. Identify existing or potential, general controls.
2. Determine whether they are capable of providing information (indicators, intelligence) for activating specific controls in the current or later steps.
3. Assess the effectiveness of each general control in terminating the threat process. If so, assume the termination constitutes a fail-safe abort by the terrorist; if not, continue to 4.
4. Identify existing or potential specific controls (responses).
5. Determine whether these have been activated as a result of item 2.
6. Assess the effectiveness of each specific control in terminating the threat process. If so, assume the termination constitutes apprehension of the terrorist ("jail"); if not, the threat process flow continues to the next stimulus, resource, or action to be checked for controllability.

General controls may be looked upon as preventive or anticipatory; specific controls, as pre-emptive or reactive.

DERIVATION OF CONTROL SYSTEM CHARACTERISTICS

To achieve greater specificity in identifying controls, a summary diagram of the phases, important steps, and major options of the threat process is presented in Figure 10-1. While this particular version

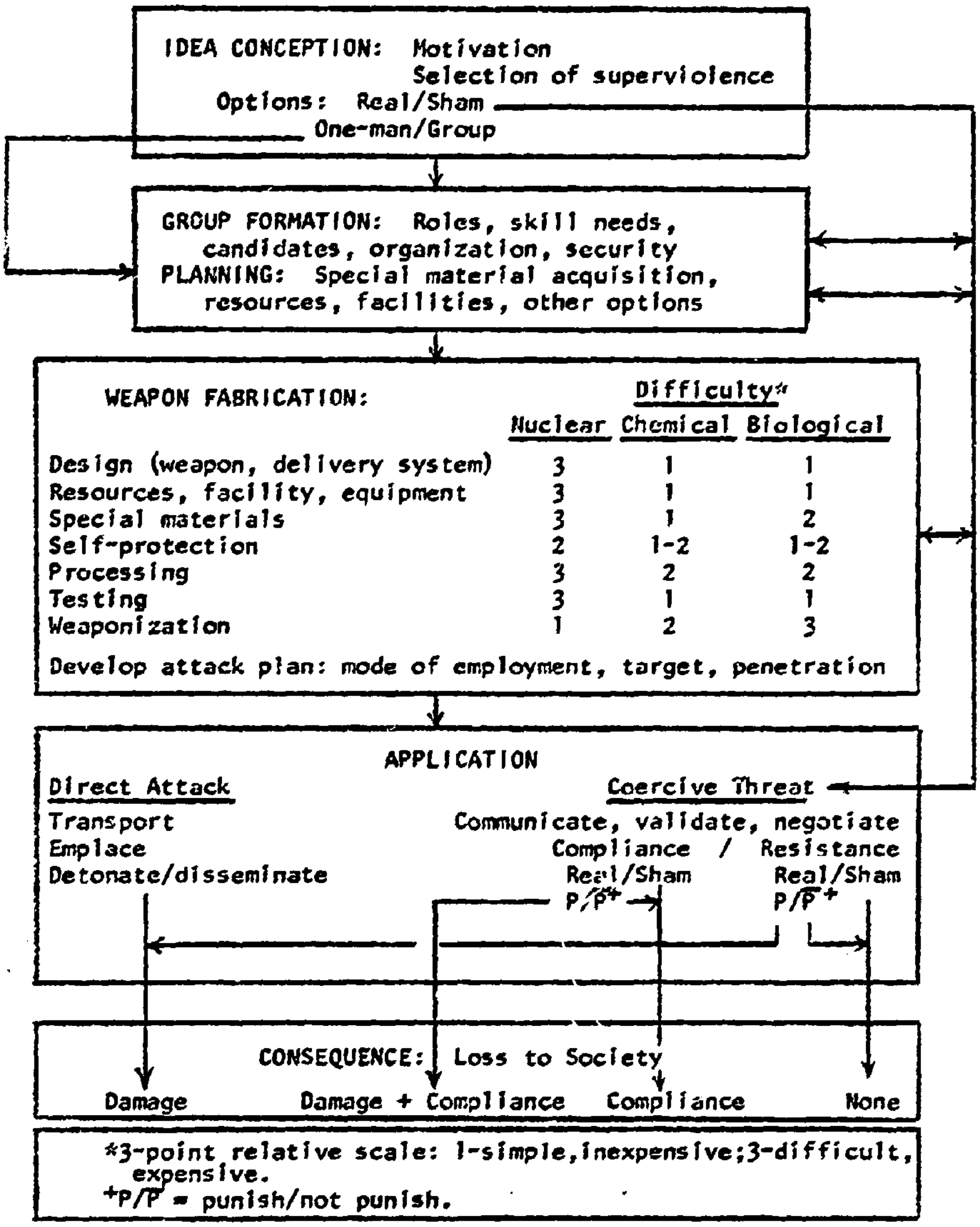


Figure 10-1. The Superviolent Threat Process

of the process may be representative, it cannot be made complete or exhaustive, the steps need not occur in the sequence shown, and it is difficult (or perhaps impossible) to maintain a consistent level of abstraction throughout. The figure is a partial summary of the key ideas presented in Chapters 2 through 9, and is used to suggest relevant controls. For each phase of the threat process, the steps, their implications, and appropriate general and specific controls are discussed.

Phase I. Idea Conception

<u>Steps</u>. Motivation

Selection of superviolent form

The steps of Phase I occur within the mind of a single person or, possibly, are communicated tentatively among a very small number of individuals. These steps have almost certainly been taken by many individuals at various times, but they become of practical interest only when accompanied by a combination of specialized stimuli: environment, experience, perception, opportunity, frustration, mental illness, and powerful motivation. A little technical information and that rare degree of psychopathology capable of overriding normal inhibitions against mass murder or destruction are the only resources needed. The actions taken in this phase are negligible or imperceptible.

The selection of superviolent form, the next step, presents the first of the series of major options. Whatever motive or intent is involved, it must first be decided that ordinary violence is inadequate. We will not dwell on this issue, but it must be resolved if the possibility of superviolence is to be accepted. Given such acceptance, the next choice is weapon type: nuclear, chemical, or biological. The determinative factors here appear to be the proclivities and opportunities (either at hand or developable) of the terrorist, his intent or goal, and possibly the characteristics of his intended target. If a motive is identified, a tentative choice between direct attack and coercive threat can be made. If the choice is coercion, the option of real threat or sham presents itself, with the contingent option of the latter being a deferred choice predicated on failure of the former. The decision whether the operation is the effort of one man or a group must be made consistent with these choices. Finally, the transition from Phase I to the overt, conspiratorial actions of Phase II reflects a decision to proceed, presumably based upon some promise of success as regards resources, assistance, security, etc., even if some problems that come to mind are temporarily put aside.

Controls. General controls designed to limit the motivation for superviolence (mental health, absence of poverty, happiness with the conditions of life, etc.) are outside the scope of this study. Effective law enforcement, penetration of violent groups, a good security image, in short, a social posture suggestive of a low success probability, could inhibit the transition to Phase II. The possibilities of thought control and information control at the intense levels required to affect this phase are either impossible or unacceptable. If society has created the potential for superviolence, it must live with the possibility. Indicators for Phase I steps are virtually nil and specific controls, inapplicable.

Phase II. Group Formation and Planning

Steps. Designate leader role
Determine personnel needs
Preselect candidates for skills, motives, and security
Communicate with candidates
Assemble group
Candidates interact and mutually evaluate each other

Consolidate group and assure internal trust

Organize group

Plan superviolent process

Since the presupposition that a well-structured, full-capability threat group with adequate motivation, commitment, intent, and resources just "happens" to exist is impossible to justify, it follows that it must be created. In one form or another, all of the steps of Phase II must be accomplished; as soon as they are taken, the group members become vulnerable to conspiracy charges.

As in Phase I, the stimuli and resources required to accomplish the steps of Phase II are primarily subjective attributes of the people involved. If it is difficult to justify the one-man superviolent operation on the basis of the necessary confluence of motive, skill, and resources, the difficulty of accounting for an n-man threat group must certainly be increased to at least the n^{th} power. Successfully navigating the group formation steps requires very special motives and people who can stably combine animosity towards society with high mutual trust towards each other. The actions of Phase II can reasonably require several meetings involving much discussion, if not argument, as well as travel, phone calls, and strange and tentative inquiries. Should any of the individuals contacted be under surveillance or should the group be penetrated by an informer, indicators of the threat could be obtained.

The process of organizing the threat group suggests some special problems regarding roles of the members. While neither a formal organization nor a one-to-one relationship between roles and individuals must exist, it is worth noting some of the less obvious functions to be performed in implementing the threat process. Assuming compatibility between the charismatic group leader and its technical chief (they may be the same individual), the specialized functions of administration, maintaining security, managing resources, procuring supplies and equipment, finding adequate facilities, and acquiring special materials must be performed by someone to support the direct effort devoted to weapon fabrication and attack. Is it not rather much to ask that, under the circumstances of this kind of operation, all these functions will be performed without discord or defection?

The last step of Phase II, occurring after at least the nucleus of the threat group is formed, is the critically important planning step. In the INW case, a number of special questions associated with SNM acquisition arise. At least four key and interrelated options exist: whether there is an "inside man" who can, at least, provide information; whether he can assist by taking definite actions; whether the SNM is to be acquired by overt theft or covert diversion; and whether a real device or only evidence supporting a credible sham is to be obtained. Option 1, inside information, bears on the confidence with which planning can be done regarding the form, nature, amount, and access to the SNM required; this information clearly interacts with the weapon design step of Phase III. Option 2, inside help, may be in addition to inside information or may be less sophisticated such as a guard, workman, or janitor leaving a gate unlocked, providing a key, deactivating an alarm system, etc. The overt-covert question, Option 3, obviously depends on the two that precede it, and dictates the degree of cover and security required by the threat group after SNM acquisition is accomplished. One or more overt thefts of material cumulatively approaching a critical amount would certainly trigger a massive recovery operation. Even if the fabrication steps require no more than two weeks, the threat group is extremely vulnerable to reward-motivated defection of one of its members during this period, to say nothing of the activities of the police and investigative agencies which would be looking for it. The fourth option, real device or sham, interacts with the SNM acquisition process on two bases: for a real device, a critical quantity of SNM is needed; for a sham, some physical evidence is required, but the overt theft of a sub-critical quantity is self-defeating. In this latter case, reasonable evidence that the threatener possesses the total quantity required must be provided; a claim of diversion within accepted MUF levels which cannot be substantiated on investigation appears to be a slim basis for a credible sham. In contrast, inside assistance involving falsification of records, for example, would certainly contribute to the credibility of the threat.

The four dichotomous options described generate a combinatorial set of 16 sub-scenarios at this one point in the threat process. Only four of the 16 demonstrate incompatible attributes; they arise because covert diversion (Option 3) is unlikely without inside help (Option 2). Excluding these leaves 12 potential paths among which the plotters may choose. In addition to this choice and its personnel and resource implications, full operational planning by the threat group must identify the totality of resources required (money, facilities, equipment and supply sources, etc.), and must finally determine whether these resource requirements can be satisfied. If not, the planning step of Phase II may well signal the end of even a serious attempt at a superviolent plot.

For the reasons set forth in Chapters 8 and 9, the planning for chemical or biological weapon fabrication is appreciably less demanding. The smaller threat group, lesser resource needs, and greater availability of the few special materials required suggest that Phase II has a higher probability of successful accomplishment in this case than in the INW case. Many CB sub-scenarios can be derived from the available options (toxic chemical or biological pathogen, particular type, quantity required, mode of dissemination, attack or sham, etc.), but they do not form an intensely interdependent set with strong resource implications as discovered in the INW plot.

Controls. The stimuli, resources, and actions of Phase II are similar to those of Phase I except that more individuals become involved. Consequently, the general controls of Phase II are oriented towards behavioral patterns of potentially involved personnel. These include a wide range of activities: public awareness programs designed to deter specific acts of superviolence (publicity given regulatory legislation and penalties), monitoring and tracking uniquely qualified individuals or anyone whose severance from a threat-related activity might suggest their potential complicity in a superviolent act, and direct efforts to infiltrate or solicit informers from potential threat groups. Indicators of possible complicity include changed behavior patterns on the part of qualified individuals remaining in threat-related industries, low employment levels in those industries, and even generally enhanced social unrest, especially when accompanied by incidents of conventional conspiratorial violence (although this may be poorly correlated with superviolence).

The objective of identifying (rather than, at this stage, evaluating) controls justifies enumerating them even if a presumptive determination of impracticability can easily be made. The justifiability of extending and intensifying personnel security control has been a major issue throughout this study. Ideally, such action offers the promise of excluding untrustworthy individuals from positions in which they can do harm. Practically, however, the not infrequent examples of important failures in personnel security programs suggest that they would not provide reliable control of elite, sophisticated, infrequent efforts at superviolence. Cost, intrusiveness, and (in certain situations) potential violation of civil rights contribute to the devaluation of widespread, personnel security screening to control superviolence. The defining characteristics of derogatory information (ranging from treason to demonstrated financial irresponsibility [10 CFR 10.11]) are appropriate for AEC-cleared personnel for many reasons other than potential involvement in INW plots. Personnel screening to control complicity by non-AEC, nuclear industry personnel or individuals prone to chemical or biological superviolence, however, cannot be considered as showing much promise at all.

One potential control specifically directed against the threat of superviolence and not dependent on prior indicators or intelligence would result from establishing a group of specialized undercover agents. These men would have either appropriate scientific skills or contacts affording access to special materials. By letting their (apparent) disaffection and availability be known in the "right" circles, they might attract recruitment to a superviolent threat group. Their function would be to serve as a sponge or magnet, attempting to absorb whatever propensities for superviolence they might encounter, and reporting this to cognizant authorities. Needless to say, such activity must assiduously avoid any overtones of entrapment or of promoting superviolence.

Phase III. Weapon Fabrication

In an attempt to maintain generality, the steps of the weapon fabrication phase are expressed to encompass all three types of superviolent instruments. The action details of these steps are described in earlier chapters and will not be repeated. For the three kinds of weapons, some of the steps differ significantly in their difficulty and the control opportunities offered. Although all but two of the steps are necessary in any weapon fabrication effort, they may be accomplished in a variety of ways and in different sequences. In particular, the time period available to the threat group once it has entered the fabrication phase is a major determinant of the way these steps are conducted.

Steps. Design weapon
Design delivery or dissemination system
Acquire necessary financial resources
Acquire fabrication facility (location, utilities, etc.)
Acquire special materials and equipment
Acquire ordinary materials and equipment
Provide self-protection (optional)
Perform materials processing
Test product (optional)
Acquire delivery or dissemination system
Assemble weapon system ("weaponize;" transport, fuzing, etc.)
Develop final attack or threat plan

If all the conditions and prerequisites for getting to the operational steps of Phase III have been satisfied, it is reasonable to assume that the process now becomes self-stimulating as long as the group's motivation and commitment remain intact and the steps are successfully accomplished within the available resources. Physical resources are the key to Phase III, especially the special (in contrast to the ordinary) materials and equipment The distinction between them relates to whether they are legally and readily available for purchase or freely available in nature (as is the case for certain microorganisms), rather than requiring special authorization, licensing, or investigation of the user. The special materials obviously provide a basis for control, as do other steps in this phase; these are identified later.

Other than choice of weapon type, the option with greatest impact on Phase III is real weapon vs. sham. For a credible version of the latter, all the fabrication steps must be carried out; some in detail (design, material processing in small quantities) and some by simulation. The design effort, evidence of materials acquisition and processing, the physical sample, and a reasonable plan are all components of the credible threat package described in Chapter 9. Of course, the scale of the sham operation is much smaller than that of the real weapon effort, but the threatener's inability to account for any of the critical steps during the coercive threat negotiating process will help to disclose its sham nature.

In the case of a real INW attempt, there are options and necessary interrelationships among the steps of Phase III which are more complex than the twelve planning scenarios identified in Phase II. These derive from the particular route selected, be it theft of a tactical weapon or fabrication from unprocessed SNM. The complexity stems from the requirement that, for an efficient process, the steps must fit together consistently. For example, if the duration of the vulnerable period of the threat group is to be minimized, if the time-consuming design and planning phase was predicated on an implosion device, and if overt theft of the SNM is selected, then the "hit"—the SNM acquisition step—must produce the right quantity of the right material; there is little opportunity for reorientation of the effort. It would be easier for the threat group to acquire their SNM first so that weapon design and processing facilities could be keyed to the material actually at hand, but the time requirements might make this route unacceptable. Long-term, low-rate clandestine diversion would permit a better balanced and less frenzied process, but the extended duration might subject the diverter to detection by routine material management and safeguard techniques or to disappointment should the conditions enabling the diversion change before enough material has been accumulated.

Since only Phase III offers pre-attack physical indicators of the existence of the threat process, it is tempting to consider relying on these for control purposes. A little reflection, however, will indicate that—unless prior intelligence suggesting and localizing the threat operation is available—general monitoring of wastes and effluents on a nation-wide scale is an impossible task. Such a system, could it exist, would undoubtedly give many significant, positive alarms (radioactivity, toxic chemicals, microbial pathogens—if they could even be detected) which would require investigative efforts of considerable magnitude and would prove to be of no threat significance in the overwhelming majority of cases. Moreover, control of wastes and effluents is a relatively easy and justifiable part of a real threat group's task, so monitoring would not be likely to detect anything other than the kind of accident which could well induce the group to abandon its effort anyway.

There is a class of what might be called "administrative indicators" that warrants investigation as a potential control measure. These are evidences of attempts to acquire ordinary but specialized materials or equipment in slightly suspicious ways or by unknown purchasers. In essence, this amounts to moving the threshold for distinguishing between special and ordinary materials. The utility of administrative indicators for control is discussed in the following section.

Controls. The most relevant general and specific control over the possibility of INW superviolence is, of course, the prevention of SNM diversion to unauthorized persons. Over this there is no question. Where the question arises is over the perception of threat likelihood and the kind and level of effort justified to control it. This study finds the real INW threat to be of intrinsically low probability; it also identifies forms of superviolence which are totally unaffected by any degree of SNM control. Until and unless a policy-level consensus as to the logical probability (credibility) of the INW threat—not its technical feasibility—is reached, it will not be possible to perform the necessary risk-benefit analysis of alternative SNM protective systems which have been suggested.

One basis for asserting the feasibility of the superviolent process is that each of its steps, considered individually, has its analogue in the world of ordinary violence and crime (Taylor and Humpstone, 1970). This is true, and has a pertinent implication: general control measures over many of the steps presently exist. For example, if the financial resources for a plot are acquired illegally (as by bank robbery), regular police and insurance investigations are conducted. These are sometimes successful. There is no reason why the motives or skills of super-violence should make the crime of bank robbery for its support less subject to solution than ordinary bank robbery; in fact, the opposite may well be the case. While apprehension of the robbers or recovery of the money may not be accomplished, some chance clue might point to the threat group and lead to disclosure of the operation.

Similar arguments can be put forth for other steps. City fire or license inspectors may not be looking for a terrorist laboratory when they inspect a new, "small business" (actually a cover operation), but if something about the facility or its personnel should arouse their suspicions, their general public safety orientation might lead to a follow-up investigation. Even a clandestine facility poses problems: how does the threat group dispose of the curious neighbor, the door-to-door salesman, the too-helpful delivery-man, etc?

The possibility of using the administrative indicators referred to earlier should be considered. The basic concept is that suppliers of certain items might be willing to provide information regarding suspicious or unusual inquiries or purchases on an informal basis. Regulation or control of these items is <u>not</u> desirable; this would simply force the terrorist to uncontrolled alternatives or other sources of supply.

Examples of such potential indicator materials are the special kinds of explosives required for fabricating an implosion-type INW or neutron sources adaptable to a gun-type INW (Kinderman <u>et al</u>., 1969), pathogens or the antitoxins and sera used in typing them, etc. (There is nothing unique, however, among the chemicals required for synthesis of the poisons investigated.) It may be that the number of commercial transactions involving such items or the number of legitimate purchasers is so large that monitoring efforts would be as impractical as in the case of effluents. Moreover, the interposition of local distributors of indicator items may preclude the possibility of intelligence collection.

If the potential threat incidence is thought to justify it, the feasibility of this general control for obtaining indicators of a superviolent process should be investigated. The investigation should include identification of specific threat device items, their status in commerce and channels of distribution, criteria for reporting possible misuse, and ability or willingness of manufacturers to assist in such a program.

Until the threat group has achieved enough of an operational attack capability to coerce the authorities into at least granting them immunity from prosecution or safe conduct from the country, they remain vulnerable to the same specific controls that apply to ordinary law breakers. That is, if the general controls function and disclose the threat operation, the specific controls needed to terminate it are at hand in every community. Should disclosure come late in the weapon fabrication phase, however, timely response is of the essence because the threat group might undertake ill-considered or precipitate attack if they believed that their operations had been discovered.

Finally, a comment about the first step of this phase, weapon design, and the availability of the information resources for superviolence. Examination of the list of references of this report shows the expected concentration on violence, terrorism, evil, crime, nuclear technology, poisons, diseases, and threats—an unsavory list of subjects at the best. Virtually all these publications were consulted at a medium-size university library, and many, if not the majority, of them were borrowed by the authors of this report. The only reaction engendered was a comment on one occasion by a student assistant at the check-out desk: "What an interesting set of titles you have there."

Phase IV. Application

If the steps of Phases I - III are successfully accomplished, and if the chosen option is direct attack, then Phase IV consists of the single step: deliver attack as planned. Whether the attack is successful (!) is another matter; whether the process can be controlled at this stage is the subject here. Again invoking the premise of self-consistency, attack planning would have been conducted as rationally as the rest of the weapon fabrication phase. Consequently, there is no good reason to believe that the direct attack should be vulnerable to detection during weapon transport, emplacement, activation, or other specific actions involved. The variety of ways by which a superviolent attack might be delivered and the large number of potential targets open to attack force the conclusion that general controls are not likely to be effective in the application phase.

If the chosen option is coercive threat, the application phase of the process becomes much more involved, as evidenced by the subjects treated in Chapter 9. The steps involved are summarized briefly.

Steps (Coercive Threat)

Deliver initial threat communication (demands, etc.)
Validate threat claim
Establish communication (two-way?)
Negotiate
Evaluate degree of compliance
Decide whether to accept
Decide whether to punish (real weapon case only)

The steps are defined from the threatener's point of view even though, in this phase, they interact intensely with society and the coerced authorities. At this stage in the process, the threatener's resource requirements are nil; control over that flow, therefore, is ignored. Relevant actions and options are implied by the steps listed and discussed previously; reactions to them are more appropriately termed "responses" rather than "controls."

Responses (Coercive Threat). At this stage, the game of superviolence may be close to won by the threatener. The authorities are faced with two major tasks: investigation to verify the threat claim or counter the threat, and decision whether to comply or, at least, negotiate.

Verify: to establish or test the truth of a statement by means of special investigation. The specialized scientific knowledge required to assess both the weapon and impact of the superviolent threat force the conclusion that it would be most unfortunate for the verification process to be conducted on an *ad hoc* basis or not to utilize the best investigative methods available. This leads to the major recommendation of this study: the creation of responsibility for the threat verification task and its assignment to an appropriate agency. From a practical point of view, only a Federal agency is in a position to effectively command the resources needed to rapidly investigate and evaluate superviolent threats. This, in turn, suggests the desirability of legislation making conspiracy, threat to use, or actual use of nuclear devices or biological pathogens—other than with Presidential authority—a Federal offense; provisions regarding chemical weapons depend on establishing a legal definition which excludes the poisoning of one or a few individuals. (Under such legislation, for example, the 19-year-old Californian who threatened to release plague organisms at a Lake Tahoe casino in July 1972, and wound up with a 10-year sentence in the Nevada State Prison, would have been guilty of a Federal offense.)

The agency designated to respond to incidents of superviolence would presumably develop contingency plans for such cases, develop and maintain contacts with other agencies and individuals capable of providing expertise in the verification of threat claims, and, possibly, manage negotiations with the threatener or have directive authority over some of the response capabilities available. The utility of having centralized planning and management of these functions when they are needed is apparent, but whether the need is sufficient to warrant infringing on the authority of local jurisdictions to this extent must be determined on a political basis.

Alternatively, an advisory agency, whose services are available to any threatened jurisdiction, could provide the technical and investigative expertise and resources to support response to a superviolent threat. By whichever arrangement, the Federal government's unique ability to assist in achieving the best resolution of a superviolent crisis must be organized and prepared for use before the time of need.

Coercive threats of superviolence, if found to have sufficient credibility to override the presumption of sham (see Chapter 9), may be countered in several ways: should the investigation lead to the threatener, the threat may be neutralized at the source; failing that, its impact may be reduced by negotiation, compliance, or defensive measures.

With regard to neutralization at the source, there is a crucial difference between the INW and CB weapons. An INW detonation is an instantaneous, discrete action; dissemination of chemicals or pathogens is a process. Once in position, the INW can be booby-trapped or remotely detonated if the threatener is cornered; the CB attack would be of much reduced impact were it to be made suddenly as a last resort of the attacker. Explosive or high-pressure dissemination of poisons or pathogens from their storage place might represent a serious threat, but not one as serious as if they are optimally employed. Consequently, the relative invulnerability of the INW confers something analogous to a stable strategic deterrent quality; it is almost as if its possessor has a second-strike capability. To follow the analogy further, he may be able to ride out his capture or even the discovery of the device without losing the coercive power of his threat. In contrast, the CB attacker is less stable, and might therefore be more prone to attack if he believes the investigation is leading to him. In this sense, the CB threat is the more dangerous of the two and, since it is less demanding of skills and resources—as well as being less subject to control—it may, on balance, be much the greater problem.

Reflection on the outcomes of the two, recent, politically motivated coercive plots recounted in Chapter 9 (the Cross kidnapping and, to a lesser extent, the PFLP hijackings) suggests that once the threatener has been found and is confronted with the superior power of the authorities, his resolve apparently erodes to a point at which his demands become acceptable to the state. We cannot be certain that the greater impact of the superviolent instrument alters this conclusion. At the final moment, the cornered terrorist—faced with the choice between accepting minimal concessions (his life, free passage from the country, a small monetary payoff) and imposing large-scale destruction and death (including his own, in all likelihood)—may abandon his original goals in favor of a much reduced set. Achieving this outcome is the purpose of the authorities willingness to seek negotiation as the response to a credible coercive threat. This line of analysis, however, is contingent on the authorities successfully locating the threatener or localizing the threat; if that cannot be done, neutralization at the source is impossible.

The second response category, negotiation and compliance, can only be evaluated in the complete context of an actual threat situation. Part of the context within which a political leader may have to make the unpleasant decision of acceding to an extortionist's demands is the level of risk experienced in various socially accepted activities. It provides a partial basis for determining both the desirability of control measures and the acceptability of the comply-or-resist decision, and is examined in the next major section of this chapter.

The last response category, defensive measures, is more properly treated as part of the final phase of the superviolent threat process.

Phase V. Consequences

From society's viewpoint, superviolent plots may lead to any of four outcomes:

1. no loss resulting from a sham threat detected as such, an undetected sham coupled with a resist decision, or a real coercive threat coupled with resist and not punish decisions (threatener's failure of resolve);
2. compliance loss resulting from an undetected sham coupled with a comply decision (successful sham threat) or a real coercive threat coupled with comply and not punish decisions (successful real threat);
3. mass damage loss as a result of direct attack or real coercive threat coupled with resist and punish decisions; and
4. mass damage plus compliance loss in the case of a real coercive threat and comply but punish decisions.

In all cases, it is expected that the investigative and enforcement power of the state is directed against the perpetrator. The cases involving mass damage loss (3 and 4) present two response conditions: direct attack, permits only post-attack response, while the coercive threat situations permit both pre- and post-attack response.

Few, if any, communities have the resources for a rapid and effective post-attack response to superviolence. As in natural disasters, emergency resources are drawn from the surrounding, unaffected area, and special needs are filled by Federal assistance. Considering the great variability in attack types, potential targets, and degrees of preparedness for disaster operations among target communities, it is difficult to be specific about post-attack responses. Planning for disaster operations is a continuing responsibility at local, state and national levels; assistance in planning, stockpiling, and operations is provided by government agencies (Office of Emergency Preparedness, Office of Civil Defense, various executive departments), the American National Red Cross, and various public safety and industry associations.

The extent of pre-attack responses to coercive superviolent threats which do not appear to be shams depends strongly on weapon type and target localizability in space and time. For a nuclear threat, a known target area, and a reasonably short time window, evacuation is a possibility. We have indicated, however, that there is no necessity for the threatener to provide all this information. For a biological threat, the same conditions and conclusions apply, with the additional possibilities of prophylactic immunization of the target population and urgent deployment of supplemental medical facilities. Because of its smaller scale, a chemical threat may be subject to counteraction by avoidance, but again, target locale and threat duration must be known. Should the threatener be so cooperative as to provide both verifiable evidence of his capability and specific indication of his attack plan, the appropriate pre-attack responses will be evident and can be taken. We have not investigated the very complicated problem of whether and how the members of a threatened community could be induced to evacuate, and what the real costs of such an action might be. Lacking specific knowledge of the attack plan, however, the only actions open to the authorities are the organization and assembly of rescue and recovery resources at some central location and preparation for their rapid deployment to the affected target.

SOCIAL RISK AND DECISION MAKING

An appropriate perspective for the decision maker concerned with the superviolent threat is provided by the daily milieu of social risk-benefit tradeoffs, hazardous industries (nuclear, chemical, etc.), and risks to national security.

Although our society has been classified and measured in a variety of ways, few system perspectives concerning social risk-benefit tradeoffs are available. Studies have been conducted in the fields of safety engineering, disaster research, management science, and similar areas, and some data comparisons have been presented by Starr (1969, 1971). Yet we have no aggregated, quantitative, life-impact ordered data. Society is continually discovering, identifying, and becoming sensitive to additional risks and hazards due to a combination of technological "new arrivals" and the ability to probe more sensitively into the social risk problem.

> If we understood quantitatively the causal relationships between specific technological developments and societal values we might deliberately guide and regulate technological developments to achieve maximum social benefit at minimum social cost... [but] our society historically has arrived at acceptable balances empirically—by trial, error, and subsequent corrective steps. (Starr, 1969).

By summarizing and comparing risk and benefit data on involuntary (society-imposed) and voluntary (self-imposed) activities, Starr concludes:

1. The indications are that the public is willing to accept voluntary risks roughly 1,000 times greater than involuntary risks. The acceptable risk level is about 10^{-4} occurrences per exposure.
2. The statistical risk of death from disease appears to be a psychological yardstick for establishing the level of acceptability of other risks.
3. The acceptability of risk appears to be crudely proportional to the third power of benefits (real or imagined).
4. The social acceptance of risk is directly influenced by public awareness of the benefits as determined by advertising, usefulness and the number of people participating.

Another interpretation of item 1 is that society is essentially "forced" to pay a thousand times more for involuntary risks to achieve equality with accepted voluntary risks.

The social risk contributions from the nuclear power industry, other than the IMW threat, include thermal and radioactive effluent pollution and the hazard of major reactor failures (as in a loss of coolant accident) with their attendant possibilities of damage, injuries, and deaths. There have been radiation accidents, industry fires, "Broken Arrow" events, accidental releases of fission products to the atmosphere, reactor incidents of various types including sabotage, and the usual industrial accidents. These aspects are described by Larus (1967) and Tamplin and Gofman (1970).

Though concern has been expressed about the more conventional hazards, no one has taken up the crusade for "zero risk." In the reactor safety area, for example:

> The AEC has admittedly taken the attitude that nuclear power reactors should be reasonably safe, but not necessarily as safe as is technically feasible. This policy scares people. (Bingham, 1971 p.48).

Several discussions have talked of "decreasing the over-conservative reactor safety designs once more operational data is accumulated." (KTTV, 1972), Similarly, the chemical industry contributes significant social risks other than the potential mass threat.

> There are over 100,000 chemical materials in the working environment. Many of these have unknown qualities and effects on humans. ... In 1969, millions of American workers were subjected to toxic chemicals, toxic gases, and airborne particulates without being able to protect themselves or to even be told about exposure until it is too late. ... These exposures caused over 10^6 new cases of occupational disease last year alone. (Congressional Record, April 13, 1972, E3809).

The requirements of national security similarly impose risks from military and diplomatic activities, especially those associated with the transportation, storage, and use of nuclear, chemical, and biological weapons. These risk levels are incurred to enable us to enjoy peaceful pursuits (with their attendant risks).

The term "social risk" is frequently used to encompass all types of risk,but the distinction of those associated with national security is needed because of the significantly different risks of conducting a war, preventing a war, and providing defense resources, in order of decreasing risk magnitude. One rationale is that national defense must be sufficient, or all is lost. Life and property are placed at risk in providing and maintaining a defense posture, and significantly higher risks are involved when the capability is used; all these risks are accepted. In contrast, risks arising from peaceful pursuits can be reduced by imposing safety requirements but these are often resisted; many controls are not instituted because of their economic penalties and the belief that "extreme" safety provisions might decrease product acceptance. Generally, national security issues show much greater resource drawing-power than social issues.

A justifiable level of acceptable risk of superviolence vis-a-vis national security is that associated with the illicit use of licit weapons that might arise from wrongful use by a proper authority. (The recent case of General Levelle usurping civilian authority has concerned some about the "theft" of nuclear weapons.) Another threshold level would be that of an accidental explosion. Larus (1967) cites Oskar Morgenstern: "Someday there will be an accidental explosion of a nuclear weapon, a pure accident which has nothing whatsoever to do with military or political plans, intentions or operations...[but] simply because sheer numbers of weapons are increasing." Basically, this limit is set by the quality of weapon safety programs encompassing handling and storage procedures as well as the design and provision of inherent fail-safe mechanisms. The considerable improvement in weapon safety over the last two decades was at least partially motivated by several "unnerving" events; in the nuclear weapon case, the early lack of fail-safe mechanisms and foreign power access to control; in the CB weapon case, the Dugway containment failure accident.

All technologies appear to produce outputs that directly or inadvertently place a part of society in jeopardy, sometimes in an obscure way, in addition to providing the benefits expected of them. Nuclear weapons are one example. The growth of commercial air transport is another which not only produces noise pollution and airport congestion, but inadvertently offers a social vulnerability through hostaging passengers to criminal hijacking. The technological component of superviolence, therefore, may be partly understood in the context of a "degree of coupling" between the legitimate nuclear or chemical industries and their spurious, undesired exploitation.

EVALUATION OF CONTROL SYSTEM CONCEPTS

The decision maker's evaluation of superviolence in a social risk context involves two factors: the probability of a mass threat occurring and, should it occur, its probable resultant devastation or impact. Yet this concept of "expected impact significance" (Dror, 1971 p.97) does not appear to be a systems rationale by which safety measures, defenses, or security actions are consistently apportioned. There are several reasons for this deviation from (or, at least, non-attraction for) applying such a measure to the mass threat problem: the uncertainties in quantifying the threat probability (or, in the limit, its lack of its meaning without historical data) and the fact that its subjective impact may easily transcend any arithmetic composite of people killed or injured and property destroyed or damaged.

The probability spectrum of mass threat estimates ranges across contrasting viewpoints as very improbable, highly probable, or somewhere in between. Assuming equal a priori probability for each of n threat or hazard states across this range, simple statistics indicate that the real future will lie between the extremes cited by the believers and the sceptics. (We should not be dismayed unduly that both sides state their cases at the extremes; they are simply realistically adjusting to a contemporary, communication-saturated culture.)

Part of the subjective intensity of impact stems from awareness of the pervasiveness of a threat to the class affected. For example, a presidential assassination has high impact (beyond the implications of political office and national power) because the class has unique occupancy. Yet there is an awareness that the category will be reoccupied—unlike that in the death of a loved one. Similarly, the destruction of most or all congressmen or airline pilots or nuclear physicists at a mass meeting would have impact beyond that of the same number of diversely classed individuals. (Yet there is a limit based on other subjective images of class categories: "all the passengers on one airplane" or "the residents of a whole sector of the city" or "the army division was decimated.") Another subjective dimension illustrates the differing impact of the death of an explorer within the confines of conventional society or in the vast "unknown." Certainly, public response was internalized differently for those astronauts who died in a training plane accident, in the flaming Apollo capsule, or who might have been trapped in space.

A partial reflection of this subjective impact factor (the combination of event probability and threat pervasiveness in a given class) is provided by defining contours of "equal social trauma." That is, given a category or class descriptor, its size (population at risk) and its experienced hazard death rate can be quantified, as shown in Figure 10-2; the social risk data indicated provide for the reader's subjective evaluation. The diagonal bands reflect the assumption that a constant degree of pervasiveness represents approximately equal trauma. The upper limit is that of complete devastation; the lower, some minimum level of awareness. The median band reflects the variable threshold of contemporary, daily trauma. All the bands, however, are subjective and sensitive to categories of personal concern.

Subjective impressions of the probability of occurrence of future risk derive from the historical data of past misfortunes. Some analysts specialize in the various mathematical manipulations available to shape and refine such projections; others comment on the absurdity or, at least, meaninglessness of this activity. The most appropriate perspective recognizes such considerations as belonging to the domain of trans-science: "issues at the interface between science and politics...that are in principle beyond the proficiency of science to answer." (Weinberg, 1972).

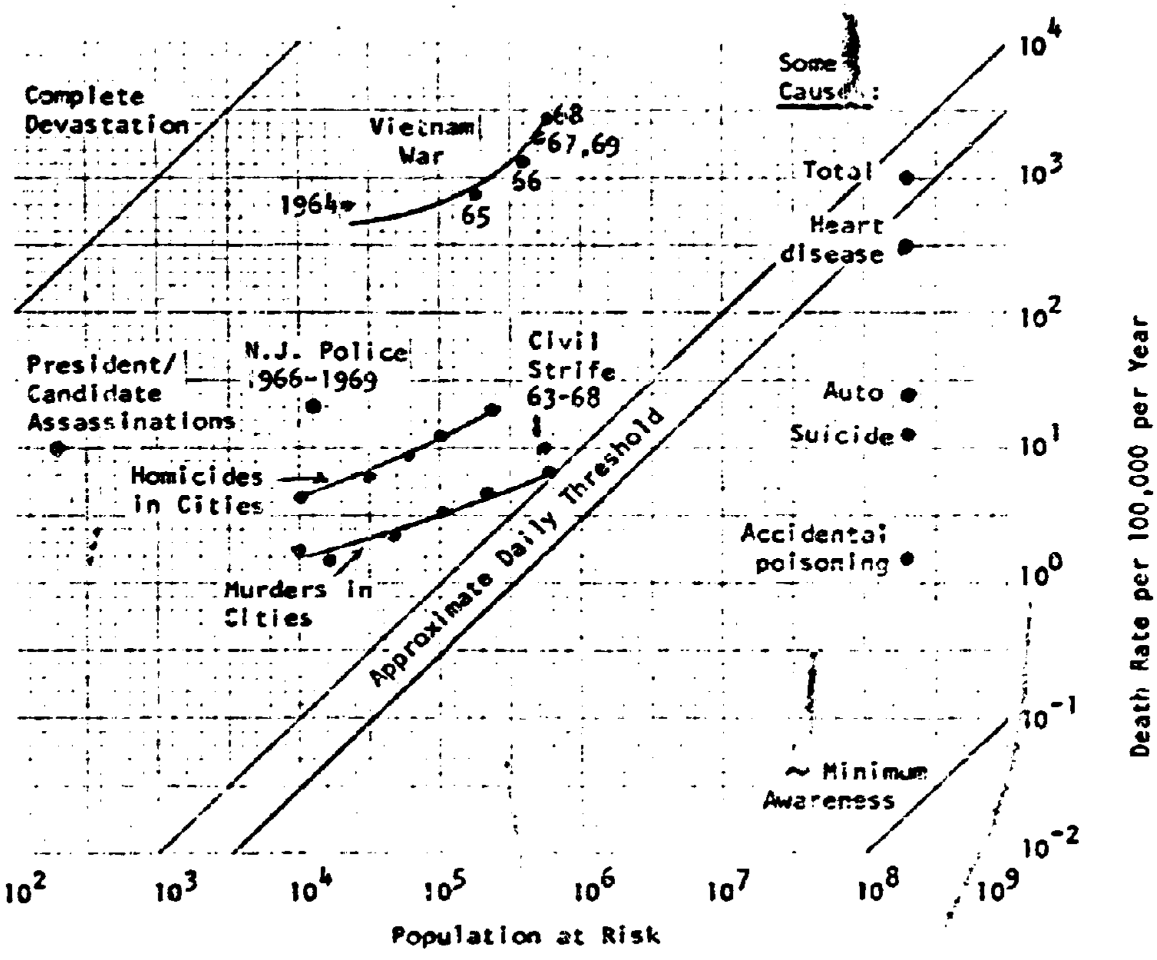


Figure 10-2. Death as a Traumatic US Social Experience

Our tendency is to use the available data in probabilistic fashion, attending to the interpretation of its meaning and displaying its trans-scientific nature by providing appropriately large uncertainty bands. In the limit, complete uncertainty about the occurrence of a future event classically implies equal probability for each possible state. This is consistent with the principles of information theory which attributes to such assessment zero a priori information. Later information is proportional to the logarithm of successive estimates of the probability of occurrence based on additional observations. Hence, the occurrence of an infinitesimally expected event has high information quantity when it occurs preceded by a long sequence of essentially no information during periods of its non-occurrence.

Though statistics provide only partial descriptions of disaster, Figure 10-3 illustrates another people-property catastrophe summary encompassing several superviolent possibilities. We have not defined the transition region where conventional disasters change into unacceptable mass threats. The two Taylor and Humpstone (1970) targets seem well beyond acceptable disaster levels as does the bacteriological attack described in Chapter 9. Yet, curiously, the casualty levels do not differ much from our far different perceptions of annual auto accident deaths, while US World War deaths strike still another subjective response.

At this point, then, we cannot be more definitive than to indicate that the occurrence of INW or CBW superviolence appears to be of significantly greater impact than its uncertain intensity. A mass CBW attack appears at a different perceptual level when it encompasses a group several orders of magnitude beyond the capability of the lone poisoner, and awareness that a small group rather than a nation has detonated a nuclear weapon is bound to result in significant social trauma.

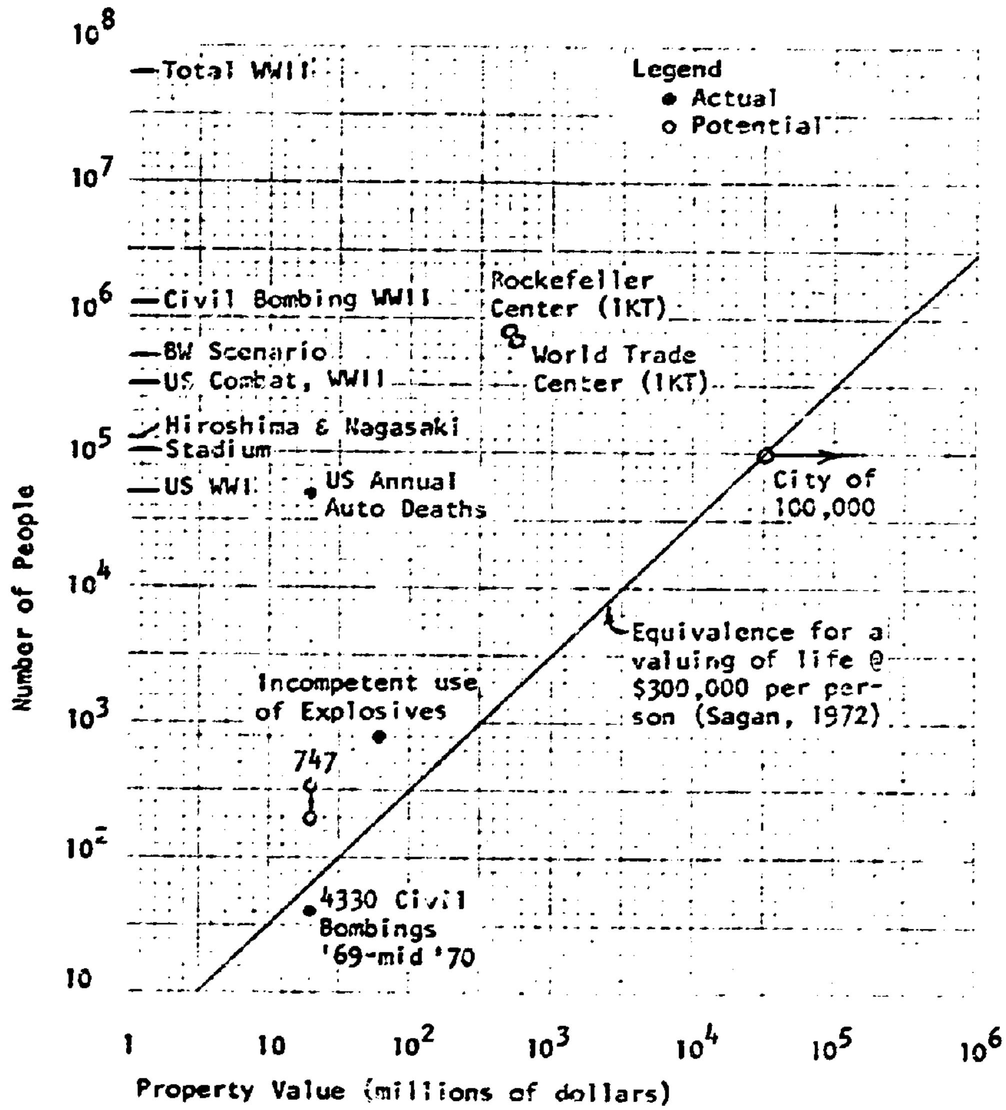


Figure 10-3. Social Disasters

Decision Making Rationales

What then is the nature of the decision pressure encompassing the issues of concern: is there a threat? if there is, how great is it? what should be done about it? Although the mass threat has been elevated here to a sensitive issue, it is but a part of the pattern of pressures on decision makers in a technological, contemporary society:

> In our social climate of aggressive change, technology has evolved to a special station. As a catalyst of change, technology has become a basic implement of economic and political power. As a consequence, technological decisions are made on the limited sociological and physiological scales dictated by specific economic and political responses. This decoupling of the decision from the complete world is the indulgence of a society that is socially diffuse and physically unconfined. ...the promoter is the characteristic influence in society's attitude to technology. (Geesaman, 1971).

Policy tradeoffs are generally determined by a relatively narrow spectrum of decision makers, but individual expression by the people can be a myriad of diversities. Whether the projectable risks of superviolence entertained by an invidiuals or a nation are acceptable or whether they motivate the assessor to further controls depends on the established value system. A Technology Assessment panel of the National Academy of Sciences found that:

> ... historically, the burden has tended to fall on those who challenge the wisdom of a technological trend. The usual presumption has been that a trend ought to be allowed to continue as long as it can be expected to yield a profit for those who are exploiting it, and that any harmful consequences that it might ensue either will be manageable or will not be serious enough to warrant a decision to interfere with the technology. (Lamm, 1971).

Lamm sees more than the opposing pressures of technological growth confronting the challenger seeking adequate proof of cause. Old mechanisms are not adequate to control new dangers because of: the rapidly accelerating rate of technological change, our ability to affect greater numbers of people, control mechanisms which require "proof" of harm, and a traditional market system of control no longer adequate to guide rapid technological development. As a result, Lamm asserts the importance of the "development of mechanisms to rate adequately both the costs and benefits of new technologies." The issues are amplified in the sense of affecting society on an ever-increasing scale; decisions now carry with them a scope of impact not experienced in the past:

Contemporary societies differ in their insistence on protective measures against the "once in one hundred years" catastrophe. We have numerous examples in the US where such catastrophes are permitted to occur or are excluded from control actions. The rationale, in part, is that the damge, while extensive, may not exceed the long term pro rata of hundreds of lives or tens of millions of dollars or most probably not occur at all. Another rationale is that of the "act of God or of nature." A contrast is offered by the Netherlands philosophy where the expected one per hundred year flood disaster has elicited preventive response due to the overwhelming impact it would have on their society.

Decision making must consider the extent to which national purposes are fulfilled without undue social risk. The informed decision maker sees, at one level, the benefits of hazardous industries vs. the aggregate risk. At a more detailed level, he considers the chance of occurrence and the impact of superviolence in the context of other risks associated with each industry. One could desire to document the excess, adequacy or inadequacy of safeguards and mass threat deterrent measures in the context of ranked risks and benefits. This cannot be done.

Schlesinger (1971) has sought to place the implications of potential disaster in decision-maker perspective:

> The focus of concern should be the likelihood of small accidents, small spills, unplanned shutdowns. ... Potentially these could be the source of far more trouble over the long run than the possibility of hypothetical disasters. We must of course give careful consideration to these hypothetical accidents, even though their occurrence may have virtually zero probability. But we must insure that such consideration does not unduely divert our limited resources in management and technical personnel from adequate attention to the unglamorous engineering tasks.

In a sense, US society was placed "at risk" in new ways by the policy actions which implemented nuclear and CB weapon programs and initiated and promoted the civil nuclear industry and a diversity of chemical and bacteriological products. Obviously, the counterpoints to each of these policy actions were significant economic or national benefits. Each policy decision gave some new and different meanings to "common defense and security," but no threshold has been established which defines that term to exclude all risks, from any and all causes, which increase the probability of death to any citizen beyond that due to natural causes, acts of God, and normal social activities. Thus, what once constituted an unacceptable risk can be redefined as legal and prudent action; an example is the rescoping of "restricted data" by the Atoms for Peace legislation.

Seen in this relative risk-benefit light, the inventory of general and special controls derived from the threat description is unimpressive. If not for the intrinsically low probability of real or credible super-violence, the social problem it might impose would be extreme. It is important to emphasize the reasons for this asserted low a priori probability; they derive from the human factors involved, not the technical feasibility of the process. Technically qualified personnel are extremely unlikely to be threat-motivated to the extent required when the full impact of cost, risk, opportunity for failure, and consequences is considered;

those who remain threat-motivated in the face of these factors are unlikely to be technically qualified or, if they are, unlikely to be able to enlist the additional skills, resources, and opportunities to accomplish the INW threat. It is for this reason that we are satisfied that the continued development of the present nuclear diversion safeguards program, coupled with foreseeable improvements in industrial and transportation security, constitutes the most justifiable SNM control.

The other versions of the superviolent threat—especially the city-scale biological attack—all point to the same conclusion: the only promising method of control depends on the awareness of investigative and law enforcement agencies regarding the possibilities for superviolence. The control facilities exist; what is needed is the training and coordination that will enable them to maintain surveillance, utilize informants, and follow up potential indicators of danger. Only a few control concepts uniquely related to superviolence were identified. Chief among these are: the use of scientifically qualified, special investigators posing as potential terrorists in an effort to absorb whatever intent for superviolence may exist; and the possibility of obtaining useful indications from efforts to acquire specialized but not illegal, weapon-oriented, supplies or equipment.

The amorphous nature of these control concepts and the technological character of the threat underlie our recommendations that superviolence be recognized as a national-level problem and that the responsibility for its management be assigned to a Federal agency. This appears to be the best present response to a not yet real problem.

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13. ABSTRACT
Superviolence is defined as the illegitimate use of nuclear, chemical, or biological mass destruction devices by domestic agents for attack or threat against U.S. civil society. Political extremism, severe mental imbalance, and criminal gain are examined as possible motivations. Since the nuclear industry constitutes the primary source of fissionable material for fabricating an illicit weapon, its policies, practices, and diversion safeguards program are investigated.

The threat process is analyzed in five phases: idea conception, group formation, weapon fabrication, application (attack or threat), and consequences. The steps of each phase are described for various weapons, with emphasis on the human factors, skills and resources involved. Potential failure modes are identified, and assessed as more severe in the nuclear than in the chemical or biological case. The important distinctions between direct attack, coercive threat, and sham are analyzed in detail.

Actual nuclear superviolence is held to be an extremely unlikely phenomenon due to its dependence on the coalescence of specialized motives, high commitment, inhibition of restraints, technical skills, and significant resources in a risky, failure-prone process of inapparent utility. Chemical or biological superviolence is deemed more practicable, with the latter having an anti-personnel potential greater than the nuclear case. Provisions for controlling and responding to superviolent incidents are examined.

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