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AN APPROACH TO DEFINING POSTATTACK RECOVERY
MANAGEMENT CONCEPTS AND TECHNIQUES

By: DONALD E. CLARK, JR., CARL F. MILLER, AND GEORGE D. HOPKINS

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INTRODUCTION

The present emphasis in civil defense is on the development and use of available fallout shelter and associated systems. This emphasis, in the initial stages of developing a civil defense system, is logical and appropriate, since a no-cost fallout shelter clearly provides the highest lifesaving potential per dollar expended in comparison with any other protective measure. However, considerations of national recovery following a nuclear war indicate that the cost-effectiveness of a civil defense system cannot be correctly evaluated simply on the basis of system effectiveness in protecting the population from the immediate effects of attack. A wide range of postattack actions is required to ensure the continued survival of the initially protected population and the eventual recovery of the nation.

The number of potentially available postattack countermeasures is large, although the applicability of any one measure depends on local postattack environments. The application of postattack countermeasures generally requires the active use of manpower, equipment, supplies, and resources; proper organization and management is required for their most effective use. Relatively little preparatory work has been done on the systematic development of coordinated postattack recovery operations, and essentially nothing has been done to develop management systems for these operations. This report represents an effort to outline the composition of an integrated postattack countermeasure system and functional requirements for managing the system.

Postattack recovery activities in this report are defined as those civil defense activities that take place from the time that exit from shelter can occur (i.e., when the protective characteristics of shelter are no longer a factor in the continued survival of the occupants) or must occur (i.e., when survival supplies are depleted). These activities, such as decontamination, radiation exposure control, debris clearance, and damage repair, are countermeasures against nuclear weapon effects that must be implemented to ensure national survival and recovery.

The rates at which survivors may use up stockpiles of surviving resources determine whether recovering production of survival items and services would be required at early postattack times. Failure to recover this production by the required times could lead to additional casualties.¹ Consequently, the shelter exit time should be as soon after attack as .

possible, depending primarily on the survival needs of the occupants. When survival is not critically dependent on the early recovery of production, the shelter exit time would depend primarily on the habitability of the external environment. Shelter exit time would vary from a few hours after the attack in undamaged areas without fallout to a period of several days or weeks after attack in undamaged areas with fallout having an initial high radiation intensity.

In damaged areas, the shelter exit time would depend on the degree of damage sustained by the shelters from the blast, thermal, and resulting fire effects; the fallout levels; and the amount of debris in the area. Where shelters fail to provide protection against blast or fire, the relocation of survivors to intact shelters would occur before the start of the postattack recovery period. In damaged areas that do not receive fallout, the exit time from intact shelters would depend on whether large scale fires occurred and, if so, on the time when the fires were out (a few days). If fallout also occurs in such areas, the exit time from the intact shelters could depend on the same factors as for undamaged areas that receive fallout.

General descriptions of the primary factors for defining the various postattack environments, and the postattack countermeasures applicable to each, have been discussed by Miller.² These descriptions, within the context of a large scale nuclear war, suggest that postattack recovery operations could occur at different times and areas and with various operational techniques, depending on the residual environment and the characteristics of the shelter system that is available and used at the time of attack.

Postattack recovery is generally considered to occur in two time periods: an initial survival period when the recovery of life-sustaining resources and systems is emphasized (or required), and a later recovery period when long term recovery of socioeconomic systems is carried out. These two periods will be of different duration for each recoverable system, depending on environmental effects and survivor needs. In some systems, the transition from survival to recovery activities may be difficult to define, particularly if both periods are considered in a long term integrated plan for a large area or for the nation as a whole. Thus, some consideration of recovery on a national scale is required to guide selection of effective overall recovery procedures for the regions and local areas.

Postattack recovery operations involve the application of physical processes by people. While the details of the physical characteristics of many postattack countermeasures are fairly well understood and should be amenable to organization and management, personal reactions to performing the operations under the stress of the postattack environment are not

all known and are less subject to evaluation. Therefore, only the physical processes and their technical feasibility will be considered initially. While this approach tacitly implies that the people would willingly carry out tasks that are feasible; it does not imply that such an assumption should not be evaluated separately once the technical aspects are clarified.

Within the scope of the above discussion, the objectives of this research are:

1. To summarize current countermeasures and the organizational responsibility for each of them.
2. To develop an approach to find concepts and decision guides for organization and management of postattack recovery operations.

GENERAL DISCUSSIONS OF POSTATTACK COUNTERMEASURES

A land surface burst of a nuclear weapon in the megaton-yield range produces blast, thermal, and residual radiation effects covering hundreds of square miles. Yield-dependent scaling equations for blast, thermal, and initial radiation effects have been developed from weapon effects field tests.³ Although the residual radiation hazards of fallout are difficult to predict because of uncertainties in the meteorological distribution process, single weapon fallout pattern prediction models have been developed.²

Saturation attacks on the United States could spread devastation over thousands of square miles of populated regions. This has been shown by hypothetical, computer programmed multiweapon attacks on the United States, using current weapon effects technology^{2,3} against data bases of various national resources to estimate national survival and recovery capabilities.⁴ Although the precise description of the postattack environment at any selected location on a national scale in such damage assessment studies is always uncertain because of variable enemy strategy, aiming accuracy, and wind conditions for fallout distribution, the computational errors are decreased somewhat, because the area subjected to similar resultant effects from large yield weapons is extensive. Therefore, in contrast to damage from effects of conventional weapons, these studies indicate that a given nuclear postattack environment could extend uniformly throughout a large community. In other words, for purposes of discussing postattack countermeasures, environmental descriptions apply to areas of community size rather than to a smaller area occupied by single buildings or a city block.

No generally accepted concept or definition of the effectiveness of a postattack countermeasure system exists at this time, although various measures of effectiveness of individual postattack countermeasures are used. The overall effectiveness of a system of countermeasures would depend on its applicability to a given environment, its availability for use in terms of securing manpower and physical resources, and the degree to which the latter can be organized and managed so as to accomplish all the required recovery tasks.

Under the concept of widespread area coverage of the damage phenomena of nuclear weapons that might be employed in a large scale attack, the organization of the countermeasures that are applicable during the early

postattack period must include management capability for carrying out operations at an autonomous, highly localized level. Applicability of the countermeasure system components, as mentioned previously, would depend on the type and magnitude of the weapon effects that create the environment. Capability to carry out many postattack countermeasures would depend on both preattack hardening plus dispersal and postattack survival of countermeasure resources--human and material; in other words, the ability to carry out countermeasures would be related to the amount and disposition of the surviving resources at the beginning of the postattack period. Because of the size of the affected areas in a large scale nuclear attack and the expected degree and geographical extent of attack effects, the peacetime practice of committing virtually unlimited external resources to the recovery of a relatively localized area of devastation would, in general, not be possible. However, some areas of the country would not be directly affected by the various damage phenomena, and the resources in these areas could be utilized to assist in the recovery of the directly affected areas.

The initial step in this study was to summarize all the major proposed postattack countermeasures and to indicate currently available concepts related to their application and management.

The most comprehensive list of countermeasures encountered in the course of this study was that developed in the Project Harbor study.¹ Table 1 lists some countermeasures, rough estimates of the postattack time period within which the countermeasures might be employed, and the organizations that are now primarily responsible for the countermeasure management.

The listing of organizations responsible for specific countermeasures conforms with the National Plan for Emergency Preparedness,⁵ as developed by the Office of Emergency Planning (OEP) from Executive Orders Prescribing Emergency Preparedness Responsibilities of the Federal Government.⁶ Also shown are the postattack damage environments in which each countermeasure would have to operate, the estimated present state of basic knowledge about the countermeasure as a recovery technique, and the general postattack environment to which it applies. The list may not be complete, depending on the definitions of countermeasures considered and of the term "postattack period," but the list should serve as a basis for discussion and subsequent analysis of operational management problems.

Each of the listed countermeasures is discussed qualitatively below in the light of its prospective implementation effectiveness and responsible organization. However, emphasis has been given to those countermeasures related to physical plant recovery; these might be used for developing postattack management requirements, in terms of feasibility for conducting recovery operations.

Table 1

PARTIAL LISTING OF POSTATTACK COUNTERMEASURES

Countermeasure	Time of Countermeasure Action					Action Organizations	Applicable Postattack Damage Environments	Estimated State of Basic Knowledge Extent of Need
	Pre-Attack	Hours	Days	Postattack Weeks	Months			
Protective measures								
Food stockpile	X					USDA Commodity Credit Corp.	All	Good
Hardening industrial and utility sites	X					Local industry with federal guidance	B, FO	Fair
Protection of livestock and poultry		X	X	X	X	Local farmer, guided by USDA and local OCD	FO	Fair
Dispersal of capital resources	X					Industry and federal agencies, with federal guidance	All	Fair
Industrial shutdown procedures	X	X				Industry with federal guidance	B, FO	Poor
Postattack evacuation		X	X	X		Local civil defense	B, FO	Poor
Radiological recovery								
Area and selected site decontamination		X	X	X		Local civil defense	FO	Poor
Exposure control procedures		X	X	X	X	Local civil defense	FO	Fair
Food and water contamination control		X	X	X	X	State and local civil defense plus USDA, DHEW	FO	Fair
Radiological waste disposal		X	X	X	X	Local civil defense	FO	Fair
Medical recovery								
Medical supplies stockpile	X					Local, state, and national public health service	All	Fair
Medical treatment		X	X	X	X	Local public health service	B, F	Fair
Housing, health and welfare		X	X	X	X	Local and state welfare agencies	All	Fair
Sanitation		X	X	X	X	Local public health service	B	Fair
Disease and pest control		X	X	X	X	Local public health service	B, FO	Fair
Disposal of dead		X	X	X	X	Local public health service	B, FO	Fair
Ecological recovery								
Erosion and flood control				X	X	USDA Bur. of Reclamation	F, FO	Poor
Reforestation				X	X	USDA Forestry	F, FO	Fair
Farm land management practices			X	X	X	Farmers and USDA	All	Fair
Livestock and poultry management practices		X	X	X	X	Farmers and USDA	FO	Fair
Insect control				X	X	USDA	B, FO	Fair

Table 1 (continued)

Countermeasure	Time of Countermeasure Action					Action Organizations	Applicable Postattack Environment ^a	Estimated State of Basic Knowledge	Extent of Need
	Pre-Attack	Hours	Days	Weeks	Months				
Economic recovery									
Debris clearance		X	X	X	X	Local civil defense	B	Good	Poor
Damage repair		X	X	X	X	Local civil defense, utilities, industry, ODR	B, FO	Good	Poor
Salvage of plants and equipment		X	X	X		Local civil defense, utilities, industry, ODR	B, FO	Good	Poor
Stockpiling raw materials	X					Industry with federal incentives	All	Good	Fair
Stockpiling machine parts, tools, equipment	X					Industry with federal incentives	All	Good	Poor
Stockpiling finished products	X					Industry with federal incentives	All	Good	Poor
Resource allocation		X	X	X	X	ODP	All	Fair	Poor
Restoration of management			X	X	X	Industry	All	Fair	Poor
Economic control techniques			X	X	X	CEP	All	Fair	Poor
Compensation for loss				X	X	Treasury Dept.	B, F	Fair	Poor
Reorganization of commercial capabilities				X	X	Industry associations	All	Fair	Poor
Social recovery									
Individual rehabilitation			X	X	X	Local and state welfare	All	Fair	Poor
Adaptive community reorganization			X	X	X	Local government	All	Fair	Poor
Reconstruction of family units		X	X			Post Office Dept. and local welfare agencies	All	Fair	Poor
Provisions for orphans and broker families		X	X	X		Local and state welfare	All	Fair	Poor
Continued education of the young				X	X	State and local boards of education	All	Fair	Poor
Skilled retraining for segments of labor forces				X	X	State and local boards of education, labor organizations	All	Fair	Poor
Reconstruction of local, state, federal government		X	X	X	X	Local, state, federal government	All	Fair	Poor
Reconstruction of democratic political processes		X	X	X	X	Local, state, federal government	All	Fair	Poor
Maintenance of valued social institutions				X	X	State welfare	All	Fair	Poor

^a B = Blast damage
F = Fire
FO = Fallout

Source: Stanford Research Institute and Reference 1

Protective Measures

Protective measures consist of those activities that are planned and implemented during the preattack or very early postattack periods and that contribute to postattack recovery. Protective measures may be passive or active.

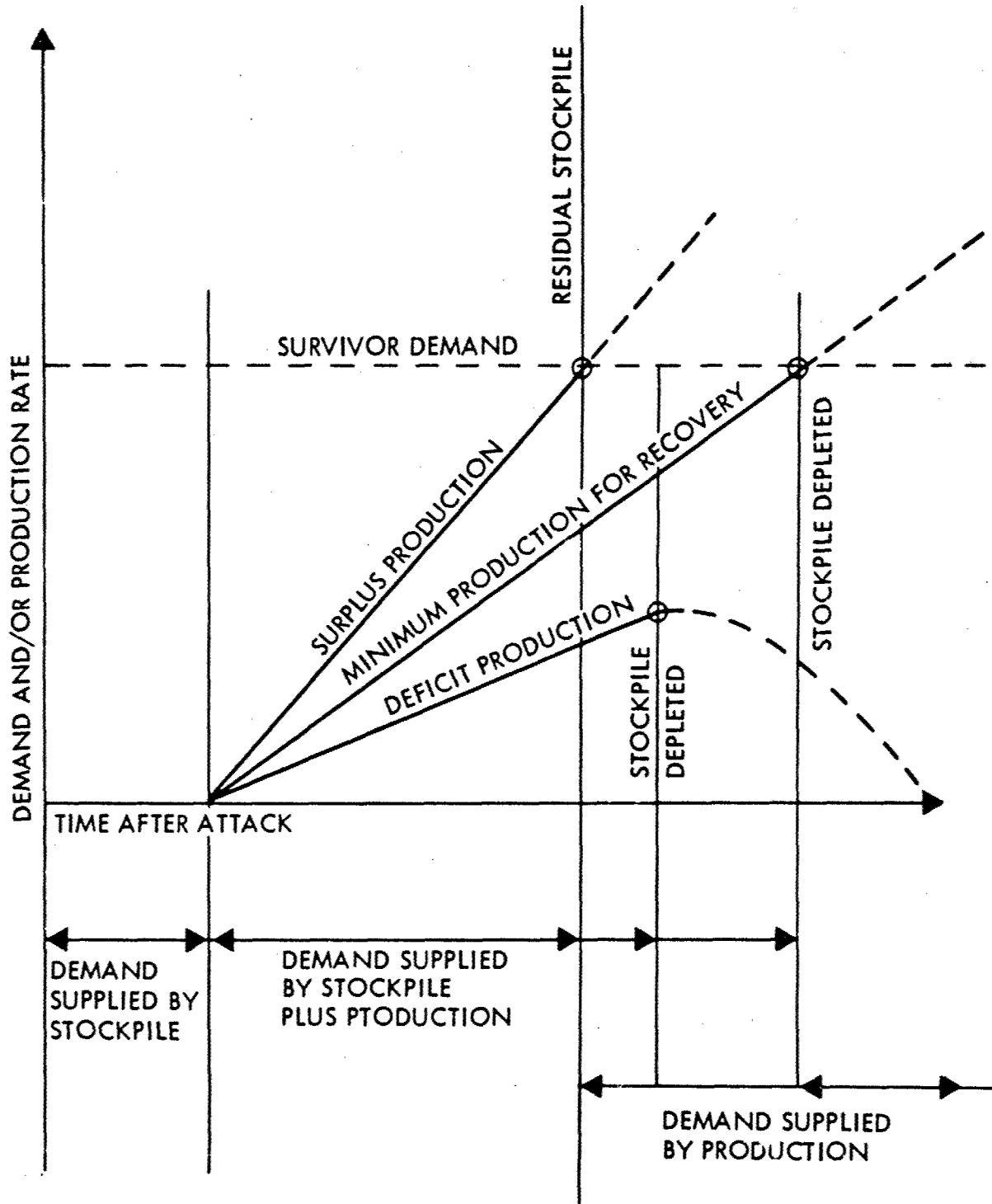
Passive protective countermeasures are stockpiling, shielding from weapon effects, and dispersal of capital resources. These countermeasures, to be effective, must be carried out well in advance of the attack and kept in a state of continuous readiness. The costs for these countermeasures would vary from a single initial investment in shielding or non-perishable stockpile items to the initial and maintenance costs of stockpiling materials that must be replaced on schedule to ensure maximum usefulness of the stockpile during postattack recovery. A more subtle change must be made in stockpiles over longer periods of time as population shifts occur and as estimates of postattack requirements are better understood.

The concept of stockpiling as a part of a countermeasure system in postattack survival and recovery is illustrated in Figure 1. The rate of depletion and amounts available of each item or system (e.g., food, medical supplies, critical parts) in the stockpiled inventory must be taken into consideration in developing requirements of the time-phased restoration of the production and distribution system to meet the needs or demands of the survivors. For critical survival items, the estimated time for depletion of the stockpile will be a factor in determining when production recovery operations must be initiated and the rate at which the recovery must be achieved.

Production-demand equilibrium at the survival level is the initial minimum goal of recovery for all basic production and supply systems. Figure 1 shows how three production recoveries might apply to a stockpile with a constant survivor demand. The stockpile provides the survivor demands until production recovery is initiated; then the stockpile plus production provides the demand with the stockpile decreasing more slowly as the production rate increases. The minimum recovered production rate reaches production-demand equilibrium at a time when the stockpile is depleted. Surplus production could reach production-demand equilibrium at an earlier time to provide a residual stockpile, or could become the minimum production for recovery starting at a later time. Deficit production would fail to reach production-demand equilibrium; controlled use (i.e., enforced decrease in consumption rate) of a survival item could extend the time of stockpile depletion but it could also decrease production. Analyses of all systems necessary for survival and recovery must be made in terms of these relationships between the depletion rates of stockpiles and recovery rates of production to establish realistic requirements for the time-scheduling of postattack countermeasures. Where possible, it is necessary to take into account the known national goals that include postattack military requirements.

Figure 1

STOCKPILE USE-PRODUCTION RATE RELATIONSHIPS



Some active protective countermeasures, such as taking shelter, industrial shutdown, and preattack evacuation, are not considered to be postattack countermeasures. Other protective countermeasures may be taken in the early postattack period to protect damaged production facilities from further deterioration. However, all these activities would contribute to environmental conditions of initial earlytime postattack operations where the relative disposition of the survivors and intact resources would influence the organization and management of the post-attack operations. For example, uncontrolled dispersion of the population would greatly increase problems of communication and command and control of recovery operations. Postattack evacuation, as an organized countermeasure, requires preattack planning, which takes into account subsequent activities of the displaced persons and the use of trained personnel at the site of the recovery countermeasures at the time required for effective implementation. In all routines that may be employed within an established system, the staff of a postattack management organization must consider the sequence of postattack events in the development of preattack preparations that are designed to contribute to subsequent survival and recovery operations.

Food Stockpile

The existence of a large dispersed food stockpile could be an extremely important national asset in the postattack period. Stockpile requirements should be developed on the basis of potential recovery problems of surviving population and food supplies that may exist in postattack production, processing, and distribution systems to achieve a balanced supply-demand relationship, as shown in Figure 1. Such requirements can only be derived from detailed studies and analyses of the postattack situations resulting from a range of nuclear wars.

Previously reported data⁷ using 1960 census figures show that a 15-day food inventory per person is continuously available in retail food stores. Four-fifths of this inventory can be stored for relatively long periods without special handling. cursory studies⁴ showed that even with a full fallout shelter program, a heavy attack on the United States could reduce the normal (1960) food supplies approximately as shown in the tabulation on page 11.

This tabulation omits the surplus edible and raw food stocks owned by the government. The amounts are undetermined for use in long term planning, but have been great enough at certain periods in the past to double the tabulated supply totals. The total supplies listed assume that the recovery of processing facilities would be possible to the extent that supplies on hand can be processed without loss.

	<u>Days of Supply</u>		<u>Percent Reduction</u>
	<u>Normal</u>	<u>Postattack</u>	
Homes and institutions	12	9	25.0%
Retail food stores	15	11	29.0
Wholesale food facilities	16	10	37.5
Edible processor stocks	45	18	60.0
Raw processor stocks	55	22	60.0
Farm crops and feeds (spring)	630	407	35.3
Farm livestock	165	117	29.0
Total	938	594	36.7
	(2.6 yr)	(1.6 yr)	

One approach for obtaining a food stockpile is through the agricultural subsidies program of the Commodity Credit Corporation, in which the preattack flexibility of the stockpile is maintained by joint planning efforts among the Departments of Agriculture (USDA), Health, Education and Welfare (DHEW), and the Office of Civil Defense. Considerable research has been conducted on dietary requirements of the population under disaster conditions, so the principal preattack management problem is that of the size and location of stockpiles to meet estimated postattack needs. The latter should be derived from assessment studies in which the current posture of the civil defense system is taken into account.

Protection and Recovery of Food Supply Systems

The vulnerability of livestock and poultry to radiation is about the same as for man.⁴ Generally, a proportionate survival of human and animal populations is desired to preserve the production capability for a balanced food supply in the postattack period. In addition, it is important that a proportionate capacity of the processing and distribution systems remains operable.

One of the important tasks of the postattack management organization will be to reestablish the flow of farm products to the consumer. This involves food production on the farm; the transport of produce to consumers or to processing and packaging facilities; the recovery and operation of these facilities; and the distribution of food products to wholesalers, retailers, or consumers. The main postattack problems will undoubtedly be associated with achieving and maintaining the operating capability of these systems rather than with how much the food might be contaminated.

Postattack recovery operations on the farms will undoubtedly be on the basis of smaller groups than operations in the cities and suburban areas. In the more sparsely populated areas, a capability for independent action, both in assessing and in coping with the postattack environment, will be needed. Later, communication with farm product marketing systems (perhaps through the Agricultural Marketing Service) will be essential to the best utilization of the surplus food on the farms in the overall national recovery effort. Initial recovery actions on the farm might consist of salvaging meat from animals killed by radiation or harvesting crops that were standing at the time of attack.

As manager of an independent production unit, each farmer will need guidance on such pertinent items as animal shielding and fallout levels. He will need practical advice on how to take care of domestic animals under various attack and postattack situations, on conditions under which certain crops should be planted or harvested (without being subjected to radiation overexposure or without wasting reserve fuel stocks), and on how to conserve essential food products until processing and distribution systems become operable. To meet these needs, USDA has published several pamphlets,⁸⁻¹¹ which have been reviewed by OCD for their concurrence with technical descriptions of the postattack environment. However, this guidance seems inadequate and is not based on a serious study of postattack problems on the farm, where the farmer is a major component of the food production system. More comprehensive guidance is currently being generated for early distribution.¹²

Clearly, both USDA and OCD are responsible for seeing that the farmer is prepared to cope with the postattack environment. The USDA, with its nationwide organization serving the rural population in peacetime, is best able to disseminate postattack survival and recovery information.

Mass feeding is one method of local (consumer level) food distribution for early postattack survival. This method would be applicable to a civil defense system in which the population was sheltered in relatively large groups during attack. Food rationing in the World War II sense, where each individual obtained his limited fair share through normal distribution channels, may not be a feasible method of food distribution, since it does not consider problems of getting the food to individual consumers. The potential damage both to normal food distribution systems and to family preparation systems must be considered in the selection of the most efficient procedures for obtaining, preparing, and serving food in the post-attack period. In addition, the possibility of radiation dose control during food acquisition from the stockpile and distribution during the early postattack period suggests that the primary problem will be that of supplying rather than rationing food.

Preattack preparation of postattack countermeasures for the food industry, according to USDA guidance and policy statements,¹³ is the

responsibility of each plant; the government only offers guidance for voluntary compliance by industry. Postattack emergency food management from the farm through the wholesaler is currently delegated to the USDA Agricultural Marketing Service. The principles of postattack food management require conservation of stocks through an immediate temporary freeze on food sales or distribution (varied by state) to consider the situation. Perishable foods are to be used first so as to conserve non-perishable foods, and consumption is to be limited by rationing after distribution has been restored. Occasionally alternative marketing and supply systems, or the possible restoration of previous systems, is considered in terms of surviving resources. But for the most part, the details of implementation under nuclear war conditions are not outlined, and the concepts have not been thoroughly evaluated. In many ways, the current concepts of food management do not support the more general objectives of postattack recovery, and could hinder, rather than promote, the process. The redressing of conventional war measures for possible application to nuclear war situations should always be subject to critical analysis.

To ensure implementation of postattack food management, USDA has established an auxiliary parallel organization of defense boards at state and county levels.¹³ Personnel for these boards, appointed from local employees of major USDA agencies, have been trained to function independently if communication difficulties are experienced in the postattack period.

Hardening and Recovering of Industrial Plants and Utilities

The essential components of many vital industrial plants and utilities are subject to damage by relatively low blast overpressures. In addition, damage may result from shutdown operations following warning of an attack or from the absence of maintenance personnel over an extended period.

Examples of some protective countermeasures that could reduce the vulnerability of industrial plants and utilities at modest cost are:

1. Screening the valves and gauges from light debris at natural gas pumping stations.
2. Hardening the gas lines and providing alternate fuel supplies at coke ovens of steel furnaces.
3. Hardening the oxygen system at steel mills.

4. Providing fallout shelter for operating personnel in control rooms of petroleum refineries and steam generating plants, treatment plants, gas pumping stations, etc.
5. Providing standby electric power for water and sewage pumping stations and for important radio transmitters.
6. Developing and testing rapid shutdown procedures to minimize damage to essential equipment.

None of these countermeasures would make a given facility invulnerable to attack. However, they would decrease the general vulnerability of many systems, permitting the systems to remain operative through a much wider range of attack situations and facilitating their recovery in the postattack period. These protective countermeasures would, for a particular situation, increase the potential productive capability of the nation, since the available resources at the start of the postattack period would be larger; they could also reduce the manpower and radiation dose requirements for recovery of a given facility.

As with the food industry, agencies of the federal government offer general guidance on protective measures that may be used; however, the current policy is that detailed planning and preparations, as well as implementation of postattack recovery measures, are the responsibility of private management (or owners). Some industry associations¹⁴⁻¹⁶ have produced detailed company survival plans.

The responsibility of preattack hardening of industrial and utility sites rests with individual plant management, but general government guidance and incentives are provided by the Departments of Commerce and the Interior with coordination by the Office of Emergency Planning. The mechanism by which private management may assume control over its surviving employees for carrying out the plans also appears to be the prerogative of private management.

The literature on the preattack protection measures and later recovery of industrial facilities shows that there is no consistent operation concept that can be classified as an operational system component for analysis in the classical sense. Gaps in guidance, in plans, and in organization and management are apparent everywhere in this sector; these gaps will no doubt become more evident when further evaluations of the postattack recovery requirements become available and when the implications of the current guidance are tested.

Dispersal and Recovery of Capital Resources

Several categories of capital resources are concentrated in a few large metropolitan areas and are vulnerable to attacks on cities. Among those vulnerable resources important to postattack survival and recovery are the medical supply, rubber, communications equipment, transportation equipment, and printing industries. A large fraction of the production capacity of each of these industries could be destroyed by relatively few weapons.

One potential countermeasure for the protection of capital resources is a geographic dispersal program that would decentralize vital industries to underdeveloped areas. Although a program of this type would not make an industry invulnerable, it should protect vital industries unless an enemy made a special effort to destroy them. However, it does not seem likely that a program of this type would succeed unless there are compensating economic incentives for industries to move to or to develop in rural areas. In fact, the economies of scale are such that, with growth, major industries tend to concentrate rather than disperse. The government has had limited success in the past in persuading wholly government supported industries to disperse (e.g., Lockheed Aircraft Company). Hence, the dispersal of central resources, except in very large civil defense programs, does not appear to be a countermeasure that would be easily implemented without great pressure.

Guidance has been offered¹⁵ and action has been taken by a few corporations to disperse their corporate records (usually a duplication of their active files) to remote or protected storage sites. This dispersal mostly ensures survival of the corporate entity and a portion of management rather than survival of physical plant and production capability.

The responsibility for dispersal of capital resources is not clearly defined. The Business and Defense Services Administration (BDSA) is one agency that could manage such a program, since it is concerned with assessment of the vulnerability of production resources, except for those resources that are the responsibility of the Departments of Interior and Agriculture.

Industrial Shutdown Procedures

Damage to process equipment during rapid shutdown of many industrial facilities, such as steel mills, chemical plants, and petroleum refineries, can be avoided if certain procedures are followed. In

addition, the use of appropriate shutdown procedures may facilitate or speed up the resumption of production in the postattack period. Most industrial facilities have developed peacetime emergency shutdown procedures for the protection of their capital equipment and materials in process; these or similar procedures should be applicable to nuclear attack situations where physical and radiological weapon effects on the plant are not the primary cause of damage or denial of use of the factory. OCD has sponsored research to define shutdown procedures in several industries; however, details of feasible and effective procedures must still be developed by the operating management of each plant.

Although the development and implementation of industrial shutdown procedures currently is the responsibility of individual industrial facilities, further development of these procedures might be stimulated through joint efforts of the appropriate industry associations and the Office of Civil Defense.

Postattack Evacuation

Evacuation is a countermeasure that may be applicable to several postattack environments:

1. Areas where people have adequate blast and fire protection to survive the direct effects of the attack, but where dwelling units and vital support systems such as utilities are destroyed.
2. Areas where good fallout shelter exists, but where early decontamination is not feasible because of very high radiation intensities or because of insufficient resources to accomplish this recovery.
3. Areas where time-distance relationships by available mode of transportation permit movement to a less contaminated area under established permissible radiation dose criteria (to facilitate an earlier use of the manpower involved).
4. Areas where the recoverable resources exceed the capability of the survivors to achieve recovery tasks (movement to, rather than from, these areas is indicated).

Management of postattack evacuation, at least initially, is a local civil defense responsibility. Much detailed input information is required before the decision to evacuate can be made. Although it is possible to set up guidelines through preattack planning, only detailed postattack

assessment of local environment can provide a valid decision on evacuation. Evacuations or population redistributions at later times may result from decisions to abandon certain areas and to concentrate recovery efforts in other areas.

Radiological Recovery

Radiological countermeasures are designed to cope with residual radiation from fallout as the principal deterrent to uncontrolled exit from shelter. Control or regulation of exposures within a given radiation dose allowance among the surviving population generally will be required to ensure the effective performance of skilled tasks in the early post-attack recovery period. If this regulation is not achieved as part of the civil defense system, tasks associated with some countermeasures system components may be impossible to complete because of overexposure effects on the available labor pool. It is therefore apparent that the unused allowable dose of the population is a resource that must be allocated on the basis of the radiological effectiveness of the overall available countermeasures system; for each person, the allocation must include not only the dose for the immediate postattack operational recovery period, but also the doses received in shelter and in the long term recovery period where contamination control may be the central radiological countermeasure.

Area and Selected Site Decontamination

In many areas having high residual radiation intensities, it may be necessary to leave shelter or to recover vital facilities before the radiation has decayed to a level that might be considered "safe" for uncontrolled operations or work routines. The primary countermeasure for these conditions is area or selected site decontamination. This countermeasure is applicable during postattack operational recovery to shorten in-shelter time (as previously discussed) and to decrease the delay in the reactivation of vital facilities.

The undesirable radioactivity of fallout from a land surface burst is associated with soil particles. Therefore, decontamination consists of the physical removal and disposal of the fallout particles by normal cleaning methods and equipment. In the case of cities, suitable equipment includes street sweepers, street flushers, fire hoses and pumps, motor graders, scrapers, loaders, plows, tillers, shovels, brooms, and wheelbarrows. A limited amount of data on the effectiveness and application effort of several of these methods are available.¹⁷⁻²¹

Each type of site or area can be decontaminated by some method or combination of methods. Fire hosing is suitable for roofs and paved areas; sweeping or flushing is used on paved areas; and scraping or plowing is suitable for unpaved areas. Several studies have been completed on planning and implementing operational details of an integrated system of decontamination methods that may be required for the recovery of urban and rural areas.^{22,23}

The management of postattack decontamination appears to be a local civil defense responsibility. Decisions must be made at the local level to coordinate detailed environmental information and activities with overall recovery plans. Detailed information requirements include availability and location of trained personnel, equipment and water, and the environment of the area to be decontaminated. The current hardware capabilities for decontamination are ahead of the present management and operational capabilities.

Radiological waste disposal is best planned for and coordinated with decontamination operations, of which it is an important part. Preattack selection of disposal sites relative to achieving permanent isolation of the wastes would be desirable to simplify postattack decision-making.

Exposure Control Procedures

On the premise that any radiation dose does some harm, the ideal radiological defense system would be one that provided complete protection from fallout radiation for the entire population. However, this is impossible, and a more practical approach to the dosage control problem is to minimize the dose to the majority of the population by allowing emergency operating and recovery personnel to accept doses from which they can ultimately recover.

Much research²⁴ (and conjecture) has gone into the establishment of 200r ERD as the maximum effective residual dose from which essentially all humans are expected to recover without medical treatment and to perform normal work. The principal concern of postattack management is not with how or why the permissible doses are arrived at, but with the methods by which the dose for each individual can be minimized or kept within the set limit.

The first requirement for dose control is a measuring instrument, such as a pocket dosimeter (or a dose rate meter and a clock). These instruments would be particularly useful for the measurement and control of dose to personnel on special missions in a radiological environment. Since the entire population cannot be completely equipped, instrumentation may have to be restricted to mission personnel and instrumented

individual exposures may have to be applied to all individuals of a group. Large quantities of dose rate meters have been purchased and supplied to shelters.²⁵ Many of these will be uncalibrated or inoperable when needed and cannot be readily used to estimate exposure doses of individuals. At best, uncalibrated meters can detect the presence of radiation and measure the relative intensities from one location to another or from one time to another. Thus dose rate meters cannot readily be used in exposure control procedures, but are suitable for measuring the effectiveness of decontamination and other radiological recovery operations. Calibration equipment is being made available to states by the Federal Government on the condition that states implement a calibration program¹² but the problem of measuring dose in a variable dose rate environment remains.

The second requirement for dose control is a record system, preferably on an individual basis (perhaps like the vaccination records of world travelers). These records would be required for the effective use of countermeasures requiring dose control and could be used to determine the feasibility of any proposed postattack recovery operation relative to unused allowable dose of the individuals or group involved.

All dosage control plans and operations must consider the total exposure dose for each individual to ensure that a given expenditure of unused dose, together with past and anticipated future exposures, will remain within the allowable lifetime exposures (exceptions to this degree of control should be based on an evaluation of all hazards associated with a given situation).

Management of postattack radiation dose control is a local civil defense function. Local management groups should have the preattack capability of planning dose-measuring procedures and establishing record-keeping systems for use in the postattack period (as well as during the shelter period).

Food and Water Contamination Control

The magnitude and the nature of controlling food and water contamination are related to (1) the general level of attack sustained and (2) the postattack standards for maximum internal (absorbed) doses to the surviving population. Realistic internal dose levels may be determined sometime during the early postattack period so they are consistent with the availability of food and water needs of the survivors and their previous exposure doses. Although biological effects from the contamination of food and water are not expected to present more than a secondary health problem, it may be desirable to minimize the intake of radionuclides in the long term period to minimize possible health problems.

The primary early postattack food and water contamination problem is concerned with the intake of soluble I^{131} in water and milk, and the possible consequent damage to the thyroid glands (primarily in children). The problem could arise as a result of drinking water from shallow impoundments or from river-draining watersheds having very high fallout levels.²⁶ Methods for countering this hazard are well known; and in all known cases, the hazard from internal doses is very small compared with that from external doses.

Contamination of surviving processed packaged foods is unlikely if the container is intact and if reasonable care is exercised in removing the contents for preparation. Long term food contamination problems are concerned with elimination of long-lived radionuclides, such as Sr^{90} and Cs^{137} , from the human food chain. This secondary health problem could be part of the overall agricultural management, which would include the monitoring of foodstuffs produced in certain regions that received high levels of fallout and allocating food distribution for current needs. For example, if the food production exceeded the demands, the more highly contaminated foods could be fed to animals or be discarded. Also, once excess production was assured, the more highly contaminated land could be left fallow.

The USDA and DHEW are best qualified to carry out preattack planning and preparation of food and water contamination control countermeasures. Local civil defense organizations could assist in applying the postattack assessment techniques.

Medical Recovery

Medical recovery, like nearly all types of postattack recovery, depends on the adequacy of preattack planning and preparation to support postattack activities. Medical doctors will be in seriously short supply to cope with postattack casualties where the patient-to-doctor ratio may be as high as 1,700 in some areas.²⁷ The pool of medical skills may be augmented by dentists, veterinarians, registered nurses, pharmacists, and others with knowledge and skill in medicine gained from preattack experience and training.

Medical Supplies (Stockpile)

The medical supply industry is one of the most vulnerable of industries if major cities are attacked. The production of a number of very critical drugs could be practically nonexistent following attacks on

cities.⁴ These drugs include those for the treatment of attack casualties and those for the treatment of chronic diseases. The medical supply industry may be incapable of meeting the demands placed on it for many months after attack. A shortage of drugs could produce a small increase in deaths among attack casualties and a more serious increase in the death of survivors requiring drugs for chronic disease. A well-planned medical supply stockpile is essential if other surviving medical facilities are to be used to their fullest potential.

The development of a medical supply stockpile should be managed by the Office of Civil Defense in coordination with DHEW since it is a very expensive, special purpose program that must be parallel to other civil defense efforts. The stockpile size and dispersal should at least be consistent with the capabilities of surviving physicians--the probable limiting factor in postattack medical care.²⁷ Austere inventories of pharmaceuticals that should be stockpiled for emergency hospitals have been prepared.²⁸

Postattack management of the stockpile should be divided among several levels of the civil defense organization. During the first 30 days after attack, the local civil defense organization could assure prompt allocation to meet current requirements. Management at later times should be at higher levels that have a suitable inventory control system for determining national resource requirements; organizationally, the management of this system should be the responsibility of a DHEW agency.

Medical Treatment

A large number of blast fatalities could be averted if prompt, thorough medical treatment could be provided for the injured. Unfortunately, if cities are attacked with megaton-yield weapons, relatively few of those who might be saved could receive treatment because of basic limitations (fallout, debris) on movement needed to unite patients and physicians.

A triage operated by the most experienced physicians, and the use of emergency facilities and auxiliary and paramedical personnel could extend medical treatment to a much larger group.²⁹ Several auxiliary groups³⁰⁻³³ are capable of augmenting the inadequate supply of physicians available to give postattack medical treatment. An extensive first aid³⁴ and self-help³⁵ program should be useful in the first few postattack days when many injured people will not be able to get skilled medical attention.

Management of medical treatment during the early postattack period, consists currently⁵ of local public health departments and Office of

Civil Defense organizations directly supporting the requirements of surviving physicians. Many postattack activities of physicians will be guided by current plans developed by county medical societies (and developed nationally by various groups within the American Medical Association). However, local civil defense organizations may be required to regulate the activities of medical personnel to the extent that facilities for continuing medical treatment will be available.

After the first week or two, when most emergency treatment of the direct effects is no longer required, the medical treatment problem will be corrective procedures for casualties having incomplete emergency treatment, minimal support treatment of fallout casualties, normal health care, and preventive medicine. During this period, the management of medical treatment should pass to public health agencies at all levels.

Housing, Health, and Welfare

A major problem that could occur in targeted urban areas is that of a large fraction of the surviving population who may not have housing after leaving shelter. If good fallout shelters are provided, about one-third of the national survivors may be homeless. In some damaged cities, the ratio of dwellings to survivors has been estimated to be less than one-fifth of the preattack ratio of dwellings to residents.⁴ This loss of homes (including clothing and other subsistence items) will result in a severe welfare problem in most damaged communities. However, if good fallout shelter is not available and the cities are not attacked, there may be an excess of postattack housing due to fallout fatalities. The initial postattack problem is first to locate available spaces that are near water, food, and other necessities, and then effect the required relocation of survivors. Special lodging must be arranged to meet the needs of the aged, infirm, and very young.

The primary countermeasure in the initial recovery period is to move survivors out of damaged areas to lodging in undamaged or lightly damaged areas. Although some lodging is available in hotels and motels most lodging will be found in private dwellings in peripheral areas around targeted cities. The more fortunate survivors may have to share their homes and clothing with those less fortunate for some time in the post-attack period. No detailed studies have been made on how these operations might be carried out within the scope of a large scale nuclear war.

During the survival period, emergency housing and utilities would be developed in damaged areas. Many months might be required to meet local

survival requirements, even on a very austere basis. Part of the problem could be solved by migration to undamaged areas. In some cases where the damage encompasses the whole urban area, it may have to be abandoned for an extended period after an attack.

Although major problems could occur in the movement of people (particularly through debris) to undamaged areas, the problems could be solved. Probably the worst problems could exist in California where 76 percent of the people live in a few large vulnerable metropolitan areas, and the remainder live in many small widely scattered communities. Although some survivors would move several hundred miles, most could find adequate lodging (two people per room in private dwellings) within 100 miles of home.⁴

The movement of survivors from damaged to undamaged areas has not been studied sufficiently to outline the requirements for carrying out the countermeasure. Clearly, a command control and communication system must be available to direct the flow of refugees to adequate housing. Where local moves are required, most able-bodied people can move on foot; but for longer distances, as in California, transportation is required. Debris problems have not been studied to ascertain the requirements for debris clearance to facilitate population movement.

The information required to solve the postattack housing, health, and welfare problems includes knowledge of the location and status of refugees, the location of usable lodging, and the nature of the environment between the locations. Communications are required, not only to gather the necessary information, but also to disseminate movement instructions to the survivors. A major command and control system is required to coordinate the effort of housing people and carrying out the associated welfare tasks.

Housing, health, and welfare problems will be urgent ones in the postattack world and must be resolved by the local civil defense emergency organization. Guidelines for conducting these operations are being developed by the DHEW. The responsibility for resolving financial problems associated with the development of postattack housing and utilities falls within the Housing and Home Finance Agency.⁵

Sanitation

Damage to local water and sewage systems, could result in disruption of the normal sanitation systems. Areas receiving high levels of fallout may also suffer sanitation system disruptions from personnel casualties or denial of access in a radiological environment.

In general, sewage systems will be operational in areas where the water system is operational, although the treatment plant may not be operating. The loss of treatment plants should not be a hazard over a short period, as the plant can be bypassed. The loss of lift pumps may result in stoppage and overflow of sewage, but need not be a serious problem over a short period if a sump can be arranged.

Alternate means of supplying minimal requirements of water are by truck, firehose, or surface laid irrigation pipe. In most areas, latrines can be dug and refuse can be buried. In some cases, however, it may be necessary to evacuate heavily built-up areas in which water and sewage systems cannot be recovered.

The resolution of the sanitation problem would require decisions on which countermeasures to use. Detailed knowledge of the local situation,³⁶ particularly the locations of knowledgeable persons and maps and diagrams of the preattack system, would be needed for assessment of damage. The repair of surviving facilities would require skilled manpower and supplies. Communication systems will be required to gather data on the situation, direct repair activities, and disseminate the necessary countermeasures information to the survivors.

Since the primary sanitation problems would occur during the post-attack recovery period in cities suffering from blast effects, the problem must be solved through the joint efforts of local civil defense, utilities, public health organizations, and refuse collection agencies.

Disease and Pest Control

In the wake of a nuclear attack, a substantial increase in communicable disease can be expected. The incidence of upper respiratory infections, and possibly of enteric diseases (unless acceptable sanitation facilities are available), would be wide spread among people crowded into public shelters for several weeks. People subjected to significant but sublethal doses of radiation will probably have an increased susceptibility to disease. Refugees crowded into reception centers and doubled up in undamaged homes will have increased exposure rates to disease. People living in damaged or makeshift dwellings or in buildings without heating systems, will suffer from increased exposure to the elements. The breakdown of sanitation systems, delayed burial of the dead, and damaged structures would lead to an increase in the insect and rodent population. Shortages of chlorine and other treatment chemicals may decrease effectiveness of water purification even in undamaged areas. Jerry-rigged food processing plants may result in reduced sanitation standards. The

effect of these factors, singly or in combination, on the health of the survivors or on their capabilities to perform postattack recovery tasks, is not well known. Some studies of these problems have been made.³⁶⁻³⁸

The primary countermeasure to these effects is a substantially increased public health program directed toward each problem. The specific countermeasures include restoration or improvisation of utilities, evacuation of people from untenable dwellings, welfare programs to provide clothing and bedding, burial of dead, and use of pesticides (probably requiring preattack stockpiling and increased efforts in normal public health measures). Preattack and postattack immunization (probably requiring stockpiling) against selected diseases could substantially reduce the problem if enough people could be immunized.

There will be little choice but to follow most of these countermeasures. Although an increase in the incidence of communicable disease is inevitable in the postattack environment, a concerted public health education and immunization program could help avert epidemics that might jeopardize the postattack recovery program. To carry out a program of this magnitude would require trained manpower, stocks of pesticides and vaccines, and spare parts and equipment for the restoration of utilities. A general immunization program would probably involve such an expensive stockpiling program that a cost-effectiveness analysis would be required to determine its utility.

Local civil defense, welfare organizations, and the utilities will be major participants in the control of disease through the survival and early recovery periods.⁵ The major problems would occur in damaged areas, but problems will also exist in areas of heavy fallout, as well as areas with a high concentration of relocated survivors.

Disposal of the Dead

Dead bodies provide a disease focus for insect and rodent vectors, as well as psychological and esthetic problems in the postattack environment. From the public health standpoint, it is desirable (but probably not critical) to dispose of the bodies that are in or near inhabited areas at an early postattack date.

Clearly, normal mortuary procedures will not suffice in cities suffering from blast damage; mass burial will be required. Little immediate effort could be expended on identification where the casualty ratio was high. An army "dogtag" system might assist in identification.

Burial will require considerable manpower for a short period during the initial recovery period. This manpower may be difficult to recruit without martial law. Heavy equipment will be necessary to dig mass graves. Face masks, boots, and protective clothing were found useful at Hamburg,³⁹ and may be useful for other applications after a nuclear attack.

The only management problems that arise in connection with burial would be selection of the cemetery site and recruitment of men and equipment. Burial is probably not sufficiently urgent to incur any significant fallout hazards. Management of registration and disposal of the dead after a nuclear attack is currently a responsibility of DHEW.⁵

Ecological Recovery

Restoration of the balance to natural life cycle systems is a gradual and long term adjustment that is beyond the scope of immediate postattack survival and recovery.⁴ However, consumption of the preattack resource stockpiles (e.g., food supplies) should be coordinated with the listed countermeasures for ecological recovery (Table 1) to replenish the stockpiles.

Economic Recovery

The postattack period must be used to establish a sound basis for the recovery of an austere version of the preattack economy. This will require judicious allocation of human and material resources under some system of control and incentive compensation. Government information and planning capabilities can be used to establish the goals and to suggest the means of accomplishment. Government confiscation of industry should not be necessary (and probably would not be possible if the government is carrying out effective social recovery countermeasures), if incentive compensation for normal corporate survival and goodwill are provided.

Debris Clearance

Debris will certainly impede many postattack recovery operations in blast and fire areas. Clearance of debris will be essential to the success of many recovery operations ranging from early rescue, evacuation, or supply missions to the later salvaging and reconstruction of industrial sites.

Unfortunately, the studies of debris production and clearance have been primarily concerned with heavily built-up areas subjected to high

overpressures. Postattack areas of primary interest may be the fringe areas, subjected to lower overpressures, where significant numbers of people and resources might survive. In these important fringe areas, debris clearance will be concerned with fallen trees and utility poles, which can be cleared with light road maintenance equipment. In most cases, the first debris clearance operations would involve the establishment of access routes (clearing, but not moving the debris more than necessary).

The clearance of debris in inland waterways is particularly important. Debris from a few bridges, dams, or canal locks (which may be very difficult to clear) could tie up a great deal of shipping on inland waterways. The techniques for clearing the debris from these heavy structures in a short time is not well established, and the alternative countermeasure of bypassing blocked areas would not usually be feasible.

Debris clearance will generally require very substantial amounts of manpower and heavy equipment. The large effort involved will require careful planning in radiological environments for proper dose controls. Beyond the immediate emergency application in support of other postattack countermeasures, debris clearance on an extensive scale will have to await decay of radioactivity or will have to be done only in areas free of fallout.

Management of debris clearance operations should be the responsibility of local civil defense units who coordinate municipal and private capabilities for debris removal. After the establishment of access, a second stage of debris clearance operations should involve the clearance of the debris around recoverable vital facilities. More extensive debris clearance operations may be undertaken after survival has been assured and permanent recovery of an area is indicated.

Damage Repair and Salvage of Equipment

Massive nuclear attack may leave extensive damaged but repairable areas on the periphery of target areas. Materials, equipment, and manpower for repair work will be more limited and the demand greater than under normal conditions. The magnitude of the postattack damage repair problems may well make it the major activity after emergence from shelter; it will utilize the full capacity of the construction industry plus all assignable sectors of the labor force.

Early postattack protection of equipment to prevent its further deterioration could reduce both the time and effort required to restore

industrial production. Planning and providing suitable materials (canvas or plastic cover and preservatives that can be painted or sprayed) must be done in the preattack period. Relatively inexpensive precautionary measures of this type could ensure the continuing usefulness of vital equipment when its repair or replacement could be delayed.

Because of the potentially heavy demands of postattack damage repair on surviving human and material resources, effective management of resource allocation would be very important with respect to the achievement of required recovery tasks. Requirements for national recovery must be quickly assessed and detailed recovery scheduling delegated to state and local agencies. At the local level, the general requirements for repair will be building materials (particularly glass or suitable substitute) and manpower. Under current policy and guidance,⁵ the repair of recoverable industrial facilities is the responsibility of the owners. Further analyses of the problem are needed to verify whether this policy is consistent with achieving, most effectively, the recovery of the needed damaged industrial resources.

Stockpiling Raw Materials, Tools, and Finished Products

Although the continuous maintenance of large preattack inventories of finished products could be hopelessly expensive, certain items for use in the immediate postattack period should be stockpiled. Beyond these immediately useful items, stockpiling should concentrate on the assurance of production capability and essential supporting raw materials. Since many industries need products from other industries, the resulting production chain requires maintaining stockpiles for all production capabilities of the chain.

Achieving desired stockpiles in industry may require federal subsidies as incentives; the cost of producing and maintaining a not-for-sale inventory and the cost of local inventory property taxes may require compensation.

A desired balance among stockpiles of raw materials, tools, and finished products should be established by preattack planning. Present preattack management of stockpiles rests with the Office of Emergency Planning.⁵ However, Office of Civil Defense and BDSA should take an active part in preattack policy determination and in the postattack dispersal of surviving stockpiles. Technical analyses on a continuing basis would be required to provide guidance on the kind and quantity of these stockpiles.

Resource Allocation

The survival of the economy after a massive attack would be highly dependent on efficient use of every available resource. This requires careful allocation of all scarce resources and highly skilled manpower, equipment, and facilities among alternative production activities, geographical areas, and time schedules. Detailed planning and management efforts generally would be required to bring resources together in appropriate combinations so as to avoid bottlenecks, delays, or other instances of faulty timing; and to avoid the use of resources on unessential production or on other activities that may degrade the chances of economic survival. Careful, smooth, and efficient resource allocation is vital to the conduct of recovery operations at the local levels.

Management of resource allocation requires coordination among many federal agencies, each responsible for some segment of the total resources. Some agencies having emergency planning roles are: Departments of Commerce, Defense, Interior, and Labor; DHEW and USDA; and NASA.⁵ Preattack coordination should probably be by the Office of Emergency Planning. Postattack coordination at federal, state, and local levels will be required over an extended period to guide the overall recovery of the national entity in the postwar world.

Restoration of Corporate Management

As mentioned previously under Dispersal and Recovery of Capital Resources, some steps have been taken to plan for the survival and continuity of corporate management for a few industries.¹⁴⁻¹⁶ These plans generally provide for succession of company officers, as well as a communication system for postattack instruction and the guidance of surviving employees. The tacit assumptions in most plans are that corporate records will be preserved and that a sufficient number of key personnel (officers, directors, and others) will survive to meet the legal management quorum requirements of their incorporation charter.¹⁵

Current responsibility for the restoration of corporate management rests with the corporation, acting within the restraints of its bylaws. A desirable postattack expedient would be uniform state laws similar to the present New York State Emergency Defense Act, which permits the adoption of emergency bylaws to supersede normal bylaws during periods of emergency.

Economic Control Techniques, Compensation for Loss, and Reorganization of Commercial Capabilities

These countermeasures may not be widely applicable during the post-attack survival and early recovery period. However, if techniques are available, some basic preparation for the later use of countermeasures can be made. The assessment of surviving population and resources for input for more effective application of these countermeasures would be particularly useful.

Social Recovery

Abnormal behavior of distraught survivors in times of disaster makes knowledge of social recovery countermeasure effectiveness the most uncertain of all the countermeasures listed in Table 1. However, through the study of human behavior during periods of extreme stress at individual, group, and organizational levels, much knowledge can be obtained that is applicable to individual and social aspects of disaster behavior. Although present behavioral research may not provide solutions to the total post-attack social behavior problems, it has reached the point where "selective management (of research) by mature and perceptive scholars is essential if we are to proceed beyond the 'interesting hypothesis' stage."⁴⁰

Each of the social recovery countermeasures is based on continuation and reestablishment of the preattack status. The expected magnitude of all postattack social recovery tasks is so large that welfare and political agencies will, at best, provide administrative guidance only for self-help implementation of the countermeasures. Some estimates of these problems and techniques for their management are suggested below.

Individual Rehabilitation

Each survivor in the postattack period may have a need for rehabilitation with respect to medical care and occupational training. Large numbers of sick or injured survivors may suffer from specific physical handicaps or from mental and psychological disturbances of preattack or transattack origin. Occupational training may be required because of destruction of the normal work place or emphasis on new work demands generated by the postattack environment. Housing may be needed for short term survival, support of postattack countermeasures, and new occupational requirements.

Preattack study of these rehabilitation requirements is difficult but very desirable. All alternative countermeasures should be considered so as

to cope with the potential postattack constraints of shortage of trained personnel and facilities and the generally poor or degraded living conditions that may prevail. A general policy should be to make everyone as useful and self-supporting as possible, within the limits of postattack rehabilitation and organization.

Management of individual rehabilitation should be in the hands of state and local welfare agencies, with assistance and guidance from federal agencies such as DHEW and the Department of Labor.⁵ Centralized facilities would be desirable for specialized medical and psychiatric care to ensure the best use of surviving skills. Similarly, central facilities should be used for unusual types of occupational training of national importance. Vocational training programs are discussed in a later section.

Adaptive Community Organization

The postattack community environment would show general deterioration in the standard of living. An additional complication would occur in solving problems of local government. There would be a disruption of normal mass transportation and movement of private autos and delivery vehicles. Further complications could include an immediate shortage of consumer goods, community and commercial service personnel; housing, schools, and recreational and other facilities.

Adaptive community organization may be carried out by the widespread organization of volunteer groups to cope with specific local needs. Improvisation using locally available resources and local training, experience, and ingenuity should help to improve general morale of the survivors by encouraging broad participation in vital community activities.

Management of all such community affairs should be under the control of local governments, with advice and support from higher authority. The self-help at the community level aspect of this countermeasure indicates that preattack plans should be made to meet a major part of the physical postattack requirements. Aid from state and federal government or from neighboring communities will be uncertain, particularly at early times after attack.

Reconstruction of Family Units

Since the family is the basic unit of our society, its preservation or reconstruction in the postattack period is vital to restoration of

maximum individual performance and a societal structure. Depending on time of attack, warning, evacuation, and other such factors, there could be many broken families. The invasion of privacy from sharing housing and the weakening of social restraints from general deterioration of the social structure could cause further strains on family integrity.

No good substitute exists for the family unit. Its physical reconstitution must be aided and supplemented by restoration of normal political and social forces. The basis for family structure in religious and legal sanction and in social, educational and psychological pressure must be maintained.

Management of family unit reconstruction should start with the identification and location of the broken family. This would involve the operation of central locator registers, first at local levels and proceeding to state and national levels as required. A system must be set up to register all survivors, possibly as a broadened function of the Social Security system or Post Office Department. Central registers could also be made to serve many postattack countermeasures that involve manpower in planning and implementation.

Provisions for Orphans and Broken Families

After a nuclear attack, there will be large numbers of orphans, aged dependents, or family members detached from family units. Some will be temporarily detached until they can be reunited through a locator register system, while others, due to casualties, may be detached permanently. Many surviving fragments of broken families will require institutional care pending adulthood or restoration to a family unit. Assistance will also be needed in finding employment, day care for children of employable parents, living quarters, counseling from social workers, or other aid.

Management of this countermeasure must be at the local level, with assistance from staffs of state and federal agencies for counseling and guidance or for maintenance of specialized and centralized institutions. Preattack preparation will be especially important for efficient and prompt handling of the flood of temporary cases in the early postattack period.

Continued Education of the Young

Although the primary importance of all forms of education is of long term significance, there will be some early postattack benefits derived

from continued education of the young. These relate mostly to keeping the young usefully employed to counteract potential juvenile delinquency and antisocial behavior. An imbalance of facilities and students may exist if the normal concentration of school buildings in cities is destroyed while the school age population is saved by shelter or evacuation. The judicious use of surviving educational materials and improvisation may help meet the needs. The use of marginally trained teachers, or even older students, may alleviate the teacher shortage.

Curricula should be analyzed with respect to postattack requirements. Perhaps the physical rebuilding of the postattack world will require emphasis on trade skills rather than on normal academic curricula.

Management of education should be a continuation of preattack administration by local school systems, assisted by the usual school boards, PTA, and civic groups. State and federal guidance should be provided as needed.

Skill Retraining for Segments of the Labor Force

As previously mentioned, large segments of the labor force may be unemployable because of shifts in demand that have deemphasized their industry, locality, and skill, or because of changes in technology or practice. To reemploy these groups, a major training program will be necessary. Rather than allow unemployable skilled labor groups to drop into the pool of unskilled labor or remain unemployed, steps should be taken to adapt their potential skills for current use.

Management of this training program involves many different elements at several levels of government organization. A few of the training techniques are on-the-job training by private enterprise, specialized training in public school systems, and federally supported and managed specialized training. Overall labor requirements essential for reestablishment of the national economy should be determined, but individual choice in relation to need and potential should be considered.

Reconstruction of Government and Democratic Political Processes

The functioning of postattack governments and political processes will be hampered by many factors: physical, economic, legal, political, and sociological. Physical disruption from casualties and general uncertainty of the government's capability to cope with the postattack environment could undermine confidence in and respect for government activities.

The appropriate agent for reconstructing federal, state, or local government is the surviving part of that government itself. External help, below the federal level, would be required only in the event of complete breakdown of succession. In these cases a government would take over or seek to reestablish inoperative units at the next lower level of organization. Preattack planning and training in postattack operational procedures are vital if all levels of government are to survive a nuclear war.

A democratic government, relying on free elections and due process of law for its existence, must promptly reestablish itself. A government "of the people" requires that its constituents be properly identified, located, and advised so they could participate in democratic political processes. The use of a survivor locator register would be essential to the effective operation of the postattack government.

Maintenance of Valued Social Institutions

In periods of crisis, there is a tendency to be impatient with institutions and safeguards of intangible significance that appear to stand in the way of quick solutions to pressing and immediate threats to survival. These institutions include all individual rights, guarantees, and liberties, as well as legal and social pressures opposing or penalizing unfair, selfish, or dangerous activity contrary to the welfare of the community. The preservation of traditional principles of liberty; equality under the law; equal opportunities to earn a living, to marry, to worship and to gain an education with individual capabilities are essential for maintaining the sound basis of our system. Crises can produce many pressures and subtle changes likely to undermine these principles and the institutions that support them.

Maintenance of valued social institutions must be managed by local, state, and federal governments. The judiciary has first responsibility, but other branches have an equal responsibility to support the courts by avoiding the abuse of emergency powers that undermine the valued institutions. An alert public and informed electorate, whose judgments are based on a wide dissemination of facts, can contribute to the survival of our way of life.

CONCEPTS OF AND APPROACH TO POSTATTACK RECOVERY MANAGEMENT

Concepts

In general, effective management practices and organization should be derived from analysis of the activities that are to be managed. In the case of postattack survival and recovery countermeasures, management must be able to: (1) Assess the situation and define the problems to be solved, (2) select countermeasures that are appropriate to the postattack situation, (3) evaluate the potential success of these countermeasures within the limits imposed by the available surviving human and material resources and the survival requirements, and (4) implement a formulated recovery plan. An intermediate internal management function includes decision-making with respect to selection of the alternative possible actions and the available means to gather, process, and disseminate information.

In the early postattack period when establishing the basis for continued survival is of immediate concern, minimal measures would include avoiding further fatalities and alleviating basic environmental hardships. When these measures are accomplished, other measures for the recovery of economic potential and social functions may be initiated. In all cases, the potential capabilities to perform all the recovery operations must be greater than survival needs; if they are not greater, secondary fatalities will occur and the base for continued existence will be further degraded.

Basically, the questions that a postattack management system must answer are:

- What to do?
- When to do it?
- How to do it?
- Who will do it?

"What to do" is established by the available resources, the needs and desires of the survivors, and restoration requirements of systems essential to survival and recovery. At early postattack times, individual biological needs of water, food, health and sanitation, and housing must be provided. Socio-economic system recovery must be implemented to the extent that long term recovery goals will be achieved. Management functions include the determination of what these needs are and what must and what can be done to fulfill these needs. The postattack situation and recovery goals are major factors that will determine what should be done in a given area.

"When to do it" is also established on the basis of survivor needs and situation conditions; part of management function includes the determination of when a survival requirement must be met and, from this, the development of plans for the scheduling of countermeasure options. Early postattack scheduling is critical and must be geared to survival and recovery requirements; after survival is assured, the selection of the economic and social functions to be recovered may be less critical. Scheduling decisions at any time may include consideration of the ultimate system effectiveness; to avoid wasted effort or resources, temporary measures should be considered for long term usefulness.

"How to do it" is established by the nature of the recovery task and the procedural details of the countermeasures. The role of management is to make decisions for the implementation of the scheduled countermeasures (including detailed coordination of surviving skills and materials with supporting activities such as communication, transportation, and equipment). In addition, management functions include the evaluation of operational results for further planning as the operations are carried out. Behavioral factors generally would be included under this item.

"Who will do it" is established by both the postattack activity required and the survivors available to carry it out. Ideally, work skills should be matched with recovery tasks, but this may be difficult to do, particularly in the early survival period when self-help with autonomous local management may be the only effective method of countermeasure implementation. During the later recovery period, interchangeability of skills will be less important because of the decreased urgency to get the job done.

About six general levels of management authority may be identified from the various levels of responsibilities of government agencies and other organizations as described in the National Plan.⁵ These are: (1) single shelters, (2) shelter groups, (3) cities or parts of cities and counties, (4) states, (5) regions, and (6) national. None of these levels appears to be generally suitable for the planning, organization, and management of postattack countermeasures. However, most of these levels of responsibility coincide with existing levels of governmental authority and control that must be incorporated some way into any proposed postattack recovery management system. And since existing levels of government are always associated with defined land areas, one aspect in any consideration of the organizational system must be land area with specified boundaries that correspond to some degree with existing jurisdictional authority.

With respect to the preattack planning of postattack countermeasures, a maximum area would likely exist for which a cadre staff could make detailed and accurate plans. However, the area size could vary depending on the type of countermeasure and the characteristics of the area. With respect to the conduct of postattack recovery operations, a suitable area for management would be an area over which a single set of postattack recovery options would be applicable. Generally, this area would be larger than the area around a single shelter because the manpower and other resources would not be sufficient to make a meaningful separate contribution to the recovery of a larger region and, in addition, most vital supplies and facilities would not be co-located with single shelters (at least not in the current shelter program). A maximum operational area would also exist within the concept of restricting the area size on the basis of minimizing the number of recovery countermeasures that apply to a given postattack situation. Under this concept, the selection of the "what to do" alternatives would be simplified and the management of the recovery operations would be easier than it would for an area in which all post-attack countermeasures would have to be employed simultaneously (or in an ordered sequence). In general, the area sizes where application of this concept is possible would be less than the area covered by most large cities and would probably be larger than areas covered by shelter groups.

Some indication of suitable planning operational area sizes may be derived from data for a 5-MT land-surface detonation given in Reference 2. In that report, the various affected areas where postattack operations are feasible are given as follows:

1. Radep Area (fallout only)
2. Damaged Area (blast and thermal or fire, no fallout)
3. Radep and Damaged Areas (all effects)*
4. Free Areas

The smallest affected areas with a given postattack situation category are the damaged areas and the damaged areas that also receive fallout. The estimate of the width, or depth, of the circular damage area is 3 miles in the crosswind direction and almost 5 miles in the upwind direction. The outer boundary of this region would generally be determined by the fire perimeter and the inner boundary by the deposition of fallout. The width of the circular band where the blast damage would be very severe

* This category is not given separately in the referenced report.

and where the fallout levels would be very high is estimated to be between 2 and 4 miles. The outer perimeter of this area coincides with the inner boundary of the damaged area and the inner boundary is where complete destruction of all above-ground structures would occur.

To minimize operational control difficulties, the operating areas should be more in the shape of squares than in the shape of long thin rectangles. If in the general shape of squares, the above estimates indicate that suitable area sizes would be between 4 and 25 square miles. Perhaps reasonable average sizes for the operational areas would be between 10 and 20 square miles for urban areas; and, in rural areas, the township jurisdictional area might be assumed for the operating area (communications and operations over a whole county in the Radep situation would probably not be easily accomplished in the first few weeks to a month after an attack). To accommodate the stated policy by which industrial and military organizations are to provide their own individual plans and preparations, the larger industries and military installations could be designated as separate operating areas. For some of these, the operating area could be less than one square mile.

Once established, the operating area cadre staff, as part of the planning organization, could serve as the focal point at which detailed preattack planning for the postattack recovery of the resources of the area would occur, receiving guidance from city (and county) levels of supervision. The operating area organization would, in turn, coordinate plans and provide guidance to shelter groups and individual shelter commanders.

As part of the operating organization (during and after attack) the operating area staff would be the lowest organizational level at which damage assessment data would be accumulated and processed. It would be responsible for identifying the damage category of the area and for selecting the recovery countermeasures applicable to the area, depending on the available resources in the area. Operations within the area would be under the control of the operating area commander and the commander would be the point of communication with adjacent areas and with higher (city or county) echelons of the organization for cooperative and larger-scale recovery operations.

The ideal evolution of the operating organization and its operations would be for the operating areas to be capable of independent action where actions are feasible at early times after attack (and of receiving or giving assistance to adjacent areas) and at later times, where the city or county organization has the capability for directing larger scale operations, to be assimilated within the scope of these longer term recovery efforts. Further evaluation of postattack operations is needed

to establish the stage of organization development that should be in effect when postattack recovery operations are to be initiated in a given situation. Other factors that require consideration in the definition of the operating areas include population density, land use characteristics, and general effectiveness of the available shelter system.

Early postattack survival measures at the local operating level are applicable to all levels of authority for physical survival of the system (i.e., at least in areas where recovery potential existed). Beyond ensuring their own survival, upper levels of management would be integrated into their local shelter group to provide the management functions for recovery operations.

After an operating postattack management system has been established, staff functions at all management levels should be pursued, within the scope and detail of required responsibility, as follows:

1. Collect data for assessment of the situation
2. Process data, assess situation, transmit assessment data
3. Develop survival and recovery criteria for the assessment
4. Derive plans for recovery operations, and options thereof, for decision-making
5. Communicate decisions to operational groups (and to other levels of organization)
6. Collect data on operations, (i.e., repeat from item 1 as necessary).

Detailed data on the physical situation may be obtained from single shelters or special reconnaissance missions. The initial data probably should be summarized and evaluated at the group shelter level. Upper management level functions would consist primarily of coordination effort to effectively plan countermeasures for recovering activities of larger scope (communication, transportation, utilities). Detailed implementation of these planned countermeasures, however, might be under control of the group shelter management.

Two types of personnel would operate at each management level. Functional staff groups would perform the six major staff functions given above. Top management functions would be concerned with the decision-making and plan selection, and with changes thereto, from evaluation of data on the operations for future recovery actions. Decision-making capability could be improved through exchange of information among various areas of the country.

Approach

An approach to the development of concepts for the management of postattack countermeasures and the associated organizational characteristics is to consider, in some detail, the system of operations to be performed.

In any area or region, the system of operations would consist of one or more of the countermeasures listed in Table 1. Generally, some options in the selection of the countermeasures would be available, depending on the particular situation existing at the beginning of the postattack period. For those countermeasures whose techniques and performance are understood to the degree that derivable relationships between effort and effectiveness exist, standardized postattack recovery routines can be developed. Where this is the case, it should be possible to determine the potential feasibility* of a given countermeasure application (as well as that of a system of countermeasures) for a given postattack situation.

Specification of the technical and operational parameters and the relationships between these parameters and situation parameters, performance rates, and survival requirements are required to develop a description of a standard postattack recovery routine (or scenario) for each countermeasure of Table 1. (Although the basic data on the various countermeasures will be summarized and used as part of this work, it is generally assumed that the data will be available as the result of related efforts.) The descriptive data on the postattack recovery routines, within the scope of the continuing study, will become part of the input data and assessment methodology of the management staff.

When consideration is given to the recovery of specific systems, the performance parameters of a given type of countermeasure can be expected to be highly system dependent; this is illustrated by the listing in Table 2, where some of the systems essential to continued survival are given. While the listing of systems is in order of importance for survival and recovery, the true order or priority is situation dependent; the procedural details of damage repair for a water system are generally different than those for a food processing plant.

The focal point in developing management concepts is the staff functions and the assessment methodology in which (1) situation data are gathered (as inputs) and assessed and (2) recovery plans (optional) are

* Potential feasibility refers to the physical possibility of application within the constraints imposed by manpower, time, equipment, supplies and other similar factors, excepting behavioral factors.

formulated or finalized for a decision to implement (as outputs), in the manner described in the previous section. The major emphasis in this approach is to summarize and organize available assessment methodology and to develop new methods, where necessary, for describing the staff functions of management at various organizational levels.

While the staff of an operating postattack organization would obtain situation data on the number of survivors, amount of resources of various kinds, operability of facilities, fallout levels, and other inputs (as determined from the inputs required by the assessment methodology), similar inputs as part of the study program would be generated by suitable damage assessment procedures. Data on systems descriptions and on the countermeasure parameters would be incorporated preattack into the assessment methodology.

Table 2

POSTATTACK SYSTEM RECOVERY LIST

Systems for Individual Survival

- Water
- Food
- Housing
- Sanitation and health
- Communications
- Utilities (electricity, fuel)
- Clothing

Economic Systems

- Utilities (electricity, fuel)
- Economic controls
- Reestablishment of commercial capabilities, damage repair
- Compensation for loss

Social Systems

- Government process continuity
- Reconstruction of family units
- Adaptive community organization
- Law and order
- Individual rehabilitation

The initial step in the assessment methodology would be to select the countermeasure options that are applicable to the postattack situation

for a given area. (In the damage assessment study case, the smallest area might be a single census tract.) The next step would be to develop system recovery requirements on the basis of (1) the number of survivors in the area, (2) the amount of recoverable resources available for consumption by the survivors (on a minimum survival level), and (3) the amount of one resource consumed on the recovery of the other resources. Then, from consumption rate data and countermeasure parameter information, minimum required and minimum feasible recovery times could be estimated and compared. If no favorable matching of times results for a set of countermeasure options, continued survival in the area without outside assistance would not be possible.

If the minimum feasible time is less than the required time, the next step would be to develop the options and schedules on the basis of need; the priority would follow according to the order of the minimum required recovery times.

To develop organizational concepts and decision-guidance information, the study format is to be further developed to investigate the consequences, for the potential recovery of various systems, of decisions on the selection of differential optional postattack recovery routines. This will require the development of additional computational procedures for providing feedback information on the recovery operations.

A preliminary outline of the factors that would be considered in the recovery of a water system is given in Table 3. Water consumption rates are indicated and other parameters of interest are listed. Quantitative information for the production, recovery, and consumption rate factors may be derived from past, present or future research.⁴¹

The information derivable from the described approach includes:

1. Description of staff functions (and assessment methodology) at different organizational levels.
2. Composition and size of staff required to utilize the assessment methodology, make decisions, and communicate.
3. Type of input data required for assessment and the development of operational recovery plans.
4. Decision-guidance criteria.
5. Size and composition of the recovery effort as a function of postattack situations.

WATER SYSTEM RECOVERY REQUIREMENTS

Surviving Component	Solution to Shortage	Operations to Support Solution	Basic Resource Requirements
Consumption			
Survivors (gal/day times number persons)	Rationing	Rationing controls and techniques	Personnel, metering devices
Industry (Σ gal/day facility)	Rationing or use scheduling		
Countermeasure (Σ gal/day per operation)			
Fire fighting			
Decontamination			
Distribution system			
Surviving system (gal/day)	Repair/replace	Debris clearance	Men equipment materials, power
Bottled or tank truck (gal/day)	Temporary mobile distribution	Radiological control Construction Bottling plant Transport system	Trucks fuel
Quality			
Potable (gal/day)	Purify nonpotable	Debris clearance	Men, equipment, materials
Nonpotable (gal/day)	Reuse	Radiological control Construction	materials
Source			
Surviving storage (gal)	Repair facility	Debris clearance	Men, equipment, materials
Wells, rivers (gal/day)	New sources	Radiological control Construction Aqueducts Well drilling	materials

6. Recovery management preparation and training activities that can be done preattack and during shelter occupancy.
7. Requirements of preattack preparations for postattack countermeasures.
8. Data applicable to the derivation of the cost estimates for postattack countermeasures as part of the overall civil defense system.
9. Gaps in current guidance and in the available data on postattack countermeasures.

The approach described above, and the detailed results to derived from it, requires equally detailed input data. The detailed data on many individual countermeasure capabilities and requirements, which data is part of the management organization's plans and preparations to cope with the postattack environment, are known from past research effort.¹⁷ Methods for the implementation management of these known individual countermeasures can be developed for a range of postattack situations within the current knowledge of the effects of nuclear weapons. However, the area of least knowledge for the management of postattack recovery is that of selecting and implementing a countermeasures system for a specific area.

In order to manage the postattack recovery of a specific area, a data base of survivors and resources is required in greater detail than is generally available.⁴² The details of local assessment include the survivors' locations, needs, and capabilities, as well as the physical environmental situation for all resources; these may be different for all locations in configuration and in degree and type of damage. To meet postattack recovery management requirements for these diverse situations, generalized recovery patterns should be derived, if possible, from a series of scenarios or detailed case studies.

SUMMARY AND RECOMMENDATIONS

A listing of postattack countermeasures was given under the six general categories of protective, radiological, medical, ecological, economic, and social countermeasures. Within each general category, a series of specific countermeasures was discussed briefly in terms of its applicability in meeting the requirements of the attack survivors to cope with a range of postattack environments. The current responsibilities for management of the specific countermeasures have been stated so as to understand the existing concepts of overall postattack recovery management and to serve as a possible basis for future research on postattack recovery management concepts.

Active physical countermeasures, which are implemented at the time of shelter egress as required for immediate survival have been emphasized. These survival countermeasures, whose individual effort-effectiveness relationships are moderately well understood from past research, offer a starting point from which functional countermeasure system management concepts can be developed. Their implementation may serve as a basis for planning and implementing other long term recovery countermeasures. Functional management concepts to assess situations and to formulate, select, and implement recovery plans can be derived from these countermeasures. The less well understood behavioral factors of recovery, as they become better understood through other related research efforts, can be superimposed on the known countermeasures.

In concept, postattack recovery management must answer the questions of what, when, how, and who to achieve the most effective use of surviving resources, human and material, in a countermeasures system that improves the habitability of the postattack environment. "What to do" is established by the resources available to meet the needs and desires of the survivors. "When to do it" is also established on the basis of survivor needs and situation conditions and helps to develop the scheduling of countermeasure options. "How to do it" is established by the nature of the recovery task and procedural details of the available countermeasures. "Who will do it" is established by the available survivors and the required postattack activity.

Six possible levels of postattack countermeasure management, as now exist for many government agencies, could be utilized as a basis for staff coordination. At each level, functional staff groups would perform the functions of data collection and processing, situation assessment, development of recovery criteria, and derivation of recovery plans and options

for selection by management. Depending on the size of the survivor groups and geographic areas, different levels of management are needed to handle planning and implementation of countermeasures of varying scope.

The development of postattack countermeasures management requirements may be facilitated through use of either a selected series of post-attack scenarios or selected case studies. In this process, a series of optional postattack recovery routines would be evaluated for application to possible postattack environments. Here, situation dependent system recovery priorities would be established for system dependent countermeasures. The methodologies of assessment and countermeasure implementation for case studies would reveal decision-guidance information and functional management requirements.

The described approach requires detailed information to generate the input data for organizing recovery operations in very localized areas (such as a census tract) as well as for larger areas (such as a city, a region, or the nation). The specification and organization of this input data, and the procedures for handling and processing the data, are being investigated as part of the current and future work on this research task.

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Italy

Lorenzo Franceschini
Via Macedonio Melloni 49
Milan, Italy
Tel. 72 32 46

TITLE: An Approach to Defining Postattack Recovery
Management Concepts and Techniques

By: Donald E. Clark, Jr., Carl F. Miller, and
George D. Hopkins

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