

# A Bibliography of Selected RAND Publications

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R-3850-DARPA AM Broadcast Emergency Relay (AMBER): Final  
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P-3074 The Chinese Nuclear Explosion, N-Nation  
Development and Civil Defense.

## ABSTRACTS

### MONOGRAPH/REPORTS

**MR-303-A** The Army's Role in Domestic Disaster Support: An Assessment of Policy Choices. J. Y. Schrader. 1993.

This report begins identifying the central issues for determining the appropriate Army role in disaster relief. The study finds three potential options for an expanded Army role in civil emergency response: (1) continue to support the Federal Emergency Management Administration's (FEMA's) leadership of disaster response planning; (2) expand the Director of Military Support office to include formal state liaison offices; and (3) designate civil disaster support as a fifth pillar of national defense strategy and incorporate disaster-support missions into the Army's primary missions. The last two options expand the Army's current role and will require both internal changes and outside actions. While weighing these options and examining the issues surrounding them, the Army should take three steps to make its force ready to meet the current expectations of the American people in the event of a disaster at home: (1) transfer executive authority for military support from the Secretary of the Army to the Chairman of the Joint Chiefs; (2) support formal acceptance of civil disaster response as a mission for both active and reserve forces; and (3) review legal constraints on military participation in civil disaster relief.

**MR-557-OSD** Assessing the State and Federal Missions of the National Guard. R. A. Brown, W. Fedorochko, J. Schank. 1995.

A series of developments has focused attention on the important domestic mission responsibilities of the National Guard. These developments included a series of domestic disasters and emergencies, the passage of new legislation authorizing the Guard to participate in domestic initiatives designed to alleviate pressing national problems, the emergence of State Governors' concerns about the consequences of reducing the National Guard, and the Secretary of Defense's Bottom-Up Review, which acknowledged the need to support domestic missions. These developments contributed to existing concerns that a smaller National Guard would be unable to meet both state and federal mission requirements. This study investigates whether the projected size of the Guard, planned through FY 1999 will be adequate; whether the current system of assigning federal missions to Guard units could be altered; whether it is advisable or feasible for states to engage in cooperative agreements to share Guard capabilities; and whether alternative federal-state

cost-sharing arrangements should be implemented for Guard units whose principal function is to support state missions.

### REPORTS

**R-0251-AEC** Worldwide Effects of Atomic Weapons: Project SUNSHINE. 1953.

A presentation of a 1953 estimate of the fallout problem. The report discusses the various aspects of long-range contamination due to the detonation of large numbers of nuclear devices. An improved methodology for assessing the human hazard is developed, and an extensive experimental program is proposed.

**R-0322-RC** Report on a Study of Non-Military Defense. 1958.

A report on nonmilitary defense that considers such problems as population shelters, long-term fallout, economic recuperation, possible nonmilitary defense programs, and interactions with other aspects of national defense. The study was initiated in the belief that nonmilitary defense measures, if they could be made effective in protecting the civilian population, economy, and institutions of the United States, might make two significant contributions to the national defense. First, they might alleviate the catastrophe of a nuclear attack and, if military victory were attained, they might provide a reasonable chance that the United States as a nation could survive. Second, they might increase U.S. freedom of action in conducting peacetime foreign policy and in implementing a broad deterrence strategy.

**R-0425-PR** A Review of Nuclear Explosion Phenomena Pertinent to Protective Construction. H. L. Brode. 1964.

A report specifically oriented to the design of protection from the effects of nuclear weapons. It deals with the phenomena of the intense or close-in regions not always adequately covered in other standard works on the subject. It emphasizes early fireball growth, prompt nuclear radiation near an explosion, cratering and intense ground shock, high-overpressure air blast, hot fireball air and intense thermal exposure, and distribution of debris and after-winds. It includes information on all aspects of nuclear explosions known to be pertinent to the design of shelters.

**R-1184-ISA** Territorial Defense in NATO and Non-NATO Europe. H. Mendershausen. February 1973.

Pressures working on defense structures of European NATO countries, particularly those of the Federal Republic of Germany (FRG), tend to favor a change to latent conscript forces oriented toward territorial defense on one hand, standing volunteer armies on the other. Political, financial, and military potentialities of a combination of such forces are discussed, and a detailed comparison made of territorial defense concepts and forces, as well as civil defense preparations, in four countries—Switzerland and Yugoslavia (which do not participate in NATO's military integration) and Norway and France (which do so to a much lesser extent than the FRG). As long as the Germans and others in NATO believe that a shift toward latent forces endangers the alliance, and as long as U.S. attitudes confirm this belief, the potentialities of such forces will not be fully realized. The study draws on interviews the author conducted with military and civil defense specialists in West Germany, Norway, Sweden, and France. 114 pp.

**R-1871-ARPA** Military Operations in Built-Up Areas: Essays on Some Past, Present, and Future Aspects. L. Dzirkals, K. Kellen, H. Mendershausen. June 1976.

An effective defense of the cities of Western Europe could be critical in the defense of the NATO alliance. But present inclinations of European governments are in the direction of avoiding city fighting entirely. One of the essays in this report sketches six urban battles of the recent past. A second essay examines the Soviet style of urban fighting as revealed by Soviet memoirs and other literature. A third reveals a spectrum of European attitudes toward preparedness for urban defense, as gleaned by the author from personal conversations with civilian and military officials in several countries. A final essay, adopting the premise that urban defense could prove useful, suggests that organized, common-sense preparations would go further than technological innovation—both in buttressing the actual defense of cities and in preserving deterrence. 102 pp. Ref.

**R-3500-DOT/NCS** Feasibility of Using Interstate Highway Right-of-Way to Obtain a More Survivable Fiber-Optics Network. R. W. Hess, B. M. Mitchell, E. C. River, D. H. Jones, B. Wolf. 1988.

This report analyzes the legal, institutional, and economic feasibility of a possible solution for hardening the emerging U.S. fiber-optics communications "backbone" against the physical and electronic threats associated with nuclear explosions at no out-of-pocket cost to the government. The proposed solution would exchange access to interstate highway right-of-way, which telephone companies are currently prohibited from using but which

is quite attractive to them from the perspective of installation cost savings, for the hardening of fiber-optics systems using such right-of-way.

**R-3850-DARPA** AM Broadcast Emergency Relay (AMBER): Final Report. E. Bedrosian, E. D. Harris, K. J. Hoffmayer, C. R. Lindholm, E. I. Wojtaszek. 1990.

This report presents the results of an investigation of the technical feasibility of establishing a nationwide digital network using commercial AM radio broadcast stations that can support both voice and data transmission. The proposed network, called AMBER (AM broadcast emergency relay), is meant to support emergency communications for civilian and military users when other communication facilities are not available. The authors describe AMBER assets and users; consider key network issues and technical considerations; present preliminary cost estimates; describe the AMBER data link; and discuss a large-scale, nationwide computer simulation that has been developed for AMBER at RAND, including the propagation and noise models incorporated into this simulation and the methodology, host computer, and components of the AMBER simulation. The report concludes with a study of the connectivity of an illustrative network.

## NOTES

**N-1265-AF** Reflections on Territorial Defense. H. Mendershausen. 1980.

A territorial defense posture is a system that (1) is defensive, unsuited to attack across borders, and unlikely to be perceived as a threat by other states; (2) relies principally on latent rather than standing forces, involving many citizens; (3) relies on weapons and technologies different in type and composition from those of intervention and bombardment systems; and (4) relates the military resources of a society so closely to the defense of its own territory and institutions that it constrains the country's participation in an international military alliance, especially one that calls for an integration of alliance forces. A territorial defense doctrine goes with a military function or type of force that plays a greater or smaller role in a country's total military establishment, besides other functions or force types that have doctrines of their own. Aside from international political and strategic conditions, domestic political factors may increase or reduce the prominence given to territorial forces in a country's military system.

**N-2456-ARPA** Amplitude and Phase Demodulation of Filtered AM/PM Signals. E. Bedrosian. 1986.

This Note reports on part of an investigation of strategic communications. It presents an analysis of the distortion experienced by a hybrid AM/PM signal that has been filtered in the amplification stages of a typical receiver and then demodulated.

**N-2838-AF** The Civil Reserve Air Fleet: An Example of the Use of Commercial Assets to Expand Military Capabilities During Contingencies. M. E. Chenoweth. 1990.

This Note documents the Civil Reserve Air Fleet (CRAF) as a case study on the use of commercial assets to augment military capabilities during contingencies or national emergencies. The CRAF illustrates some of the issues one might expect to find in a similar program using civil and commercial satellites. Both contend with the problem of providing an appropriate mix of incentives to participate, both must overcome or cope with design incompatibilities between commercial and military systems, and both must balance the need to maintain a high state of readiness and responsiveness with the need to maintain high participation levels. While solutions that work for CRAF may or may not be transferable to space-based systems, the CRAF does provide an example of how one defense program addressed these basic problems and continues to do so as industry's and the military's needs evolve. A paper prepared for the AGARD/NATO Lecture Series, "The Application of Design to Cost and Life-Cycle Cost to Aircraft Engines," scheduled for May 1980. A methodology is described for life-cycle analysis of aircraft turbine engines from historical data. The methodology enables the weapon-system planner to acquire early visibility of cost magnitudes, proportions, and trends associated with a new military engine's life cycle, and to identify "drivers" that increase cost and can lower capability. The methodology is applied at the engine subsystem and aircraft system levels for a military fighter aircraft to demonstrate that decisions about engine performance/schedule/cost must be made at the system level. Commercial considerations are discussed, as is limited historical experience in engine monitoring, an approach to obtaining the necessary information, and procedures for performance and cost feedback to the engine designer. This Note presents portions of previously published RAND work on life-cycle analysis of aircraft turbine engines and engine monitoring systems, together with some recent unpublished work applying the earlier efforts at the aircraft system level.

## ISSUE PAPERS

**IP-100** Why Not a Civil DARPA? G. L. Donohue, R. H. Bueneke, W. G. Walker. 1992.

**IP-102-AF** "The Day After . . ."--Nuclear Proliferation in the Post-Cold War World. M. D. Millot, R. C. Molander, P. Wilson. 1993.

A nation with a small, survivable nuclear arsenal has the potential to undermine current U.S. national military strategy for dealing with regional conflicts. So concluded government officials and defense analysts who participated in a series of exercises to explore U.S. policy options in response to nuclear proliferation. Among the suggestions reported in this issue paper are to dramatically enhance conventional counterforce capabilities, to develop very high confidence theater ballistic missile defenses, and to implement operational concepts for power projection that minimize the exposure of U.S. personnel to attack.

**IP-104** Do We Need Special Federal Programs to Aid Defense Conversion? C. R. Neu, M. Kennedy. 1993.

It is in the national interest to ease the transition of industrial resources from a military to civilian focus. Are special federal programs necessary to accomplish this? This issue paper examines arguments that defense conversion requires a different response from that to normal industrial turnover. The authors conclude that there is no good justification for programs designed to aid only the conversion of defense industries. They suggest that government assistance should be triggered by any economic dislocation, regardless of its cause or the particular industry affected. They claim that the economy would be better served by policies that improve the quality and flexibility of all U.S. workers and that reduce barriers to the movement of people and resources among all its sectors. They also caution that to the extent that government policies shield workers, managers, or investors from the consequences of changing economic circumstances, these policies weaken incentives for the decisions that will finally result in the conversion of resources to new and productive uses. Excessive efforts to ease the pain of conversion only slow it.

**IP-120** DoD Centralization: An Old Solution for a New Era? G. L. Donohue, M. A. Lorell, G. K. Smith, W. G. Walker. 1993.

In response to enormous pressures to economize, the Department of Defense has set out to reform the logistics and acquisition system. One of the options being considered is to centralize acquisitions in order to reduce overhead, improve management, eliminate duplication, increase economies of scale, and tighten controls to minimize cost growth and schedule slippage. This issue paper explores the idea through a summary of the history of the U.S. acquisition reform, a review of the centralized acquisition bureaucracies of some U.S. allies, and a discussion of current management theory and industry practice and how they might apply to defense acquisition.

The authors suggest that instead of being centralized, the acquisition system should be reformed to encourage self-managed teamwork, efficient information technologies, flatter internal organizations, and integrated external networks of responsive suppliers.

**IP-140-AF** Revamping the Infrastructure That Supports Military Systems. G. L. Donohue, M. K. Brauner. 1993.

This issue paper presents the results and recommendations of a workshop addressing whether the industrial infrastructure that supports military systems should undergo fundamental redesign. Workshop participants included senior representatives from the Department of Defense (DoD) and private industry, as well as nongovernment policy analysts. Throughout the discussions, participants stressed that although the military has much to learn from private industry where restructuring is concerned, supplying forces in combat is fundamentally different from the goals and tasks of commercial industry. Problems identified with the current DoD approach to restructuring include lack of clear guidelines, legal obstructions to management initiatives, overemphasis on competition, and failure of information-system development. Seven guiding principles were developed to help integrate the complex array of problems, clarify options and tradeoffs, and provide criteria for making decisions. Ten research questions were presented that would yield empirical findings to help policymakers reach informed decisions on restructuring issues.

## TESTIMONY

**CT-138** Risks to the U.S. Infrastructure from Cyberspace. R. H. Anderson. 1996.

Testimony presented by Robert H. Anderson before the Permanent Subcommittee on Investigations, Government Affairs Committee, U.S. Senate, June 25, 1996. The author raises two points regarding risks in cyberspace (the global collection of internetted computers and communications systems) and three issues for consideration. The first point is that the information revolution is continuing, bringing new security risks. To date the market has emphasized increased functionality, not security. The second point is that a continuing partnership between government and industry is needed to address vulnerabilities as they arise. The first issue for consideration is the advisability and feasibility of creating a Minimum Essential Information Infrastructure. Second, the U.S. should focus on increasing the robustness of U.S. infrastructure systems. Third, roles and missions among

those responsible for security must be clarified and coordinated.

## RAND MEMORANDA

**RM-3079-PR** Disaster and Recovery: A Historical Survey. J. Hirshleifer. 1963.

An investigation of economic characteristics of some major disasters and recoveries of modern times. Four periods are covered in detail: Russian war communism, 1917–1921; the American Confederacy, 1861–1865; Japan, pre- and post-World War II; and Germany, pre- and post-World War II. Emphasis is on the mechanism of collapse, whether the source was technological or organizational, and on what forces promoted or hindered recovery.

**RM-3223-PR** The Resolution of the Soviet Controversy over Civil Defense. L. Gouré. June 1962.

A discussion of some recent developments in the Soviet civil defense program. The differences between foreign and domestic Soviet propaganda on civil defense are shown. A debate among the Soviet leaders on the value of civil defense is also described, a debate that was resolved at the May 1962 Congress of DOSAAF (the civil volunteer organization). Recent vigorous endorsement of DOSAAF by Party and press may be one indication of impending changes in Soviet domestic and foreign policies.

**RM-3436-PR** Economic Viability After Thermonuclear War: The Limits of Feasible Production. S. G. Winter. 1963.

A study of certain aspects of the question of how, and under what circumstances, the resources surviving a thermonuclear war could be used to create an economy capable of supporting the population, maintaining its capital stock, and meeting other urgent national needs. The main focus is on the limits imposed on production in the postattack economy by the availability of resources and the technological conditions. The reorganization problem is treated as being synonymous with the problem of achieving a viable economy. A solution to the problems of making effective use of surviving resources is satisfactory only if it is permanent. No predictions are made of the course of economic events after a war; instead a range of situations is considered and discussed in terms of production limits, rather than of actual outcomes given particular organizational arrangements. Some tentative judgments are made on the levels of attack at which viability would become unlikely without preattack preparations.

**RM-3703-PR** The Role of Civil Defense in Soviet Strategy. L. Gouré. June 1963.

A description of the Soviet military's views on the importance of civil defense in a future war. These views derive from an image of war in which the opponent's will to resist and economic capability to continue the struggle are primary targets for attack. The importance of such targets increases in the event of a protracted war, whose occurrence is regarded by the Soviets as sufficiently likely to justify considerable investment in a civil defense program designed to permit the Soviet Union to survive and to seek to win strategic nuclear superiority in the course of the war. (See also RM-3223.)

**RM-3902-TAB** Notes on the Estimation of Fire Damage to Non-Urban Areas from Nuclear Attack. J. E. Doner. 1965.

An examination of the elementary model developed by the Broadview Research Corporation for assessment of nonurban fire damage from nuclear attack. Such fire damage is extremely difficult to estimate because of the complexity of the burning process and the large number of variables involved. This Memorandum suggests possible approaches for improving the model.

**RM-3962-PR** Dynamic Response of Lined and Unlined Underground Openings. C. C. Mow. March 1964.

A brief review of the recent development of stress-wave-cavity interaction problems pertinent to protective construction of underground openings. It concludes that with elastic, homogeneous, isotropic earth media, the dynamic stress concentration factors for cylindrical, elliptical, and square holes are about 10 to 20 percent higher than those for their corresponding static cases. Elastic liners increase the strength of the hole in relatively soft earth, but not in hard earth such as granite. The sphere is the optimal shape.

**RM-4030-TAB** Systems Analysis for the Postattack Environment: Some Reflections and Suggestions. R. D. Specht. 1964.

A discussion of uses and limitations of mathematics and systems analysis in the study of biological and environmental consequences of nuclear war. The Memorandum suggests that a program of research on problems of the biosphere in the postattack environment should include not only detailed technical studies, but also some activities devoted to unifying the research approach, such as facilitating interdisciplinary communication, structuring the program, discovering what technical studies are needed, in what order, and to what degree of detail. Suggestions are made for such unifying aids, a

contextual map, special conference design, and a pilot study.

**RM-4238-TAB** Floods and the "Postattack Biology Problem": A Preliminary Survey. H. H. Mitchell. January 1965.

A study to estimate some upper bounds on the magnitude of the flood problem in the postattack environment. It suggests that they can be estimated by considering the maximum floods that have already occurred, for, if large floods do occur, their severity is not likely to be greatly affected by the loss of ground cover caused by the fire and radiation effects of a thermonuclear attack. The limit so estimated is \$4 billion, at a 1950-51 cost and development level. Health aspects of floods and human adjustments are considered in the light of past experience. Some problems related to the postattack situation are suggested for further study.

**RM-4700-TAB** Disaster and Recovery: The Black Death in Western Europe. J. Hirshleifer. 1966.

A discussion of the Black Death of 1348-1350 in Western Europe and its aftermath as a disaster-recovery experience. Described are (1) the immediate social, political, and economic effects of the first decade, and (2) possible effects during the century following the initial plague disaster. (See also RM-3079, RM-3436.)

**RM-4706-TAB** Sensitivity of Mortality Estimates to Uncertainties in Some Nuclear Damage Parameters. M. E. Arnsten. 1966.

A survey of some of the varying estimates of parameters that describe the lethality of radiation and nuclear prompt effects, and an evaluation of these variations in the context of hypothetical thermonuclear attacks on the United States. Charts show the ranges of mortality estimates from three counterforce attacks as the following are varied: mid-lethal radiation dose, biological recovery parameters, mid-lethal overpressure for prompt effects, fission fraction, gamma activity level, wind patterns, and distribution of radioactivity with debris particle size. The use of uncertain mortality estimates in the analysis of a few representative defense problems is briefly discussed.

**RM-4707-TAB** Sensitivity of Mortality Estimates to Uncertainties in Some Nuclear Damage Parameters. M. E. Arnsten. November 1966.

A series of ninety-five graphs enables the reader to explore the sensitivity of attack outcomes to uncertainties in some nuclear damage parameters in the context of three hypothetical counterforce attacks on the United States. These graphs permit the reader to select his own estimates of mid-lethal radiation dose, biological recovery parameters, mid-lethal over pressure for prompt effects,

fission fraction, gamma activity level, and distribution of radioactivity with debris particle size and then to calculate, for the three attacks, the corresponding mortality estimates. Wind patterns and civil defense postures can also be varied.

**RM-4725-TAB** Some Implications of Uncertainties in the Hiroshima Explosion. B. F. Goeller, R. D. Specht. 1966.

A consideration of possible implications of uncertainties about the Hiroshima bomb in estimating nuclear prompt effects damage from weapons in the megaton range. Within the range of uncertainties considered, that relating to the scaling exponent made the greatest difference. Variations in yield and wind pattern followed, both more important than the various possible height of burst values. In counterforce attacks that are constrained to avoid collateral civil damage, the uncertainties can have significant effects on such damage and on the selection of targets.

**RM-4827-TAB** Nuclear War and Soil Microflora. S. Blumenfeld. 1966.

An examination of the possibility that large-scale nuclear war might result in long-term derangement of the microbial flora of the soil, with subsequent adverse effects on food production in the postwar period. Two nuclear bombardment phenomena that could affect the soil microflora are considered: ignition of extensive fires in forests and crops, and acute and chronic irradiation of the soil by fallout. Experimental data and field observations in agriculture, forestry, soil microbiology, and radiation biology are examined. Tentative conclusions are presented.

**RM-4904-TAB** Effects of Acute Doses of  $\gamma$ -Radiation on Pine Trees. J. P. OKunewick. October 1966.

A review of existing theoretical and experimental data concerning radiation sensitivity of some economically important pine species in U.S. forest areas. This Memorandum reports on one aspect of a study of biological and environmental consequences of nuclear war and presents data that give reason for concern about the problems of radiation damage to pine forests in regard to ecology and the economic situation in a postattack environment.

**RM-4910-TAB** A Re-Examination of Fallout Models. R. R. Rapp. 1966.

A review of the information necessary to produce an operational fallout model. Each facet of the problem is discussed, the attendant difficulties pointed out, and the possible compromises suggested. A comparison of current fallout models is attempted so that strengths and

weaknesses of each model can be assessed. Finally, a suggested program for the development of a flexible computer model is made. Such a model could provide a method for examining the variation in prediction as a function of the variation of the input.

**RM-4968-TAB** Plague in the United States: An Assessment of Its Significance as a Problem Following a Thermonuclear War. H. H. Mitchell. 1966.

An investigation of the possibility that bubonic or pneumonic plague could appear in the United States in a postattack situation. Although modern methods of control and treatment make it unlikely that a plague of vast proportions could occur, a study of plague ecology and projected disturbances in a postattack environment suggests that it is a possible danger. The Memorandum suggests current planning that includes surveys for locating endemic foci of plague in wild rodents and for coordinating the results with evacuation plans of the civil defense system.

**RM-4989-TAB** The Effects of Nuclear War on the Weather and Climate. E. S. Batten. 1966.

A study of the possible effects of energy, debris, and radioactivity from nuclear detonations on weather and climate. The large quantities of debris injected into the troposphere and stratosphere seem to be the most likely agent of modification. This debris could act in several ways. It might provide an additional source of nonsoluble condensation nuclei and ice nuclei. As ice nuclei, it might increase the thin cirrus clouds, thus affecting the radiation balance, or it might increase the efficiency of the ice-crystal mechanism of precipitation formation in supercooled clouds. The very fine dust particles left behind in the atmosphere, if abundant, would interfere with the radiation entering and leaving the atmosphere. In addition to the effects of the debris, extensive fires ignited by nuclear detonations might change the surface characteristics of the area and modify local weather patterns. Despite the possibility of such changes, however, a more thorough knowledge of the atmosphere is necessary to determine their exact nature, extent, and magnitude.

**RM-5048-TAB** The Relationship Between Post-Irradiation Recovery and Equivalent Residual Dose. J. P. OKunewick. 1966.

An investigation of the problem of estimating the effective residual dose (ERD) of radiation retained by a man or an animal, with a view toward developing a model that will simulate experimentally observed recovery behavior. Such a model should prove useful in making post-nuclear war recovery predictions. The relationship between the establishment of an ERD for men and animals and the

physiological mechanism underlying radiosensitivity is examined in detail, and it is found that recovery may be oscillatory in nature rather than exponential. Applicability of current models is discussed, and some factors that must be considered in developing a generally applicable recovery model are listed.

**RM-5052-TAB** Nutrition in the Postattack Environment. R. S. Pogrund. 1966.

An investigation of the problem of providing an adequate diet for the population surviving a nuclear attack on the United States. American dietary habits and the extent that they contribute to the inefficient use of land in the United States are examined. Alternative food sources and the human ability to adapt to unfamiliar foods are considered in the context of a postattack environment.

**RM-5073-TAB** The Simultaneous Flammability of Wildland Fuels in the United States. R. E. Huschke. 1966.

An estimate is made of the fire hazard in the continental U.S. wildlands at a given time of year, to provide a basis for predicting wartime fire hazard and resource survival. Flammability, or dryness, is quantitatively expressed by "burning indexes" for different plant types; "critical" levels were selected arbitrarily. The burning indexes are mathematical models derived from a 10-year set of daily weather observations made at 89 locations throughout the United States. It was necessary to devise a national wildland-fuel distribution inventory, a growth cycle (phenological) calendar for each principal species as a function of geographical location, and a method for simulating the fire-depressing effects of snow cover. Annual cycles of simultaneously flammable area for eight different fuel-type combinations at several frequency levels are shown graphically. Additional graphs present the principal results as recalculated by varying over a wide range the burning index level taken as critical.

**RM-5083-TAB** Long-Term Radiation Damage: Evaluation of Life-Span Studies. B. B. Brown. 1966.

A statistical evaluation of 39 experimental reports of the life spans of laboratory mice which survived whole-body exposure to acute doses of X-rays or gamma rays. For the same age, life shortening increases roughly linearly with dosage. For the same dose, life shortening decreases linearly with age at exposure. Data are lacking for assessing radiation effects on man; however, extrapolation by using comparative life span, life expectancy, or mortality rates, gives an estimated range of 7 to 12 days life shortening per roentgen. Theories of radiation damage are summarized, as well as the underlying theories of aging. Methodology for testing hypotheses nonparametrically is given in the appendix.

**RM-5090-TAB** Survey of the Infectious Disease Problem as It Relates to the Postattack Environment. H. H. Mitchell. 1966.

The incidence of infectious diseases and methods of control are examined to indicate measures that might be taken to prevent the occurrence of epidemics in a postattack environment. The possible collapse of quarantine regulations and a lack of immunization facilities after a nuclear attack suggest that public health measures may have to include compulsory immunization against diseases not now prevalent in the United States. As tuberculosis may well be one of the great problems of a postattack environment, current tuberculosis control measures should be evaluated. A study that projects the epidemiology of various diseases into the postattack environment will help to indicate the resources that will be needed and reveal where emphasis should be placed in planning for postattack recovery.

**RM-5096-TAB** The Genetic Effects of Radiation: Postattack Consequences. N. Arnheim. 1966.

An analysis of the sensitivity of human genetic mechanisms to mutations induced by irradiation and the effect of new mutations on the population in a postattack environment. Increased levels of radiation in the postattack environment will increase the frequency of mutant genes. Based on the concept that most new mutations are harmful, the population could suffer the effects of genetic damage through subsequent generations. An extension of the genetic death concept to the postattack environment indicates that mutant genes harmful to the population will eventually be eliminated. Experimental irradiation of animals shows that the total dose received, the dose rate, and the kinds of cells affected influence the frequency of mutation. Prevention of conception for a period after radiation exposure can reduce genetic damage.

**RM-5100-TAB** Decay of a Disturbance in the Natural Distribution of Carbon-14. M. S. Plesset, D. J. Dugas. 1966.

An attempt is made to calculate more accurately the excess of carbon-14 remaining in the biosphere in the event of a nuclear war. Two models have been developed describing the carbon-14 excess injected into the atmosphere: a chain model and a cyclic model, each having four reservoirs for exchangeable carbon. The time decay patterns resulting from each of these models are given. The cyclic model is more realistic than the chain model because it considers the atmosphere to have an interface with both the mixed ocean layer and the deep sea. The decay rate over the long term of carbon-14 in the atmosphere is shown to change markedly with the ratio of the atmosphere/mixed-layer exchange rate to the atmosphere/deep-layer exchange rate over the range of 1 to 3.

**RM-5115-TAB** The Postattack Population of the United States. I. S. Lowry. 1966.

An analysis of the demographic consequences of a nuclear attack on the United States in terms of size of the postattack population; its rate of growth in subsequent decades; its composition by age, sex, and color; and postattack patterns of fertility and mortality. Five nuclear attacks are simulated and the demographic consequences computed by means of the RAND damage-assessment model, QUICK COUNT. The range of alternative outcomes from the five simulated attacks is increased to fifteen by variation of damage-assessment parameters. In terms of total fatalities, these outcomes range from 2 to 62 percent of the preattack population. Only disparities of age among those surviving appear to have short-run or long-run significance either in a purely demographic sense or from the perspective of recovery planning.

**RM-5140-TAB** Dimensions of Survival: Postattack Survival Disparities and National Viability. N. A. Hanunian. 1966.

A study of the changes that massive nuclear attack might produce in the U.S. societal structure. Eight exemplar attacks, delivering between 800 and 13,200 megatons, are modeled realistically, and survival of well over a score of demographic and economic entities is assessed. Conclusions are that even heavy damage from nuclear attacks is likely to be so distributed as to leave the economy's resource balance, in terms of nationwide aggregates, much as it was beforehand. The agricultural sector, however, will tend to suffer much less damage than other sectors. The impact of nuclear war on society seems much more oppressive when examined in terms of a substantial number of well chosen indicators than when appraised on the basis of some single measure of outcome, such as nationwide mortalities. New insights are furnished by calculations of not only how many people would be killed, but also which people.

**RM-5141-TAB** The Sensitivity of Mortality Estimates to Variations in Aggregate Population Representations. B. F. Goeller. 1966.

An analysis of the changes in mortality estimates that occur with changes in the population representations used for damage assessment. Representations for the U.S. population are created by laying a square mesh grid of a specified dimension over a map of the United States and adding up the population contained within each cell. The populations represented within grid sizes of 5, 10, 20, and 50 km are considered. Two hypothetical attacks are employed: a low-collocation attack and an indiscriminate or unrestrained targeting attack. For both attacks, mortality estimates tend to decrease as the grid size of the population representation increases.

**RM-5203-TAB** Nuclear War and Soil Erosion: Some Problems and Prospects. Y. H. Katz. 1966.

A survey of present knowledge about the extent, effects, and prevention of soil erosion as background for further investigations related to the situation after a hypothetical thermonuclear attack on the United States. Erosion, presently the dominant conservation problem on more than half the U.S. land, seriously affects land and water resources and waterways. The interruption of man's constant battle to save the soil would probably rank high in accelerating erosion in a postattack environment. The best protection against erosion is undisturbed vegetative ground cover; clean-tilled cropland may lose thousands of times as much soil per year as areas covered with protective vegetation. More than a third of U.S. cropland presently requires antierosion treatment. In addition to basic information on present land use and the erosion hazard, further research is needed on effective agricultural practices and on radiation-resistant plant species. Plants should be established in areas now endangered by erosion and should be stockpiled for emergencies.

**RM-5272-PR** A Mathematical Model for Post-Irradiation Hematopoietic Recovery. J. P. Okunewick, A. L. Kretchmar. July 1967.

A mathematical model of the recovery after irradiation of the system producing blood cells in the body. The model is based on the hypothesis that hematopoietic stem cells, which are unable to reproduce as stem cells following irradiation, may still retain an ability to differentiate. The model demonstrates both an abortive recovery rise and a true recovery rise following irradiation. As a first approximation, the model shows no irreconcilable differences from experimental data and generally represents the phenomena observed in the recovery of erythropoiesis following acute irradiation. In addition, certain postulates basic to blood-cell development are derived. 42 pp. Ref.

**RM-5362-PR** The Problem of Tuberculosis in the Postattack Environment. H. H. Mitchell. June 1967.

An assessment of the problem of tuberculosis in an environment created by a nuclear attack in the United States. Tuberculosis is still a relatively important public health problem, and even with current rates of decline continuing, eradication will not have been accomplished by the year 2000. Any postattack population must expect to have individuals infected with tuberculosis among its members. The conditions that have been correlated with high tuberculosis rates in the past are to be expected in the postattack environment: malnutrition, poor housing, overcrowding. The modern chemotherapeutic and chemoprophylactic agents and BCG vaccines, if available in the postattack environment, make tuberculosis control a

reasonable goal if accompanied by an adequate public health program. In the absence of active control, tuberculosis could well be the most serious infectious disease problem of the postattack environment. 81 pp.

**RM-6043-PR** Limiting Damage from Nuclear War. W. M. Brown. October 1969.

Based on the current concept that nuclear attack would occur only after an international crisis, thus providing from several days to several months of strategic warning, this study maintains that D/L systems can be designed that would reduce present estimates of about 100 million fatalities by 90 percent. Two extreme programs are considered: a "cheap" program based on urban evacuation and improvised fallout shelters, and an "expensive" program based on urban blast shelters and active defense. In the cheap program the major expenses would be deferred until needed; the major labor would be contributed by the people for their own survival. The annual cost would be \$200 million or less, and the principal peacetime output would be plans for emergency action and a small number of trained professionals to guide mobilization when needed. For the expensive program, a model is proposed that would greatly reduce population vulnerability. The main advantages of this program are not fewer fatalities but high confidence, low socioeconomic disturbance, and less dependence on amount of warning. The model shows, however, that passive defense is the essential component of any effective D/L system. 105 pp. Ref.

**RM-6113-PR** Soviet Civil Defense Revisited, 1966-1969. L. Gouré. November 1969.

Initiated in the 1950s and upgraded in 1961, the Soviet civil defense program has increased in scope and intensity since 1966. The system is considered vital to the maintenance of crucial military, industrial, and political capabilities in the event of a nuclear attack. Because of economic constraints, special shelters have been built only for those workers engaged in critical national services. The remainder of the population will be protected mainly by means of evacuation and dispersal to preselected safety zones. Because the program relies heavily on several days' warning of attack and is primarily concerned with protecting certain population elements, the Soviet leaders might be very sensitive to economic damage strikes against their cities. This seems to be borne out by their increasing concern with recovery operations for industrial, utilities, and transportation facilities. In any case, this survey leaves no doubt that Soviet leaders are continuing to invest heavily in civil defense. 111 pp.

## PAPERS

**P-1927** Lecture on Civil Defense. H. H. Mitchell. 1960.

A talk presented before the Staff College of the New York State Civil Defense Commission at West Point, New York, February 9, 1960. Such aspects of civil defense are stressed as its effect on alleviating the catastrophe of a nuclear attack on the United States, the necessity of preparations to reconstruct and reconstitute our nation to its preattack status, and its contribution to U.S. freedom of action in conducting peacetime foreign policy and in implementing a broad deterrence strategy. The casualty problem at Hiroshima and Nagasaki is reviewed. RAND's civil-defense study, begun in 1957, is described, and the objectives of the program are summarized (namely, whether a civil-defense program is feasible, and whether a feasible program can be devised to make a plausible case for implementing it).

**P-2009** Time and Civil Defense. H. H. Mitchell. 1960.

A discussion of the importance of civil defense, which is examined from the viewpoint of historical time, present time, clock time, and calendar time. Such aspects of civil defense are considered as the preparations to limit the extent of damage the United States may suffer, Soviet civil defense efforts, the feedback effect of civil defense on foreign policy and military decisions, and the preventive effect of civil defense in connection with medical problems in a postattack situation.

**P-2340** Civil Defense Training in Russia. L. Gouré. 1961.

A discussion of Soviet efforts, especially since 1955, to develop a large civil defense organization and to train the majority of its population in civil defense. Such aspects are considered as organization and administration, training objectives and program, training procedures and techniques, control over participation and quality, and the present status of civil defense training.

**P-2523** Some Effects of Radiation on Man. H. Laitin. 1961.

A review of certain aspects of radiation and of its effects on man. Such topics are discussed as: (1) the effects of radiation at the cellular level; (2) the somatic or total body effects resulting from injury at the biochemical and cellular level, with emphasis on the early effects of whole body exposure to penetrating ionizing radiation; and (3) recovery and long-term effects.

**P-2554** The Soviet Civil Defense Program. L. Gouré. 1962.

A description of the key features of the Soviet civil defense program and especially of those aspects that deal with defense against radioactive, chemical, and bacteriological agents. The reasons for the long-standing Soviet interest in civil defense are discussed, as well as the basic concepts of Soviet civil defense doctrine. Despite the fact that Soviet authorities appear to be losing interest in some types of urban shelters, and current Soviet propaganda is denying the value of civil defense, the author indicates that the Soviet Union still has an active civil defense program.

**P-2665** Southern California in a Thermonuclear War. H. L. Brode. 1962.

A discourse on the safety of Southern California in the event of nuclear attack. The author examines the likelihood of thermonuclear warfare, the consequences of such an attack on our cities, the warning that could be expected, possible targets to be bombed, our defense against attack, and the fallout effects of nuclear bursts. Southern Californians would undergo enormous destruction if a nuclear attack occurred. However, survival is possible for many, and much can be done to enhance that possibility.

**P-2751** Civil Defense Revisited. J. D. Williams. 1963.

A review of the current state of civil defense. Suggestions for the use of existing protection are given and a pattern of organization before and during crisis is outlined.

**P-2752** Recent Developments in the Soviet Civil Defense Program. L. Gouré. 1963.

A survey of recent Soviet activities in civil defense. The information comes mainly from open Soviet publications and from the author's personal observations in 1960. The program is far from complete and suffers from a variety of shortcomings. In the author's opinion, however, the available evidence shows that the Soviet Union is engaged in an extensive civil defense program, which it believes to be worth further effort and continued investment.

**P-3074** The Chinese Nuclear Explosion, N-Nation Development and Civil Defense. E. R. Zilbert. April 1965.

A discussion of the implications for civil defense of nuclear proliferation. Civil defense activities of the past twenty years are reviewed and the present situation appraised. 26 pp.

**P-3160** Economic Recovery. J. Hirshleifer. 1965.

A discussion of the possibilities of economic survival and recovery following a nuclear war. The author discusses available resources measured against the needs of the postattack society, and the successful use of them to meet those needs. He concludes that, though a postattack period of privation is to be expected, the historical record does not justify pessimism on the issue of ultimate recovery. (See also RM-3079-PR, RM-3436-PR.)

**P-3165-1** Active and Passive Defense. A. L. Latter, E. A. Martinelli. August 1968.

A chapter in a forthcoming study of civil defense (Professor Eugene Wigner, editor), which will deal primarily with blast shelters—a passive form of defense. Because passive defense cannot be discussed meaningfully without an understanding of its relationship to active defense, i.e., intercepting and destroying the attacking bombers and ballistic missiles, this paper describes the technical aspects of active defense, particularly ballistic missile defense. The authors also discuss the question of which is more effective—active or passive defense, or some combination of the two. 13 pp.

**P-3170** A Survey of the Weapons and Hazards Which May Face the People of the United States in Wartime. H. L. Brode. June 1965.

A discussion of various hazards that might threaten the populace of the United States in wartime. The paper considers such nonnuclear weapons as conventional high explosives, biological, chemical, and radiological weapons, but emphasizes that the logistics of delivery and distribution favor the use of nuclear weapons. Our general knowledge of such factors as blast damage, thermal radiation, ground shock and craters, and precautions to be taken against them are also considered. 24 pp.

**P-3278** Offensive Weapons and Their Effectiveness. H. L. Brode. 1965.

A brief discussion of biological weapons and the effectiveness of nuclear weapons on a civilian population. The discussion is divided into sections dealing with the various effects of nuclear explosions: blast waves, thermal radiation, fallout, ground shock, and craters. Each section comments on factors limiting or extending damage.

**P-3526** A Critical Look at the Data Problem in Studies of Wildland Flammability. R. E. Huschke. February 1967.

A new appraisal of the complex functional relationships among the many variables required to define the degree of fire danger due to wildland flammability. A previous study (RM-5073-TAB) pointed out a serious lack of information on the distribution and growth cycles of vegetation. The present paper provides a network analysis

of the elements of wildland fires (other than human behavior). The variety of fire-danger rating systems reflects the differences in plant fuel conditions in different areas. It seems inevitable that our natural biological environment will some day have to be monitored, predicted, and managed in a comprehensive and conceptually unified way, yet today we have inadequate knowledge of even such obvious things as when leaves fall from trees. The long-overdue Forest Service project to develop a national forest fuel appraisal system could provide a framework for the much-needed national ecological survey. (Prepared for presentation at the Conference on Fair-Weather Meteorology, Santa Barbara, February-March 1967.) 20 pp. Ref.

**P-3737** The Federal Role in Postattack Economic Organization. S. G. Winter. 1967.

This paper, presented at the Symposium on Postattack Recovery sponsored by the National Academy of Sciences, challenges the basic axiom, exemplified in the "National Plan for Emergency Preparedness," that direct governmental control of economic activity is a sound, or feasible, policy for the postattack situation. It stresses that the appropriate action described is an alternative, not a complement, to the National Plan and outlines the drawbacks to reliance on controls. Research suggestions are made in line with this view.

**P-3764** On Reorganizing After Nuclear Attack. W. M. Brown. January 1968.

An analysis of current thinking on the possibility of a U.S. recovery from a nuclear attack that destroys or severely damages all major cities and hundreds of others. The economic viability of the country is not assured even though a major fraction of the physical resources survive. Preplanning for a civil defense mobilization will enable it to proceed rapidly and effectively when needed. A large emergency organization could be indispensable to ensure an effective postattack economic reorganization. Effective civil defense mobilization would tend to produce a "paragovernmental" agency of several million trained people to manage reorganization problems. A major problem will be the collapse of federal currency, resulting in misallocation of food supplies and fragmentation of resources. Preventive actions could include an option to nationalize the food industry during the reorganization period. Stockpiles of petroleum, metals, chemicals, and medical supplies could be built up for use as additional currency to ensure that the government would survive and function. Research and analysis of the requirements for planning a mobilization effort may require modest federal funding for a decade. 27 pp. Ref.

**P-4042** Soviet Emergency Planning. L. Gouré. February 1969.

A review of the Soviet civil defense system, prepared for publication in NATO—Fifteen Nations. Considerable effort and investment apparently have been expended in the long-standing Soviet civil defense program in progressive recognition of the character of strategic weapons and their effects. However, no information has been published on the program's scope. Relying heavily on early warning of an attack (several days), the present system gives priority to the survival of population elements essential to the preservation of the political organization and of military and economic potential. Soviet officials claim a high degree of effectiveness for the system, but continue to call for improvements. The Eastern European Communist states have similar civil defense operations, and their staff leaders are trained in Soviet schools; but these countries' investments and capabilities are not uniform. 14 pp.

**P-4275** On the Postattack Viability of American Institutions. W. M. Brown. January 1970.

This paper attempts to (1) delineate a set of crucial problems which could develop if a nuclear war collapsed the federal government as an authoritative presence; and (2) discuss some that might be insurmountable even if the federal government survived. The first set represents the threat to viability from the dependence on the suddenly missing presence of the federal government; the second because the government would not be skilled at its vital postattack functions. The author concludes that: (1) The problems of the early survival period and the reorganization period may be intangible ones rather than ones involving shortages of material sources. (2) If the federal authority disappeared after a nuclear attack, reconstituting it could be very difficult. (3) An alternative approach to postattack federal functions is needed to provide a desirable orientation for postattack planning. (4) Some countermeasures are possible that might be implemented in a future crisis if planned for in peacetime. 29 pp. Ref.

**P-4320** PACBIR--A Form of Regional Governmental Cooperation. E. J. Savage. 1970.

Examines the purpose, scope, and accomplishments of the Pacific Coast Board of Intergovernmental Relations (PACBIR), a regional, voluntary assembly of national, state, and local leaders formed shortly after World War II to study intergovernmental problems. Because PACBIR had no formal or legal power, it accomplished its purposes through the exchange of information and the formulation of recommendations. Because PACBIR brought together informally all levels of governmental officials, it established friendly intergovernmental working relationships and enabled the speedy mobilization of any governmental agency on the Pacific Coast. Specific problems it considered during its five years of successful

operation included: duplication among national, state, and local laws; welfare costs; intergovernmental fiscal relations; disaster preparedness planning; the impact of the increasing percentage of elderly people in the population; and conservation of water resources.

**P-5662** U.S. Participation in the Relief of International Disasters: Issues for a Proposed Task Force. W. R. Harris. June 1976.

In FY 1965 through FY 1970 the United States government participated in relief of 302 foreign disasters, an average of 50 per annum, in an average of 38 countries. The author, who has a background in international law, poses questions and suggestions with respect to the organization and coordination of U.S. disaster relief efforts. Issues discussed include the use of military technology in the estimation of damage and also in the identification of damage in the case of "creeping disasters" such as drought, and the application of technological advances in housing construction. He discusses organizational alternatives, resource management, cost-sharing, and disaster insurance pooling. 18 pp.

**P-7988** A Qualitative Methodology for the Assessment of Cyberspace-Related Risks. R. O. Hundley, R. H. Anderson. 1996.

The problem addressed here is assessing the risks to which some organization or activity is exposed as a result of some combination of cyberspace-related vulnerabilities and threats. It is an attempt to assess risk without resorting to quantitative methods, which can appear to offer more accuracy and precision than is in fact warranted. The methodology proposed, although a work in progress, has three favorable points: (1) it is transparent, in that the nature and substance of the judgments and combinatorial steps are apparent; (2) it does not pretend to greater accuracy than can be justified; and (3) it is believed to capture the key elements and interactions involved in assessing cyberspace risk. The methodology does, however, require the user to make a large number of qualitative judgments and to combine them in a subjective fashion. The paper is presented as an annotated briefing.

**P-8031** The Implications of COTS Vulnerabilities for the DoD and Critical U.S. Infrastructures: What Can/Should the DoD Do? R. H. Anderson, R. O. Hundley. 1998.

There is a growing reliance on commercial off-the-shelf (COTS) products within critical systems on which the security and safety of the United States depend. Next-generation command and control systems within DoD depend heavily on COTS hardware and software. Typical COTS software products are large and complex, often comprising millions of lines of source code. This

complexity precludes complete, unambiguous analysis of the code for "trap doors," "logic bombs," and other malevolent code possibly buried within it. In addition, increasing amounts of such code are developed by non-U.S. citizens and offshore workers with uncertain loyalties to the United States. Market forces favor functionality over security and reliability, so the problem is unlikely to disappear. In addition, DoD and the U.S. government lack sufficient market strength to compel greater security in COTS products. There are two basic approaches to "managing" this problem: making COTS used by the DoD more secure; and learning to live with insecure COTS. There are initiatives that can be undertaken in both of these areas. The authors have identified a number of candidate elements supporting each of these approaches. Those specific elements can support a variety of overall solution strategies. An outline of a possible research agenda addressing this problem is presented.

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