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SERIOUS RADIATION EVENT - HANFORD CAPABILITIES

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SERIOUS RADIATION EVENT - HANFORD CAPABILITIESI. INTRODUCTION

The need for an industrial plant to know its capabilities to rescue personnel and minimize damage to vital operating equipment in the event of a serious accident has long been recognized. Although Hanford's experience has been without a serious radiation event as characterized in this report, it is prudent to have an objective assessment of the capabilities which do exist and an analysis of the general capabilities which the plant should possess to maximize the effectiveness of rescue action in such an event and to limit the consequences to personnel, vital equipment, and the surrounding environs.

Hanford should assure that its resources of men, highly competent in many disciplines, and specialized equipment would be utilized in a timely and effective manner following any serious radiation event. The realization that such an event could occur at any time and without advanced warning is fundamental to the development of an adequate emergency philosophy. The value of pre-planning and emergency procedures is unquestioned.

It is the purpose of this report to: (1) make an assessment of the capabilities which are currently in place at Hanford to handle the multitude of serious problems arising from a serious radiation event; and (2) define the level of capability which the Hanford Atomic Products Operation should possess to minimize the consequences of such an accident. It is not the intent of this presentation to discuss the possibilities, probabilities, prevention or courses of serious radiation events.

In the analysis of the desired levels of capability, there are many cases in which the speed of response and other expected performances are stated specifically. While achieving the stated level of capability is desired and intended, the fact that the stated levels of capability are generally accepted

as an appropriate posture for a complex such as Hanford does not assure that these capabilities will in fact be manifested without fail by responsible people at the time that a serious radiation event is experienced. Reasonable deviations from the stated level of capabilities which were believed to have been achieved prior to a serious radiation event are to be expected, should an event ever be experienced. Responsible total action by trained individuals at the time of an emergency will be a combination of inspired individual efforts and disappointing performances. Nevertheless, having in place an analysis which broadly contains the overall desired level of capability will maximize the likelihood of effective rescue and recovery actions by individual plant components following a serious radiation event.

This study should be of value to the general management of Hanford and, specifically, to each department having responsibilities to plan and execute action following a serious radiation event. It is envisioned that the planning for emergency action will be conducted in each department to the point where the desired levels of capability are generally achieved. The action which may be deemed to be appropriate by the several concerned HAPD departments will vary substantially depending on the potential for serious radiation events and the current state of readiness.

II. CHARACTERIZATION OF SERIOUS RADIATION EVENT

A serious radiation event may result from a conventional type of non-nuclear accident occurring in facilities where large amounts of radioactive materials may be dispersed, or the accident may result from a nuclear event which in itself is the sole initiator of the loss of control.

In the nuclear event, uncontrolled criticality may occur where a large inventory of fission products exists prior to the excursion, and, therefore, is available for dispersal by an associated steam explosion or other similar occurrence. The nuclear event also may result from achieving prompt criticality from engagement of two or more individual subcritical components with no prior inventory of fission products involved. In the non-nuclear event, a fire or explosion which is not the result of any nuclear phenomenon may occur in a way that hazardous amounts of fission products are released to locations where extremely high dose rates to personnel may result and/or large on-plant and off-plant areas may be severely contaminated.

The following types of conditions are viewed as real possibilities even though improbable; they could exist either singly or in combinations as a result of a major radiation accident in the Hanford complex.

- (a) Ten to twenty persons may be killed or seriously injured and unable to move.
- (b) Seriously injured as well as uninjured personnel may be in locations where extremely high dose rates exist and high level air-borne and surface contamination are present.
- (c) Surviving victims may be dusted, pierced by minute missiles of fission products, or otherwise contaminated to where they themselves are hazardous to rescue and treatment personnel.

- (d) The facility involved may be in a status of complete disarray involving dislocated equipment, loss of power, fire, smoke, and noxious fumes which will badly hamper effective and prompt rescue action.
- (e) The conditions which caused the accident may still be unstable and capable of repeating the event, e.g., oscillating criticalities.
- (f) Areas may exist where a lethal dose of radiation may be received from uncontrolled or accidental entry by personnel.
- (g) Large inventories of fission product may escape to the environs, contaminating large areas to the extent that it may be necessary to evacuate non-plant personnel, deny access to public roads and other areas, and confiscate crops or other personal property.
- (h) The Columbia River may be seriously contaminated by an uncontrolled release of radioactive materials resulting in the necessity for prompt denial of access to and use of river water.

A realistic assessment of the demands that may be placed upon an operating organization following a serious radiation event indicates several important points.

- (1) Speed is essential in rescuing personnel from locations where high dose rates exist. The shorter the time which rescue personnel have to achieve the rescue, the more important it is that the rescue be made promptly.
- (2) Radiation levels and contamination levels will be orders of magnitude greater than those usually encountered in normal operating practices.

- (3) Medical personnel and facilities will be taxed to the maximum in endeavoring to treat effectively highly contaminated, seriously injured personnel.
- (4) The dispersal of large amounts of radioactive materials to the environs will tax the resources of Hanford and public officials to minimize serious radiation dose and property damage.

III. DESIRABLE PRACTICAL CAPABILITY

Hanford planning and capability to minimize and to recover from any serious radiation event should be advanced in a fully practical manner. This analysis does not constitute the ultimate in capability to cope with a serious radiation event; rather, it is intended to represent a reasonable balance between benefits and risks. The concepts presented are viewed as realistic and believed to be basically attainable with presently available technology.

Some of the desirable capabilities discussed in this section can be rather easily and quickly attained, while others are more involved and are more costly to implement. The quickly attainable capabilities should be in place in the near future - within the next 12 months. The more difficult capabilities should be attained as a second step toward improved preparedness and should be in place in the following year or two.

A. Detection

To minimize radiation dose following a serious radiation event, it is necessary to provide immediate signals to personnel located in the vicinity of the occurrence. A detection system with suitable alarms should be located in each plant facility that contains large inventories of radioactive materials. To assure immediate and proper response by plant personnel, it should be a system provided in addition to that necessary for routine detection of abnormal process conditions. The system should be capable of providing knowledge of the time of occurrence of the serious radiation event. It should provide an alarm due to a general high dose rate or to a gross emission of either beta-gamma or alpha emitting radioactive materials. The alarm should be clearly and distinctly recognized by all personnel in the vicinity. There should be no confusion or

uncertainty as to the meaning of the signal or the action that is required. To assure that any serious radiation event is detected promptly, the alarm signal should also be sounded at one always-occupied position remote from the location at which the event occurred.

To prevent the undue spread of contamination and to terminate the event as rapidly as possible, it is desirable that the detection system be equipped, where warranted, with automatic feedback equipment designed to initiate appropriate action such as the immediate shutdown of the process equipment, turning on of fog spray or cooling water protective systems, or the activation of similar protective equipment. If automatic feedback from detection systems does not control equipment such as process equipment, or fog sprays, then remote operating controls should be available, as warranted, to restore control over the event.

A high integrity detection system which remains operative over long periods of inactivation is required. False alarms should be eliminated to the extent possible; however, personnel training should be such that each alarm is treated as an actual occurrence and evacuation and emergency procedures are initiated and followed until evidence proves conclusively that equipment malfunction has occurred.

B. Evacuation

Immediate evacuation from the scene of the event is required to reduce the number of people who might be injured by the event and to minimize the time of their involvement. Immediate and correct response to the pre-established evacuation signals and evacuation plans is required of all personnel, including visitors and new employees. The affected facility or building should be evacuated without delay. Evacuation to the extent

necessary should be completed in less than 5 minutes. Transportation to accommodate evacuees should be available if necessary, and in a ready state.

Rescue personnel need the best information available to enable them to function at their top efficiency during the course of their rescue activity. An accounting of personnel normally assigned to the facility and any visitors should be completed within 15 minutes after the event, and should be reported to the rescue personnel to aid in the assessment of rescue requirements. In addition, information concerning people remaining in the building, and the cause or nature of the event should be promptly available from a quick interrogation of the directly involved personnel.

o C. Notification o

Immediately following the detection of a serious radiation event, it is necessary to provide notification to pertinent responsible persons including Fire Protection personnel, security patrol, medical personnel and management. The notification system should function rapidly, reliably, and completely regardless of the time of the event. All notification messages should be clear and well understood.

In a serious radiation event where high dose rates are encountered, prompt rescue action is required if lives are to be saved. There will not be time to plan prompt rescue actions (as contrasted to recovery actions) or to collect rescue equipment immediately after the event. The notification of Fire Protection or other rescue personnel, therefore, must be completed immediately and certainly within the first few minutes after the event.

In addition to notifying rescue personnel and emergency teams, assured notification of concerned functional groups, such as analytical laboratories, process technology personnel, and radiation protection personnel,

is required. These notifications should be completed within 10 minutes. The adjoining facilities should also receive prompt notifications so that any appropriate action may be initiated. The assistance of personnel in adjoining facilities may also be required and notification should clearly request assistance as appropriate. Direct communications channels between the site of the event and the Hanford Emergency Relocation Center (ERC), which is located in the 703 Building, should be rapidly established.

D. Rescue

Organized rescue responsibility should fall clearly to the professional rescue teams from the Fire Protection Operation. They should be prepared to cope with the rescue aspects of the event in the initial stages without assistance from other groups. They should be available immediately after the event; however, for a practical capability, arrival should be assured within 15 minutes. They should be prepared to rescue as many as 20 persons from the disaster site.

The rescue team should have an effective leader who will be capable of making on-the-spot decisions on the feasibility of rescue actions. The relationship between the authorities and responsibilities of Fire Protection rescue personnel and operating management should be clear. The rescue team should have instrumentation capable of measuring whole body penetrating radiation dose rates up to 5000 r/hr. They should be trained and competent to provide adequate control of radiation dose to themselves in the event that this is necessary. Rescue and recovery personnel should be capable of providing effective monitoring at extremely high dose rates.

E. Treatment

Emergency medical treatment facilities should be located near Hanford production or laboratory facilities such that injured and/or highly

contaminated personnel from the site of a serious event can be transported to a treatment facility within 15 minutes after rescue is effected. Competent medical staff should be available within 30 minutes to assure effective decontamination and medical treatment of injured personnel. A method for promptly segregating contaminated personnel and non-contaminated personnel is required. Good control of penetrating radiation dose and surface contamination is required at the emergency treatment facilities to minimize radiation dose to both patients and medical personnel.

The medical facilities should be equipped to decontaminate and treat as necessary 10 to 20 highly contaminated persons by semi-remote methods. Equipment and plans should be in place to perform necessary surgery and other medical treatment on contaminated personnel. In addition, these facilities should have the capability for providing necessary nursing and medical treatment for an extended period of time (several months).

A method to identify and segregate promptly personnel who have received penetrating radiation doses greater than 100 rads is required. These personnel may require direct medical treatment to improve their chances for survival. The general course of treatment for these patients and/or high internal deposition patients should be thoroughly planned and well known by all physicians. All immediately required equipment and supplies for proceeding with this treatment should be available at the emergency treatment facilities.

A method of controlling and measuring the radiation dose to all personnel at the local First Aid station and at the emergency treatment facilities is required. The radiation dose received by physicians, nurses, and other helpers in the course of treatment should be controlled to appropriate emergency limits.

F. Control of Event Area

Trained personnel with equipment to establish a safe boundary around the event area and prevent unauthorized entry should be available. Readily accessible and safe control points through which entries and exits are made to the event location should be established within 30 minutes. These control points should have facilities for interrogation, contamination survey, dosimeter collection, segregation of high dose personnel, medical check, communication, and necessary transportation to decontamination and First Aid facilities.

Within two hours a more permanent site staging area should be in place to assure adequate field headquarters and communications with the Hanford Emergency Relocation Center (ERC). The site staging area should provide local authoritative leadership in controlling and directing personnel movement and effort, directing the utilization of equipment, measuring and controlling dose, recording information obtained, and maintaining necessary accounting of persons re-entering the involved location.

G. Analysis of Event

Technical support teams should be assembled to reconstruct the cause and course of the event and determine its severity. The support team should normally include physicists, radiation protection personnel, management, and local supervision and process development group personnel knowledgeable in the process and equipment involved. Major team members should be pre-selected on a permanent basis. The team should have the ability to make quick and complete interrogation of involved personnel by pre-planned methods. Maps should be available which indicate the location of charts, instrument readings, process procedures and current status, etc., which may be of assistance in making assessments in the problem area. Pre-planned

methods of securing these charts, instrument readings, and other data in a safe manner are required.

Pertinent samples which can supply timely data in helping to determine the magnitude of the event should be obtained. Some of these samples may be available only temporarily because of their rapid radioactive decay. The type of samples to be collected and where and how they can best be collected should be planned before the event. The type of analysis required and the equipment needed to complete timely analysis should be considered as part of the pre-event planning. The retrieval of fixed criticality and other dosimeters necessary for personnel treatment purposes should be completed within a period of 2 hours. The equipment and procedures for interpretation of these dosimeters should be immediately available.

H. Stabilization

Remote methods to terminate and prevent a recurrence or extension of a serious radiation event without undue radiation dose to personnel should be considered for each process and for each facility. It is necessary to assure at an early time that the event has been stabilized and that a recurrence has been prevented.

Design and operating practices should assure a minimum release of radioactive material from any breach in the facility's confinement. Methods and equipment to control the spread of contamination within the facility and in the environs should be ready for use within one hour. Prompt control of contamination at the locations near the event can appreciably reduce subsequent environmental problems.

° I. Control Center

Promptly following notification that a serious event has occurred, the activation of the Hanford Emergency Relocation Center (ERC) should be initiated. At the ERC located in the 703 Building basement, a collection of both management and appropriate technical representatives should be assembled promptly, within 30 minutes. The relationships involving authorities and responsibilities between the ERC and the ranking management of the field headquarters should be clear. A clear and concise method of reporting the chronology and the status of the activities at the event site should be established at the ERC.

J. Dosimetry

A method is required to identify within one hour personnel who have received penetrating radiation doses probably greater than 100 rads. This identification process should be possible for personnel with or without Hanford personnel dosimeters. The penetrating radiation dose in rads of each individual involved should be established to within ± 25 percent within the first 2 hours.

The ability to identify within the first hour personnel with probable internal radionuclide depositions greater than one-half the maximum permissible body burden for radionuclides with effective half-lives greater than 3 years is required so that prompt medical treatment to minimize body depositions can be initiated. The magnitude of the internal radionuclide depositions of all personnel involved in the event should be determined to within a factor of 2 within the first few days.

During all emergency operations penetrating radiation dose measurements should be capable of establishing personnel doses to within ± 25 percent. A

Careful record of total radiation exposure for each person involved in the event and for each person participating in the recovery from the emergency should be maintained.

K. Delineation of Extent of Problem

An essential part of taking care of any physical emergency is the determination of the boundary of the problem and the severity within the boundary. The radiation status at the site of the event should be known within 2 hours. In conjunction with dose rate determinations at the site of the event, the extent and severity of contamination in the adjacent areas and in the environs should be determined. Changing conditions should be detected quickly to prevent involvement of large numbers of people and large quantities of equipment. Air contamination and radiation surveys should be completed within one hour to permit the selection of a site staging area which is unlikely to be affected by changing conditions.

The radiation status of the Columbia River should be determined within an hour. Significant contamination in the river should be detected in time to prevent access to or use of the highly contaminated river water by downstream users.

It should be possible to determine within a 30-minute period if off-plant areas will have significant contamination problems. Mobilization for aerial and automotive surveys should be underway within 30 minutes following a radiation event. If a cloud of radioactive material is formed, the estimated dose rates from the cloud and its probable path should be determined within one hour. Hanford personnel should be capable of delineating promptly land areas where: (1) confiscation of milk, produce, and other foodstuffs is probably necessary; (2) controlled entry or evacuation is necessary; and (3) severe radiation dose is likely.

L. Off-Plant Control

Detailed plans for the confiscation of produce, milk, and other food-stuffs, and the necessity for evacuation of people should be in place. With the assistance of public officials, control over entry to and exit from highly contaminated zones should be established within 2 hours following the event. Emergency survey and decontamination field stations should be manned within the first few hours. A program to determine amounts of internally deposited radioactive materials in people in the environs should be available.

M. Technical Assistance

Expert assistance in areas of physics, reactor control, radiation protection, meteorology, and other technical fields should be available within one hour to provide necessary technical guidance to the Hanford Emergency Relocation Center staff. Within the first few hours following the event, there should be capability of proving or disproving the occurrence of a nuclear excursion. The total number of fissions occurring in any nuclear excursion should be known within 6 hours. Special equipment and technical analysis should be available to provide an approximate determination of gamma energies at the event site to assist in the correct interpretation of personnel dosimeters.

Within one hour of the event, analytical laboratories should be activated and ready for the analysis of soil, water, foods, and process samples. Full capability should be achieved for analysis of "group samples" to provide rapid assessment of their radiological significance.

N. Support Capabilities

Needed equipment and equipment operators should be available at the event site within a 2-hour period. The maintenance of this equipment under

severe conditions is required. The aid of various types of specialists, such as construction foremen, special equipment operators, shop craftsmen, etc., should be available within a period of 2 hours.

Sets of architectural and process drawings of any facility within which an event has occurred may be of fundamental value in the analysis of both rescue action and personnel dosimetry. Drawings of any facility should be available to any group having need for them within a time interval of one hour.

0. Information

Direct communications between the site staging area and the Hanford Emergency Relocation Center should be established within 30 minutes. These lines of communications should provide for transmitting complete and accurate information concerning the event, rescue, and progress of the recovery operations. Policies, facilities and planned methods for transmitting information to the AEC, plant forces, public officials, and the general public are required. Capability for effectively handling direct inquiries from news reporters and others who come to collect information on a first-hand basis should be assured.

IV. PRESENT CAPABILITY

Hanford's current capability is derived primarily from the abundance of technical ability, extensive radiation control experience, and special equipment available. The Hanford complex also provides in depth readily available support in analytical, fabrication, and maintenance facilities. In reviewing these capabilities, it should be recognized that in any actual situation exceptional performance may be evidenced in some areas through inspired individual efforts while disappointing performance in other areas should also be anticipated.

A. Detection

In the 100 Areas, all reactor buildings process areas are equipped with provisional detectors, pending procurement of specially designed equipment. Alarms consist of a siren in all but one installation. Alarm relays do not provide a continuous alarm. The alarms are actuated at various dose rates dependent upon the local operating conditions.

High radiation alarm systems are installed at various points of high potential throughout the reactor buildings, including the front and rear reactor faces and at the wash pad and transfer area pits. Trip points are normally adjustable. Personnel action on alarm is normally to investigate the cause of the alarm rather than to evacuate. Trip point adjustment and alarm reset controls are readily accessible and frequently used. At the present time, there is no assurance that the occurrence of a high dose rate event would be promptly detected.

In the 200 Areas, 31 criticality or high-level radiation detectors are installed, and 5 more are planned for installation during 1961. The locations of the 200 Area detectors are given in Table I.

TABLE I

HIGH DOSE RATE RADIATION DETECTORS - 200 AREAS

<u>Location</u>	<u>Detector Light & Siren</u>	<u>Remote Alarms</u>
<u>In Place</u>		
234-5 Bldg.	10	10
224-U	1	1
224-UA	1	1
202-A	10	17
233-S	2	3
202-S	2	3
222-S	1	2
231-Z	4	2
<u>Planned</u>		
Incinerator Bldg.	1	1
Recuplex	3	6
Waste Treatment	1	1

All alarms actuate at 500 mr/hr and continue to sound until reset regardless of the duration of the high dose rate conditions. Each facility has equipment and procedures to calibrate and functionally check each detector once each week. The alarms are bypassed during test but the return of alarms to service is automatic. All detectors are switched to the emergency electrical system on loss of electrical power, without sounding the alarms.

The 200 Area criticality audible alarms are sirens. Other siren signals in the 200 Area facilities have been removed to avoid any possible confusions. In most situations, two detectors view the same work locations although they are not placed together. In the last year and a half there has been but one false alarm. It appears reasonably certain that a criticality event occurring in a 200 Area facility would be promptly detected.

Nineteen criticality or high-level radiation detectors with alarms have been installed in 300 Area facilities, and one other is planned for installation in the Plutonium Recycle Program Critical Facility. The locations of the 300 Area detectors are given in Table II.

TABLE II

HIGH DOSE RATE RADIATION DETECTORS - 300 AREA

<u>Location</u>	<u>Number of Detectors</u>
305-B Bldg.	1
306	2
308	8
309	3
321	1
325	2
326	1
327	1

There are no remote alarms for the 300 Area installations except for an alarm from the Columbia River Monitoring Station. Alarms are actuated at various dose rates dependent upon the local operating conditions and continue to sound until reset regardless of the duration of the high dose rate conditions. Two false alarms have been experienced in the 300 Area.

Specific instrumentation for recording the time of an occurrence is not generally incorporated in detection systems in the 300 Area, and except for containment trips at the Plutonium Recycle Test Reactor, automatic actuation of shutdown of equipment has not been deemed to be warranted and is not utilized. There appears to be reasonable assurance that a high dose rate event occurring in the 300 Area facilities would be promptly detected.

Generally, throughout the Hanford production facilities and laboratories there are systems of supplementary alarming instrumentation which are used for normal operational control. These provide broad detection coverage of abnormal radiation conditions, whether of serious radiation event magnitude or routinely encountered operating conditions.

Equipment employed in the 200 and 300 Areas is generally capable of distinguishing between a severe radiological event and an abnormal process condition. Equipment and methods employed in the 100 Areas provide less assurance that such a distinction can be made.

B. Evacuation

Evacuation procedures have not been prepared and thoroughly discussed with all personnel in some of the Hanford facilities. Posting of the descriptions of different alarm signals or the distribution of a brief note describing procedures and signals has been commonly used. This has not resulted in an adequate understanding of what action is expected. Some facilities have extensive, periodic and individual training of their personnel. Pre-planned practice evacuations have shown that clearing of buildings requires about 5 minutes, and clearing of an area requires about 10 to 15 minutes.

Very few facilities have provision for automatic shutdown of process or ventilation equipment on high-level radiation or criticality signals. Some procedures do, however, require manual shutdowns on receipt of such a signal in the control room. No information has as yet been given operating personnel which would enable them to judge the feasibility and consequences of attempting to rescue an injured fellow worker or taking time to manually shut down equipment prior to evacuation.

In practice evacuations, no known attempts are made to account for personnel. Also, facility supervision normally has no way of knowing who, or how many people are in the facility at any given time. It is likely that in case of a serious radiation event, an accounting of personnel would not be possible. The operating crew could be accounted for, but visitors and transient personnel could not.

Current procedures require the notification of Patrol in any kind of emergency event; their prompt response to the site of the emergency is assured. Patrolmen are trained, equipped, and expected to direct and control traffic and to provide emergency transportation and communications. Patrolmen are experienced in these functions, but can be expected to satisfactorily carry them out in a radiological emergency only if they are given enough information to know what actions are appropriate. Procedures specifically spelling out Patrol's initial action following a radiation event have not been prepared.

C. Notification

All emergency procedures require the prompt notification of the local Patrol station. Communication facilities at these area Patrol stations are continuously manned. Notification to Patrol of a serious radiation event would be by telephone, radio, or messenger. In most cases, an oral description would be used, which would not assure prompt understanding of the nature of the event by the patrolman. Significant delays in notification can result when the message is transmitted by a messenger. Upon being informed of an emergency event, the local Patrol stations is required by procedure to notify the Patrol Emergency Officer immediately. This officer is responsible for activating the appropriate crash alarm notification or evacuation plans; however, these actions are to be taken only on

specific instruction of designated management. This restriction is intended to prevent errors of judgment on the part of Patrol personnel. It can result in excessive delays in notification of rescue personnel.

The professional rescue teams from the Fire Protection Operation are best qualified and equipped to provide initial organized rescue functions following a serious radiation event. Current procedures require the notification of the Fire Stations. If a fire or possible loss of life were reported, or if they were specifically requested by the Patrol Emergency Officer, the firemen would proceed to the site. The prompt response of Fire Protection personnel to a signal of a radiation event without an accompanying fire or immediate loss of life would not therefore be assured by existing procedures.

Patrol notification action is independent of the nature of the event. This uniform response to an unusual event minimizes the possibility of an incorrect choice from several call lists. The call list does not provide special notification of supervision in facilities adjacent to the one affected.

The rapid response of Patrol cars to the site of a local emergency assures the rapid establishment of direct radio communications between the site and the Hanford Emergency Relocation Center.

D. Rescue

The professional rescue teams composed of Fire Protection personnel are trained and equipped for prompt, organized rescue operations, and will normally be relied upon to perform this function. Assistance should not, in general, be expected from personnel who were present at the site of the event. It is not anticipated that Patrolmen or others near the site will participate in immediate rescue; they are not trained or equipped for this

service, nor can they be counted on to have the detailed knowledge of the facility layout which is required. On proper notification, firemen are capable of rapid movement to the site. Since they maintain a constant state of readiness, their delay in getting to the site is essentially only the travel time required. Emergency equipment useful in rescue work is carried on each fire truck and is immediately available. Each engine carries four independent air supply masks, light sources, and other conventional rescue equipment.

The Fire Protection officers are trained to make quick decisions. The firemen are trained to obey all commands from these officers promptly and without question. Rescue leadership appears assured.

Fire Protection officers are called upon to make risk-benefit evaluations as a normal part of their work. They are not trained or equipped to include radiological factors in risk evaluations. The 100 Area Fire Protection groups do not carry radiation monitoring equipment of any type. The 200 Area and 300 Area fire trucks carry a single monitoring instrument, capable of measuring dose rates up to 5 r/hr. In general, it is established procedure for operations personnel to meet the firemen before they enter a building in order to provide detailed information on current operating conditions.

Some reluctance to enter radiation fields as high as 100 r/hr or greater can be expected from many non-professional Hanford employees, since they are trained for normal operating conditions, and have not been specially trained in extremely high dose rate emergency work. While all plant firemen have received cursory instructions in the use of common radiation monitoring instruments, they are not equipped or familiar with instruments capable of measuring the very high dose rates expected to result from a criticality or other serious radiation event.

Area rescue squads not composed of firemen have been established within all areas, and constitute a second line of defense to the firemen. The 300 Area rescue squad consists of nine specially-trained supervisory personnel. This squad has demonstrated the ability to mobilize in less than 10 minutes on day shift and could be mobilized and ready for action in about 30 to 45 minutes at other times. The area rescue squads in the 100 and 200 Areas are composed primarily of operating personnel. The practice of rotating men through this assignment on a rather rapid frequency results in limited capabilities.

In a major radiological emergency, the rescue training and prompt arrival of the firemen would probably limit the need for the rescue squad for immediate emergency rescue; however, the backup personnel and equipment provided by the area rescue vehicles could prove invaluable as the rescue work proceeds. Each area rescue vehicle is equipped with conventional rescue equipment plus eight independent air supply masks and four emergency monitoring kits.

E. Treatment

Patrol operates an ambulance service which is continuously available at all areas on request. In addition, Patrol cars at the scene can provide transportation to First Aid stations or emergency treatment facilities.

First Aid stations are maintained in all plant areas with the only emergency treatment facility located at the 200 West Area. The 200 West facility is equipped for major surgery but could treat only a few seriously injured and highly contaminated patients. It is not equipped with radiation shielding to control the radiation dose to the medical staff. The waiting room provides space for 10 to 20 incoming patients. Other First Aid stations are equipped for only the routine first aid services to a few patients

at a time. If access to First Aid stations in the local area is not denied by the event, patients can be delivered to medical facilities within about 5 minutes after rescue. If local facilities were not accessible, or if more than a few patients were involved, it would be necessary to transport patients, including those seriously injured and/or contaminated to adjacent area First Aid stations. Moving seriously injured and/or highly contaminated patients to 200 West Area would be medically necessary because of the lack of adequate medical facilities at other First Aid stations. Transporting highly contaminated patients to the Kadlec Hospital is not feasible and is viewed as an unacceptable threat to primary community medical facilities.

A First Aid nurse would usually be available within the first 15 minutes. The nurses can treat injured patients but would require the assistance of well trained monitoring personnel to cope with grossly contaminated patients. Physicians would probably not arrive for 30 to 60 minutes, although telephoned directions from medical authorities should be available almost immediately. Several Hanford staff doctors could be available within the first hour. Additional assistance by private practice physicians could be obtained through established medical channels.

The Hanford physician staff is competent to cope with the acute effects of contamination or high radiation doses. Care of delayed effects, including bone marrow transplants, can be provided using makeshift arrangements and equipment. Hanford has a sufficient number of highly trained and experienced radiation protection personnel to provide technical assistance to the physicians in radiation dosimetry and control techniques.

To assure the prompt medical treatment of involved personnel, it is necessary to sort injured from uninjured, contaminated from non-contaminated, and high dose individuals from low dose individuals. The injury status of

individuals can be quickly determined by physicians. Contamination sorts can be made only if instruments, personnel capable of using them, and a sufficiently low background are available. Some delay can be expected in completing contamination checks; there is no assurance that highly contaminated patients will not be taken into First Aid facilities without detailed knowledge of their contamination status. The First Aid stations are not designed or equipped to control the spread of contamination in the amounts which may be expected in a serious radiation event. Contamination spread between patients, and to equipment and supplies can be anticipated.

Inadequate facilities exist for handling contaminated patients. Shower facilities are available for use in personnel decontamination at several locations in each area. These shower facilities are not normally equipped to handle high level contamination cases. Generally required equipment and methods for assistance in the prompt and effective decontamination of 10 to 20 highly contaminated persons are not available.

During the treatment of highly contaminated patients, physicians can receive significant radiation doses. Not all Hanford staff physicians routinely wear personnel dosimeters. If medical assistance were required at the site of an event outside of a plant area, there is not complete assurance that the radiation dose to the physicians would be measured. Since dosimeters are issued on entry to plant areas, the radiation dose received by medical personnel at the First Aid stations and at the emergency treatment facility would be measured.

Procedures to be used in minimizing radiation doses to medical personnel have not been established. The use of lead-filled aprons for shielding personnel during work on highly contaminated patients has been considered. Aprons could easily be obtained; however, they are not on hand at the First Aid stations.

F. Control of Event Area

Detailed procedures to be used in controlling personnel access to the site of the event have not been established. The patrolmen who will arrive promptly at the site are experienced and ready to perform this function, but have not been instructed beforehand in a course of action.

Radiation surveys are required to select safe control points. Without pre-established procedures, and assured prompt monitoring, significant delay can be expected before control is achieved over the area surrounding the event. The establishment of a safe control perimeter cannot be assured until after the arrival of supporting monitoring forces together with necessary survey equipment.

Several functions should be performed immediately following the evacuation of the facility, including accounting for personnel, interrogation of those involved, and segregating the injured, the contaminated, and the highly exposed. Directly involved persons cannot be counted on to perform these functions. The work would fall to others available at the site shortly after the event.

It is generally agreed that operating personnel would concern themselves with personnel accounting, interrogation of directly involved persons, and attempting to determine the nature and severity of the event; some pre-planning for accomplishing these functions has been done.

Immediately after the event, assisting personnel will find themselves faced with a multitude of problems more severe and numerous than they normally experience. Monitoring personnel are partially trained for emergency work. They would be in demand to secure protective equipment, perform the "quick sort", and assist in decontamination, contamination control, and in dosimeter issue and collection. General procedures for coping with

the heavy monitor work load which may be expected have not been prepared. Considerable confusion can be expected at the site of the event, and it is questionable that necessary emergency work would be performed in an orderly and timely manner in all locations.

It would be difficult to achieve control over personnel movements, assure proper recording of information, and mobilize necessary personnel and equipment until an effective site staging area has been established. Although formal criteria for establishing site staging areas have not been prepared, the general dispersement of Hanford services and facilities provide adequate assurance that effective field headquarters could be established promptly.

Control of radiation dose to persons within the affected area can be achieved by dose rate monitoring. Fifty instruments capable of measuring dose rates to 5000 r/hr were recently purchased but are not yet deployed to field locations. Direct reading, high range (0-50 r) pocket dosimeters are available but not yet deployed to field locations. Measurement and control of penetrating radiation dose received by rescue and recovery personnel during emergency operations at the site appears adequate.

G. Analysis of the Event

Valuable information relating to the nature and severity of the event may be obtained from involved personnel. Procedures for obtaining first-hand observed information have been established for the major chemical processing plants. There is little assurance, at other locations, that all pertinent information available from the evacuees would be promptly available for analysis.

Large numbers of people highly competent in a broad variety of technical and functional fields are available at Hanford. A capability for organizing the required technical support teams at the site appears assured.

Most Hanford facilities are equipped with process and radiological recording instrumentation. Access to this information would be of value in analyzing the event. Shift coverage in many production and laboratory facilities provides increased assurance that knowledge of the location and function of this equipment would be readily obtainable from persons not involved in the event.

Special samples of materials for radiochemical analysis would be necessary. Little planning of selected materials for sampling has been done. Complete laboratory facilities and a wide variety of equipment are available at Hanford for sample analyses. The lack of special planning to cope with high-level samples increases the possibility of laboratory contamination with the subsequent loss of analytical sensitivity. Large numbers of radiation monitoring instruments and air samplers can be made available at the site within one hour of the event. Capabilities for determining the source and magnitude of the event are good.

H. Stabilization

Action which may be required to stabilize a radiological event such as poisoning or disassembling a critical assembly, the application of water by fog spray or fire drenching systems to minimize the release of radioactive materials, soil stabilization, and erection of shielding walls to improve accessibility are generally known to many Hanford people. These techniques have been applied in minor incidents in the past. Although little detailed planning has been done for applying such techniques in case of a serious radiation event, extension of these techniques to a major event condition appears practical.

I. Control Center

The Hanford crash alarm systems would call the alert for manning the Hanford ERC at the 703 Building. Previous crash alarm calls have indicated that the ERC can be partially manned in about 15 minutes. The division of responsibilities between the site staging area and the ERC has not been specifically defined. Methods for recording and assembling information at the site staging area and at the ERC have not been specifically prepared to assure effective utilization of all available information.

J. Dosimetry

Hanford policy requires that all persons who enter plant areas wear an individually-assigned personnel dosimeter. This practice makes it unlikely that any person involved in an event would not be wearing a personnel dosimeter; however, the dosimeter may be lost during the course of the event or in the subsequent rescue action. If the personnel dosimeter is available, a determination of the gamma dose can be made within 90 minutes after the dosimeter is delivered to the 300 Area. Present capabilities provide for the evaluation of penetrating gamma radiation doses in the range from 0.05 r to 2000 r. The error of the evaluations is about ± 10 percent at the lower doses but increases gradually to about ± 50 percent at 2000 r. The neutron dose would be difficult to establish from the personnel dosimeter. Estimates of neutron dose from blood sample counting should be available in a few hours.

A "quick sort" procedure has been formalized, and personnel have been partially trained in segregation of highly exposed individuals following high neutron exposure. The "quick sort" procedure can identify within a few minutes after the event an individual who has received a high neutron

dose, if the individual is not contaminated, and a low background is available at the sorting location. Personnel could, in certain situations, receive massive doses of gamma radiation without external contamination and not be detected by the "quick sort" method which is specific for high neutron doses. In such a case, personnel dosimeter evaluation would provide the first signal that a large radiation dose had been received. This information would be available in about 2 hours after the event.

In support of the individually-issued dosimeters, there are 90 threshold neutron detectors located throughout Hanford which are suitable for evaluating both neutron spectra and flux. To the extent practical, these detectors were placed for easy recovery. The neutron flux and spectra data would be available one hour after receipt of these detectors in the 300 Area. Included with each threshold neutron detector are three glass rod dosimeters which can be evaluated in about 30 minutes after delivery to the 300 Area. Also, there are some 240 emergency monitoring film dosimeter stations which can be evaluated for gamma doses to 2000 r.

Complete film dosimeter processing facilities are available. Personnel can be mobilized within one hour. An isolated supply of dosimeter film is retained at the Central Stores Building. Alternate film processing centers could be established easily in Richland, although no specific plans to do this are in place.

A fully-equipped calibration facility is available. This facility could be manned within about one hour. Calibration support can be provided even if only limited access to the building and equipment is possible. The simultaneous loss of access to the Calibrations Building and film processing facilities would prevent film dosimeter evaluation until alternate calibrations arrangements could be established.

Bioassay procedures have been established for identifying, within the first few hours, individuals with greater than one maximum permissible body burden. Persons with greater than one MPBB of plutonium can be identified in the first few hours. Whole body counting techniques can be used to identify persons with significant fission product deposition. The policies to be followed with respect to very highly radioactive bioassay samples have not been formalized, although screening of samples at the 329 Building could be readily accomplished.

K. Delineation of Extent of Problem

The Environmental Studies and Evaluation group would assess the environmental consequences of a serious radiation event. Members of this group have radio-equipped cars, and access to one airplane. They are experienced in assessing the environmental consequences of small emissions, but have not experienced a serious radiation event. The group can be mobilized promptly during day shift, and can be mobilized in about one hour on night shifts. Special mobilization plans for a serious radiation event have not been prepared.

Technical assistance would be promptly available from Atmospheric Physics and Radiological Physics personnel during the day shift. At other times representatives of these groups can be assembled in about one hour. Prompt notification to the meteorologists following the event will permit a prediction of the azimuths between which the fission product cloud should pass. This prediction can be completed within 15 minutes. Several of the members of the Atmospheric Physics and the Environmental Studies and Evaluation groups can predict the probable area of maximum deposition and could establish the theoretical boundaries which should

contain all "significant" deposition. Field measurements of the deposition and boundaries of the affected area are required to confirm the predictions. Initial ground survey results should be available within 2 hours.

The rapid confirmation of predictions required for effective evacuation action can be attained only by aerial survey methods. The aerial survey plane is maintained in standby condition. Aerial surveys should define the boundaries of the affected area within the first 2 hours, if flying conditions prevail and the aircraft is available. The relative priority which aerial survey would demand as compared with other uses of the Hanford aircraft during times of emergency has not been established.

Contamination problems in the Columbia River would also require prompt attention. Hanford representatives could be sent to the downstream water intake pumping stations to watch for the arrival of any abnormal contamination condition. A boat is available for river survey. Calibrated instrumentation to relate water dose rates or count rates to contamination status is not immediately available.

L. Off-Plant Control

Emergency limits for confiscation of contaminated foodstuffs and crops contaminated with I^{131} have been investigated but have not been formally documented. Emergency limits for other radionuclides have not been established. Procedures to be followed in the confiscation of milk and foodstuffs have not been prepared, although some special instruments for assessing I^{131} concentrations in milk and water are available. With the cooperation of public officials, a control program could be placed into operation in time to prevent significant internal deposition by ingestion.

Telephone, television, and radio evacuation instructions could be issued within one hour. No specific procedures have been established for providing evacuation notifications.

It appears unlikely that fast action to clear the river of personnel would be required. The river flow times should provide better than a day before reactor contaminants would reach water users. Only a serious radiation event at the Plutonium Recycle Test Reactor or other 300 Area facility could necessitate prompt river control action. The radionuclide concentrations at which pumping of Columbia River water into sanitary systems should be stopped have not been formalized.

M. Technical Assistance

Because a large number of highly-skilled employees reside in the immediate vicinity of the plant, expert assistance of almost any type could be available within one hour. The role that these people would be expected to play and the extent of their responsibilities in case of a serious radiation event has not been defined.

Analytical laboratory facilities are available within one hour. Analytical work could be performed in the 200 Areas if the 300 Area facilities were not available. Hanford Laboratories' people would be available to assist in performing these functions. Poorer sensitivities exist at these facilities but this should not particularly limit their usefulness under emergency conditions.

N. Support Capabilities

Hanford is well equipped with motor-powered equipment and skilled operators. A summary of some of the equipment available at Hanford is given in Table III.

TABLE III

MOTOR-POWERED EQUIPMENT AVAILABLE

<u>Equipment</u>	<u>Number Available</u>
Ambulances	8
Fire Trucks	16
Emergency Rescue Vehicles	4
"Disaster" Trailers	2
Dump Trucks	20
Light Plants	62
Tank Trucks	17
Dozers	19
Cranes	17
Road Oilers	1

Portable light sources are located within all major buildings, and portable light plants are available. Protective clothing and respiratory protection equipment can be rapidly assembled. The wide distribution of equipment assures the availability of sufficient equipment and supplies. Generally, any Hanford equipment can be delivered to the site within 2 hours of a request.

Following an event, radiation monitoring instruments could be collected from the adjoining plant facilities for emergency use during rescue efforts. The only shortage that might occur would be high range dose rate instruments.

The shift and geographical distribution of personnel skilled in radiation monitoring makes it very probable that adequate radiation monitoring assistance for rescue and recovery work would be available within 30 minutes after the event occurred.

Each plant area has a maintenance shop capable of fabricating special equipment. The large Hanford supply of various craft skills assures that

specially-skilled manpower could be mobilized within about an hour. Engineering files including architectural and process drawings of all Hanford facilities are available. Special plans to assure their availability on an emergency basis have not been made. At the present time, these drawings could be made available in about 4 hours.

O. Information

Direct communications between the site staging area and the 700 Area ERC is assured by the prompt response of radio-equipped Patrol cars. Two disaster trailers equipped with complete communication centers including radio, telephone, and teletype services are available for use as a mobile ERC. About 4 hours would be required to mobilize and move this equipment to any Hanford location.

If an event occurs within the Hanford perimeter, the normal access restrictions will effectively control newsmen and other members of the public who wish to observe or to collect information first-hand. For an event occurring outside of the Hanford perimeter, the barricade will, of course, not provide a physical barrier to prevent direct public observations and news collection at the event site. In either situation, there will undoubtedly be many calls to operating personnel from the public and news services. Plant personnel have not been specifically instructed in the policies to be followed should they receive one of these calls or be asked for a statement.

Formal information releases to news media and the public can be effectively handled through established channels. Effective procedures are also established for distributing information throughout the plant workforce.

V. ACTION SCHEDULE

Achieving the desirable level of capability to cope with a major radiation accident with a reasonable balance between risk, benefit, and cost requires a number of actions ranging in time and magnitude of expenditure. While the individual actions which will be required by the several components at Hanford will be different in need and degree, the final level of capability which should be achieved should be about the same in each Hanford processing or laboratory facility. Similarly, there should be some generally uniform early level of capability achievable by administrative actions which should be assured at each pertinent location at Hanford.

Those capabilities in Section III which can be attained by appropriate administrative actions such as planning, procedure preparation or training should be promptly attained as intermediate steps toward the achievement of the eventual level of capability. Completion of these steps will provide a high percentage of the total required capability at a low percentage of the total cost. These steps should be completed on a priority basis in the near future, 6 to 12 months.

Some of the desired practical capabilities require the design or purchase of equipment or facilities. Although it is not reasonable to obtain full capability in areas requiring this action within a 12-month period, the necessary planning and the initial steps leading to the design or procurement of the required equipment or facilities should begin now as part of the longer-range program (about 2 years) to achieve the capabilities as described in Section III. Items such as the design and installation of more elaborate and more automatic detection systems and the addition of the emergency medical treatment facilities are viewed as a part of the longer-range program.

END

**DATE
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9/22/93