OBJECTIVE 5: EMERGENCY WORKER EXPOSURE CONTROL

OBJECTIVE 5: EMERGENCY WORKER EXPOSURE CONTROL

OBJECTIVE

Demonstrate the capability to continuously monitor and control radiation exposure to emergency workers.

INTENT

This objective is derived from NUREG-0654 which provides that OROs should have the capability to determine the radiation exposure received by emergency workers; provide for the distribution, collection, and processing of direct-reading dosimeters and non-self-reading dosimeters, provide for direct-reading dosimeters to be read at appropriate frequencies by emergency workers; maintain a radiation dose record for each individual emergency worker; and provide for establishing a decision chain or authorization procedure for emergency workers to incur radiation exposures in excess of routinely authorized emergency exposure limits. This objective should be evaluated in concert with Objective 6, Field Radiological Monitoring - Ambient Radiation Monitoring; Objective 8, Field Radiological Monitoring - Airborne Radioiodine and Particulate Activity Monitoring; Objective 18, Reception Center - Monitoring, Decontamination, and Registration; Objective 20, Medical Services - Transportation; Objective 21, Medical Services - Facilities; Objective 22, Emergency Workers, Equipment, and Vehicles - Monitoring and Decontamination; Objective 24, Post-Emergency Sampling; and Objective 25, Laboratory Operations. (See evaluation criteria from Planning Standards H., K., and N.)

An **emergency worker** is an individual who has an essential mission to protect the health and safety of the public who could be exposed to ionizing radiation from the plume or its deposition. The emergency worker must be trained in the basic characteristics of ionizing radiation and its health effects. The individual working in a high radiation exposure rate area must be able to determine his or her cumulative radiation exposure with a direct-reading dosimeter and know what to do when turn-back radiation exposure limits and exposure rate values are reached while carrying out a mission to protect the health and safety of the public.

Individuals who may be required to incur significant radiation exposure under emergency conditions include the following: radiation monitoring team personnel; transportation services (evacuation vehicle/bus drivers); law enforcement, fire fighting, and rescue personnel, including ambulance crews; personnel carrying out backup route alerting procedures; traffic control personnel; some personnel at institutional, health service, or industrial facilities, and some essential services or utility personnel (electric, gas, water, water treatment, telephone, etc.). These personnel are considered emergency workers

when their services are required to protect the health and safety of the general public during the emergency phase of an accident.

For purposes of assigning direct-reading dosimeters, emergency workers should be categorized as to: (1) the particular emergency worker assignment, (2) whether they will be working in a potentially high exposure rate area [greater than 0.1 Roentgens per hour (R/h)], or (3) whether they will be working in a potentially low exposure rate area (less than 0.1 R/h). Areas inside the plume emergency planning zone (EPZ) should be considered in category (2). Areas outside the plume EPZ should be considered in category (3).

Emergency workers assigned to categories (1) or (2) include the following: radiation monitors, police and law enforcement, firemen, rescue personnel, ambulance crews, evacuation vehicle/bus drivers, essential services or utility personnel, and personnel carrying out backup alerting or traffic control functions. They may be exposed to the airborne release while carrying out their missions. Consequently, the means for measuring the radiation exposure of these personnel should be available at the beginning of the nuclear accident.

The following are examples of emergency worker activities that should be performed in category (3), a low exposure rate area: dosimeter issuance and collection, and dose record keeping at dispatch locations for radiological monitors, emergency workers, and environmental/agricultural sampling team collectors; traffic and access control points for reentry, emergency operating centers; counting laboratories; communication centers; reception centers where evacuees are monitored for contamination; decontamination facilities; hospitals and other medical facility personnel.

Radiation exposure limits for emergency workers, as defined by the Environmental Protection Agency (EPA), are the allowable accumulated dose emergency workers may be permitted to incur during an emergency.[1] This dose, which is based on an actual personal dosimeter reading, is in contrast to the protective action guides (PAG) which are estimates of future dose that can be avoided by specific protective actions. Radiation dose limits, as used in this objective, are only for individuals (workers) under emergency conditions. The emergency is assumed to end when the uncontrolled release of radioactive material has been stopped, the source of radioactive material in the reactor has been brought under control, and the public has been protected through the implementation of protective actions, such as sheltering, evacuation, and relocation. However, additional short term emergencies could occur (e.g., the need to fight a fire in a high radiation area). The dose to emergency workers should be treated as a once-in-a-lifetime exposure, and should not

[1] Manual of Protective Action Guides and Protective Actions for Nuclear Incidents, EPA 520/1-75-001A

be added to occupational radiation exposure accumulated under non-emergency conditions.
Emergency workers without a public health and safety mission, such as farmers for animal care, other agribusinesses, essential utility service personnel, or other members of the public who must reenter a restricted radiation area following the plume passage and delineation of the restricted area, should be limited to the lowest emergency worker exposure limit.

To assure adequate protection of minors and the unborn during emergencies, the performance of an emergency service, where the radiation exposure could be significant for the emergency worker, should be **limited to nonpregnant adults.** As in the case of normal occupational exposure, doses received under emergency conditions should be minimized in accordance with good health physics practices (e.g., use of potassium iodide (KI) where appropriate, limiting the time spent on jobs in radiation areas, and the rotation of available emergency workers).

Radiation exposure of individuals after the emergency has ended should be limited in accordance with relevant provisions of Federal Radiation Protection Guidance for Occupational Exposure.[2] This guidance recommends an upper limit of five Roentgen equivalent man (rem) per year for adults and one tenth this value for minors and the unborn. This exposure can be in addition to any dose received by emergency workers during the emergency phase of the accident.

Demonstration of this objective involves both the use of dosimetry for the measurement of radiation exposure received by emergency workers and actions required to minimize accrued dose. Direct-reading dosimetry provides measurement data to the individual so that the individual may be in control of how much radiation exposure to gamma radiation is received. When communicated properly to supervisory personnel, this information should be used in decisions concerning actions to control and minimize radiation exposure to emergency personnel and authorize appropriate mission-exposure limits.

Dosimeters measure only the whole-body exposure to gamma radiation. Additional exposure to the thyroid from the inhalation of radioiodines, nor internal exposure of the other organs from inhalation of particulates by an individual immersed in the plume, are not measured by personal dosimeters. It is recommended that all emergency workers be selected who are not sensitive to KI; and that for category (1) and (2) emergency workers, KI be taken if their is any likelihood that radioiodine is being released in the accident. Emergency workers suspected of inhaling significant amounts of radioiodine should have

[2] Radiation Protection Guidance to Federal Agencies for Occupational Exposure (52 F.R. 2822; January 27, 1987)

their thyroid monitored at the completion of their final mission involving direct exposure to the plume.

Following participation in an accident where significant contamination has resulted, as indicated by projected doses, field measurements, or personal dosimetry, those potentially exposed emergency workers should be scheduled for and given a routine examination for internally deposited radioactive contamination. This is a procedure which should be performed using standard health physics techniques and could be conducted at a mobile laboratory van or in a local hospital. As a minimum, the examination should include the taking of both fecal and urine samples for analyses. In the event that initial sampling indicates any internal exposure, whole-body counting at a special facility and further sampling should be instituted.

DEMONSTRATION CRITERIA

NUREG	CRITERION	
H.10. K.3.a.	**1.**	**The ORO utilizes appropriate dosimetry for emergency worker radiation exposure control.**

Explanation

A non-self-reading dosimeter consisting of a thermoluminescent dosimeter (TLD) or film badge should be provided to each emergency worker. This will provide a more accurate and legal record of the emergency worker's actual radiation exposure received during the duration of the accident, as well as being a backup device for the direct-reading dosimeter(s).

The TLD or film badge should be read by a processor accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) or other accreditation program in accordance with American Nuclear Science Institute Standard N13.11-1983, Personal Dosimetry Performance Criteria for Testing. NVLAP accreditation should be for the specific type of dosimetry in use and should be for the type of radiation(s) for which the individual wearing the dosimeter is monitored. These actions should be effected prior to exercises as part of ongoing preparedness and do not need to be included in exercise evaluations.

The non-self-reading dosimeters require a record as to whom each dosimeter was assigned. An emergency worker should keep the assigned non-self-reading dosimeter throughout the emergency phase, unless the ORO requests earlier return to verify anomalous readings on a direct-reading dosimeter or the ORO reissues all non-self-reading dosimeters. A specific location or contact should be identified to emergency workers regarding the time and location for the return of these dosimeters.

OBJECTIVE 5: EMERGENCY WORKER EXPOSURE CONTROL

In addition to the non-self-reading dosimeters, OROs should demonstrate their capability to provide direct-reading dosimetry to emergency workers assigned in categories (1) and (2). These are a minimum acceptable system and a recommended system as follows:

- o Minimum Acceptable System

  One direct-reading dosimeter with a range capable of measuring a radiation exposure of at least 20 Roentgen (R) and a minimum exposure of 0.5 R.

- o Recommended System

  Two direct-reading dosimeters with different ranges that can adequately measure a range of radiation exposure from 0.5 R to 100 R.

  - One dosimeter with the ability to measure radiation exposures as low as 0.5R and up to at least 5R, but no more than 20R; and

  - One dosimeter with the ability to measure radiation exposures from about 5R up to at least 100R.

Either system should provide the capability to determine each emergency workers exposure for each mission. The second dosimeter in the recommended system will provide for measuring total accumulated whole body exposure above the full scale range of the lower range dosimeter and measure exposures up to and even above the recommended limit for individuals that volunteer to undertake a lifesaving mission or to protect large populations groups.

The reasons for recommending an upper limit of 100 R is that there are many direct-reading dosimeters available which cover this range, e.g., a 0-100 R CD V-730 or a 0-200 R CD V-742, and they have adequate sensitivity to measure exposures of as little as approximately 1R and 2R, respectively.

Low-range (less than 0-1 R full scale) dosimeters are inadequate for emergency workers during the emergency phase of a radiological accident. It is recognized that the as low as reasonably achievable (ALARA) principle should be applied where possible. However, the very nature of this type of emergency may necessitate that a small number of emergency workers incur significant radiation exposure in order to reduce the overall radiation exposure of the general public.

OBJECTIVE 5: EMERGENCY WORKER EXPOSURE CONTROL

If a dosimeter is assigned to an individual for the duration of the emergency, ranges of 0-5 R would be appropriate and would minimize the need to have the dosimeter frequently re-zeroed, would still provide the measurement accuracy needed, and would read in the same units (R) which would contribute to less confusion and reading error. However, a 10-1 R dosimeter, or even a dosimeter with a range as low as 0-200 milliroentgen (mR) could be used if dosimeters are collected and read after each mission.

Problems that State and local governments must be aware of is that direct-reading dosimeters with a full scale range of less than 1 R are much more difficult to re-zero; exhibit much more geotropism (error in reading); are extremely likely to exhibit erratic electrical leakage, especially if they are not used on a continuous daily basis and routinely charged on the same charger; should be recharged on a special charger which grounds the center electrode charging pin and decreases the amount of electrical leakage; and are much more susceptible to high or totally lost readings if dropped onto a hard surface from a distance of more than 2 or 3 feet. The civil defense CD V-138 0-200 mR dosimeter exhibits the above problems, except for the loss of reading due to being dropped. It is <u>not recommended</u> that the CD V-138 dosimeter be used for operational purposes for emergency response.

Great precision in the ability to read the direct-reading dosimeter is <u>not</u> required, since this device <u>primarily</u> provides an immediate indication of the general amount of radiation exposure received. The legal record of a worker's radiation exposure will be determined from the processed TLD or film badge. Further, during the recovery/reentry phase of an accident sequence, an individual may be exposed to low exposure rates for a more prolonged period of time. Under these conditions, the direct-reading dosimeters recommended for the emergency worker may not be sensitive enough to provide an accurate indication of the individual's daily accumulated exposure, although any significant daily exposure, e.g., approximately 200 mR, will be able to be read on a 0-20 R dosimeter and approximately 50 mR on a 0-5 R dosimeter. Therefore, it is recommended that all individuals rely upon their permanent record TLD dosimeters to provide a record with more accuracy of exposure accrued during all phases of the accident. If individuals encounter significant ground deposition hot spots (exposure rates greater than 100 mR/h) during the recovery/reentry phase, they would be adequately monitored by the proper use of the direct-reading 0-5 R or 0-20 R dosimeter, as well as by the measurements indicated by their radiation survey instruments.

Direct-reading dosimeters should be tested, initially, for accuracy. Those that read in mR should be inspected for electrical leakage on a quarterly basis and recharged or replaced if necessary. Those that read in Roentgens should be inspected for electrical leakage on an annual basis and recharged or replaced, if necessary.

Although it is desirable for all emergency workers in categories (1) and (2) to each have a

direct-reading dosimeter, there may be situations where team members will be in close proximity to each other during the entire mission and adequate control of exposure can be effected for all members of the team by one dosimeter worn by the team leader. This arrangement would be acceptable in cases where there is a shortage of dosimeters. Direct-reading dosimeters need not be assigned permanently to one individual, but can be reassigned to personnel for use only when they are performing their mission.

Individual emergency workers or teams who may be exposed in category (3) low exposure rate areas should also be issued at least one direct-reading dosimeter to monitor their radiation exposure, which is expected to be less than the lower end of the range of exposures authorized for emergency workers. The range of the dosimeters used for these workers should be determined by the State. Emergency workers who are assigned to low exposure rate areas in category (3), e.g. at reception centers, counting laboratories, emergency operations centers, and communication centers, may have individual direct-reading dosimeters or they may be monitored by dosimeters strategically placed in the work area.

Low-range direct-reading dosimeters (less than 0-1 R full scale) are not an appropriate range for use during an emergency accident at a nuclear power plant. If direct-reading dosimeters with a full scale reading of less than 1 R are used, they should be used only by individuals who use these routinely every day (under NRC or State byproduct material licensed activities) and in conjunction with one or more higher range direct-reading dosimeters. The provisions for their limited use should be documented with the parent organization during the formulation of the State radiological emergency preparedness plans.

In addition to the above, supplementary equipment and procedures are necessary. Each group or team of emergency workers should have a dosimeter charger available to zero or recharge the direct-reading dosimeter(s) before deployment to their assigned location. Also, instructions should be issued, along with the dosimeters, reminding emergency workers how to use the dosimeters, how frequently the dosimeters should be read, and how to record readings at the end of each assigned mission.

Extent of Play

Under this criterion, direct-reading dosimeters and non-self-reading TLD or film badges should actually be distributed to a representative number of emergency workers who are required to have them at each location. The full-scale ranges of the direct-reading dosimeters, the most recent evidence of their inspection for leakage, and the most recent evidence of when the non-self reading dosimeters were or need to be replaced should be recorded by the evaluator.

NUREG CRITERION

OBJECTIVE 5: EMERGENCY WORKER EXPOSURE CONTROL

K.3.,4. **2. Emergency workers periodically read, and at the end of each mission, record their dosimeter readings on the appropriate exposure record or chart. Procedures are followed to manage radiological exposure so that emergency workers do not incur excess doses.**

Explanation

Each emergency worker team should demonstrate procedures for either the recording of the initial reading as a base value or of precisely zeroing the dosimeter at the time of issuance. This will include actually using chargers at the point of dosimeter distribution; charging dosimeters to zero; and recording of the initial values.

Each emergency worker team should demonstrate knowledge of the radiation exposure limits allowed for each assigned mission. Each emergency worker should be capable of determining his or her cumulative radiation exposure with a direct-reading dosimeter. Each worker should know what to do and whom to notify when dose limits or turn-back exposure rate values are being approached or reached while performing the emergency assignment. When required by the emergency plan, emergency workers should take turn-back dose limits into account when reading dosimeters.

Responsible OROs should ensure that each emergency worker has an exposure record, chart, or card as well as a hard copy of instructions to remind the individual of how and when to read the direct-reading dosimeter and record its reading. An emergency worker should read the dosimeters at periodic intervals of time, as prescribed in the plan, or if not stated in the plan, periodically during the exercise (e.g., at intervals of 15 to 30 minutes). The emergency worker should know where and to whom dosimeters and radiation exposure records should be turned into at the end of each mission, if dosimeters are not kept by each individual for the duration of the emergency.

Extent of Play

Under this criterion, each emergency worker should demonstrate the basic knowledge of radiation exposure limits and turn-back exposure rate values through an interview process. Procedures to monitor and record dosimeter readings and to manage radiological exposure control should be demonstrated as they would be in an actual emergency. Evaluators should observe emergency workers to see if they take periodic dosimeter readings and record such readings on the appropriate exposure record chart or card.

During the exercise, at least one emergency worker should demonstrate the procedures to be followed when exposure limits and turn-back exposure rate values are reached. In the

absence of sufficient simulated exposure rates from the scenario, controller inject of simulated exposure levels can be used as a catalyst for demonstrations. The emergency worker should contact the supervisor and report the level of exposure. Supervisors should demonstrate their decision making capabilities by determining whether or not to replace the worker or to authorize the worker to incur exposures in excess of the lower end of the range of exposure limits for emergency workers. If scenario events do not force all emergency workers to seek authorizations for additional exposure, evaluators should interview a representative number of emergency workers, to determine their knowledge of knowing whom to contact in the event authorization is needed to incur exposure in excess of the lower end of the range of exposure limits for emergency workers.

NUREG	CRITERION	
K.3.,4.	**3.**	**Appropriate decisions are made to send emergency workers into areas within the plume exposure pathway emergency planning zone where special missions require higher dose limits.**

Explanation

OROs authorized to send emergency workers into the plume exposure pathway EPZ should demonstrate the following capabilities on the basis of information in the emergency plan:

- o determine radiation exposure limits to be authorized for emergency workers
- o appropriate decision making on the basis of projected doses and in accordance with emergency workers exposure limits whether or not to send emergency workers to areas within the plume exposure pathway EPZ
- o establishment of procedures to allow emergency workers to voluntarily choose to enter the plume exposure pathway EPZ where radiation levels may expose individuals to higher than pre-authorized exposures for lifesaving missions, to protect valuable property, or to protect large populations.

Whenever emergency personnel are planning to undertake an operation, it is essential that the best estimate of the situation be known by the personnel directing the operation. All sources of information, including projected exposure rate patterns, should be considered and a best estimate made of the exposure likely to be received during a specific mission. The mission must be planned by taking into consideration the most likely situation as well as the most potentially hazardous situation. Items to be considered include alternative

entry and exit routes, potential changes in meteorological conditions, areas or roads to be avoided, equipment and vehicle failure, and other relevant items.

Responsible OROs should demonstrate the capability to make decisions concerning the authorization of exposure levels in excess of pre-authorized levels and to manage the number of emergency workers receiving radiation dose above pre-authorized levels.

The procedures should comply with guidance in the emergency response plan for such functions.

Extent of Play

Under this criterion, all activities are to be carried out as specified in the plan. If simulated radiation levels within the plume exposure pathway EPZ are not sufficiently high to drive decision making, interviews with emergency workers may be conducted wherein questions based on assumptions of higher radiation levels may be raised with emergency personnel that have responsibility for decisions on sending emergency workers into the plume EPZ for both essential and lifesaving missions.

NUREG	CRITERION	
N.1.a.	**4.**	**All activities described in the demonstration criteria for this objective are carried out in accordance with the plan, unless deviations are provided for in the extent-of-play agreement.**

Explanation

Responsible OROs should demonstrate the capability to follow policies, implement procedures, and utilize equipment and facilities contained in their plans and procedures. They should demonstrate that they can follow sequences outlined in the various procedures and perform specified activities, as necessary.

Extent of Play

Under this criterion, all activities should be carried out as specified in the plan, unless deviation from the plan is provided for in the extent-of-play agreement. As a general rule, deviations from the plan should be allowed under extent-of-play agreements only in those cases where it is clear the organization has recently developed new procedures not incorporated into the plan.

OBJECTIVE 5: EMERGENCY WORKER EXPOSURE CONTROL

CLARIFICATION OF TERMS

The following definitions describe the limited meaning of terms in the context of the Exercise Evaluation Methodology and may vary from the full technical definition for all circumstances.

Committed dose refers to the dose that will be received over a period of 50 years from the ingestion or inhalation of a particular quantity of a radionuclide or a specific mix of radionuclides.

Counting refers to using an instrument to detect individual particles or gamma rays which interact with the detector on the instrument. For example, ambient radiation can be counted, or, alternatively, the radiation emitted by specific samples can be counted.

Dose limits for emergency workers refers to the allowable accumulated dose during the entire period of the emergency. Action to avoid exceeding the limit is taken based on actual measurements of integrated gamma exposure. In contrast, protective action guides are trigger levels of projected dose at which actions are taken to protect the public. These actions are taken prior to the dose being received.

Emergency phase refers to the initial phase of response actions, during which actions are taken in response to a threat of release or a release in progress.

Emergency worker refers to an individual who has an essential mission within or outside the plume exposure pathway emergency planning zone to protect the health and safety of the public who could be exposed to ionizing radiation from the plume or from its deposition. Some examples of emergency workers are: radiation monitoring personnel; traffic control personnel; evacuation vehicle drivers; fire and rescue personnel, including ambulance crews; medical facilities personnel; emergency operations center personnel; personnel carrying out backup alerting procedures; and essential services or utility personnel.

Exposure rate refers to the amount of gamma radiation that a individual would receive in one hour as measured in air (typically expressed in units of milliroentgens per hour or Roentgens per hour).

High exposure rate refers to exposure rates greater than 100 milliroentgens per hour.

KI (potassium iodide) is a prophylactic drug that can be used effectively to block the uptake of radioiodine by the thyroid gland.

Low exposure rate refers to exposure rates less than 100 milliroentgens per hour.

OBJECTIVE 5: EMERGENCY WORKER EXPOSURE CONTROL

Measuring refers to counting to detect radiation levels or determining other parameters, such as the energy of radiation or physical characteristics of samples, such as the volume of an air sample.

Monitoring refers to the measurement of radiation levels, usually with a portable survey instrument.

Projected dose is the estimated or calculated amount of radiation dose to an individual from exposure to the plume and/or deposited materials, over a period of time, in the absence of protective action.

Recovery refers to the process of reducing radiation exposure rates and concentrations in the environment to acceptable levels for unconditional occupancy or use after the emergency phase of a radiological emergency.

Traffic control refers to all activities accomplished for the purpose of facilitating the evacuation of the general public in vehicles along specific routes.

Turn-back values are total accumulated external exposure limits or exposure rates, established by the offsite health authority, at which the emergency worker should automatically leave the area immediately without further consultation or direction.

Voluntary lifesaving missions may be authorized for emergency workers who voluntarily choose to be exposed to radiation levels greater than the dose limits established for the purpose of assignment of emergency workers to lifesaving missions or to missions involving large reduction of cumulative dose to the population.