

March 1995

**STATEMENTS OF CONSIDERATION FOR
FEMA-REP-21:
CONTAMINATION MONITORING STANDARD
FOR A PORTAL MONITOR USED FOR
RADIOLOGICAL EMERGENCY RESPONSE**

FEDERAL EMERGENCY MANAGEMENT AGENCY

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INTRODUCTION:

In September 1992, The Federal Emergency Management Agency (FEMA) published in the Federal Register a notification of availability for comment on the Interim-Use Portal Monitor Standard. As a result, written comments were received from several sources. In addition verbal comments have been received at meetings and workshops. All of the comments have been reviewed and considered. Similar comments have been combined into single "Issues" for purpose of the Statements of Consideration (SOC). FEMA plans to incorporate the revised Standard and the background information document in the next revision of the Radiological Emergency Preparedness (REP) Exercise Manual (FEMA-REP-14).

Only substantive changes are discussed in this document, but editorial changes and minor clarifications have also been made. Comments on the "Contamination Monitoring Standard for a Portal Monitor Used for Emergency Response (FEMA-REP-21)" and "Background Information on FEMA-REP-21: Contamination Monitoring Standard for a Portal Monitor Used for Emergency Response" are discussed separately below. The following is a "General Comment" that is applicable to both the Standard and the Background Document:

General Comment: Hot particles should not be the controlling exposure pathway. There is no evidence that they would occur from a reactor accident. In any case they would not occur from an atmospheric release in the absence of other widespread contamination.

Discussion: Similar comments were received from several sources. FEMA agrees that hot particles should not be the limiting exposure pathway. However, there are references in the literature that discuss the presence of hot particles deposited both inside and outside the USSR from the Chernobyl accident.

The basis for eliminating hot particles as the leading exposure pathway is that, if they are deposited from an airborne plume from a reactor accident, they would be accompanied by other deposited widespread contamination. When this condition is applied, the leading exposure pathway changes to "acute exudative radiodermatitis" from a fraction of the contamination on an individual being concentrated into a small spot of skin. In the absence of empirical information, it is assumed that hot particles (if they occur) will constitute no more than 10 percent of the deposited material. This is in accordance with assumptions that had previously been made with regard to the fraction of widespread contamination that would be concentrated on a small spot of skin. Revisions to resolve this comment did not change the numerical value of the previously selected minimum detectable level (MDL) of 1 microcurie (μCi) of contamination.

Changes from resolution of this comment resulted in the controlling exposure pathway being transferred from "hot particles" to "concentrated activity on a small area of skin." This change required considerations regarding the acceptable size of the area for the effect to occur in rare occasions when a significant fraction of the total measurable activity on an individual would be within that area. The conclusion was that the rare occurrence of a deterministic health effect on a spot of skin no larger than a circle 0.5 centimeters in diameter (0.2 cm^2) from undetected contamination would be an acceptable trade-off for faster monitoring under emergency conditions. The previous Background Document had provided calculations of sizes of areas where the different radiation effects could occur if the Standard were established at $1 \text{ } \mu\text{Ci}$ and if 10 percent of the total contamination on an individual were concentrated within the respective area. These calculations provided the basis for the current selection of the 0.2 cm^2 area for the rare occasion of a health effect.

Disposition: Revise the Standard and Backup Document to reflect these changes.

STATEMENTS OF CONSIDERATION FOR THE STANDARD:

Issue 1: FEMA has no legislative authority to set contamination limits. They should be set by the State or by the American National Standards Institute (ANSI) with input from the Health Physics Society. It is recommended that the Standard receive close scrutiny by ANSI and the National Health Physics Society.

Discussion: The proposed Standard was noticed for comment in the Federal Register. It was developed jointly with the Nuclear Regulatory Commission (NRC) and received close scrutiny from the Environmental Protection Agency (EPA), the Agency with primary responsibility for environmental radiation standards. FEMA's authority for promulgating a National Standard for portal monitors is derived from Public Law 96-295 (1980) and supports the development and Federal evaluation of off-site radiological emergency planning and preparedness. Some commenters commended FEMA for setting the Standard so that interpretation of monitoring needs would be consistent nationwide. To clarify this issue, a new first paragraph should be added to the Standard as follows: "The Federal Emergency Management Agency (FEMA), along with the Nuclear Regulatory Commission (NRC) is charged with the responsibility under Public Law (P.L.) 96-295 (1980) to promulgate National Standards for State and local governments and NRC licenses of commercial nuclear power plants to develop off-site radiological emergency plans and preparedness and for FEMA and NRC to use in evaluating the adequacy of off-site radiological emergency preparedness. The establishment of National Standards is intended under P.L. 96-295 to assure adequate protection of public health and safety from commercial nuclear power plant accidents. FEMA published an interim Portal Monitor Standard in the Federal Register in September 1992. The Standard set forth in this document is published as FEMA's contamination monitoring Standard for portal monitors used by State and local Governments in response to commercial nuclear power plant accidents.

Disposition: Revise the Standard as indicated above.

Issue 2: Some portal monitors may not have a feature that permits adjustment of their counting times to compensate for increasing background radiation levels. If such monitors have marginal ability to detect activity equivalent to the Standard, they will not be suitable for use after the radiation background level increases in the monitoring center due to the accumulation of radioactive material on confiscated clothing and other contaminated items. This should be addressed in the Standard.

Discussion: FEMA agrees that this could present a problem. However, the preferred solution is to use special monitoring procedures to prevent the build-up of contaminated items near the monitoring station. Additional guidance should be added to REP-14, Objectives 18 and 22, Demonstration Criterion 2 regarding the need to store contaminated clothing and other items in a location that will minimize the build up of background radiation at monitoring stations.

Disposition: No change to the Background Document is warranted. However Rep-14 should be revised as indicated above.

Issue 3: Some portal monitors do not sum the counts over all of the detectors and, therefore, are not assisted in detecting a small spot containing a concentrated small fraction of the total activity on an individual by the presence of the remaining large fraction of the activity that may be near various detectors. A smaller check source (possibly 0.1 μCi) would be more appropriate for these monitors.

Discussion: FEMA agrees that this is a problem. However, the solution is not in reducing the size of the check source used for confirming proper operation of the portal monitor. The Standard should be modified to more clearly state that the activity to be detected is in the form of widespread non-uniformly distributed contamination. The Background Document should be modified to indicate the following:

Portal monitors have varying designs with regard to (1) whether the counts are integrated over time or simply presented as the instantaneous count rate and (2) the number of detectors for which the counts are summed to trigger an alarm. Time integration of the counts is an important feature for portal monitors to permit adjustment of the counting time in order to maintain adequate sensitivity to the contamination in increasing levels of background radiation. This feature also increases the overall sensitivity of the portal monitor compared to those that use an instantaneous count rate to trigger an alarm.

The test procedure using one microcurie of cesium-137 at the centerline between the columns of the portal monitor as described in the Standard applies specifically to a portal monitor design that sums the counts from all of the detectors to trigger an alarm. This feature allows the detection of widespread contamination to indicate the potential for the presence of a small spot of highly concentrated contamination that would, by itself, be undetectable but could cause a health effect. Portal monitors that do not sum the counts from all detectors will be less sensitive for the detection of contamination that is widespread and non-uniformly distributed on an individual as assumed for the Standard. Portal monitors that sum the counts from all detectors are, therefore, preferred because if they meet the detectability test of 1 μCi of Cs-137 at the centerline between the columns,

they will have sufficient sensitivity to detect either fixed or removable contamination at the level of the Standard.

The Standard is designed to detect contamination at the level of concern for fixed contamination. This level is significantly lower than the level of concern for removable contamination. Therefore, the MDL for contaminated individuals who have not bathed and changed clothes may be designated at a higher threshold than that which is set forth in the Standard. This means that portal monitors that do not sum the counts and that meet the detectability test, can be assumed to meet the Standard for monitoring evacuees who have been sent directly to the monitoring center by the responsible off-site response organization (ORO). This is because the contamination on these individuals will be primarily removable.

Other evacuees who have evacuated to locations other than the monitoring centers and have bathed and changed clothes before arriving at the monitoring center should be monitored using a portal monitor that sums the counts or a portable survey instrument. This is because portal monitors that do not sum counts may not have sufficient sensitivity to detect fixed contamination at the level of the Standard. Individuals who have been decontaminated should be remonitored using a portable survey instrument instead of any type of portal. This is because portable survey instruments are more sensitive to small spots of concentrated contamination than portal monitors and they can be used to find the exact location of such spots to support decisions for further actions. The following guidance is intended to aid offsite response organizations in determining the conditions under which different types of portal monitors should be used, along with portable instruments.

<u>MONITORING SITUATION</u>	<u>APPLICABLE INSTRUMENTS</u>
Evacuees sent by the ORO directly to the monitoring center	<ul style="list-style-type: none">– Portal Monitor that <u>sums</u> the counts from all detectors– Portal Monitor that <u>does not sum</u> the counts from all detectors– Portable Instrument
Individuals who have evacuated to locations other than the monitoring center and have bathed and changed clothes before arriving at the monitoring center.	<ul style="list-style-type: none">– Portal monitor that <u>sums</u> the counts from all detectors– Portable Instrument
Individuals who have been monitored with a portal monitor or a portable instrument and have been decontaminated at the monitoring center	<ul style="list-style-type: none">– Portable Instrument

Disposition: Revise the Standard and the Background Document as indicated above.

Issue: 4: Since the individual being monitored would be physically at a distance of six inches or less from the side detectors, the portal monitor should be required to detect 1 μCi of Cs-137 at a distance of six inches from the side of the portal monitor at several points instead of at the centerline as proposed. Pending tests, it is believed that changing the distance to 6 inches would result in the Ludlum 50 portal monitors, and other portal monitors that have been purchased by states, being able to meet the one μCi Standard.

Discussion: Contamination on an individual would not necessarily be evenly distributed or limited to the feet, hands, and sides of the individual. Concentrated contamination could also be on any part of the body including the face, hair, or other anterior or posterior parts, thus reducing the ability of the monitor to detect it.

In addition, the centerline location for determination of compliance is favored because of the physical variation in sizes of openings within portal monitors and in recognition of the fact that a significant portion of the contamination may be at distances much greater than six inches from the detectors. FEMA has concluded that the proposed health-based Standard should not be further compromised to accommodate the limitations of specific equipment. Furthermore, the use of a vertical line centered between the two side columns of a portal monitor is intended to assure adequate protection of individuals by virtue of an individual - versus an equipment-oriented location for the detectability test.

Disposition: No change to the Standard is warranted.

Issue 5: The guidance fails to account for the acute sensitivity to beta radiation by the detectors in a portal monitor.

Discussion: The Section "Determination of Compliance with the Standard" addresses this concern. It provides for the Cs-137 source to be sealed in a manner such that both beta and gamma radiations are emitted.

Disposition: No change to the Standard is warranted.

Issue 6: The Standard should be refocused to be a functional standard rather than one that meets laboratory test criteria. The functional standard approach would provide for effective use of portal monitors to enhance public health, and would not limit the use of existing designs of portal monitors without good reason. The cost of implementing the proposed Standard may result in the avoidance of using portal monitors and result in a net detriment to public health. Cost/benefit analyses should be derived on site-by-site basis to determine whether the initial capital cost is offset by the continual training, calibration, and maintenance costs associated with hand-held detection equipment.

Discussion: A functional standard as proposed would not provide reasonable assurance that the risk of deleterious health effects would be maintained within established guidelines for emergency response. It is logical to use cost effectiveness in the process of deciding whether to procure portal monitors. However, this must be done in the context that public health is adequately protected. That is, cost should not be permitted to drive a decision to use portal monitors that cannot provide protection at a specified minimum level that is based on health effects. The Standard meets this specified minimum level.

Disposition: No change to the Standard is warranted.

Issue 7: The Standard is based on the ability to detect a hot particle with no accompanying widespread contamination. This is not a logical assumption and results in a standard that is more restrictive than necessary. Also, the Standard acknowledges that there is no known basis for assuming that the public will be exposed to hot particles from an accident at a nuclear power facility. Yet, the Standard is based on the ability to detect hot particles. The Standard should be revised to be more realistic with regard to the type of contamination expected.

Discussion: This comment has been accepted. The assumption that hot particles, if they occur, will be accompanied by widespread contamination and thus be more easily detected, changes the limiting health effect and much of the discussion in the Background Document. However, as discussed in the "General Comment" in the "Introduction" to this document, the numerical value of the Standard has not changed.

Disposition: No change to the numerical value of the standard is warranted.

Issue 8: FEMA has proposed a standard of risk that is significantly lower than the commonly accepted risk factor for "safe" industries (the risk factor used in determining dose limits for occupational radiation exposure)

Discussion: It is not commonly accepted to permit the same risk to members of the general public as to occupationally exposed workers. FEMA has used the risk levels by the Environmental Protection Agency (EPA) as being adequately protective of public health under emergency conditions.

Disposition: No change to the standard is warranted.

Issue 9: The Standard should not include a requirement that an auxiliary power source should be provided for portal monitors. Specifically, (1) this type of requirement is not consistent with the intent of the Standard and should remain in the facility standards and not be scattered through various ancillary standards, and (2) reception centers or other facilities used for monitoring and decontamination would be rendered inoperable by the loss of power, and if auxiliary power were not available for all of the other required services, the center would be closed and moved to a place that had power. Therefore, there is no need to single out the portal monitor as a separate item needing an alternate source of power.

Discussion: FEMA agrees. Discussion of an alternate source of power for portal monitors is better suited for guidance in REP-14, Objective 2 "Facilities: Activation, Equipment, and Displays." and in Objective 18 "Reception Center - Monitoring, Decontamination, and Registration."

Disposition: The Standard should be revised to delete this guidance. It should be incorporated into the next revision of REP-14 as indicated above.

Issue 10: Some commenters objected to the use of the term "acceptable level of risk" when discussing radiation induced cancer. They thought that the wording should be softened.

Discussion: The statements should be revised to be less disturbing and more in line with statements used by EPA in their principles for establishing protective action guides. The third sentence of the first paragraph of the Standard under "Purpose" should be revised as follows: "The objective of this Standard is to provide reasonable assurance that the risk of skin cancer and other detrimental radiation effects to the skin of individuals from radioactive contamination on the skin and clothing does not exceed guidelines established by the Environmental Protection Agency (EPA 400-R-92-001) regarding adequate protection of public health under emergency conditions". The Background Document should be similarly revised.

Disposition: Revise the Standard and the Background Document as indicated above.

Issue 11: Monitoring and decontamination not only provides for protection from skin cancer, but also from transfer to the mouth/ingestion pathway and from resuspension and inhalation. This should be addressed in the Standard.

Discussion: FEMA agrees. The following statement should be added as the penultimate sentence in paragraph 1 of the Standard and likewise to the Background Document: "Although the primary reason for monitoring and decontamination of evacuees is to reduce the risk of radiation effects to the skin, these actions also reduce the risk of cancer to internal organs that could result from inadvertent ingestion of the contamination on skin and clothing or from inhalation of contamination resuspended from clothing into the air."

Disposition: Revise the Standard and the Background Document as indicated above.

STATEMENTS OF CONSIDERATION FOR THE BACKGROUND DOCUMENT

Issue 1: EPA guidance lists 0.1 mR/h as a level for contamination monitoring. This is a conservative value and should be adequate for protecting the health and safety of the public.

Discussion: The numerical guidance on contamination limits given in the EPA PAG Manual is for portable survey instruments where a single detector is near the contamination. Portal monitors, on the other hand, measure the radiation emitted from contamination over the entire body or over wide undefined areas without regard to its distribution, and from distances ranging from one to 20 or more inches. Therefore exposure rate limits designed for portable survey instruments are not applicable to portal monitors. The third paragraph under "Background Information" should be clarified as follows:

"Tables of recommended surface contamination screening levels (Table 7-6 and 7-7) are provided in the EPA PAG Manual for measurements taken with portable survey instruments. These are not applicable to portal monitors."

Disposition: Revise the Background Document as indicted above.

Issue 2: The assumptions of 36 hours before washing and changing clothing and 14 days for removal of fixed contamination both appear to be too long. Following a nuclear power plant accident, it is believed that evacuees will attempt to adhere to their routine personal hygiene habits of bathing at least daily. Also, experience with oil and grease contamination has shown that fixed contamination is removed by normal washing within a few days.

Discussion: The 36 hour assumption is supported by FEMA guidance for completing monitoring within about 12 hours and a recommendation that persons exposed to the plume should bathe and change clothes within at least 24 hours after being monitored. The assumed 36 hour period of exposure for evacuees who are monitored and found to be not contaminated in excess of the standard can also be argued to be on the liberal side. This is because monitoring of individuals may not start immediately for early evacuees so that if monitoring requires a total of 12 hours, the last to be monitored will have already been exposed for more than 12 hours. Also, some evacuees may not have ready access to clean clothing and bathing facilities within 24 hours. However, errors in this assumption do not affect the overall error because the Standard is based on fixed contamination with a 14 day exposure period for the skin.

The 14 day period for removal of contamination by natural processes refers to the natural process of skin replacement. It is appropriate to consider this possibility because iodine, one of the expected radioactive constituents in a release from a nuclear power plant accident, is known to be absorbed by skin. (Oil and grease is not representative of radioactive chemicals such as iodine with regard to skin absorption). The Background Document discusses the fact that this assumption and some of the other assumptions may

be conservative. However, some conservatism is justified in order to counter the non conservative assumptions (e.g., all of the contamination on an individual will be visible to the detectors; a significant portion of the contamination will not be further from the detector than the distance from the center line to the detectors). The Background document includes a discussion of assumptions on duration of exposure.

Disposition: No change in the assumptions on duration of exposure is warranted.

Issue 3: Too much emphasis is given to skin contamination. Leukemia, lung cancer, thyroid cancer and other thyroid dysfunctions pose a greater concern by health professionals under these accident conditions. It is believed that members of the public will not receive extreme beta burns.

Discussion: It is true that cancer and other dysfunctions of internal organs pose a greater concern, but evacuation, not decontamination, is the primary protective action recommended for reducing the risk of these effects. However, persons who do not evacuate in time to avoid exposure to the plume will be at risk from radiation effects to the skin in addition to radiation effects to internal organs. At this time, it is too late to take actions to protect internal organs from dose due inhalation from the plume (except possibly administration of KI to protect the thyroid) but not too late to reduce the risk of health effects to the skin by decontamination.

Disposition: No change to the document is warranted.

Issue 4: Prior to finalizing the Standard, FEMA should request the manufacturers of portal monitors to test and report on the sensitivity of their existing equipment using a one μCi cesium137 source and possibly other beta and/or gamma sources. Once these tests have been completed, a comprehensive review of the data can be performed. At that time, you will have a very good idea of the actual impact of the Standard.

Discussion: FEMA has confirmed that there are several manufacturers of portal monitors that can detect 1 μCi of Cs-137 at the centerline of the monitor. It is not necessary for FEMA to confirm that existing equipment by all manufacturers can meet the standard. The Standard is based primarily on considerations of reducing the risk of radiation health effects and it should not be weakened because there is some equipment on the market that cannot meet the Standard.

Disposition: No change to the document is warranted.

Issue 5: In lieu of the "hot particle" approach, a more plausible rationale would be avoidance of health effects, due to absorption of some radioiodine compounds through the skin. This type of absorption is a much more likely scenario than hot particles.

Discussion: Based on information from a study conducted by Pacific Northwest Laboratories and published in Vol. 17 pp. 730 - 731 of *Health Physics*, absorption of radioiodine by the skin would be expected to contribute only 1/500 to 1/1000 of the total thyroid burden from inhalation following an atmospheric release of I-131. Based on information presented in Table C-9 of the PAG Manual, the dose to the skin from the plume plus 12 hours exposure to contamination on skin and clothing would be comparable to the dose to the thyroid from inhalation from the plume. Therefore, based on these analyses, the dose to the thyroid from skin absorption would be much less significant than the dose to the thyroid from inhalation or beta dose to the skin. These analyses do not apply directly to hot particles as discussed in the comment, however, with the revised basis for the Standard, hot particles are no longer the leading exposure pathway.

Disposition: No change to the document is warranted.

Issue 6: Paragraph 3 under "Background Information" is not in support of the Portal Monitor Standard. It relates only to portable survey instrument standards and should be deleted.

Discussion: This information is intended to show that the existing contamination guidance is for portable survey instruments and is not suitable for use with a portal monitor. However, more information is given than needed. The paragraph should be revised as follows: "Tables of recommended surface contamination screening levels (Table 7-6 and 7-7) are also provided in the PAG Manual for measurements taken with a portable survey instrument. This guidance is based on ability to detect radioactive contamination using portable survey instruments. It is not applicable to portal monitors." Other portions of this discussion on portable survey instruments should be deleted.

Disposition: Revise the Background Document as indicated above.

Issue 7: The Standard and the Background Document state that the Standard applies to both adults and children. However, the assumptions regarding the area of the skin of the whole body is that for an adult. The Background Document should address this.

Discussion: FEMA agrees. The assumed area of the skin of the whole body applies only to analyses related to risk of skin cancer. Reducing the area of the skin by even a factor of 10 or more would not affect the selection of the controlling exposure pathway because of the difference in the required minimum detectable level between skin cancer and the controlling effect, acute exudative radiodermatitis (see Table 1 of the Background Document). However, the last paragraph under "Stochastic Effects" should be revised as follows: "...To determine the time-integrated activity necessary to yield a dose of 10 rem to the skin of the whole body, it is necessary to multiply the time-integrated concentration

per square centimeter that will yield a dose of 10 rem times the area of the skin on the whole body (about 18,000 cm² for an adult). Although the area of a child's skin would be smaller, the margin of safety in the activity threshold for adequate protection from cancer compared to the activity threshold for the controlling health effect is so large that no adjustment to the area of the skin is needed. Based on the above data, the threshold level corresponding to an acceptable increase in the risk of skin cancer for a portal monitor is a time-integrated activity of 25,000 μCi·h (i.e., 1.4 μCi·h/cm² x 18,000 cm²). This is independent of the distribution of the contamination on the skin."

Disposition: Revise the Background Document as discussed above.

Issue 8: Table 1 is confusing. It is not clear whether the "Maximum Area of Condition" shown in the last column refers to the number of microcuries shown for each "Condition," or to the one microcurie Standard.

Discussion: FEMA agrees. The Table should be expanded to include additional columns and footnote "c" should be expanded to clarify that areas shown are those affected from 0.1 μCi (10 percent of the Standard).

Disposition: Revise the Table and Footnotes as indicated above.