DEPARTMENT OF THE ARMY

US ARMY COMMUNICATIONS-ELECTRONICS COMMAND

FORT MONMOUTH, NEW JERSEY

ENVIRONMENTAL ASSESSMENT

AND

FINDING OF NO SIGNIFICANT IMPACT

FOR THE

AN/UDM-1 RADIAC CALIBRATOR SET

Prepared By:

Joseph M Santarsiero

JOSEPH M. SANTARSIERO
Health Physicist

Reviewed By:

Steven A Horne for

BARRY J. SILBER
Chief, Radiological Engr

Approved By:

Steven A Horne

STEVEN A. HORNE
Acting Chief, Safety Office

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A. Security Verification

1. The Environmental Assessment and Finding of No Significant Impact for the AN/UDM-1 Radiac Calibrator Set supports a US Nuclear Regulatory Commission (NRC) license in accordance with requirements set forth in Army Regulation (AR) 200-2 and AR 385-11.

2. The information contained within this environmental documentation has been reviewed in accordance with OPSEC intentions/requirements in AR 530-1, and has been determined to be acceptable for public release.

Prepared by: Joseph M. Santarsiero
JOSEPH M. SANTARSIERO
Health Physicist

Concurred by: Christopher Kencik
CHRISTOPHER KENCIK
OPSEC Officer
CECOM Safety Office

LISTING OF ABBREVIATIONS

AIRDC	US Army Ionizing Radiation Dosimetry Center
ALI	Annual Limit on Intake
AR	Army Regulation
Bq	Becquerel
CECOM	US Army Communications-Electronics Command
CFR	Code of Federal Regulations
Ci	Curie
cm	centimeter
Co-60	Cobalt 60
cpm	counts per minute
dy	day
DA	Department of the Army
DOD	Department of Defense
DOT	Department of Transportation
hr	hour
ICRP	International Commission on Radiological Protection
m	meter
NRC	Nuclear Regulatory Commission
OPSEC	Operations Security
lb	pound
LLI	Lower Large Intestine
sec	second
SI	Small Intestine
Sv	Sievert
TM	Technical Manual

ULI	Upper Large Intestine
wk	week
yr	year

II. Finding of No Significant Impact

1. Transfer of the life-cycle management responsibilities for the AN/UDM-1 Radiac Calibrator Set from the US Army Armament, Munitions and Chemical Command to the US Army Communications-Electronics Command (CECOM) is proposed following Nuclear Regulatory Commission (NRC) approval of the CECOM license application submission. The AN/UDM-1 Radiac Calibrator Set incorporates a single Cobalt-60 (Co-60) sealed source for use as a calibration standard in the checking and calibration of various radiation detection instruments possessed by the Army. The AN/UDM-1 Radiac Calibrator Set has been successfully utilized by Army activities in the calibration of radiation detection instrumentation for at least the past 30 years and has exhibited previous successful use by the US Navy for some years prior to that. The Environmental Assessment supports the NRC license application and complies with AR 200-2, Environmental Quality, Environmental Effects of Army Actions, which requires the evaluation of any radionuclide proposed for use within Army activities.

2. The assessment provides complete dosimetric analyses for external/internal exposure which may be presented to both occupational and non-occupational individuals from highly improbable incidents causing the release of radioactivity to the environment. Included in this assessment are hypothetical scenarios involving source damage, improper disposal, installation (storage) fire and transport accidents for evaluation of radiological/environmental impact. The dosimetric evaluations identify air/water concentrations and exposure levels below regulatory requirements. The internal exposure presented individuals through various pathways have also been identified as below Interna-

tional Commission on Radiological Protection (ICRP) recommendations. Based on these findings, stringent military radiation safety policy and previous long-term successful use without documented hazard, the Environmental Assessment has concluded no discernable radiological health and/or environmental quality degradation can be associated with the AN/UDM-1 Radiac Calibrator Set. The Environmental Assessment is available for review upon request from: Commander, USACECOM, ATTN: AMSEL-SF-MR, Fort Monmouth, New Jersey 07703-5024.

III. Environmental Assessment

A. Summary and Conclusion

1. Concurrent with an application for a NRC license to receive, possess, use, store and transfer radioactive material, the following Environmental Assessment, supporting a Finding of No Significant Impact, has been prepared to maintain compliance with AR 200-2. The basic objective specified in this regulation is to perform all actions necessary to minimize adverse effects on the quality of the human environ without impairment of the Army mission.

2. The use, need and description of the AN/UDM-1 Radiac Calibrator Set including maximum safety design specifications are provided within the applicable supplements provided in the NRC license packet. The evaluation concludes and documents that there is no degradation or potential for degradation of the environmental quality or a significant radiological impact to occupational or public health resulting from the possession, use or storage of the AN/UDM-1 Radiac Calibrator Set.

3. The implementation of basic radiation safety techniques for operations involving the AN/UDM-1 Radiac Calibrator Set precludes any unnecessary radiation

exposure to the occupational worker or the general public and excludes the consideration of any potential release to the environment. In determining radiological hazards to the radiation worker or general public, assessments for both internal and external exposures are presented. ICRP Publication 30 identifies recommended Annual Limits for Intake (ALI) of various radionuclides for workers. These recommendations are based upon mathematical and biological parameters of the standard man for which exposure risk from a given radionuclide to an individual is acceptable. The recommendations are derived from specific quantities of radionuclides which have been identified as not leading to the inducement of a significant biological effect and are computed in terms of committed dose equivalent spanned over fifty years following the ingestion and inhalation of a unit activity of a specific radionuclide. The maximum committed internal dose equivalent for an occupational worker was determined to be 3.55E-02 Sieverts (Sv) or 3.55E+00 rem to the Upper Large Intestine (ULI). This dose was received through the oral ingestion of 3.70E+06 Bequerels (Bq) (0.1 millicuries (mCi)) of Co-60 due to sealed source damage. The ingested activity is 53 percent of the ALI given for oral ingestion and is below ICRP recommendations. Various hypothetical scenarios involving the release of radioactive material through various pathways were assessed for presented internal exposure with results summarized in Table A-1. The consideration of external radiation exposure was made through theoretical calculations, actual radiation measurements and the lack of documented overexposures, as determined by thermoluminescent dosimetry techniques and film badge assignments to users/personnel involved with the AN/UDM-1 Radiac Calibrator Set. The complete derivation of the evaluations, identification of assumptions and comparison with ICRP recommendations and NRC requirements are provided in Part B of the environmental assessment document

which identifies, under the most severe conditions, minimal environmental and/or radiological impact associated with the AN/UDM-1 Radiac Calibrator Set.

TABLE A-1

Summary of Committed Dose Equivalents to Various Organs
Due to Occurrence of Presented Hypothetical Scenarios

Hypothetical Scenario	Organ of Concern	Dose in Sieverts (rem)
Source leakage/damage (Oral Ingestion)	Gonads	2.66E-02 (2.66E+00)
	Breast	1.89E-02 (1.89E+00)
	R Marrow	2.04E-02 (2.04E+00)
	Lungs	1.85E-02 (1.85E+00)
	SI Wall	3.03E-02 (3.03E+00)
	ULI Wall	3.55E-02 (3.55E+00)
	LLI Wall	5.18E-02 (5.18E+00)
	Liver	4.81E-02 (4.81E+00)
Source Incineration (Inhalation)	Gonads	2.28E-10 (2.28E-08)
	Breast, R Marrow	2.40E-10 (2.40E-08)
	Lungs	2.05E-09 (2.05E-07)
	LLI Wall	4.67E-10 (4.67E-08)
	Liver	5.24E-10 (5.24E-08)
Leaching Into Public Drinking Reservior (Oral Ingestion)	Gonads	1.81E-07 (1.81E-05)
	Breast	1.28E-07 (1.28E-05)
	R Marrow	1.38E-07 (1.38E-05)
	Lungs	1.26E-07 (1.26E-05)
	SI Wall	2.06E-07 (2.06E-05)
	ULI Wall	2.42E-07 (2.42E-05)
	LLI Wall	3.52E-07 (3.52E-05)
	Liver	3.27E-07 (3.27E-05)
Installation Fire (Inhalation)	Gonads	1.44E-06 (1.44E-04)
	Breast, R Marrow	1.51E-06 (1.51E-04)
	Lungs	1.30E-05 (1.30E-03)
	LLI Wall	2.96E-06 (2.96E-04)
	Liver	3.32E-06 (3.32E-04)
Transportation Accident (Inhalation)	Gonads	5.32E-06 (5.32E-04)
	Breast, R Marrow	5.58E-06 (5.58E-04)
	Lungs	4.79E-05 (4.79E-03)
	LLI Wall	1.10E-05 (1.10E-03)
	Liver	1.22E-05 (1.22E-03)

B. Environmental/Radiological Impact of the AN/UDM-1 Radiac Calibrator Set.

1. The following paragraphs will present information and theoretical/actual data regarding the use and storage of the AN/UDM-1 Radiac Calibrator Set to identify non-existent to insignificant environmental and/or radiological impact.

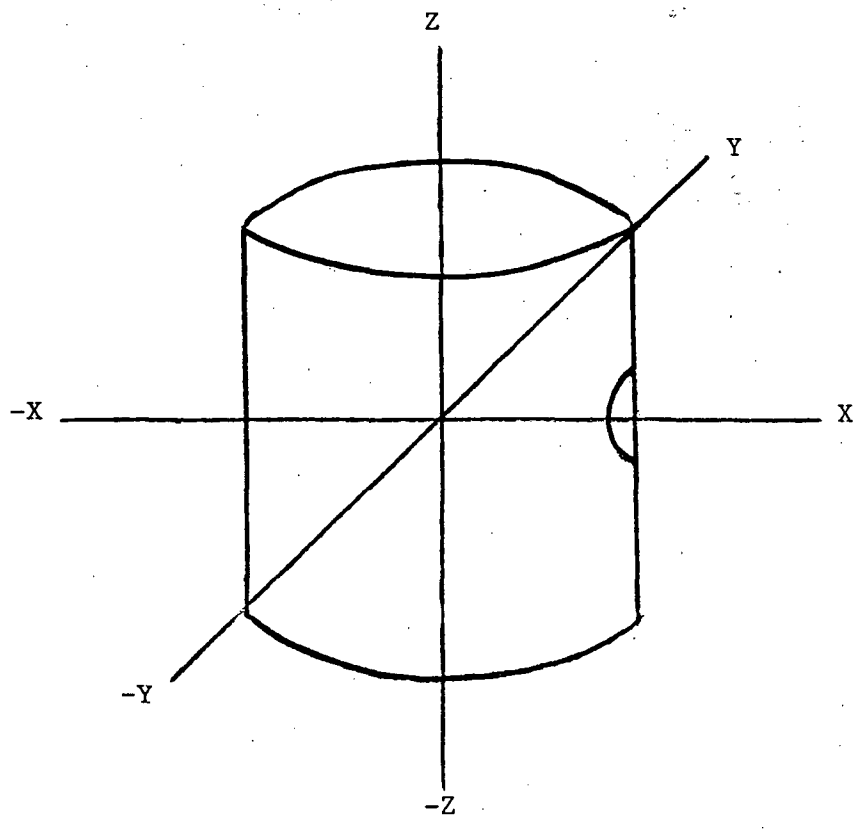
a. A computerized theoretical dose evaluation was conducted by Science Applications Inc. (SAI) for the AN/UDM-1 Radiac Calibrator Set to determine the radiological impact to operating personnel. The evaluation concludes that no radiological impact can be associated with the AN/UDM-1 Radiac Calibrator Set when used under normal operating conditions and following proper operating procedures. The theoretical evaluation identified a dose rate from a 10 Curie (Ci) Co-60 source to be approximately 50 millirem per hour (mr/hr) in the minus X direction at a distance of approximately 151 centimeters (cm). This is representative of a typical operator distance of approximately 152 cm (5 feet). The Technical Manual (TM) (TM 11-1176), indicates a leakage radiation intensity of less the 4 mr/hr at 150 cm. Actual physical measurements of the leakage radiation intensity emanating through the walls of the chamber were performed on April 1984 by CECOM health physics personnel in conjunction with AN/UDM-1 Radiac Calibrator Set operating personnel located at the Army Ionizing Radiation Dosimetry Center (AIRDC), Lexington, KY. The results of these measurements are provided at Table B-1 and are in agreement with the exposure measurement indicated in TM 11-1176, i.e., less than 4 mr/hr at 150 cm. Specifically, measurements at the surface of the calibrator set in the minus X and in the Y directions, indicated radiation leakage intensity of 3.5 mr/hr. At 30 cm from the calibrator surface, the radiation leakage intensity was found to be less

than 1.0 mr/hr. Beyond 30 cm the radiation leakage was negligible. As evidenced by these actual radiation leakage measurements, the computerized theoretical estimation provided by SAI represents a gross overestimation of the actual leakage radiation present. If the maximum operator time is assumed to be 20 hours per week (hr/wk), 50 weeks per year (wk/yr), the total whole body exposure presented to an operator located at the surface of the calibrator set is 4 rem/yr. The actual use factor identified is approximately 15 hr's/wk. This would represent a total yearly whole body exposure of 3 rem if an operator were located at the surface of the calibrator set. However, these annual exposures are calculated assuming the operator is located at the surface of the AN/UDM-1 Radiac Calibrator Set when, in actuality, typical operator distance is 150 cm (5 feet) from the surface, the distance at which the operator controls are located. Therefore, at the proper operating distance, the radiation exposure to user personnel is much less than the indicated 3 rem/yr, which in itself is approximately one-half the annual external whole body exposure limits stipulated in Title 10, Code of Federal Regulations (CFR), Part 20 and AR 40-14 for occupational radiation exposure.

TABLE B-1

Exposure Rate Determinations Utilizing
Radiation Detection Instrumentation
On The AN/UDM-1 Radiac Calibrator Set

Distance From AN/UDM-1 (cm)	Dose Rate (mr/hr) -X axis	Dose Rate (mr/hr) Y and - Y axis	Dose Rate (mr/hr) Z and -Z axis
Surface	3.5	3.5/3.5	2.0/0.2
5	2.4	2.3/2.3	1.8/0.2
10	1.6	1.5/1.5	1.5/0.2
20	1.0	1.0/1.0	0.7/0.2
30	0.7	-------	-------
40	0.5	-------	-------



NRC FORM 313
(1-84)
10 CFR 30, 32, 33, 34, 35 and 40

APPLICATION FOR MATERIAL LICENSE

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED BY OMB
3150-0120
Expires: 5-31-87

INSTRUCTIONS: SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO COPIES OF ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

ALL AGENCIES FILE APPLICATIONS WITH:

U.S. NUCLEAR REGULATORY COMMISSION
DIVISION OF FUEL CYCLE AND MATERIAL SAFETY, NMSS
WASHINGTON, DC 20555

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS, IF YOU ARE LOCATED IN:

CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, MAINE, MARYLAND, MASSACHUSETTS, NEW JERSEY, NEW YORK, PENNSYLVANIA, RHODE ISLAND, OR VERMONT, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION I
NUCLEAR MATERIAL SECTION B
631 PARK AVENUE
KING OF PRUSSIA, PA 19406

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA, PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA, SEND APPLICATIONS TO:

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MATERIAL RADIATION PROTECTION SECTION
101 MARIETTA STREET, SUITE 2900
ATLANTA, GA 30323

IF YOU ARE LOCATED IN:

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION III
MATERIALS LICENSING SECTION
799 ROOSEVELT ROAD
GLEN ELLYN, IL 60137

ARKANSAS, COLORADO, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, SOUTH DAKOTA, TEXAS, UTAH, OR WYOMING, SEND APPLICATIONS TO:

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611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TX 76011

ALASKA, ARIZONA, CALIFORNIA, HAWAII, NEVADA, OREGON, WASHINGTON, AND U.S. TERRITORIES AND POSSESSIONS IN THE PACIFIC, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION V
MATERIAL RADIATION PROTECTION SECTION
1450 MARIA LANE, SUITE 210
WALNUT CREEK, CA 94596

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S. NUCLEAR REGULATORY COMMISSION JURISDICTION.

1. THIS IS AN APPLICATION FOR *(Check appropriate item)*

[X] A. NEW LICENSE
[ ] B. AMENDMENT TO LICENSE NUMBER _____
[ ] C. RENEWAL OF LICENSE NUMBER _____

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include Zip Code)*

U.S. Army Communications-Electronics Command
ATTN: AMSEL-SF
Ft. Monmouth, NJ 07703-5024

3. ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED.

See Supplement A

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION

Barry J. Silber, Radiation Protection Officer

TELEPHONE NUMBER: 201-544-4427

SUBMIT ITEMS 5 THROUGH 11 ON 8½ x 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL
a. Element and mass number, b. chemical and/or physical form, and c. maximum amount which will be possessed at any one time. See Supplement B

6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.
See Supplement C

7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING AND EXPERIENCE. See Supplement D

8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.
See Supplement E

9. FACILITIES AND EQUIPMENT. See Supplement F

10. RADIATION SAFETY PROGRAM.
See Supplement G

11. WASTE MANAGEMENT. See Supplement H

12. LICENSEE FEES *(See 10 CFR 170 and Section 170.31)*
FEE CATEGORY: Exempt
AMOUNT ENCLOSED $

13. CERTIFICATION. *(Must be completed by applicant)* THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT. FOR THE COMMANDER:

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, AND 40 AND THAT ALL INFORMATION CONTAINED HEREIN, IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.

WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948, 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

SIGNATURE-CERTIFYING OFFICER	TYPED/PRINTED NAME	TITLE	DATE
	RAYMOND E. B. KETCHUM, II	Colonel, GS, Chief of Staff	7 May 1987

14. VOLUNTARY ECONOMIC DATA

a. ANNUAL RECEIPTS
[ ] <$250K [ ] $1M–3.5M
[ ] $250K–500K [ ] $3.5M–7M
[ ] $500K–750K [ ] $7M–10M
[ ] 750K–1M [ ] >$10M

b. NUMBER OF EMPLOYEES *(Total for entire facility excluding outside contractors)*

c. NUMBER OF BEDS

d. WOULD YOU BE WILLING TO FURNISH COST INFORMATION *(Dollar and/or staff hours)* ON THE ECONOMIC IMPACT OF CURRENT NRC REGULATIONS OR ANY FUTURE PROPOSED NRC REGULATIONS THAT MAY AFFECT YOU? *(NRC regulations permit it to protect confidential commercial or financial–proprietary–information furnished to the agency in confidence)*
[ ] YES [ ] NO

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TYPE OF FEE	FEE LOG	FEE CATEGORY	COMMENTS	APPROVED BY
			ML10 106761 "OFFICIAL RECORD COPY"	
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PRIVACY ACT STATEMENT ON THE REVERSE

PRIVACY ACT STATEMENT

Pursuant to 5 U.S.C. 552a(e)(3), enacted into law by section 3 of the Privacy Act of 1974 (Public Law 93-579), the following statement is furnished to individuals who supply information to the Nuclear Regulatory Commission on NRC Form 313. This information is maintained in a system of records designated as NRC-3 and described at 40 Federal Register 45334 (October 1, 1975).

1. **AUTHORITY:** Sections 81 and 161(b) of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2111 and 2201(b)).

2. **PRINCIPAL PURPOSE(S):** The information is evaluated by the NRC staff pursuant to the criteria set forth in 10 CFR Parts 30, 32, 33, 34, 35 and 40 to determine whether the application meets the requirements of the Atomic Energy Act of 1954, as amended, and the Commission's regulations, for the issuance of a radioactive material license or amendment thereof.

3. **ROUTINE USES:** The information may be (a) provided to State health departments for their information and use; and (b) provided to Federal, State, and local health officials and other persons in the event of incident or exposure, for their information, investigation, and protection of the public health and safety. The information may also be disclosed to appropriate Federal, State, and local agencies in the event that the information indicates a violation or potential violation of law and in the course of an administrative or judicial proceeding. In addition, this information may be transferred to an appropriate Federal, State, or local agency to the extent relevant and necessary for an NRC decision or to an appropriate Federal agency to the extent relevant and necessary for that agency's decision about you.

4. **WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUAL OF NOT PROVIDING INFORMATION:** Disclosure of the requested information is voluntary. If the requested information is not furnished, however, the application for radioactive material license, or amendment thereof, will not be processed. A request that information be held from public inspection must be in accordance with the provisions of 10 CFR 2.790. Withholding from public inspection shall not affect the right, if any, of persons properly and directly concerned need to inspect the document.

5. **SYSTEM MANAGER(S) AND ADDRESS:** U.S. Nuclear Regulatory Commission
   Director, Division of Fuel Cycle and Material Safety
   Office of Nuclear Material Safety and Safeguards
   Washington, D.C. 20555

2. To determine the radiological/environmental impact due to the storage/possession of the AN/UDM-1 Radiac Calibrator Set, hypothetical scenarios involving source damage, improper disposal, installation (storage) fire and transport accident are presented. The radiological assessments are based upon ICRP 30 data. Results are expressed in terms of the committed dose equivalent determined for organs with the greatest potential exposure risk resulting from highly improbable incidents causing inhalation and/or ingestion of radioactive material, i.e., Co-60.

a. Source Damage Leading to Ingestion:

(1) The [ ] Co-60 source which is wipe tested for removable contamination (leakage) semi-annually and prior to calibration and shipment to an authorized/approved user. The hypothetical incident presented involves source damage during a leak testing procedure resulting in the ingestion of Co-60 with the following assumptions:

(a) One percent of the total activity (1.00E+02 mCi or 3.70E+09 Bq) is distributed within the radiation outport.

(b) Ten percent of the distributed activity (1.00E+01 mCi or 3.70E+08 Bq) is accessible for contamination and is transferred to the individual.

(c) One percent (1.00E-01 mCi or 3.70E+06 Bq) is assumed to be orally ingested by the individual.

(2) The tabulated committed dose equivalents are presented in Table B-2.

Ex 2

TABLE B-2

Committed Dose Equivalents to Various Organs
Following Ingestion of Removable Contamination
From Co-60 Source Leakage/Damage

Activity Ingested	Gonads	Breast	R Marrow	Lungs
3.70E+06 Bq 1.00E-01 mCi	2.66E-02 Sv (2.66E+00 rem)	1.89E-02 Sv (1.89E+00 rem)	2.04E-02 Sv (2.04E+00 rem)	1.85E-02 Sv (1.85E+00 rem)

SI Wall	ULI Wall	LLI Wall	Liver
3.03E-02 Sv (3.03E+00 rem)	3.55E-02 Sv (3.55E+00 rem)	5.18E-02 Sv (5.18E+00 rem)	4.81E-02 Sv (4.81E+00 rem)

The total ingested activity of 3.70E+06 Bq (1.00E-01 mCi) represents 53 percent of the recommended ALI (7.00E+06 Bq) given for oral ingestion.

(3) It should be noted that source contamination/leakage problems of greater than 0.005 uCi have never been identified. Therefore, the aforementioned assumptions are extreme in consideration of the actual quantities available for contamination and subsequent ingestion. In addition, operator training and guidance indicated in the TM, precludes mishandling of the calibrator set and further ensures proper handling and leak testing procedures.

b. Improper Disposal in a Public Incinerator

(1) The following assessment proposes incineration of an AN/UDM-1 Radiac Calibrator Set. This incident is considered highly improbable due to calibrator size, weight, restricted access to storage/user areas and radioactive warning symbols attached to the calibrator housing.

(a) An AN/UDM-1 Radiac Calibrator Set containing 1.00E+02 Ci (3.70E+11 Bq) Co-60 (Q_i) is incinerated in a municipal incinerator processing 300 tons of refuse per day at fifty percent excess air.

(b) Due to source encapsulation, only one tenth of one percent of the initial activity is released during the incineration process (f_s).

(c) The efficiency of the required air pollution control systems for particulates contained within the incinerating system is 90 percent (i.e., the fraction of Co-60 which escapes the stack is 0.1 (f_r)).

d. The aerodynamic mean activity diameter of the released particles is one micron.

(e) The number of individuals feeding on incinerator disposal route is also assumed to be the exposed population of 73,000 individuals.

(f) All the Co-60 is released within a 24 hr period.

(g) Fifty percent excess of the theoretical volume of air required for complete combustion of one pound (lb) of refuse is 2.00E+06 cm^3/lb (V_a).

(h) The weight of refuse incinerated is 6.00E+05 lbs (W_r).

(i) The atmospheric dispersion coefficient (X/Q) is 2.00E-05 sec/m^3.

2. The total activity released per day is given by:

$$Q = Q_i \, f_s \, f_r$$

3. Based on the assumptions above, the total activity released per day is 3.70E+07 Bq (1.00E+00 mCi). The continuous release rate (Q') over a 24 hr

period is 4.28E+02 Bq/sec (1.16E-05 mCi/sec).

4. The concentration of Co-60 in the stack gas (X_s) is given by:

$$X_s = Q/V_a \, W_r$$

The average 24 hr concentration of Co-60 is 3.08E-05 Bq/cm^3 (8.33E-13 mCi/cm^3).

5. Assuming a constant wind speed of one meter per second (m/sec) and moderately stable meteorological conditions, the maximum downwind concentration (X) is estimated by:

$$X = Q' \, (X/Q)$$

and, in this scenario, indicates a value of 8.56E-03 Bq/m^3 (2.31E-10 mCi/m^3).

6. Assuming an average daily breathing rate of 20.0 m^3/dy, the maximum exposed individual would inhale 1.71E-01 Bq (4.62E-09 mCi) on the day of incineration. Conservatively assuming that the average person inhales an amount of Co-60 equal to one-third of this concentration, the total inhaled activity would be 5.70E-02 Bq (1.54E-09 mCi).

7. Committed dose equivalent limits using ICRP 30 dosimetric data are summarized in Table B-3. It is noteworthy to reiterate that realistic consideration of this scenario can be virtually eliminated based upon calibrator size, radiation markings and access to storage/user locations restricted to authorized personnel.

TABLE B-3

Committed Dose Equivalents to Various Organs Resultant From Inhalation of Co-60 Following Source Incineration

Effected Group	Activity Inhaled	Gonads	Breast and R Marrow	Lungs
Average Exposed Person	5.70E-02 Bq (1.54E-09 mCi)	2.28E-10 Sv (2.28E-08 rem)	2.40E-10 Sv (2.40E-08 rem)	2.05E-09 Sv (2.05E-07 rem)

LLI Wall	Liver
4.67E-10 Sv (4.67E-08 rem)	5.24E-10 Sv (5.24E-08 rem)

Effected Group	Activity Inhaled	Gonads	Breast and R Marrow	Lungs
Maximum Exposed Person	1.71E-01 Bq (4.62E-09 mCi)	6.84E-10 Sv (6.84E-08 rem)	7.18E-10 Sv (7.18E-08 rem)	6.15E-09 Sv (6.15E-07 rem)

LLI Wall	Liver
1.40E-09 Sv (1.40E-07 rem)	1.57E-09 Sv (1.57E-07 rem)

8. The maximum downwind air concentration was estimated to be 8.56E-03 Bq/m^3 (2.31E-10 mCi/m^3). The air concentration limit for unrestricted areas, as specified in 10 CFR Part 20, is given as 3.70E+02 Bq/m^3 (1.00E-08 uCi/cm^3) for soluble forms and 1.11E+01 Bq/m^3 (3.00E-10 uCi/cm^3) for insoluble forms. The air concentration resulting from this hypothetical scenario as identified as being below Federal and Army requirements and continue to demonstrate insignificant to nonexistent environmental/radiological impact.

c. Improper Radioactive Source Disposal Into a Public Landfill:

(1) Assume the remains from the AN/UDM-1 Radiac Calibrator Set incinerated in the previous scenario is transferred to a solid municipal waste landfill for disposal. The exposure of the surrounding population is through the ingestion of radiocontaminated groundwater that has leached from the burial site into the public drinking water supply. The following details the parameters assumed in evaluating the environmental impact and the radiological impact presented to the feeding population:

(a) One percent leaching of the total sealed source activity (A_t = 3.70E+09 Bq or 100 mCi) has occurred and enters the groundwater without further dispersion (f_{L1} = 1.0).

(b) Accounting only for the average precipitation infiltrate of ten inches per year, the total volume of leachate generated per year from an average 25 acre landfill, based on US Environmental Protection Agency estimates is 6.76E+06 gallons per year (2.56E+10 cm^3).

(c) No significant dilution of the radiocontaminated zone occurs from surrounding groundwater (f_{L2} = 1.0).

(d) One percent of the radiocontaminated water is withdrawn for domestic water supply (f_{d1}) and five percent is consumed as drinking water (f_{d2}).

(2) The concentration of Co-60 in the leachate (A_L) as it enters the zone of saturation is given by:

$$A_L = A_t f_{L1} f_{L2} / V_L$$

Under the above assumptions, the average Co-60 concentration generated per year is 1.44E+05 Bq/m^3 (3.89E-06 uCi/cm^3).

(3) The amount of activity ingested (A_{ing}) as a result of radiocontaminated water in the drinking water supply can be estimated by

$$A_{ing} = V_L f_{d1} f_{d2} A_L$$

The dietary intake by the surrounding population (73,000) is 1.84E+06 Bq (4.97E-02 mCi). The average individual dietary intake would be 2.52E+01 Bq (6.81E-07 mCi).

(4) The dose commitment to the maximally exposed individual is assessed with the assumption that the annual dietary intake of water (I_w) is 3.70E+05 cm^3 and consists entirely of groundwater contaminated with Co-60 at the same concentration as calculated for leachate (A_L = 1.44E+05 Bq/m^3 or 3.89E-06 uCi/cm^3) incorporated into the formula:

$$A_{ing} = I_w A_L$$

The total activity estimated to be consumed is 5.32E+04 Bq (1.44E+00 uCi). Committed dose equivalents due to leaching from a municipal solid waste landfill to public drinking water are summarized in Table B-4.

TABLE B-4

Committed Dose Equivalents to Various Organs From Ingestion of Drinking Water Contaminated with Co-60

Effected Group	Activity Ingested	Gonads	Breast	R Marrow
Average Exposed Person	2.52E+01 Bq (6.81E-07 mCi)	1.81E-07 Sv (1.81E-05 rem)	1.28E-07 Sv (1.28E-05 rem)	1.38E-07 Sv (1.38E-05 rem)
Lungs	**SI Wall**	**ULI Wall**	**LLI Wall**	**Liver**
1.26E-07 Sv (1.26E-05 rem)	2.06E-07 Sv (2.06E-05 rem)	2.42E-07 Sv (2.42E-05 rem)	3.52E-07 Sv (3.52E-05 rem)	3.27E-07 Sv (3.27E-05 rem)
Maximum Exposed Person	Activity Ingested	Gonads	Breast	R Marrow
	5.32E+04 Bq (1.44E+00 uCi)	3.83E-04 Sv (3.83E-02 rem)	2.71E-04 Sv (2.71E-02 rem)	2.92E-04 Sv (2.92E-02 rem)
Lungs	**SI Wall**	**ULI Wall**	**LLI Wall**	**Liver**
2.66E-08 Sv (2.66E-02 rem)	4.36E-04 Sv (4.36E-02 rem)	5.10E-04 Sv (5.10E-02 rem)	7.45E-04 Sv (7.45E-02 rem)	6.91E-04 Sv (6.91E-02 rem)
Total Population	Activity Ingested	Gonads	Breast	R Marrow
	1.84E+06 Bq (4.97E-02 mCi)	1.32E-02 Sv (1.32E+00 rem)	9.38E-03 Sv (9.38E-01 rem)	1.01E-02 Sv (1.01E+00 rem)
Lungs	**SI Wall**	**ULI Wall**	**LLI Wall**	**Liver**
9.20E-03 Sv (9.20E-01 rem)	1.51E-02 Sv (1.51E+00 rem)	1.77E-02 Sv (1.77E+00 rem)	2.58E-02 Sv (2.58E+00 rem)	2.39E-02 Sv (2.39E+00 rem)

(5) The maximum permissible water concentration of Co-60 in unrestricted areas as specified in 10 CFR Part 20 is 1.85E+06 Bq/m^3 (5.00E-05 uCi/cm^3) for soluble forms and 1.11E+06 Bq/m^3 (3.00E-05 uCi/cm^3) for insoluble forms. The Co-60 concentrations as assessed in the leachate are 7.78 percent of the soluble limit and approximately 13 percent of the insoluble limit. It should be noted that the above calculations give no consideration to actual dispersion coefficients, deposition or dilution factors which normally occur during groundwater transport and would serve to decrease the already acceptable calculated levels.

d. Installation Fire:

(1) The proposed incident involves an installation fire which occurs during bulk storage of AN/UDM-1 Radiac Calibrator Sets and causing release of Co-60. The firefighting unit is familiar with the radioactive material storage area and has established standard operating procedures including the use of protective clothing and self-contained respiratory devices, procedures limiting water usage and, if necessary, immediate evacuation of personnel from downwind areas. This hypothetical incident assumes the following for occupational personnel in the immediate vicinity performing firefighting operations.

(a) One [2] Radiac Calibrator Set [2] is engulfed by flames and releases one tenth of one percent of its total activity. One percent of the activity is not deposited within the calibrator housing and is released as airborne particulates. The activity released during a one hour time interval is 3.70E+06 Bq (1.00E-01 mCi).

(b) The volume of air in the warehouse is estimated to be 1.23E+04 m^3, yielding 3.01E+02 Bq/m^3 (8.13E-06 mCi/m^3).

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(c) The breathing rate of personnel involved is 1.20 m^3/hr.

(d) The total intake for each firefighter is 3.61E+02 Bq (9.76E-06 mCi), assuming no implementation of respiratory protective devices during the one hour period.

(2) The committed dose equivalents as calculated using ICRP 30 data are given in Table B-5. No additional estimates were included for the general public due to conservative dose equivalents derived for non-occupational individuals in the immediate vicinity and dispersion factors which would further reduce dose commitments. It should also be noted that no consideration in dose estimates for firefighters included ventilation of the building during extinguishment or the use of respiratory protective devices. The total inhaled activity is 6.02E-03 percent of the ALI (6.00E+06 Bq) recommendation for inhalation. The air concentration (3.01E+02 Bq/m^3 or 8.13E-09 uCi/cm^3) when averaged over one year (365 days) is equivalent to 8.24E-01 Bq/m^3 (2.23E-11 uCi/cm^3). The concentration limits as specified in 10 CFR Part 20 are 3.70E+02 Bq/m^3 (1.00E-08 uCi/cm^3) for soluble forms and 1.11E+01 Bq/m^3 (3.00E-10 uCi/cm^3) for insoluble forms. The concentration limits derived in this evaluation are below maximum permissible limits specified for soluble forms accounting for variation of individual doses. Further considerations such as particle size, pathway and deposition parameters would also serve to reduce the calculated dose commitments.

TABLE B-5

Committed Dose Equivalents to Various Organs
Following Inhalation of Co-60 Due to Installation Fire

Activity Inhaled	Gonads	Breast and R Marrow	Lungs
3.61E+02 Bq (9.76E-06 mCi)	1.44E-06 Sv (1.44E-04 rem)	1.51E-06 Sv (1.51E-04 rem)	1.30E-05 Sv (1.30E-03 rem)

LLI Wall	Liver
2.96E-06 Sv (2.96E-04 rem)	3.32E-06 Sv (3.32E-04 rem)

(3) In the highly unlikely event of such an occurrence, procedures would be conducted with an awareness of the potential radiation hazards and would involve the use of protective breathing apparatus to reduce inhalation risks. The probability of an installation fire involving the AN/UDM-1 Radiac Calibrator Set approaches zero due to installation structural composition and firefighting units that would respond prior to any conceivable incorporation of units containing radioactive materials.

(4) In addition, the AN/UDM-1 Radiac Calibrator Set is primarily of lead construction and does utilize an NRC approved Co-60 sealed source. These parameters alone would ensure the integrity of the radioactive material contained within the housing should the unlikelihood of an installation fire occur. The scenario also gives no consideration in the dose estimate to firefighters to include building ventilation during extinguishment of the fire. These parameters would decrease the already acceptable exposure levels presented in this scenario and further support finding of no significant radiological/environmental impact associated with the use/possession of the AN/UDM-1 Radiac Calibrator Set.

e. Transportation Accident.

(1) Transportation of the AN/UDM-1 Radiac Calibrator Set is limited to transfer from the storage facility to an approved requisitioner and/or to the manufacturer. This transport scenario involves collision of the transporting vehicle resulting in fire, explosion and subsequent release of radioactive material to the environment. Inhalation risk will be considered the primary mode of exposure to individuals in the vicinity of the accident with the following assumptions:

(a) One [2] Radiac Calibrator Set, total activity [2] is involved in the accident.

(b) Five percent of the total activity is instantaneously and uniformly distributed within a hemispherical volume of 200 meters radius, yielding a total volume of 1.67E+07 m^3 with an activity per unit of volume of 1.11E+03 Bq/m^3 (2.99E-05 mCi/m^3).

(c) The breathing rates of individuals involved is 1.20 m^3/hr. Assuming the concentration of radioactive material to be constant and no evacuation of personnel takes place, the total activity inhaled in one hour is 1.33E+03 Bq (3.59E-05 mCi).

(2) The committed dose equivalents to various organs using ICRP 30 data are given in Table B-6. The air concentration of 1.11E+03 Bq/m^3 (2.99E-05 mCi/m^3) averaged over one year (365 dy) is 3.04E+00 Bq/m^3 (8.19E-11 uCi/m^3). The concentration limits as specified in 10 CFR Part 20 are 3.70E+02 Bq/m^3 (1.00E-08 uCi/cm^3) for soluble forms and 1.11E+01 Bq/m^3 (3.00E-10 uCi/cm^3) for insoluble forms. The values identified are 8.21E-01 percent of the soluble limit and

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2.73E+01 percent of the insoluble limit. A large reduction in the inhaled activity and resultant committed dose equivalents would occur if wind dispersion and evacuation of personnel from radio-contaminated areas was performed.

TABLE B-6

Committed Dose Equivalents to Various Organs Due to Inhalation of Co-60 Following Transportation Accident

Activity Inhaled	Gonads	Breast and R Marrow	Lungs
1.33E+03 Bq (3.59E-05 mCi)	5.32E-06 Sv (5.32E-04 rem)	5.58E-06 Sv (5.58E-04 rem)	4.79E-05 Sv (4.79E-03 rem)

LLI Wall	Liver
1.10E-05 Sv (1.10E-03 rem)	1.22E-05 Sv (1.22E-03 rem)

(3) The probability of a transportation accident occurring as hypothesized is highly improbable. Since its inception into the DOD, the AN/UDM-1 Radiac Calibrator Set has not been involved in any type of transportation accident which resulted in the release of its radioactive contents. Transporting/ packaging of the calibrator set is in accordance with applicable DOT regulations. Any conceivable damage to the calibrator set in transit would be of a minimal nature and would not result in the release of radioactive material to the environment. Upon observation of any damage, appropriate action would be taken to isolate the unit for return and/or disposal.

(4) Table A-1 summarizes resultant committed dose equivalents to various organs from the proposed hypothetical scenarios. The occupational worker is

identified as receiving the maximum internal exposure through oral ingestion of source material as a result of source leakage/damage. Each proposed incident although regarded as highly improbable demonstrates internal exposure levels below these recommended by ICRP or regulatory standards. Additionally, the total intake of Co-60 estimated for the presented scenarios are based upon general assumptions which are in gross excess of more realistic parameters. An assessment utilizing actual parameters would identify internal exposures to be orders of magnitude less than those indicated. This predication, coupled with properly implemented radiation safety procedures and strict operational guidelines, virtually eliminates the association of a radiological/environmental impact with the AN/UDM-1 Radiac Calibrator Set.

C. References:

1. International Commission on Radiological Protection, Publication 26, Recommendations of the International Commission on Radiological Protection, Pergamon Press, New York, adopted 1977.

2. International Commission on Radiological Protection, Publication 30, Limits for Intakes of Radionuclides by Workers, Pergamon Press, New York, Adopted 1978.

3. Technical Manual 11-1176, Radiac Calibrator Set, AN/UDM-1, April 1955.

4. Army Regulation 385-11, Safety, Ionizing Radiation Protection (Licensing, Control, Transportation, Disposal and Radiation Safety), 1 May 1980.

5. Army Regulation 700-64, DLAM 4145.8, NAV SUPINST 4000.34B, AFR 67-8, MCO P4400.105C, Radioactive Commodities in the DOD Supply Systems, 19 April 1985.

6. Army Regulation 40-14, Control and Recording Procedures for Occupational Exposure to Ionizing Radiation and Radioactive Materials, 15 March 1982.

7. US Department of Health, Education and Welfare, Radiological Health Handbook, Public Health Service, Rockville, Maryland, 1970.