40-8598

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
HEADQUARTERS US ARMY COMMUNICATIONS-ELECTRONICS COMMAND
AND FORT MONMOUTH
FORT MONMOUTH, NEW JERSEY 07703

REPLY TO
ATTENTION OF:

DRSEL-SF-H

24 FEB 1982

SUBJECT: Renewal and Complete Revision of US Nuclear Regulatory Commission (NRC) Source Material License Number SMB-1300

RECEIVED
MAR 16 1982
U.S. Nuclear Regulatory Commission
NMSS
Mail Section

Commander
US Army Material Development and Readiness Command
ATTN: DRCSF-P
5001 Eisenhower Avenue
Alexandria, Virginia 22333

1. The inclosed application for the renewal and complete revision of subject license for the use of ^{232}Thorium Fluoride as optical coatings in thermal imaging Night Vision devices is submitted for review and forwarding to the NRC.

2. The inclosed application is submitted in fulfillment of the requirements of Section 40.31 and 40.43 of Title 10, Code of Federal Regulations, Part 40.

FOR THE COMMANDER:

JOHN T. PATTERSON
Colonel, GS
Chief of Staff

E/13

20394

US NUCLEAR REGULATORY COMMISSION (NRC) LICENSE APPLICATION FOR RENEWAL AND COMPLETE REVISION OF NRC SOURCE MATERIAL LICENSE NUMBER SMB-1300 FOR THORIUM FLUORIDE COATINGS ON THERMAL IMAGING SYSTEMS

HEADQUARTERS
U. S. ARMY COMMUNICATIONS-ELECTRONICS COMMAND
(CECOM)
Fort Monmouth, New Jersey 07703

FORM **NRC-2**
(7-77)
10 CFR 40

Approved by GAO
R0203

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR SOURCE MATERIAL LICENSE

Pursuant to the regulations in Title 10, Code of Federal Regulations, Chapter 1, Part 40, application is hereby made for a license to receive, possess, use, transfer, deliver or import into the United States, source material for the activity or activities described.

1. (*Check one*)
☐ (*a*) New license
☐ (*b*) Amendment to License No.
☒ (*c*) Renewal of License No. SMB-1300
☐ (*d*) Previous License No.

2. NAME OF APPLICANT
See Supplement A

3. PRINCIPAL BUSINESS ADDRESS
See Supplement A

4. STATE THE ADDRESS(ES) AT WHICH SOURCE MATERIAL WILL BE POSSESSED OR USED
See Supplement B

5. NAME OF PERSON TO BE CONTACTED CONCERNING THIS APPLICATION
Steven A. Horne, Supervisory Health Physicist

6. TELEPHONE NO. OF INDIVIDUAL NAMED IN ITEM 5
201-544-4427

7. DESCRIBE PURPOSE FOR WHICH SOURCE MATERIAL WILL BE USED
See Supplement C

8. STATE THE TYPE OR TYPES, CHEMICAL FORM OR FORMS, AND QUANTITIES OF SOURCE MATERIAL YOU PROPOSE TO RECEIVE, POSSESS, USE, OR TRANSFER UNDER THE LICENSE

(*a*) TYPE	(*b*) CHEMICAL FORM	(*c*) PHYSICAL FORM (*Including % U or Th.*)	(*d*) MAXIMUM AMOUNT AT ANY ONE TIME (*kilograms*)
NATURAL URANIUM			
URANIUM DEPLETED IN THE U-235 ISOTOPE			
THORIUM (ISOTOPE)	See Supplement C		

(*e*) MAXIMUM TOTAL QUANTITY OF SOURCE MATERIAL YOU WILL HAVE ON HAND AT ANY TIME (*kilograms*)

9. DESCRIBE THE CHEMICAL, PHYSICAL, METALLURGICAL, OR NUCLEAR PROCESS OR PROCESSES IN WHICH THE SOURCE MATERIAL WILL BE USED, INDICATING THE MAXIMUM AMOUNT OF SOURCE MATERIAL INVOLVED IN EACH PROCESS AT ANY ONE TIME, AND PROVIDING A THOROUGH EVALUATION OF THE POTENTIAL RADIATION HAZARDS ASSOCIATED WITH EACH STEP OF THOSE PROCESSES.
See Supplement C

10. LIST THE NAMES AND ATTACH A RESUME OF THE TECHNICAL QUALIFICATIONS INCLUDING TRAINING AND EXPERIENCE OF APPLICANT'S SUPERVISORY PERSONNEL AND THE PERSON RESPONSIBLE FOR THE RADIATION SAFETY PROGRAM (OR OF APPLICANT IF AN INDIVIDUAL).
See Supplement D

11. DESCRIBE THE EQUIPMENT AND FACILITIES WHICH WILL BE USED TO PROTECT HEALTH AND MINIMIZE DANGER TO LIFE OR PROPERTY AND RELATE THE USE OF THE EQUIPMENT AND FACILITIES TO THE OPERATIONS LISTED IN ITEM 9; INCLUDE: (*a*) RADIATION DETECTION AND RELATED INSTRUMENTS (including film badges, dosimeters, counters, air sampling, and other survey equipment as appropriate. The description of radiation detection instruments should include the instrument characteristics such as type of radiation detected, window thickness, and the range(s) of each instrument).
See Supplement E

(*b*) METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED IN (*a*) ABOVE, INCLUDING AIR SAMPLING EQUIPMENT (for film badges, specify method of calibrating and processing, or name supplier).
See Supplement F

11(c). VENTILATION EQUIPMENT WHICH WILL BE USED IN OPERATIONS WHICH PRODUCE DUST, FUMES, MISTS, OR GASES, INCLUDI PLAN VIEW SHOWING TYPE AND LOCATION OF HOOD AND FILTERS, MINIMUM VELOCITIES MAINTAINED AT HOOD OPENINGS AND P CEDURES FOR TESTING SUCH EQUIPMENT.

Not applicable. There will be no processing or maintenance performed on these commodities requiring ventilation.

12. DESCRIBE PROPOSED PROCEDURES TO PROTECT HEALTH AND MINIMIZE DANGER TO LIFE AND PROPERTY AND RELATE THESE PROCEDURES TO THE OPERATIONS LISTED IN ITEM 9; INCLUDE: (a) SAFETY FEATURES AND PROCEDURES TO AVOID NONNUCLEAR ACCIDENTS, SUCH AS FIRE, EXPLOSION, ETC., IN SOURCE MATERIAL STORAGE AND PROCESSING AREAS.

See Supplement G

(b) EMERGENCY PROCEDURES IN THE EVENT OF ACCIDENTS WHICH MIGHT INVOLVE SOURCE MATERIAL.

See Supplement H

(c) DETAILED DESCRIPTION OF RADIATION SURVEY PROGRAM AND PROCEDURES.

See Supplement I

13. WASTE PRODUCTS: *If none will be generated, state "None" opposite (a), below. If waste products will be generated, check here ☐ and explain on a supplemental sheet:*

(*a*) Quantity and type of radioactive waste that will be generated. None

(*b*) Detailed procedures for waste disposal. See Supplement J

14. IF PRODUCTS FOR DISTRIBUTION TO THE GENERAL PUBLIC UNDER AN EXEMPTION CONTAINED IN 10 CFR 40 ARE TO BE MANUFACTURED, USE A SUPPLEMENTAL SHEET TO FURNISH A DETAILED DESCRIPTION OF THE PRODUCT, INCLUDING:

(*a*) PERCENT SOURCE MATERIAL IN THE PRODUCT AND ITS LOCATION IN THE PRODUCT.

(*b*) PHYSICAL DESCRIPTION OF THE PRODUCT INCLUDING CHARACTERISTICS, IF ANY, THAT WIL PREVENT INHALATION OR INGESTION OF SOURCE MATERIAL THAT MIGHT BE SEPARATED FROM THE PRODUCT.

(*c*) BETA AND BETA PLUS GAMMA RADIATION LEVELS (*Specify instrument used, date of calibration and calibration technique used*) AT THE SURFACE OF THE PRODUCT AND AT 12 INCHES.

(*d*) METHOD OF ASSURING THAT SOURCE MATERIAL CANNOT BE DISASSOCIATED FROM THE MANUFACTURED PRODUCT.

CERTIFICATE

(*This item must be completed by applicant*)

15. *The applicant, and any official executing this certificate on behalf of the applicant named in Item 2, certify that this application is prepared in conformity with Title 10, Code of Federal Regulations, Part 40, and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.*

FOR THE COMMANDER:

Department of the Army
US Army Communications-Electronics Command
BY:
(*Signature*)

Dated 24 Feb 82

JOHN T. PATTERSON
(*Print or type name*)

Colonel, GS
Chief of Staff
(*Title of certifying official authorized to act on behalf of the applicant*)

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.

1. Inclosures 1, 2, 3, 4, 5, 6 and 7 are concurrences from the major Army commands which are responsible for the use of the various thermal imaging Night Vision devices.

2. Inclosures 8, 9, 10, 11 and 12 are concurrences from the effected DARCOM Major Subordinate Commands who are responsible for the management of the various fire control systems utilizing the Night Vision devices.

3. Inclosures 13, 14, 15 and 16 are concurrences from the effected DESCOM Depots with regard to bulk storage and/or maintenance functions associated with these Night Vision devices.

4. This license application was reviewed and concurred in by the Fort Monmouth Ionizing Radiation Control Committee on 19 February 1982.

DEPARTMENT OF THE ARMY
200TH THEATER ARMY MATERIEL MANAGEMENT CENTER
APO NEW YORK 09052

8 FEB 1982

AEAGD-MMC-RA-CS

SUBJECT: Application for Renewal and Complete Revision of US Nuclear Regulatory Commission (NRC) Source Material License Number SMB-1300

Commander
US Army Communications-Electronics
Command and Fort Monmouth
ATTN: DRSEL-SF-H
Fort Monmouth, NJ 07703

1. Reference letter, DRSEL-SF-H, US Army Communications-Electronics Command, dated 20 January 1982, subject as above.

2. This Center has reviewed the subject license for matters pertaining to the implementation of regulatory requirements for the control of these radioactive commodities and concurs in the proposed license.

3. POC this Center is MAJ Lind, ZBN MIL (2281-) 6211/7328.

FOR THE COMMANDER:

Bobby N Crowe
BOBBY N. CROWE
LTC, OD
Chief, Armament Systems Division

Incl 1

AFLG-MAC (20 Jan 82) 1st Ind
SUBJECT: Application for Renewal and Complete Revision of US Nuclear Regulatory Commission (NRC) Source Material License Number SMB-1300

HQ, FORSCOM, Ft McPherson, GA 30330 2 FEB 1982

TO: Commander, US Army Communications - Electronics Command and Fort Monmouth, ATTN: DRSEL-SF-H, Fort Monmouth, New Jersey 07703

Concur in subject application.

FOR THE COMMANDER:

M. Black

wd incl

M. A. BLACK
CPT, AGC
Asst AG

Incl 2

AJGC-OT (20 Jan 82) 1st Ind MAJ Kluender/jk/233-4806
SUBJECT: Application for Renewal and Complete Revision of US Nuclear Regulatory Commission (NRC) Source Material License Number SMB-1300

Headquarters, United States Army Japan/IX Corps, APO San Francisco 96343
10 FEB 1982

TO: Commander, United States Army Communications-Electronics Command and Fort Monmouth, ATTN: DRSEL-SF-H, Fort Monmouth, New Jersey 07703.

1. Concur with application as written.

2. POC this headquarters is MAJ Schubert, 233-4806.

FOR THE COMMANDER:

wd all Incl

COLEMAN P. GIBSON
SGM, USA
Asst AG

Inc 3

DJ-MS-MC (20 Jan 82) 1st Ind
SUBJECT: Application for Renewal and Complete Revision of US Nuclear Regulatory Commission (NRC) Source Material License Number SMB-1300

Headquarters, Eighth United States Army, APO San Francisco 96301 3 FEB 82

TO: Commander, US Army Communications-Electronics Command and Fort Monmouth
ATTN: DRSEL-SF-H, Fort Monmouth, New Jersey 07703

Concur in subject application.

FOR THE COMMANDER:

James K. Owen

wd all incl

JAMES K. OWEN
SFC, USA
Assistant Adjutant General

Incl 4

NGB-ARL-M (20 Jan 82)
SUBJECT: Application for Renewal and Complete Revision of US Nuclear Regulatory Commission (NRC) Source Material License Number SMB-1300

HQ, Departments of the Army and the Air Force, National Guard Bureau, Washington, DC 20310 19 FEB 1982

TO: Commander, US Army Communications-Electronics Command,
ATTN: DRSEL-SF-H, Fort Monmouth, NJ 07703

Concur.

FOR THE CHIEF, NATIONAL GUARD BUREAU:

1 Incl
nc

WILLIAM C. MACKERT
Colonel, GS
Chief, Army Logistics Division

Incl 5

S: 17 Feb 82

ATCD-NC (20 Jan 82) 1st Ind
SUBJECT: Application for Renewal and Complete Revision of US Nuclear
Regulatory Commission (NRC) Source Material License Number SMB-1300

HQ TRADOC, Ft Monroe, VA 23651 09 FEB 1982

TO: Cdr, US Army Communications-Electronic Command and Ft Monmouth,
ATTN: DRSEL-SF-H, Ft. Monmouth, NJ 07703

Subject application has been reviewed, this headquarters concurs.

FOR THE COMMANDER:

Doreatha Mangrum
DOREATHA MANGRUM
ASSISTANT ADJUTANT GENERAL

1 Incl
nc

Incl 6

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
HEADQUARTERS, UNITED STATES ARMY WESTERN COMMAND
FORT SHAFTER, HAWAII 96858

REPLY TO
ATTENTION OF:

APOP-NC

28 January 1982

SUBJECT: Application for Renewal and Complete Revision of US Nuclear Regulatory Commission (NRC) Source Material License Number SMB-1300

Commander
HQ US Army Communications-Electronics
  Command and Fort Monmouth
ATTN: DRSEL-SF-H
Fort Monmouth, NJ 07703

Subject application has been reviewed by this headquarters. Concur with application as written.

FOR THE COMMANDER:

James T Bushong

JAMES T. BUSHONG
LTC, GS
Chief, NBC Div, ODCSOPS

Incl 7

DRSAR-SF (26 Jan 82) 1st Ind Mr. Morris/sjh/AUTOVON 793-3482
SUBJECT: Application for Renewal and Complete Revision of US Nuclear Regulatory Commission (NRC) Source Material License No SMB-1300

HQ, ARRCOM, Rock Island, IL 61299 12 FEB 1982

TO: Commander, US Army Communications-Electronics Command,
ATTN: DRSEL-SF-H, Fort Monmouth, NJ 07703

Concur in subject application.

FOR THE COMMANDER:

L E Smith

wd all incl

LAWRENCE E. SMITH
Chief, Safety Office

Incl 8

DRDEL-SS (LTR, 26 Jan 82) 1st Ind
SUBJECT: Application for renewal and complete revision of US Nuclear Regulatory Commission (NRC) Source Material License SMB 1300

HQ, USA ERADCOM, Adelphi, MD 20783 22 Feb 82

TO: Cdr, CECOM, ATTN: DRSEL-SF-H, Ft. Monmouth, NJ 07703

This HQ has reviewed and concurs on SUBJ license renewal.

FOR THE COMMANDER:

for

RONALD W. KAESE
Chief, Safety Office
ERADCOM

Incl 9

ROUTINE

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                    PT 00039    054/01097                         PAGE 01

DRSEL:GS:CP:FMD:HI:TG:IL:IO:LE:LG:ME:MM:MS:PA:PC:PL:PT:OC:SF:SS:SCCO:4
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P 221900Z FEB 82
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TO CDR CECOM FT MONMOUTH NJ//DRSEL-SF-H//
BT
UNCLAS A6
SUBJ:  APPLICATION FOR RENEWAL AND COMPLETE REVISION OF US NUCLEAR
       REGULATORY COMMISSION (NRC) SOURCE MATERIAL LICENSE NO
       SMB-1306
A.  LETTER, DRSEL-SF-H, 26 JAN 82, SAP.
B.  ARPANET DARCOM-KA, 22 FEB 82, 10:46:00. BSAVAJKO.
CONCUR WITH SUBJECT LICENSE APPLICATION.
BT
#4364

NNNN
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ROUTINE

Incl 10

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PTTUZYUW RUCIWMA1494 0562247-UUUU--RUEDBIA.

ZNR UUUUU

P 251400Z FEB 82

FM CDRTACOM WARREN MI //DRSTA-CZ//

TO CDRCECOM FT MONMOUTH NJ //DRSEL-SF-H//

BT

A/

UNCLAS

SUBJ: DRAFT NRC LICENSE APPLICATION NO. SMB-1300

A. LETTER, DRSEL-SF-H, HQ CECOM, 27 JAN 81, SUBJECT: APPLICATION FOR RENEWAL AND COMPLETE REVISION OF US NUCLEAR REGULATORY COMMISSION (NRC) SOURCE MATERIAL LICENSE SMB-1300.

1. THE TACOM SAFETY OFFICE CONCURS WITH THE DRAFT NRC LICENSE APPLICATION FURNISHED UNDER REFERENCE A.

2. THE LICENSE APPLICATION HAS BEEN COORDINATED WITH AND CONCURRED IN BY PMS FOR ABRAMS TANK SYSTEM, FIGHTING VEHICLE SYSTEM, M60 TANKS, M113(ITV) AND FSTV.

BT

#1494

NNNN

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Incl 4

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SEL:GS:CP:FMD:HI :IG:IL:IO:LE:LG:ME :MM:MS:PA:PC:PL:PT:OC:SF:SS:SCCO:
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ZNR UUUUU
R 132130Z FEB 82
FM CDRTSARCOM STL MO //DRSTS-X//
TO CDRCECOM FT MONMOUTH NJ //DRSEL-SF-H//
BT A4
UNCLAS
SUBJECT APPLICATION FOR RENEWAL AND COMPLETE REVISION OF US NUCLEAR REGULATORY COMMISSION (NRC) SOURCE MATERIAL LICENSE NO. SMB-1300

A. REFERENCE LETTER, HQ, CECOM, DRSEL-SF-H, 26 JANUARY 1982, SAB.

1. SUBJECT APPLICATION HAS BEEN REVIEWED BY APPROPRIATE ELEMENTS OF HQ, TSARCOM, HQ, AVRADCOM, AND THE PROGRAM MANAGER FOR ADVANCED ATTACK HELICOPTER. ALL ELEMENTS CONCUR IN THE LICENSE APPLICATION AS IT APPLIES TO AIRCRAFT FIRE CONTROL SYSTEMS.

2. POINT OF CONTACT FOR THIS ACTION IS MICHAEL HEARD, DRSTS-XS, AUTOVON 693-3227.

#6356

NNNN

Incl 12

DEPARTMENT OF THE ARMY
NEW CUMBERLAND ARMY DEPOT
NEW CUMBERLAND, PENNSYLVANIA 17070

IN REPLY REFER TO:

SDSNC-ASA 9 February 1982

SUBJECT: Application for renewal and complete revision of US Nuclear Regulatory Commission (NRC) Source Material License No. SMB-1300

Commander
US Army Communication-Electronics Command
ATTN: DRSEL-SF-H
Ft. Monmouth N.J. 07703

Reference letter, subject as above, dated 21 Jan 82.

Proposed License application has been reviewed and concurrence is provided.

FOR THE COMMANDER:

for DAVID WILE
Safety Director

CF:
COMDR, NCAD

Incl 13

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DRSEL:GS:CP:FMD:HI:IG:IL:IO:[illegible]:LG:ME:MM:MS:PA:PC:PL:PT:OC:SF:SS:SCCO:
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PTTUZYUW RUWTBFA1245 0532145-UUUU--RUEDBIA.

ZNR UUUUU

P 222030Z FEB 82

FM CDR RRAD TEXARKANA TX //SDSRR-AF//

TO CDR CECOM FT MONMOUTH NJ //DRSEL-SF-H//

BT

UNCLAS

SUBJECT: APPLICATION FOR RENEWAL AND COMPLETE REVISION OF U.S. NRC SOURCE MATERIAL LICENSE NUMBER SMB 1300

A. REF LETTER, HQ, CECOM, DRSEL-SF-H, 26 JAN 82, SAB

1. CONCUR WITH SUBJECT LICENSE RENEWAL BASED UPON TELEPHONE CONVERSATION BETWEEN MR. STEVE HORNE, HQ, CECOM, AND MR. WARREN GRAEF, SAFETY MANAGER THIS INSTALLATION.

BT

#1245

NNNN

Incl 14

DEPARTMENT OF THE ARMY
SACRAMENTO ARMY DEPOT
SACRAMENTO, CALIFORNIA 95813

REPLY TO
ATTENTION OF:

SDSSA-ASO

8 February 1982

SUBJECT: Application for Renewal and Complete Revision of US Nuclear Regulatory Commission (NRC) Source Material License No. SMB-1300

Commander
US Army CECOM
ATTN: DRSEL-SF-H
Fort Monmouth, NJ 07703

1. Reference your letter, subject as above, dated 21 January 1982.

2. Concur with application as proposed.

Herman E. McGrew
HERMAN E. McGREW
Radiation Protection Officer

Incl 15

ROUTINE

FT 00457 050/2321Z PAGE 01

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DRSEL:GS:CP:EMO:HT:TG:IL:IO:LF:LG:MF:MM:MS:PA:PC:PL:PT:OC:SF:SS:SCCO: 5
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ZNR UUUUU
R 192015Z FEB 82
FM CDR SHAD LATHROP CA //SDSSH-GOC//
TO CDR CECOM FT MONMOUTH NJ //DRSEL-SF-H//
BT
UNCLAS A6
SUBJECT: APPLICATION FOR RENEWAL AND COMPLETE REVISION OF US NUCLEAR REGULATORY COMMISSION (NRC) SOURCE MATERIAL LICENSE NO. SMB-1300
A. CECOM LTR, DRSEL-SF-H, 21 JAN 82.
1. CONCUR WITH DRAFT APPLICATION FOR SOURCE MATERIAL LICENSE.
2. POC THIS ACTIVITY E. EARNEST AUTOVON 462-2182.
BT
#5153

NNNN

ROUTINE

hd 16

SUPPLEMENT A

1. Reference: Items 2 and 3 of Form NRC-2.

2. Department of the Army
US Army Communications-Electronics Command
ATTN: DRSEL-SF-H
Fort Monmouth, New Jersey 07703

SUPPLEMENT B

1. Reference: Item 4 of Form NRC-2.

2. Commodities containing radioactive material will be possessed, maintained and used by US Department of Defense (DOD) installations and activities worldwide under the control of Department of the Army (DA) military/or civilian personnel. Maintenance of assets containing radioactive material will be performed at Sacramento Army Depot (SAAD), Sacramento, California. In addition, bulk storage only of assets containing radioactive material will be provided by New Cumberland Army Depot (NCAD), New Cumberland, Pennsylvania, Red River Army Depot (RRAD), Texarkana, Texas, and Sharpe Army Depot (SHAD), Lathrop, California.

SUPPLEMENT C

1. Reference: Items 7, 8 and 9 of Form NRC-2.

2. The radioactive material utilized under this license is ^{232}Thorium Fluoride (ThF_4)* in solid form (approximately 75.4 percent Thorium) as multi-layer anti-reflective (MLAR) optical coatings on thermal imaging lenses of the Forward Looking Infrared (FLIR) systems (Night Vision devices). The maximum quantity that will be possessed at any one time under this license will be 40 kilograms. The maximum quantity incorporated in any FLIR system will not exceed 2.0 grams of Thorium.

3. ThF_4 as used in Infrared (IR) Spectrum has a low index of refraction and is used extensively in the manufacturing of wideband MLAR coatings.

4. ThF_4 has a low water solubility which is very important since ThF_4 films are used as the outer layer of IR MLAR coatings and offer good environmental protection.

5. ThF_4 is extremely stable, exhibiting no appreciable decomposition in the coating deposition process. The melting point is greater than 900°C.

6. ThF_4 was selected for its high transmittance capabilities within the IR spectral region. All ionic crystals exhibit lattice vibration absorption at predictable wavelengths in the IR region. The absorption regions move toward longer wavelengths with increasing atomic weight. ThF_4 is very useful since it is nearly the heaviest fluoride compound available and its lattice absorption region is well beyond the 8-14 micron operating region of the IR systems of military interest.

7. Due to the stringent military requirements for maximum IR transmission and high performance in adverse environments, ThF_4 offers one of the best components for MLAR coatings.

8. This command is designated Primary Inventory Control Activity (PICA) for Federal Supply Classification (FSC) 5855 commodities which includes Night Vision equipment. The primary armament subsystem manager maintains full responsibility for the fire control system and ancillary subsystems. For FSC 5855 thermal imaging systems authorized under this license used as ancillary subsystems to fire control systems managed by other commands, CECOM only maintains PICA responsibilities for the thermal imaging subsystems (common modules)whereas these managers maintain PICA responsibilities. It is requested that the license issued for these systems be of broad scope in nature to cover all types of equipment that have been developed or will be developed in the future. This will negate the need to continually amend this license each time new equipment enters the Army logistical system.

* For simplicity purposes, the use of the term ThF_4 is employed in lieu of the term ^{232}Thorium Fluoride or $^{232}ThF_4$.

9. In evaluating possible radiological hazard resultant from utilization of ThF_4 coated objective lenses in Night Vision devices, an Environmental Assessment (EA) was prepared based on conservative assumptions for a single generic system of quantities greater than that contained in any current system. The external dose rate at operational distances of one foot indicated 2.57E-04* rads per hour. Beta particle emission is the primary contributing factor to this level. For internal dose evaluation, various incidents are proposed inclusive of ingestion or inhalation through source damage, improper disposal, installation fire and transport accident. No hypothetical situation identified committed dose equivalents to various organs above recommendations stated in International Commission on Radiological Protection (ICRP) Publications 26 and 30. Complete analyses for external and internal doses are presented within the EA for radiological considerations. Exposure levels presented confirm that the incorporation of ThF_4 into optical coatings poses insignificant to non-existent radiological consideration. The EA is included as Annex I.

10. It should be noted that the various Night Vision thermal imaging devices containing ThF_4 within the specific afocal lenses and common modules are opaque to the human eye. Based on the above, the various intermediate lenses as contained within these devices and the specific eyepiece viewing system precludes any exposure to the user's eye.

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* The use of exponential (scientific) notation, i.e. 2.57E-04 (2.57×10^{-4}) is employed in lieu of standard notation, i.e. 0.000257.

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
HEADQUARTERS US ARMY COMMUNICATIONS-ELECTRONICS COMMAND
AND FORT MONMOUTH
FORT MONMOUTH, NEW JERSEY 07703

REPLY TO
ATTENTION OF:

DRSEL-SF-H 24 February 1982

SUBJECT: Environmental Assessment and Finding of No Significant Impact for Night Vision Systems

Commander
US Army Materiel Development and Readiness Command
ATTN: DRCSF-P
5001 Eisenhower Avenue
Alexandria, VA 22333

1. Reference is made to the following:

a. Letter, DRCIS-A, 11 August 1980, subject: National Environmental Policy Act (NEPA) Compliance for Proposals Involving Nuclear Licensing.

b. Army Regulation AR-200-2 entitled Environmental Quality, Environmental Effects of Army Actions, dated 1 September 1981.

2. In accordance with references 1a and 1b, subject environmental documents are provided for your review and concurrence.

FOR THE COMMANDER:

BM Savaiko

2 Incl
as

BERNARD M. SAVAIKO
Chief, Safety Office

DEPARTMENT OF THE ARMY

US ARMY COMMUNICATIONS - ELECTRONICS COMMAND

ENVIRONMENTAL ASSESSMENT

AND

FINDING OF NO SIGNIFICANT IMPACT

RENEWAL OF NUCLEAR REGULATORY COMMISSION LICENSE NUMBER SMB-1300 GOVERNING NIGHT VISION SYSTEMS

FORT MONMOUTH, NEW JERSEY

PREPARED BY:

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Chief, Safety Office
Commander Designee

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LIST OF ABBREVIATIONS

AAH	Advanced Attack Helicopter
ALI	Annual Limit on Intake
AR	Army Regulation
Bq	Becquerel
CECOM	US Army Communications-Electronics Command
CFR	Code of Federal Regulations
CFV	Cavalry Fighting Vehicle
CONUS	Continental United States
DA	Department of the Army
DAC	Derived Air Concentration
DARCOM	US Army Materiel Development and Readiness Command
DESCOM	Depot Systems Command
DOD	Department of Defense
DOT	Department of Transportation
DS/GS	Direct Support/General Support
EAA	End Article Application
EPA	Environmental Protection Agency
FLIR	Forward Looking Infrared
Gy	Gray
Hq	Headquarters
IAW	In accordance with
ICRP	International Commission on Radiological Protection
IFV	Infantry Fighting Vehicle
IR	Infrared
ISU	Integrated Sight Unit
M-1	Full Tracked Combat Tank (Abrams Main Battle Tank)
M-2(IFV)	Bradley Fighting Vehicle System
M-3(CFV)	Bradley Fighting Vehicle System
M60A3	Full Tracked Combat Tank (Battle Tank)

MLAR	Multilayer antireflective
MOU	Memorandum of Understanding
MSC	Major Subordinate Command
NCAD	New Cumberland Army Depot
NICP	National Inventory Control Point
NODLR	Night Observation Device Long Range
NRC	Nuclear Regulatory Commission
NVS	Night Vision Sight
PICA	Primary Inventory Control Activity
PM	Project Manager
RPO	Radiation Protection Officer
RRAD	Red River Army Depot
SAAD	Sacramento Army Depot
SHAD	Sharpe Army Depot
SICA	Secondary Inventory Control Activity
SLAR	Single layer antireflective
Sv	Sievert
TADS/PNVS	Target Acquisition Designation System/Pilot Night Vision System
ThF_4	^{232}Thorium fluoride
TIS	Thermal Imagery Sight
TOW	Tube-launched, optically tracked, wire-guided
TTS	Tank Thermal Sight
TWS	TOW Weapon System

I. Finding of No Significant Impact

1. The US Army Communications-Electronics Command (CECOM), as the US Nuclear Regulatory Commission (NRC) license manager for all US Army Materiel Development and Readiness Command (DARCOM) activities procuring Night Vision Systems, has prepared an environmental assessment prior to NRC License No. SMB-1300 renewal. The NRC license is a broad scope source material license encompassing all forward looking infrared (FLIR) systems within night vision equipment. The FLIR systems incorporate ^{232}Thorium Fluoride (ThF_4) coated optical elements for optimal night viewing capabilities in defense/weapon system functions.

2. Army contractual specifications require optical systems operable in the eight to fourteen micrometer infrared spectral region with high transmittance capabilities and the ability to withstand severe environmental conditions during tactical (field) use. The incorporation of ThF_4 within optical coatings enables conformance to these provisions. Alternative inorganic dielectric compounds proposed for substitution are unable to comply with necessary performance specifications.

3. The Environmental Assessment documents government contractual requirements for Thorium content within infrared or eyepiece elements to insure compliance to Title 10, Code of Federal Regulations (10 CFR) Part 40, and environmental durability requirements for coating integrity to insure safety and proper performance during implementation of night vision equipment. In addition, Army regulatory policy compliant with 10 CFR Part 20 is outlined establishing maximum safety and management protocol governing the control of night vision devices, inclusive of proper possession, use, storage, transfer and disposal.

4. Initial overview of the incorporation of ThF_4 in optical coatings does not identify any radiological consequence leading to significant environmental impact or health hazard in consideration of pre- and post- procurement safety controls, the minimal quantity of ThF_4 required to produce specified optical performance, and the actual assembly into which optical elements are incorporated. Complete analyses are proposed for radiological considerations with regard to external exposure presented to occupational workers and highly improbable hypothetical incidents involving internal exposure to occupational or non-occupational individuals resultant from ingestion or inhalation subsequent to optical element damage, improper disposal, installation fire, and transport accident. Final computations for external and internal exposure levels presented through various pathways confirm that the incorporation of ThF_4 into optical coatings poses insignificant to non-existent radiological consideration for systems within Army management. Further, dose calculations identified levels which remain below regulatory requirements when hypothesized with severe assumptions for maximum possible exposure outcome. Additional analysis or review of the proposed action is not warranted based on the findings established within the general assessment.

5. The Environmental Assessment offers assurance in response to required Federal and Department of the Army (DA) regulations governing evaluation of Army actions leading to possible environmental quality degradation. Army policy requires environmental evaluations as an integral component of procurement or implementation of radioactive materials within any equipment as a responsible effort in insuring national environmental goals are attained. The Environmental Assessment is available for review upon request from Commander, US Army Communications-Electronics Command, ATTN: DRSEL-SF-H, Fort Monmouth, New Jersey 07703.

II. Environmental Assessment

A. Summary and Conclusion

1. The following Environmental Assessment supporting a Finding of No Significant Impact has been prepared prior to the proposed action of NRC license renewal governing ThF_4 coated optical elements within night vision equipment and in accordance with requirements of Army Regulation (AR) 200-2, Environmental Quality, Environmental Effects of Army Actions [1]. The basic objectives specified in AR 200-2 are to plan, initiate and perform all actions/programs with consideration given to minimize adverse effects on the quality of the human environment without impairment to the Army mission. The scope of this assessment evolves solely around the incorporation of ThF_4 coated optics within night vision assemblies inclusive of general system description, life cycle management, and proposed hypothetical scenarios for determination of possible radiological health hazard or environmental impact. Evaluations have led to the conclusion that no potential environmental degradation or radiological health hazard can be substantiated.

2. The electro-optical system incorporated into night vision assemblies contains ThF_4 on lens components to produce proper infrared spectral optics with high transmittance and low reflectance capabilities. The system allows conversion of infrared energy to visual display during night time tactical (field) activities. The general system description and life cycle management detailed in Section B outlines safety protocol which identifies compliance to all applicable Federal and Army regulations. To insure radiological, environmental, and performance requirements, contractual agreements for procurement of optical elements require testing of components for compliance to military specifications and 10 CFR Part 40. No optical element used in the proximity of the eye shall possess greater than 5.00E-02* percent by weight thorium in compliance with 10 CFR Part 40.13(a). Any optical element which is ThF_4 coated is never employed as the viewing eyepiece.

3. Testing for coating durability withstanding severe environmental conditions, optical performance and screening for detectable levels of contamination on optical elements are performed for compliance to military requirements. All testing and assessments have been exclusive of identifying any significant hazard or radiological exposure level to individuals involved in the use or handling of night vision equipment or subcomponents. Currently, technical manuals for items of issue which have been fielded contain within the proper warning statements for identification of the radioactive ThF_4 coating and specific handling/cleaning instructions for prevention of possible element damage or radiological hazard. Item control and inventory are more stringent than those for standard supply procedure due to the cost and sensitive nature of the item insuring authorized and limited possession.

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* The use of exponential (scientific) notation, i.e., 5.00E-02 (5.00×10^{-2}) is employed in lieu of standard notation, i.e., 0.05.

4. The Environmental Assessment proposes various hypothetical incidents which completely dissolve any concern of environmental impact or risk to the health and safety of individuals involved with the night vision equipment. Determinations have been prepared incorporating radioactive material quantities in excess of actual optical element content to encompass current systems and those systems in research and development stages which would also be incorporated under the broad scope NRC license issued for ThF_4 optical coatings. This approach eliminates analysis of each separate system and further analysis for compliance to AR 200-2 prior to implementation of future night vision systems. The NRC license stipulates maximum permissable quantities of ThF_4 per system to be 2.00 grams (gm) with a total possession limit of forty kilograms at any one time.

5. As indicated above, assessments were performed assuming the maximum quantity of 2.00E+02 microcuries (uCi) per system contained in a single optical element. External exposure levels, inclusive of both beta and gamma energies, indicated for continuous presence during a forty-hour work week at a distance of one foot a total of 5.30E-03 Sieverts (Sv) per year (5.30E-01 rem per year). Calculations yield conservative (high) dose estimates for the handling of individual optical elements to completely identify insignificant radiological levels to the primary handling maintenance personnel and authorized user. Hypothetical incidents involving the storage or transportation of optical elements are based upon a fifteen pound limit per activity to identify conceivable internal exposure levels presented to the general public or environ subsequent to fire or vehicle accident. It is inconceivable that any activity will exceed a fifteen pound possession limit at any one time. The determination of compliance with environmental standards for radioactive release is assessed in Section C predicting the environmental transport and subsequent dose associated with ThF_4 released during accident situations. Uncertainties associated with the assumptions lead to over-estimates of actual environmental concentrations or doses which are acceptable when prediction leads to estimates of environmental concentrations or doses that are no cause for concern. The maximum internal dose was determined for an occupational worker who ingested ThF_4 from optical coating damage resulting in 1.41E-02 Sv (1.41E+00 rem) to the bone surface. This remains below the International Commission on Radiological Protection (ICRP)[2] limit recommendations of 5.00E-01 Sv (5.00E+01 rem) for non-stochastic effects as specified in ICRP 30. Table A-1 summarizes potential individual and population doses to bone surface as calculated under assumptions provided in this assessment.

6. Presently no alternative for substitution of ThF_4 in optical coatings offers comparable environmental stability or performance compliant to specifications as detailed in Section B and D. Assessment involving the use of Night Vision Systems incorporating ThF_4 coated optical elements has not defined any radiological impact or concern warranting discontinuation of usage or exclusion of ThF_4 from optical coatings. The overall advantages offered the systems incorporating thorium coated optics outweigh the insignificant to non-existent consideration of radiological hazard or environmental impact which when assessed continually results in external or internal dose levels magnitudes below required air/water concentrations or exposure levels stipulated in 10 CFR Part 20.

TABLE A - 1

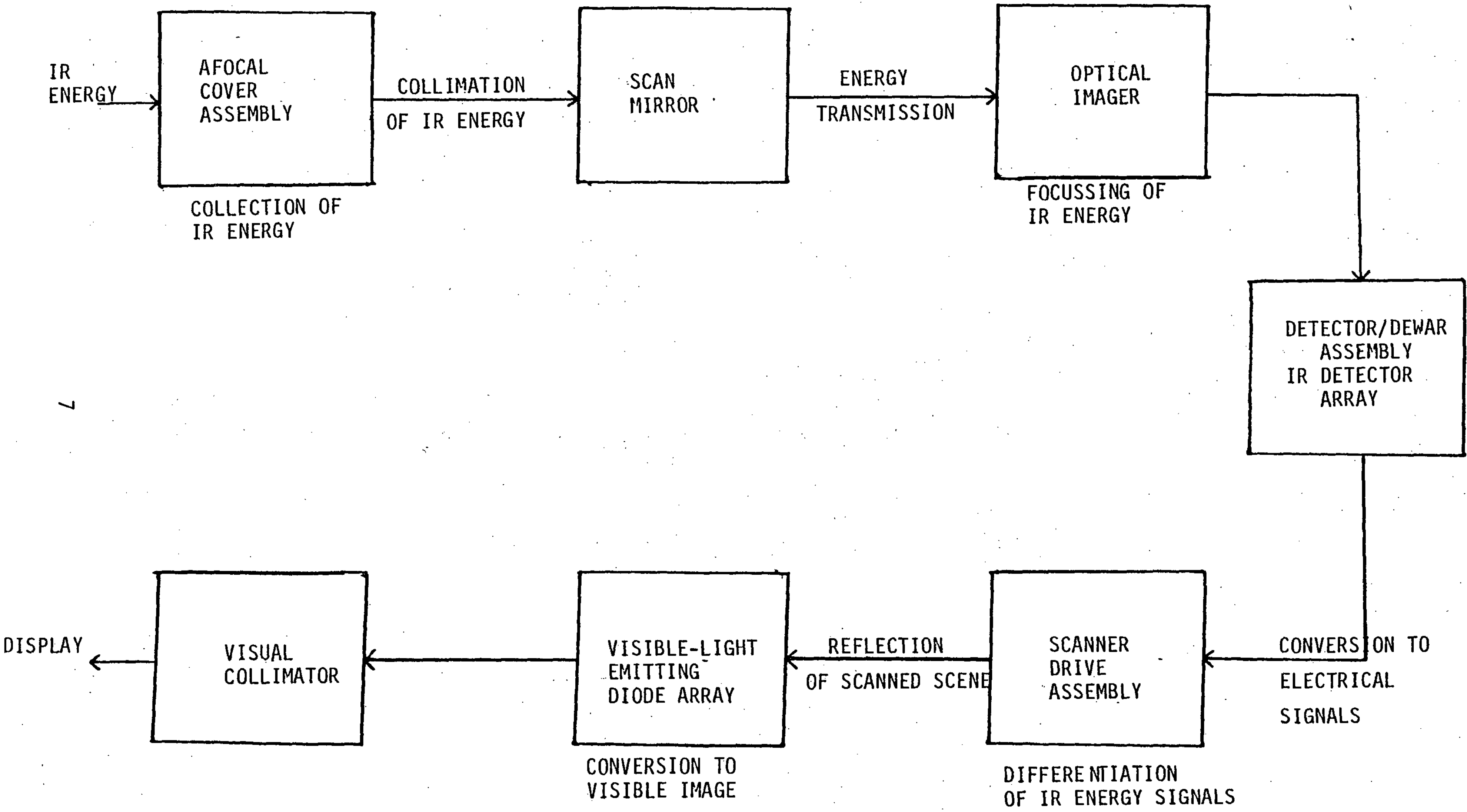
SUMMARY OF COMMITTED DOSE EQUIVALENT LIMITS TO BONE SURFACE SUBSEQUENT TO HYPOTHETICAL INCIDENT

INCIDENT	Sv (rem)
CONTAMINATION	1.41E-02 (1.41E+00)
INSTALLATION FIRE	7.46E-03 (7.46E-01)
SOURCE INCINERATION	7.55E-07 (7.55E-05)
TERRESTRIAL TRANSPORT	4.05E-05 (4.05E-03)
TRANSPORTATION	1.10E-02 (1.10E+00)

B. General Description and Control of Night Vision Systems.

1. Night Vision Sights (NVS) are integral components of major weapon systems. The NVS is a passive thermal imaging assembly providing night viewing capabilities. The night vision assemblies are electro-optical systems including both infrared and visible light optics. The optical elements of night vision systems are composed of infrared transmitting substrates such as Germanium or Silicon with a single or multilayer antireflective (SLAR/MLAR) coating. These coatings are designed to increase substrate transmission and reduce reflection losses associated with substrate materials having a high index of refraction within specific wavelength intervals. Antireflective coatings contain radioactive ThF_4. Several considerations for the incorporation of the ThF_4 in antireflective coatings are detailed in Section D identifying ThF_4 as the primary coating component for producing optimal transmission and durability for optical element performance required by government contract specifications. The total quantity of ThF_4 contained in each complete night vision system varies dependent on specific system characteristics and requirements for necessary field of view, magnification or final visual display. Current night vision equipment and those within developmental stages proposed for future deployment contain radioactive quantities ranging from 3.69E+01 bequerels (Bq) (9.97E-04 uCi) to 5.77E+03 Bq (1.56E-01 uCi) of ThF_4.

2. The basic modules within the night vision systems which contain ThF_4 coated optical elements are the optical imager and the detector/dewar assembly. Ancillary equipment containing ThF_4 coatings are the infrared (IR) window, afocal cover assembly and the boresight collimator. Generally, the thermal imagery modules receive IR energy (heat emission) from the viewing or target area. The IR energy is converted to electrical signals which are then transformed to visible light displayed as a real-time scene for viewing. The IR energy is initially collected in the afocal cover assembly consisting of a two-field-of-view telescope with an objective lens, made of IR passive material, common to both fields of view inclusive of interchangeable lens sets providing various magnifications of view. Typically, the narrow field of view consists of two IR lenses and the wide field of view is composed of a single IR lens. After collection of IR energy, it is collimated to a mechanical scan mirror which transmits the energy to an optical imager. The optical imager assembly is composed of IR imaging lenses and a folding mirror. The optical imager focuses the IR energy into the IR detector array in the detector/dewar assembly. The IR detector array converts incident energy into electrical signals. The scanned scene focussed on the IR detector array is reflected by a scanner drive assembly which senses differences in the IR energy. Electrical signals are converted to visible images which are then transmitted from a visible-light emitting diode array through a visual collimator into a display for viewing through an eyepiece or upon a video screen. Figure B-1 provides a block diagram of system conversion of IR energy to visible viewing. The afocal cover assembly, optical imager and detector/dewar subassemblies are contained within a cast aluminum housing which is then enclosed within an exterior metal housing/ Thus, only the exterior window of the afocal cover assembly is exposed for collection of IR energy in the night vision system.



BLOCK DIAGRAM OF SYSTEM CONVERSION OF IR ENERGY

FIGURE B-1

3. The remaining assembly containing ThF_4 coated optical elements associated with some night vision systems is the boresight collimator. The collimator is a precision electro-optical device attached to the NVS for provision of boresight alignment between the NVS and other assemblies such as the tube-launched, optically tracked, wire-guided (TOW) weapon system (TWS) or laser rangefinder dependent on the major system. Collimated beams of energy generated by the boresight collimator enter the day/night sight collimator producing an alignment image in the night sight.

4. For all procurements of night vision optical elements incorporated into modular subassemblies, the Army requires that the contractor test the thorium coated optics to insure that all elements comply with specifications for radiation (Incl 1) and environmental (Incl 2, 3, 4 and 5) requirements. Radiation requirements specify compliance with the following:

a. Control for lens element traceability to insure required testing is performed for each lot.

b. Screening of optical elements for detectable levels of radiation.

c. Provision of technical drawings, operational and cleaning instructions to insure future maintenance of the night vision program.

d. X-ray fluorescence analysis for first element and suspect element (actinides) of the visible lenses (eyepiece) to insure compliance to 10 CFR Part 40.

e. Environmental durability specifications to insure proper operation and coating adherence under severe environmental conditions.

5. The following environmental tests in a prescribed sequence or equivalent must be performed to identify conformance to optical coating specifications:

a. A witness sample from each coating run shall be subjected to the adherence and hardness tests as specified in MIL-M-13508 (Incl 2).

b. A witness sample from each coating run shall be subjected to the twenty-four hour or five day salt spray (fog) test, respectively dependent on whether it is an internal or external lens element. Testing is outlined in MIL-STD-810 (Incl 3), ANSI/ASTM B 117-73 (Incl 4) and MIL-C-675 (Incl 5).

c. A witness sample from each coating run shall be subjected to the cyclic twenty-four hour or ten-day humidity test dependent on whether it is an internal or external lens element. Procedural testing is described in MIL-M-13508.

Each lot does not proceed for further testing until each witness sample has satisfied environmental test requirements. In addition, the durability of all IR coatings is tested to insure that a sample from every lot of coated optical elements meets or exceeds the scotch tape, eraser rub abrasion and environmental tests as specified in Inclosures 3 and 5 or MIL-C-48497 (Incl 6).

Any witness sample or lot not meeting test standards will not be incorporated into the appropriate subassemblies for night vision devices.

6. Warning notices are contained in all technical manuals for both the operator or maintenance personnel involved with equipment containing ThF_4 optical elements stating:

RADIATION HAZARD

> The antireflective coating on all infrared optics contain thorium fluoride which is slightly radioactive. The only potential hazard involves ingestion (swallowing or inhaling) of this coating material. Dispose of broken lenses, etc, in accordance with AR 385-11[3].

The operating instructions emphasize that the equipment is an electro-optical instrument which must be carefully handled. The maintenance instructions for the various preventative maintenance for both eyepiece and external lens requires the inspection for any disfiguration such as abrasion, blemish, flaking or fissure. If any of these conditions which will effect the overall operation are discovered, the item is returned to various Direct Support/General Support (DS/GS)* maintenance levels. Specific instructions for cleaning of optical lenses outlines cleansing solutions and procedures emphasizing the lens surface coating is easily damaged. The operator's maintenance is limited to the replacement of the battery or coolant cartridge and cleaning of the external lens. The DS/GS personnel are authorized to replace common modules such as the Detector/Dewar and Optical Imager. All other maintenance functions pertaining to night vision devices are performed at Sacramento Army Depot (SAAD) for worldwide activities. Within eighteen months, maintenance for night vision equipment for European theater will be performed at Mainz Army Depot, Germany. All maintenance functions are exclusive of any grinding or removal of the ThF_4 coatings.

7. The program for control of the various night vision devices is similar to control of supply items as prescribed in AR 700-64, Radioactive Commodities in the Department of Defense (DOD) Supply Systems[4] and AR 385-11, Ionizing Radiation Protection, which establishes requirements for NRC licenses and Department of the Army (DA) authorizations for radioactive material possession, requirements for controlled items of supply, transportation, and disposal of radioactive materials. Regulatory guidance is implemented by the various Major Subordinate Command (MSC) or Project Manager (PM) governing the life-cycle management of the assigned materiel, logistics management/support, procurement, maintenance, storage, and transportation including packaging and disposal.

8. Headquarters (HQ) DARCOM has assigned HQ CECOM the responsibility of NRC license management for possession and use of FLIR imaging systems inclusive of all radiation protection management responsibilities within DA installations

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* The DS/GS function also refers to the comparable aircraft maintenance echelon, i.e. Aviation Unit Maintenance and Aviation Intermediate Maintenance.

and worldwide activities. CECOM has established Memorandums of Understanding (MOU) with other effected MSC's and/or PM's having the individual logistical control based on the type of system incorporating thermal imaging devices as a component subassembly. These agreements stipulate command responsibilities for compliance to the NRC license and coordination of responsibilities for item assignments, procurement, future revisions, engineering, product assurance, technical data packages and international logistics. CECOM maintains Primary Inventory Control Activity (PICA) responsibilities for the various thermal imaging subsystems while other MSC's maintain PICA responsibilities for the entire system.

9. CECOM life cycle management control is inclusive of the following:

a. Coordination with the National Inventory Control Point (NICP), an element of CECOM at Fort Monmouth, to assure that requisitioning elements are authorized to and technically capable of receiving the item and that procurements do not exceed the quantity or use limitations imposed by the license.

b. Performance of pre- and post- award health physics reviews and surveys of contractors.

c. Provision of health physics advice to be included in instructions for disposal of radioactive waste, and serve as headquarters for notification, investigation and preparation of reports required in the event of accidents/ incidents in which radioactive items may be involved.

d. Annual quality assurance testing of a random sampling of at least six FLIR assets by the inspection of the ThF_4 assessable lenses. Lenses are inspected for flaking and/or pitting of the ThF_4 MLAR coatings.

10. The NICP has adopted special procedures for individually controlled radioactive items that are in addition to standard Army supply practices used for all type-classified items through the following:

a. Record maintenance of procurements, receipts, storage locations, shipments, and using locations.

b. Authorization and provision of items assuring adequate supply.

c. Review of the submitted requisition and upon approval, the NICP will issue material release orders to the designated storage depots for shipment of the material directly to the requisitioner. The control point bases requisition approval on previously established authorization of the requisitioner to receive the item from supply standpoint. Reports of excess items are submitted through various command channels to the NICP for review of serviceability, turn-in, or disposal as radioactive material. The NICP, in conjunction with assistance and directive provided by health physicists at the CECOM Safety Office, determines disposition of excess items.

11. Bulk storage, maintenance, serviceability, surveillance and issue of the various night vision devices are provided by the designated Depot Systems Command (DESCOM) storage activity when approved by the NICP. Primary DESCOM storage activities are New Cumberland Army Depot (NCAD), Red River Army Depot (RRAD), and Sharpe Army Depot (SHAD). SAAD only provides maintenance and serviceability of night vision assets. Where radioactive materials are involved, DESCOM activities have established warehousing facilities and handling procedures which are governed by a formal radiation protection program administered by a qualified Radiation Protection Officer (RPO). Items are inspected when received, at intervals during storage, and immediately before shipment. Warehouse facilities are fire resistant buildings posted with appropriate radiation warning signs and secured for protection against unauthorized removal. Facilities at DESCOM storage activities are constructed of 36 inch poured concrete and protected by fire sprinkler systems encompassing one hundred percent of the area. Fire-fighting personnel are available within short time intervals at all activities in the event additional fire control is necessary. Installations are surrounded by chain-linked fence with patrols eliminating the possibility of unauthorized possession.

12. Shipment from depots/activities of night vision assemblies containing ThF_4 are excepted from specification packaging, markings and labeling. They are also excepted from the provisions of Department of Transportation (DOT) regulations, 49 CFR Part 173.393, testing for removable exterior package surface contamination. The shipper is advised to include the following notice on shipments:

> "This shipment is exempt from DOT specification packaging, marking, and labeling requirements IAW Title 49 CFR 173.391."

13. If any of the ThF_4 components are beyond repair, they will be disposed of as radioactive waste in accordance with AR 385-11. The Defense Logistics Agency assures that designated and identified radioactive materials are not sold, transferred or donated to non-licensed recipients through a computerized system.

C. Radiological Exposure and Environmental Considerations Proposed for Night Vision Systems.

1. Optical elements coated with ThF_4 contained within night vision devices incorporate from 3.69E+01 Bq (9.97E-04 uCi) to 5.77E+03 Bq (1.56E-01 uCi) for the total system quantity (Table C-1). The external dose calculations were performed assuming a total quantity of 7.40E+03 Bq (2.00E-01 uCi) in foresight of future systems incorporating an additional lens element and in further demonstration of insignificant exposure levels. The Thorium series decay chain is inclusive of alpha, beta and gamma emission.[5] External dosimetric calculations accounting for gamma and beta contributions have assumed the following:

a. A disc source measuring 2.74 centimeters (cm) in diameter (R_o=1.37 cm) containing 7.40E+03 Bq (2.00E-01 uCi) of Thorium-232 (Th-232) yielding an

TABLE C - 1

End Article Application (EAA) and Total System Quantity

	EAA	Bq (uCi)
1.	AN/TAS-4 (TOW*)	2.11E+03 (5.70E-02)
2.	AN/TAS-5 (DRAGON)	9.99E+02 (2.70E-02)
3.	AN/TAS-6 (NODLR*)	2.11E+03 (5.70E-02)
4.	AN/VSG-2 (TTS*) M60A3*	5.55E+03 (1.50E-01)
5.	NIGHT CHAPARRAL SUBSYSTEM M48	5.77E+03 (1.56E-01)
6.	ISU* IFV*(M-2)*/CFV*(M-3)*	2.11E+03 (5.70E-02)
7.	TIS* M-1*	2.11E+03 (5.70E-02)
8.	TADS/PNVS* AAH*	5.44E+02 (1.47E-02)
9.	Thermal Driver Viewer M-1, M-2, M-3	3.69E+01 (9.97E-04)

* Abbreviations are clarified at the beginning of this Report.

activity concentration per unit area (C_A) of 1.26E+03 Bq/cm^2 (3.40E-08 Ci/cm^2).

b. Determination of external exposure resultant from gamma energies associated with the decay scheme employed the following equations[6]:

(1) The gamma flux (I_o) at a distance of 30.5 cm directly above the source is given as:

$$I_o = 2.96E{+}09\ E' C_A\, \pi \ln\left(\frac{R_o^2 + h^2}{h^2}\right)$$

(2) The absorbed dose rate for tissue is then determined incorporating values of I_o into the general formula:

$$\text{Gray/hour (Gy/h)} = 5.76E{-}05\ \mu I_o / 100$$

where μ = mass absorption coefficient (cm^2/gm) or the equivalent mass energy absorption coefficient for various energies in a tissue medium, i.e., H_2O with a density of 1.0 g/cm^3.

Table C-2 summarizes resulting values for gamma flux and the associated absorbed dose rate. Calculations employing point source geometry yield identical absorbed dose rates due to the distance at which exposure levels are determined with regard to source diameter.

c. The external absorbed dose rate contribution from beta particle energies is assessed incorporating Loevinger point source attenuation[6]:

$$\text{Gy/h} = \frac{KC}{(vr)^2}\left\{ c\left[1 - \frac{vr}{c}\ e^{1-(vr/c)}\right] + vre^{1-vr}\right\} \div 100$$

where K = normalization constant

$$= \frac{1.70E{+}05\,\rho^2 v^3 E_{av}}{3c^2 - e(c^2-1)} \quad \text{(rads/hr/Ci)}$$

C = Curies

r = Distance from source (g/cm^2)

ρ = Mass density of the absorbing medium

$$c_{tissue} = \begin{array}{lrcl} 2.00 & 0.17 \leqq & E_{max} < & 0.50\ \text{MeV} \\ 1.50 & 0.50 \leqq & E_{max} < & 1.50\ \text{MeV} \\ 1.00 & 1.50 \leqq & E_{max} < & 3.00\ \text{MeV} \end{array}$$

v_{tissue} = Apparent absorption coefficient (cm^2/g)

$$= \frac{18.6}{(E_{max} - 0.036)^{1.37}}\left[2 - \frac{E_{av}}{E_{max}}\right]$$

TABLE C - 2

INDIVIDUAL GAMMA FLUX VALUES WITH RESULTANT ABSORBED DOSE RATES

Isotope	E(MeV)	Gamma Intensity[2]	E′(MeV/disintegration)	I_o(MeV/cm^2/sec)	μ(cm^2/g)	Gy/h(rad/hr)
^{228}Ac	3.40E-01	1.50E-01	5.10E-02	3.22E-02	3.20E-02	5.94E-10(5.94E-08)
	9.08E-01	2.50E-01	2.27E-01	1.43E-01	3.13E-02	2.58E-09(2.58E-07)
	9.60E-01	2.00E-01	1.92E-01	1.21E-01	3.10E-02	2.16E-09(2.16E-07)
^{228}Th	8.40E-02	1.60E-02	1.34E-03	8.47E-04	2.54E-02	1.24E-11(1.24E-09)
	2.14E-01	3.00E-03	6.42E-04	4.06E-04	2.99E-02	6.99E-12(6.99E-10)
^{224}Ra	2.41E-01	3.70E-02	8.92E-03	5.64E-03	3.05E-02	9.91E-11(9.91E-09)
^{220}Rn	5.50E-01	7.00E-04	3.85E-04	2.43E-04	3.27E-02	4.58E-12(4.58E-10)
^{212}Pb	2.39E-01	4.70E-01	1.12E-01	7.08E-02	3.05E-02	1.24E-09(1.24E-07)
	3.00E-01	3.20E-02	9.60E-03	6.07E-03	3.17E-02	1.11E-10(1.11E-08)
^{212}Bi	4.00E-02	2.00E-02	8.00E-04	5.06E-04	6.77E-02	1.97E-11(1.97E-09)
	7.27E-01	7.00E-02	5.09E-02	3.22E-02	3.19E-02	5.92E-10(5.92E-08)
	1.62E+00	1.80E-02	2.92E-02	1.85E-02	2.75E-02	2.93E-10(2.93E-08)
^{208}Tl	5.11E-01	8.28E-02	4.23E-02	2.67E-02	3.27E-02	5.03E-10(5.03E-08)
	5.83E-01	3.10E-01	1.81E-01	1.14E-01	3.26E-02	2.14E-09(2.14E-07)
	8.60E-01	4.32E-02	3.72E-02	2.35E-02	3.15E-02	4.26E-10(4.26E-08)
	2.61E+00	3.60E-01	9.41E-01	5.95E-01	2.37E-02	8.12E-09(8.12E-07)
					TOTAL =	1.89E-08(1.89E-06)

d. Beta dosimetric calculations summarized in Table C-3 result in maximized dose rates due to difficulties presented when attempting within mathematical models to consider the characteristics of continuous energy spectrum and scattering interactions which would yield significant change in resultant values. No inclusion of beta energies less than 5.00E-02 MeV or alpha particle consideration is incorporated in absorbed dose rates due to the short distance of less than three (3.00) centimeters traveled in air.

e. Total absorbed dose rates resultant from gamma and beta energies is 2.47E-06 Gy/h (2.47E-04 rad/hr). It should be noted that no consideration has been given to system shielding of the radioactive elements, actual quantity, distance and duration of operation which would further reduce resultant levels. Assuming continuous exposure during a forty hour work-week, the total absorbed dose for a one year period results in 5.13E-03 Gy/yr(5.13E-01 rad/yr). The dose equivalent value is 5.13E-03 Sv/yr(5.13E-01 rem/yr) assuming a quality factor and dose modifying factor of one (1) for associated energies. These values assume whole body irradiation and do not account for the absorption of beta energies within the first centimeter of tissue.

f. The NRC occupational exposure limits, as specified in 10 CFR Part 20, allow for an occupational whole body dose of 5.00E+00 rem per year. The Metric System (SI) equivalent value would be 5.00E-02 Sv per year as an equivalent exposure limit for uniform irradiation of the whole body. The external exposure presented under normal usage does not demonstrate excessive occupational exposure levels and is similar to non-occupational exposure levels set forth in 10 CFR Part 20.

2. In determining possible internal dose from ThF_4 as a result of incidental inhalation or ingestion, maximum quantities of 7.40E+03 Bq (2.00E-01 uCi) per optical element are assumed. Metabolic data for Th-232 indicates that the bone surface has the highest fractional deposition factor upon translocation of the element following ingestion. For inhalation specific classes have been assigned by the ICRP based upon associated retention in the pulmonary region. ThF_4 is assumed to have a retention half-time from ten to one hundred days (CLASS W). All committed dose equivalents as assessed are below recommendations and regulatory standards. The described incidents are highly improbable but reveal that there would not be significant harm to occupational/non-occupational individuals or degradation to the quality of the environ. Internal exposure was considered the primary risk presented excluding complete assessment of total exposure which would include external exposure contribution. External exposure assessment due to submersion within a semi-infinite cloud was performed only for the hypothetical scenario involving installation fire to illustrate minimal external exposure presented in comparison to internal exposure consideration.

a. Damage of Optical Elements Resulting in Ingestion:

(1) During use of night vision devices, optical elements coated with ThF_4 may become scratched during inspection or cleaned improperly leading to personnel contamination and subsequent ingestion. The following assumptions are considered:

TABLE C-3

Individual Beta Energies with Resultant Absorbed Dose Rates

Isotope	E_{max}(MeV)[7]	E_{avg}(MeV)[7]	c_{tissue}	K	v	Gy/h (rad/hr)
^{228}Ra	3.89E-02	9.90E-03	2.00	--	--	--
^{228}Ac	2.08E+00	3.75E-01	1.00	4.35E+07	1.27E+01	4.26E-07 (4.26E-05)
^{212}Pb	5.73E-01	9.90E-02	1.50	2.53E+09	7.97E+01	6.30E-07 (6.30E-05)
^{212}Bi	2.25E+00	7.17E-01	1.00	4.70E+07	1.05E+01	6.71E-07 (6.71E-05)
^{208}Tl	1.79E+00	5.58E-01	1.00	9.64E+07	1.45E+01	7.27E-07 (7.27E-05)
					TOTAL =	2.45E-06 (2.45E-04)

(a) During the inspection of an afocal cover assumed to contain a maximum quantity of 7.40E+03 Bq (2.00E-01 uCi), the coating becomes scratched removing ten percent of the total activity (7.40E+02 Bq or 2.00E-02 uCi).

(b) Fifty percent of the removed activity is assumed personnel contamination.

(c) Ten percent of the personnel contamination is ingested yielding a total intake of 3.70E+01 Bq (1.00E-03 uCi).

(2) The committed dose equivalents to various organs using internal dosimetry data provided in ICRP 30 and NUREG/CR-1962 [8] are tabulated in Table C-4. The total ingested activity is 1.23E-01 percent of the given Annual Limit on Intake (ALI) for ingestion, which is given as 3.00E+04 Bq.

(3) Even under the assumption that the entire ten percent of the removed activity is entirely consumed, the total ingested activity remains below the recommended ALI for ingestion identifying minimal quantities non-substantive of significant radiological health hazard to individuals involved in the handling of these devices. Committed dose equivalents are presented in Table C-4 for comparison of both hypothetical situations.

(4) The possibility of damage to optical elements leading to removal of source activity is highly unlikely due to specific handling and cleaning instructions provided in technical manuals and bulletins as described in Section B. It should be noted that assumed quantities are extremely overstated in comparison to actual quantities present in any single element of the system.

b. Installation Fire:

(1) The proposed incident involves installation/depot warehouse fire occurring during storage at SAAD in which night vision devices/replacement parts awaiting maintenance are enveloped releasing Th-232. The warehouse facility is equipped with complex sprinkler systems inclusive of pressure monitors and automatic alert to firefighting units which have a minimum response time. The quantity of fifteen pounds is assumed stored in the warehouse resulting in the following scenario with the additional assumptions:

(a) The specific activity of the radioactive material is assumed to be for the pure form yielding a total activity of 2.75E+07 Bq (7.42E+02 uCi) for a fifteen pound storage limit.

(b) Ten percent of the total activity in various units is involved releasing one percent to the warehouse area (2.75E+04 Bq or 7.42E-01 uCi) prior to extinguishment.

TABLE C-4

Committed Dose Equivalents to Various Organs Resultant from Ingestion Following Contamination/Source Damage

Incident	Activity Ingested	Bone Surface	R. Marrow	Liver*	Gonads*
CONTAMINATION	3.70E+01 Bq (1.00E-03 uCi)	7.03E-04 Sv (7.03E-02 rem)	5.55-05 Sv (5.55-03 rem)	3.77E-07 Sv (3.77E-05 rem)	4.55E-08 Sv (4.55E-06 rem)
SOURCE DAMAGE	7.40E+02 Bq (2.00-02 uCi)	1.41E-02 Sv (1.41+00 rem)	1.11E-03 Sv (1.11E-01 rem)	7.56-06 Sv (7.56E-04 rem)	9.11E-07 Sv (9.11E-05 rem)

* Internal dosimetry data from NUREG/CR-1962.

Remaining committed Dose Equivalents are assessed using ICRP 30 Data.

(c) The volume of air in the warehouse is 1.23E+04 m^3 yielding 2.24E+00 Bq/m^3 (6.03E-05 uCi/m^3).

(d) The breathing rate of persons involved is 1.20 m^3/hr.

(e) The total intake for each firefighter is 6.72E-01 Bq (1.81E-05 uCi) assuming no implementation of respiratory protective devices during a fifteen minute period following initial firefighting operations.

(2) The committed dose equivalents to various organs are given in Table C-5. Estimates are not considered for the general public due to conservative dose estimates indicated and consideration of dispersion parameters which would further decrease estimated committed dose equivalents. It should be noted that no consideration of standard operating procedures inclusive of respiratory devices or ventilation of the building during extinguishment were considered which would reduce estimated doses. The committed dose equivalent limit for bone surface remains below recommended non-stochastic dose equivalent limits. The total inhaled activity is 6.72E-01 percent of the ALI (1.00E+02 Bq) recommended for inhalation.[3] The air concentration stated in 2.b.(1)(c) is equivalent to 2.24E+00 Bq/m^3 (6.03E-11 uCi/ml). The air concentration does not cause the inhalation of a quantity of radioactive material greater than the quantity which would result from inhalation for forty hours per week for thirteen (13) weeks at uniform concentrations of radioactive materials in air as specified in 10 CFR Part 20 for restricted areas.

(3) Although it is highly improbable that a total of fifteen pounds of ThF_4 incorporated into various night vision devices are stored at any one time in a depot or that envelopment could occur of these units prior to containment of the fire, the incident is demonstrative of levels which do not present significant radiological health impact. Additionally, operations of fire-fighting would be conducted with awareness of the potential hazard leading to measures for respiratory protection. Finally, as previously indicated, warehouse facilities are constructed for prevention of fire leading to envelopment of stored materials. Additional areas such as replacement facilities ("clean rooms") at SAAD also contain sprinkler systems but would never possess quantities assumed within this assessment.

(4) For assessment of complete exposure presented to individuals during this hypothetical incident, the following calculations are performed to identify external exposure resultant from a one hour time frame:

(a) Assuming a homogenous cloud with dimensions establishing an equilibrium condition where the rate of energy absorption is equal to the rate of energy released within an equivalent unit volume, the following equations[9] are employed for resultant radiation absorbed doses from beta and gamma energies respectively:

TABLE C - 5

Committed Dose Equivalents to Various Organs Resultant from Inhalation Following Bulk Storage Installation Fire

Inhaled Activity	Bone Surface	Liver*	Lung*	R. Marrow
6.72E-01 Bq	7.46E-03 Sv	4.19E-06 Sv	9.68E-06 Sv	6.00E-04 Sv
(1.81E-05 uCi)	(7.46E-01 rem)	(4.19E-04 rem)	(9.68E-04 rem)	(6.00E-02 rem)

* Internal Dosimetry Data from NUREG/CR-1962.

Remaining committed Dose Equivalents are assessed using ICRP 30 Data.

$$\text{Gy/sec} = 2.29\text{E-03}\ \bar{E}_{\beta}\chi$$

$$\text{Gy/sec} = 2.54\text{E-03}\ \bar{E}_{\gamma}\chi$$

where χ = Curies/m^3.

(b) Tables C-6 and C-7 give resulting values assuming a constant concentration as stated in b.(1)(c) within a semi-infinite cloud whose radius is equal to or greater than the range of any beta or gamma energy. The receptor was assumed centrally located to exclude media of different absorbing characteristics. It should be noted absorbed dose rate variation for beta energies due to field perturbation from the individual is excluded. The total absorbed dose is approximated to be 2.86E-09 Gy/h (2.86E-07 rad/hr) or equivalent to 2.86E-09 Sv (2.86E-07rem) within a one hour time frame. It can be seen that the external dose consideration with the given assumptions in view of the fifty year internal committed dose equivalent is minimal and will not be included in following hypothetical incident assessments.

c. Source Loss Leading to Improper Disposal to an Incinerator:

(1) SAAD procures replacement parts to different night vision systems. The following incident assesses transfer to a commercial incinerator, a package containing twenty elements for night vision systems assuming a maximum activity of 7.40E+03 Bq (2.00E-01 uCi) per element. Transfer of these components to unauthorized areas is considered highly inconceivable based on stringent inventory controls imposed on the item, physical size, and monetary values of these devices. The assessment is presented to identify levels below regulatory standards for unrestricted areas and to demonstrate that there would be no significant resultant environmental impact or radiological hazard to the surrounding public. The assumptions[10] used to evaluate the amount of Th-232 in incinerator emissions are as follows:

(a) The initial activity (Q_i) from twenty optical elements is 1.48E+05 Bq (4.00E+00 uCi).

(b) The incinerator processes 300 tons of refuse per day at fifty percent excess air.

(c) The Th-232 released during the incineration process (f_s) is approximately one hundred percent of the total activity.

(d) The efficiency of the air pollution control systems for particulates is 90 percent (i.e. the fraction of Th-232 which escapes with stack gases, f_r = 0.1)

(e) The aerodynamic mean activity diameter of released particles is one micron.

TABLE C - 6

AVERAGE BETA ENERGIES AND ABSORBED DOSE RATES RESULTANT FROM SUBMERSION WITHIN A SEMI-INFINITE CLOUD

ISOTOPE	$\bar{E}_\beta$ (Mev)[7]	Gy/s (rad/sec)	Gy/h (rad/hr)
^{228}Ra	9.90E-03	1.36E-15 (1.36E-13)	4.91E-12 (4.91E-10)
^{228}Ac	3.75E-01	5.17E-14 (5.17E-12)	1.86E-10 (1.86E-08)
^{212}Pb	9.90E-02	1.36E-14 (1.36E-12)	4.91E-11 (4.91E-09)
^{212}Bi	7.17E-01	9.88E-14 (9.88E-12)	3.56E-10 (3.56E-08)
^{208}Tl	5.58E-01	7.69E-14 (7.69E-12)	2.77E-10 (2.77E-08)
		TOTAL =	8.73E-10 (8.73E-08)

TABLE C - 7

AVERAGE GAMMA ENERGIES AND ABSORBED DOSE RATES RESULTANT FROM SUBMERSION WITHIN A SEMI-INFINITE CLOUD

ISOTOPE	$\bar{E}_{\gamma}$(Mev)[7]	Gy/s (rad/sec)	Gy/h (rad/hr)
^{228}Ac	9.48E-01	1.45E-13 (1.45E-11)	5.23E-10 (5.23E-08)
^{228}Th	1.73E-01	2.65E-14 (2.65E-12)	9.54E-11 (9.54E-09)
^{224}Ra	4.65E-01	7.12E-14 (7.12E-12)	2.56E-10 (2.56E-08)
^{220}Rn	5.50E-01	8.42E-14 (8.42E-12)	3.03E-10 (3.03E-08)
^{212}Pb	1.77E-01	2.71E-14 (2.71E-12)	9.76E-11 (9.76E-09)
^{212}Bi	1.07E+00	1.64E-13 (1.64E-11)	5.90E-10 (5.90E-08)
^{208}Tl	2.24E-01	3.43E-14 (3.43E-12)	1.24E-10 (1.24E-08)
		TOTAL =	1.99E-09 (1.99E-07)

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

(g) The entire activity of Th-232 is released within a twenty-four hour time frame.

(h) The inhalation of Th-232 occurs within twenty-four hours.

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

(j) The weight of the refuse incinerated (W_r) is 6.60E+05 pounds.

(k) The atmospheric dispersion coefficient (X/Q) is assumed to be 2.00E-05 seconds/m^3.

(2) The total activity released in a day (Q) would be:

$$Q = Q_i f_s f_r$$

Incorporating values specified in b.(2)(b, c and d), calculations yield 1.48E+04 Bq (4.00E-01 uCi) released from incineration. The continuous release rate (Q') over twenty-four hours is 1.71E-01 Bq/s (4.63E-06 uCi/sec).

(3) The concentration of Th-232 in the stack gas (X_s) is given by $X_s = Q/V_a V_r$. Substituting values indicated in b(1)(i and j) and b(2), the average 24 hour concentration of Th-232 is 1.12E-08 Bq/cm^3 (3.03E-13uCi/cm^3).

(4) The wind speed is assumed constant at 1.0 m^2/sec under stable meteorological conditions.

(5) The maximum downwind concentration (X) substituting values from 2.c(1)(k) and 2.c(2) into the general formula X = Q' (X/Q) is estimated to be 3.43E-06 Bq/m^3 (9.26E-11 uCi/m^3) or equivalent to 3.43E-06 Bq/m^3 (9.26E-17 uCi/ml). The air concentration limits specified in 10 CFR Part 20 for unrestricted areas is stated as 3.70E-02 Bq/m^3 (1.00E-12 uCi/ml).

(6) The average daily breathing rate of 20.0 m^3 per day is assumed. Therefore, the maximum exposed individual would inhale approximately 6.86E-05 Bq (1.85E-09 uCi).

(7) The average person is assumed to inhale an amount of Th-232 equal to one third the total activity yielding 2.29E-05 Bq (6.17E-10 uCi). Approximation of committed dose equivalents to various organs using ICRP 30 and NUREG/CR-1962 are summarized in Table C-8.

TABLE C - 8

COMMITTED DOSE EQUIVALENTS TO VARIOUS ORGANS RESULTANT FROM INHALATION FOLLOWING SOURCE INCINERATION

EFFECTED GROUP	ACTIVITY INHALED	BONE SURFACE	LIVER*	LUNG*	R. MARROW
Maximum Exposed Individual	6.86E-05 Bq (1.85E-09 uCi)	7.55E-07 Sv (7.55E-05 rem)	4.27E-10 Sv (4.27E-08 rem)	9.88E-10 Sv (9.88E-08 rem)	6.11E-08 Sv (6.11E-06 rem)
Average Exposed Individual	2.29E-05 Bq (6.17E-10 uCi)	2.52E-07 Sv (2.52E-05 rem)	1.43E-10 Sv (1.43E-08 rem)	3.30E-10 Sv (3.30E-08 rem)	2.04E-08 Sv (2.04E-06 rem)

* Internal dosimetry data from NUREG/CR-1962.

Remaining committed Dose Equivalents are assessed using ICRP 30 Data.

(8) Realistic consideration of the above incident is eliminated based on user ability to maintain proper authorized possession and accountability.

d. Source Loss Resulting in Improper Disposal Directly to a Public Landfill:

(1) The quantity of Th-232 incinerated in c.(1)(a) is assumed transferred to a public solid waste landfill. Surrounding populations may be exposed through ingestion of contaminated groundwater. The following parameters are assumed for complete assessment:

(a) Leaching of the total activity of 1.48E+05 Bq (4.00E+00uCi) is one hundred percent (A_t).

(b) One hundred percent is assumed to contaminate groundwater without any dispersion (f_{L1}).

(c) The total volume (V_L) of leachate generated per year from an average 25 acre landfill based on US Environmental Protection Agency (EPA) estimates is 6.76E+06 gallons (2.57E+10ml) accounting for only the average precipitation infiltrate of ten inches per year.

(d) There is no further dilution in the zone of contamination (f_{L2}) is equivalent to one).

(e) One percent is assumed withdrawn for domestic water supply (f_{d1}) and five percent for public drinking water (f_{d2}).

(2) The total activity in the leachate is determined by:

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

The activity substituting proper values is estimated to be 5.76E-06 Bq/ml (1.55E-10 uCi/ml).

(3) In determining the activity ingested by surrounding populations the equation $A_{ing} = V_L f_{d1} f_{d2} A_L$ is employed.

The dietary intake by the entire population (73,000) surrounding the landfill would be 7.40E+01 Bq (2.00E-03 uCi). The average dietary intake would be 1.01E-03 Bq (2.74E-08 uCi).

(4) The dose commitment to the maximally exposed individual is assessed with the assumption that the annual dietary intake of water (I_w) is 370 liters (1) and consists entirely of drinking water contaminated with Th-232 at the same concentration as calculated for leachate (5.76E-06 Bq/ml)

incorporated into the formula: $A_{ing} = I_w A_L$. This yields an ingestion of 2.13E+00 Bq (5.75E-05 uCi). The Th-232 intake and committed dose equivalents to various organs are summarized in Table C-9.

(5) The maximum permissible concentrations for unrestricted areas as specified in 10 CFR Part 20 are 7.40E+04 Bq/m^3 (2.00E-06 uCi/ml) for soluble forms and 1.48E+06 Bq/m^3 (4.00 E-05 uCi/ml) for insoluble forms. The concentration of the radionuclide in the leachate is approximately 7.78E-03 percent of the soluble limits and 3.88E-04 percent of the insoluble limits.

(6) The maximum exposed individual ingests 7.10E-03 percent of the ICRP recommended ALI (3.00E+04 Bq) for ingestion. The resulting committed dose equivalent to bone surface is 8.10E-03 percent of the recommendations for non-stochastic effects (5.00E-01 Sv).

e. Transportation Incidents:

(1) A transport incident involving an assumed maximum quantity of Th-232 is proposed to demonstrate levels below regulatory limits for unrestricted areas. Transportation of night vision devices having a total of fifteen pounds within a single shipment would never occur. The assessment considers inhalation risk as the primary immediate mode of exposure to individuals in the vicinity of an incident under the assumptions:

(a) A maximum quantity of fifteen pounds is transported yielding a total activity of 2.75E+07 Bq (7.42E+02 uCi).

(b) Fifty percent of the total activity is instantaneously and uniformly spacially distributed within a hemispherical volume whose radius equals 200 meters yielding a total volume of 1.67E+07 m^3 and whose activity concentration per unit volume is 8.23E-01 Bq/m^3 (2.22E-05 uCi/m^3).

(c) Assuming no change in activity per unit volume from dispersion during a one hour time period, an individual with a breathing rate of 1.2 m^3/hr remaining for an hour would inhale an activity of 9.88E-01 Bq (2.67E-05 uCi). The concentration when averaged over a one year period is 2.25E-03 Bq/m^3 (6.08E-14 uCi/ml). Based on the calculations, this value is shown to be several orders of magnitudes below NRC air concentration specifications for restricted (1.11E+00 Bq/m^3 or 3.00E-11 uCi/ml) or unrestricted (3.70E-02 Bq/m^3 or 1.00E-12 uCi/ml) areas stated for insoluble/soluble forms.

(2) The total quantity inhaled is approximately 2.47E+00 percent of the recommended ALI (4.00E+01 Bq) for inhalation. The resulting dose equivalent to bone surface is 2.20E+00 percent of the yearly dose equivalent limit (5.00E-01Sv) recommendations for non-stochastic effects. Table C-10 summarizes committed dose equivalent limits to various organs.

TABLE C - 9

COMMITTED DOSE EQUIVALENTS TO VARIOUS ORGANS RESULTANT FROM INGESTION OF CONTAMINATED DRINKING WATER

Effected Group	Activity Ingested	Bone Surface	Liver *	R.Marrow	Gonads *
Total Public	7.40E+01 Bq (2.00E-03 uCi)	1.41E-03 Sv (1.41E-01rem)	7.55E-07 Sv (7.55E-05rem)	1.11E-04 Sv (1.11E-02rem)	9.10E-08 Sv (9.10E-06rem)
Maximum Exposed Individual	2.13E+00 Bq (5.75E-05 uCi)	4.05E-05 Sv (4.05E-03rem)	2.17E-08 Sv (2.17E-06rem)	3.19E-06 Sv (3.19E-04rem)	2.62E-09 Sv (2.62E-07rem)
Average Exposed Individual	1.01E-03 Bq (2.74E-08 uCi)	1.92E-08 Sv (1.92E-06rem)	1.03E-11 Sv (1.03E-09rem)	1.52E-09 Sv (1.52E-07rem)	1.24E-12 Sv (1.24E-10rem)

* Internal dosimetry data from NUREG/CR-1962.

Remaining committed dose equivalents are assessed using ICRP 30 data.

TABLE C - 10

COMMITTED DOSE EQUIVALENTS TO VARIOUS ORGANS RESULTANT FROM INHALATION SUBSEQUENT TO TRANSPORT INCIDENT

Activity Inhaled	Bone Surface	Liver *	Lung *	R. Marrow
9.88E-01 Bq (2.67E-05 uCi)	1.10E-02 Sv (1.10E+00 rem)	6.15E-06 Sv (6.15E-04 rem)	1.42E-05 Sv (1.42E-03 rem)	8.82E-04 Sv (8.82E-02 rem)

* Internal dosimetry data from NUREG/CR-1962.
Remaining committed dose equivalents are assessed using ICRP 30 data.

3. Hypothetical scenarios developed for environmental or radiological health assessment have not been identified to exceed recommended exposure levels for stochastic/non-stochastic dose limits of the ICRP or NRC regulatory requirements. Assumptions established for each incident are regarded as highly improbable. Resultant determinations even when assessed with extreme parameters do not pose significant health or environmental risk. Actual levels would be magnitudes below proposed inhalation or ingestion quantities and determined committed dose equivalents. Maximum safety controls in conjunction with contractual requirements are adequate to insure safe operation without regard to radiological or environmental impact from incorporation of ThF_4 optical coatings within night vision systems.

D. Alternatives

1. The use of optical coatings for obtaining superior spectral performance is achieved over wide wavelength ranges using SLAR/MLAR coatings free from the effects of temperature, angle of incidence shifts and coating non-uniformity. Both MLAR and SLAR coatings are designed to increase substrate transmission and reduce surface reflection for specific wavelength intervals. Typical substrates employed for optical elements are germanium or silicon. Without optical coatings, the transmittance performance of only forty-six percent is obtained in the eight to fourteen micrometer IR spectral region. The incorporation of ThF_4 as one of the multilayers in antireflective coatings produces a ninety-eight percent transmittance within the same spectral region. The development of optical elements for night vision devices with military specifications for an eight to fourteen micrometer IR region withstanding environmental degradation has necessitated the incorporation of ThF_4 as one of the multilayers for specified properties. Additional considerations for ThF_4 selection includes:

(a) The low index of refraction for antireflective coatings.

(b) The extreme stability exhibiting no appreciable decomposition in coating processes.

(c) The low water solubility lending to withstanding severe environmental conditions as an outer coating.

(d) The high transmittance offered due to the molecular lattice structure.

2. The coating for this system is important since there are as many as five lens elements within night vision assemblies. Without this coating, the interreflection losses within the lens system would significantly result in decreased performance. Incorporation of ThF_4 allows use of approximately ten coated elements without decrease in total reflective functions. Commercial laboratories have developed non-radioactive coatings which are capable of producing approximately ninety-four percent transmittance. The non-radioactive

coatings are typically inorganic dielectric type compounds. No material being prototype tested in research and development stages for objective (exterior) lenses assure or meet all military requirements. Research and testing for non-radioactive substitutes is ongoing for complete development of coatings producing higher transmission and durability characteristics.

3. In consideration of the negligible to non-existent exposure risk associated with the use of FLIR systems, alternative replacements decreasing performance are unacceptable. There is no demonstration for the need of immediate or future concern regarding the incorporation of ThF_4. Primary consideration should continue to surround provision of optimal systems for use by effected military organizations. ThF_4 antireflective coatings provide the only source for optimal characteristics/properties for use in night vision devices meeting requirements of Federal regulations, Army contracts and tactical implementation. These coatings are considered most advantageous in obtaining specified requirements for uniformly high transmission over required wavelength intervals and multiple reflectance reduction.

E. Status of Compliance

All night vision systems included under the CECOM NRC Source Material License No. SMB-1300 have been identified in Section B to comply to all regulations stipulated in 10 CFR, applicable Army regulations as specified in AR-385-11 and CECOM MOU's between other MSC's. In addition, CECOM provides assurance to compliance of regulations through annual health and safety inspections of depot areas inclusive of quality assurance testing. Further, this headquarters will assure that contractor facilities are inspected for compliance with statements and representations contained within NRC Source Material License No. SMB-1300. As previously stated in Section B, transportation of night vision thermal imagery equipment is exempted with regard to applicable DOT/NRC regulations.

F. Listing of Agencies and Persons Contacted:

1.	Nado, George:	IEL/SAL Laboratory Manager Electro-Optics Division Texas Instruments Dallas, Texas
2.	Olson, Valerie:	Assistant Program Manager, FAS Hughes Aircraft Corporation Culver City, California
3.	Vincent, Jerry:	Safety Specialist Safety Office Sacramento Army Depot Sacramento, California
4.	Zmarzly, Frederick:	Sales Manager Government Aerospace Optical Coating Laboratories, Incorporated Santa Rosa, California

G. References:

1. Army Regulation 200-2, Environmental Quality: Environmental Effects of Army Actions, Headquarters, Department of the Army, Washington, DC, 1981.

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

3. Army Regulation 385-11, Ionizing Radiation Protection (Licensing, Control, Transportation, and Disposal), Headquarters, Department of the Army, Washington, DC, 1980.

4. Army Regulation 700-64, Radioactive Commodities in the DOD Supply System, Headquarters, Department of the Army, Washington, DC, 1976.

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

6. Fitzgerald, John J., Applied Radiation Protection and Control, Gordon and Breach Inc., New York, 1970.

7. Kocher, David C., Radioactive Decay Data Tables, National Technical Information Service, Springfield, Virginia, 1981.

8. Eckerman, K. F., et al., Internal Dosimetry Data and Methods of ICRP - Part 2, Volume 1: Committed Dose Equivalents and Secondary Limits, NUREG/CR-1962, Volume 1, ORNL/NUREG/TM-433/V1, National Technical Information Service, Springfield, Virginia, 1981.

9. Slade, David H., Meteorology and Atomic Energy, National Technical Information Center, Springfield, Virginia, 1968.

10. Belanger, R., Buckley, D.W., and Swenson, J.B., Environmental Assessment of Ionization Chamber Smoke Detectors Containing Americium-241, NUREG/CR-1156, Science Applications, Inc., California, 1979.

RADIATION REQUIREMENT

The Optical Elements shall contain no thorium or other source material as defined in Title 10, Code of Federal Regulations, Part 40, in excess of 0.05 percent by weight or other added radioactive material (See Definition A).

The contractor shall include the preceding requirement in all purchase orders for Optical Glass.

1. Optical Elements (Visible Lenses)

a. Inventory Control - Each lens element shall be traceable to a particular lot and vendor. Lots shall be separated according to date received, lens type and vendor. For accounting and control purposes, each lot will be documented as to the number in the lot, type of lens, source of supply and date received. Individual lots must be kept separated until unit testing has been completed and the lots are approved for use (see below). This inventory control system shall be open for Government inspection throughout the life of the contract and one copy of the applicable portion of the inventory records will be submitted along with each test report for Government retention.

* b. Screening Test - All completed glass elements will be individually screened for detectable radiation by using a Government approved radiation monitor (See Definition B). All glass elements will be unwrapped before screening and screening will be done on both sides of the glass. Each glass element will first be screened using an end window probe. All glass passing this test will then be screened by using an Alpha Probe. Any lens element which indicates a positive reading on the monitor, a steady reading twice background or greater, will be cause for rejecting the lot.

* c. X-Ray Analysis for First Element in Eyepiece - After screening the lots as described in part b, 10 percent of the accepted screen elements in each lot will be randomly selected and tested by X-Ray Fluorescence (See Definition C)for compliance with the test requirement (NOTE: At least one sample from each lot will be tested and all sample quantities will be rounded to the next higher integer). If the analysis shows a source material concentration greater than 0.05 percent by weight, 500 parts per million, for any sample, all glass elements in the lot associated with this sample will be rejected and replaced with acceptable glass elements at the contractors expense. Government prior approval of the test facility that will perform the X-Ray Analysis is required (See Definition C).

d. X-Ray Analysis for Suspect Elements in Eyepiece- After screening the lot as described in part b, one percent of the accepted screened elements in each lot will be randomly selected and tested by X-Ray Fluorescence (See Definition C) for compliance with the test requirement. (NOTE: At lease one sample from each lot will be tested and all sample quantities will be rounded to the next higher integer). If the analysis shows a source material concentration greater than 0.05 percent by weight, 500 parts per million, for any sample, all glass elements in the lot associated with this sample will be rejected and replaced with acceptable glass elements at the contractors expense. Government prior approval of

Encl 1

the test facility that will perform the X-Ray Analysis is required, (See Definition C).

e. One glass sample which has not received the X-Ray fluorescence test from each lot associated with c and d above may be randomly selected by the Government QAR and sent as part of the test report for Government verification testing. If tests show a source material concentration greater than 0.05 percent by weight, 500 parts per million, all glass elements in the lots associated with the sample will be rejected and replaced with acceptable glass elements at the contractors expense. The sample will be returned fifteen (15) days after date of receipt.

f. The plan shall include a sample test report (see DD 1423 DI-T-1906)which demonstrates the ability to determine compliance with the requirement by examination of the report.

g. Alternate Methods of Certification. Equivalent alternate procedures may be submitted for Government approval at the time of and in addition to the submission of the Contractor test plan. The alternate plan must contain adequate documentation concerning the relative cost and difficulties of implementing this note and the alternate plan and of the equivalence of the alternate certification plan in terms of assuring compliance with paragraph a., while maintaining the contractual delivery schedule and minimizing additional costs.

2. Optical Elements IR Coated (Thorium Fluoride)

a. Restriction of Optical Fluoride Coatings on IR Optics. Thermal Imaging Systems, especially developed in the 8-14 um region, and delivered under this contract may have Infrared Optics containing thorium fluoride anti-reflective coatings. Since this material is radioactive, 10CFR requires the items using this coating material be controlled. All systems utilizing thorium fluoride coatings shall be tested to assure durability of the coatings. Furthermore, on all materials prepared in support of the equipment, as required by the contract, the Contractor shall inform the customer/reader of the existence of the thorium coatings and shall indicate that licensing authorization has been approved from the Nuclear Regulatory Commission (NRC) for their use. The prime Contractor shall assume full responsibility for the implementation of this note and shall include this note in all subcontracts.

(1) Operating Instructions. Manuals or other operating instructions shall state that the objective lenses are coated with indicated numerical value amount of radioactive material and that licensing authorization for its use has been obtained from NRC. Also, methods to be used in cleaning the lenses shall be defined in the manuals.

(2) Testing. IR coatings shall pass adherence and abrasion tests. IR coatings shall not flake, peel or pit when subjected to environmental requirements.

(3) Drawings. Drawings describing thorium coated elements shall indicate that the element is thorium fluoride coated. The amount of thorium compound per square centimeter in the total coating will be provided.

(4) Certification or Safety Statement. The contractor shall specifically provide the following information as a separate item or as part of another data item such as the safety statement, final report, or radioactive material data list:

(a) Part number of all optical elements with IR coatings.

(b) Diameter of each element with a radioactive IR coating.

(c) The amount of thorium compound per square centimeter in the total coating will be provided.

(This information is required under NRC Source Material License Number SMB-1300 issued to USACERCOM)

Definitions

A. Radioactive Material - Material requiring specific licensing, under the regulation issued pursuant to the Atomic Energy Act of 1954, as amended, and any other radioactive material not requiring specific licensing in which the radioactivity per gram is greater than 0.002 microcuries.

B. Radiation Monitor - Must have both audible and meter detection ability. The monitor must have capability to be used with both a thin window probe and a Alpha Probe (Equivalent to Eberline Model RM-15 or RM-19).

Minimum Requirements for Probes

1. Alpha Probe - Target surface must be of Aluminized Mylar no heavier than 1.5 mg/sq cm (Equivalent to Eberline Model AC-3-7/AC-3B-7).

2. Thin End Window Probe - End window must be Mica no heavier than 2 mg/sq cm (Equivalent to Eberline Model HP-230A).

C. Government Approval of Test Facility - Will be based on the ability to use X-Ray Fluorescence techniques to analyze glass with a minimum detectable level for thorium and other source material of at least 100 parts per million with an accuracy of ± 25 parts per million. Equipment to be used in performing the X-Ray Fluorescence must be calibrated and correlated against Government standards.

F-17-25

MIL-M-13508C
19 March 1973
SUPERSEDING
MIL-M-13508B
16 November 1966

MILITARY SPECIFICATION

MIRROR, FRONT SURFACED ALUMINIZED: FOR OPTICAL ELEMENTS

This specification is mandatory for use by all Departments and Agencies of the Department of Defense

1. SCOPE

1.1 Scope. This spe[illegible]n covers a mirror coating consisting of a deposited aluminum refl[illegible]ive film overlaid with a transparent dielectric protective film applied on the front surface of optical elements.

2 APPLICABLE DOCUMENTS

2.1 The following documents of the issu[illegible]ffect on date invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

* Federal

L-T-90	Tape, Pressure-Sensitive, Adh[illegible] (Cellophane and cellulose ac[illegible]
CCC-C-440	Cloth, Cheesecloth, Cotton, Bleached and unbleached

Military

MIL-0-13830	Optical Components for Fire Control Instruments; General Specification Governing the Manufacture, Assembly, and Inspection of

FSC 6650

THIS DOCUMENT CONTAINS 6 PAGES

12[illegible]

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STANDARDS

Federal

Federal Test Method, Standard No. 151	Metals; Test Methods

Military

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-1241	Optical Terms and Definitions

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Optical terms and definitions.- Reference shall be made to MIL-STD-1241 to define optical terms used.

3.2 Optical elements.- The supplier is responsible for the quality of the optical elements used as backing for a front surface mirrored finish. Optical elements shall have been manufactured, tested and approved for use in accordance with the applicable element drawing and referenced specifications prior to the coating process.

3.3 Coating process.- The coating process producing the front surface mirror finish shall cause no impairment to the optical element. Optical elements which have met the requirements of 3.2 shall not be rejected because of fine hair lines, scratches, digs or stains which are made more visible by the coating process.

3.3.1 Aluminum film.- The deposited film shall be of high quality aluminum. There shall be no visible discontinuities or blemishes that adversely affect the field of view as seen with the eye in the specified viewing position.

* 3.3.2 Protective film.- The front surface aluminum film shall be protected by a film of high quality uniform magnesium fluoride or silicon monoxide or as otherwise specified on the applicable drawing. The film shall be free from holes, foreign matter and perceptible variations in density.

3.4 Reflectance.- The finished coated surface, for visible use, shall have more than 86 percent luminous reflectance when measured at required angle of incidence, or a refalctance as otherwise specified on the applicable drawing.

3.5 Optical quality.- The finished coated surface shall conform to the pertinent optical requirements set forth on the applicable drawing.

3.6 Coated area.- The optical element shall be coated over its entire effective aperture or as otherwise specified by the applicable drawing.

3.7 Temperature influence.- The coated surface shall show no signs of deterioration or removal of films after being subjected to ambient temperature of -80°F and also +160°F for a period of five hours at each temperature.

3.8 Hardness.- The coated surface shall show no signs of deterioration such as streaks or hairline scratches as defined in MIL-O-13830 after being hand rubbed with a dry cloth.

3.9 Adherence.- No part of the aluminum or protective films shall be removed when cellulose tape is pressed against the coated surface and slowly removed.

3.10 Humidity and salt spray.- When specified in the contract the coated surface shall show no evidence of corrosion or pitting when exposed to a relative humidity of 95 to 100 percent at 120°F ± 4°F for a period of 24 hours and when exposed to a salt spray for the same time period. (See 6.1)

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. - Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 General provisions

4.2.1 Submission of product. - Unless otherwise specified in the contract inspection lot size, lot formation and presentation for acceptance shall be in accordance with MIL-STD-105.

4.3 Examination and tests. - Examination and tests related to Section 3 herein shall be performed on a single defect (individual characteristic) basis in accordance with MIL-STD-105 and Table I specified herein.

TABLE I, CLASSIFICATION OF DEFECTS

Class	Requirement	Test Procedure
Critical: None defined		
Major: AQL 0.65% defective		
101. Aluminum film	3.3.1	4.4.1
102. Protective film	3.3.2	4.4.1
103. Reflectance	3.4	4.4.2
104. Optical quality	3.5	4.4.3
105. Coated area	3.6	4.4.1
106. Temperature influence	3.7	4.4.4
107. Hardness	3.8	4.4.5
108. Adherence	3.9	4.4.6
109. Humidity	3.10	4.4.7
110. Salt spray	3.10	4.4.8
Minor: None defined		

4.4 Test Methods and procedures.

4.4.1 Coating process.- Use a visual inspection and procedures set forth in MIL-0-13830 to determine compliance with requirements 3.3.1, 3.3.2, and 3.6.

★ 4.4.2 Reflectance.- The reflectance of the finished mirror at the required angle of incidence shall be measured either with a photometer device shown in Figure 1 for luminous reflectance or an instrument (spectrophotometer) capable of measuring nonvisual reflectance as otherwise specified on the applicable drawing to determine conformance with the requirements of 3.4.

4.4.3 Optical quality.- Use testing procedures as specified in MIL-0-13830 or as otherwise specified on applicable drawing to determine compliance with requirement 3.5.

4.4.4 Temperature influence.- The element shall be exposed to ambient temperatures of -80 and +160°F for a period of 5 hours at each specified temperature. A visual inspection shall be made after the element is returned to standard ambient temperature (+60° to 90°F) to determine compliance with the requirement 3.7.

* 4.4.5 Hardness. - This test shall be performed using a pad of clean dry laundered cheesecloth, conforming to CCC-C-440, approximately 3/8 inch diameter and approximately 1/2 inch thick. Bearing with a force of one pound ± 1/4 lb on the protected clean surface of the element, rub a minimum of 50 strokes across the surface in straight lines or circular motions. Subsequent to this procedure the protective coating must meet the requirements of 3.8.

* 4.4.6 Adherence. - Place the sticky surface of cellulose tape, conforming to TYPE I, Class A of L-T-90, over a portion of the coated surface. Press the tape firmly against the coated surface. Pull the tape down over the edges of the element and then slowly remove the tape. A visual inspection shall be made of the tested area to assure that the films have not been removed from the substrate material to determine compliance with 3.9. Edges not forming a part of the reflecting surface shall not be considered when inspection is being performed.

4.4.7 Humidity. - The coated elements shall be exposed for a period of 24 hours in a thermostatically controlled humidity chamber having a relative humidity of between 95 and 100 percent of 120° ± 4°F. The elements shall be removed from the chamber and dried with lens tissue or soft cloth, then visually inspected to determine compliance with the requirements of 3.10. (See 6.1).

* 4.4.8 Salt spray. - A visual inspection of the element shall be made of the coating after exposure to the salt spray test described in Federal Test Method Std No. 151 to determine compliance with the requirements of 3.10 (See 6.1).

5. PREPARATION FOR DELIVERY - This section not applicable to this specification.

6. NOTES

* 6.1 Humidity and salt spray. - Humidity and salt spray requirements and tests are applicable only when specifically required by contract. The contract shall also prescribe the specific protective coating that will meet the environmental requirements of 3.10. Federal Test Method Std No. 151 Metals, Test Methods, should be furnished as part of applicable documents required under 2.1.

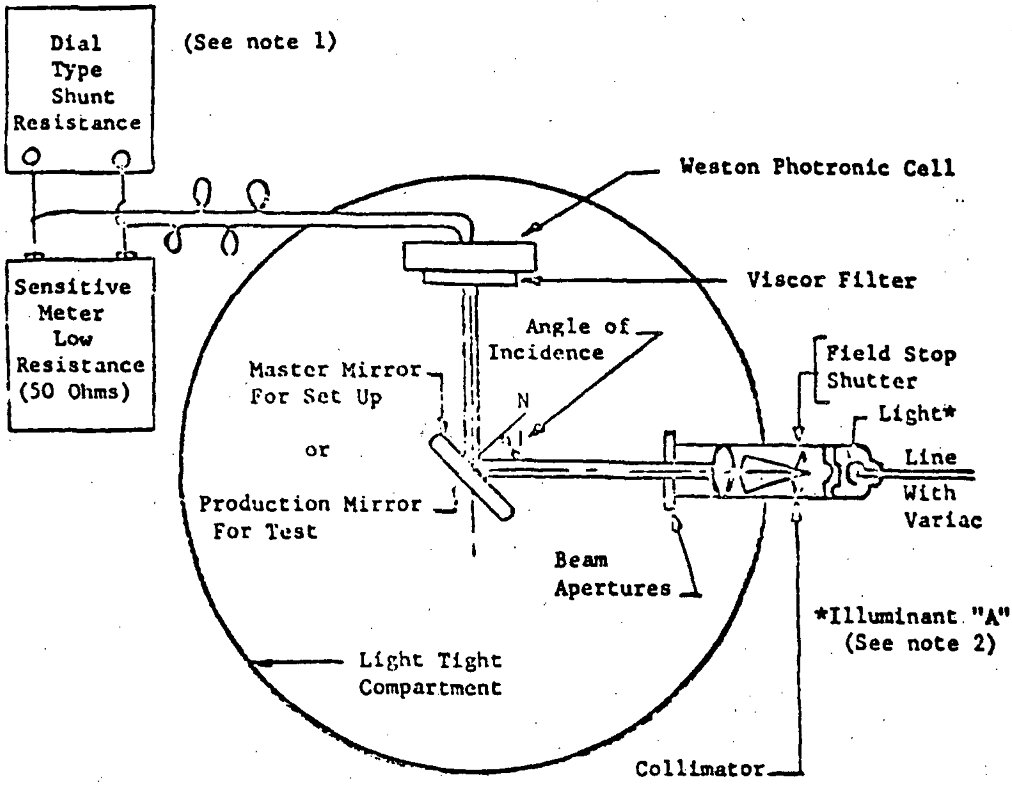
Custodians:
Army - MU
Air Force - 82

Review activity:
Army - MU
Air Force - 82

User activity:
Army - EL, ME, MI
Navy - OS, SH
Air Force - None

Preparing activity:
Army - MU (FA)

Project No. 6650-0060



Notes: 1. The load resistance of the photocell is reduced by meter adjustment shunt.

2. Illuminant "A" is an incandescent tungsten lamp having a spectral distribution corresponding to a black body at a temperature at 2848°K.

* Figure 1. Weston Photronic Cell, Viscor Filter and Tungsten Light

☆ U. S. GOVERNMENT PRINTING OFFICE: 1973-714-546/5550

1291

MIL-STD-810C
10 March 1975
SUPERSEDING
MIL-STD-810B
15 June 1967

MILITARY STANDARD

ENVIRONMENTAL TEST METHODS

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

Incl, 3

Environmental Test Methods

MIL-STD-810C

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Recommended corrections, additions, or deletions should be addressed to Commander, Aeronautical Systems Division, Attn: ASD/ENYESA, Wright-Patterson Air Force Base, Ohio 45433.

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FIGURES (Cont'd)

CONTENTS

FIGURES (Cont'd)

METHOD 507.1

HUMIDITY

1. PURPOSE. The humidity test is conducted to determine the resistance of equipment to the effects of exposure to warm, highly humid atmosphere such as is encountered in tropical areas. This is an exaggerated environmental test, accomplished by the continuous exposure of the equipment to high relative humidity at cycling elevated temperatures. These conditions impose a vapor pressure on the equipment under test which constitutes the major force behind the moisture migration and penetration.

1.1 General effects. Corrosion is one of the principal effects of humidity. Hygroscopic materials are sensitive to moisture and may deteriorate rapidly under humid conditions. Absorption of moisture by many materials results in swelling, which destroys their functional utility and causes loss of physical strength and changes in other important mechanical properties. Insulating materials which absorb moisture may suffer degradation of their electrical and thermal properties. Cycling temperature and humidity may cause condensation of moisture inside of the equipment which could cause the equipment to malfunction due to electrical shorts or cause binding due to corrosion or fouling of lubricants between moving parts.

2. APPARATUS. Humidity-temperature chamber and associated equipment.

2.1 Chamber. The chamber and accessories shall be constructed and arranged in such a manner as to avoid condensate dripping on the test item. The chamber shall be trap-vented to the atmosphere to prevent the buildup of total pressure. Relative humidity shall be determined from the dry bulb-wet bulb thermometer comparison method or an equivalent method approved by the procuring activity. When readout charts are used, they shall be capable of being read with a resolution within 0.6°C (1°F). When the wet bulb control method is used, the wet bulb and tank shall be cleaned and a new wick installed at least every 30 days. The air velocity flowing across the wet bulb shall be not less than 900 feet per minute. Provisions shall be made for controlling the flow of air throughout the internal chamber test space where the velocity of air shall not exceed 150 feet per minute. Steam or distilled, demineralized, or deionized water having a pH value between 6.0 and 7.2 at 23°C (73°F) shall be used to obtain the specified humidity. No rust or corrosive contaminants shall be imposed on the test item by the test facility.

3. PROCEDURES

3.1 Procedure I. Airborne electronic equipment.

Step 1 - Prepare the test item in accordance with General Requirements, 3.2. Prior to starting the test, the internal chamber temperature shall be at standard ambient with uncontrolled humidity.

Step 2 - Gradually raise internal chamber temperature to 65°C (149°F) and the relative humidity to 95 +5 -3 percent over a period of 2 hours.

Step 3 - Maintain conditions of step 2 for not less than 6 hours.

Step 4 - Maintain 85 percent, or greater, relative humidity and reduce internal chamber temperature in 16 hours to 30°C (86°F).

Step 5 - Repeat steps 2, 3, and 4 for a total of 10 cycles (not less than 240 hours). Figure 507.1-1 is an outline of the humidity cycle for this procedure.

Step 6 - At the end of the tenth cycle, while still at 30°C (86°F) and 85 percent relative humidity, operate the test item and obtain results in accordance with General Requirements, 3.2.

Step 7 - Remove and inspect the test item and obtain results in accordance with General Requirements, 3.2.

3.2 Procedure II. Ground and airborne electronic equipment.

Step 1 - Prepare the test item in accordance with General Requirements, 3.2, except that initial measurements are taken in step 4.

Step 2 - Dry the test item at 54°C (129°F) for 24 hours.

Step 3 - Condition the test item at 23°C (73°F) and 50 ±10 percent relative humidity for 24 hours.

Step 4 - Take initial measurements in accordance with General Requirements, 3.2.1

1+2;

NOTE: The test item may be readjusted or realigned, as necessary, to meet specification requirements. No further realignment or readjustment shall be permitted throughout the test period, other than with accessible controls employed for operation of the test item. No repair or replacement of parts shall be permitted. Equipment shall be operated only when specified test measurements are being performed.

Step 5 - Raise the internal chamber temperature to 30°C (86°F) and the relative humidity to 94 ±4 percent.

Step 6 - Subject the test item to five continuous 48-hour cycles in accordance with figure 507.1-2. Take measurements in accordance with General Requirements, 3.2.3 at the periods shown on figure 507.1-2, unless otherwise specified in the equipment specification. Prior to measurements, accumulated moisture may be removed by turning the test item upside down or shaking. Wiping is not permitted. (Certain operating procedures require an effective preconditioning of the test item environment prior to operation. When this occurs, the period of measurement shall be kept as short as possible.)

Step 7 - After completion of step 6 cycling, condition the test item for 24 hours at 23°C (73°F) and 50 ±10 percent relative humidity.

Step 8 - Operate the test item, adjusting for optimum performance only as permitted in step 4 note, and compare with data obtained in step 4.

Step 9 - Inspect the test item in accordance with General Requirements, 3.2.4 within an hour.

3.3 Procedure III. Ground and airborne sealed electronic equipment (other than hermetic sealed).

Step 1 - Prepare the test item in accordance with General Requirements, 3.2.

Step 2 - Dry the test item at 54°C (129°F) for 24 hours.

Step 3 - Condition the test item at 23°C (73°F) and 50 ±10 percent relative humidity for 24 hours.

Step 4 - Take initial measurements in accordance with General Requirements, 3.2.1.

NOTE: The test item may be realigned or readjusted as necessary to meet specification requirements. No further realignment or readjustment shall be

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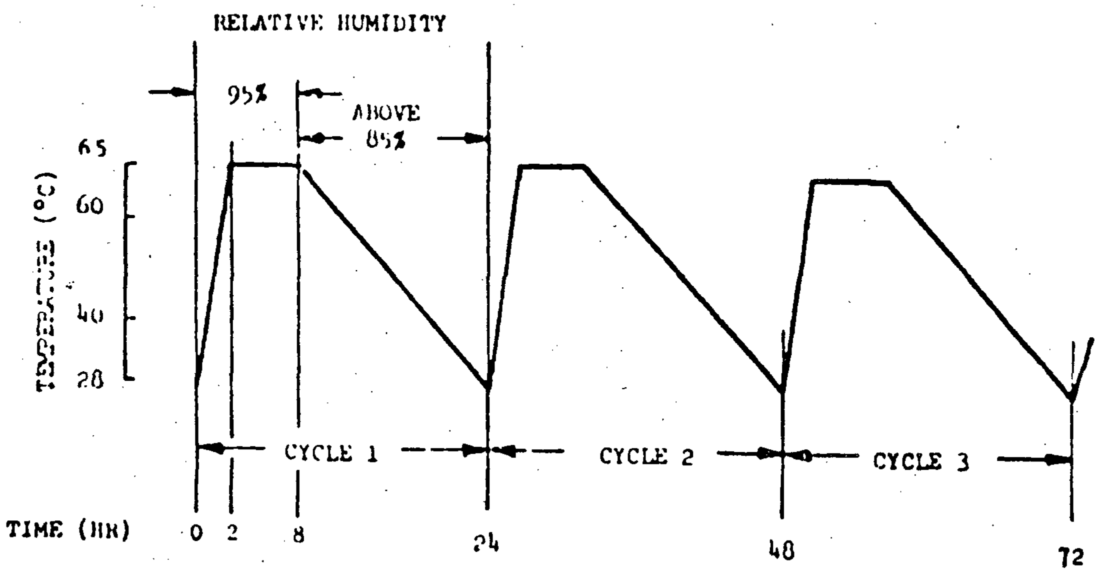

CONTINUE FOR A TOTAL OF 10 CYCLES (240 HR)

FIGURE 507.1-1. Humidity Cycle - Procedure I

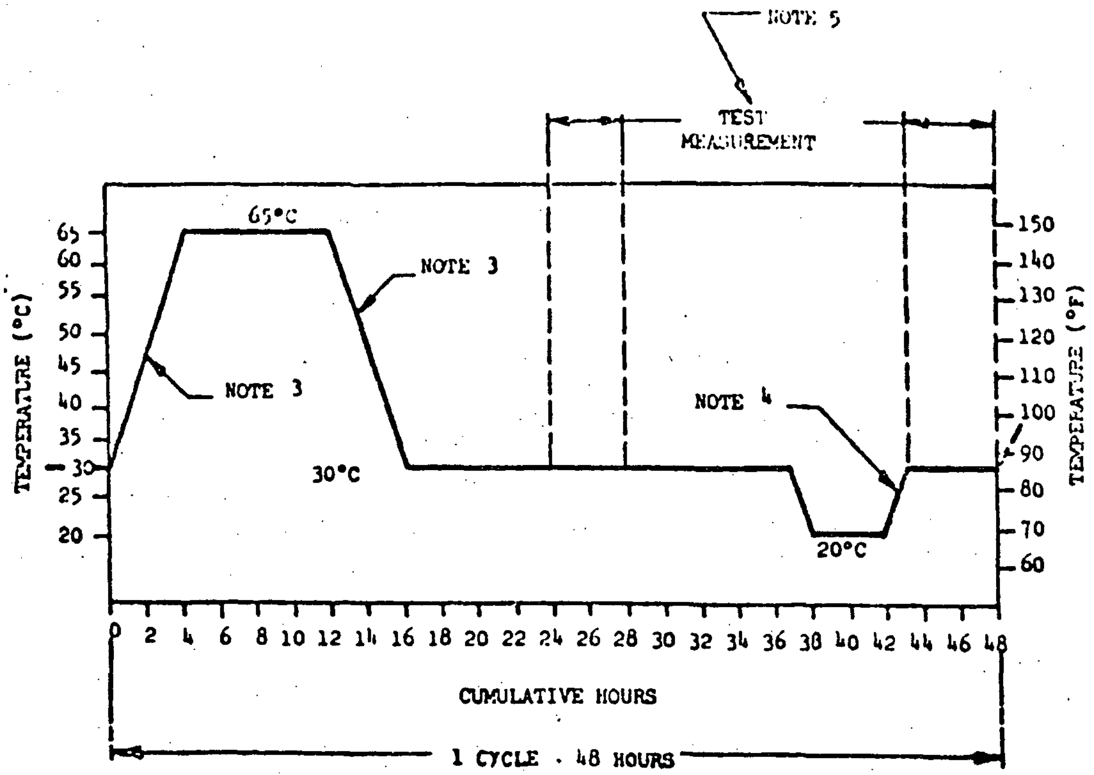

FIGURE 507.1-2. Humidity Cycle Procedures II and III

NOTES:

1. Tolerance during temperature change shall be not greater than 3°C (5°F).

2. Relative humidity shall be maintained at 94 ±4 percent at all times, except that during the descending temperature period, the relative humidity may be permitted to drop as low as 85 percent.

3. Rate of temperature change between 30° and 65°C (86° and 149°F) shall be not less than 8°C (14.4°F) per hour.

4. The temperature increase in this portion of the curve shall be not less than 10°C (18°F).

5. Test measurements shall be taken only at the period specified in the applicable equipment or system specification.

permitted throughout the test period other than with accessible controls employed for operation of the test item. No repair or replacement of parts shall be permitted. Equipment shall not be operated, except when specified test measurements are being performed.

Step 5 - Raise the internal chamber temperature to 30°C (86°F) and the relative humidity to 94 ±4 percent.

Step 6 - Subject the test item to five continuous 48-hour cycles in accordance with figure 507.1-2. The relative humidity shall be maintained at 94 ±4 percent at all times. Take measurements in accordance with General Requirements, 3.2.3 at the periods shown on figure 507.1-2 unless otherwise specified in the equipment specification. Prior to measurements, accumulated moisture may be removed by turning the test item upside down or shaking. Wiping is not permitted. (Certain operating procedures require an effective preconditioning of the test item environment prior to operation. When this occurs, the period of measurement shall be kept as short as possible.)

Step 7 - After completion of the step 6 cycling, open the test item and remove the chassis from its enclosure, in the test chamber.

Step 8 - Maintain the internal test chamber temperature at 30°C (86°F) with the relative humidity at 94 ±4 percent for 480 hours. During the last 5 hours of exposure, take measurements as specified in the equipment specification. Additional measurements may be made at the end of each 24-hour period, if so specified in the equipment specification. Prior to measurements, accumulated moisture may be removed by turning the test item upside down or shaking. Wiping is not permitted. For electronic equipment, if removal of the test chassis from its enclosure will, of itself, adversely affect the operation of the test item, the test item may be replaced in its enclosure for measurements.

Step 9 - After completion of the 480-hour test, condition the test item at 23°C (73°F) and 50 ±10 percent relative humidity for 24 hours.

Step 10 - Adjust the test item to optimum performance only as permitted in the step 4 note.

Step 11 - Operate and inspect the test item, and obtain results in accordance with General Requirements, 3.2, within 1 hour.

3.4 Procedure IV. Ground fire control and shipboard equipment.

Step 1 - Prepare the test item in accordance with General Requirements 3.2.

Step 2 - Dry the test item at a temperature of not less than 40°C (104°F) nor more than 50°C (122°F) for not less than 2 hours.

Step 3 - Condition the test item at 25° ±5°C (77° ±9°F) and 50 percent relative humidity for 24 hours.

Step 4 - Take initial measurements as specified in the equipment specification in accordance with General Requirements, 3.2.

NOTE: The test item may be readjusted or realigned as necessary to conform to the equipment specification requirements. No further realignment or readjustment shall be permitted throughout the test period other than with accessible controls, external to the test item, employed for operation of the test item. If repairs, replacement of parts, or adjustments other than by the accessible external controls are made at any time prior to completion of the measurements required at the end of the fifth cycle, all five of the 24-hour cycles shall be repeated. Repairs include any change to the test item that is not made by use of the accessible controls external to the test item. The test item shall only be operated when specified test measurements are being performed.

Step 5 - Subject the test item to five 24-hour cycles in accordance with figure 507.1-3. A 24-hour cycle consists of 16 hours at 60° ±5°C (140° ±9°F) and approximately 8 hours at 30° ±5°C (86° ±9°F) (includes transition times). The relative humidity shall be maintained at 95 percent, or greater, at both temperatures. Each transition time between 30° ±5°C (86° ±9°F) and 60° ±5°C (140° ±9°F) shall be not greater than 1-1/2 hours. The relative humidity during each transition need not be controlled. Approximately 2 hours after stabilization during the high temperature and low temperature portions of the first or second cycle, a sampling of the atmosphere in the chamber shall be made to determine that the conditions of temperature and relative humidity are uniform throughout the chamber.

Measurements as specified in the equipment specification shall be made during the second cycle at 60° ±5°C (140° ±9°F) immediately prior to decreasing to 30° ±5°C (86° ±9°F).

The test item shall be energized only a sufficient time to allow the required warmup and measurements specified in the equipment specification.

Step 6 - After completion of the fifth cycle with the test item in the chamber and the chamber at 30° ±5°C (86° ±9°F) and a relative humidity of not less than 95 percent, take measurements specified in the equipment specification (no repair, realignment, readjustment or replacement of parts shall be made, except as specified herein). Obtain results in accordance with General Requirements, 3.2.

Step 7 - Condition the test item at 25° ±5°C (77° ±9°F) and 50 ±5 percent relative humidity for not less than 12 hours nor more than 24 hours.

Step 8 - While at 25° ±5°C (77° ±9°F) and 50 percent relative humidity, take measurements as specified in the equipment specification.

Step 9 - Inspect test item to detect evidence of physical degradation (such as corrosion of metal parts, distortion of plastic parts, and insufficient lubrication of moving parts) in accordance with General Requirements, 3.2.

3.5 Procedure V. Ammunition and natural environment cycles.

Step 1 - Prepare the test item in accordance with General Requirements, 3.2, except that initial measurements are taken in step 5.

Step 2 - Dry the test item at 54°C (129°F) for 24 hours.

Step 3 - Condition the test item at 23°C (73°F) and 50° ±10 percent relative humidity for 24 hours.

Step 4 - Gradually raise the internal chamber temperature to 40.5°C (105°F) and 90 percent relative humidity in 2 hours.

Step 5 - Take initial measurements in accordance with General Requirements, 3.2.

NOTE: The test item may be readjusted or realigned as necessary to meet specification requirements. No further readjustment or realignment shall be permitted throughout the test period other than with accessible controls employed for operation of the test item. No repair or replacement of parts shall be permitted. Equipment shall be operated only when specified test measurements are being performed.

Step 6 - Maintain the internal chamber temperature at 40.5°C (105°F) and the relative humidity at 90 percent for 16 hours.

Step 7 - Gradually decrease the internal chamber temperature to 21°C (70°F) and increase the relative humidity to 95 percent in 2 hours.

Step 8 - Maintain the internal chamber temperature at 21°C (70°F) and the relative humidity at 95 percent for 4 hours.

Step 9 - Repeat steps 4, 6, 7, and 8 for a total of 20 cycles (480 hours). Take measurements as specified in the equipment specification. Prior to measurements, accumulated moisture may be removed by turning the test item upside down or shaking. Wiping is not permitted. Figure 507.1-4 is an outline of the humidity cycle for this procedure.

Step 10 - After completion of step 9 cycling, operate the test item adjusting for optimum performance only as permitted in step 5 note, and inspect the test item to obtain results in accordance with General Requirements, 3.2 within 1 hour.

4. SUMMARY. The following details shall be specified in the equipment specification:

a. Procedure number

b. Pretest data required

c. Failure criteria

d. Periods at which measurements are to be taken

e. Method for determining purity of water if a more precise method is desired. (An alternate to pH criteria is to perform a conductivity measurement. The maximum acceptable value would be that resistance which is equivalent to 3.5 parts per million total ionized solids.)

f. If test item must be exposed to extreme temperature prior to test (procedure I).

g. Number of cycles if other than 20 (procedure V, step 9).

h. Whether cycle is to be limited to first 24 hours (procedure II, step 6).

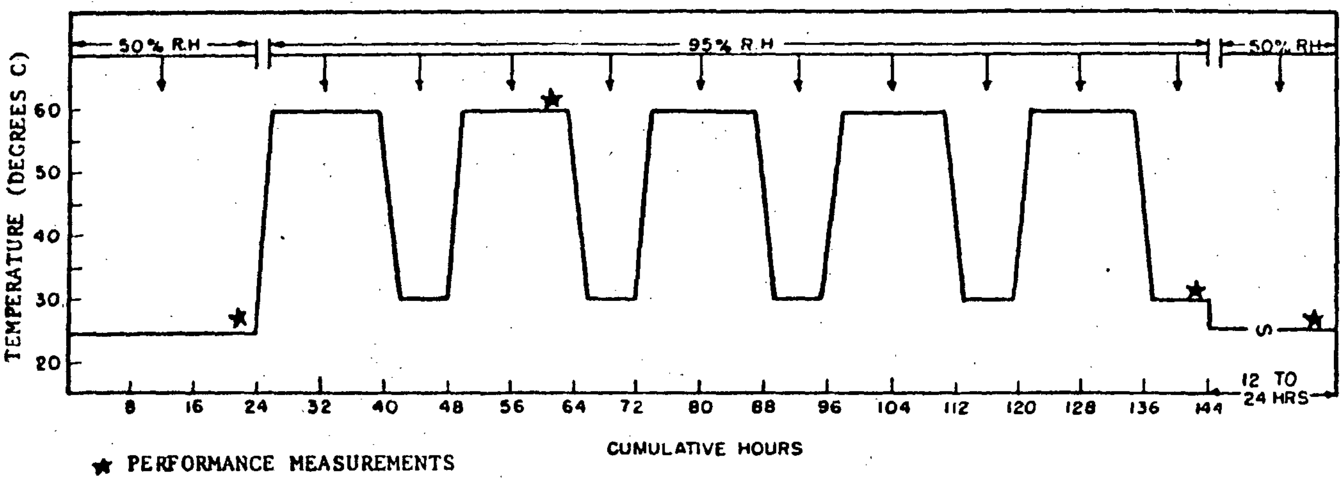

FIGURE 507.1-3. Humidity Cycle - Procedure IV

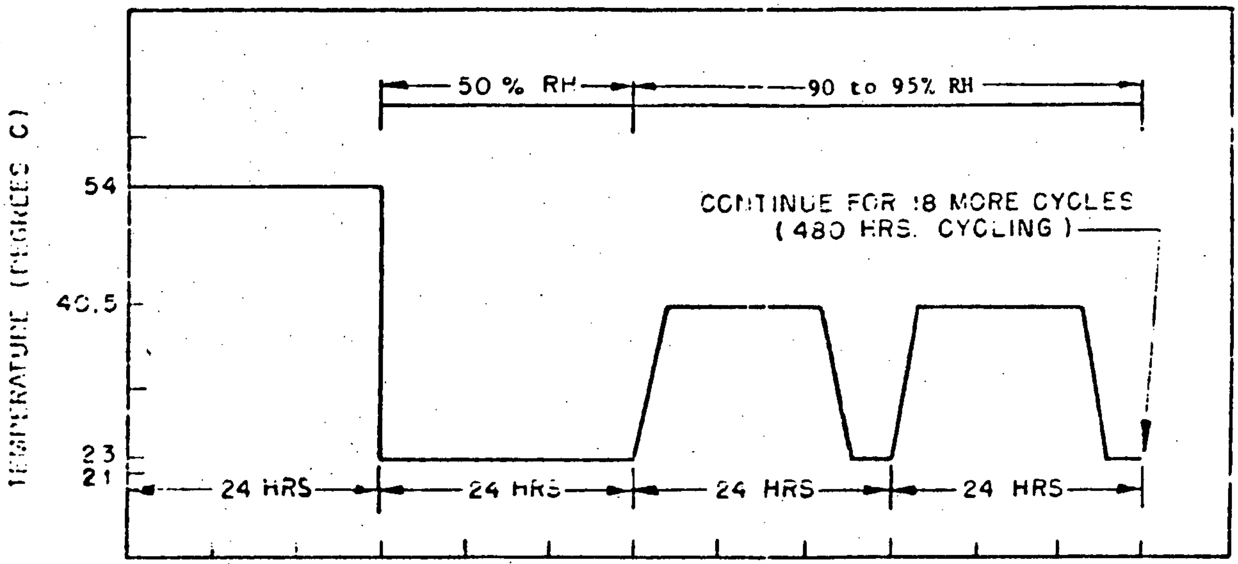

FIGURE 507.1-4. Humidity Cycle - Procedure V

METHOD 509.1

SALT FOG

1. PURPOSE. The salt fog test is conducted to determine the resistance of equipment to the effects of a salt atmosphere. The specified concentration of moisture and salt is greater than is found in service. The test is applicable to any equipment exposed to salt fog conditions in service.

1.1 Application. This test is valuable for determining the durability of coatings and finishes exposed to a corrosive salt atmosphere. For other applications, this test should be applied only after full recognition of its deficiencies and limitations which are as follows:

1.1.1 General effects

1.1.1.1 Deficiencies

a. The successful withstanding of this test does not guarantee that the test item will prove satisfactory under all corrosive conditions.

b. The salt fog used in this test does not truly duplicate the effects of a marine atmosphere.

c. It has not been demonstrated that a direct relationship exists between salt-fog corrosion and corrosion due to other media.

d. This test is generally unreliable for comparing the corrosion resistance of different materials or coating conditions, or for predicting their comparative service life. (Some idea of the service life of different samples of the same, or closely related metals, or of protective coating-base metal combinations exposed to marine or seacoast locations can be gained by this test provided the correlation of field service test data with laboratory tests that such a relationship does exist, as in the case of aluminum alloys, such correlation tests are also necessary to show the degree of acceleration, if any, produced by the laboratory test.)

1.1.1.2 Limitations

a. The salt fog test is acceptable for evaluating the uniformity (i.e., thickness and degree of porosity) of protective coatings, metallic and nonmetallic, of different lots of the same product, once some standard level of performance has been established. (When used to check the porosity of metallic coatings, the test is more dependable when applied to coatings which are cathodic rather than anodic toward the basic metal.)

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b. This test can also be used to detect the presence of free iron contaminating the surface of another metal by inspection of the corrosion products.

2. APPARATUS. The apparatus used in the salt fog test shall include the following:

a. Exposure chamber with racks for supporting test items.

b. Salt solution reservoir with means for maintaining an adequate level of solution.

c. Means for atomizing salt solution, including suitable nozzles and compressed air supply.

d. Chamber heating means and control.

e. Means for humidifying the air at a temperature above the chamber temperature.

2.1 Chamber. The chamber and all accessories shall be made of material that will not affect the corrosiveness of the fog, e.g., glass, hard rubber, plastic, or kiln dried wood other than plywood. In addition, all parts which come in contact with test items shall be of materials that will not cause electrolytic corrosion. The chamber and accessories shall be constructed and arranged so that there is no direct impingement of the fog or dripping of the condensate on the test items, that the fog circulates freely about all test items to the same degree, and that no liquid which has come in contact with the test items returns to the salt-solution reservoir. The chamber shall be properly vented to prevent pressure buildup and allow uniform distribution of salt fog. The discharge end of the vent shall be protected from strong drafts which can create strong air currents in the test chamber.

2.2 Atomizers. The atomizers used shall be of such design and construction as to produce a finely divided, wet, dense fog. Atomizing nozzles shall be made of material that is nonreactive to the salt solution.

2.3 Air supply. The compressed air entering the atomizer shall be essentially free from all impurities, such as oil and dirt. Means shall be provided to humidify and warm the compressed air as required to meet the operating conditions. The air pressure shall be suitable to produce a finely divided dense fog with the atomizer or atomizers used. To insure against clogging the atomizers by salt deposition, the air should have a relative humidity of at least 85 percent at the point of release from the nozzle. A satisfactory method is to pass the air in very fine bubbles through a tower containing heated water which should be automatically maintained at a constant level. The temperature of the water should be at least 35°C (95°F). The permissible water temperature increases with increasing volume of air and with decreasing insulation of the chamber and the chamber's surroundings. However, the temperature should not exceed a value above which an excess of moisture is introduced into the chamber (for example 43°C (109°F) at an air pressure of 12 psi) or a value which makes it impossible to meet the requirements for operating temperature.

2.4 Preparation of salt solution. The salt used shall be sodium chloride containing on the dry basis not more than 0.1 percent sodium iodide and not more than 0.5 percent of total impurities. Unless otherwise specified, a 5 ±1 percent solution shall be prepared by dissolving five parts by weight of salt in 95 parts by weight of distilled or demineralized water. The solution shall be adjusted to and maintained at a specific gravity between the limits shown on figure 509.1-1 by utilizing the measured temperature and density of the salt solution. Sodium tetraborate (common borax) may be added to the salt solution in [illegible] ratio not to exceed 0.7 gms (1/4 level teaspoon) sodium tetraborate to 20 gallons of salt solution as a pH stabilization agent.

2.4.1 Adjustment of pH of the salt solution shall be so maintained that the solution atomized at 35°C (95°F) and collected by the method specified in 3.1.3 will be in the pH range of 6.5 to 7.2. Only diluted C.P. hydrochloric acid or C. P. sodium hydroxide shall be used to adjust the pH. The addition of sodium tetraborate as recommended in 2.4 will aid in maintaining a stable pH value. The pH measurement shall be made electrometrically, using a glass electrode with a saturated potassium chloride bridge, or by a colorimetric method, such as bromothymol blue, provided the results are equivalent to those obtained with the electrometric method. The pH shall be measured when preparing each new batch of solution and as specified in 3.1.4.

2.5 Filter. A filter fabricated of noncorrosive materials similar to that shown in figure 509.1-2 shall be provided in the supply line and immersed in the salt solution reservoir in a manner such as that illustrated in figure 509.1-3.

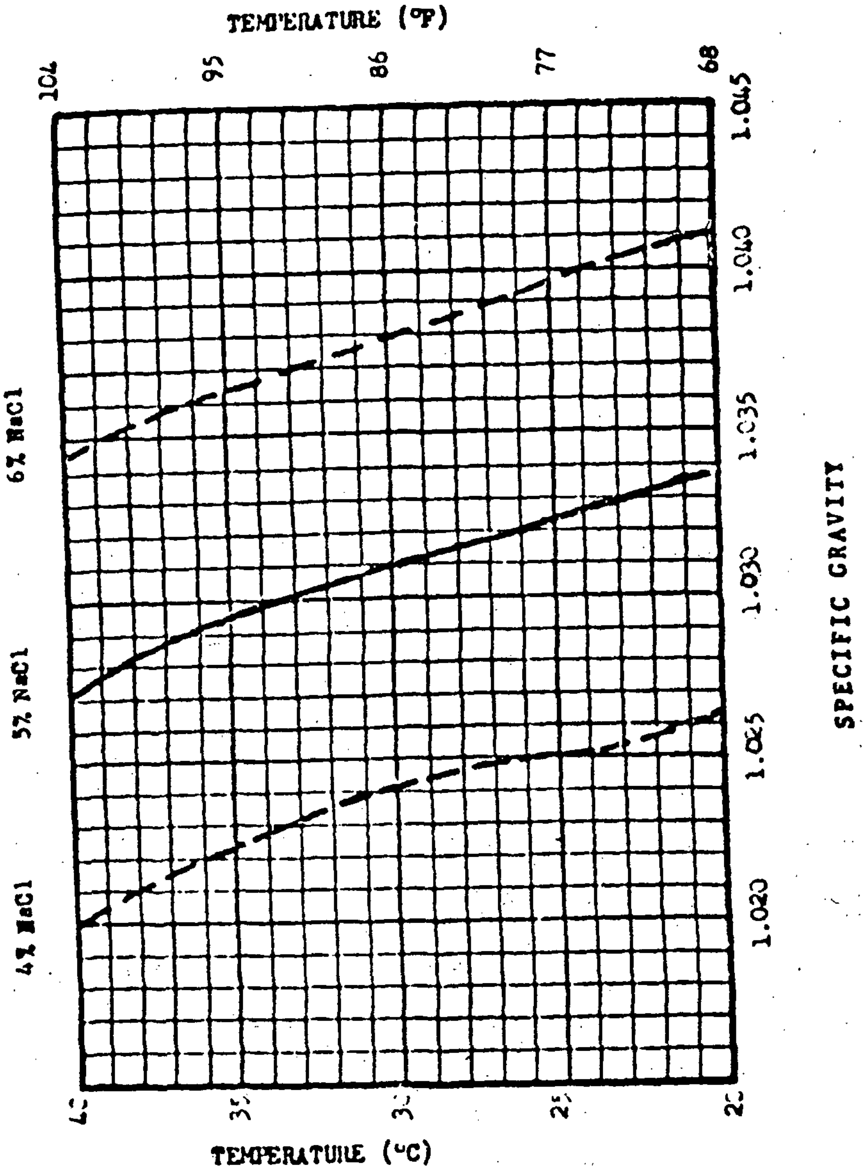
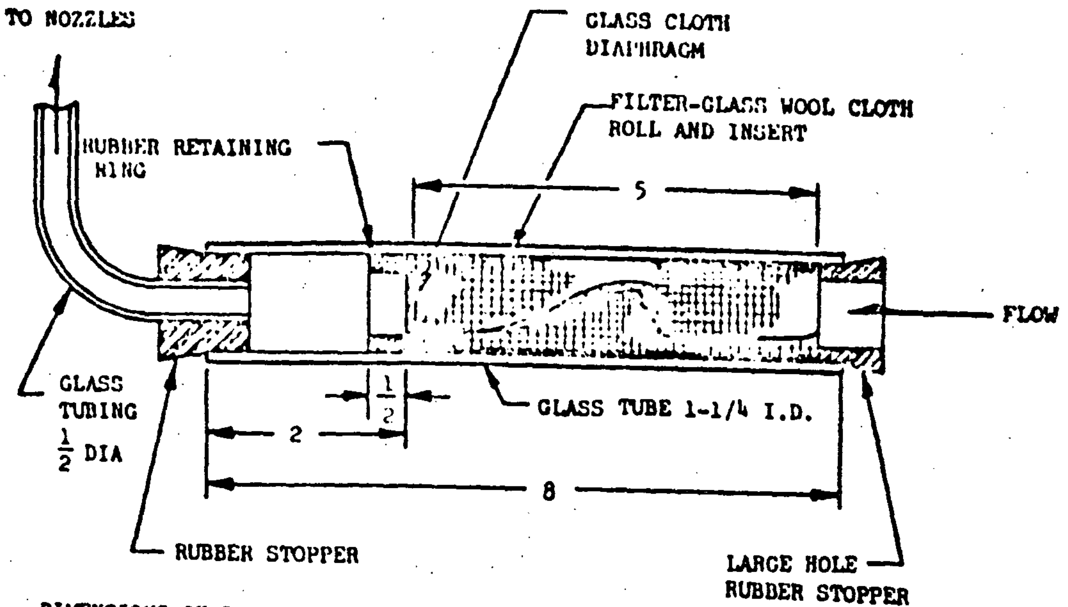


Figure 509.1-1 Variations of Specific Gravity of Salt (NaCl) Solution with Temperature



DIMENSIONS IN INCHES.

Figure 509.1-2 Salt Solution Filter

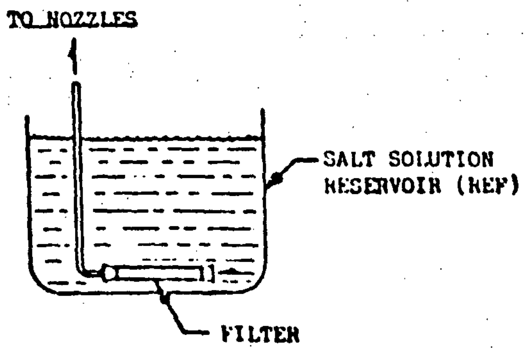


Figure 509.1-3 Location of Salt Solution Filter

3. PROCEDURE

3.1 Procedure I

3.1.1 Temperature. The test shall be conducted with a temperature in the exposure zone maintained at 35°C (95°F). Satisfactory methods for controlling the temperature accurately are by housing the apparatus in a properly controlled constant temperature room, by thoroughly insulating the apparatus and preheating the air to the proper temperature prior to atomization, or by jacketing the apparatus and controlling the temperature of the water or of the air used in the jacket. The use of immersion heaters within the chamber for the purpose of maintaining the temperature within the exposure zone is prohibited.

3.1.2 Atomization. Suitable atomization has been obtained in chambers having a volume of less than 12 cubic feet under the following conditions:

a. Nozzle pressure shall be as low as practicable to produce fog at the required rate.

b. Orifices between 0.02 and 0.03 inch in diameter.

c. Atomization of approximately 3 quarts of salt solution per 10 cubic feet of chamber volume per 24 hours.

When using large size chambers having a volume considerably in excess of 12 cubic feet, the conditions specified may require modification to meet the requirements for operating conditions.

3.1.3 Placement of salt fog collection receptacles. The salt fog conditions maintained in all parts of the exposure zone shall be such that a clean fog collecting receptacle placed at any point in the exposure zone will collect from 0.5 to 3 milliliters of solution per hour for each 80 square centimeters of horizontal collecting area (10 centimeters diameter) based on an average test of at least 16 hours. A minimum of two receptacles shall be used, one placed nearest to any nozzle and one farthest from all nozzles. Receptacles shall be placed so that they are not shielded by test items and so no drops of solution from test items or other sources will be collected.

3.1.4 Measurement of salt solution. The solution, collected in a manner specified in 3.1.3, shall have the sodium chloride content and pH specified in 2.4 when measured at a temperature of 35°C (95°F). The salt solution from all collection receptacles used can be combined to provide that quantity required for the measurements specified.

3.1.4.1 Measurement of sodium chloride content. The solution, maintained at the specified temperature, can be measured in a graduate of approximately 2.5 centimeters inside diameter. A small laboratory type hydrometer will be required for measurement within this volume.

3.1.4.2 Measurement of pH. The pH shall be measured as specified in 2.4.1.

3.1.4.3 Time of measurements. The measurement of both sodium chloride content and pH shall be made at the following specified times:

a. For salt fog chambers in continuous use, the measurements shall be made following each test.

b. For salt fog chambers that are used infrequently, a 24-hour test run shall be accomplished followed by the measurements. The test item shall not be exposed to this test run.

3.1.5 Preparation of test item. The test item shall be given a minimum of handling, particularly on the significant surfaces, and shall be prepared for test immediately before exposure. Unless otherwise specified, uncoated metallic or metallic coated devices shall be thoroughly cleaned of oil, dirt, and grease as necessary until the surface is free from water break. The cleaning methods shall not include the use of corrosive solvents nor solvents which deposit either corrosive or protective films, nor the use of abrasives other than a paste of pure magnesium oxide. Test items having an organic coating shall not be solvent cleaned. Those portions of test items which come in contact with the support and, unless otherwise specified in the case of coated devices or samples, cut edges and surfaces not required to be coated, shall be protected with a suitable coating of wax or similar substance impervious to moisture.

3.1.6 Performance of test. The test item shall be placed in the test chamber in accordance with General Requirements, 3.2.2, and exposed to the salt fog for a period of 48 hours or as specified in the equipment specification. At the end of the exposure period, unless otherwise specified, the test item shall be operated and the results compared with the data obtained in accordance with General Requirements, 3.2.1. The test item shall be inspected for corrosion in accordance with General Requirements 3.2.4. If necessary to aid in examination, a gentle wash in running water not warmer than 38°C (100°F) may be used. The test item shall then be stored in an ambient atmosphere for 48 hours or as specified in the equipment specification for drying. At the end of the drying period, when specified, the test item shall be again operated and the results compared with the data obtained in accordance with General Requirements, 3.2.1. The test item shall then be inspected in accordance with General Requirements, 3.2.4.

4. SUMMARY. The following details shall be specified in the equipment specification:

a. Pretest data required

b. Failure criteria

c. Applicable salt solution, if other than 5 percent

d. Salt fog exposure period if other than 48 hours (see 3.1.6)

e. Drying period if other than 48 hours (see 3.1.6)

f. Inspection and operation after 24 hours of salt fog exposure where buildup of salt deposits are critical to the proper operation of the test item

g. Specify if operation of electrical system is required (see 3.1.6).

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AMERICAN NATIONAL STANDARD **ANSI/ASTM B 117 - 73 (Reapproved 1979)**

Endorsed by American
Electroplaters' Society
Endorsed by National
Association of Metal Finishers

Standard Method of
SALT SPRAY (FOG) TESTING[1]

This Standard is issued under the fixed designation B 117; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

This method has been approved for use by agencies of the Department of Defense to replace Method 811.1 of Federal Test Method Standard No. 151b and for listing in DoD Index of Specifications and Standards.

1. Scope

1.1 This method sets forth the conditions required in salt spray (fog) testing for specification purposes. Suitable apparatus which may be used to obtain these conditions is described in Appendix A1. The method does *not* prescribe the type of test specimen or exposure periods to be used for a specific product, nor the interpretation to be given to the results. Comments on the use of the test in research will be found in Appendix A2.

NOTE 1—This method is applicable to salt spray (fog) testing of ferrous and non-ferrous metals, and is also used to test inorganic and organic coatings, etc., especially where such tests are the basis for material or product specifications.

2. Apparatus

2.1 The apparatus required for salt spray (fog) testing consists of a fog chamber, a salt solution reservoir, a supply of suitably conditioned compressed air, one or more atomizing nozzles, specimen supports, provision for heating the chamber, and necessary means of control. The size and detailed construction of the apparatus are optional, provided the conditions obtained meet the requirements of this method.

2.2 Drops of solution which accumulate on the ceiling or cover of the chamber shall not be permitted to fall on the specimens being tested.

2.3 Drops of solution which fall from the specimens shall not be returned to the solution reservoir for respraying.

2.4 Material of construction shall be such that it will not affect the corrosiveness of the fog.

3. Test Specimens

3.1 The type and number of test specimens to be used, as well as the criteria for the evaluation of the test results, shall be defined in the specifications covering the material or product being tested or shall be mutually agreed upon by the purchaser and the seller.

4. Preparation of Test Specimens

4.1 Metallic and metallic-coated specimens shall be suitably cleaned. The cleaning method shall be optional depending on the nature of the surface and the contaminants, except that it shall not include the use of abrasives other than a paste of pure magnesium oxide nor of solvents which are corrosive or will deposit either corrosive or protective films. The use of a nitric acid solution for the chemical cleaning, or passivation, of stainless steel specimens is permissible when agreed upon by the purchaser and the seller. Care shall be taken that specimens are not recontaminated after cleaning by excessive or careless handling.

4.2 Specimens for evaluation of paints and other organic coatings shall be prepared in accordance with applicable specification(s) for the material(s) being tested, or as agreed upon by the purchaser and supplier. Otherwise, the test specimens shall consist of steel meeting the requirements of ASTM Methods D 609 for Preparation of Steel Panels for Testing

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[1] This method is under the jurisdiction of ASTM Committee G-1 on Corrosion of Metals, and is the direct responsibility of Subcommittee G01.05 on Laboratory Corrosion Tests.

Current edition approved March 29, 1973. Published June 1973. Originally published as B 117 - 39 T. Last previous edition B 117 64.

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Paint, Varnish, Lacquer, and Related Products,[7] and shall be cleaned and prepared for coating in accordance with applicable procedure of Method D 609.

4.3 Specimens coated with paints or nonmetallic coatings shall not be cleaned or handled excessively prior to test.

4.4 Whenever it is desired to determine the development of corrosion from an abraded area in the paint or organic coating, a scratch or scribed line shall be made through the coating with a sharp instrument so as to expose the underlying metal before testing. The conditions of making the scratch shall be as defined in ASTM Method D 1654, Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments,[8] unless otherwise agreed upon between the purchaser and seller.

4.5 Unless otherwise specified, the cut edges of plated, coated, or duplex materials and areas containing identification marks or in contact with the racks or supports shall be protected with a suitable coating stable under the conditions of the test, such as ceresin wax.

NOTE 2—Should it be desirable to cut test specimens from parts or from preplated, painted, or otherwise coated steel sheet, the cut edges shall be protected by coating them with paint, wax, tape, or other effective media so that the development of a galvanic effect between such edges and the adjacent plated or otherwise coated metal surfaces, is prevented.

5. Position of Specimens During Test

5.1 The position of the specimens in the salt spray chamber during the test shall be such that the following conditions are met:

5.1.1 Unless otherwise specified, the specimens shall be supported or suspended between 15 and 30 deg from the vertical and preferably parallel to the principal direction of horizontal flow of fog through the chamber, based upon the dominant surface being tested.

5.1.2 The specimens shall not contact each other or any metallic material or any material capable of acting as a wick.

5.1.3 Each specimen shall be so placed as to permit free settling of fog on all specimens.

5.1.4 Salt solution from one specimen shall not drip on any other specimen.

NOTE 3—Suitable materials for the construction or coating of racks and supports are glass, rubber, plastic, or suitably coated wood. Bare metal shall not be used. Specimens shall preferably be supported from the bottom or the side. Slotted wooden strips are suitable for the support of flat panels. Suspension from glass hooks or waxed string may be used as long as the specified position of the specimens is obtained, if necessary by means of secondary support at the bottom of the specimens.

6. Salt Solution

6.1 The salt solution shall be prepared by dissolving 5 ± 1 parts by weight of sodium chloride in 95 parts of distilled water or water containing not more than 200 ppm of total solids. The salt used shall be sodium chloride substantially free of nickel and copper and containing on the dry basis not more than 0.1 percent of sodium iodide and not more than 0.3 percent of total impurities. Some salts contain additives that may act as corrosion inhibitors; careful attention should be given to the chemical content of the salt. By agreement between purchaser and seller, analysis may be required and limits established for elements or compounds not specified in the chemical composition given above.

6.2 The pH of the salt solution shall be such that when atomized at 35 C (95 F) the collected solution will be in the pH range of 6.5 to 7.2 (Note 4). Before the solution is atomized it shall be free of suspended solids (Note 5). The pH measurement shall be made electrometrically at 25 C (77 F) using a glass electrode with a saturated potassium chloride bridge in accordance with Method E 70, Test for pH of Aqueous Solutions with the Glass Electrode[9]; or colorimetrically using bromothymol blue as indicator, or short range pH paper which reads in 0.2 or 0.3 of a pH unit (Note 6).

NOTE 4—Temperature affects the pH of a salt solution prepared from water saturated with carbon dioxide at room temperature and pH adjustment may be made by the following three methods:

(1) When the pH of a salt solution is adjusted at room temperature, and atomized at 35 C (95 F), the pH of the collected solution will be higher than the original solution due to the loss of carbon dioxide at the higher temperature. When the pH of the salt solution is adjusted at room temperature, it is therefore necessary to adjust it below 6.5 so the collected solution after atomizing at 35 C (95 F) will meet the pH limits of 6.5 to 7.2. Take about a 50-ml sample of the salt solution as prepared at room temperature, boil gently for 30 s, cool, and determine the pH. When the pH of the salt solution is adjusted to 6.5 to 7.2 by this procedure, the pH of the atomized and collected solution at 35 C (95 F) will come within this range.

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[8] *Annual Book of ASTM Standards*, Part 27.

[9] *Annual Book of ASTM Standards*, Parts 22, 30, and 41.

(*2*) Heating the salt solution to boiling and cooling to 95 F or maintaining it at 95 F for approximately 48 h before adjusting the pH produces a solution the pH of which does not materially change when atomized at 35 C (95 F).

(*3*) Heating the water from which the salt solution is prepared to 35 C (95 F) or above, to expel carbon dioxide, and adjusting the pH of the salt solution within the limits of 6.5 to 7.2 produces a solution the pH of which does not materially change when atomized at 35 C (95 F).

NOTE 5—The freshly prepared salt solution may be filtered or decanted before it is placed in the reservoir, or the end of the tube leading from the solution to the atomizer may be covered with a double layer of cheesecloth to prevent plugging of the nozzle.

NOTE 6—The pH can be adjusted by additions of dilute cp hydrochloric acid or cp sodium hydroxide solutions.

7. Air Supply

7.1 The compressed air supply to the nozzle or nozzles for atomizing the salt solution shall be free of oil and dirt (Note 7) and maintained between 69 and 172 kN/m^2 (10 and 25 psi) (Note 8).

NOTE 7—The air supply may be freed from oil and dirt by passing it through a water scrubber or at least 610 mm (2 ft) of suitable cleaning material such as asbestos, sheep's wool, excelsior, slag wool, or activated[4] alumina.

NOTE 8—Atomizing nozzles may have a "critical pressure" at which an abnormal increase in the corrosiveness of the salt fog occurs. If the "critical pressure" of a nozzle has not been established with certainty, control of fluctuation in the air pressure within plus or minus 0.7 kN/m^2 (0.1 psi), by installation of a suitable pressure regulator valve[5] minimizes the possibility that the nozzle will be operated at its "critical pressure."[6]

8. Conditions in the Salt Spray Chamber

8.1 *Temperature*—The exposure zone of the salt spray chamber shall be maintained at 35 + 1.1 − 1.7 C (95 + 2 − 3 F). The temperature within the exposure zone of the closed cabinet shall be recorded at least twice a day at least 7 h apart (except on Saturdays, Sundays, and holidays when the salt spray test is not interrupted for exposing, rearranging, or removing test specimens or to check and replenish the solution in the reservoir).

NOTE 9—A suitable method to record the temperature is by a continuous recording device or by a thermometer which can be read from outside the closed cabinet. The recorded temperature must be obtained with the salt spray chamber closed to avoid a false low reading because of wet-bulb effect when the chamber is open.

8.2 *Atomization and Quantity of Fog*—At least two clean fog collectors shall be so placed within the exposure zone that no drops of solution from the test specimens or any other source shall be collected. The collectors shall be placed in the proximity of the test specimens, one nearest to any nozzle and the other farthest from all nozzles. The fog shall be such that for each 80 cm^2 of horizontal collecting area there will be collected in each collector from 1.0 to 2.0 ml of solution per hour based on an average run of at least 16 h (Note 10). The sodium chloride concentration of the collected solution shall be 5 ± 1 weight percent (Note 11). The pH of the collected solution shall be 6.5 to 7.2. The pH measurement shall be made electrometrically or colorimetrically using bromothymol blue as the indicator.

NOTE 10—Suitable collecting devices are glass funnels with the stems inserted through stoppers into graduated cylinders, or crystallizing dishes. Funnels and dishes with a diameter of 10 cm have an area of about 80 cm^2.

NOTE 11—A solution having a specific gravity of 1.0255 to 1.0400 at 25 C (77 F) will meet the concentration requirement. The concentration may also be determined as follows: Dilute 5 ml of the collected solution to 100 ml with distilled water and mix thoroughly; pipet a 10-ml aliquot into an evaporating dish or casserole; add 40 ml of distilled water and 1 ml of 1 percent potassium chromate solution (chloride-free) and titrate with 0.1 N silver nitrate solution to the first appearance of a permanent red coloration. A solution that requires between 3.4 and 5.1 ml of 0.1 N silver nitrate solution will meet the concentration requirements.

8.3 The nozzle or nozzles shall be so directed or baffled that none of the spray can impinge directly on the test specimens.

9. Continuity of Test

9.1 Unless otherwise specified in the specifications covering the material or product being tested, the test shall be continuous for the duration of the entire test period. Continuous operation implies that the chamber be

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[4] Registered U. S. Patent Office.

[5] The Nullmatic pressure regulator (or equivalent) manufactured by Moore Products Co., H and Lycoming Sts., Philadelphia, Pa. 19124, is suitable for this purpose.

[6] It has been observed that periodic fluctuations in air pressure of ±3.4 kN/m^2 (0.5 psi) resulted in about a twofold increase in the corrosivity of the fog from a nozzle which was being operated at an average pressure of 110 kN/m^2 (16 psi). Controlling the fluctuations within ±0.7 kN/m^2 (0.1 psi), however, avoided any increase in the corrosivity of the salt fog. See Darsey, V. M. and Cavenagh, W. R., "Apparatus and Factors in Salt Fog Testing," *Proceedings*, ASTEA, Am. Soc. Testing Mats., Vol. 48, 1948, p. 153.

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closed and the spray operating continuously except for the short daily interruptions necessary to inspect, rearrange, or remove test specimens; to check and replenish the solution in the reservoir, and to make necessary recordings as described in Section 8. Operations shall be so scheduled that these interruptions are held to a minimum.

10. Period of Test

10.1 The period of test shall be as designated by the specifications covering the material or product being tested or as mutually agreed upon by the purchaser and the seller.

NOTE 12 – Recommended exposure periods are to be as agreed upon by the purchaser and seller, but exposure periods of multiples of 24 h are suggested.

11. Cleaning of Tested Specimens

11.1 Unless otherwise specified in the specifications covering the material or product being tested, specimens shall be treated as follows at the end of the test:

11.1.1 The specimens shall be carefully removed.

11.1.2 Specimens may be gently washed or dipped in clean running water not warmer than 38 C (100 F) to remove salt deposits from their surface, and then immediately dried. Drying shall be accomplished with a stream of clean, compressed air.

12. Evaluation of Results

12.1 A careful and immediate examination shall be made for the extent of corrosion of the dry test specimens or for other failure as required by the specifications covering the material or product being tested or by agreement between the purchaser and the seller.

13. Records and Reports

13.1 The following information shall be recorded, unless otherwise prescribed in the specifications covering the material or product being tested:

13.1.1 Type of salt and water used in preparing the salt solution,

13.1.2 All readings of temperature within the exposure zone of the chamber,

13.1.3 Daily records of data obtained from each fog-collecting device including the following:

13.1.3.1 Volume of salt solution collected in milliliters per hour per 80 cm^2,

13.1.3.2 Concentration or specific gravity at 35 C (95 F) of solution collected, and

13.1.3.3 pH of collected solution.

13.4 Type of specimen and its dimensions, or number or description of part,

13.5 Method of cleaning specimens before and after testing,

13.6 Method of supporting or suspending article in the salt spray chamber,

13.7 Description of protection used as required in 4.5,

13.8 Exposure period,

13.9 Interruptions in test, cause and length of time, and

13.10 Results of all inspections.

NOTE 13—If any of the atomized salt solution which has not contacted the test specimens is returned to the reservoir, it is advisable to record the concentration or specific gravity of this solution also.

APPENDIXES

A1. CONSTRUCTION OF APPARATUS

A1.1 Cabinets

A1.1.1 Standard salt-spray cabinets are available from several suppliers, but certain pertinent accessories are required before they will function according to this method and provide consistent control for duplication of results.

A1.1.2 The salt spray cabinet consists of the basic chamber, an air-saturator tower, a salt solution reservoir, atomizing nozzles, specimen supports, provisions for heating the chamber, and suitable controls for maintaining the desired temperature.

A1.1.3 Accessories such as a suitable adjustable baffle or central fog tower, automatic level control for the salt reservoir, and automatic level control for the air-saturator tower are pertinent parts of the apparatus.

A1.1.4 The cabinet should be of sufficient size to test adequately the desired number of parts without overcrowding. Small cabinets have been found difficult to control and those of less than 0.43-m^3 (15-ft^3) capacity should be avoided.

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A1.1.5 The chamber may be made of inert materials such as plastic, glass, or stone, but most preferably is constructed of metal and lined with impervious plastics, rubber, or epoxy-type materials or equivalent.

A1.2 Temperature Control

A1.2.1 The maintenance of temperature within the salt chamber can be accomplished by several methods. It is generally desirable to control the temperature of the surroundings of the salt spray chamber and to maintain it as stable as possible. This may be accomplished by placing the apparatus in a constant-temperature room, but may also be achieved by surrounding the basic chamber of a jacket containing water or air at a controlled temperature.

A1.2.2 The use of immersion heaters in an internal salt-solution reservoir or of heaters within the chamber is detrimental where heat losses are appreciable, because of solution evaporation and radiant heat on the specimens.

A1.2.3 All piping which contacts the salt solution or spray should be of inert materials such as plastic. Vent piping should be of sufficient size so that a minimum of back pressure exists and should be installed so that no solution is trapped. The exposed end of the vent pipe should be shielded from extreme air currents that may cause fluctuation of pressure or vacuum in the cabinet.

A1.3 Spray Nozzles

A1.3.1 Satisfactory nozzles may be made of hard rubber, plastic, or other inert materials. The most commonly used type is made of plastic. Nozzles calibrated for air consumption and solution atomized are available. The operating characteristics of a typical nozzle are given in Table A1.

A1.3.2 It can readily be seen that air consumption is relatively stable at the pressures normally used, but a marked reduction in solution sprayed occurs if the level of the solution is allowed to drop appreciably during the test. Thus, the level of the solution in the salt reservoir must be maintained automatically to ensure uniform fog delivery during the test.[7]

A1.3.3 If the nozzle selected does not atomize the salt solution into uniform droplets, it will be necessary to direct the spray at a baffle or wall to pick up the larger drops and prevent them from impinging on the test specimens. Pending a complete understanding of air-pressure effects, etc., it is important that the nozzle selected shall produce the desired condition when operated at the air pressure selected. Nozzles are not necessarily located at one end, but may be placed in the center and can also be directed vertically up through a suitable tower.

A1.4 Air for Atomization

A1.4.1 The air used for atomization must be free of grease, oil, and dirt before use by passing through well-maintained filters. Room air may be compressed, heated, humidified, and washed in a water-sealed rotary pump, if the temperature of the water is suitably controlled. Otherwise cleaned air may be introduced into the bottom of a tower filled with water, through a porous stone or multiple nozzles. The level of the water must be maintained automatically to ensure adequate humidification. A chamber operated according to this method and Appendix will have a relative humidity between 95 and 98 percent. Since salt solutions from 2 to 6 percent will give the same results (though for uniformity the limits are set at 4 to 6 percent), it is preferable to saturate the air at temperatures well above the chamber temperature as insurance of a wet fog. Table A2 shows the temperatures, at different pressures, that are required to offset the cooling effect of expansion to atmospheric pressure.

A1.4.2 Experience has shown that most uniform spray chamber atmospheres are obtained by increasing the atomizing air temperature sufficiently to offset heat losses, except those that can be replaced otherwise at very low-temperature gradients.

A1.5 Types of Construction

A1.5.1 A modern laboratory cabinet is shown in Fig. A1. Walk-in chambers are not usually constructed with a sloping ceiling due to their size and location. Suitably located and directed spray nozzles avoid ceiling accumulation and drip. Nozzles may be located at the ceiling, or 0.91 m (3 ft) from the floor directed upward at 30 to 60 deg over a passageway. The number of nozzles depends on type and capacity and is related to the area of the test space. A 11 to 19-dm^3 (3 to 5-gal) reservoir is required within the chamber, with the level controlled. The major features of a walk-in type cabinet, which differs significantly from the laboratory type, are illustrated in Fig. A2. Construction of a plastic nozzle, such as is furnished by several suppliers, is shown in Fig. A3.

A2. Use of the Salt Spray (Fog) Test in Research

A2.1 The detailed requirements of this method are primarily for quality acceptance and should not be construed as the optimum conditions for research studies. The test has been used to a considerable extent for the purpose of comparing different materials or finishes with an acceptable standard. The recent elimination of many cabinet variables and the improvement in controls have made the three ASTM Salt Spray Tests: Method B 117, Method B 287, Acetic Acid-Salt Spray (Fog) Testing,[8] and Method B 368, for Copper-Accelerated Acetic Acid-Salt Spray (Fog) Testing (CASS),[9] into useful tools for many industrial and military production

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[7] A suitable device for maintaining the level of liquid in, either the saturator tower, or reservoir of test solution may be designed by a local engineering group, or may be purchased from manufacturers of test cabinets as an accessory.

[8] *Annual Book of ASTM Standards*, Parts 9, 10, and 27.

[9] *Annual Book of ASTM Standards*, Parts 9 and 27.

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and qualification programs.

A2.2 The test has been used to a considerable extent for the purpose of comparing different materials or finishes. It should be noted that there is seldom a direct relation between salt spray (fog) resistance and resistance to corrosion in other media, because the chemistry of the reactions, including the formation of films and their protective value, frequently varies greatly with the precise conditions encountered. Informed personnel are aware of the erratic composition of basic alloys, the possibility of wide variations in quality and thickness of plated items produced on the same racks at the same time, and the consequent need for a mathematical determination of the number of specimens required to constitute an adequate sample for test purposes. In this connection it is well to point out that Method B 117 is not applicable to the study or testing of decorative chromium plate (nickel-chromium or copper-nickel-chromium on steel or on zinc-base die castings or of cadmium plate on steel. For this purpose Methods B 287 and B 368 are available, which are also considered by some to be superior for comparison of chemically-treated aluminum (chromated, phosphated, or anodized), although final conclusions regarding the validity of test results related to service experience have not been reached. Method B 117 is considered to be most useful in estimating the relative behavior of closely related materials in marine atmospheres, since it simulates the basic conditions with some acceleration due to either wetness or temperature or both.

A2.3 When a test is used for research, it may prove advantageous to operate with a different solution composition or concentration or at a different temperature. In all cases, however, it is desirable to control the temperature and humidity in the manner specified, and to make certain that the composition of the settled fog and that of the solution in the reservoir are substantially the same. Where differences develop, it is necessary to control conditions so that the characteristics of the settled fog meet the specified requirements for the atmosphere.

A2.4 Material specifications should always be written in terms of the standard requirements of the appropriate salt-spray method, thereby making it possible to test a variety of materials from different sources in the same equipment.

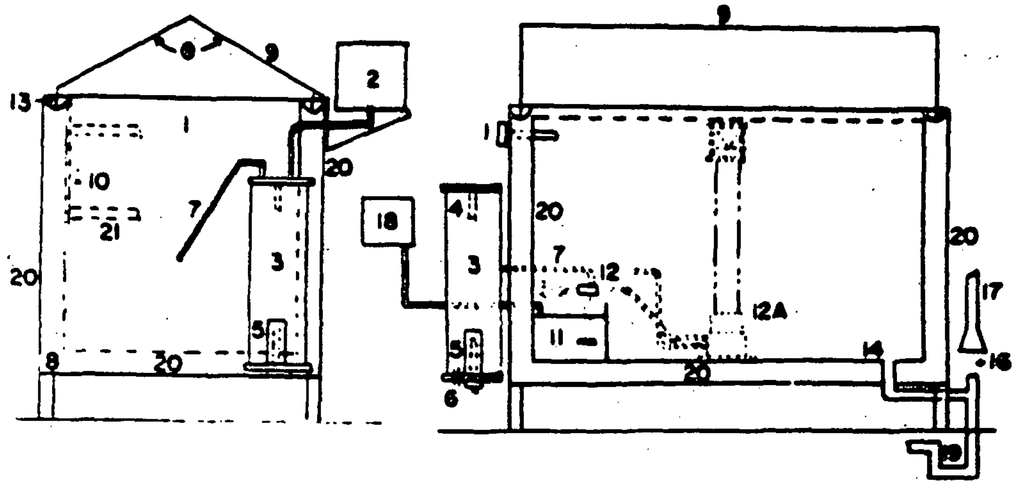
TABLE A1 Operating Characteristics of Typical Spray Nozzle

Siphon Height, in.	Air Flow, liters min				Solution Consumption, ml h			
	Air Pressure, psi				Air Pressure, psi			
	5	10	15	20	5	10	15	20
4	19	26.5	31.5	36	2100	3840	4584	5256
8	19	26.5	31.5	36	636	2760	3720	4320
12	19	26.5	31.5	36	0	1380	3000	3710
16	19	26.6	31.5	36	0	780	2124	2904

Siphon Height cm	Air Flow, dm³/min				Solution Consumption, cm³/h			
	Air Pressure, kN/m²				Air Pressure, kN/m²			
	34	69	103	138	34	69	103	138
10	19	26.5	31.5	36	2100	3840	4584	5256
20	19	26.5	31.5	36	636	2760	3720	4320
30	19	26.5	31.5	36	0	1380	3000	3710
40	19	26.6	31.5	36	0	780	2124	2904

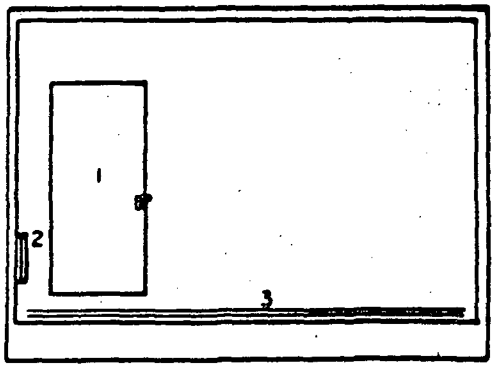
TABLE A2 Temperature and Pressure Requirements for Operation of Test at 95 F

	Air Pressure, psi			
	12	14	16	18
Temperature, deg F	114	117	119	121
	Air Pressure, kN/m²			
	83	96	110	124
Temperature, deg C	46	47	48	49



θ -- Angle of lid, 90 to 125 deg
1 — Thermometer and thermostat for controlling heater (Item No. 8) in base
2 — Automatic water levelling device
3 — Humidifying tower
4 — Automatic temperature regulator for controlling heater (Item No. 5)
5 — Immersion heater, non-rusting
6 — Air inlet, multiple openings
7 Air tube to spray nozzle
8 -- Strip heater in base
9 — Hinged top, hydraulically operated, or counterbalanced
10 — Brackets for rods supporting specimens, or test table
11 — Internal reservoir
12 - Spray nozzle above reservoir, suitably designed, located, and baffled
12A — Spray nozzle housed in dispersion tower located preferably in center of cabinet
13 — Water Seal
14 — Combination drain and exhaust. Exhaust at opposite side of test space from spray nozzle (Item 12), but preferably in combination with drain, waste trap, and forced draft waste pipe (Items 16, 17, and 19).
16 — Complete separation between forced draft waste pipe (Item 17) and combination drain and exhaust (Items 14 and 19) to avoid undesirable suction or back pressure.
17 — Forced draft waste pipe.
18 — Automatic levelling device for reservoir
19 -- Waste trap
20 -- Air space or water jacket
21 — Test table or rack, well below roof area

FIG. A1 Typical Salt Spray Cabinet.



NOTE—The controls are the same, in general as for the laboratory cabinet (Fig. A1), but are sized to care for the larger cube. The chamber has the following features:

(1) Heavy insulation,

(2) Refrigeration door with drip rail, or pressure door with drip rail, inward-sloping sill,

(3) Low-temperature auxiliary heater, and

(4) Duck boards on floor, with floor sloped to combination drain and air exhaust.

FIG. A2 Walk-in Chamber, 1.5 by 2.4 m (5 by 8 ft) and Upward in Over-all Size.

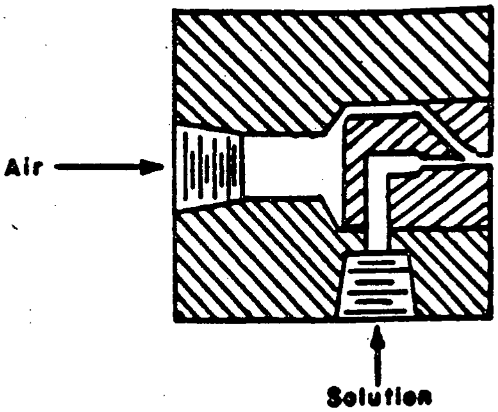


FIG. A3 Typical Spray Nozzle.

1.11.15

MIL–C–675A
6 JANUARY 1964

SUPERSEDING
JAN–F–675
17 SEPTEMBER 1948

MILITARY SPECIFICATION

COATING OF GLASS OPTICAL ELEMENTS (ANTI-REFLECTION)

This specification has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force.

1. SCOPE

1.1 This specification covers the application and tests of magnesium fluoride coating (hereinafter referred to as film) having a wavelength between 450 millimicrons and 600 millimicrons (see 6.1).

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

QQ–M–151 —Metals, General Specifications for

MILITARY

JAN–M–621 —Magnesium Fluoride (Optical Use)

MIL–E–12397 —Eraser, Rubber-Pumice for Testing Coated Optical Elements

MIL–O–13830 —Optical Components for the Fire Control Instruments; General Specification Governing the Manufacture Assembly and Inspection of

MIL–I–45208 —Inspection Requirements, General Specification for

STANDARDS

MILITARY

MIL–STD–105 —Sampling Procedure and Tables for Inspection by Attributes

MIL–STD–1241 —Optical, Terms and Definitions

DRAWINGS

U.S. ARMY MUNITIONS COMMAND

C7641866 —Surface Quality Comparison Standards

D7680600 —Optical Coating Standard

D7680606 —Coating, Eraser Abrasion Tester

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Material. The material used for the film shall be magnesium fluoride in accordance with Specification JAN–M–621.

3.2 Coating process. The coating process used to apply the film shall not cause impairment of the optical surface which would cause rejection of the optical element when inspected in accordance with Specification MIL–O–13830.

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Incl 5

3.3 Light absorption. There shall be no more than 0.5 percent light absorption allowed within the wavelength range from 440 to 650 millimicrons when tested as specified in 4.6.2.

3.4 Film thickness. The optical thickness of the film on each treated surface shall be more than a 0.25 wavelength of light having a wavelength of 450 millimicrons but less than 0.25 wavelength of light having a wavelength of 600 millimicrons, when inspected as specified in 4.6.3.

3.5 Color range. When white light strikes the coated surface at any angle of incidence from 0 to 30 degrees, the rays reflected from the coated surface shall appear yellow-red yellow from films having the minimum permissible optical thickness (0.25 wavelength of 450 millimicrons) and purple-blue from film having the maximum permissable optical thickness (0.25 wavelength of 600 millimicrons) when tested as specified in 4.6.3.

3.5.1 *Color variations.* Color variations over a coated surface shall be allowed provided they are within the color range specified in 3.5. Films on elements having severely curved surfaces shall be acceptable provided the thickness and colors at the central areas are within 500 to 560 millimicrons range even though the total color range from centers to peripheries are not within the 450 to 600 millimicron range. The central area shall be considered that area that has a projected diameter equal to 85 percent of the radius of curvature on the surface.

3.6 Reflectance.

3.6.1 *Position of minimum point.* The minimum point on the spectrophotometric curve of a reflectance for each coated surface shall lie between the wavelength limits of 450 and 600 millimicrons.

3.6.2 *Reflectance at the minimum point.* The magnitude of the specular reflectance at the minimum point on the spectrophotometric curve of reflectance of each coated surface shall not exceed the following value:

TABLE I

Index of refraction of glass	Maximum percent reflectance
1.51	1.6
1.52	1.5
1.54	1.4
1.58	1.2
1.61	1.0
1.62	0.9
1.65	0.8
1.70	0.6

3.6.3 *Reflectance at limits.* The specular reflectance of each coated surface at the wavelengths of 450 and 600 millimicrons shall not exceed the values in the following table:

TABLE II

Index of refraction of glass	Maximum percent reflectance	
	450 millimicrons	600 millimicrons
1.51	2.5	2.1
1.52	2.5	2.0
1.54	2.5	1.9
1.58	2.5	1.8
1.61	2.5	1.7
1.62	2.5	1.7
1.65	2.5	1.7
1.70	2.5	1.6

3.7 Coated area. Each optical element shall be coated over its entire effective aperture except that coating closer than 3/4 millimeter to an edge of an element shall not be required. Unless otherwise specified, areas outside the effective aperture may be coated at the discretion of the contractor.

3.7.1 *Cemented surfaces.* A glass surface or portion thereof which is to be cemented to another glass surface or portion thereof shall not be coated on the area to be cemented. A film on such a surface shall be cause for rejection of the element.

3.8 *Surface quality.* Films shall be sensibly free from holes, solid particles of the coating material and other imperfections arising from dust and dirt or stained glass sufaces beneath the film.

3.9 Durability.

3.9.1 *Solubility.* There shall be no visible evidence of film destruction after being subjected to the solubility test specified in 4.6.8.

3.9.2 *Humidity.* There shall be no visible evidence of film deterioration after being subjected to the conditions specified in 4.6.9.

3.9.3 *Salt spray fog.* There shall be no visible evidence of film deterioration after the coated optical element has been subjected to the salt spray fog specified in 4.6.10 for a continuous period of 24 hours.

3.9.4 *Abrasion resistence.* There shall be no visible damage to the rubbed area of a coated surface after being subjected to the abrasion resistance test specified in 4.6.11.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 General requirements. Except where otherwise specified herein, the contractor's inspection system shall be in accordance with Specification MIL–I–45208.

4.3 Lot formation. When inspection lot sizes and lot formations are applicable, they shall be in accordance with Standard MIL–STD–105 and shall also be defined in the contractor's inspection system.

4.3.1 *Defective units and lots.* Defective units and lots shall be processed as specified in Standard MIL–STD–105 and shall not be included as a part of the quantity specified in the contract until formal approval is obtained.

4.4 Inspection provisions. Components coated with magnesium fluoride shall be examined in accordance with the inspection provisions contained in Specification MIL–O–13830 and 4.4.1 herein. Test and control of materials not covered by Supplementary Quality Assurance Provisions (SQAP's) shall be in accordance with "Test Data" provisions of Specification MIL–I–45208. Inspection related to Section 3 of this specification shall be performed in accordance with 4.4.1. The control sampling specified herein shall constitute the minimum inspection to be performed by the contractor prior to Government acceptance. The Government reserves the right to inspect for any applicable requirement, and to reject individual nonconforming items.

4.4.1 *Control inspection.* The first 25 coated elements produced, and 5 selected at random from every 100 subsequently produced (or from each month's production, whichever occurs first) shall represent the control samples for control inspection. Control samples shall be subjected to the examinations and tests specified herein to determine compliance with all requirements specified in section 3. The examinations and tests shall be conducted by the contractor under surveillance of the Government representative at the contractor's facility or Government approved laboratory, using test equipment authorized for use by the contract, or otherwise approved by the contracting officer.

4.4.1.1 *Control sample failure.* Should a control sample fail to meet the requirements specified in 4.4.1, the contractor shall cease those operations causing rejection until necessary corrections have been made by the contractor and approved by the Government. When production has resumed, inspection of those requirements that have previously caused rejection shall be performed on a 100 percent basis until 25 consecutively produced coated elements meet these requirements. When this is accomplished, control inspection (4.4.1) may be continued.

4.5 Inspection equipment. Supply, calibration, maintenance and use of inspection equipment shall be in accordance with Specification MIL-I-45208. The Government reserves the right to use all approved test equipment, both Government furnished and contractor acquired, for verification inspection.

4.5.1 *Equipment to perform durability test.* The standard Test Equipment Drawing D7680606 Coating Tester used for testing the durability of the film or coating deposited on the optical elements is the hand held type, which can be used on all optical elements curved or flat, i.e., lenses, prisms or reflectors. The device shall be equipped with an eraser that shall comply to Military Specification MIL-E-12397 and shall be used as described in 4.6.11.

The Abrasion Resistance Instrument (fig. 1.) illustrated is one of several types, commercially available, that will test the durability of the film or coating deposited on flat optical elements. The rubbing arm is adjustable on a rotating disk and is adjustable to various diameters. A rubbing pad on the arm is rotated at 100 rpm with a total weight of 1.5 to 1.6 P.S.I., and shall be used as described in 4.6.11.

4.6 Test methods and procedures.

4.6.1 *Coating process and surface quality.* A visual inspection shall be made at the completion of each coating process. A comparison shall be made using the surface quality scratch and dig Standard C7641866 of the film only, any imperfections in the glass shall not be considered by this inspection. This has been performed with Specification Standard MIL-O-13830. There shall not be more than the allowable scratches or digs in the central zone (what appears to be scratches or pin holes in the film usually are caused by dirt or lint left or deposited in the process) and they shall not exceed the allowable size designated as surface quality requirements on the element drawing and as required by 3.2 and 3.8 when checked with white light or equivalent.

4.6.2 *Light absorption* This inspection test shall be performed using a standard spectrophotometer. The specular reflectance and transmittance curves shall be obtained for the wavelength range required by 3.3 for samples coated on both sides. Plotted curves from uncoated samples will determine how much absorption of light the film has made. Absorption in films can be computed as illustrated:

A (Percent) = 100 − R (Percent) + T (Percent) = Glass Absorption (Percent)
(R) = Specular Reflectance
(T) = Specular Transmittance
(A) = Light Losses Due to Film

One half of the result of (A) is absorption per coated surface

4.6.3 *Film thickness and color range.* A visual inspection of the film or coating shall be made to determine compliance with 3.4 and 3.5. Using an optical coating comparison Standard D7680600 and a fluorescent lamp (white) positioned so that both the sample and the color standard are reflecting the image of the fluorescent tube. The sample can then be compared to each of the lenses in the standard for the acceptable range, a variance of color over the coated area is permissible as long as it is within the range and area specified in 3.5.1.

4.6.4 *Position and reflectance of minimum point.* This test shall be mandatory when the optical coating comparison standard is not available. The inspection shall be made with the aid of a standard spectrophotometer by plotting a typical reflectance curve from the samples selected. The curve shall indicate the minimum point position specified for the wavelengths specified in 3.6.1. In case of discrepancy 4.6.4 takes precedence over 4.6.3. The reflectance at the minimum point shall match the tolerance at maximum percent reflectance for the index of refraction of the glass being inspected as required by table I.

4.6.5 *Reflectance limits.* The limits of reflectance will be inspected for each coated

[illegible]

surface with a standard spectrophotometer for the wavelengths specified in table II for the samples with the index listed. Reflectance shall not exceed the percentage factor listed under maximum percent reflectance column.

4.6.6 *Coated area.* A visual inspection shall be made of the coated area and the uncoated area of the element. The uncoated area usually at the extreme edge of the element shall not exceed the tolerance specified in 3.7. This uncoated area is caused by the holding adapter of the coating machine during process.

4.6.7 *Cemented surfaces.* A visual inspection shall be made of all elements to be cemented (crowns, flints, prisms, etc.) to a mating element. These elements shall not have coating material on the surface or surfaces to be cemented together. Coating material may prevent the adhesive from making the proper seizure and cause separation.

4.6.8 *Solubility.* The coated optical elements shall be immersed for a period of 24 hours in a solution of water and common table salt (sodium chloride). The mixture shall be 6 ounces of salt per gallon of water at room temperature. After the required period of time the samples shall be removed from the solution and dried with lens tissue or soft cloth, then visually inspected for deterioration or removal of the coating. The coating shall meet the requirements of 3.9.1.

4.6.9 *Humidity.* The coated optical elements shall be exposed for a period of 24 hours in a thermostatically controlled humidity chamber having a relative humidity of between 95 and 100 percent of 120° ± 4° F. The elements shall be removed from the chamber and dried with lens tissue or solft cloth, then visually inspected for deterioration or removal of the coating. The coating shall meet the requirements of 3.9.2.

4.6.10 *Salt spray (fog).* A visual inspection of the element shall be made of the coating after exposure to the salt spray test described in Specification QQ-M 151. The method as described, the equipmen and the time cycle are mandatory, and the elements must survive the test described in 4.6.11 and shall meet the requirements of 3.9.3.

4.6.11 *Abrasion resistance.* The coated optical elements shall be visually inspected for deterioration of removal of coating after being subjected to the following test:

> The coating or film shall be tested by holding a standard holding device in the hand and rubbing the coated surface with a standard eraser mounted in the holding device, Drawing D7680606. A force of approximately 2.0 to 2.5 pounds at a rotating speed of 100 revolutions per minute shall be applied. Strokes of about one inch shall be made if the size of the element will permit it, smaller strokes for smaller elements. All strokes shall be made on one path for 20 complete strokes. After the rubbing has been completed the element shall be cleaned and inspected visually in accordance with 3.9.4.
>
> An alternative method may be employed, if available. The abrasion resistance instrument Fig. I may be used in lieu of the hand rubbing method. The instrument uses a rubbing pad at the contact point using pure powdered magnesium fluoride as an abrasive agent. Some other instruments have replaced the rubbing pad with the holder and eraser to complete the required tests.

5. PREPARATION FOR DELIVERY

This section not applicable to this specification.

6. NOTES

6.1 **Intended use.** The film covered by the specification is applied to the surface of optical elements for reducing reflections and increasing light transmission.

6.2 **Definitions.** Words, terms and expressions used in this specification which are peculiar to the general field of optics are defined in MIL-STD-1241, Optical, Terms and Definitions.

6.3 Ordering data. Procurement documents should specify the following:

(a) Title, number and date of this specification.

(b) When areas outside the effective aperture are to be coated.

Custodians:
Army—MU
Navy—Ships
Air Force—MAA
Interest:
Review
MO, Sh, 67
User
MI, MC

Preparing activity:
Army—MU
Project No. 6650-0096

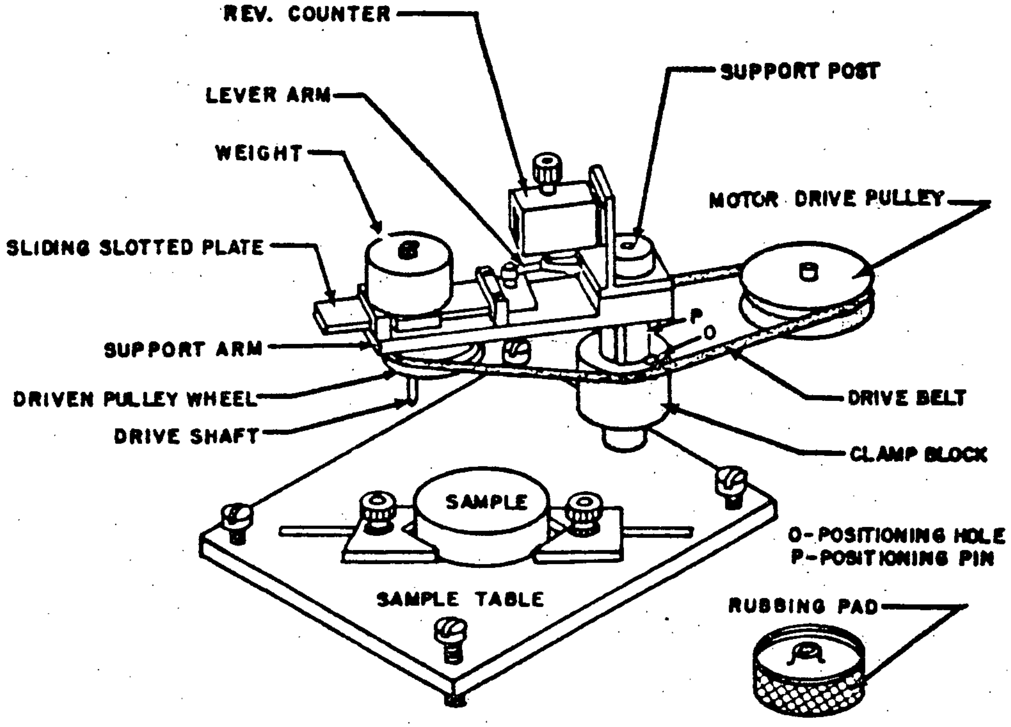

FIGURE 1. *Abrasion-resistance instrument.*

#-09-01

MIL-C-48497A
8 September 1980
SUPERSEDING
MIL-C-48497 (AR)
27 June 1974

MILITARY SPECIFICATION

COATING, SINGLE OR MULTILAYER, INTERFERENCE: DURABILITY REQUIREMENTS FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification establishes minimum quality and durability requirements for single layer and multilayer interference coatings that are primarily used within the protective confines of sealed optical systems. (See 6.1).

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

Federal

L-T-90	Tape, Pressure-Sensitive, Adhesive, (Cellophane and Cellulose Acetate)
O-A-51	Acetone, Technical
O-E-760	Ethyl Alcohol (ethanol), Denatured Alcohol, and Proprietary Solvent
O-T-634	Trichloroethylene, Technical
CCC-C-440	Cloth, Cheesecloth, Cotton Bleached and Unbleached

Military

MIL-E-12397	Eraser, Rubber Pumice, for Testing Coated Optical Elements
MIL-E-13830	Optical Components for Fire Control Instruments; General Specification Governing the Manufacture, Assembly and Inspection of
MIL-I-45607	Inspection Equipment, Acquisition, Maintenance and Disposition of

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document, should be addressed to: Commander, US Army Armament Research and Development Command, ATTN: DRDAR-TST-S, Dover, New Jersey 07801, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426), appearing at the end of this document, or by letter.

☆US GOVERNMENT PRINTING OFFICE 1980-703 023 4247

FSC 6650

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STANDARDS

Military

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-109	Quality Assurance Terms and Definitions
MIL-STD-1241	Optical Terms and Definitions

DRAWINGS

U. S. Army, Armament Research & Development Command

7641866	Surface Quality Standards for Optical Elements
7680606	Coating, Eraser Abrasion Tester

(Copies of specifications, standards, drawings and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Optical terms and definitions. Terms and definitions peculiar to the general field of optics as used herein are defined in MIL-STD-1241.

3.2 Coated area. Optical components shall be coated over their entire clear aperture.

3.3 Coating quality. The coating shall be uniform in quality and condition and shall conform to the following:

3.3.1 Physical. The coating shall have no evidence of flaking, peeling, cracking or blistering.

3.3.2 Cosmetic. When specified the coating shall conform to the cosmetic requirements (stains, smears, discolorations, streaks, cloudiness, etc.) stated on the component drawing or other documents.

3.3.3 Environmental and solubility blemishes. The coated surface shall be free of blemishes such as stains, smears, discolorations, streaks, cloudiness, etc., that would cause non-conformance to the coating's spectral requirements as stated on the component drawing or other documents.

3.3.4 Spatter and holes. Coating spatter and holes in the coating shall be considered as a dig and shall not exceed the allowable dig size and quantity stated on the componet drawing or other documents.

3.3.5 Surface defects (scratch and dig). Coating scratches and digs shall not exceed the values specified for the substrate on the component drawing or other documents. Coating scratches and digs shall be considered separate from the substrate scratch and dig requirements.

3.3.5.1 Transparent coated surfaces. Scratch and dig requirements for transparent coated surface shall be specified by two (2) numbers separated by a hyphen (i.e. 60-40) in accordance with MIL-O-13830.

3.3.5.2 Opaque coated surfaces. Scratch and dig requirements for opaque coated surfaces shall be specified by two letters separated by a hyphen (i.e. F-C). The first letter of the pair is the maximum scratch value; the second letter is the maximum dig value.

3.3.5.2.1 Scratches. The scratch letter defines the width of the scratch in accordance with the following table:

SCRATCH LETTER	SCRATCH WIDTH(MICRONS)	SCRATCH WIDTH (INCHES)
A	5	.00020
B	10	.00039
C	20	.00079
D	40	.00157
E	60	.00236
F	80	.00315
G	120	.00472

3.3.5.2.1.1 Density of maximum size scratches. The accumulated length of all maximum size scratches present shall not exceed 1/4 the average diameter of the coated surface.

3.3.5.2.1.2 Density of all scratches. When a maximum size scratch is present, the sum of the products of the widths designated by the scratch letters times the ratio of their length to the diameter of the coated surface shall not exceed one half the width specified by the scratch letter. When a maximum size scratch is not present, the sum of the products of the widths designated by the scratch letters times the ratio of their length to the diameter of the coated surface shall not exceed the width specified by the scratch letter.

3.3.5.2.2 Digs. The dig letter specifies the average diameter of the dig in accordance with the following table:

DIG LETTER	DIAMETER (MM)	DIAMETER (INCHES)
A	0.05	.0020
B	0.10	.0039
C	0.20	.0079
D	0.30	.0118
E	0.40	.0158
F	0.50	.0197
G	0.70	.0276
H	1.00	0.394

The permissible number of maximum size digs shall not exceed one per each 20 millimeters of (.80 inches) diameter or fraction thereof on any single coated surface. The sum of the diameters of all digs shall not exceed twice the diameter of the maximum size specified by the dig letter per 20 millimeters of diameter.

3.4 Coating durability.

3.4.1 Environmental and pyhsical durability. The coated optical surface shall meet the following service conditions in the order specified:

3.4.1.1 Adhesion. The coated optical surface shall show no evidence of coating removal when cellophane tape is pressed firmly against the coated surface and quickly removed at an angle normal the the coated surface.

3.4.1.2 Humidity. After exposure in an atmosphere of 120° ± 4°F and 95 to 100% relative humidity, the coated optical surface shall meet the requirements of 3.3.1 and 3.3.3.

3.4.1.3 Moderate abrasion. The coated optical surface shall show no signs of deterioration such as streaks or scratches when abraded with a dry, clean cheesecloth pad.

3.4.2 Thermal and cleaning durability. The coated optical surface shall meet the following conditions:

3.4.2.1 Temperature. The coated optical surface shall be exposed to temperatures of -80°F and +160°F for 2 hours at each temperature. The rate of temperature change shall not exceed 4°F per minute. Subsequent to these exposures, the coated optical surface shall meet the requirements of 3.3.1 and 3.4.1.1.

3.4.2.2 Solubility and cleanability. After immersion in trichloroethylene, acetone and ethyl alcohol and wiping with cheesecloth, the coated optical surface shall show no evidence of coating removal or scratches and shall meet the requirements of 3.3.1 and 3.3.3.

3.4.3 Optical durability requirements. When specified on the component drawing or other documents (See 6.2) the following requirements shall be added or substituted:

3.4.3.1 Severe abrasion. Abrasion by an eraser conforming to MIL-E-12397 shall not cause deterioration such as streaks or scratches on the coated optical surface.

3.4.3.2 Salt solubility. After immersion in a saline solution, the coated optical surafce shall meet the requirements of 3.3.1 and 3.3.3.

3.4.3.3 Water solubility. After immersion in distilled water, the coated surface shall meet the requirements of 3.3.1 and 3.3.3.

3.5 Optical. The coated component shall conform tothe pertinent optical requirements specified on the component drawing or other documents (See 6.2).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements (See 6.2).

4.1.1 General provisions. Definitions of inspections terms shall be as listed in MIL-STD-109.

4.1.2 Witness piece. Unless otherwise specified, witness pieces as defined in 4.1.3 or coated componets may be used to test the optical and durability requirements of the coated component. (See 4.2, 4.3 & 6.2). The witness pieces shall be positioned in the coating chamber such that they represent the optical and durability characteristics of the whole evaporated lot (See 6.4). The Government reserves the right to test the actual coated component with the same test to which the witness pieces were subjected. Should a component fail, even though the witness pieces pass the test, the lot shall be rejected.

4.1.3 Characteristics of the witness piece. When witness pieces are used to test the optical and durability requirements of the coated component they shall exhibit the following characteristics:

a. The witness piece shall have the same refractive index and absorption coeffecient as the componets to be coated.

b. The witness piece shall have a surface finish similar to that of the component to be coated.

c. The witness piece shall be such that it presents no difficulty in measuring and testing the optical and durability requirements of the coating.

d. Where transmission characteristics are required the witness piece shall simulate the axial thickness of the component by either computational methods or using a witness piece that has the same thickness as the coated component.

4.2 First article (initial production) approval. The requirement for first article approval and the responsibility (government or contractors) for first article testing shall be as specified in the contract. (See 6.2). Unless otherwise specified, the sample for first article approval tests shall consists of five (5) coated components plus ten (10) coated witness pieces (See 4.1.2 and 4.1.3). The 5 coated componets shall be tested, as specified herein, for all the requirements of 3.2, 3.3.1, 3.3.2, 3.3.4 and 3.3.5. Five coated witness pieces shall be tested, as specified herein, for all the requirements of 3.4.1 and 3.5. The other 5 coated witness pieces shall be tested as specified herein for all the requirements of 3.4.2 and 3.5. The government reserves the right to subject the coated components to all the tests specified here. The sample shall be coated in the same manner, using the same materials, equipment, processes, and procedures as used in regular production. All parts and materials including packaging shall be obtained from the same source of supply as used in regular production.

4.2.1 Government testing. When the Government is responsible for conducting first article approval tests, the contractor, prior to submitting the sample to the government, shall inspect the sample to insure that it conforms to all the requirements of the contract and submit a record of this inspection with the sample, including certificates of conformance for materials, as applicable.

4.2.2 Contractor testing. When the contactor is responsible for conducting first article approval tests, the sample shall be inspected by the contractor for all the requirements of the contract. The sample and a record of this inspection, including certificates of conformance for materials, shall be submitted to the government for approval. The government reserves the right to witness the contsactor's inspection.

4.3 Inspection provisions.

4.3.1 Submission of product.

4.3.1.1 Inspection lot size. The inspection lot size shall consist of all-components or subassemblies (unit of product) coated within one (8 hour or 10 hour) work shift.

4.3.1.2 Lot formation and presentation of lots. The unit of product shall be submitted for inspection on a moving inspection lot basis where the components or subassemblies are continuously offered for inspection in the order produced.

NOTE: Each evaporation lot forming a part of a moving inspection lot shall be identified for subsequent evaluation, if required.

4.3.2 Examination and tests.

4.3.2.1 Components and subassemblies. All coated componets and subassemblies shall be inspected in accordance with this specification and the inspection provisions contained in Supplementary Quality Assurance Provisions (SQAP) listed in the Technical Data Package (TDP). Examination and tests related to Section 3 herein shall be performed on a class basis in accordance with MIL-STD-105 and the sampling plans specified in Tables I and II herein. The tabulated classification of defects in Tables I and II shall constitute the minimum inspection to be performed by the supplier after first article approval and prior to Government acceptance or rejection by item or lot.

TABLE I - CLASSIFICATION OF DEFECTS FOR COMPONENTS

CLASS	CHARACTERISTIC	REQUIREMENT	TEST PROCEDURE
CRITICAL:	NONE DEFINED		
MAJOR:	AQL 1.0%		
101.	Coated area	3.2	4.5.1
102.	Coating quality, physical	3.3.1	4.5.2.1
103.	Coating quality, cosemtic	3.3.2	4.5.2.2
104.	Coating quality, spatter & holes	3.3.4	4.5.2.4
105.	Coating quality, scratch & dig	3.3.5	4.5.2.5
MINOR:	NONE DEFINED		

NOTE: The inspection for the characteristics in Table I shall be conducted at a temperature between +60°F and +90°F.

4.3.2.2 Acceptance and rejection. Rejected lots shall be screened for all defective characteristics. Removal of defective units and resubmittal or rejected lots shall be in accordance with "Acceptance and Rejection" as specified in MIL-STD-105.

4.3.2.3 Special sampling.

4.3.2.3.1 Environmental and physical durability. A minimum of one (1) coated witness piece (or one (1) coated component, when required) shall be selected from each evaporation lot to form a minimum of five (5) samples for each inspection lot. The samples shall meet the requirements and tests in Table II.

TABLE II - ENVIRONMENTAL & PHYSICAL DURABILITY

NO.	CHARACTERISTIC	REQUIREMENT	TEST PROCEDURE
301.	Adhesion	3.4.11	4.5.3.1
302.	Coating quality, physical (post humidity)	3.4.1.2, 3.3.1	4.5.3.2, 4.5.2.1
303.	Coating quality, blemishes (post humidity)	3.4.1.2, 3.3.3	4.5.3.2, 4.5.2.3
304.	Moderate abrasion	3.4.1.3	4.5.3.3
305.	Optical	3.5	4.5.6

NOTE: The inspection for the characteristics in Table II shall be conducted at a temperature between +60°F and +90°F.

4.3.2.3.2 Failure of sample. Should any one item of a special sampling fail to meet the specified test requirements, acceptance of the represented inspection lot shall be suspended by the Government until necessary corrections have been made by the contractor and the resubmitted items have been approved. (See 4.3.2.2).

4.4 Inspection equipment. Except as otherwise provided for by the contract, the contractor shall supply and maintain inspection equipment in accordance with the applicable requirements of MIL-I-45607.

4.4.1 Government furnished inspection equipment. Where the contract provides for Government furnished test equipment, supply and maintenance of test equipment shall be in accordance with applicable requirements specified in MIL-I-45607.

4.4.2 Contractor furnished inspection equipment.

4.4.2.1 Government design. All inspection equipment specified by drawing number in specifications or SQAP forming a part of the contract shall be supplied by the contractor in accordance with technical data included in the contract.

4.4.2.2 Contractor equipment. The contractor shall supply inspection equipment compatible with the "Test Methods and Procedures" specified in 4.5 of this specification. Since tolerance of test equipment is normally considered to be within 10% of the product tolerance for which it is intended, this inherent error in the test equipment must be considered as part of the prescribed product tolerance limit. Thus, concept, construction, materials, dimensions and tolerances used in the test equipment shall be so selected and controlled as to insure that the test equipment will reliably indicate acceptability of a product which does not exceed 90% of the prescribed tolerance limit, and permit positive rejection when non-conforming. Construction shall be such as to facilitate routine calibration of test equipment.

4.5 Test methods and procedures.

4.5.1 Coated area. The coated area of the component or subassembly shall be examined with standard measuring equipment (See 6.4). The coated area shall conform to the requirements of 3.2.

4.5.2 Coating quality.

4.5.2.1 Physical. The coating shall be visually examined by reflection, with the unaided eye, for evidence of flaking, peeling, cracking or blistering. The examination shall be performed using two 15 watt cool white fluorescent light tubes as the light source. The viewing distance from the coated surface to the eye shall not exceed 18 inches. The coated surface shall be viewed against a black matte background. The only illumination in the test area shall be from the light source used for testing. This method of examination is as depicted in Figure 1. The coating shall conform to the requirements of 3.3.1.

4.5.2.2 Cosmetic. The coated component shall be examined using the test method specified in 4.5.2.1 for evidence of discoloration, stains, smears, streaks, cloudiness, etc. The coating shall conform to the requirements of 3.3.2.

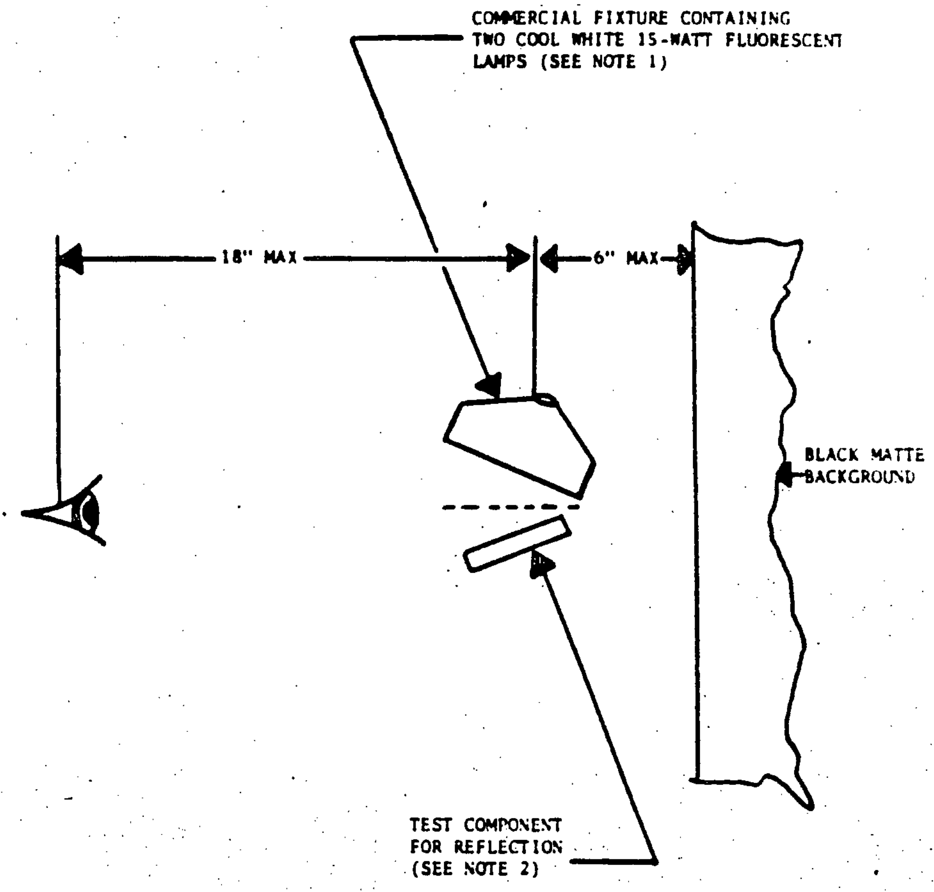
4.5.2.3 Environmental and solubility blemishes. The coated witness samples (or coated components, when required) shall be examined using the test method specified in 4.5.2.1 for evidence of discoloration, stains, smears, streaks, cloudiness, etc. The coating shall conform to the requirements of 3.3.3 When evidence of blemishes is found, the blemished area shall be examined (See 4.5.6) for compliance to the spectral requirements specified on the component drawing.

4.5.2.4 Spatter and holes. The coated components shall be examined for dig size and quantity using the applicable test method specified in 4.5.2.5. The coating shall conform to the requirements of 3.3.4.

4.5.2.5 Surface defects (scratch and dig).

4.5.2.5.1 Transparent coated surfaces. Transparent coated surfaces shall be examined utilizing the technique specified in 4.5.2.1, except that (hole) in the coating shall be evaluated by comparison with the Surface Quality Standards for Optical Elements (scratch & dig) Drawing 7641866. The visual appearance of the scratch, and the diameter of the digs in the coating shall conform to the requirements of 3.3.5.1. The lengths and density of all scratches, and the diameters and density of all digs shall conform to the requirements of MIL-O-13830.

4.5.2.5.2 Opaque coated surfaces. Opaque coated surfaces shall be examined utilizing the lumination, reflection and viewing background technique specified in 4.5.2.1. The length and width of scratches, and the dig (hole) diameters shall be determined by use of interferometry, microscopic measuring



NOTES:
1. THE ONLY ILLUMINATION IN THE TEST AREA SHALL BE FROM THE LIGHT SOURCE USED FOR TEST.
2. TILT AT AN APPROPRIATE ANGLE TO SEE THE COATED SURFACE.

FIGURE 1

devices, calibrated precision comparators, or similar applicable precision measuring devices. The width, length and density of all scratches in the coating shall conform to the requirements of 3.3.5.2. The diameter and density of all digs (holes) in the coating shall conform to the requirements of 3.3.5.2.

4.5.3 Environmental physical durability tests. The coated components or witness samples shall withstand exposure to the following test conditions:

4.5.3.1 Adhesion. The coated component or witness samples shall be subjected to an adhesion test using 1/2" wide cellophane tape conforming to Type I of L-T-90. Press the adhesive surface of the cellophane tape firmly against the coated surface and quickly remove at an angle normal to the coated surface. A visual inspection shall be made for conformance to 3.4.1.1. Subsequent to this test, the coated component or witness sample shall be subjected to the test of 4.5.3.2.

4.5.3.2 Humidity. The coated components or witness samples shall be placed into an environmentally controlled test chamber and exposed to a temperature of 120°F and 95% to 100% relative humidity. The coating shall be exposed for a minimum of 24 hours. Subsequent to this exposure, the coating shall be cleaned and evaluated for conformance to 3.3.1 and 3.3.3. The coated component or witness sample shall then be subjected to the test specified in 4.5.3.3.

4.5.3.3 Moderate abrasion. Within one hour after the humidity test of 4.5.3.2, the coated component or witness sample shall be subjected to a moderate abrasion test. It shall consist of rubbing a minimum of 50 strokes across the surface in straight lines. The abrader shall be a 1/4" thick by 3/8" wide pad of clean dry, laundered cheesecloth conforming to CCC-C-440. The bearing force shall be a minimum of 1 pound and shall be applied approximately normal to the coated surface. The actual test apparatus shall be the Eraser Abrasion Coating Tester of Drawing 7680606 except that the eraser portion shall be completely covered with cheesecloth and the cheesecloth shall be secured to the shaft of the tester with an elastic band. Subsequent to this test, the coating shall be evaluated for conformance to 3.4.1.3. Following the tests of 4.5.3.1, 4.5.3.2 and 4.5.3.3 the coated component or witness sample shall be evaluated for conformance to the provisions of 4.5.6.

4.5.4 Thermal and cleaning durability. The witness samples shall withstand exposure to the following test conditions:

4.5.4.1 Temperature. The witness samples shall be subjected to temperatures of -80°F ± 2°F and +160°F ±2°F for a period of 2 hours at each temperature. After each exposure the coated componets or witness samples shall be stabilized at an ambient temperature between +60° and +90°F and subjected to the test specified in 4.5.3.1. Subsequent to this test, the coating shall be evaluated for conformance to 3.4.1.3 and 3.3.1. The rate of temperature change between any two temperature levels shall not exceed 4°F per minute.

4.5.4.2 Solubility and cleanability. The witness samples shall be immersed, in sequence, in the following solutions maintained at room temperature (+60° to +90°F): trichloroethylene conforming to O-T-634; acetone conforming to O-A-51; and ethyl alcohol conforming to O-E-760. The immersion time in each solution shall be a minimum of ten minutes. Upon removal from each solution, the solvent shall be allowed to evaporate to dryness without wiping or forced drying before proceeding to the next solution. Upon removal from the alcohol solution, and after drying any resultant stains on the coated surface shall be removed by wiping the coating to a clean, stain-free condition with an ethyl-alcohol-mositened cheesecloth. Subsequent to this cleaning, the coating shall be evaluated for conformance to 3.4.2.2, 3.3.1, 3.3.3 and 3.5.

4.5.5 Optional durability tests. The coated componets or witness samples shall withstand exposure to the following test conditions when specified in the contract, purchase order or on the componet drawing. (See 6.2).

4.5.5.1 Severe abrasion. The coated componets or witness samples shall be subjected to a severe abrasion, rubbing the coated surface with a standard eraser conforming to MIL-E-12397 mounted in the Eraser Abrasion Coating Tester of Drawing 7680606. The bearing force shall be between 2 and 2 1/2 lbs. Applied approximately normal to the coated surface. A total of 20 strokes shall be made along a straight line path. Subsequent to this test the coating shall be evaluated for conformance to 3.4.3.1 and then subjected to the test specified in 4.5.3.

4.5.5.2 Salt solubility. The coated components or witness samples shall be immersed for a period of 24 hours in a solution of water and sodium chloride (salt). The mixture shall be 6 ounces of salt per gallon of water at room temperature (+60 to +90°F). Subsequent to this immersion, the coated componets or witness samples shall be removed from the solution, dried with clean, laundered, cheesecloth, and then evaluated for conformance to 3.3.1 and 3.3.3.

4.5.5.3 Water solubility. The coated componets or witness samples shall be immersed for a period of 24 hours in distilled water at room temperature (+60°F to +90°F). Subsequent to this immersion, the coated componets or witness samples shall be removed from the solution, dried with clean laundered cheesecloth, and then evaluated for conformance to 3.3.1 and 3.3.3.

4.5.6 Optical. Appropriate optical instruments such as spectrophotometers, radiometers, etc. shall be used to test conformance to the optical requirements of 3.5.

5. PACKAGING

This section is not applicable to this specification.

6. NOTES

6.1 Intended use. This specification establishes minimum quality and durability requirements for single or multi-layer interference coatings applied to components in optical systems. It is applicable to coatings utilized on a wide variety of substrate materials for such items as lenses, prisms, mirrors, beam splitters, reticles, laser elements, windows, filters, etc.

Coatings produced to the requirements of this specification may be exposed without damage to those handling and cleaning procedures associated with optical instrument assembly practice and will generally be employed within the protective confines of a sealed instrument.

Certain applications may necessitate the use of additional or expanded quality and durability requirements, some of which are included within the optical durability section of this specification. (See 3.4.3). Other quality and durability requirements with the appropriate test methods must be defined when they are applicable. All additional requirements must be specified on the applicable drawing or other documents. Examples of coating applications where additional requirements must be specified include laser systems where resistance to laser energy damage is necessary; also when coatings are used outside the confines of a sealed instrument, resistance to such environments as salt fog, fungus, extended humidity, etc. may be necessary.

This specification is not intended as a substitute for other coating specifications, e.g., MIL-C-675, MIL-C-14806, etc. It is intended that this specification provide the durability requirements for coating applications not covered by other documents and in some cases to serve as a supplement, by reference, in other coating specifications.

6.2 Ordering data. Purchasers should exercise any desired options offered herein, and procurement documents should specify the following:

a. Title, number and date of this specification.
b. Optional abrasion, salt solubility, and water solubility requirements (see 3.4.3 and 4.5.5)
c. Optical requirements of coating (See 3.5)
d. Responsibility for performance of inspection requirements (See 4.1)
e. Mandatory use of coated componets for tests (See 4.1.2)
f. Requirement for first article approval (See 4.2, 4.2.1 and 4.2.2)

6.3 First article sample. When the government is responsible for conducting first article approval tests the required article sample specified in 4.2 shall be forwarded to:

Commander
US Army Armament Research & Development Command
ATTN: DRDAR-QAF
Dover, NJ 07801

6.4 Definitions.

6.4.1 Evaporation lot. An evaproation lot is defined as the group of parts which has the coating applied at the same time and in the same chamber.

6.4.2 Standard measuring equipment (SME). Standard measuring equipment is defined as the common measuring devices which are usually stocked by commercial supply houses for ready supply (shelf items) and which are normally used by an inspector to perform dimensional inspection of items under procurement. This category also includes commercial testing equipment such as meters, optical comparators, etc.

Custodian:	Preparing Activity:
Army - AR	Army-AR
Air Force - 11	

Project No. 6650-0108

SUPPLEMENT D

1. Reference: Item 10 of Form NRC-2.

2. Management of the radiation protection program for the FLIR systems and subsystems are the responsibility of Mr. Bernard M. Savaiko, License Manager, Mr. Steven A. Horne, Radiation Protection Officer (RPO), Mr. Barry J. Silber, Alternate RPO, and Ms. Patricia Ann Elker, Alternate RPO. Inclosures 1, 2, 3 and 4 are the qualifications of these individuals.

BERNARD M. SAVAIKO, Chief, Safety Office, US Army Communications-Electronics Command (CECOM), Fort Monmouth, New Jersey

a. Education: 1957 - B.S. Industrial Engineering, Columbia University, New York, New York.

b. Professional Experience:

(1) 5 years - Safety Officer - US Air Force.

(2) 4 years - Industrial Safety - U.S. Steel Corporation.

(3) 20 years - Industrial Safety and Chief, Safety Office- USACECOM (formerly US Army Communications and Electronics Materiel Readiness Command and US Army Electronics Command) Fort Monmouth, New Jersey, including 3 years experience as a Radiation Protection Officer with responsibilities for the control of various commodities containing radioactive materials.

Mr. Savaiko is designated as the manager of Nuclear Regulatory Commission Licenses and Department of the Army Authorizations.

STEVEN A. HORNE, Chief, Readiness Division, Safety Office and Health Physicist, US Army Communications-Electronics Command (CECOM), Fort Monmouth, New Jersey

1. Educational Background:

Old Dominion University Norfolk, Virginia	3 Years	1964 - Associate in Applied Science
The Catholic University of America Washington, DC	2 Years	1975 - BSE Nuclear Science and Engineering
The Catholic University of America Washington, DC	-	1975 - Graduate Work in Nuclear Science and Engineering

2. Formal Training and Experience in Radiation Protection Methods, Measurements and Effects:

	Duration of Training	On The Job	Formal Course
a. Fifty-six semester hours pertaining to radiation, including college physics, Environmental Aspects of Nuclear Power Plant Management, Environmental Radioactivity, Nucleonic Fundamentals, Nuclear Properties and Interactions, Nuclear Physics, Nuclear Radiation Detection, Nuclear Reactor Physics, Radiation Biology, Radioisotope Techniques and Radiological Physics - Old Dominion University and The Catholic University of America.	1961-1975	No	Yes
b. Radiation Detection Effects and Devices Utilizing various type of high energy accelerators - Virginia Associated Research Center Newport News, Virginia, and NASA Langley Research Center, Langley, Virginia.	1 Year	Yes	No
c. Radiation safety, detection instrumentation and isotopic handling equipment - Flow Corp, Fort Belvoir, Virginia.	2 Months	Yes	No

Incl 2

	Duration of Training	On The Job	Formal Course
d. Radiological Safety Course pertaining to Nuclear Moisture/ Density Instrumentation - Seaman Nuclear Corporation, Milwaukee, Wisconsin.	24 Hours	No	Yes
e. Occupational Radiation Protection Course 212 - Public Health Services, Las Vegas, Nevada.	80 Hours	No	Yes
f. Fundamentals of Non-Ionizing Radiation Protection Course 264 - Public Health Service, Rockville, Maryland.	40 Hours	No	Yes
g. Laser Safety Course - University of Cincinnati, Ohio.	40 Hours	No	Yes
h. Radionuclide Analysis by Gamma Spectrocopy Course 208 - Public Health Service, Winchester, Massachusetts.	80 Hours	No	Yes
i. Radiation Guides and Dose Assessment Course 272 - Environmental Protection Agency, Las Vegas, Nevada.	80 Hours	No	Yes

3. Experience with Radioisotopes:

Isotope	Maximum Activities in Curies	Duration of Experience	Type of Experience
$^{241}\mathrm{Am}$	1	3 Years	For all radionuclides listed, experience consisted of laboratory analysis, wipe tests, experiments and evaluations utilizing these sources.
$^{252}\mathrm{Cf}$	.27	3 Years	
$^{57}\mathrm{Co}$	0.1	4 Years	
$^{60}\mathrm{Co}$	1200	8 Years	
$^{137}\mathrm{Cs}$	1	8 Years	
$^{3}\mathrm{H}$	20	8 Years	
$^{192}\mathrm{Ir}$	100	8 Years	
$^{147}\mathrm{Pm}$	1	8 Years	

Isotope	Maximum Activities in Curies	Duration of Experience
^{226}RaBe	1	5 Years
^{239}PuBe	1	1 Year
^{90}Sr	0.1	2 Years

4. Experience with other Radiation Producing Machines:

Radiation Machine	Duration of Experience	Type of Experience
a. NASA Langley Research Center, and Virginia Associated Research Center's, Space Radiation Effects Laboratory consisting of a 2 MeV Van de Graff accelerator, 3 MeV Dynamitron accelerator, 10 MeV Linear Electron Accelerator, a 600 MeV Proton Synchrocyclotron Accelerator and a 14 MeV Neutron Generator.	1.5 Year	Radiation damage Shielding Experiments and Related Health Physics Studies.
b. 250 KeV General Electric Corporation X-ray machine	8 Years	Health Physics and laboratory experiments.
c. Various energy dispersive and wave length X-ray fluorescence spectrometry with X-ray generators up to 50 KeV.	8 Years	Health Physics and laboratory experiments.

5. Experience with radiation:

1964-1965 - Virginia Associated Research Center, NASA, Langley Research Center, Virginia as Health Physics Technologist.

1965-1966 - E.R. Squibb, New Brunswick, New Jersey as Radiochemist Isotope Technologist.

1966-1968 - Flow Corporation, Nuclear Division, Fort Belvoir, Virginia as Radiation Engineer.

1968-1976 - US Army Mobility Equipment Research and Development Command, Fort Belvoir, Virginia as Health Physicist.

1976-1978 - US Army Electronics Command, Fort Monmouth, New Jersey as Health Physicist.

1978-1981 - US Army Communications and Electronics Materiel Readiness Command, Fort Monmouth, New Jersey, as Health Physicist.

1981-Present - US Army Communications-Electronics Command, Fort Monmouth, New Jersey, as Chief, Readiness Division, Safety Office and Supervisory Health Physicist.

BARRY J. SILBER, Health Physicist, US Army Communications-Electronics Command (CECOM), Fort Monmouth, New Jersey

a. Education:

(1) A.A. - Brooklyn College of the City University of New York, Brooklyn, New York - 1965.

(2) B.S. - Brooklyn College of the City University of New York, Brooklyn, New York - 1969. Major: Chemistry.

b. Professional Experience:

(1) October 1966 - May 1967:
Allen Pharmacal Corporation, 175 Pearl Street, Brooklyn, New York.
Laboratory Technician - Analytical Chemistry Laboratory.
Laboratory analyses of pharmaceuticals at various stages of manufacture to insure compliance with Food and Drug Administration Regulations as well as United States Pharmacopeia and National Formulary Monographs.

(2) June 1967 - March 1970:
EON Corporation, 175 Pearl Street, Brooklyn, New York.
Chemist - Responsible for all health physics activities, including radiation surveys, air sampling and wipe tests, leak testing of sealed sources, decontamination of facilities and equipment, disposal of radioactive wastes, calibration of radiation survey and measurement instrumentation, record-keeping, etc., to insure compliance with US Nuclear Regulatory Commission (NRC) and New York State Regulations; liaison between regulatory agencies and corporate management; authorized radiation worker (user) of multiple types of radioactive materials used in the manufacture of radiation sources for commercial, military and highly specialized (custom-made) use; responsible for all chemistry activities including metallurgical applications on products at various stages of manufacture to meet quality control specifications.

(3) March 1970 - June 1977:

State of New York Department of Labor, Division of Safety and Health, 2 World Trade Center, New York, New York.
Senior Radiophysicist - Radiological Health Unit.
Responsible for the review of applications, including the evaluation of facilities, equipment, personnel and products containing radioactive materials, and in the preparation of State licenses authorizing the possession and use of radioactive materials by persons in industry and related activities in this State; assist in the administration of the licensing program; consult with and assist industrial management personnel and others in establishing radiation protection programs; conduct inspections, special prelicensing investigations, radiation surveys and tests at the sites of licensees and registrants using radiation sources to enforce state regulations and to insure that radiation workers and the general public are fully protected; assemble environmental research data, analyze and interpret this data, assist in the publication of scientific reports, and training of new staff members.

(4) June 1977 - January 1978:
US Army Electronics Command (ECOM), Fort Monmouth, New Jersey.
Health Physicist - Responsible for health physics functions in the establishment and implementation of the ECOM Safety Program aimed at establishing life cycle controls of ECOM commodities utilizing radioactive material and ionizing radiation producing devices; responsible for the evaluation of radiological protection programs and radiation facilities to determine their adequacy and to insure compliance with DA Authorizations and NRC Licenses; perform studies and evaluations necessary to minimize the health risks to personnel; prepare and review applications for DA Authorizations and NRC Licenses; establish and maintain radiation protection records and files.

(5) January 1978 - April 1981:
US Army Communications and Electronics Materiel Readiness Command (CERCOM), Fort Monmouth, New Jersey.
Duties are the same as in Item b(4) above. Name change from ECOM to CERCOM.

(6) May 1981 - Present:
CECOM, Fort Monmouth, New Jersey.
Duties are the same as in Item b(4) above. Name change from CERCOM to CECOM.

c. Formal Training in Radiation Protection Methods, Measurements and Effects:

	Duration of Training	On-The-Job	Formal Course
(1) X-Ray Technology for Radiological Health Personnel-Memorial Hospital for Cancer and Allied Diseases, 444 East 68th Street, New York, New York - 11 January - 14 January 1971.	3 Days	No	Yes
(2) Orientation Course in Regulatory Practices and Procedures - NRC, Bethesda, Maryland - 1 March - 19 March 1971.	3 Weeks	No	Yes
(3) Health Physics and Radiation Protection - Special Training Division, Oak Ridge Associated Universities, Oak Ridge, Tennessee - 12 February 1973 to 20 April 1973. Sponsored by the NRC for Agreement State regulatory personnel.	10 Weeks	No	Yes
(4) Radiological Safety Course - US Army Ordnance and Chemical Center and School, Aberdeen Proving Ground, Maryland - 25 October - 15 November 1977.	3 Weeks	No	Yes
(5) Internal Dosimetry for Fixed Nuclear Facilities-Oak Ridge Associated Universities, Oak Ridge, Tennessee - 5 November - 9 November 1979.	1 Week	No	Yes
(6) Managers' Environmental Course - US Army Logistics Management Center, Fort Lee, Virginia - 13 July - 17 July 1981.	1 Week	No	Yes

d. Experience with Radiation.

	Isotope	Maximum Amount	Duration of Experience	Type of Use
(1)	$^{14}\mathrm{C}$	60 mCi	3 Years	For items 1 through 10-manufacture of sealed sources, health physics surveys and wipe tests.
(2)	$^{32}\mathrm{P}$	10 mCi	3 Years	
(3)	$^{36}\mathrm{Cl}$	10 mCi	3 Years	
(4)	$^{63}\mathrm{Ni}$	10 mCi	3 Years	
(5)	$^{90}\mathrm{Sr}/^{90}\mathrm{Y}$	50 mCi	3 Years	For items 11 and 14-calibration of radiation instrumentation, health physics surveys and wipe tests.
(6)	$^{99}\mathrm{Tc}$	100 mCi	3 Years	
(7)	$^{106}\mathrm{Ru}/^{106}\mathrm{Rh}$	50 mCi	3 Years	
(8)	$^{144}\mathrm{Ce}/^{144}\mathrm{Pr}$	500 mCi	3 Years	
(9)	$^{147}\mathrm{Pm}$	500 mCi	3 Years	For items 12 and 13-health physics surveys and wipe tests.
(10)	$^{204}\mathrm{Tl}$	50 mCi	3 Years	
(11)	$^{60}\mathrm{Co}$	10 mCi	3 Years	
(12)	$^{60}\mathrm{Co}$	200 Ci	3 Years	
(13)	$^{137}\mathrm{Cs}$	250 Ci	3 Years	
(14)	$^{226}\mathrm{Ra}$	20 mCi	3 Years	

PATRICIA ANN ELKER, Health Physicist, US Army Communications-Electronics Command (CECOM), Fort Monmouth, New Jersey

a. Education:

(1) Rutgers University, New Brunswick, New Jersey
Presently completing program of graduate study in Radiation Science. Course work has included: Bioinorganic Chemistry; Radiation Physics; Special Topics in Radiologic Health; Laboratory Methods of Radiation Detection; Radiation Chemistry; Radiation Biophysics; Electronics and Instrumentation; Advanced Special Problems; Radiation Dosimetry.

(2) J.F.K. School of Nuclear Medicine, Edison, New Jersey
Certificate in Nuclear Medicine Technology, 1976. ARRT, NM-1976, NMTCB-1978. Award: Mallinckrodt Academic Achievement Award.

(3) Monmouth College, West Long Branch, New Jersey
BS Degree in Biology, January 1976. Minor - Medical Technology

(4) Susquehanna University, Selinsgrove, PA
Biology program 1971-1973.

b. Professional Experience:

(1) July 1981 - present

Health Physicist, US Army Communications-Electronics Command, Fort Monmouth, NJ.

Responsible for health physics functions in the establishment and implementation of the CECOM Safety Program aimed at establishing life cycle controls of CECOM commodities utilizing radioactive material and ionizing radiation producing devices; responsible for the evaluation of radiological protection programs and radiation facilities to determine their adequacy and to insure compliance with DA Authorizations and NRC Licenses; perform studies and evaluations necessary to minimize the health risks to personnel; prepare and review applications for DA Authorizations and NRC Licenses; establish and maintain radiation protection records and files.

(2) July 1980 - July 1981

Supervisor, Radioactive Material Section, Radiation Physicist, Department of Environmental Protection (DEP), Bureau of Radiation Protection (BRP) Trenton, NJ.

Responsible for supervision and coordination of the radioactive material (RAM) program. Authorized to approve or reject licenses or amendments for possession and use of RAM after assessment of user qualification, radiation safety program, and compliance with State rules and regulations. Reorganized program format and developed inspection procedures, forms and criteria. Evaluated and provided recommendations for quality assurance of radiopharmaceuticals and instruments at facilities. Assigns and trains inspectors for RAM facility program review. Issued letters of non-compliance or compliance resulting from inspection. Performed inspections and violation investigations. Registered NRC licensable materials. Registered accelerators and reviewed radiation safety surveys. Authorized to approve or reject applications for certificates of handling in the transportation of any RAM above 20 curies. State Radiological Assessment Officer on call for nuclear generating station emergency response, and assists in emergency planning. Member of emergency response team with authority to make immediate decisions relative to public health and safety regarding control of radiation. Maintained Bureau's RAM storage area and records of accountability, radiation safety surveys, and compliance with NRC license requirements. Responsible for monthly report and statistic preparation involving RAM users, inspections, violations, NRC registrations, and accelerators. Responded to all inquiries involving RAM or non-ionizing radiations. Developed fee schedule format, and maintained records. Proposed regulations for NJ Administrative Code adoption.

(3) February 1980 - July 1980

Radiation Physicist, DEP, BRP, Trenton, NJ.

Enforced State rules and regulations governing medical and industrial or research radiation producing units. Responsible for compliance testing and evaluation, report preparation, and performance of radiation safety surveys. Authorized to impound non-compliant units preventing usage establishing public and/or occupational safety. Conducted special projects evaluating radiation hazards and development of procedures for control and reduction of unnecessary radiation.. Investigated violations and incidents post notification of radiation hazard with authority to establish improved radiation safety requirements. Participated as member of radiation emergency response team.

(4) January 1979 - January 1980

Nuclear Medicine Technologist, St. Peter's Medical Center, New Brunswick, NJ.

Performed diagnostic imaging and evaluation for improved medical diagnosis. Performed quality control and calibration of instrumentation and computer. Responsible for patient orientation to procedures, radiopharmaceutical preparation, dose calculation and assay for intravenous or other approved aseptic method of dose administration. Performed radiation monitoring for safety and regulation compliance evaluation. Responsible for proper radioactive waste disposal compliant with all regulatory agencies and safety standards. Performed sophisticated computer analysis for diagnostic studies. Performed in vivo diagnostic evaluations. Responsible for on call emergency routines.

(5) May 1976 - January 1979

Nuclear Medicine Technologist, Jersey Shore Medical Center, Neptune, New Jersey

Same as above, including ultrasound and Doppler technologies for diagnostic procedures. Radioimmunoassay for in vitro procedures. Responsible for monitoring and maintaining records for therapeutic sealed source storage area.

c. Additional Formal Training in Radiation Protection Methods, Measurements, Effects:

(1) Internal Dosimetry for Fixed Nuclear Facilities-Special Training Division, Oak Ridge Associated Universities, Oak Ridge, TN, September 1981. One week formal course.

(2) Emergency Response for Nuclear Incidents - Sponsored by the Federal Emergency Management Agency at the DOE Nevada Test Site, Las Vegas, Nevada, November 1980. Two week formal course.

(3) Emergency Response - Sponsored by the NJ Bureau of Emergency Response at the NJ Bureau of Radiation Protection, Trenton, NJ, 1980. One week formal course.

(4) Quality Control in Radiographic Procedures and Processing - E.I. duPont Nemours Training Center, 1980. One week formal course.

(5) Quality Control in Nuclear Medicine - Bureau of Radiological Health program, sponsored by the NJ State Society of Nuclear Medicine at Middlesex General Hospital, New Brunswick, NJ, 1979. Twelve hours formal training.

d. Experience with Radioactive Materials:

(see attached list).

	Isotope	Maximum Amount	Duration of Experience	Type of Use
1.	^{99}Mo/^{99m}Tc	1.0-3.0 Ci	5 Years	
2.	^{131}I	10 mCi	5 Years	For items 1 through 16, radiopharmaceutical preparation, dose injection, and/or related diagnostic procedures, health physics surveys, wipe test analysis, and instrument calibration.
3.	^{75}Se	5 mCi	5 Years	
4.	^{67}Ga	50 mCi	5 Years	
5.	^{201}Tl	30 mCi	5 Years	
6.	^{32}P	20 mCi	5 Years	
7.	^{133}Xe	100 mCi	5 Years	
8.	^{81}Rb/^{81m}Kr	25 mCi	2 Years	
9.	^{125}I Sealed Source RIA	50 mCi	5 Years	
10.	^{123}I	10 mCi	5 Years	
11.	^{137}Cs	500 mCi	5 Years	
12.	^{226}Ra	500 mg	5 Years	
13.	^{192}Ir	80 Ci	6 months	
14.	^{60}Co	100 Ci	1 month	
15.	^{57}Co	30 mCi	5 Years	
16.	^{133}Ba	10 mCi	5 Years	
17.	PuBe	1 Ci	1 month	

SUPPLEMENT E

1. Reference: Item 11(a) of Form NRC-2.

2. The depots responsible for bulk storage, maintenance, serviceability, surveillance and issue of thermal imaging systems possess radiation detection/measurement instrumentation for monitoring and measuring the radiation emitted from these devices.

3. Radiation detection instrumentation: They are the AN/PDR-54, AN/PDR-56F and AN/PDR-60 standard Army alpha detection instruments (radiac sets) or commercial equivalent instrumentation such as the Eberline Instrument Corporation (EIC) PAC series portable alpha survey instruments. In addition, these depots possess, as a minimum, the AN/PDR-27( ) standard Army beta-gamma detection instrument or commercial equivalent instrumentation for beta-gamma radiation detection. The sensitivity range of the AN/PDR-54 Radiac Set is zero to 1.00E+05 counts per minute (cpm) in three decade scales, the AN/PDR-56F Radiac Set is zero to 1.00E+06 cpm in four decade scales, and the AN/PDR-60 Radiac Set is zero to 2.00E+06 cpm in four decade scales. The sensitivity range for the AN/PDR-27( ) Radiac Set is zero to 500 mR/hr in four decade scales.

4. Radiation measurement instrumentation: They are the Nuclear Measurements Corporation (NMC) Model PC-3A or PC-4 Internal Proportional Counter. In addition, depots may possess the EIC Model SAC-3A Scintillation Counter.

SUPPLEMENT F

1. Reference: Item 11 (b) of Form NRC-2.

2. The AN/PDR-54, AN/PDR-56F and AN/PDR-60 standard Army alpha detection instruments and the AN/PDR-27 ( ) standard Army beta-gamma detection instrument used for health and safety purposes are calibrated in accordance with the frequency specified in Technical Bulletin 43-180, Calibration Requirements for the Maintenance of Army Materiel, and procedures prescribed in the technical manuals issued with the instruments. Presently, the calibration frequency specified is once every 90 days. Calibration standards used for the AN/PDR-54 and AN/PDR-60 are the AN/UDM-6 and AN/UDM-7C ^{239}Plutonium Radiac Calibrator Sets. The calibration standard used for the AN/PDR-56F is the AN/UDM-7C Radiac Calibrator Set. Calibration standards used for the AN/PDR-27 ( ) are the AN/UDM-1 (^{60}Cobalt), AN/UDM-1a (^{137}Cesium) or equivalent. All calibration standards are certified by, or traceable to, the National Bureau of Standards (NBS).

3. The NMC Model PC-3A, Model PC-4 and the EIC Model SAC-3A are calibrated as recommended by the manufacturer with calibration reference sources certified by, or traceable to, the NBS.

SUPPLEMENT G

1. Reference: Item 12 (a) of Form NRC-2.

2. For all MLAR coatings of IR optical elements, the Army requires that the contractor test the ThF_4 coated optics to insure that all elements comply with specifications for radiation and environmental requirements. Testing is inclusive of the following or equivalent:

a. A witness sample from each coating run shall be subjected to the hardness and adherence tests as specified in paragraphs 4.4.5 and 4.4.6 of MIL-M-13508.

b. A witness sample from each coating run shall be subjected to the 10 day humidity test of Method 507.1 of MIL-STD-810.

c. A witness sample from each coating run shall be subjected to the salt spray (fog) test as specified in paragraph 4.6.10 of MIL-C-675.

3. In addition, the durability of all IR coatings shall be tested to insure that a sample from every batch of coated optical elements meets or exceeds the scotch tape, eraser rub and environmental tests as specified in the following Military Specifications and/or Standards: MIL-C-675, MIL-M-13508, MIL-STD-810 and MIL-C-48497.

4. There will be no marking requirements for these devices based upon the revision made to Section 40.22 of Title 10, Code of Federal Regulations, Part 40. This revision allows government agencies to possess/use and transfer up to 15 pounds of source material for operational purposes. Further, in the NRC's Statements of Consideration (40-SC-10) concerning this revision, it was pointed out that paragraph (a)(4) of Section 40.22 is applicable to any size unit, other than individuals, which is physically separate from other units.

SUPPLEMENT H

1. Reference: Item 12(b) of Form NRC-2.

2. In the event that ThF_4 coated optics are badly scratched, deformed or otherwise defective, they will be returned to either Direct Support/General Support (DS/GS)* maintenance echelons or to SAAD for disposition, i.e., repair, replacement, or disposal as radioactive waste.

3. Appropriate warning and caution instructions to thermal imaging systems are incorporated into the technical manuals for these equipment as indicated in Supplement I of this license application.

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* The DS/GS function also refers to the comparable aircraft maintenance echelon, i.e. Aviation Unit Maintenance and Aviation Intermediate Maintenance.

SUPPLEMENT I

1. Reference: Item 12(c) of Form NRC-2.

2. The Army program for control of radioactive items of supply is prescribed specifically in two regulations. AR 700-64, Radioactive Commodities in the DOD Supply Systems, is an interservice regulation which prescribes responsibilities for control of radioactive items and components which are introduced in the supply system. AR 385-11, Ionizing Radiation Protection, establishes requirements for obtaining NRC licenses for radioactive materials and authorizations to possess radioactive material not controlled by NRC, and requirements for individually controlled items of supply, the transportation of radioactive materials and the disposal of unwanted radioactive material. Major Army commands are implementing these DA regulations.

3. The authority contained in NRC licenses and DA authorizations issued to CECOM permits DOD installations and activities to acquire and use thermal imaging systems incorporating ThF_4 without obtaining their own license or authorization for these items (a DA authorization is required for radioactive material not controlled under an NRC specific license). This is based upon commitments made by CECOM that all Army elements will comply with conditions contained in those licenses and authorizations and with pertinent Federal, DOD and Army regulations. Both NRC and DA require control of all operations involving radioactive items to insure the safety of personnel and property. Army activities possessing licensed radioactive sources and the agencies controlling them are subject to inspection by the NRC in addition to inspection by Army elements.

4. The mission of CECOM includes the management and performance of all materiel life cycle functions and services and acts as DA licensee for Army-wide distribution of these items. The following is a description of functions of the various CECOM elements providing a coordinated effort:

a. The functions for the manager of the NRC License/DA Authorization are assigned to the Chief, Safety Office of the Command Staff of this headquarters. The responsibilities of the manager are to:

(1) Coordinate, obtain, administer, review, amend and maintain necessary licenses/authorizations for radioactive commodities managed by this command.

(2) Provide information and guidance to all commanders, with respect to limitations, constraints, conditions or procedures which affect the responsibilities of those commanders for the radioactive commodity.

(3) Monitor the various elements of the life cycle program of the radioactive commodities to assure compliance with conditions of the applicable license/authorization.

(4) Assure that licensed/authorized material is not transferred to unauthorized persons or organizations.

b. The health physicists serve as the CECOM staff contact for radiation control and license/authorization matters to the Army Materiel Development and Readiness Command (DARCOM), other major commands and DA elements, other services and federal agencies; provide advice and assistance to other CECOM elements involved in the fielding of radioactive items, the National Inventory Control Point (NICP) (an element of CECOM), depots and other Army elements; prepare applications for NRC Licenses/DA Authorizations for Army-wide distribution of assigned items; prepare radiation safety instructions for incorporation in technical literature and other published guidance pertaining to the items; coordinate with the NICP to assure that requisitioning elements are authorized to and technically capable of receiving the item and the procurements do not exceed the quantity or use limitations imposed by the various licenses; perform pre-award and post award health physics surveys of contractors; provide health physics advice to be included in instructions for disposal of radioactive waste, and serve as staff officers for notification, investigation, and preparation of reports required in the event of an accident or incident in which this command's radioactive items may be involved.

c. The CECOM NICP located at Fort Monmouth, New Jersey has adopted procedures for individually controlled radioactive items that are in addition to standard Army Supply practices used for all type classified items. The control point maintains records of procurements, receipts, storage locations, shipments, using locations, authorizes, issues, and assures adequate supply. Similar NICP procedures have been implemented by other DARCOM Major Subordinate Commands (MSC) who have PICA responsibilities for the assigned major weapon system. It reviews requisitions submitted and when approved, issues material release orders to the designated depot for shipment of the material to the requisitioner. Requisitions are submitted through various command control channels. The control point bases its approval on previously established authorizations of the requisitioner to receive the item from the supply standpoint such as an approved Table of Allowances. Upon approval of the requisition, the control point issues a material release order to the depot storing the item. The depot ships the item directly to the requisitioner, notifies the control point and furnishes other shipping data which is forwarded also through supply property office channels.

d. The major Army commands have established regulatory requirements for control of the radioactive items. Each major command has established at the headquarters level a radioactive material control point and appointed a command radiation control officer to administer control of radioactive items within the command. That officer reviews and concurs in the qualifications of local RPO's within the command, maintains records of radioactive items by location and assures periodic inventory and leak tests by using activities, performs periodic inspections/audits of accountable installations/activities to assure that items are properly handled in accordance with Army and NRC regulations, and to assure the submission of inventory and leak test reports and accident/incident reports to the appropriate commodity command as required by Army regulations. The local RPO is responsible for administering the local radiation protection program. Local programs provide for designated controlled areas, dosimetry, instrumentation, operating procedures to supplement published manuals for the items, receipts, transfers, storage and records. Requisitions originated by using elements are processed through the local RPO to the major command radiation control officer. The requisition is reviewed from the radiation protection standpoint and logistics authority for possession. If approved, the requisition is forwarded to the NICP. Upon receipt of notification from the NICP of the transaction the information is forwarded to the local radiation protection officer who assumes radiation protection responsibility for the item. Requests for transfers of items between installations/activities are reviewed by the command radiation control officer and if approved reported to the NICP. Transfers outside the major commands are reviewed and approved by the NICP. Reports of excess items are submitted through command channels to the NICP for review for serviceability, turn-in, or disposal as radioactive waste. The NICP, in conjunction with assistance and directives provided by health physicists of the CECOM Safety Office, determines the disposition of the excess items.

e. NCAD, RRAD, and SHAD will provide bulk storage, surveillance and issue of thermal imaging systems. SAAD, in addition, will provide maintenance and serviceability of these equipment. There will be no maintenance and serviceability performed involving the grinding or removal of the ThF_4 coatings from these equipment. Where radioactive materials are involved, the depots have established special warehousing facilities, handling procedures and have established formal radiation protection programs administered by qualified RPO's. Mr. Henry Newlin (NCAD), Mr. John D. Rayburn (RRAD), Mr. Herman McGrew (SAAD) and Mr. Eugene Ernest (SHAD) have been designated to serve in this capacity. Items are inspected when received, at intervals during storage and immediately before shipment. The inspections are conducted according to established surveillance procedures as determined by CECOM for each item. The quality surveillance procedures for thermal imaging systems containing ThF_4 coatings will be performed by the depot RPO, his alternates or the CECOM health physicists and will involve the annual visual inspection of a random sampling of at least six (6) each FLIR assets for flaking and/or pitting of the ThF_4 coatings. The depots will provide the NICP with notification of individually controlled item receipts, inspections and shipments.

f. The program for control of thermal imaging systems, as with other radioactive items is, to the extent practical, the same logistics procedures applied to other Army supplies. Regulatory guidance has been established by DA and implemented by the various commands governing the management process, life-cycle management of material, logistics management and support, procurement, maintenance, storage, transportation, including packaging and disposal. For radioactive items the procedures are augmented by specific regulatory controls pertaining to the possession and use of radioactive materials, control of personnel radiation exposure, safe storage, handling, maintenance, transportation and disposal of the items. For thermal imaging systems, more stringent controls have been established as distribution of these devices are classified confidential and due to their high dollar value, are limited to authorized activities. These controls include identifying and insuring that these systems are coded in the Commodity Command Standard System (CCSS) Automated Data Processing Program as radioactive in accordance with Appendix A of AR 708-1, Cataloging and Supply Management Data. These systems are coded with a Special Control Item Code (SCIC) of 8 meaning Radioactive Item, A meaning Regulated and contains a Radioactive Item, or B meaning Regulated-Principal and contains a Radioactive Item. Requisitions are processed initially by computers and, due to their radioactive SCIC designation and their high dollar value, are then processed manually by the NICP item manager to verify that the requisitioners are authorized to receive the item.

g. It is DA philosophy for one DARCOM MSC to obtain an NRC license for the possession and use of single type radioactive commodities while having other MSC's responsible for the management of fire control systems incorporating these commodities. In essence, this means that in the case of fire control systems, the primary armament subsystem manager will have the fire control responsibility for the weapon system. He, in turn, will be supported by the secondary armament material readiness manager and any other materiel readiness managers as required. This means that the weapon system manager will maintain full responsibility for its fire control system and ancillary subsystems.

h. The program for control of thermal imaging devices as it relates to this command and the weapon system managers, i.e., other DARCOM MSC's is implemented by effected Memorandums of Understanding/Support Agreements which includes the following:

(1) CECOM will:

(a) Perform all duties as indicated in this radiation protection program.

(b) Maintain required NRC license.

(c) Review proposed design and literature changes that may effect the NRC license.

(d) Coordinate with other DARCOM MSC's at the time of renewals/amendments of NRC license.

(e) Assure that all radioactive components are coded on the CCSS with an SCIC of either 8, A or B.

(f) Furnish all applicable contract data statements/test procedures to the effected DARCOM MSC's.

(2) Effected DARCOM MSC's will:

(a) Insure that the thermal imaging systems and subsystems assigned to them are coded in the CCSS with an SCIC of either 8, A or B.

(b) Insure that the Troop Authorization and Equipment Distribution Program World-wide Asset Quarterly Posture pertaining to these items are furnished to the CECOM Safety Office.

(c) Insure that all procurements pertaining to these items are coordinated with the CECOM Safety Office.

(d) Insure that all radioactive items assigned to them are disposed of as radioactive waste and notify the CECOM Safety Office annually of the total number disposed.

(e) Insure that the technical literature contain the required radiation warnings and that proposed changes effecting these warnings are coordinated with the CECOM Safety Office.

(f) Inspect depots not inspected by CECOM annually to determine compliance with NRC licenses and regulations. This shall include annual quality assurance inspections of thermal imaging systems and subsystems under their purview.

(g) Insure that all optical elements and lens coatings of thermal imaging systems and subsystems are in compliance with Title 10, Code of Federal Regulations and with NRC license requirements and regulations.

i. Further controls involve the following:

(1) The objective lenses will be procured with the wideband MLAR (ThF_4) coating already applied.

(2) In the field, normal optical cleaning procedures will be utilized by the users. The Army will not perform any maintenance involving the removal of the MLAR coatings or its replacements.

(3) Replacements of thermal imaging components containing ThF_4 coatings may be performed at DS/GS levels. This is the intermediate maintenance level between the user and SAAD.

(4) Maintenance of the Night Vision devices containing the ThF_4 coatings will be performed at SAAD. This maintenance will not include grinding or the removing of the ThF_4 coatings off of the thermal imaging components.

j. Warning instructions as contained in both the operator's manuals, the DS/GS Maintenance manuals, and the Depot Maintenance Work Requirements for thermal imaging systems contain the following notices:

Warning

Radiation Hazard

The antireflective coating on all infrared optics contain thorium fluoride which is slightly radioactive. The only potential hazard involves ingestion (swallowing or inhaling) of this coating material. Dispose of broken lenses etc, in accordance with AR 385-11.

k. The following illustrate operating instructions listed in the operators manuals for various Night Vision devices:

Caution

This equipment is a precision electro-optical instrument and must be handled carefully

Caution

Do not use M1 antifogging kit on front lens of night sight, as this will degrade the infrared image. See lens cleaning instructions, table 3-1.

Caution

The boresight collimator is a precision optical instrument and must be handled carefully. Do not drop.

l. The maintenance instructions for the various preventive maintenance checks and services for eyepiece and front lenses are inclusive of the following information as applicable to the Night Vision device:

(1) Examine lenses for scratches, chips, or cracks. Report any damage to direct support/general support maintenance. Inspect for dirt, dust, oil, and fingerprints.

(2) Clean lenses (if necessary).

Caution

To avoid scratches on lens coating, do not rub cleaning solution on surface. Use only approved materials and procedures for cleaning lenses.

(a) Flush off surface of lens with potable water (clean water, suitable for drinking) to remove dust and grit.

(b) Thoroughly moisten a pad of cotton from night sight lens cleaning kit with lens cleaning solution.

(c) Apply lens cleaning solution to lens by dabbing lightly (do not rub) until surface is evenly covered.

(d) Wait one to three minutes depending on condition for solution to loosen heavy contamination (do not allow solution to dry).

(e) Flush off the solution with potable water.

(f) Repeat steps (b) through (d) until heavy contamination is removed.

(g) Clean lens in small sections by applying cleaning solution and gently wiping with clean pad.

Caution

> Wiping motion should be accomplished in one direction only. The pad thus contaminated should be immediately discarded and not used for further cleaning.

(h) Rinse lens with potable water.

(i) Dry lens by wiping lightly in a single direction only with clean cotton pad.

(j) During freezing weather, the lenses may be cleaned by using warm (not hot) potable water and cleaning solution mixed with warm potable water.

m. The operator's troubleshooting is limited to the replacement of the battery, replacement of the coolant cartridge, and cleaning of the lenses. The statement below is incorporated into preventative maintenance instructions. If these steps do not restore the night sight to operation, the operator is referred to DS/GS maintenance.

Caution

> The lens surface coating is easily damaged. Use extreme care to protect it from dirt, dust, fingerprints and humidity whenever possible. Do not breathe on lens surface, or use any cleaning or defogging material that is not specially approved for this application.

n. The maintenance concept for the various end item thermal imaging systems authorizes only DS/GS personnel to perform any required maintenance functions. The only common modules authorized at this maintenance level for replacement are the Detector-Dewar, either DT-591 or 594/UA and the Imager, Optical, either SU-97 or 103/UA. All other maintenance functions pertaining to those devices will be performed at SAAD. This maintenance will not include grinding or the removing of the ThF_4 coatings off of the common modules.

o. Since the ThF_4 is used solely on IR objective lenses and would never be used in the proximity of the eye, there does not appear to be any danger to personnel using equipment which contains the coated objective lenses.

p. Based on the low exposure potential, the instructions contained in the technical literature are considered sufficient radiation safety control over the user.

q. On all procurements, the Army will require that the contractors test the thermal imaging components containing the ThF_4 coated optics to insure that these devices comply with all specifications and with Title 10, Code of Federal Regulations. The method of testing must be approved by the Government.

Additionally, a small number of these devices will be selected at random to be independently tested to insure that the material complies with all specifications. The independent test will be performed either by Government personnel at a Government facility, or by an independent testing contractor.

r. ThF_4 coated lenses are excepted from specification packaging, markings and labeling, and are excepted from the provisions of Title 49, Code of Federal Regulations, Part 173.393. The shipper is advised to include the following notice on all shipments:

(1) "This shipment is exempt from DOT specification packaging, marking, and labeling requirements IAW Title 49 CFR 173.391."

(2) The purpose of this instruction is to avoid confusing shippers and transportation control personnel as a result of the labeling requirements imposed by the NRC for the carrying and shipping case and the assemblies within the systems which contain the ThF_4 coated elements. Army users will not be required to monitor shipping containers.

SUPPLEMENT J

1. Reference: Item 13 (b) of Form NRC-2.

2. Title 10, Code of Federal Regulations, AR 385-11 and AR 700-64 are followed for the disposal of radioactive waste. Presently, initial request for disposition is submitted to the effected DARCOM MSC NICP for review. After determination has been made for final disposition as radioactive waste, the effected NICP notifies the user to dispose of the radioactive material in accordance with AR 385-11. Headquarters, US Army Armament Materiel Readiness Command (ARRCOM) has been delegated the responsibility of management coordination for radioactive waste disposal. ARRCOM assures that all radioactive wastes are packaged and shipped in accordance with all applicable requirements.