3480

Cobalt-60 Facilities Available for Hardness Assurance Testing

J. C. Humphreys and Charles M. Dozier

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
National Measurement Laboratory
Center for Radiation Research
Ionizing Radiation Division
Gaithersburg, MD 20899

This work sponsored by Defense Nuclear Agency under Project RV, Task RA and Work Unit 119.

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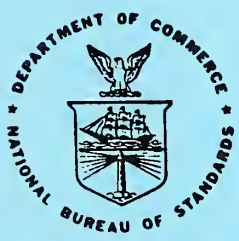

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, *Secretary*
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

Cobalt-60 Facilities Available

For Hardness Assurance Testing

ABSTRACT

This report contains a list of cobalt-60 gamma-ray irradiation facilities that are available for hardness assurance testing of electronic devices. A summary of source type, absorbed-dose rates, experimental volume available, and other pertinent information is given for each facility.

Key Words: absorbed-dose rate, cobalt-60 facility, gamma rays, irradiation volume, radiation hardness testing.

A. INTRODUCTION

Many organizations occasionally need access to cobalt-60 facilities for gamma-ray irradiation of microelectronic devices or systems as part of a hardness assurance testing program. Some of these organizations have in-house irradiation facilities. For those organizations that do not, facilities listed in this report can provide such services. The list summarizes the pertinent information about each facility such as source type, absorbed-dose rates available, irradiation volume, user contact points, etc. The facilities listed are wide-spread geographically, but are not inclusive. An earlier list included all known facilities worldwide, but gave no details other than the operator and plant designer [1].*

If the reader represents an organization that he feels should be on the list, he should contact one of the authors. It is planned that the list will be revised periodically and reissued to keep it as current as possible.

The list of characteristics for each facility is summarized from information supplied by the facility operator and, in some cases (such as absorbed dose rates), may be only approximations, due to such variables as source geometry. A prospective user should communicate with the contact person listed at the facility for the latest and most accurate information.

The facilities listed have been designed for a wide variety of applications. The energy spectral characteristics of many of them probably are not well known. Calculations of the energy spectra of a few types of sources have been made and indicate

that significant low-energy components exist for certain geometries [2, 3]. These low-energy components may cause serious dosimetry errors due to absorbed dose enhancement effects near interfaces. As a result, it is recommended that all testing be conducted with the devices-under-test and the dosimeters contained within a lead-aluminum filter box. A discussion of the potential dosimetry errors and recommended material thicknesses for such a filter box are given in reference [4].

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*Figures in brackets indicate the literature references which are listed at the end of this report.

REFERENCES

1. "World List of Industrial Gamma Irradiators", compiled by Atomic Energy of Canada Ltd., Association of International Industrial Irradiation, Newsletter No. 12, pp. 163-167, (Oct 1984).

2. Woolf, S.,and Frederickson, A.R., "Photon Spectra in ^{60}Co-γ Test Cell", IEEE Trans. Nuc. Sci., NS-30, pp. 4371-4376 (1983).

3. Woolf, S., and Burke, E.A., "Monte Carlo Calculations of Irradiation Test Photon Spectra", IEEE Trans. Nuc. Sci., NS-31, pp. 1089-1094 (1984).

4. Brown, D.B., and Dozier, C.M, "Reducing Errors in Dosimetry Caused
by Low Energy Components of Co-60 and Flash X-Ray Sources", IEEE Trans. Nuc. Sci., NS-29 pp. 1996-1999 (1982).

ORGANIZATION: Armed Forces Radiological Research Institute
Bethesda, MD

TYPE OF SOURCE: H_2O pool, 33′ by 33′ by 33′. Samples can be placed in interior of source region.

MAXIMUM ABSORBED DOSE RATE (in Si): 4×10^5 rad/h

USABLE IRRADIATION VOLUME: Central region 8" by 8" by 14"

TEMPERATURE RISE DURING IRRADIATION: None

COST: Depends on test

USER PRIVILEGES: AFRRI operates source. User sets up and runs experiment.

CONTACT: Capt. Leonard Alt
Armed Forces Radiological Research Institute
NMC-NCR
Bethesda, MD 20814
Telephone: (202) 295-1096

ORGANIZATION: Battelle Memorial Institute
Columbus, OH

TYPE OF SOURCE: Room source, 3300 Curies (acquiring 50 kCuries in near future). Sources are cylindrical rods which are arranged for test.

MAXIMUM ABSORBED
DOSE RATE (in Si): 1×10^6 rad/h

USABLE IRRADIATION VOLUME: 9′ by 25′ by 30′

TEMPERATURE RISE DURING IRRADIATION: None

COST: Depends on test - Typical test programs $5K-10K

USER PRIVILEGES: Operator supplied for source. User free to control and operate own test equipment.

CONTACT: Dr. V. Pasupathi
Battele Columbus Laboratories
505 King Avenue
Columbus, OH 43201
Telephone: (614) 879-5140

ORGANIZATION: Boeing Aerospace Company
Seattle, WA

TYPE OF SOURCE:
(1) Gammacell 220
(2) Gammacell 220
(3) Gammacell 200
(4) Gamma Lab (room)

MAXIMUM ABSORBED DOSE RATE (in Si):
(1) 1×10^6 rad/h
(2) 4×10^5 rad/h
(3) 6×10^3 rad/h
(4) 9×10^3 rad/h

USABLE IRRADIATION VOLUME:
(1) and (2) 6" dia. by 8" height
(3) 3.5" dia. by 5.5" height
(4) 5' by 15' room

TEMPERATURE RISE DURING IRRADIATION: Up to 37°C

COST: $800/Day

USER PRIVILEGES: Unlimited within established operating procedures. Automated test equipment is available.

CONTACT: Mr. Dennis Russell
Boeing Aerospace Company
P.O. Box 3999
Seattle, WA 98124
Mail Stop 2R-00
Telephone: (206) 655-6712

OPERATION: Brookhaven Gamma-Irradiation Facilities
Brookhaven National Laboratory
Upton, New York

TYPE OF SOURCE: Water Pool

MAXIMUM ABSORBED
DOSE RATE(in Si): 4×10^6 rad/h

USABLE IRRADIATION VOLUME: 4" diameter by 10" height
in center of source

TEMPERATURE RISE DURING IRRADIATION: N/A

COST: N/A

USER PRIVILEGES: Staff inserts sample

CONTACT: Mr. Walter Becker
Brookhaven National Laboratory
Bldg. 830
Upton, NY 11973
Telephone: (516) 282-4533 or 4526

ORGANIZATION: General Electric Company
Utica, NY

TYPE OF SOURCE: AECL Gammacell 220

MAXIMUM ABSORBED
DOSE RATE (in Si): 6×10^5 rad/h

USABLE IRRADIATION VOLUME: 6" dia. by 8" height

TEMPERATURE RISE DURING IRRADIATION: N/A

COST: Depends on test program

USER PRIVILEGES: Users may do their own irradiations under staff supervision. Visitors must have a security clearance and be escorted to and from the facility.

CONTACT: Mr. Charles M. Hewison
General Electric Company
Aerospace Electronic Products Dept.
French Road
Utica, NY 13502
Telephone: (315) 793-5375

ORGANIZATION: General Electric Company
Space Division
Valley Forge, Pennsylvania

TYPE OF SOURCE: Gammacell 220

MAXIMUM ABSORBED
DOSE RATE (in Si): 2×10^5 rad/h

USABLE IRRADIATION VOLUME: 6" dia. by 8" height

TEMPERATURE RISE DURING IRRADIATION: Monitored

COST: Approx $900/day (includes technician support)

USER PRIVILEGES: User can operate with technician support. Automated test equipment for up to 24 pin devices available. GE will also do all testing and supply test results.

CONTACT: Mr. Larry C. Jeffers
P.O. Box 8555
Philadelphia, PA 19101
Telephone: (215) 962-3811 x3196

ORGANIZATION: Georgia Institute of Technology
Atlanta, Georgia

TYPE OF SOURCE: Room source - stored in H_2O pool. Have 8 source frames and 5 cylindrical sources. 30 ports for 1" cables.

MAXIMUM ABSORBED DOSE RATES (in Si): 3×10^6 rad/h

USABLE IRRADIATION VOLUME 7′ by 13′ by 23′

TEMPERATURE RISE DURING IRRADIATION: Max 50°C

COST: $850/day

USER PRIVILEGES: User operates own equipment. Institute operates source and can provide calculations, dosimetry and pictures.

CONTACT: Mr. Jerry Taylor
Georgia Institute of Technology
Frank H. Neely Nuclear Research Center
900 Atlantic Drive, NW
Atlanta, GA 30332
Telephone: (404) 894-3608

ORGANIZATION: Hughes Aircraft Company
El Segundo, CA

TYPE OF SOURCE: (1) Gammacell 220
(2) GR9
(3) GR9

MAXIMUM ABSORBED
DOSE RATE (in Si): (1) 2×10^6 rad/h
(2) 2×10^5 rad/h
(3) 4×10^4 rad/h

USABLE IRRADIATION VOLUME: (1) 6" dia. by 8" height
(2) and (3) 4" dia. by 5" height

TEMPERATURE RISE DURING IRRADIATION: Negligible

COST: Depends on test procedure

USER PRIVILEGES: HAC operates source, will do testing for user, or allow user to run own test program.

CONTACT: Mr. Joe Zeleck
Hughes Aircraft Company
P.O. Box 902
Bldg. E-2 MS-S107
El Segundo, CA 90245
Telephone: (213) 616 -0277

ORGANIZATION: International Nutronics
Irvine, CA

TYPE OF SOURCE: 1.6 MCuries in 195 cylindrical rods. Source also used for medical and food irradiations.

MAXIMUM ABSORBED DOSE RATE (in Si): 5×10^6 rad/h

USABLE IRRADIATION VOLUME: 20′ by 40′ room

TEMPERATURE RISE DURING IRRADIATION: Room temperature

COST: Depends on test

USER PRIVILEGES: Company supplies dosimetry and operates source. Experimenter operates own euipment.

CONTACT: Mr. Robert Baldwin
International Nutronics
1962 Barranca Rd.
Irving, CA 92714
Telephone: (714) 863-9361

ORGANIZATION: International Nutronics
Palo Alto, CA

TYPE OF SOURCE: 250 kCuries in 48 cylindrical rods. Source also used for medical and food irradiations.

MAXIMUM ABSORBED DOSE RATE (in Si): 3×10^6 rad/h

USABLE IRRADIATION VOLUME: 10' by 12'room

TEMPERATURE RISE DURING IRRADIATION: Room temperature

COST: Depends on test

USER PRIVILEGES: Company supplies dosimetry and operates source. Experimenter operates own equipment.

CONTACT: Mr.Tom Rensel
International Nutronics
1237 N. San Antonio Road
Palo Alto, CA 94303
Telephone: (415) 968-5257

ORGANIZATION: IRT Corporation
San Diego, CA

TYPE OF SOURCE: Gammacell 220

MAXIMUM ABSORBED
DOSE RATE (in Si): 3×10^5 rad/h

USABLE IRRADIATION VOLUME: 6" dia. by 8" height

TEMPERATURE RISE DURING IRRADIATION: Approx. $3^{\circ}C$ per Mrad

COST: Negotiable

USER PRIVILEGES: Staff operated

CONTACT: Mr. John Harrity
IRT Corporation
3030 Callan Rd.
San Diego, CA 92121
Telephone (619) 450-4343

ORGANIZATION: Jet Propulsion Laboratory
Pasadena, CA

TYPE OF SOURCE: Room source. Two Co-60 sources on rails.

MAXIMUM ABSORBED
DOSE RATE (in Si): 3×10^5 rad/h

USABLE IRRADITION VOLUME: 20' by 20' by 14'

TEMPERATURE RISE DURING IRRADIATION: Room temperature

COST: Evaluated case-by-case

USER PRIVILEGES: Licensed operator required to operate source. User allowed to run the experiment.

CONTACT: Mr. Michael Gauthier
Jet Propulsion Laboratory
MS-T1180
4800 Oak Grove Drive
Pasadena, CA 91109
Telephone: (818) 354-2126

ORGANIZATION: Martin Marietta Aerospace
Orlando, FL

TYPE OF SOURCE: J.L. Shepard Model 109 -- 6 rods in Pb shielding container. H_2O cooled.

MAXIMUM ABSORBED
DOSE RATE (in Si): 7×10^5 rad/h

USABLE IRRADIATION VOLUME: 3" dia. by 6" height

TEMPERATURE RISE DURING IRRADIATION: None

COST: Depends on test

USER PRIVILIGES: Operator is supplied. Have electronics for tests. Will do testing.

CONTACT: Mr. Jim Simmons
Martin Marietta Aerospace
P.O. Box 5837
MS-163
Orlando, FL 32855
Telephone: (305) 356-4458

ORGANIZATION: National Bureau of Standards
Gaithersburg, MD

TYPE OF SOURCE:
(1) AECL Gammacell 220
(2) Pool source: 12 source pencils in cylindrical array
(3) Teletherapy collimated beam source

MAXIMUM ABSORBED DOSE RATE (in Si):
(1) 1×10^6 rad/h
(2) 4×10^5 rad/h
(3) 1×10^3 rad/h

USABLE IRRADIATION VOLUME:
(1) 6" dia. by 8" height
(2) 3" dia. by 4" height
(3) 12" dia. collimated beam

TEMPERATURE RISE DURING IRRADIATION:
(1) ~40°C
(2) none
(3) none

COST: Depends on Test

USER PRIVILEGES: Source operator provided. User provides and operates own test equipment.

CONTACT: Mr. J. C. Humphreys
National Bureau of Standards
C216 Radiation Physics Building
Gaithersburg, MD 20899
Telephone: (301) 921-2201

ORGANIZATION: Naval Research Laboratory
Washington, DC

TYPE OF SOURCE: Water pool; Two sources: (1) & (2).
Sample can be placed in center of source
or in several positions surrounding the source.

MAXIMUM ABSORBED
DOSE RATE (in Si): (1) 1×10^4 rad/h
(2) 4×10^2 rad/h

USABLE IRRADIATION VOLUME: 3" by 11" height

TEMPERATURE RISE DURING IRRADIATION: None

COST: $100 (insertion + 24 hr) $30 each addl. 24 hrs.

USER PRIVILEGES: User can operate after training

CONTACT: Mr. L.S. August
Radiation, Beams, and Sources Section
Code 6614
Naval Research Laboratory
Washington, DC 20375
Telephone: (202) 767-3938

ORGANIZATION: Rockwell International
Anaheim, CA

TYPE OF SOURCE: (1) AECL Gammacell 200
(2) J.L. Shepard Model 109
(3) J.L. Shepard Model 81
(semicollimated source
in shielded room)

MAXIMUM ABSORBED
DOSE RATE (in Si): (1) 1×10^6 rad/h
(2) 9×10^4 rad/h
(3) N/A

USABLE IRRADIATION VOLUME: (1) 3.5" dia. by 5" height
(2) 4" dia. by 6" height
(3) 12' x 12' room

TEMPERATURE RISE DURING IRRADIATION: N/A

COST: N/A

USER PRIVILEGES: N/A

CONTACT: Mr. Larry Green or Rick Halverson
Rockwell International
Defense Electronics Operations
3370 Miroloma Ave., P.O. Box 3105
Anaheim, CA 92803
Telephone: (714) 632-0775

ORGANIZATION: Rome Air Development Center (RADC)
Hanscom AFB, MA

TYPE OF SOURCE: Room source - 20 rods approximately 12" long arranged in 5" diameter cylindrical array.

MAXIMUM ABSORBED
DOSE RATE (in Si): 5×10^6 rad/h

USABLE IRRADIATION VOLUME: Inside source - 5" dia. by 6" height.
Room 8' by 8' by 12'

TEMPERATURE RISE DURING IRRADIATION: Cooling can be provided.

COST: Operator salary - $218 to $374 per day

USER PRIVILEGES: Supplies dosimetry and operates source.
User supplies own equipment.

CONTACT: Mr. John Schott
RADC/ESR
Hanscom AFB, MA 01731
Telephone: (617) 861-3445

ORGANIZATION: Sandia National Laboratories
Albuquerque, NM

TYPE OF SOURCE: Gamma Irradiation Facility.
Room source with sources in one corner of room.

MAXIMUM ABSORBED
DOSE RATE (in Si): 2×10^6 rad/h

USABLE IRRADIATION VOLUME: Room 8' by 8' by 8'.
Inside source rods:
7.5" by 5.5" by 9.5"

TEMPERATURE RISE DURING IRRADIATION: None

COST: $85/hour

USER PRIVILEGES: Operator controls the source.
User responsible for experimental setup and operation of experiment.

CONTACT: Dr. David Vehar
Sandia National Laboratories
Org 6452
P.O. Box 5800
Albuquerque, NM 87185
Telephone: (505) 844-4820

ORGANIZATION: Southwest Research Institute Gamma Facility
Southwest Research Institute
San Antonio, TX

TYPE OF SOURCE: Two hot cells.
Multiple configurations possible.

MAXIMUM ABSORBED
DOSE RATE (in Si): 3×10^6 rad/h

USABLE IRRADIATION VOLUME: 9′ by 15′ by 13′

TEMPERATURE RISE DURING IRRADIATION: 20°C in SS per Mrad/h

COST: Approx. $500/day, negotiable

USER PRIVILEGES: Staff operated

CONTACT: Mr. David G. Cadena, Jr., Senior Research Physicist
Department of Fuels and Lubricant Technology
Southwest Research Institute
6220 Culebra Road
San Antonio, TX 78238
Telephone: (512) 684-5111

ORGANIZATION: TRW, Inc.
Redondo Beach, CA

TYPE OF SOURCE: (1) Gammacell 220
(2) Gammacell 220

MAXIMUM ABSORBED
DOSE RATE (in Si): (1) 7×10^5 rad/h
(2) 1×10^5 rad/h

USABLE IRRADIATION VOLUME: 6" dia. by 8" height

TEMPERATURE RISE DURING IRRADIATION: (1) 32°C
(2) None

COST: Depends on test.

USER PRIVILEGES: Facility operates irradiators.
User may do own testing or in
collaboration with facility staff.

CONTACT: Mr. Paul Guilfoyle
TRW, Inc.
MS 84/1002
One Space Park
Redondo Beach, CA 90278
Telephone: (213) 535-0056

ORGANIZATION: University of Lowell
Lowell, MA

TYPE OF SOURCE: Approximately 1 MCi plaque array of sources in H_2O pool. Moved to 1/2" Al window for irradiations. 4 plugs and 4 electrical conduits for access to experiment.

MAXIMUM ABSORBED
DOSE RATE (in Si): 5×10^6 rad/h

USABLE IRRADIATION VOLUME: 8' by 8' by 8'

TEMPERATURE RISE DURING IRRADIATION: Controlled by vent.

COST: Depends on test -- $50/irradiation avg.

USER PRIVILIGES: University operates source.
User runs own equiment.

CONTACT: Mr. Tom Wallace
University of Lowell
Radiation Laboratory
1 University Ave.
Lowell, MA 01854
Telephone: (617) 452-5000

ORGANIZATION: University of Maryland
College Park, MD

TYPE OF SOURCE: Room source. 10 source pencils in cylindrical array 3.25" in diameter. Sources stored in water, raised to irradiate position 30 inches above floor.

MAXIMUM ABSORBED
DOSE RATE (in Si): 9×10^5 rad/h

USABLE IRRADIATION VOLUME: In cylinder: 3" dia. by 12" height.
Room: 15′ by 15′ by 10′ high.

TEMPERATURE RISE DURING IRRADIATION: None

COST: Depends on test

USER PRIVILEGES: User operates own experiment

CONTACT: Dr. Walter J. Chappas
University of Maryland
Chemical Engineering Building
College Park, MD 20742
Telephone: (301) 454-8757

ORGANIZATION: White Sands Missile Range
White Sands, NM

TYPE OF SOURCE: Room source. 1 to 10 cylindrical source capsules are transferred pneumatically from storage to head assembly. Samples can be placed in cavity in head assembly for maximum absorbed dose rate.

MAXIMUM ABSORBED
DOSE RATE (in Si): 10×10^6 rad/h

USABLE IRRADIATION VOLUME: 5 cm dia. cavity. Room: 12.8 meters by 6.1 meters by 3.7 meters high.

TEMPERATURE RISE DURING IRRADIATION: N/A

COST: Determined by test

USER PRIVILEGES: Facility operates source

CONTACT: Mr. Roland Penny
White Sands Nuclear Effects Facility
Gamma Radiation Facility
White Sands Missile Range
NM 88002
Telephone: (505) 678-1161

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Defense Nuclear Agency
Attn: (RAEV, Major R. C. Zittel)
Washington, DC 20305

10. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)*

This report contains a list of cobalt-60 gamma-ray irradiation facilities that are available for hardness assurance testing of electronic devices. A summary of source type, absorbed-dose rates, experimental volume available, and other pertinent information is given for each facility.

12. KEY WORDS *(Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)*

absorbed-dose rate, cobalt-60 facility, gamma rays, irradiation volume, radiation hardness testing.

13. AVAILABILITY

☒ Unlimited

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