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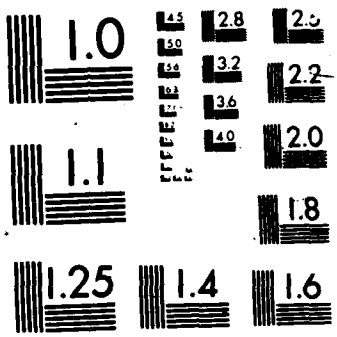
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USAFOEHL REPORT

86-069RE0094HXA

# TECHNICAL EVALUATION OF DOSIMETER CORPORATION OF AMERICA MODEL 005 POCKET DOSIMETER USAFOEHL, BROOKS AFB TX

JOHN A. CALDWELL, II, TSGT, USAF

August 1986

Final Report





USAF Occupational and Environmental Health Laboratory
Aerospace Medical Division (AFSC)
Brooks Air Force Base, Texas 78235-5501

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JOHN J. COUGHLIN, Colonel, USAF, BSC
Commander

Prepared by:

JOHN A. CALDWELL II, TSgt, USAF
NCOIC, Instrumentation and Calibration Branch

Reviewed by:

DAVID C. ADAMS, Capt, USAF, BSC
Chief, Instrumentation and Calibration Branch

DAVID R. CASE, Lt Col, USAF, BSC
Chief, Radiation Services Division

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| | | | |
| | | | |

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

A technical evaluation of the DCA Model 005 Pocket Dosimeter was accomplished on 18-19 Jun and 1 Jul 86 at Kelly and Brooks AFB to access the variability caused by temperature and humidity extremes. Discrepancies were identified and considerations recommended.

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Contents

I. **BACKGROUND:** As requested by San Antonio Air Logistics Center (SA-ALC), a technical evaluation of the Dosimeter Corporation of America (DCA) model 005 pocket dosimeter was accomplished to (1) determine variability with changes in temperature and humidity, and (2) verify the response capability of the dosimeters rejected by PMELs and returned to SA-ALC. On 18-19 Jun and 1 Jul 86 USAFOEHL personnel performed the evaluation at Kelly AFB and Brooks AFB TX.

II. **SURVEY PERSONNEL** TSgt John A. Caldwell, II

III. **PERSONS CONTACTED**

| | | |
|---|---|---|
| Capt Michael Stroup | Project Engineer, NDI Equipment | 925-6961 |
| 1Lt Gary Schultz | Project Engineer, Radiation Detection Equipment | 925-6961 |
| Mr Luciano Guerra | Equipment Specialist, Radiation Detection Equipment | 925-8635 |

**IV. TEMPERATURE AND HUMIDITY PROCEDURE**

A. A Sperry 160 kVp x-ray tube, model SPX-160, was used to irradiate the dosimeters in an environmentally controlled chamber.

B. The dosimeters were evaluated under two environmental extremes; 100°F/100% RH, and 20°F/20%RH. Both conditions were accomplished at ambient barometric pressure.

C. The dose rate from the x-ray unit was determined with the MDH Model 1015, OEHL No. 1883, Serial No. 1615, calibrated 24 Jan 86 with an MDH Mammography probe, Model 10X5-6M, Serial No. 7087.

D. The x-ray beam was attenuated using 2.5 mm of aluminum to reduce the dose rate of the x-ray unit to acceptable levels. The dose rate was 0.505 R/min at 1 meter.

E. The dosimeters were subjected to an integrated exposure of 250 mR with the x-ray unit operating at 80 kVp, 1.7 mA exposure.

F. The dosimeters were centered in the beampath of the unit and allowed to stabilize in the chamber for 15 minutes prior to the first exposure.

G. The dosimeters to be evaluated were separated into three groups; New, Repackaged, and Returned. Five dosimeters from each group were selected at random for the evaluation.

H. All indicated exposures in Tables 1 and 2 were the average of three consecutive exposures.

I. All readings were multiplied by an Air Density Correction Factor (ADCF) to increase the accuracy. The ADCF was calculated as follows:

$$\frac{273.15 + TEMP}{295.15} \times \frac{760}{BP}$$

Where: TEMP = Temperature in degrees Celsius
BP = Barometric Pressure in mm Hg

## V. TEMPERATURE AND HUMIDITY METHODOLOGY

A. All exposures were made in free air.

B. All dosimeters were zeroed, exposed and read in the vertical position.

C. The MDH x-ray monitor was used to determine exposure time required for an integrated exposure of 250 mR. The correction factor is the number by which the readings on the dosimeter should be multiplied to get the actual exposure which the dosimeter (and the user) received.

D. The indicated exposure is the dose reading from the dosimeter.

E. The correction factor was obtained as follows:

Correction Factor = (Actual Exposure)/(Indicated Exposure)

## VI. TEMPERATURE AND HUMIDITY RESULTS AND CONCLUSIONS

The data indicate that the response of the model 005 Pocket Dosimeter to x-ray radiation is approximately 6% to 50% low depending on the environmental conditions. Consideration should be given to generating an Air Density Correction Factor (ADCF) for each base location according to their particular environmental factors at the time or by the season. This would help compensate for the wide variability of the dosimeter readings. Note that ADCF calculations are <u>not</u> required by T.O. 33K7-2-1-1.

## VII. RESPONSE CAPABILITY PROCEDURE

A. The evaluation of the returned D-005 dosimeters was accomplished IAW T.O. 33K7-2-1-1. There were two deviations from the T.O.; all measurements indicated in Tables 3 and 4 are the average of three consecutive exposures, and ADCF was applied to increase the accuracy.

B. Twenty (59%) of the original 34 dosimeters satisfied leak test criteria and were used in the evaluation. The 14 dosimeters that were not evaluated were rejected for quality control acceptance reasons; namely, hairlines that could not be located.

## VIII. RESPONSE CAPABILITY RESULTS AND CONSIDERATIONS:

A. As determined by the data in Tables 3 and 4 and IAW T.O. 33K7-2-1-1, the acceptance level would increase from 60% to 75% by the application of the ADCF to each dosimeter correction factor.

B. The reason for the return of the 13 acceptable dosimeters to SA-ALC/MMIRAC is unknown.

C. If there are any questions concerning this report, please contact TSgt Caldwell, AV 240-2613, Comm 536-2613.

TABLE 1

Response of the DCA Model 005 Pocket Dosimeter to X-Ray

18 Jun 86

PARAMETERS: 80 kVp, 1.7 mA, 2.5 mm Al Total Filtration
0.505 R/min Dose Rate
Actual Dose: 250 mR, Exposure Time: 30 sec.

CALIBRATION STANDARD: MDH Model 1015, OEHL No. 1883, SN 1615
Used with the Mammography Probe Model 10X5-6M, SN 7087

ENVIRONMENTAL CONDITIONS: Temperature: 100°F, Relative Humidity: 100%
Barometric Pressure: 741.9 mm Hg
ADCF: 1.079

| | DOSIMETER SN | INDICATED EXPOSURE (mR) | CF W/O ADCF | CF W/ ADCF |
|---|---|---|---|---|
| GROUP I | | | | |
| | 50051 | 240 | 1.042 | 1.124 |
| | 50054 | 225 | 1.111 | 1.199 |
| | 50100 | 235 | 1.064 | 1.148 |
| | 60190 | 230 | 1.087 | 1.165 |
| | 60198 | 243 | 1.028 | 1.109 |
| GROUP II | | | | |
| | 10006 | 240 | 1.042 | 1.124 |
| | 10019 | 255 | 0.980 | 1.057 |
| | 10033 | 243 | 1.029 | 1.110 |
| | 10062 | 233 | 1.073 | 1.158 |
| | 10074 | 236 | 1.059 | 1.143 |
| GROUP III | | | | |
| | 60209 | 325 | 0.769 | 0.829 |
| | 60234 * | - | - | - |
| | 80327 | 166 | 1.506 | 1.625 |
| | 80340 * | - | - | - |
| | 80346 | 246 | 1.016 | 1.096 |

Each value listed is average of three exposures

Average Correction Factor W/O ADCF = 1.067

+ 7.8% Difference

Average Correction Factor W/ADCF = 1.145

* These dosimeters failed because the hairlines were not visible at the beginning of the exposure procedure nor throughout two or more exposures.

TABLE 2

Response of the DCA Model 005 Pocket Dosimeter to X-Ray

19 Jun 86

PARAMETERS: 80 kVp, 1.7 mA, 2.5 mm Aluminum Total Filtration
0.505 mR/min Dose Rate
Actual Dose: 250 mR, Exposure Time: 30 sec.

CALIBRATION STANDARDS: MDH Model 1015, OEHL No. 1883, SN 1615
Used with the Mammography Probe Model 10X5-6M, SN 7087

ENVIRONMENTAL CONDITIONS: Temperature: 20°F, Relative Humidity: 20%
Barometric Pressure: 741.9 mm Hg
ADCF: 0.971

| | DOSIMETER SN | INDICATED EXPOSURE (mR) | CF W/O ADCF | CF W/ ADCF |
|---|---|---|---|---|
| GROUP I | | | | |
| | 50051 | 175 | 1.429 | 1.388 |
| | 50054 | 192 | 1.302 | 1.264 |
| | 50100 | 188 | 1.339 | 1.300 |
| | 60190 | 183 | 1.366 | 1.326 |
| | 60198 | 168 | 1.488 | 1.445 |
| GROUP II | | | | |
| | 10006 | 180 | 1.389 | 1.349 |
| | 10019 | 205 | 1.219 | 1.184 |
| | 10033 | 215 | 1.163 | 1.129 |
| | 10062 | 180 | 1.389 | 1.349 |
| | 10074 | 233 | 1.073 | 1.042 |
| GROUP III | | | | |
| | 60209 | 208 | 1.202 | 1.167 |
| | 60234 * | - | - | - |
| | 80327 | 76 | 3.289 | 3.194 |
| | 80340 * | - | - | - |
| | 80346 | 233 | 1.073 | 1.042 |

Each value listed is the average of three exposures

Average Correction Factor W/O ADCF = 1.494

- 9.6% Difference

Average Correction Factor W/ADCF = 1.398

* These dosimeters failed because hairlines were not visible at the beginning of the exposure procedure nor throughout two or more exposures.

TABLE 3

Response of the DCA Model 005 Pocket Dosimeter to Cs-137

For 100 mR Exposure, 1 July 86

PARAMETERS: 130 Ci Cs-137 J.L. Shepperd Model 81-10 Irradiator
Dose Rate: 9.9 R/Hr @ 2 meters
Exposure Time: 100 mR = 0.606 minutes

CALIBRATION STANDARD: Performed by Manufacturer on 20 Mar 86 using an MDH Model 2025, SN 2127, with a 3 cc probe, SN 4126, Traceable to the National Bureau of Standards

ENVIRONMENTAL CONDITIONS: Temperature: 24°C, Barometric Pressure: 745.4 mmHg
ADCF: 1.026

| DOSIMETER SN | REASON FOR RETURN* | INDICATED EXPOSURE (mR) | CF W/O ADCF | CF W/ ADCF |
|---|---|---|---|---|
| 30031 | NHL | 93 | 1.07 | 1.098 |
| 30423 | OT | 125 | 0.80 | 0.821 |
| 30437 | OT | 112 | 0.90 | 0.923 |
| 50021 | OT | 120 | 0.83 | 0.852 |
| 50075 | MDR | 123 | 0.81 | 0.831 |
| 60117 | MDR | 122 | 0.82 | 0.841 |
| 60201 | NHL | 120 | 0.83 | 0.852 |
| 60208 | NHL | 122 | 0.82 | 0.841 |
| 60209 | OT | 123 | 0.81 | 0.831 |
| 60245 | UNK | 117 | 0.86 | 0.882 |
| 80307 | NHL | 113 | 0.88 | 0.903 |
| 80315 | NHL | 117 | 0.86 | 0.882 |
| 80326 | NHL | 118 | 0.85 | 0.872 |
| 80327 | NHL | 118 | 0.85 | 0.872 |
| 80339 | NHL | 117 | 0.86 | 0.882 |
| 80342 | NHL | 100 | 1.00 | 1.026 |
| 80343 | NHL | 108 | 0.92 | 0.944 |
| 80346 | NHL | 108 | 0.92 | 0.944 |
| 80390 | OT | 120 | 0.83 | 0.852 |
| 80437 | NHL | 112 | 0.90 | 0.923 |

*Reasons for Return by PMELs:
NHL = No Hair Line
OT = Out of Tolerance
MDR = Maintenance Deficiency Report
UNK = Unknown Discrepancy

Average Correction Factor without ADCF = 0.871

+2.26% Difference

Average Correction Factor with ADCF = 0.894

TABLE 4

Response of the DCA Model 005 Pocket Dosimeter to Cs-137

For 400 mR Exposure, 1 July 86

PARAMETERS: 130 Ci Cs-137 J.L. Shepperd Model 81-10 Irradiator
Dose Rate = 9.9 R/Hr @ 2 meters
Exposure Time: 400 mR = 2.424 minutes

CALIBRATION STANDARD: Performed by Manufacturer on 20 Mar 86 using an MDH Model 2025, SN 2127, with a 3 cc probe, SN 4126, Traceable to the National Bureau of Standards

ENVIRONMENTAL CONDITIONS: Temperature: 24°C, Barometric Pressure: 745.4 mmHg, ADCF: 1.026

| DOSIMETER SERIAL No. | REASON FOR RETURN* | 400mR AVE | CF W/O ADCF | CF W/ ADCF |
|---|---|---|---|---|
| 30031 | NHL | 362 | 1.11 | 1.139 |
| 30423 | OT | 478 | 0.84 | 0.862 |
| 30437 | OT | 480 | 0.83 | 0.852 |
| 50021 | OT | 482 | 0.83 | 0.852 |
| 50075 | MDR | 477 | 0.84 | 0.862 |
| 60117 | MDR | 495 | 0.81 | 0.831 |
| 60201 | NHL | 463 | 0.86 | 0.882 |
| 60208 | NHL | 475 | 0.84 | 0.862 |
| 60209 | OT | 488 | 0.82 | 0.841 |
| 60245 | UNK | 472 | 0.85 | 0.872 |
| 80307 | NHL | 447 | 0.90 | 0.923 |
| 80315 | NHL | 445 | 0.90 | 0.923 |
| 80326 | NHL | 450 | 0.89 | 0.913 |
| 80327 | NHL | 473 | 0.85 | 0.872 |
| 80339 | NHL | 463 | 0.86 | 0.882 |
| 80342 | NHL | 425 | 0.94 | 0.964 |
| 80343 | NHL | 447 | 0.90 | 0.923 |
| 80346 | NHL | 437 | 0.92 | 0.944 |
| 80390 | OT | 472 | 0.85 | 0.872 |
| 80437 | NHL | 440 | 0.91 | 0.934 |

*Reasons for Return from PMELs:
NHL = No Hair Line
OT = Out of Tolerance
MDR = Maintenance Deficiency Report
UNK = Unknown Discrepancy

Average Correction Factor without ADCF = 0.878

+2.2% Difference

Average Correction Factor with ADCF = 0.900

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