Medical Physics Review of 36th Medical Group, Dental and Medical Radiology, Andersen AFB, Guam

31 Mar 05

Consultative Letter # IOH-DO-BR-CL-2005-0011

Prepared by:

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DEPARTMENT OF THE AIR FORCE
DETACHMENT 3, AIR FORCE INSTITUTE FOR OPERATIONAL HEALTH
(AFIOH)
APO AP 96368-5213

31 Mar 05

MEMORANDUM FOR 36 MDOS/SGOAB
Unit 14010 Box 19
APO AP 96543-5000

FROM: Det 3, AFIOH/CDR
Unit 5213
APO AP 96368-5213

SUBJECT: Consultative Letter (CL), IOH-DO-BR-CL-2005-0011, Medical Physics Review of 36 Medical Group, Dental and Medical Diagnostic Imaging Elements, Andersen AFB, Guam

1. Introduction: This consultative letter documents Entrance-Skin-Exposure (ESE) measurements for diagnostic x-ray systems used by the 36 MDSS/SGSAR Diagnostic Imaging Element and the 36 MDOS/SGOD Dental Clinic. ESE calculations were completed for each x-ray unit based on the most recent Medical Equipment Repair Center (MERC) calibration report. A review of radiation safety training, x-ray error logs, and the overall radiation safety program was also completed during this visit. Calculated ESE values and the overall radiation safety program meet established guidelines.

2. References: AFI 48-148, *Ionizing Radiation Protection*, paragraph 4.7, requires calculation and evaluation of ESEs for diagnostic radiology equipment on an annual basis. ESEs were calculated for common techniques and compared to National Exposure Trends (NEXT) guidelines to ensure patient dose from x-ray procedures are not unreasonably high. ESE guideline values are listed in Table 1 below and references are provided in attachment 1.

Table 1: *ESE Guidance for Common Diagnostic Projections*

Projection	Patient Thickness (cm)	Handbook of Radiation Doses[1] (mR)	NEXT[2] (200 speed) (mR)	NEXT[2] (400 speed) (mR)	FRPG ESEG[3] (mR)
Chest (PA)	23	25	25	15	30
Skull (Lat)	15	280	145	70	300
Abdomen (AP)	23	-	490	300	750
Cervical Spine (AP)	13	260	135	95	250
Thoracic Spine (AP)	23	665	260	145	900
Full Spine (AP)	23	280	-	-	300
Lumbar Spine (AP)	23	885	570	330	-
Lumbo-Sacral Spine (AP)	23	910	-	-	1000
Retrograde Pyelogram (AP)	23	-	-	-	900
Hip (AP)	23	450	-	-	-
Feet (AP)	8	-	-	-	270
Dental/Bitewing	0	-	-	334	700

3. Personnel Contacted:

Name	Office Symbol	Duty Title
Maj Kerry Lewis	36 MDOS/SGOAB	Aerospace Medicine Flight Commander, Base Radiation Safety Officer (RSO)
MSgt Gerald Campbell	36 MDOS/SGOAB	Superintendent Bioenvironmental Engineering Element
MSgt Armando Oaks	36 MDSS/SGSLF	Superintendent Biomedical Equipment Repair
TSgt Jason Bennett	36 MDSS/SGSAR	NCOIC, Diagnostic Imaging Element
TSgt Charles Comer	374 MDSS/SGSLE	NCOIC, Medical Equipment Repair Center
SSgt David Chesko	36 MDOS/SGOD	Dental

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4. Findings and Discussion:

a. Table 2 lists the diagnostic radiology equipment for which ESEs were calculated. Table 2 also lists the attachment and pages where ESE charts can be found.

Table 2: *Diagnostic Radiology Equipment*

Unit	MERC ID	Section	Room	ESE Data
GE Med Systems	2889	Radiology	Exam RM	Atch 2
Gendex 1000	2603	Dental	123	Atch 3 (page 1)
Planmeca PM2002	123	Dental	123	Atch 3 (page 2)
Trophy IRIX70	2991	Dental	Portable	Atch 3 (page 1)

b. ESEs were calculated using x-ray tube output data from the latest MERC inspection report. ESEs were all within AFI 48-148, *Ionizing Radiation Protection*, ESE guidelines and comparable to NEXT data for common diagnostic procedures.

c. Radiation safety training was properly completed and documented for the Diagnostic Imaging Element . The safety training binder could not be located for the Dental Clinic during this visit and was therefore not reviewed. Ensure this document is located and training is properly documented.

d. Radiation scatter surveys completed by the Bioenvironmental Engineering Element (BEE) were reviewed and show that shielding is adequate for the medical and dental x-ray systems currently in use. The medical x-ray unit was not operable during this visit. Ensure that a new radiation scatter survey is completed if the x-ray tube head is changed or a new system is installed.

e. The Diagnostic Imaging Element properly tracks repeat x-rays and completes a systematic analysis to determine cause. Over the last year the total repeat rate averaged less than five percent per month, well within national guidelines.

5. Recommendations: Retain this report in Radiology and BEE files for future Joint Commission on Accreditation of Healthcare Organizations (JCAHO) inspections. Additionally, ensure radiation safety training is documented for new individuals assigned to the Diagnostic Imaging Element and the Dental Clinic.

6. If you have any questions regarding this letter, please call me at DSN 315-634-2636, or e-mail me at bruce.goplin@kadena.af.mil.

Bruce A. Goplin

BRUCE A. GOPLIN, Capt, USAF, BSC
Chief, Radiation Services Branch

3. Atch
1. References
2. Medical ESE Charts
3. Dental ESE Charts

cc: 374 MDSS/SGSAR

References

1. Keriakes JG and Rosenstein M., Handbook of Radiation Doses in Nuclear Medicine and Diagnostic X-ray. Boca Raton FL. CRC, 212-213; 1980.

2. Conference of Radiation Control Program Directors. Nationwide Evaluation of X-ray Trends (NEXT), Tabulation and Graphical Summary of Survey 1984 through 1987. Frankfort, KY, 1989.

3. Radiation Protection Guidance to Federal Agencies for Diagnostic X-rays. Federal Register, Vol. 43, No. 22. 1 Feb 1978

RADIOGRAPHIC ENTRANCE SKIN EXPOSURES

A. SYSTEM PARAMETERS COMMONLY USED

1. System Designation: *General Electric, Fixed, ID # 2889*

	Minimum	Maximum
2. Range of kVps:	*50*	150
3. Range of mAs:	*0.64*	800
4. Source to Image Receptor Distance (SID):	40 in	
5. Typical Patient Thickness at Chest or Abdomen:	9 in	
6. Table Top to Image Receptor Distance (TTID):	3.75 in	
7. Source to Patient Distance for 9 in (23 cm) patient:	27.3 in	

B. RADIATION OUTPUT MEASUREMENTS

MERC data, 25 Jan 05

Technique: 100 mAs
Source to Chamber Distance: 27 in
Inverse Square Correction Factor: 0.98

kVp	Exposure mR	Calc. mR/mAs	Fit mR/mAs	%Diff
120	3142	31.42	31.55	0.41%
110	2704	27.04	26.92	-0.45%
100	2271	22.71	22.65	-0.26%
90	1882	18.82	18.75	-0.38%
80	1518	15.18	15.21	0.19%
75	1347	13.47	13.58	0.78%

		c1		*c2*		*c3*
Fit:	**mR/mAs=**	**-0.00274**	**+**	**0.04454 kVp**	**+**	**0.00182 kVp^2**

C. CALCULATED FREE AIR ENTRANCE SKIN EXPOSURES BY GENERAL PROCEDURE

	Est. films per Mo	Technique ** kVp	Technique ** mAs	SID (in)	TTID (in)	Patient (in)
1. Chest (PA)	92	120	3.2	72	2.75	9
2. Skull (Lat)	2	64	8	44	3.75	6
3. Abdomen (AP)	9	75	40	44	3.75	9
4. Cervical Spine (AP)	8	70	6	44	3.75	5
5. Thoracic Spine AP	6	76	25	44	3.75	9
6. Lumbar Spine (AP)	15	70	50	44	3.75	9
7. Retrograde Pyel. (PA)	0			44	3.75	9

***Obtained from TSgt Jason Bennett, 1 Mar 05*

	Calculated ESE (mR)	**Nat'l Avg ESE (mR) * 200 speed system**
1. Chest (PA)	**20.27**	25.00
2. Skull (Lat)	**51.22**	145.00
3. Abdomen AP	**405.36**	490.00
4. Cervical Spine (AP)	**42.36**	135.00
5. Thoracic Spine AP	**259.31**	260.00
6. Lumbar Spine (AP)	**449.13**	570.00
7. Retrograde Pyel. (PA)	**N/A**	Not Available

* ref: NEXT Survey

FOR MORE DETAILED INFORMATION, CONSULT THE COMPLETE ESE REPORT FOR THIS UNIT LOCATED IN THE CONTROL AREA WITH THE MANUAL TECHNIQUE CHART. FOR FURTHER QUESTIONS, CONSULT KADENA AT (315) 634-2636.

RADIOGRAPHIC ENTRANCE SKIN EXPOSURES

D. CALCULATED FREE AIR ENTRANCE SKIN EXPOSURES BY TECHNIQUE

Source to Chamber Distance: 27 in. Table Top to Film Distance: 3.75 in

Source to Image Distance: 40 in. Patient Thickness: 9 in

Inverse Square Correction Factor: 0.98174

	kVp							
mAs	50	70	80	90	100	110	120	130
1	6.7	11.8	14.9	18.4	22.2	26.4	31.0	35.9
2	13.3	23.6	29.9	36.8	44.5	52.9	61.9	71.8
4	26.6	47.3	59.7	73.6	88.9	105.7	123.9	143.5
6	39.9	70.9	89.6	110.4	133.4	158.6	185.8	215.3
8	53.2	94.5	119.4	147.2	177.9	211.4	247.8	287.0
10	66.5	118.1	149.3	184.1	222.4	264.3	309.7	358.8
12	79.8	141.8	179.2	220.9	266.8	317.1	371.7	430.5
14	93.1	165.4	209.0	257.7	311.3	370.0	433.6	502.3
16	106.4	189.0	238.9	294.5	355.8	422.8	495.6	574.0
18	119.7	212.6	268.8	331.3	400.3	475.7	557.5	645.8
20	133.0	236.3	298.6	368.1	444.7	528.5	619.5	717.6
22	146.3	259.9	328.5	404.9	489.2	581.4	681.4	789.3
24	159.6	283.5	358.3	441.7	533.7	634.2	743.4	861.1
26	172.9	307.1	388.2	478.5	578.2	687.1	805.3	932.8
28	186.2	330.8	418.1	515.4	622.6	740.0	867.3	1004.6
30	199.5	354.4	447.9	552.2	667.1	792.8	929.2	1076.3
32	212.8	378.0	477.8	589.0	711.6	845.7	991.2	1148.1
34	226.1	401.7	507.6	625.8	756.1	898.5	1053.1	1219.8
36	239.4	425.3	537.5	662.6	800.5	951.4	1115.0	1291.6
38	252.7	448.9	567.4	699.4	845.0	1004.2	1177.0	1363.4
40	266.0	472.5	597.2	736.2	889.5	1057.1	1238.9	1435.1
42	279.3	496.2	627.1	773.0	934.0	1109.9	1300.9	1506.9
44	292.6	519.8	656.9	809.8	978.4	1162.8	1362.8	1578.6
46	305.9	543.4	686.8	846.6	1022.9	1215.6	1424.8	1650.4
50	332.5	590.7	746.5	920.3	1111.9	1321.3	1548.7	1793.9
52	345.8	614.3	776.4	957.1	1156.3	1374.2	1610.6	1865.6
54	359.1	637.9	806.3	993.9	1200.8	1427.0	1672.6	1937.4
56	372.4	661.5	836.1	1030.7	1245.3	1479.9	1734.5	2009.1
58	385.7	685.2	866.0	1067.5	1289.8	1532.8	1796.5	2080.9
60	399.0	708.8	895.8	1104.3	1334.2	1585.6	1858.4	2152.7
65	432.3	767.9	970.5	1196.3	1445.4	1717.7	2013.3	2332.0
70	465.5	826.9	1045.1	1288.4	1556.6	1849.9	2168.2	2511.4
75	498.8	886.0	1119.8	1380.4	1667.8	1982.0	2323.0	2690.8
80	532.0	945.1	1194.5	1472.4	1779.0	2114.1	2477.9	2870.2
90	598.6	1063.2	1343.8	1656.5	2001.4	2378.4	2787.6	3229.0
100	665.1	1181.3	1493.1	1840.5	2223.7	2642.7	3097.4	3587.8
110	731.6	1299.5	1642.4	2024.6	2446.1	2907.0	3407.1	3946.5
120	798.1	1417.6	1791.7	2208.6	2668.5	3171.2	3716.8	4305.3
130	864.6	1535.7	1941.0	2392.7	2890.9	3435.5	4026.6	4664.1
140	931.1	1653.9	2090.3	2576.8	3113.2	3699.8	4336.3	5022.9
150	997.6	1772.0	2239.6	2760.8	3335.6	3964.0	4646.0	5381.6
200	1330.1	2362.7	2986.1	3681.1	4447.5	5285.4	6194.7	7175.5
250	1662.6	2953.3	3732.7	4601.3	5559.4	6606.7	7743.4	8969.4

RADIOGRAPHIC ENTRANCE SKIN EXPOSURES

E. CALCULATED FREE AIR ENTRANCE SKIN EXPOSURES BY SPECIFIC PROCEDURE: ADULT

Using Typical (Non Site-Specific) Techniques

General Site	Specific Site	View	SID (in)	TTID (in)	Thick (cm)	kVp	mAs	Exposure (mR)
Thoracic	Chest	PA/AP	72	2.75	23	110	8	43.3
Thoracic	Chest	Lat.	72	2.75	30	110	20	119.0
Thoracic	Chest	RAO-Obl	72	2.75	30	110	10	59.5
Thoracic	Chest	LAO-Obl	72	2.75	30	110	10	59.5
Thoracic	Chest	Decubitus	50	0	23	90	10	81.5
Thoracic	Chest	Lordotic	72	2.75	23	110	16	86.7
Thoracic	Ribs	PA/AP	72	2.75	20	60	120	214.2
Thoracic	Ribs	Obliques	72	2.75	25	64	175	372.4
Thoracic	Sternum	RAO	40	2.75	30	60	80	831.1
Thoracic	Sternum	LAO	40	2.75	30	60	80	831.1
Thoracic	Sternum	Lateral	40	2.75	30	66	100	1223.9
Abdomen	Abdomen	KUB/flat	40	3.75	23	76	35	479.4
Abdomen	Abdomen	KUB/Upright	40	2.75	23	76	50	637.1
Abdomen	Abdomen	Decubitus	40	3.75	23	76	30	410.9
Abdomen	Bladder	Cone Down	40	3.75	23	76	25	342.4
Head	Skull	PA	40	3.75	20	70	25	272.4
Head	Skull	AP Towne	40	3.75	20	70	40	435.8
Head	Skull	Lat.	40	3.75	15	66	16	137.6
Head	Sinuses	Waters	40	2.75	20	72	30	320.3
Head	Sinuses	Lateral	40	2.75	15	68	15	127.3
Head	Sinuses	PA Caldwell	40	2.75	20	68	25	241.6
Head	Facial Bones	Waters	40	3.75	20	66	50	491.8
Head	Facial Bones	Lat	40	3.75	20	62	20	176.6
Head	Facial Bones	PA Caldwell	40	3.75	20	64	30	279.8
Head	Facial Bones	SMV for ZygoA.	40	2.75	20	68	20	193.3
Head	Facial Bones	SMV CR IOML	40	2.75	20	68	60	579.9
Head	Mandible	PA	40	3.75	20	70	25	272.4
Head	Mandible	AP Towne	40	3.75	20	70	40	435.8
Head	Mandible	RT/LT Obliq.	40	0	20	58	15	92.2
Head	Mandible	SMV	40	2.75	20	70	60	609.9
Spine	Cervical	AP	40	2.75	23	70	12	132.4
Spine	Cervical	Open-Mouth	40	2.75	23	70	16	176.6
Spine	Cervical	Lat	72	2.75	30	76	40	122.8
Spine	Cervical	Obl. (5 view)	40	2.75	27	68	15	176.6
Spine	Thoracic	AP	40	3.75	23	72	16	199.3
Spine	Thoracic	Lat	40	3.75	30	72	75	1157.0
Spine	Thoracic	Fuch's	40	2.75	23	74	40	486.4
Spine	Thoracic	Swimmers	40	2.75	23	80	90	1255.2
Spine	Lumbar	AP	40	3.75	23	76	60	821.8
Spine	Lumber	Lat	40	3.75	27	80	160	2702.5
Spine	Lumbar	L-1/S-1 Spot	40	3.75	23	86	160	2726.6
Spine	Lumbar	Obliques	40	3.75	23	80	60	899.5

RADIOGRAPHIC ENTRANCE SKIN EXPOSURES

E. CALCULATED FREE AIR ENTRANCE SKIN EXPOSURES BY SPECIFIC PROCEDURE: ADULT

Using Typical (Non Site-Specific) Techniques

General Site	Specific Site	View	SID (in)	TTID (in)	Thick (cm)	kVp	mAs	Exposure (mR)
Spine	Sacrum	AP (15° ceph.)	40	3.75	23	74	30	392.1
Spine	Sacrum	Lateral	40	3.75	23	76	25	342.4
Spine	Coccyx	AP	40	3.75	23	70	30	355.8
Spine	Coccyx	Lateral	40	3.75	23	74	40	522.8
Spine	Scoliosis	AP	72	0	23	76	32	81.8
Spine	Scoliosis	Lat	72	0	23	76	45	115.0
Extrem.-Upper	Finger	AP/Obl/Lat	40	0	2	58	5	20.6
Extrem.-Upper	Hand	PA/Obl	40	0	5	58	5	21.9
Extrem.-Upper	Hand	Lat	40	0	5	60	7	32.5
Extrem.-Upper	Wrist	PA/Obl/Radial	40	0	5	60	6.5	30.2
Extrem.-Upper	Wrist	Lat.	40	0	5	62	7	34.4
Extrem.-Upper	Forearm	AP/Lat	40	0	7	64	6	32.5
Extrem.-Upper	Elbow	AP/Lat/Obl	40	0	7	66	6	34.3
Extrem.-Upper	Humerous	AP/Lat	40	2.75	7	64	14	88.4
Extrem.-Upper	Shoulder	AP Int. & Ext.	40	2.75	16	64	20	156.8
Extrem.-Upper	Shoulder	Y-view 10°	40	2.75	16	68	35	304.7
Extrem.-Upper	Acromio-Clavi.	AC Joints	72	2.75	16	72	25	58.1
Extrem.-Upper	Clavicle	AP/Angle	40	2.75	20	66	10	91.8
Extrem.-Upper	Scapula	AP	40	2.75	20	64	14	121.8
Extrem.-Upper	Scapula	Y-view	40	2.75	20	68	35	338.3
Extrem. - Lower	Pelvis	AP	40	3.75	23	76	25	342.4
Extrem. - Lower	Hip	AP/Frog	40	3.75	21	76	25	323.4
Extrem. - Lower	SI Joints	AP 30-35 caud	40	3.75	21	74	30	370.3
Extrem. - Lower	Femur	AP Proximal	40	3.75	17	68	20	191.0
Extrem. - Lower	Femur	AP Distal	40	3.75	17	68	12	114.6
Extrem. - Lower	Femur	Lat Proximal	40	3.75	17	68	22	210.0
Extrem. - Lower	Femur	Lat Distal	40	3.75	17	68	12	114.6
Extrem. - Lower	Knee	AP/Lat	40	3.75	12	60	12	81.2
Extrem. - Lower	Knee	AP with wt.	72	2.75	12	65	25	46.3
Extrem. - Lower	Knee	Homeblad	40	0	12	64	10	60.4
Extrem. - Lower	Knee	Sunrise	40	0	12	66	8	50.9
Extrem. - Lower	Tibia-Fibula	AP/Lat	50	0	12	64	10	36.6
Extrem. - Lower	Ankle	AP/Mort./Lat	40	0	10	64	8	46.2
Extrem. - Lower	Oscalcis (heel)	Inferior/Sup.	40	0	10	64	18	103.9
Extrem. - Lower	Oscalcis(heel)	Lateral	40	0	10	62	8	43.7
Extrem. - Lower	Foot	AP/Oblique	40	0	5	58	6	26.3
Extrem. - Lower	Foot	Lateral	40	0	5	62	8	39.3
Extrem. - Lower	Toe	AP/Lat/Obl	72	0	2	58	5	6.3

RADIOGRAPHIC ENTRANCE SKIN EXPOSURES

E. CALCULATED FREE AIR ENTRANCE SKIN EXPOSURES BY SPECIFIC PROCEDURE: PEDS

Using Typical (Non Site-Specific) Techniques

General Site	Specific Site	View	SID (in)	TTID (in)	Thick (cm)	kVp	mAs	Exposure (mR)
Thoracic	Chest	PA/AP	72	0	11.5	70	6	11.6
Thoracic	Chest	Lateral	72	0	15	76	8	18.5
Head	Skull	AP/AP Towne	40	3.75	10	64	12	86.3
Head	Skull	Rt Lat	40	3.75	7.5	60	8	48.5
Head	Sinuses	Waters	40	3.75	10	62	15	102.2
Head	Sinuses	Caldwell	40	3.75	10	62	10	68.1
Abdomen	Abdomen	KUB	40	3.75	11.5	68	14	116.0

Prepared by: BRUCE A. GOPLIN, Capt, USAF, BSC
Health Physicist
Det 3, AFIOH/CDR
Kadena AB, Okinawa, Japan

Dental Entrance Skin Exposure

Entrance Skin Exposure (ESE) Calculations

A. SYSTEM PARAMETERS COMMONLY USED

1. System Designation:

Gendex Model 1000 Index # 2603

Control S/N: 1290489DP; Tube S/N: 18359

2. Source to Image Receptor Distance (SID)*:

16 in

**Also assumed to be the distance to the patient*

B. RADIATION OUTPUT MEASUREMENTS

Technique: 10 mAs

Source to Chamber Distance: 16 in

kVp	Exposure mR
90	297

MERC data collected Jan 05

C. FREE-AIR ENTRANCE SKIN EXPOSURE

Calculated ESE (mR)	Typical Bitewing ESE (mR)**
297.00	334.00

**Ref: NEXT Survey

The Entrance Skin Exposure for this unit using MERC technique is:

297 mR

Prepared by: BRUCE A. GOPLIN, Capt, USAF, BSC
Health Physicist
Det 3, AFIOH/CDR
Kadena AB, Okinawa, Japan

Entrance Skin Exposure (ESE) Calculations

A. SYSTEM PARAMETERS COMMONLY USED

1. System Designation:

Trophy Model IRIX70 Index # 2991 (Portable)

Control S/N: S23045; Tube S/N: 330030

2. Source to Image Receptor Distance (SID)*:

12 in

**Also assumed to be the distance to the patient*

B. RADIATION OUTPUT MEASUREMENTS

Technique: 10 mAs

Source to Chamber Distance: 12 in

kVp	Exposure mR
90	296.6

MERC data collected Jan 05

C. FREE-AIR ENTRANCE SKIN EXPOSURE

Calculated ESE (MR)	Typical Bitewing ESE (mR)**
296.60	334.00

**Ref: NEXT Survey

The Entrance Skin Exposure for this unit using MERC technique is:

297 mR

Prepared by: BRUCE A. GOPLIN, Capt, USAF, BSC
Health Physicist
Det 3, AFIOH/CDR
Kadena AB, Okinawa, Japan

Entrance Skin Exposure (ESE) Calculations

A. SYSTEM PARAMETERS COMMONLY USED

1. System Designation:

Planmeca Panoramic Model PM 2002 CC Index # 2933

Control S/N: RCC 013990; Tube S/N: 0L9504

2. Source to Image Receptor Distance (SID)*:

12 in

**: Also assumed to be the distance to the patient*

B. RADIATION OUTPUT MEASUREMENTS

Technique: 228 mAs 19 sec, 12 mA

Source to Chamber Distance: 12 in

One Sweep

kVp	Exposure mR
80	332

C. FREE-AIR ENTRANCE SKIN EXPOSURE

Calculated ESE (mR)
332.00

The Entrance Skin Exposure for this unit assuming a typical adult technique is:

332 mR

FOR MORE DETAILED INFORMATION, CONSULT THE COMPLETE ESE REPORT FOR THIS UNIT LOCATED IN THE CONTROL AREA WITH THE MANUAL TECHNIQUE CHART. FOR FURTHER QUESTIONS, CONSULT KADENA AT (315) 634-2636.

Prepared by: BRUCE A. GOPLIN, Capt, USAF, BSC
Health Physicist
Det 3, AFIOH/CDR
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