FORT McCLELLAN

Anniston, Alabama

APPENDIX K

AIR SAMPLE DATA and ANALYSIS

DECEMBER 1996

ALLIED TECHNOLOGY GROUP

AIR SAMPLE IDENTIFICATION RECORD

Project/Location: FORT MCCLELLAN - B3192

Sample ID	Date	Location	Initial Count α Results In μCi/ml	Initial Count βγ Results In μCi/ml	Decayed Count α Results In μCi/ml	Decayed Count βγ Results In μCi/ml	# of Hours Decayed
FMA-101	11/13/95	B 3192 CLASSROOM	$1.35E^{-10}$	$2.19E^{-10}$	$8.9E^{-12}$	$2E^{-13}$	3
FMA-102	11/14/95	B 3192 CLASSROOM	$1.0E^{-11}$	$1.8E^{-11}$	$3.6E^{-12}$	$7.1E^{-12}$	3
FMA-103	11/14/95	EAST WALL Remov Block Removal	$5.0E^{-11}$	$8.9E^{-10}$	$1.1E^{-12}$	$1.2E^{-12}$	3
FMA-104	11/14/95	CLASSROOM Bldg 3192 Ceiling Removal	$2.3E^{-10}$	$4.5E^{-10}$	$1.3E^{-11}$	$3.6E^{-11}$	3
FMA-105	11/15/95	CLASS Room Bldg 3192 Ceiling Removal	$8.5E^{-12}$	$1.6E^{-11}$	N/A	N/A	N/A
FMA-106	11/15/95	CLASS Room Bldg 3192 METAL Removal	$4.9E^{-12}$	$8.6E^{-12}$	N/A	N/A	N/A
FMA-107	11/16/95	G/A	$5.2E^{-12}$	$7.7E^{-12}$	N/A	N/A	N/A
FMA-108	11/16/95	VENT CUT B2	$9.5E^{-11}$	$1.8E^{-10}$	N/A	N/A	N/A
FMA-109	11/16/95	G/A	$5.2E^{-11}$	$9.4E^{-11}$	N/A	N/A	N/A
FMA-110	11/16/95	VENT CUT	$1.8E^{-11}$	$3E^{-11}$	N/A	N/A	N/A
FMA-111	11/20/95	CLASSROOM Bldg 3192	$9.7E^{-12}$ ~~$3.9E^{-12}$~~	$8.8E^{-13}$ ~~$2.1E$~~	N/A	N/A	N/A
FMA-112	11/20/95	CLASS ROOM Bldg 3192	$1.1E^{-11}$	$2.7E^{-11}$	N/A	N/A	N/A
FMA-113	11/20/95	HOT CELL ROOF	$3.4E^{-13}$	$5.8E^{-13}$	N/A	N/A	N/A
FMA-114	11/21/95	SEWER HOLE	$4.3E^{-11}$	$1.1E^{-10}$	N/A	N/A	N/A
FMA-115	11/21/95	DUCTWORK CUTTING	$2.5E^{-13}$	$7.1E^{-12}$	N/A	N/A	N/A
FMA-116	11/22/95	DUCTWORK CUTTING	$6.8E^{-12}$	$1.1E^{-11}$	N/A	N/A	N/A
FMA-117	11/22/95	DUCT WORK CUTTING	$1.7E^{-11}$	$3.3E^{-11}$	N/A	N/A	N/A
FMA-118	11/27/95	INSIDE HOT CELL	$7.6E^{-11}$	$1.3E^{-10}$	N/A	N/A	N/A

AIR SAMPLE IDENTIFICATION RECORD

Project/Location: FORT McCLELLAN-B3192

Sample ID	Date	Location	Initial Count α Results In μCi/ml	Initial Count βγ Results In μCi/ml	Decayed Count α Results In μCi/ml	Decayed Count βγ Results In μCi/ml	# of Hours Decayed
FMA-119	11/27/95	HVAC	$8.3E^{-12}$	$1.5E^{-11}$	N/A	N/A	NA
FMA-120	11/28/95	BLDG 3192 CLASS Room	$1.6E^{-10}$	$2.4E^{-10}$	$5E^{-12}$	$9E^{-12}$	3
FMA-121	11/29/95	HOT Cell	$1.1E^{-10}$	$1.9E^{-10}$	$4.6E^{-12}$	$6.8E^{-12}$	3
FMA-122	11/29/95	HOT Cell	$1.1E^{-10}$	$1.9E^{-10}$	$7.2E^{-13}$	$5E^{-12}$	20
FMA-123	11/30/95	TOP HOT Cell	$1.6E^{-10}$	$2.8E^{-10}$	$6E^{-12}$	$1.5E^{-11}$	3
FMA-124	11/30/95	JACK HAMMERING I/S HOT CELL	$5.4E^{-12}$	$1.5E^{-11}$	N/A	N/A	N/A
FMA-125	11/30/95	JACK HAMMERING I/S HOT CELL	$4.6E^{-13}$	$1.5E^{-12}$	N/A	N/A	N/A
FMA-126	12/4/95	DECON TOP OF HOT CELL	$1.8E^{-10}$	$2.9E^{-10}$	$6.2E^{-12}$	$1.2E^{-11}$	3
FMA-127	12/4/95	SCABBLING IN HOT CELL	$1.7E^{-11}$	$1.1E^{-10}$	N/A	N/A	N/A
FMA-128	12/5/95	HOT Cell	$1.1E^{-10}$	$2.1E^{-10}$	$1.6E^{-12}$	$1.6E^{-11}$	20
~~FMA-129~~	~~12/6/95~~	~~TOP OF HOT CELL JACK HAMMER~~	$3.4E^{-11}$	$1.1E^{-10}$	N/A	N/A	N/A
FMA-129	12/6/95	TOP OF HOT CELL JACK HAMMER	$1.4E^{-10}$	$4.5E^{-10}$	$3.7E^{-12}$	$2.5E^{-11}$	3
FMA 130	12/6/95	TOP OF HOT Cell Jack Hammer	$1.1E^{-10}$	$4.5E^{-10}$	$3.3E^{-12}$	$2.2E^{-11}$	3
FMA 131	12/7/95	TOP OF HOT CELL	$1.2E^{-11}$	$4E^{-11}$	N/A	N/A	N/A
FMA 132	12/11/95	TOP OF HOT CELL	$3.92E^{-11}$	$1.6E^{-10}$	N/A	N/A	N/A
FMA-133	12/11/95	INSIDE OF HOT CELL	$1.8E^{-12}$	$6.4E^{-12}$	N/A	N/A	N/A
FMA-134	12/12/95	I/S HOT CELL	$1.5E^{-11}$	$6.3E^{-10}$	N/A	N/A	N/A
~~FMA-135~~	~~12/12/95~~	~~CLASSROOM HEPA FILTER~~	~~$2.7E^{-12}$~~	~~$6.8E^{-11}$~~			

JE2 12/12/95

AIR SAMPLE IDENTIFICATION RECORD

Project/Location: _____

Sample ID	Date	Location	Initial Count α Results In μCi/ml	Initial Count βγ Results In μCi/ml	Decayed Count α Results In μCi/ml	Decayed Count βγ Results In μCi/ml	# of Hours Decayed
FMA-135	12/12/95	HEPA FILTER CHANGE OUT	$6.6E^{-11}$	$2.7E^{-10}$	N/A	N/A	N/A
FMA-136	12/13/95	HOT CELL	$2.7E^{-12}$	$6.2E^{-12}$	N/A	N/A	N/A
FMA-137	12/14/95	HEPA C/O I/S HOT CELL	$4.7E^{-11}$	$1.6E^{-10}$	N/A	N/A	N/A
FMA-138	12/14/95	HOT CELL VENTILATION ROOM	$4.4E^{-11}$	$1.2E^{-10}$	N/A	N/A	N/A
FMA-139	12/18/95	JACK HAMMERING OS HOT CELL	$1.9E^{-11}$	$6.5E^{-11}$	N/A	N/A	N/A
FMA-140	12/19/95	JACKHAMMERING OS HOT CELL	$2.7E^{-11}$	$1.2E^{-10}$	N/A	N/A	N/A
FMA-141	12/20/95	JACK HAMMER O/S HOT CELL	$2.2E^{-11}$	$1.0E^{-10}$	N/A	N/A	N/A

AIR SAMPLE IDENTIFICATION RECORD

Project/Location: FT McClellan

	Sample ID	Date	Location	Initial Count α Results In μCi/ml	Initial Count βγ Results In μCi/ml	Decayed Count α Results In μCi/ml	Decayed Count βγ Results In μCi/ml	# of Hours Decayed
142	FMA-135	7-2-96	HVAC Room 3192 Bldg	1.1 E-10	1.8 E-10	N/A	N/A	N/A
143	FMA-136	7-2-96	OUTSIDE HOT CELL DOOR IN BLDG 3192	4.95 E-13	9.5 E-13	N/A	N/A	N/A
144	FMA-137	~~7-5-96~~	Bldg 3192	5.7 E-11	1.1 E-10	N/A	N/A	N/A
145	FMA-138	7-5-96	Bldg 3192	1.4 E-10	2.2 E-10	N/A	N/A	N/A
146	FMA-139	7-8-96	Hot Cell Bldg 3192	3.7 E-11	5.4 E-11	N/A	N/A	N/A
147	FMA-140	7-8-96	Hot Cell Bldg 3192	2 E-11	2.5 E-10	N/A	N/A	N/A
148	FMA-141	7-9-96	BLDG 3192	2.9 E-12	3.5 E-12	N/A	N/A	N/A
149	FMA-142	7-9-96	Hot Cell Trench	1.4 E-11	1.5 E-11	N/A	N/A	N/A
150	FMA-143	7-9-96	Hot Cell Pipe cut out	3.3 E-11	5.9 E-11	N/A	N/A	N/A
151	FMA-144	7-9-96	Bldg 3182 museum	1.9 E-12	2.1 E-11	N/A	N/A	N/A
152	FMA-145	7-10-96	Bldg 3182 museum	2.1 E-11	5 E-11	N/A	N/A	N/A
153	FMA-146	7-10-96	Bldg 3192 Hot Cell	3.3 E-11	5.8 E-11	N/A	N/A	N/A
154	FMA-147	7-10-96	Bldg 3182 Museum V/S Tent	1.8 E-11	4 E-11	N/A	N/A	N/A
155	FMA-148	7-10-96	Bldg 3182 museum V/S Tent	3.9 E-12	1.7 E-11	N/A	N/A	N/A
156	FMA-149	7-11-96	Bldg 3192 Hot Cell	7.8 E-12	2.5 E-11	N/A	N/A	N/A
157	FMA-150	7-11-96	Bldg 3192 Hot Cell	2.2 E-11	7.9 E-11	N/A	N/A	N/A
158	FMA-151	7-11-96	Bldg 3182 Museum	5.3 E-11	8 E-11	N/A	N/A	N/A
159	FMA-152	7-11-96	Bldg 3182 Museum	7.4 E-12	1.2 E-11	N/A	N/A	N/A

AIR SAMPLE IDENTIFICATION RECORD

Project/Location: FT Mc CLeCLAN

Sample ID	Date	Location	Initial Count α Results In µCi/ml	Initial Count βγ Results In µCi/ml	Decayed Count α Results In µCi/ml	Decayed Count βγ Results In µCi/ml	# of Hours Decayed
FMA-160	7-12-96	Museum Bldg 3182	1.2 E-13	2.1 E-12	N/A	N/A	N/A
FMA 161	7-12-96	Hot Cell Bldg 3192	8.9 E-13	6.5 E-12	N/A	N/A	N/A
FMA-162	7-12-96	Museum Bldg 3182	1.6 E-11	2.8 E-11	N/A	N/A	N/A
FMA-163	7-12-96	Bldg 3192 Hot Cell	3.6 E-11	8.5 E-11	N/A	N/A	N/A
FMA-164	7-15-96	Museum Bldg 3182 I/S Containment	5.4 E-13	3.6 E-12	N/A	N/A	N/A
FMA-165	7-15-96	Bldg 3192 By Trench	1.9 E-11	3.5 E-11	N/A	N/A	N/A
FMA-166	7-16-96	Bldg 3192 General Area	1.7 E-12	3.6 E-12	N/A	N/A	N/A
FMA-167	7-16-96	BDG 3192 Hot Cell	2.7 E-12	3 E-12	N/A	N/A	N/A
FMA-168	7-16-96	Bldg 3192 Hot Cell	1.5 E-11	5.6 E-11	N/A	N/A	N/A
FMA-168	7-17-96	Bldg 3192 Roof Hot Cell	2.8 E-11	4.8 E-11	N/A	N/A	N/A
FMA-169	7-17-96	Bldg 3192 Hot Cell	6.1 E-12	1.2 E-11	N/A	N/A	N/A
FMA-170	7-18-96	Bldg 3192 Hot Cell	5 E-13	-1.4 E-12	N/A	N/A	N/A
FMA-171	7-18-96	Bldg 3182 Museum	8.3 E-13	1.8 E-12	N/A	N/A	N/A
FMA-172	7-18-96	Bldg 3192 Hot Cell	3.4 E-13	2 E-12	N/A	N/A	N/A
FMA-173	7-19-96	Bldg 3192 Hot Cell	1.5 E-11	3.2 E-11	N/A	N/A	N/A
FMA-174	7-22-96	BLDG 3192 Hot Cell	9.1 E-12	2.2 E-11	N/A	N/A	N/A
FMA-175	7-23-96	Bldg 3192 Hot Cell	3.7 E-11	6.4 E-11	N/A	N/A	N/A
FMA-176	7-23-96	Bldg 3192 Hot Cell	4.8 E-11	9.5 E-11	N/A	N/A	N/A

AIR SAMPLE IDENTIFICATION RECORD

Project/Location: FORT McCLELLAN BLDG-3192

Sample ID	Date	Location	Initial Count α Results In μCi/ml	Initial Count βγ Results In μCi/ml	Decayed Count α Results In μCi/ml	Decayed Count βγ Results In μCi/ml	# of Hours Decayed
FMA177	07-24-96	BLDG 3192 Hot Cell	6.6E-12	1.9E-11	N/A	N/A	N/A
FMA 178	07-25-96	BLDG 3192 Hot Cell	2.4 E-14	2.1E-13	N/A	N/A	N/A

AIR SAMPLE IDENTIFICATION RECORD

Project/Location: Fort McClellan

Sample ID	Date	Location	Initial Count α Results In μCi/ml	Initial Count βγ Results In μCi/ml	Decayed Count α Results In μCi/ml	Decayed Count βγ Results In μCi/ml	# of Hours Decayed
FMA-101	11/13/95	Bldg. 3192 - Classroom	1.35 E^{-10}	2.19 E^{-10}	8.9 E^{-12}	2 E^{-13}	3
FMA-102	11/14/95	Bldg. 3192 - Classroom	1.0 E^{-11}	1.8 E^{-11}	3.6 E^{-12}	7.1 E^{-12}	3
FMA-103	11/14/95	East Wall Block Removal	5.0 E^{-11}	8.9 E^{-10}	1.1 E^{-12}	1.2 E^{-12}	3
FMA-104	11/14/95	Blgd. 3192 - Classroom Ceiling Removal	2.3 E^{-10}	4.5 E^{-10}	1.3 E^{-11}	3.6 E^{-11}	3
FMA-105	11/15/95	Blgd. 3192 - Classroom Ceiling Removal	8.5 E^{-12}	1.6 E^{-11}	N/A	N/A	N/A
FMA-106	11/15/95	Blgd. 3192 - Classroom Metal Removal	4.9 E^{-12}	8.6 E^{-12}	N/A	N/A	N/A
FMA-107	11/16/95	Blgd. 3192 - Classroom Metal Removal - G/A	5.2 E^{-12}	7.7 E^{-12}	N/A	N/A	N/A
FMA-108	11/16/95	Blgd. 3192 - Classroom Metal Removal - Vent Cut	9.5 E^{-11}	1.8 E^{-10}	N/A	N/A	N/A
FMA-109	11/16/95	Blgd. 3192 - Classroom Metal Removal - G/A	5.2 E^{-11}	9.4 E^{-11}	N/A	N/A	N/A
FMA-110	11/16/95	Blgd. 3192 - Classroom Metal Removal - Vent Cut	1.8 E^{-11}	3 E^{-11}	N/A	N/A	N/A
FMA-111	11/20/95	Bldg. 3192 - Classroom	4.7 E^{-12}	8.8 E^{-12}	N/A	N/A	N/A
FMA-112	11/20/95	Bldg. 3192 - Classroom	1.1 E^{-11}	2.7 E^{-11}	N/A	N/A	N/A
FMA-113	11/20/95	Hot Cell Roof	3.4 E^{-13}	5.8 E^{-13}	N/A	N/A	N/A
FMA-114	11/21/95	Sewer Hole	4.3 E^{-11}	1.1 E^{-10}	N/A	N/A	N/A

AIR SAMPLE IDENTIFICATION RECORD

Project/Location: Fort McClellan

Sample ID	Date	Location	Initial Count α Results In μCi/ml	Initial Count βγ Results In μCi/ml	Decayed Count α Results In μCi/ml	Decayed Count βγ Results In μCi/ml	# of Hours Decayed
FMA-115	11/21/95	Duct Work Cutting	2.5 E^{-13}	7.1 E^{-12}	N/A	N/A	N/A
FMA-116	11/22/95	Duct Work Cutting	6.8 E^{-12}	1.1 E^{-11}	N/A	N/A	N/A
FMA-117	11/22/95	Duct Work Cutting	1.7 E^{-11}	3.3 E^{-11}	N/A	N/A	N/A
FMA-118	11/27/95	Inside Hot Cell	7.6 E^{-11}	1.3 E^{-10}	N/A	N/A	N/A
FMA-119	11/27/95	HVAC	8.3 E^{-12}	1.5 E^{-11}	N/A	N/A	N/A
FMA-120	11/28/95	Bldg. 3192 - Classroom	1.6 E^{-10}	2.4 E^{-10}	5 E^{-12}	9 E^{-12}	3
FMA-121	11/29/95	Hot Cell	1.1 E^{-10}	1.7 E^{-10}	4.6 E^{-12}	6.8 E^{-12}	3
FMA-122	11/29/95	Hot Cell	1.1 E^{-10}	1.9 E^{-10}	7.2 E^{-13}	5 E^{-12}	20
FMA-123	11/30/95	Top Hot Cell	1.6 E^{-10}	2.8 E^{-10}	6 E^{-12}	1.5 E^{-11}	3
FMA-124	11/30/95	Jackhammering Inside Hot Cell	5.4 E^{-12}	1.5 E^{-11}	N/A	N/A	N/A
FMA-125	11/30/95	Jackhammering Inside Hot Cell	4.6 E^{-13}	1.5 E^{-12}	N/A	N/A	N/A
FMA-126	12/04/95	Decon Top of Hot Cell	1.8 E^{-10}	2.9 E^{-10}	6.2 E^{-12}	1.2 E^{-11}	3
FMA-127	12/04/95	Scabbling In Hot Cell	1.7 E^{-11}	1.1 E^{-10}	N/A	N/A	N/A
FMA-128	12/05/95	Hot Cell	1.1 E^{-10}	2.1 E^{-10}	1.6 E^{-12}	1.6 E^{-11}	20
FMA-129	12/06/95	Top of Hot Cell Jackhammer	1.4 E^{-10}	4.5 E^{-10}	3.7 E^{-12}	2.5 E^{-11}	3
FMA-130	12/06/95	Top of Hot Cell Jackhammer	1.1 E^{-10}	4.5 E^{-10}	3.3 E^{-12}	2.2 E^{-11}	3
FMA-131	12/07/95	Top of Hot Cell	1.2 E^{-11}	4 E^{-11}	N/A	N/A	N/A
FMA-132	12/11/95	Top of Hot Cell	3.92 E^{-11}	1.6 E^{-10}	N/A	N/A	N/A

AIR SAMPLE IDENTIFICATION RECORD

Project/Location: Fort McClellan

Sample ID	Date	Location	Initial Count α Results In μCi/ml	Initial Count βγ Results In μCi/ml	Decayed Count α Results In μCi/ml	Decayed Count βγ Results In μCi/ml	# of Hours Decayed
FMA-133	12/11/95	Inside of Hot Cell	$1.8\ E^{-12}$	$6.4\ E^{-12}$	N/A	N/A	N/A
FMA-134	12/12/95	Inside of Hot Cell	$1.5\ E^{-11}$	$6.3\ E^{-10}$	N/A	N/A	N/A
FMA-135	12/12/95	HEPA Filter Change Out	$6.6\ E^{-11}$	$2.7\ E^{-10}$	N/A	N/A	N/A
FMA-136	12/13/95	Hot Cell	$2.7\ E^{-12}$	$6.2\ E^{-12}$	N/A	N/A	N/A
FMA-137	12/14/95	HEPA Change Out Inside Hot Cell	$4.7\ E^{-11}$	$1.6\ E^{-10}$	N/A	N/A	N/A
FMA-138	12/14/95	Hot Cell Ventilation Room	$4.4\ E^{-11}$	$1.2\ E^{-10}$	N/A	N/A	N/A
FMA-139	12/18/95	Jackhammering Outside Hot Cell	$1.9\ E^{-11}$	$6.5\ E^{-11}$	N/A	N/A	N/A
FMA-140	12/19/95	Jackhammering Outside Hot Cell	$2.7\ E^{-11}$	$1.2\ E^{-10}$	N/A	N/A	N/A
FMA-141	12/20/95	Jackhammering Outside Hot Cell	$2.2\ E^{-11}$	$1.0\ E^{-10}$	N/A	N/A	N/A

AIR SAMPLE IDENTIFICATION RECORD

Project/Location: Fort McClellan

Sample ID	Date	Location	Initial Count α Results In μCi/ml	Initial Count βγ Results In μCi/ml	Decayed Count α Results In μCi/ml	Decayed Count βγ Results In μCi/ml	# of Hours Decayed
FMA-142	7/02/96	Bldg. 3192 - HVAC Room	1.1 E^{-10}	1.8 E^{-10}	N/A	N/A	N/A
FMA-143	7/02/96	Bldg. 3192 - Outside Hot Cell Door	4.95 E^{-13}	9.5 E^{-13}	N/A	N/A	N/A
FMA-144	7/05/96	Building 3192	5.7 E^{-11}	1.1 E^{-10}	N/A	N/A	N/A
FMA-145	7/05/96	Building 3192	1.4 E^{-10}	2.2 E^{-10}	N/A	N/A	N/A
FMA-146	7/08/96	Bldg. 3192 - Hot Cell	3.7 E^{-11}	5.4 E^{-11}	N/A	N/A	N/A
FMA-147	7/08/96	Bldg. 3192 - Hot Cell	2 E^{-11}	2.5 E^{-10}	N/A	N/A	N/A
FMA-148	7/09/96	Building 3192	2.9 E^{-12}	3.5 E^{-12}	N/A	N/A	N/A
FMA-149	7/09/96	Hot Cell Trench	1.4 E^{-11}	1.5 E^{-11}	N/A	N/A	N/A
FMA-150	7/09/96	Hot Cell Pipe Cut Out	3.3 E^{-11}	5.8 E^{-11}	N/A	N/A	N/A
FMA-151	7/09/96	Building 3182 - Museum	1.9 E^{-12}	2.1 E^{-11}	N/A	N/A	N/A
FMA-152	7/10/96	Building 3182 - Museum	2.1 E^{-11}	5 E^{-11}	N/A	N/A	N/A
FMA-153	7/10/96	Bldg. 3192 - Hot Cell	3.3 E^{-11}	5.8 E^{-11}	N/A	N/A	N/A
FMA-154	7/10/96	Bldg. 3182 - Museum - Inside Tent	1.8 E^{-11}	4 E^{-11}	N/A	N/A	N/A
FMA-155	7/10/96	Bldg. 3182 - Museum - Inside Tent	3.9 E^{-12}	1.7 E^{-11}	N/A	N/A	N/A
FMA-156	7/11/96	Bldg. 3192 - Hot Cell	7.8 E^{-12}	2.5 E^{-11}	N/A	N/A	N/A
FMA-157	7/11/96	Bldg. 3192 - Hot Cell	2.2 E^{-11}	7.9 E^{-11}	N/A	N/A	N/A
FMA-158	7/11/96	Bldg. 3182 - Museum	5.3 E^{-11}	8 E^{-11}	N/A	N/A	N/A
FMA-159	7/11/96	Bldg. 3182 - Museum	7.4 E^{-12}	1.2 E^{-11}	N/A	N/A	N/A

AIR SAMPLE IDENTIFICATION RECORD

Project/Location: Fort McClellan

Sample ID	Date	Location	Initial Count α Results In μCi/ml	Initial Count βγ Results In μCi/ml	Decayed Count α Results In μCi/ml	Decayed Count βγ Results In μCi/ml	# of Hours Decayed
FMA-160	7/12/96	Bldg. 3182 - Museum	$1.2\ E^{-13}$	$2.1\ E^{-12}$	N/A	N/A	N/A
FMA-161	7/12/96	Bldg. 3192 - Hot Cell	$8.9\ E^{-13}$	$6.5\ E^{-12}$	N/A	N/A	N/A
FMA-162	7/12/96	Bldg. 3182 - Museum	$1.6\ E^{-11}$	$2.8\ E^{-11}$	N/A	N/A	N/A
FMA-163	7/12/96	Bldg. 3192 - Hot Cell	$3.6\ E^{-11}$	$8.5\ E^{-11}$	N/A	N/A	N/A
FMA-164	7/15/96	Bldg. 3182 - Museum - Inside Containment	$5.4\ E^{-13}$	$3.6\ E^{-12}$	N/A	N/A	N/A
FMA-165	7/15/96	Bldg. 3192 - By Trench	$1.9\ E^{-11}$	$3.5\ E^{-11}$	N/A	N/A	N/A
FMA-166	7/16/96	Bldg. 3192 - General Area	$1.7\ E^{-12}$	$3.6\ E^{-12}$	N/A	N/A	N/A
FMA-167	7/16/96	Bldg. 3192 - Hot Cell	$2.7\ E^{-12}$	$3\ E^{-12}$	N/A	N/A	N/A
FMA-167	7/16/96	Bldg. 3192 - Hot Cell	$1.5\ E^{-11}$	$5.6\ E^{-11}$	N/A	N/A	N/A
FMA-168	7/17/96	Bldg. 3192 - Hot Cell Roof	$2.8\ E^{-11}$	$4.8\ E^{-11}$	N/A	N/A	N/A
FMA-169	7/17/96	Bldg. 3192 - Museum	$6.1\ E^{-12}$	$1.2\ E^{-11}$	N/A	N/A	N/A
FMA-170	7/18/96	Bldg. 3182 - Hot Cell	$5\ E^{-13}$	$1.4\ E^{-12}$	N/A	N/A	N/A
FMA-171	7/18/96	Bldg. 3192 - Hot Cell	$8.3\ E^{-13}$	$1.8\ E^{-12}$	N/A	N/A	N/A
FMA-172	7/19/96	Bldg. 3192 - Hot Cell	$3.4\ E^{-13}$	$2\ E^{-12}$	N/A	N/A	N/A
FMA-173	7/19/96	Bldg. 3192 - Hot Cell	$1.5\ E^{-11}$	$3.2\ E^{-11}$	N/A	N/A	N/A
FMA-174	7/22/96	Bldg. 3192 - Hot Cell	$9.1\ E^{-12}$	$2.2\ E^{-11}$	N/A	N/A	N/A
FMA-175	7/23/96	Bldg. 3192 - Hot Cell	$3.7\ E^{-11}$	$6.4\ E^{-11}$	N/A	N/A	N/A

AIR SAMPLE IDENTIFICATION RECORD

Project/Location: Fort McClellan

Sample ID	Date	Location	Initial Count α Results In μCi/ml	Initial Count βγ Results In μCi/ml	Decayed Count α Results In μCi/ml	Decayed Count βγ Results In μCi/ml	# of Hours Decayed
FMA-176	7/23/96	Bldg. 3192 - Hot Cell	$4.8\ E^{-11}$	$9.5\ E^{-11}$	N/A	N/A	N/A
FMA-177	7/24/96	Bldg. 3192 - Hot Cell	$6.6\ E^{-12}$	$1.9\ E^{-11}$	N/A	N/A	N/A
FMA-178	7/25/96	Bldg. 3192 - Hot Cell	$2.4\ E^{-14}$	$2.1\ E^{-13}$	N/A	N/A	N/A

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FORT McCLELLAN-B3192

A/S ID Number: FMA-101 RWP Number: FM-101 ATGS Number: FMA-101

Date Start: 11/13/95 Date Stop: 11/13/95

Time Start: 1115 Time Stop: 1315 Total Time: 120 minutes

Sample Location: CLASSROOM-B3192

Sample Type: ☐ Breathing Zone ☒ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: BASELINE - NO WORK IN PROGRESS

Technician Performing Sample: R. Nugent Date: 11/13/9

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: GAST LoVol

Sampler I.D.: ~~1292~~ R. 1192

Cal. Date: 1/17/95

Cal. Due Date: 1/17/96

Flow Rate Start: 80 ☐ cfm ☒ lpm

Flow Rate Stop: 80 ☐ cfm ☒ lpm

Average Flow Rate: 80 ☐ cfm ☒ lpm

Type Counter: L-2929

Counter I.D.: 115573

Probe I.D.: 43-10-1 #118525

Cal. Date: 11/25/94

Cal. Due Date: 11/25/95

Count Time: 10 minutes

Alpha Eff: 0.332

Beta/Gamma Eff: 0.232

Alpha Background: 0.6 CPM

Beta/Gamma Background: 90 CPM

Technician Performing Count: R. Nugent Date: 11/13/95

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{S+B}(1 + t_{S+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 1.99E-13 Beta-Gamma MDA = 2.88E-12

Technician Performing Calculation: R. Nugent Date: 11/13/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF +	EFF. cpm/dpm ÷	dpm/µCi +	Activity
α 1320	641 cts	10 min	641 cpm	0.6 cpm	641 cpm	957 .67	2883	2.22E+6	1.3E-3 µCi
βγ 1320	1121 cts	10 min	1122 cpm	90 cpm	1032 cpm	1086 .95	4681	2.22E+6	2.1E-3 µCi

Technician Performing Initial Count: R. Nugent Date: 11/13/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
120 minutes	X	N/A cfm X 2.83E+4	=	9.6E6 ml
		80 lpm X 1.0E+3		

Technician Performing Calculation: R. Nugent Date: 11/13/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 1.3E-3 µCi X FR	÷	9.6E6 ml	=	1.35E-10 µCi/ml α
βγ 2.1E-3 µCi X FR	÷	9.6E6 ml	=	2.19E-10 µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R. Nugent Date: 11/13/95

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm/dpm ÷	dpm/µCi +	Activity =
α 1620	426 cts	10 min	43 cpm	0.6 cpm	42 cpm	63 .67	0.332	2.22E+6	8.5E-5 µCi
βγ 1620	584 cts	10 min	158 cpm	90 cpm	68 cpm	72 .95	0.232	2.22E+6	1.9E-6 µCi

Technician Performing 3 Hour Count: R. Nugent Date: 11/13/95

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α 8.5E-5 µCi X FR	÷	9.6E6 ml	=	8.9E-12 µCi/ml α
βγ 1.9E-6 µCi X FR	÷	9.6E6 ml	=	2.0E-13 µCi/ml βγ

Technician Performing Calculation: R. Nugent Date: 11/13/95

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = 45.8 min

t½ βγ = 17.8 min

Technician Performing Calculation: R. Nugent Date: 11/13/95

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A RJM Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\,(hrs)}\right)}{1 - e^{-0.0655\,(hrs)}}$$

$$= \frac{____\ \mu Ci - ____\ \mu Ci\left(e^{-0.0655\,(-____\,hrs)}\right)}{1 - e^{-0.0655(____\,hrs)}}$$

$$= ____\ N/A\ ____\ \mu Ci$$

Technician Performing Calculation: N/A RJM Date: N/A

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A $\beta A_{LL}\mu Ci = (\alpha A_{LL}\mu Ci)(0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83

'al long-lived beta activity = .945 + .945 = 1.89

$\frac{1.89}{2.83} = 0.67$

Technician Performing Calculation: N/A RFM Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

hnician Performing Calculation: N/A RFM Date: 11/16/95

HP Supervisor Review: [signature] Date: 11/16/95

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FORT McCLELLAN

A/S ID Number: 1192 RWP Number: FM-101 ATGS Number: FMA102

Date Start: 11/13/95 Date Stop: 11/14/95

Time Start: 1330 Time Stop: 0945 Total Time: 1215 minutes

Sample Location: CLASS ROOM BLDG. 3192

Sample Type: ☐ Breathing Zone ☒ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: N/A

Technician Performing Sample: R. TRANGAS Date: 11/14/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: LoVol A/S

Sampler I.D.: 1192

Cal. Date: 1-17-95

Cal. Due Date: 1-17-96

Flow Rate Start: 80 ☐ cfm ☒ lpm

Flow Rate Stop: 80 ☐ cfm ☒ lpm

Average Flow Rate: 80 ☐ cfm ☒ lpm

Type Counter: L-2929

Counter I.D.: #115573

Probe I.D.: 43-10-1

Cal. Date: 11/25/94

Cal. Due Date: 11/25/95

Count Time: 10 minutes

Alpha Eff: 0.336

Beta/Gamma Eff: 0.223

Alpha Background: 0.8 CPM

Beta/Gamma Background: 92 CPM

Technician Performing Count: R. Trangas Date: 11/14/95

Analyst Initials

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{s+B}(1 + t_{s+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{s+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{s+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 3.8E-13 Beta-Gamma MDA = 5.2E-12

Technician Performing Calculation: R Zuniga Date: 11/14/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm/dpm ÷	dpm/µCi ÷	Activity =
α 10.00	4934 cts	10 min	493.4 cpm	0.8 cpm	493 cpm	735 .67	0.336	2.22E+6	9.8E-4 µCi
βγ 1000	8976 cts	10 min	898 cpm	92 cpm	806 cpm	848 .95	0.223	2.22E+6	1.7E-3 µCi

Technician Performing Initial Count: R Zuniga Date: 11/14/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time: 1215 minutes X Sample Average Flow Rate: N/A cfm X 2.83E+4; 80 lpm X 1.0E+3 = Total Volume: 9.72E7 ml

Technician Performing Calculation: Richard Trangos Date: 11/14/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 9.8E-4 µCi X FR	÷	9.72E7 ml	=	1.0E-11 µCi/ml α
βγ 1.7E-3 µCi X FR	÷	9.72E7 ml	=	1.8E-11 µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R Zuniga Date: 11/14/95

Frank White

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm/dpm ÷	dpm/µCi +	Activity =
α 1300	1766 cts	10 min	177 cpm	0.8 cpm	176 cpm	263 .67	.336	2.22E+6	3.5E-4 µCi
βγ 1300	4172 cts	10 min	417 cpm	92 cpm	325 cpm	342 .95	.223	2.22E+6	6.9E-4 µCi

Technician Performing 3 Hour Count: R Thompson Date: 11/14/95

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α 3.5E-4 µCi X FR	÷	9.72E7 ml	=	3.6E-12 µCi/ml α
βγ 6.9E-4 µCi X FR	÷	9.72E7 ml	=	7.1E-12 µCi/ml βγ

Technician Performing Calculation: R Thompson Date: 11/14/95

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = 122 min.

t½ βγ = 138 min.

Technician Performing Calculation: R Thompson Date: 11/14/95

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

Frank White

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\,(e^{-0.0655(\Delta T)})}{1 - e^{-0.0655\,(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\,(e^{-0.0655\,(hrs)})}{1 - e^{-0.0655\,(hrs)}}$$

$$= \frac{____\ \mu Ci - \mu Ci\,(e^{-0.0655\,(-___hrs)}}{1 - e^{-0.0655(__hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

N/A

Technician Performing Calculation: N/A Date: N/A

Aaron Wheeler

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A $\beta A_{LL}\mu Ci = (\alpha A_{LL}\mu Ci)(0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83

Total long-lived beta activity = .945 + .945 = 1.89

$\frac{1.89}{2.83} = 0.67$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: Robert F. Nugent Date: 11/14/95

Frank Wh Yen

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FT McCLELLAN

A/S ID Number: 1192 RWP Number: FM-101 ATGS Number: FMA 103

Date Start: 11-14-95 Date Stop: 11-14-95

Time Start: 09:45 Time Stop: 11:00 Total Time: 75 minutes

Sample Location: EAST WALL CINDER BLOCK REMOVAL

Sample Type: ☐ Breathing Zone ☒ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: N/A

Technician Performing Sample: Pete SHONKWILER Date: 11/14/9

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: Low Volume Air Sampler Type Counter: L M-2929

Sampler I.D.: 001192 Counter I.D.: # 115573

Cal. Date: 1-17-95 Probe I.D.: # 118525

Cal. Due Date: 1-17-96 Cal. Date: 11/25/94

Flow Rate Start: 75 ☐ cfm ☒ lpm Cal. Due Date: 11/25/95

Flow Rate Stop: 75 ☐ cfm ☒ lpm Count Time: 10 MIN minute:

Alpha Eff: 0.336

Average Flow Rate: 75 ☐ cfm ☒ lpm Beta/Gamma Eff: 0.223

Alpha Background: ~~0.4~~ 0 cpm (11/14/95)

Beta/Gamma Background: 92 cpm

Technician Performing Count: R Thomas Date: 11/14-95

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{S+B}(1 + t_{S+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 4.19 E -13 Beta-Gamma MDA = 3.8 E -13

Technician Performing Calculation: R Thorgan Date: 11/14/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF +	EFF. cpm/dpm +	dpm/µCi +	Activity =
α 11:15	14.15 cts	10 min	141.5 cpm	0.6 cpm	141 cpm	210 .67	.336	2.22E+6	2.8E-4 µCi
βγ 11:15	327.4 cts	10 min	327.4 cpm	92 cpm	235 cpm	247 .95	.223	2.22E+6	5.0E-4 µCi

Technician Performing Initial Count: R Thorgan Date: 11/14/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
75 minutes	X	N/A cfm X 2.83E+4	=	5.62 E6 ml
		75 lpm X 1.0E+3		

Technician Performing Calculation: R Thorgan Date: 11/14/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 2.8E-4 µCi X FR	÷	5.62 E6 ml	=	5.0 E-11 µCi/ml α
βγ 5.0 E-4 µCi X FR	÷	5.62 E6 ml	=	8.9 E-11 µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R Thorgan Date: 11/14/95

Frank Whitter

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm/dpm ÷	dpm/µCi +	Activity =
α 14:15	32 cts	10 min	3.2 cpm	0.8 cpm	3 cpm	4.5 .67	.336	2.22E+6	6E-6 µCi
βγ 14:15	944 cts	10 min	94.4 cpm	92 cpm	3 cpm	32 .95	.223	2.22E+6	6.5E-6 µCi

Technician Performing 3 Hour Count: R Jaeger Date: 11/14/95

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α 6E-6 µCi X FR	÷	5.62E6 ml	=	1.1E-12 µCi/ml α
βγ 6.5E-6 µCi X FR	÷	5.62E6 ml	=	1.2E-12 µCi/ml βγ

Technician Performing Calculation: R Jaeger Date: 11/14/95

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = 33 min

t½ βγ = 29 min

Technician Performing Calculation: R Jaeger Date: 11/14/95

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

Frank Uehata

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm/dpm ÷	dpm/µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: NA Date:_____

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\,(hrs)}\right)}{1 - e^{-0.0655\,(hrs)}}$$

$$= \frac{____\ \mu Ci - ____\ \mu Ci\left(e^{-0.0655\,(-____\,hrs)}\right)}{1 - e^{-0.0655(____\,hrs)}}$$

$$= \text{N/A}\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

Frank Whitcar

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A $\beta A_{LL}\mu Ci = (\alpha A_{LL}\mu Ci)(0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83 $\frac{1.89}{2.83} = 0.67$

Total long-lived beta activity = .945 + .945 = 1.89

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: K. Nugent Date: 11/15/95

Transmitter

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FORT McCLELLAN - B3192

A/S ID Number: ~~FMA-104~~ 1192 RWP Number: FM-101 ATGS Number: FMA-104

Date Start: 11/14/95 Date Stop: 11/14/95

Time Start: 1130 Time Stop: 1415 Total Time: 165 minutes

Sample Location: B3192 CLASS ROOM

Sample Type: ☐ Breathing Zone ☒ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: CEILING REMOVAL

Technician Performing Sample: R. Nugent Date: 11/14/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: LoVol

Sampler I.D.: 1192

Cal. Date: 1-17-95

Cal. Due Date: 1-17-96

Flow Rate Start: 75 ☐ cfm ☒ lpm

Flow Rate Stop: 75 ☐ cfm ☒ lpm

Average Flow Rate: 75 ☐ cfm ☒ lpm

Type Counter: L-2929

Counter I.D.: 115573

Probe I.D.: 43-10-1

Cal. Date: 11/25/94

Cal. Duc Date: 11/25/95

Count Time: 10 minute:

Alpha Eff: 0.336

Beta/Gamma Eff: 0.223

Alpha Background: 0.8 cpm

Beta/Gamma Background: 92 cpm

Technician Performing Count: R. Nugent Date: 11/14/95

Footer Lution

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{S+B}(1 + t_{S+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 1.7 E-12 Beta-Gamma MDA = 2.3 E-11

Technician Performing Calculation: R. Nugent Date: 11/14/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF +	EFF. cpm/dpm +	dpm/µCi +	Activity =
α 1430	1419 cts	10 min	142 cpm	0.8 cpm	141 cpm	210 .67	0.336	2.22E+6	2.8 E-4 µCi
βγ 1430	3528 cts	10 min	353 cpm	92 cpm	261 cpm	275 .95	0.223	2.22E+6	5.6 E-4 µCi

Technician Performing Initial Count: R. Nugent Date: 11/14/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
165 minutes	X	N/A cfm X 2.83E+4	=	1.24 E6 ml
		75 lpm X 1.0E+3		

Technician Performing Calculation: R. Nugent Date: 11/14/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 2.8E-4 µCi X FR	÷	1.24E6 ml	=	2.3 E-10 µCi/ml α
βγ 5.6E-4 µCi X FR	÷	1.24E6 ml	=	4.5 E-10 µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R. Nugent Date: 11/14/95

Frank Whitter

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm/dpm ÷	dpm/µCi +	Activity =
α 17:30	83 cts	10 min	8.3 cpm	.8 cpm	8 cpm	12 .67	.336	2.22E+6	1.6E-5 Ci
βγ 17:30	1127 cts	10 min	112.7 cpm	92 cpm	21 cpm	22 .95	.223	2.22E+6	4.5E-5 µCi

Technician Performing 3 Hour Count: R Tranga Date: 11/14/95

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α 1.6E-5 µCi X FR	÷	1.24E6 ml	=	1.3E-11 µCi/ml α
βγ 4.5E-5 µCi X FR	÷	1.24E6 ml	=	3.6E-11 µCi/ml βγ

Technician Performing Calculation: R Tranga Date: 11/14/95

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln\left(\frac{\text{Final Activity}}{\text{Initial Activity}}\right)}$$

t = elapsed time between counts in minutes

t½ α = 45 MIN

t½ βγ = 56 MIN

Technician Performing Calculation: R Tranga Date: 11/14/95

Frank Vitar

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\ (hrs)}\right)}{1 - e^{-0.0655\ (hrs)}}$$

$$= \frac{____\ \mu Ci - \mu Ci\left(e^{-0.0655\ (-___\ hrs)}\right)}{1 - e^{-0.0655(___\ hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

Brent White

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

_____ $\beta\ A_{LL}\mu Ci = (\alpha\ A_{LL}\mu Ci)\ (0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83 $\quad \frac{1.89}{2.83} = 0.67$

Total long-lived beta activity = .945 + .945 = 1.89

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: [illegible] Date: 11/15/95

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FORT McCLELLAN/B3192

A/S ID Number: 1192 RWP Number: FM-101 ATGS Number: FMA-105

Date Start: 11/14/95 Date Stop: 11/15/95

Time Start: 1420 Time Stop: 0750 Total Time: 1050 minutes

Sample Location: B3192 - Classroom - Ceiling removal

Sample Type: ☐ Breathing Zone ☒ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments:

Technician Performing Sample: R. Nugent Date: 11/15/9

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: LoVol - G45T

Sampler I.D.: 1192

Cal. Date: 1/17/95

Cal. Due Date: 1/17/96

Flow Rate Start: 75 ☐ cfm ☒ lpm

Flow Rate Stop: 75 ☐ cfm ☒ lpm

Average Flow Rate: 75 ☐ cfm ☒ lpm

Type Counter: L-2929

Counter I.D.: 115573

Probe I.D.: 43-10-1

Cal. Date: 11/25/94

Cal. Due Date: 11/25/95

Count Time: 10 minute

Alpha Eff: 0.338

Beta/Gamma Eff: 0.236

Alpha Background: 0.6 cpm

Beta/Gamma Background: 97 cpm

Technician Performing Count: R. Nugent Date: 11/15/9

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{S+B}(1 + t_{S+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 2.4E-14 Beta-Gamma MDA = 3.6E-13

Technician Performing Calculation: R. Nugent Date: 11/15/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF +	EFF. cpm/dpm ÷	dpm/µCi +	Activity =
α 0800	3388 cs	10 min	338 cpm	0.6 cpm	338 cpm	504 .67	0.338	2.22E+6	6.7E-4 µCi
βγ 0800	7481 cs	10 min	748 cpm	~~651~~ 97 cpm	651 cpm	685 .95	0.236	2.22E+6	1.3E-3 µCi

Technician Performing Initial Count: R. Nugent Date: 11/15/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
1050 minutes	X	N/A cfm X 2.83E+4	=	7.9E7 ml
		75 lpm X 1.0E+3		

Technician Performing Calculation: R. Nugent Date: 11/15/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 6.7E-4 µCi X FR	÷	7.9E7 ml	=	8.5E-12 µCi/ml α
βγ 1.3E-3 µCi X FR	÷	7.9E7 ml	=	1.6E-11 µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R. Nugent Date: 11/15/95

Frank White

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi +	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 3 Hour Count: N/A Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml α
βγ N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = N/A

t½ βγ = N/A

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

Front white

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\,(e^{-0.0655(\Delta T)})}{1 - e^{-0.0655\,(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\,(e^{-0.0655\,(hrs)})}{1 - e^{-0.0655\,(hrs)}}$$

$$= \frac{_____\ \mu Ci - _____\ \mu Ci\,(e^{-0.0655\,(-____hrs)}}{1 - e^{-0.0655(___hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

Grant Whitaker

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A $\beta A_{LL}\mu Ci = (\alpha A_{LL}\mu Ci)(0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83

Total long-lived beta activity = .945 + .945 = 1.89

$\frac{1.89}{2.83} = 0.67$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: [illegible] Date: 11/16/95

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FT McCLeLLAN

A/S ID Number: 1192 RWP Number: FM-101 ATGS Number: FMA-106

Date Start: 11/15/95 Date Stop: 11/15/95

Time Start: 08:00 Time Stop: 15:00 Total Time: 420 minutes

Sample Location: CLASS Room Bldg 3192

Sample Type: ☐ Breathing Zone ☒ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: N/A

Technician Performing Sample: R TRANGAS Date: 11/15/9

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: Low Volume Air Sampler Type Counter: L-2929

Sampler I.D.: 1192 Counter I.D.: # 115573

Cal. Date: 1-17-95 Probe I.D.: # 118525

Cal. Due Date: 1-17-96 Cal. Date: 11/25/94

Flow Rate Start: 75 ☐ cfm ☒ lpm Cal. Due Date: 11/25/95

Flow Rate Stop: 75 ☐ cfm ☒ lpm Count Time: 10 min minute

Alpha Eff: .336

Average Flow Rate: 75 ☐ cfm ☒ lpm Beta/Gamma Eff: .236

Alpha Background: .6

Beta/Gamma Background: 97

Technician Performing Count: R Trangas Date: 11/15/95

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{s+B}(1 + t_{s+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{s+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{s+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 6.0 E -14 Beta-Gamma MDA = 8.9 E -13

Technician Performing Calculation: R Jones Date: 11/15/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF +	EFF. cpm/dpm +	dpm/µCi +	Activity =
α 1505	782 cts	10 min	78 cpm	.6 cpm	77 cpm	115 .67	.336	2.22E+6	1.54E-4 µCi
βγ 1505	2307 cts	10 min	231 cpm	97 cpm	134 cpm	141 .95	.236	2.22E+6	2.7E-4 µCi

Technician Performing Initial Count: R Jones Date: 11/15/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
420 minutes	X	N/A cfm X 2.83E+4	=	3.15 E 7 ml
		75 lpm X 1.0E+3		

Technician Performing Calculation: R Jones Date: 11/15/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 1.54 E -4 µCi X FR	÷	3.15E 7 ml	=	4.9 E -12 µCi/ml α
βγ 2.7E -4 µCi X FR	÷	3.15E 7 ml	=	8.6 E -12 µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R Jones Date: 11/15/95

Frank Winter

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi +	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

N/a

Technician Performing 3 Hour Count: N/a Date: N/a

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α _____ µCi X FR	÷	_____ ml	=	_____ µCi/ml α
βγ _____ µCi X FR	÷	_____ ml	=	_____ µCi/ml βγ

N/a

Technician Performing Calculation: N/a Date: N/a

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = _____

t½ βγ = _____

N/a

Technician Performing Calculation: N/a Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\ (hrs)}\right)}{1 - e^{-0.0655\ (hrs)}}$$

$$= \frac{____\ \mu Ci - ____\ \mu Ci\left(e^{-0.0655\ (-____\ hrs)}\right)}{1 - e^{-0.0655(____\ hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: [signature] Date: 11/16/95

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A $\beta A_{LL}\mu Ci = (\alpha A_{LL}\mu Ci)(0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83 $\frac{1.89}{2.83}$ = 0.67

Total long-lived beta activity = .945 + .945 = 1.89

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = _____ μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: Robert F. Nugent Date: 11/15/95

Frank whitten 11/16/95

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FT McCLELLAN

A/S ID Number: 1192 RWP Number: FM-101 ATGS Number: FMA-107

Date Start: 11/15/95 Date Stop: 11/16/95

Time Start: 15:00 Time Stop: 07:45 Total Time: 1005 minutes

Sample Location: CLASS ROOM BLdg 3192

Sample Type: ☐ Breathing Zone ☒ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: N/a

Technician Performing Sample: R Trangas Date: 11/16/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: Low Volume Air Sampler

Sampler I.D.: 1192

Cal. Date: 1-17-94

Cal. Due Date: 1-17-95

Flow Rate Start: 75 ☐ cfm ☒ lpm

Flow Rate Stop: 75 ☐ cfm ☒ lpm

Average Flow Rate: 75 ☐ cfm ☒ lpm

Type Counter: L-2929

Counter I.D.: # 115573

Probe I.D.: 118525

Cal. Date: 11/25/94

Cal. Due Date: 11/25/95

Count Time: 10 mins minute

Alpha Eff: .342

Beta/Gamma Eff: .235

Alpha Background: 0.8 cpm

Beta/Gamma Background: 96 cpm

Technician Performing Count: R TRANGAS Date: 11/16/95

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{S+B}(1 + t_{S+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 1.1 E^{-14} Beta-Gamma MDA = 1.2 E^{-13}

Technician Performing Calculation: R Tranoyas Date: 11/16/96

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF +	EFF. cpm/dpm +	dpm/µCi +	Activity =
α 8:00	1974 cts	10 min	197 cpm	.8 cpm	196 cpm	29 .67	.342	2.22E+6	3.9 E^{-4} µCi
βγ 8:00	3845 cts	10 min	385 cpm	96 cpm	289 cpm	30 .95	.235	2.22E+6	5.8 E^{-4} µCi

Technician Performing Initial Count: R Tranoyas Date: 11/16/96

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
1005 minutes	X	N/A cfm X 2.83E+4	=	7.5 E^{7} ml
		75 lpm X 1.0E+3		

Technician Performing Calculation: R Tranoyas Date: 11/16/96

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 3.9 E^{-4} µCi X FR	÷	7.5 E^{7} ml	=	5.2 E^{-12} µCi/ml α
βγ 5.8 E^{-4} µCi X FR	÷	7.5 E^{7} ml	=	7.7 E^{-12} µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R Tranoyas Date: 11/16/95

Frank Whitten

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi +	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 3 Hour Count: N/A Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α _____ µCi X FR	÷	_____ ml	=	_____ µCi/ml α
βγ _____ µCi X FR	÷	_____ ml	=	_____ µCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = _____

t½ βγ = _____

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

Frank Whitcher

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\,(e^{-0.0655(\Delta T)})}{1 - e^{-0.0655\,(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\,(e^{-0.0655\,(hrs)})}{1 - e^{-0.0655\,(hrs)}}$$

$$= \frac{____\ \mu Ci - ____\ \mu Ci\,(e^{-0.0655\,(-____hrs)}}{1 - e^{-0.0655(____hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

Jean Hutchison

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/D $\beta A_{LL}\mu Ci = (\alpha A_{LL}\mu Ci)(0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83 $\quad \frac{1.89}{2.83} = 0.67$

tal long-lived beta activity = .945 + .945 = 1.89

Technician Performing Calculation: N/D Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/D μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

chnician Performing Calculation: N/A Date: N/A

HP Supervisor Review: R. Nugent Date: 11/16/95

Frank Whitak

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FORT McCLELLAN

A/S ID Number: 1192 RWP Number: FM-103 ATGS Number: FMA-108

Date Start: 11/16/95 Date Stop: 11/16/95

Time Start: 0830 Time Stop: 0930 Total Time: 60 minutes

Sample Location: HVAC ROOM B3192

Sample Type: ☒ Breathing Zone ☐ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: FIRST CUTS IN DUCT WORK.

Technician Performing Sample: R. Blank Date: 11/16/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: GAST LoVol

Sampler I.D.: 1192

Cal. Date: 1/17/95

Cal. Due Date: 1/17/96

Flow Rate Start: 75 ☐ cfm ☒ lpm

Flow Rate Stop: 75 ☐ cfm ☒ lpm

Average Flow Rate: 75 ☐ cfm ☒ lpm

Type Counter: L-2929

Counter I.D.: 115573

Probe I.D.: 43-10-1 #18525

Cal. Date: 11/25/94

Cal. Due Date: 11/25/95

Count Time: 10 minute

Alpha Eff: 0.342

Beta/Gamma Eff: 0.235

Alpha Background: 4

Beta/Gamma Background: 96

Technician Performing Count: R. Vargent Date: 11/16/95

Frank Vargent

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{S+B}(1 + t_{S+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 2.3E-13 Beta-Gamma MDA = 6.3E-12

Technician Performing Calculation: R. Nugent Date: 11/16/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF +	EFF. cpm/dpm +	dpm/µCi +	Activity =
α 0930	2226 cts	10 min	222.6 cpm	0.8 cpm	222 cpm	331 .67	342	2.22E+6	4.3E-4 µCi
βγ 0930	5084 cts	10 min	508 cpm	96 cpm	412 cpm	433 .95	1235	2.22E+6	8.3E-4 µCi

Technician Performing Initial Count: R. Nugent Date: 11/16/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
60 minutes	X	N/A cfm X 2.83E+4	=	4.5E6 ml
		75 lpm X 1.0E+3		

Technician Performing Calculation: R. Nugent Date: 11/16/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 4.3E-4 µCi X FR	÷	4.5E6 ml	=	9.5E-11 µCi/ml α
βγ 8.3E-4 µCi X FR	÷	4.5E6 ml	=	1.8E-10 µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R. Nugent Date: 11/16/95

Frank Wilson

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 3 Hour Count: N/A Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml α
βγ N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = N/A

t½ βγ = N/A

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

Frank Whitson

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\ (hrs)}\right)}{1 - e^{-0.0655\ (hrs)}}$$

$$= \frac{____\ \mu Ci - \mu Ci\left(e^{-0.0655\ (-___\ hrs)}\right)}{1 - e^{-0.0655(___\ hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

Frank Whitten

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A $\beta A_{LL}\mu Ci = (\alpha A_{LL}\mu Ci)(0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev.
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83

Total long-lived beta activity = .945 + .945 = 1.89

$\frac{1.89}{2.83} = 0.67$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: R. Vaugeot Date: 11/16/95

Transmitted

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FT McCLeLLAN

A/S ID Number: 1192 RWP Number: FM-103 ATGS Number: FMA-109

Date Start: 11/16/95 Date Stop: 11/16/95

Time Start: 09:30 Time Stop: 10:10 Total Time: 40 minutes

Sample Location: GENERAL AREA BY VAULT

Sample Type: ☐ Breathing Zone ☒ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: N/A

Technician Performing Sample: R TRANGAS Date: 11/16/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: Low Volume Air Sampler

Sampler I.D.: # 1192

Cal. Date: 1-17-~~94~~ 95

Cal. Due Date: 1-17-96

Flow Rate Start: 75 ☐ cfm ☒ lpm

Flow Rate Stop: 75 ☐ cfm ☒ lpm

Average Flow Rate: 75 ☐ cfm ☒ lpm

Type Counter: L-2929

Counter I.D.: # 115573

Probe I.D.: # 118525

Cal. Date: 11/25/94

Cal. Due Date: 11/25/95

Count Time: 10 minute

Alpha Eff: .342

Beta/Gamma Eff: .235

Alpha Background: .8 counts

Beta/Gamma Background: 96 counts

Technician Performing Count: R Trangas Date: 11/16/95

Analyzer

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{S+B}(1 + t_{S+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = $3.2\ E^{-13}$ Beta-Gamma MDA = $9.1\ E^{-12}$

Technician Performing Calculation: R TRANGAS Date: 11/16/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF +	EFF. cpm/dpm +	dpm/µCi +	Activity =
α 10:30	836 cts	10 min	84 cpm	.8 cpm	83 cpm	124 .67	.342 ~~.386~~	2.22E+6	$1.6E^{-4}$ µCi
βγ 10:30	2431 cts	10 min	243 cpm	96 cpm	147 cpm	155 .95	.235	2.22E+6	$2.9E^{-4}$ µCi

Technician Performing Initial Count: R Trangas Date: 11/16/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
40 minutes	X	n/a cfm X 2.83E+4	=	$3.0E^{6}$ ml
		75 lpm X 1.0E+3		

Technician Performing Calculation: R TRANGAS Date: 11/16/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α $1.6E^{-4}$ µCi X FR	÷	$3.0E^{6}$ ml	=	$5.3E^{-11}$ µCi/ml α
βγ $2.9E^{-4}$ µCi X FR	÷	$3.0E^{6}$ ml	=	$9.6E^{-11}$ µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R Trangas Date: 11/16/95

Front utility

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi +	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 3 Hour Count: NA Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml α
βγ N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = N/A

t½ βγ = N/A

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

Frank Vitter

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\,(e^{-0.0655(\Delta T)})}{1 - e^{-0.0655\,(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\,(e^{-0.0655\,(hrs)})}{1 - e^{-0.0655\,(hrs)}}$$

$$= \frac{_____\ \mu Ci - \mu Ci\,(e^{-0.0655\,(-___hrs)}}{1 - e^{-0.0655(___hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

Frank White

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A $\beta\ A_{LL}\mu Ci = (\alpha\ A_{LL}\mu Ci)\ (0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83

Total long-lived beta activity = .945 + .945 = 1.89

$\frac{1.89}{2.83} = 0.67$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A $\mu Ci/ml$ $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A $\mu Ci/ml$ $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: R. Nugent Date: 11/16/95

Frank Whitten

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FT McCLELLAN

A/S ID Number: 1192 RWP Number: FM-103 ATGS Number: FMA-110

Date Start: 11/16/95 Date Stop: 11/16/95

Time Start: 1405 Time Stop: 17:00 Total Time: 175 minutes

Sample Location: CLASS ROOM Bldg 3192 OVER HEAD

Sample Type: ☐ Breathing Zone ☒ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: NP

Technician Performing Sample: SHONIWICZ Date: 16NOV9

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: Low Volume AIR Sampler Type Counter: L-2929

Sampler I.D.: 1192 Counter I.D.: # 115573

Cal. Date: 1-17-95 Probe I.D.: # 118525

Cal. Due Date: 1-17-96 Cal. Date: # 11-25-94

Flow Rate Start: 70 ☐ cfm ☒ lpm Cal. Due Date: # 11-25-95

Flow Rate Stop: 60 ☐ cfm ☒ lpm Count Time: 10 MIN minute

Alpha Eff: .342

Average Flow Rate: 65 ☐ cfm ☒ lpm Beta/Gamma Eff: .235

Alpha Background: .8

Beta/Gamma Background: 96

Technician Performing Count: R TRANEAS Date: 11/16/95

Frank Wheeler

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{S+B}(1 + t_{S+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 1.9 E^{-13} Beta-Gamma MDA = 7.6 E^{-13}

Technician Performing Calculation: R Trangas Date: 11/16/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF +	EFF. cpm/dpm +	dpm/µCi +	Activity =
α 17:15	1011 cts	10 min	101 cpm	8 cpm	100 cpm	149 .67	.342	2.22E+6	1.9 E^{-4} µCi
βγ 17:15	2595 cts	10 min	2595 cpm	96 cpm	164 cpm	172 .95	.235	2.22E+6	3.3 E^{-4} µCi

Technician Performing Initial Count: R Trangas Date: 11/16/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
175 minutes	X	N/A cfm X 2.83E+4	=	1.1 E^{7} ml
		65 lpm X 1.0E+3		

Technician Performing Calculation: R. TRANGAS Date: 11/16/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 1.9E^{-4} µCi X FR	÷	1.1 E^{+7} ml	=	1.8 E^{-11} µCi/ml α
βγ 3.3E^{-4} µCi X FR	÷	1.1 E^{+7} ml	=	3 E^{-11} µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R Trangas Date: 11/16/95

Frank Ch. Tan

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF	EFF. cpm / dpm ÷	dpm / µCi +	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 3 Hour Count: N/A Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml α
βγ N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = N/A

t½ βγ = N/A

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

Frank Welch

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\ (hrs)}\right)}{1 - e^{-0.0655\ (hrs)}}$$

$$= \frac{____\ \mu Ci - ____\ \mu Ci\left(e^{-0.0655\ (-____\ hrs)}\right)}{1 - e^{-0.0655(____\ hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

Frank Whitten

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

_____ $\beta\ A_{LL}\mu Ci = (\alpha\ A_{LL}\mu Ci)\ (0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83 $\quad \frac{1.89}{2.83} = 0.67$

Total long-lived beta activity = .945 + .945 = 1.89

Technician Performing Calculation: _____ Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: R. Mangeant Date: 11/16/95

Frank Whitch

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FT McCLELLAN

A/S ID Number: 1192 RWP Number: FM-103 ATGS Number: FMA-111

Date Start: 11/20/95 Date Stop: 11/20/95

Time Start: 08:10 Time Stop: 11:30 Total Time: 210 minutes

Sample Location: CLASS ROOM

Sample Type: ☒ Breathing Zone ☐ General Area ☐ Other: ☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: WHEN VENT WAS BEING CUT

Technician Performing Sample: R TRANGAS Date: 11/20/9

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: LOW VOLUME AIR SAMPLER Type Counter: 2929/43-10-1

Sampler I.D.: 001192 Counter I.D.: 115573

Cal. Date: 1-17-95 Probe I.D.: 118525

Cal. Due Date: 1-17-96 Cal. Date: 11/25/94

Flow Rate Start: 85 ☐ cfm ☒ lpm Cal. Due Date: 11/25/95

Flow Rate Stop: 65 ☐ cfm ☒ lpm Count Time: 10 minute

Alpha Eff: 0.342

Average Flow Rate: 75 ☐ cfm ☒ lpm Beta/Gamma Eff: 0.231

Alpha Background: 0.6

Beta/Gamma Background: 90 cpm

Technician Performing Count: R TRANGAS Date: 11/20/95

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{S+B}(1 + t_{S+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = $1.1\ E^{-13}$ Beta-Gamma MDA = $1.7\ E^{-11}$

Technician Performing Calculation: R Tranquas Date: 11/20/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period +	Gross CR -	Bkgrnd CR -	Net CR -	CF +	EFF. cpm/dpm +	dpm/µCi +	Activity -
α 1318	388 cts	10 min	39 cpm	.6 cpm	38 cpm	57 .67	.342	2.22E+6	$7.5E^{-5}$ µCi
βγ 1318	1548 cts	10 min	160 cpm	90 cpm	70 cpm	74 .95	.231	2.22E+6	$1.4E^{-4}$ µCi

Technician Performing Initial Count: R Tranquas Date: 11/20/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
210 minutes	X	N/A cfm X 2.83E+4	=	$1.6E^{7}$ ml
		75 lpm X 1.0E+3		

Technician Performing Calculation: R Tranquas Date: 11/20/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α $7.5E^{-5}$ µCi X FR	÷	$1.6E^{7}$ ml	=	$4.7E^{-12}$ µCi/ml α
βγ $1.4E^{-4}$ µCi X FR	÷	$1.6E^{7}$ ml	=	$8.8E^{-12}$ µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R Tranquas Date: 11/20/95

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi +	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 3 Hour Count: N/A Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml α
βγ N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = N/A

t½ βγ = N/A

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\ (hrs)}\right)}{1 - e^{-0.0655\ (hrs)}}$$

$$= \frac{____\ \mu Ci - ____\ \mu Ci\ (e^{-0.0655\ (-____\ hrs)}}{1 - e^{-0.0655(____\ hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A $\beta\ A_{LL}\mu Ci = (\alpha\ A_{LL}\mu Ci)\ (0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83 $\quad \frac{1.89}{2.83} = 0.67$

Total long-lived beta activity = .945 + .945 = 1.89

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: R. Nugent Date: 11/21/95

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FT McCLellAN

A/S ID Number: 001192 RWP Number: FM-101 ATGS Number: FMA-112

Date Start: 11/20/95 Date Stop: 11/20/95 RG 11/20/95 1305

Time Start: ~~1435~~ 1135 Time Stop: ~~1605~~ ~~1605~~ Total Time: 90 minutes

Sample Location: General Area Classroom Bldg 3192

Sample Type: ☐ Breathing Zone ☒ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: N/A

Technician Performing Sample: R Thomas Date: 11/20/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: Low Volume Air Sampler

Sampler I.D.: 001192

Cal. Date: 1-17-95

Cal. Due Date: 1-17-96

Flow Rate Start: 85 ☐ cfm ☒ lpm

Flow Rate Stop: 65 ☐ cfm ☒ lpm

Average Flow Rate: 75 ☐ cfm ☒ lpm

Type Counter: L-2929/4310-1

Counter I.D.: # 115573

Probe I.D.: 118525

Cal. Date: 11/25/94

Cal. Due Date: 11/25-95

Count Time: 10 min minut

Alpha Eff: 0.342

Beta/Gamma Eff: 0.231

Alpha Background: .6 cpm

Beta/Gamma Background: 90 cpm

Technician Performing Count: R Thomas Date: 11/20/95

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{S+B}(1 + t_{S+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 2.7 E-12 Beta-Gamma MDA = 4.1 E-12

Technician Performing Calculation: R TRANGAS Date: 11/20/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF +	EFF. cpm/dpm +	dpm/µCi +	Activity =
α 14:00	676 cts	10 min	68 cpm	.6 cpm	67 cpm	100 .67	.342	2.22E+6	1.3E-4 µCi
βγ 14:00	1778 cts	10 min	178 cpm	90 cpm	88 cpm	93 .95	.271	2.22E+6	1.8-4 µCi

Technician Performing Initial Count: R Trangas Date: 11/20/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
90 minutes	X	N/A cfm X 2.83E+4	=	6.8E6 ml
		75 lpm X 1.0E+3		

Technician Performing Calculation: R Trangas Date: 11/20/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 1.3E-4 µCi X FR	÷	6.8E6 ml	=	1.9E-11 µCi/ml α
βγ 1.8E-4 µCi X FR	÷	6.8E6 ml	=	2.7E-11 µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R Trangas Date: 11/20/95

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi +	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 3 Hour Count: N/A Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml α
βγ N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = N/A

t½ βγ = N/A

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\ (hrs)}\right)}{1 - e^{-0.0655\ (hrs)}}$$

$$= \frac{____\ \mu Ci - ____\ \mu Ci\ (e^{-0.0655\ (-____hrs)}}{1 - e^{-0.0655(____hrs)}}$$

$$= \underline{N/A}\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A $\beta A_{LL}\mu Ci = (\alpha A_{LL}\mu Ci)(0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83 $\frac{1.89}{2.83}$ = 0.67

tal long-lived beta activity = .945 + .945 = 1.89

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}]$ > 1E-13 μCi/ml

$[A_{LL}^{\beta}]$ > 2E-10 μCi/ml

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: Robert F. Nugent Date: 11/21/95

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FT McCLELLAN

A/S ID Number: 001192 RWP Number: FM-103 ATGS Number: FMA-113

Date Start: 11/20/95 Date Stop: 11/20/95

Time Start: 14:30 Time Stop: 1555 Total Time: 100 minutes

Sample Location: On Top of Hot Cell

Sample Type: ☒ Breathing Zone ☐ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: N/A

Technician Performing Sample: R. TRANGAS Date: 11/20/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: Low Volume Air Sampler

Sampler I.D.: 001192

Cal. Date: 1-17-95

Cal. Due Date: 1-17-96

Flow Rate Start: 90 ☐ cfm ☒ lpm

Flow Rate Stop: 80 ☐ cfm ☒ lpm

Average Flow Rate: 85 ☐ cfm ☒ lpm

Type Counter: L-M-2929

Counter I.D.: #99043

Probe I.D.: #098327

Cal. Date: 11/14/95

Cal. Due Date: 5-14-96

Count Time: 10 MIN minute

Alpha Eff: .347

Beta/Gamma Eff: .198

Alpha Background: .5 cpm

Beta/Gamma Background: 52 cpm

Technician Performing Count: R TRANGAS Date: 11/21/95

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{S+B}(1 + t_{S+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = $2E^{-13}$ Beta-Gamma MDA = $2.9E^{-12}$

Technician Performing Calculation: R Tranchas Date: 11/21/96

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm/dpm ÷	dpm/µCi ÷	Activity =
α 08:00	19 cts	10 min	2 cpm	.5 cpm	1.5 cpm	2.2 .67	.347	2.22E+6	$2.9E^{-6}$ µCi
βγ 08:00	544 cts	10 min	54 cpm	52 cpm	2 cpm	2 .95	.198	2.22E+6	$5.0E^{-6}$ µCi

Technician Performing Initial Count: R Tranchas Date: 11/21/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
100 minutes	X	____ cfm X 2.83E+4	=	$8.5E^{6}$ ml
		85 lpm X 1.0E+3		

Technician Performing Calculation: R Tranchas Date: 11/21/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α $2.9E^{-6}$ µCi X FR	÷	$8.5E^{6}$ ml	=	$3.4E^{-13}$ µCi/ml α
βγ $5.0E^{-6}$ µCi X FR	÷	$8.5E^{6}$ ml	=	$5.8E^{-13}$ µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R Tranchas Date: 11/21/95

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi +	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 3 Hour Count: N/A Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml α
βγ N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\frac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = N/A

t½ βγ = N/A

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\ (hrs)}\right)}{1 - e^{-0.0655\ (hrs)}}$$

$$= \frac{____\ \mu Ci - \mu Ci\left(e^{-0.0655\ (-___\ hrs)}\right)}{1 - e^{-0.0655(___\ hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A $\beta A_{LL}\mu Ci = (\alpha A_{LL}\mu Ci)(0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83 $\frac{1.89}{2.83}$ = 0.67

Total long-lived beta activity = .945 + .945 = 1.89

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: Robert F. Vergeot Date: 11/21/95

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FT McCLeLLAN

A/S ID Number: 00 1192 RWP Number: FM-101 ATGS Number: FMA-114

Date Start: 11/21/95 Date Stop: 11/21/95

Time Start: 09:50 Time Stop: 10:30 Total Time: 40 minutes

Sample Location: Sewer Hole

Sample Type: ☐ Breathing Zone ☒ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: N/A

Technician Performing Sample: R. TRANGAS Date: 11/21/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: Low Volume Air Sampler

Sampler I.D.: 00 1192

Cal. Date: 1-17-95

Cal. Due Date: 1-17-96

Flow Rate Start: 75 ☐ cfm ☒ lpm

Flow Rate Stop: 75 ☐ cfm ☒ lpm

Average Flow Rate: 75 ☐ cfm ☒ lpm

Type Counter: L-2929

Counter I.D.: # 99043

Probe I.D.: # 098327

Cal. Date: 11/14/95

Cal. Due Date: 5/14/96

Count Time: 10 MIN minute

Alpha Eff: .347

Beta/Gamma Eff: .198

Alpha Background: .5 COUNTS

Beta/Gamma Background: 52 CPM

Technician Performing Count: R Trangas Date: 11/21/95

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{s+B}(1 + t_{s+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{s+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{s+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 4.4 E^{-13} Beta-Gamma MDA = 8.3 E^{-12}

Technician Performing Calculation: R Tranegas Date: 11/21/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF +	EFF. cpm/dpm +	dpm/µCi +	Activity =
α 10:35	681 cts	10 min	68 cpm	.5 cpm	67 cpm	100 .67	.317	2.22E+6	1.3E^{-4} µCi
βγ 10:35	1854 cts	10 min	185 cpm	52 cpm	133 cpm	140 .95	.198	2.22E+6	3.2E^{-4} µCi

Technician Performing Initial Count: R. TRANEGAS Date: 11/21/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
40 minutes	X	N/A cfm X 2.83E+4	=	3E^{6} ml
		75 lpm X 1.0E+3		

Technician Performing Calculation: R. TRANEGAS Date: 11/21/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 1.3E^{-4} µCi X FR	÷	3E^{6} ml	=	4.3E^{-11} µCi/ml α
βγ 3.2E^{-4} µCi X FR	÷	3E^{6} ml	=	1.1E^{-10} µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R TRANEGAS Date: 11/21/95

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ×	EFF. cpm / dpm ÷	dpm / µCi +	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 3 Hour Count: N/A Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml α
βγ N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\frac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = N/A

t½ βγ = N/A

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\ (hrs)}\right)}{1 - e^{-0.0655\ (hrs)}}$$

$$= \frac{____\ \mu Ci - ____\ \mu Ci\ (e^{-0.0655\ (-____\ hrs)}}{1 - e^{-0.0655(____\ hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A $\beta A_{LL}\mu Ci = (\alpha A_{LL}\mu Ci)(0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83

tal long-lived beta activity = .945 + .945 = 1.89

$\frac{1.89}{2.83} = 0.67$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

chnician Performing Calculation: N/A Date: N/A

HP Supervisor Review: R. Nugent Date: 11/21/95

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A $\beta\ A_{LL}\mu Ci = (\alpha\ A_{LL}\mu Ci)\ (0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83 $\quad \frac{1.89}{2.83} = 0.67$

Total long-lived beta activity = .945 + .945 = 1.89

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: Robert F. Nugent Date: 11/21/95

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: Ft. McClellan, AL

A/S ID Number: FMA 115 RWP Number: FM-103 ATGS Number: FMA-115

Date Start: 11/21/95 Date Stop: 11/21/95

Time Start: 1615 Time Stop: 1720 Total Time: 65 minutes

Sample Location: OVERHEAD/DUCT WORK

Sample Type: ☒ Breathing Zone ☐ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: N/A

Technician Performing Sample: P. MANNING Date: 11/21/9

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: GAST LoVol

Sampler I.D.: 1192

Cal. Date: 1-17-95

Cal. Due Date: 1-17-96

Flow Rate Start: 75 ☐ cfm ☒ lpm

Flow Rate Stop: 75 ☐ cfm ☒ lpm

Average Flow Rate: 75 ☐ cfm ☒ lpm

Type Counter: L-2929

Counter I.D.: #99043

Probe I.D.: #098327

Cal. Date: 11/14/95

Cal. Due Date: 5/14/96

Count Time: 10 minutes

Alpha Eff: 0.341

Beta/Gamma Eff: 0.199

Alpha Background: 0.2

Beta/Gamma Background: 52

Technician Performing Count: R. Vaugent Date: 11/22/95

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{S+B}(1 + t_{S+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 1.3E-13 Beta-Gamma MDA = 1.7E-12

Technician Performing Calculation: R. Nugent Date: 11/22/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α 0645	8 cts	10 min	0.8 cpm	0.2 cpm	0.6 cpm	0.8 .67	.341	2.22E+6	1.2E-6 µCi
βγ 0645	672 cts	10 min	67 cpm	52 cpm	15 cpm	16 .95	.149	2.22E+6	3.5E-5 µCi

Technician Performing Initial Count: _____ Date: _____

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time: 625 minutes X Sample Average Flow Rate: N/A cfm X 2.83E+4 / 75 lpm X 1.0E+3 = Total Volume: 4.87E6 ml

Technician Performing Calculation: R. Nugent Date: 11/22/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 1.2E-6 µCi X FR	÷	4.9E6 ml	=	2.5E-13 µCi/ml α
βγ 3.5E-5 µCi X FR	÷	4.9E6 ml	=	7.1E-12 µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R. Nugent Date: 11/22/95

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm/dpm ÷	dpm/µCi +	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 3 Hour Count: N/A Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml α
βγ N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = N/A

t½ βγ = N/A

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm/dpm ÷	dpm/µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\ (hrs)}\right)}{1 - e^{-0.0655\ (hrs)}}$$

$$= \frac{_____\ \mu Ci - \mu Ci\left(e^{-0.0655\ (-____hrs)}\right)}{1 - e^{-0.0655(____hrs)}}$$

$$= _____\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A $\beta A_{LL}\mu Ci = (\alpha A_{LL}\mu Ci)(0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83

Total long-lived beta activity = .945 + .945 = 1.89

$\frac{1.89}{2.83} = 0.67$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: R. Nugent Date: 11/22/95

AIR SAMPLE DATA AND ANALYSIS

ATGF-030 11/95

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FT McCLELLAN

A/S ID Number: 001192 RWP Number: FM-103 ATGS Number: FMA-116

Date Start: 11/22/95 Date Stop: 11/22/95

Time Start: 06:45 Time Stop: 12:15 Total Time: 330 minutes

Sample Location: Bldg 3192 By VAULT

Sample Type: ☐ Breathing Zone ☒ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: N/A

Technician Performing Sample: R. TRANGAS Date: 11/22/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: Low Volume Air Sampler

Sampler I.D.: # 001192

Cal. Date: 1-17-95

Cal. Due Date: 1-17-96

Flow Rate Start: 90 ☐ cfm ☒ lpm

Flow Rate Stop: 60 ☐ cfm ☒ lpm

Average Flow Rate: 75 ☐ cfm ☒ lpm

Type Counter: L-2929

Counter I.D.: # 99041

Probe I.D.: # 96923

Cal. Date: 11/14/95

Cal. Due Date: 5-14-95

Count Time: 10 MIN minutes

Alpha Eff: 0.359

Beta/Gamma Eff: 0.214

Alpha Background: 0.7 cpm

Beta/Gamma Background: 54 cpm

Technician Performing Count: R Trangas Date: 11/22/95

INSTRUCTION 3: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
330 minutes	X	N/A cfm X 2.83E+4	=	2.5E7 ml
		75 lpm X 1.0E+3		

Technician Performing Calculation: R TRANGAS Date: 11/22/95

INSTRUCTION 4: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29 \sqrt{R_B t_{S+B}} \left(1 + t_{S+B} / t_B\right)}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 2.6 E^{-13} Beta-Gamma MDA = 9.3 E^{-13}

Technician Performing Calculation: R TRANGAS Date: 11/22/95

INSTRUCTION 5: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF 140 ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α 12:20	946 cts	10 min	95 cpm	.7 cpm	94 cpm	~~140~~ .67	0.359	2.22E+6	1.7E^{-4} µCi
βγ 12:20	1815 cts	10 min	182 cpm	54 cpm	128 cpm	135 .95	0.214	2.22E+6	2.8E^{-4} µCi

Technician Performing Initial Count: R TRANGAS Date: 11/22/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 1.7E^{-4} µCi X FR	÷	2.5E7 ml	=	6.8E^{-12} µCi/ml α
βγ 2.8E^{-4} µCi X FR	÷	2.5E7 ml	=	1.1E^{-11} µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R TRANGAS Date: 11/22/95

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 3 Hour Count: N/A Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml α
βγ N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = N/A

t½ βγ = N/A

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\,(hrs)}\right)}{1 - e^{-0.0655\,(hrs)}}$$

$$= \frac{____\ \mu Ci - \mu Ci\left(e^{-0.0655\,(-___\,hrs)}\right)}{1 - e^{-0.0655(___\,hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A β $A_{LL}\mu Ci$ = (α $A_{LL}\mu Ci$) (0.67)

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83 $\frac{1.89}{2.83}$ = 0.67

Total long-lived beta activity = .945 + .945 = 1.89

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml [A_{LL}^{α}]

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml [A_{LL}^{β}]

If: [A_{LL}^{α}] > 1E-13 μCi/ml

[A_{LL}^{β}] > 2E-10 μCi/ml

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: Robert F. Nugent Date: 11/22/95

AIR SAMPLE DATA AND ANALYSIS

ATGF-030 11/95

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FT. McCLeLLAN

A/S ID Number: 001192 RWP Number: FM-103 ATGS Number: FMA-117

Date Start: 11/22/95 Date Stop: 11/22/95

Time Start: 12:20 Time Stop: 14:20 Total Time: 120 minutes

Sample Location: Duct Cutting out Side of Vault

Sample Type: ☐ Breathing Zone ☒ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: N/A

Technician Performing Sample: R. TRANGAS Date: 11/22/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: Low Volume Air Sampler

Sampler I.D.: 001192

Cal. Date: 1-12-95

Cal. Due Date: 1-12-96

Flow Rate Start: 90 ☐ cfm ☒ lpm

Flow Rate Stop: 70 ☐ cfm ☒ lpm

Average Flow Rate: 80 ☐ cfm ☒ lpm

Type Counter: L-2929 / 43-10-1

Counter I.D.: # 99045

Probe I.D.: # 98325

Cal. Date: 11/14/95

Cal. Due Date: 5-14-96

Count Time: 10 minutes

Alpha Eff: .341

Beta/Gamma Eff: .199

Alpha Background: .2 cpm

Beta/Gamma Background: 52 cpm

Technician Performing Count: R TRANGAS Date: 11/22/95

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{S+B}(1 + t_{S+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 1.3 E^{-13} Beta-Gamma MDA = 2.6 E^{-12}

Technician Performing Calculation: R Zuniga Date: 11/22/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF +	EFF. cpm/dpm ÷	dpm/µCi +	Activity =
α 14:30	868 cts	10 min	87 cpm	2 cpm	~~130~~ 87 cpm	130 .67	.341	2.22E+6	1.7E^{-4} µCi
βγ 14:30	1847 cts	10 min	185 cpm	52 cpm	133 cpm	140 .95	.199	2.22E+6	3.2E^{-4} µCi

Technician Performing Initial Count: R Zuniga Date: 11/22/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
120 minutes	X	N/A cfm X 2.83E+4	=	9.6 E^{6} ml
		80 lpm X 1.0E+3		

Technician Performing Calculation: R Zuniga Date: 11/22/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 1.7E^{-4} µCi X FR	÷	9.6 E^{6} ml	=	1.7 E^{-11} µCi/ml α
βγ 3.2E^{-4} µCi X FR	÷	9.6 E^{6} ml	=	3.3 E^{-11} µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R Zuniga Date: 11/22/95

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / μCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	μCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	μCi

Technician Performing 3 Hour Count: N/A Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α N/A μCi X FR	÷	N/A ml	=	N/A μCi/ml α
βγ N/A μCi X FR	÷	N/A ml	=	N/A μCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T_{1/2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

$t_{1/2}\ \alpha$ = N/A

$t_{1/2}\ \beta\gamma$ = N/A

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / μCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	μCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	μCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\,(hrs)}\right)}{1 - e^{-0.0655\,(hrs)}}$$

$$= \frac{\mu Ci - \mu Ci\left(e^{-0.0655\,(-___hrs)}\right)}{1 - e^{-0.0655(__hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A β $A_{LL}\mu Ci$ = (α $A_{LL}\mu Ci$) (0.67)

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83 $\frac{1.89}{2.83}$ = 0.67

Total long-lived beta activity = .945 + .945 = 1.89

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml [A_{LL}^{α}]

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml [A_{LL}^{β}]

If: [A_{LL}^{α}] > 1E-13 μCi/ml

[A_{LL}^{β}] > 2E-10 μCi/ml

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: Robert F. Nugent Date: 11/27/95

AIR SAMPLE DATA AND ANALYSIS

FORM ATGF-030

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FT. McCLeLLAN

A/S ID Number: 001192 RWP Number: FM-103 ATGS Number: FMA-118

Date Start: 11/27/95 Date Stop: 11/27/95

Time Start: 08:30 Time Stop: 0940 Total Time: 70 minutes

Sample Location: Bldg 3192 INSIDE HOT CeLL

Sample Type: ☒ Breathing Zone ☐ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: N/A

Technician Performing Sample: Humphries Date: 11/27/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: Low Volume Air Sampler

Sampler I.D.: 001192

Cal. Date: 1-17-95

Cal. Due Date: 1-17-96

Flow Rate Start: 75 ☐ cfm ☒ lpm

Flow Rate Stop: 75 ☐ cfm ☒ lpm

Average Flow Rate: 75 ☐ cfm ☒ lpm

Type Counter: L-2929 / 43-10-1

Counter I.D.: # 99041

Probe I.D.: #096923

Cal. Date: 11/14/95

Cal. Due Date: 5-14-96

Count Time: 10 minute

Alpha Eff: .355

Beta/Gamma Eff: .221

Alpha Background: 0.3

Beta/Gamma Background: 57

Technician Performing Count: R. TRANGAS Date: 11/27/95

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{S+B}(1 + t_{S+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = $2.6E^{-13}$ Beta-Gamma MDA = $4.17E^{-12}$

Technician Performing Calculation: R. Trangas Date: 11/27/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF +	EFF. cpm / dpm +	dpm / µCi +	Activity =
α 09:45	2128 cts	10 min	213 cpm	.3 cpm	213. cpm	318 .67	.355	2.22E+6	$4.0E^{-4}$ µCi
βγ 09:45	3831 cts	10 min	383 cpm	57 cpm	326 cpm	343 95	.221	2.22E+6	$7.0E^{-4}$ µCi

Technician Performing Initial Count: R. Trangas Date: 11/27/95

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
70 minutes	X	N/A cfm X 2.83E+4	=	$5.3E^{6}$ ml
		75 lpm X 1.0E+3		

Technician Performing Calculation: R. Trangas Date: 11/27/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α $4.0E^{-4}$ µCi X FR	+	$5.3E^{6}$ ml	=	$7.6E^{-11}$ µCi/ml α
βγ $7.0E^{-4}$ µCi X FR	+	$5.3E^{6}$ ml	=	$1.3E^{-10}$ µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R. Trangas Date: 11/27/95

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period +	Gross CR =	Bkgrnd CR -	Net CR =	CF	EFF. cpm / dpm ÷	dpm / µCi +	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 3 Hour Count: N/A Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml α
βγ N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = N/A

t½ βγ = N/A

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\,(hrs)}\right)}{1 - e^{-0.0655\,(hrs)}}$$

$$= \frac{____\ \mu Ci - ____\ \mu Ci\left(e^{-0.0655\,(-____\,hrs)}\right)}{1 - e^{-0.0655(____\,hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A $\beta A_{LL}\mu Ci = (\alpha A_{LL}\mu Ci)(0.67)$

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+ 10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83 $\quad \frac{1.89}{2.83} = 0.67$

'al long-lived beta activity = .945 + .945 = 1.89

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\alpha}]$

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml $[A_{LL}^{\beta}]$

If: $[A_{LL}^{\alpha}] > 1E\text{-}13\ \mu Ci/ml$

$[A_{LL}^{\beta}] > 2E\text{-}10\ \mu Ci/ml$

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: Robert F. Nugent Date: 11/27/95

AIR SAMPLE DATA AND ANALYSIS

ATGF-030 11/95

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FORT McCLELLAN - B3192

A/S ID Number: FMA 119 RWP Number: FM 103 ATGS Number: FMA-119

Date Start: 11/27/95 Date Stop: 11/27/95

Time Start: 1110 Time Stop: 1345 Total Time: 155 minutes

Sample Location: HVAC ROOM

Sample Type: ☒ Breathing Zone ☐ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: CUTTING DUCT WORK

Technician Performing Sample: P. MANNING Date: 11/27/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: GAST LoVOL

Sampler I.D.: 1292

Cal. Date: 1/17/95

Cal. Due Date: 1/17/96

Flow Rate Start: 80 ☐ cfm ☒ lpm

Flow Rate Stop: 80 ☐ cfm ☒ lpm

Average Flow Rate: 80 ☐ cfm ☒ lpm

Type Counter: L-2929

Counter I.D.: 99041

Probe I.D.: 96923

Cal. Date: 11/14/95

Cal. Due Date: 5/14/96

Count Time: 10 minutes

Alpha Eff: 0.355

Beta/Gamma Eff: 0.221

Alpha Background: 0.3

Beta/Gamma Background: 57

Technician Performing Count: R. Nugent Date: 11/27/95

INSTRUCTION 3: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29\sqrt{R_B t_{s+B}(1 + t_{s+B}/t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{s+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{s+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 5.6 E-13 Beta-Gamma MDA = 6.4E-12

Technician Performing Calculation: R. Nugent Date: 11/27/95

INSTRUCTION 4: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period +	Gross CR -	Bkgrnd CR -	Net CR -	CF +	EFF. cpm/dpm +	dpm/µCi +	Activity -
α 1415	546 cts	10 min	54.6 cpm	0.3 cpm	54 cpm	81 .67	0.355	2.22E+6	1.0E-4 µCi
βγ 1415	1416 cts	10 min	142 cpm	57 cpm	85 cpm	89 .95	0.221	2.22E+6	1.8E-4 µCi

Technician Performing Initial Count: R. Nugent Date: 11/27/94

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
155 minutes	X	N/A cfm X 2.83E+4	=	1.2E7 ml
		80 lpm X 1.0E+3		

Technician Performing Calculation: R. Nugent Date: 11/27/94

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 1.0E-4 µCi X FR	÷	1.2E7 ml	=	8.3E-12 µCi/ml α
βγ 1.8E-4 µCi X FR	÷	1.2E7 ml	=	1.5E-11 µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R. Nugent Date: 11/27/95

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / μCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	μCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	μCi

Technician Performing 3 Hour Count: N/A Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α N/A μCi X FR	÷	N/A ml	=	N/A μCi/ml α
βγ N/A μCi X FR	÷	N/A ml	=	N/A μCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = N/A

t½ βγ = N/A

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / μCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	μCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	μCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\,(hrs)}\right)}{1 - e^{-0.0655\,(hrs)}}$$

$$= \frac{____\ \mu Ci - ____\ \mu Ci\left(e^{-0.0655\,(-____\,hrs)}\right)}{1 - e^{-0.0655(____\,hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A β $A_{LL}\mu Ci$ = (α $A_{LL}\mu Ci$) (0.67)

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83 $\frac{1.89}{2.83}$ = 0.67
Total long-lived beta activity = .945 + .945 = 1.89

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml [A_{LL}^{α}]

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml [A_{LL}^{β}]

If: [A_{LL}^{α}] > 1E-13 μCi/ml

[A_{LL}^{β}] > 2E-10 μCi/ml

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: R. Nugent Date: 11/27/95

HP Supervisor Review: Robert F. Nugent Date: 11/27/95

AIR SAMPLE DATA AND ANALYSIS

ATGF-030 11/95

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FORT McCLELLAN - B3192

A/S ID Number: 1192 RWP Number: FM-103 ATGS Number: FMA-120

Date Start: 11/28/95 Date Stop: 11/28/95

Time Start: 0915 Time Stop: 1130 Total Time: 135 minutes

Sample Location: CLASSROOM B3192

Sample Type: ☐ Breathing Zone ☒ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: N/A

Technician Performing Sample: R. TRANGAS Date: 11/28/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: GAST LoVol

Sampler I.D.: 1192

Cal. Date: 1/17/95

Cal. Due Date: 1/17/96

Flow Rate Start: 90 ☐ cfm ☒ lpm

Flow Rate Stop: 90 ☐ cfm ☒ lpm

Average Flow Rate: 90 ☐ cfm ☒ lpm

Type Counter: L-2929

Counter I.D.: 99043

Probe I.D.: 98327

Cal. Date: 11/14/95

Cal. Due Date: 5/14/96

Count Time: 1145 minutes

Alpha Eff: 0.32

Beta/Gamma Eff: 0.199

Alpha Background: 0.5

Beta/Gamma Background: 52

Technician Performing Count: R. Nugent Date: 11/28/95

INSTRUCTION 3: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
135 minutes	X	N/A cfm X 2.83E+4	=	1.22E7 ml
		90 lpm X 1.0E+3		

Technician Performing Calculation: R. Nugent Date: 11/28/95

INSTRUCTION 4: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29 \sqrt{R_B t_{S+B} (1 + t_{S+B} / t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 5.9E-13 Beta-Gamma MDA = 6.4E-12

Technician Performing Calculation: Robert Nugent Date: 11/28/95

INSTRUCTION 5: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α 1145	8985 cts	10 min	898.5 cpm	0.5 cpm	898 cpm	1340 .67	0.32	2.22E+6	1.9E-3 µCi
βγ 1145	1252 cts	10 min	125.2 cpm	52 cpm	124 cpm	1267 .95	0.199	2.22E+6	2.9E-3 µCi

Technician Performing Initial Count: R. Nugent Date: 11/28/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 1.9E-3 µCi X FR	÷	1.22E7 ml	=	1.6E-10 µCi/ml α
βγ 2.9E-3 µCi X FR	÷	1.22E7 ml	=	2.4E-10 µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R. Nugent Date: 11/28/95

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α 1445	293 cts	10 min	29.3 cpm	0.5 cpm	29 cpm	43 .67	.320	2.22E+6	6.1E-5 µCi
βγ 1445	997 cts	10 min	100 cpm	52 cpm	48 cpm	51 .95	.199	2.22E+6	1.1E-4 µCi

Technician Performing 3 Hour Count: R. Nugent Date: 11/28/95

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α 6.1E-5 µCi X FR	÷	1.22E7 ml	=	5E-12 µCi/ml α
βγ 1.1E-4 µCi X FR	÷	1.22E7 ml	=	9E-12 µCi/ml βγ

Technician Performing Calculation: R. Nugent Date: 11/28/95

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T_{1/2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

$t_{1/2}\ \alpha$ = 35.6 min

$t_{1/2}\ \beta\gamma$ = 39 min

Technician Performing Calculation: R. Nugent Date: 11/28/95

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / μCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	μCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	μCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\,(hrs)}\right)}{1 - e^{-0.0655\,(hrs)}}$$

$$= \frac{____\ \mu Ci - ____\ \mu Ci\left(e^{-0.0655\,(-____\,hrs)}\right)}{1 - e^{-0.0655(____\,hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A β $A_{LL}\mu Ci$ = (α $A_{LL}\mu Ci$) (0.67)

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83

Total long-lived beta activity = .945 + .945 = 1.89

$\frac{1.89}{2.83}$ = 0.67

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml [A_{LL}^{α}]

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml [A_{LL}^{β}]

If: [A_{LL}^{α}] > 1E-13 μCi/ml

[A_{LL}^{β}] > 2E-10 μCi/ml

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: R. Nugent Date: 11/28/95

AIR SAMPLE DATA AND ANALYSIS

ATGF-030 11/95

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FT McCLELLAN

A/S ID Number: 001192 RWP Number: FM-104 ATGS Number: FMA-121

Date Start: 11/29/95 Date Stop: 11/29/95

Time Start: 07:40 Time Stop: 08:50 Total Time: 70 minutes

Sample Location: HOT CELL

Sample Type: ☒ Breathing Zone ☐ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: N/A

Technician Performing Sample: R TRANGAS Date: 11/29/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: Low Volume AIR Sampler

Sampler I.D.: 001192

Cal. Date: 1-17-95

Cal. Due Date: 1-17-96

Flow Rate Start: 90 ☐ cfm ☒ lpm

Flow Rate Stop: 90 ☐ cfm ☒ lpm

Average Flow Rate: 90 ☐ cfm ☒ lpm

Type Counter: L-2929

Counter I.D.: #99041

Probe I.D.: # 096923

Cal. Date: 11/14/95

Cal. Due Date: 5/14/96

Count Time: 10 MIN minutes

Alpha Eff: 0.341

Beta/Gamma Eff: 0.221

Alpha Background: .6

Beta/Gamma Background: 60cpm

Technician Performing Count: R TRANGAS Date: 11/29/95

INSTRUCTION 3: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
70 minutes	X	N/A cfm X 2.83E+4	=	6.3E6 ml
		90 lpm X 1.0E+3		

Technician Performing Calculation: R Trangas Date: 11/29/95

INSTRUCTION 4: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29 \sqrt{R_B t_{S+B}} \, (1 + t_{S+B} / t_B)}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 1.1E-11 Beta-Gamma MDA = 9.5E-12

Technician Performing Calculation: R Trangas Date: 11/29/95

INSTRUCTION 5: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α 9:00	3590 cts	10 min	359 cpm	.6 cpm	358 cpm	524 .67	.341	2.22E+6	7.1E-4 µCi
βγ 9:00	6261 cts	10 min	626 cpm	60 cpm	566 cpm	537 .95	.221	2.22E+6	1.1E-3 µCi

Technician Performing Initial Count: R Trangas Date: 11/29/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 7.1E-4 µCi X FR	÷	6.3E6 ml	=	1.1E-10 µCi/ml α
βγ 1.1E-3 µCi X FR	÷	6.3E6 ml	=	1.7E-10 µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R Trangas Date: 11/29/95

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α 12:00	161 cts	10 min	16 cpm	.6 cpm	15 cpm	22 .67	.341	2.22E+6	2.9E-5 µCi
βγ 12:00	796 cts	10 min	80 cpm	60 cpm	20 cpm	21 .95	.221	2.22E+6	4.3E-5 µCi

Technician Performing 3 Hour Count: R TRANGAS Date: 11/29/95

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α 2.9E-5 µCi X FR	÷	6.3E6 ml	=	4.6E-12 µCi/ml α
βγ 4.3E-5 µCi X FR	÷	6.3E6 ml	=	6.8E-12 µCi/ml βγ

Technician Performing Calculation: R TRANGAS Date: 11/29/95

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = 39.3 min

t½ βγ = 38.7 min

Technician Performing Calculation: R TRANGAS Date: 11/29/95

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / μCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	μCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	μCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\,(hrs)}\right)}{1 - e^{-0.0655\,(hrs)}}$$

$$= \frac{____\ \mu Ci - ____\ \mu Ci\left(e^{-0.0655\,(-____\,hrs)}\right)}{1 - e^{-0.0655(____\,hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A β $A_{LL}\mu Ci$ = (α $A_{LL}\mu Ci$) (0.67)

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83

Total long-lived beta activity = .945 + .945 = 1.89

$\frac{1.89}{2.83}$ = 0.67

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml [A_{LL}^{α}]

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml [A_{LL}^{β}]

If: [A_{LL}^{α}] > 1E-13 μCi/ml

[A_{LL}^{β}] > 2E-10 μCi/ml

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: R. Vaugeant Date: 11/29/95

~~INSTRUCTION 3: Calculate the Total Sample Volume:~~ 11/30/96

AIR SAMPLE DATA AND ANALYSIS

ATGF-030 11/95

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FT McCLeCLAN

A/S ID Number: 001192 RWP Number: FM-104 ATGS Number: FMA-122

Date Start: 11/29/95 Date Stop: 11/29/95

Time Start: 15:30 Time Stop: 16:10 Total Time: 40 minutes

Sample Location: HoT CeLL

Sample Type: ☐ Breathing Zone ☐ General Area ☐ Other: ☐ High Volume ☐ Low Volume ☐ Lapel/Personal

Comments: While chisel HAMMER IS BEING USED ON FLOOR OF HOT CELL

Technician Performing Sample: Ed Humphries Date: 11/29/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: Low Volume AIR SAMPLER

Sampler I.D.: 001192

Cal. Date: 1-17-95

Cal. Due Date: 1-17-96

Flow Rate Start: 90 ☐ cfm ☒ lpm

Flow Rate Stop: 90 ☐ cfm ☒ lpm

Average Flow Rate: 90 ☐ cfm ☒ lpm

Type Counter: L-2929

Counter I.D.: # 99041

Probe I.D.: # 096923

Cal. Date: 11/14/95

Cal. Due Date: 5/14/96

Count Time: 10 MIN minutes

Alpha Eff: .341

Beta/Gamma Eff: .221

Alpha Background: .6 cpm

Beta/Gamma Background: 60 cpm

Technician Performing Count: R TeANGAS Date: 11/29/95

INSTRUCTION 3: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
40 minutes	X	N/A cfm X 2.83E+4	=	3.6 E^6 ml
		90 lpm X 1.0E+3		

Technician Performing Calculation: R TRANGAS Date: 11/29/95

INSTRUCTION 4: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29 \sqrt{R_B t_{S+B} (1 + t_{S+B} / t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 2.0 E^-12 Beta-Gamma MDA = 1.7 E^-11

Technician Performing Calculation: R TRANGAS Date: 11/29/95

INSTRUCTION 5: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm/dpm ÷	dpm/µCi ÷	Activity =
α/1615	2097 cts	10 min	210 cpm	.6 cpm	209 cpm	312 .67	.341	2.22E+6	4.1 E^-4 µCi
βγ 1615	3883 cts	10 min	388 cpm	60 cpm	328 cpm	345 .95	.221	2.22E+6	7.0 E^-4 µCi

Technician Performing Initial Count: R. TRANGAS Date: 11/29/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 4.1 E^-4 µCi X FR	÷	3.6 E^6 ml	=	1.1 E^-10 µCi/ml α
βγ 7.0 E^-4 µCi X FR	÷	3.6 E^6 ml	=	1.9 E^-10 µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R. TRANGAS Date: 11/29/95

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 3 Hour Count: N/A Date: N/A

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml α
βγ N/A µCi X FR	÷	N/A ml	=	N/A µCi/ml βγ

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = N/A

t½ βγ = N/A

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR 0.1 -	Net CR =	CF ÷	EFF. cpm/dpm ÷	dpm/µCi ÷	Activity =
α 1215	14 cts	10 min	1.4 cpm	~~1.5~~ cpm	1.3 cpm	2 .67	.241	2.22E+6	2.6E µCi
βγ 1215	676 cts	10 min	68 cpm	6 cpm	62 cpm	8.4 .95	.216	2.22E+6	1.5E µCi

Technician Performing 20 Hour Count: K. Nugent Date: 11/3/15

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\,(hrs)}\right)}{1 - e^{-0.0655\,(hrs)}}$$

$$= \frac{____\ \mu Ci - \mu Ci\left(e^{-0.0655\,(-___\ hrs)}\right)}{1 - e^{-0.0655(___\ hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

$\alpha = 2.6E^{-5} \div 3.6E^{6} = 7.2E^{-12}$ µCi/ml

$\beta\gamma = 1.6E^{-5} \div 3.6E^{6} = 5E^{-12}$ µCi/ml

Technician Performing Calculation: K. Nugent Date: 11/3/15

INSTRUCTION 13: Using the value of alpha long-lived activity from Instruction 12, calculate the beta long-lived activity:

N/A β $A_{LL}\mu Ci$ = (α $A_{LL}\mu Ci$) (0.67)

where 0.67 is:

Nuclide	T½	Ci	Emission	Yield	Energy
Th-232	1.4E+10 yr.	1.	Alpha	100%	4.01 Mev
Ra-228	5.75 yr.	.9446	Beta	100%	0.05 Mev
Ac-228	6.13 hr.	.9446	Beta	100%	2.11 Mev
Th-228	1.91 yr.	.9171	Alpha	100%	5.4 Mev
Ra-224	3.62 day	.9169	Alpha	100%	5.5 Mev
Rn-220	55 sec.	.9169	Alpha	100%	6.3 Mev
Po-216	0.15 sec.	.9169	Alpha	100%	6.8 Mev
Pb-212	10.6 hr.	.9169	Beta	100%	0.6 Mev
Bi-212	60.6 min	.9169	Beta	100%	2.25 Mev

Total long-lived alpha activity = 1 + .917 + .917 = 2.83 $\frac{1.89}{2.83}$ = 0.67

Total long-lived beta activity = .945 + .945 = 1.89

Technician Performing Calculation: N/A Date: N/A

INSTRUCTION 14: Calculated the long-lived activity concentrations from the values determined in Instructions 12 and 13:

$\frac{A_{LL}^{\alpha}\mu Ci}{volume}$ = N/A μCi/ml [A_{LL}^{α}]

$\frac{A_{LL}^{\beta}\mu Ci}{volume}$ = N/A μCi/ml [A_{LL}^{β}]

If: [A_{LL}^{α}] > 1E-13 μCi/ml

[A_{LL}^{β}] > 2E-10 μCi/ml

Then:
- Report this to the HP Supervisor Immediately
- Post the area as Airborne Radioactivity Area
- Calculate and record DAC Hours for the affected individuals
- Send the sample out for an isotopic analysis

Technician Performing Calculation: N/A Date: N/A

HP Supervisor Review: R. Vingent Date: 11/20/95

~~INSTRUCTION 3: Calculate the Total Sample Volume:~~

AIR SAMPLE DATA AND ANALYSIS

ATGF-030 11/95

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location: FORT McCLELLAN - B3192

A/S ID Number: 1192 RWP Number: FM-104 ATGS Number: FM-123

Date Start: 11/30/95 Date Stop: 11/30/95

Time Start: 0850 Time Stop: 0945 Total Time: 55 minutes

Sample Location: TOP OF HOT CELL

Sample Type: ☒ Breathing Zone ☐ General Area ☐ Other:
☐ High Volume ☒ Low Volume ☐ Lapel/Personal

Comments: DECON OF MANWAY COVERS

Technician Performing Sample: E. HUMPHRIES Date: 11/30/95

INSTRUCTION 2: Complete the following information concerning sampling equipment and counting equipment:

Type Sampler: GAST LOW VOL

Sampler I.D.: 1192

Cal. Date: 1-17-95

Cal. Due Date: 1-17-96

Flow Rate Start: 90 ☐ cfm ☒ lpm

Flow Rate Stop: 90 ☐ cfm ☒ lpm

Average Flow Rate: 90 ☐ cfm ☒ lpm

Type Counter: L2929

Counter I.D.: 99941

Probe I.D.: 96923

Cal. Date: 11/14/95

Cal. Due Date: 5/14/96

Count Time: 0950 minutes

Alpha Eff: 0.341

Beta/Gamma Eff: 0.211

Alpha Background: 0.1 cpm

Beta/Gamma Background: 0.0 cpm

Technician Performing Count: R. Vincent Date: 11/30/95

INSTRUCTION 3: Calculate the Total Sample Volume:

Total Sample Run Time		Sample Average Flow Rate		Total Volume
55 minutes	X	N/A cfm X 2.83E+4	=	5E6 ml
		90 lpm X 1.0E+3		

Technician Performing Calculation: R. Nugent Date: 11/30/95

INSTRUCTION 4: Calculate the alpha and beta-gamma MDA values:

$$\text{MDA } \frac{\mu Ci}{ml} = \frac{2.71 + 3.29 \sqrt{R_B t_{S+B} (1 + t_{S+B} / t_B)}}{2.22E6 \cdot E \cdot V \cdot t_{S+B}}$$

where:

V	=	Sample Volume in ml
E	=	Counter Efficiency
R_B	=	Background Count Rate (cpm)
t_{S+b}	=	Sample Counting Time (min)
t_B	=	Background Counting Time (min)

Alpha MDA = 1.70 E-12 Beta-Gamma MDA = 1.60E-11

Technician Performing Calculation: Richard Nugent Date: 11/30/95

INSTRUCTION 5: Upon completion of the end of sampling period, perform the initial count of the sample within 15 minutes:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity -4=
α/1000	4095 cts	10 min	410 cpm	0.1 cpm	410 cpm	612 .67	0.341	2.22E+6	6.1E µCi
βγ/1000	7118 cts	10 min	712 cpm	60 cpm	652 cpm	686 .95	0.216	2.22E+6	1.4E µCi

Technician Performing Initial Count: R. Nugent Date: 11/30/95

INSTRUCTION 6: Determine the Initial Airborne Concentration:

Initial Activity		Volume		Initial Activity
α 6.1E-4 µCi X FR	÷	5E6 ml	=	1.62E-10 µCi/ml α
βγ 1.4E-3 µCi X FR	÷	5E6 ml	=	2.8E-10 µCi/ml βγ

FR = Filter Ratio (4" Filters = 3.0) (2" Filters = 1.0)

Technician Performing Calculation: R. Nugent Date: 11/30/95

INSTRUCTION 7: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern, then a recount of the sample is required after a 3 hour decay period to allow the short lived Radon daughters to decay.

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / µCi ÷	Activity =
α 13:00	149 cts	10 min	15 cpm	.1 cpm	15 cpm	22 .67	.341	2.22E+6	3.0E-5 µCi
βγ 13:00	944 cts	10 min	94 cpm	60 cpm	34 cpm	36 .95	.216	2.22E+6	7.5E-5 µCi

Technician Performing 3 Hour Count: R. TRANGAS Date: 11/30/95

INSTRUCTION 8: Determine the airborne concentration following 3 Hr. decay and utilizing volume data in Instruction 5:

3 Hr. Decayed Activity		Volume		3 Hr. Decayed Activity
α 3.0E-5 µCi X FR	÷	5E6 ml	=	6E-12 µCi/ml α
βγ 7.5E-5 µCi X FR	÷	5E6 ml	=	1.5E-11 µCi/ml βγ

Technician Performing Calculation: RTRANGAS Date: 11/30/95

INSTRUCTION 9: Determine the half-life of the radionuclide(s) using the following formula:

$$T\tfrac{1}{2}\ (\text{min}) = \frac{-.693\ (t)}{\ln \dfrac{\text{Final Activity}}{\text{Initial Activity}}}$$

t = elapsed time between counts in minutes

t½ α = 37.8 MIN

t½ βγ = 42.5 MIN

Technician Performing Calculation: RICHARD E TRANGAS Date: 11/30/95

INSTRUCTION 10: If either the Alpha/Beta-Gamma activity exceeds 10% of the DAC value of the known radionuclide(s) of concern following the 3 hour decay, then a 20 hour decay count of the sample is required to remove the Thoron component of the sample.

INSTRUCTION 11: Decay sample for 20 hours and then recount the sample:

Time Counted	Gross Counts	Count Period ÷	Gross CR =	Bkgrnd CR -	Net CR =	CF ÷	EFF. cpm / dpm ÷	dpm / μCi ÷	Activity =
α	cts	min	cpm	cpm	cpm	.67		2.22E+6	μCi
βγ	cts	min	cpm	cpm	cpm	.95		2.22E+6	μCi

Technician Performing 20 Hour Count: N/A Date: N/A

INSTRUCTION 12: Using the 3 hour and the 20 hour activity, determine the long-lived activity due to alpha:

$$A_{LL}^{\alpha} = \frac{A_{20}^{\alpha} - A_3^{\alpha}\left(e^{-0.0655(\Delta T)}\right)}{1 - e^{-0.0655(\Delta T)}}$$

where:

A_{LL}^{α}	=	long-lived activity which emits alpha
A_{20}^{α}	=	20 hour decayed activity due to alpha
A_3^{α}	=	3 hour decayed activity due to alpha
0.0655	=	Pb-212 decay constant; since Bi-212 is in transient equilibrium with the Pb-212 and Po-212 is in secular equilibrium with the Bi-212, it is also Po-212's decay constant.
ΔT	=	elapsed time between the 3 hour decay period midpoint and the 20 hour decay period midpoint in hours

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_3\mu Ci\left(e^{-0.0655\,(hrs)}\right)}{1 - e^{-0.0655\,(hrs)}}$$

$$= \frac{____\ \mu Ci - ____\ \mu Ci\left(e^{-0.0655\,(-____\,hrs)}\right)}{1 - e^{-0.0655(____\,hrs)}}$$

$$= \underline{\ N/A\ }\ \mu Ci$$

Technician Performing Calculation: N/A Date: N/A