VISTA Technologies, Inc.
Radiation Safety Program

PROCEDURE - 6

AS LOW AS REASONABLY ACHIEVABLE (ALARA)

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ABBREVIATIONS AND ACRONYMS

α	-	Alpha
ß	-	Beta
γ	-	Gamma
μ	-	Micro
^{241}Am	-	Americium-241
^{137}Ce	-	Cesium-137
^{234}Pa	-	Protactinium-234
^{210}Pb	-	Lead-210
^{210}Po	-	Polonium-210
^{214}Po	-	Polonium-214
^{218}Po	-	Polonium-218
^{232}Pu	-	Plutonium-232
^{226}Ra	-	Radium-226
^{228}Ra	-	Radium-228
^{219}Rn	-	Radon-219 (Actinium Series)
^{220}Rn	-	Radon-220 (Thorium Series)
^{222}Rn	-	Radon-222 (Uranium Series)
^{89}Sr	-	Strontium-89
^{90}Sr	-	Strontium-90
^{230}Th	-	Thorium-230
^{232}Th	-	Natural Thorium
^{238}U	-	Uranium-238
μCi	-	MicroCurie
μCi/hr	-	MicroCuries per hour
μCi/ml	-	MicroCuries per milliliter
μM	-	Micrometer
μR/hr	-	MicroRoentgen per hour
μg/mg	-	Microgram per milligram
ALARA	-	As low as reasonably achievable
ALI	-	Annual limit on intake
ANSI	-	American National Standards Institute
APR	-	Air-purifying respirator
Bq	-	Becquerel
Bq/m^3	-	Becquerels per cubic meter of air
BZ	-	Breathing Zone
C	-	Coulomb
C/kg	-	Coulombs per kilogram
CDE	-	Committed Dose Equivalent
CEDE	-	Committed Effective Dose Equivalent

CFR	-	Code of Federal Regulations
Ci	-	Curie
CIH	-	Certified Industrial Hygienist
CFM	-	Cubic feet per minute
CLIA	-	Clinical Laboratories Improvement Act
CLP	-	Contract Laboratory Program
cm	-	Centimeter
cm/sec	-	Centimeters per second
cpm	-	Counts per minute
CPR	-	Cardiopulmonary resuscitation
CSE	-	Certified Safety Executive
(D)	-	Duplicate count
DAC	-	Derived air concentration
DAC-h	-	DAC hours
DCA	-	Double Contingency Analysis
DDE	-	Deep Dose Equivalent
DI	-	De-ionized water
DOT	-	U.S. Department of Transportation
dm^2	-	Square Decimeter; one square decimeter equals 100 square centimeters
dpm	-	Disintegrations per minute
dpm/cm^2	-	Disintegrations per minute per square centimeter
dpm/dm^2	-	Disintegrations per minute per square decimeter
dps	-	Disintegrations per second
DRD	-	Direct reading dosimeter
DU	-	Depleted uranium
EPA	-	U.S. Environmental Protection Agency
eV	-	Electronvolt
FE	-	Feces sample
FIDLER	-	Field instrument for detection of low energy radiation
FR	-	Filter ratio
FSP	-	Field Sampling Plan
ft^2	-	Square foot
γ	-	Gamma ray
GA	-	General area
GeLi	-	Germanium - Lithium
G-M	-	Geiger-Mueller
GMC-H	-	Mine Safety Appliances Company, full-facepiece, dual ..combination filter cartridges for an APR
GPD	-	Gaseous Diffusion Plang
h	-	hours
He-3	-	Helium Three (3)

HEPA	-	High efficiency particulate air
HNO_3	-	Nitric acid
HP	-	Health Physics
hr	-	Hour
HS	-	Hot spot (radiation)
HSP	-	Site-specific Health and Safety Plan
HWP	-	Hazardous Work Permit
ICRP	-	International Commission on Radiological Protection
ID	-	Identification
IDLH	-	Immediately dangerous to life or health
IDW	-	Investigation derived waste
IP	-	Ionization potential
IVC	-	Independent verification contractor
keV	-	Kiloelectronvolt
kg	-	Kilogram
LANL	-	Los Alamos National Laboratory
lpm	-	Liters Per Minute
MCA	-	Multi-channel analyzer
MDA	-	Minimum detectable activity
meV	-	Millielectronvolt
m	-	Meter
m^2	-	Squared Meters
m^3	-	Cubic meters
mCi	-	MilliCurie
MSHP	-	Manager, Vista Safety and Health Program
mil	-	1/1000 inch
ml	-	Milliliter
mm	-	Millimeter
mR	-	MilliRoentgen
mR/hr	-	MilliRoentgens per hour
mrem	-	Millirem
mrem/hr	-	Millirems per hour
MSA	-	Mine Safety Appliances Company
MSDS	-	Material Safety Data Sheet
MSHA	-	Mine Safety and Health Administration
NaI	-	Sodium iodide
NCA	-	Nuclear Criticality Analysis
NCS	-	Nuclear Criticality Safety
NCRP	-	National Council on Radiation Protection and Measurements
NEA	-	Nuclear Energy Agency
NIST	-	National Institute of Science and Technology

U^{nat}	-	Natural uranium
UR	-	Urine sample
U.S.	-	United States
VISTA	-	Vista Technologies, Inc.
VSHP	-	VISTA Safety and Health Program
VRSP	-	VISTA Radiation Safety Program
WL	-	Working Level
WP	-	Work Plan

NIOSH	-	National Institute for Occupational Safety and Health
n. o. s.	-	Not otherwise specified
NPDES	-	National Pollutant Discharge Elimination System
NRC	-	U.S. Nuclear Regulatory Commission
NS	-	Nose swipe
NTIS	-	National Technical Information Service
NVLAP	-	National Voluntary Laboratory Accreditation Program
OHSO	-	On-Site Health and Safety Officer
ORNL	-	Oak Ridge National Laboratory
ORPO	-	On-Site Ionizing Radiation Protection Officer
OSHA	-	U.S. Occupational Safety and Health Administration
pCi	-	PicoCurie
pCi/gm	-	PicoCuries per gram
pCi/l	-	PicoCuries per liter
P.E.	-	Professional Engineer
PF	-	Protection Factor
PIC	-	Pocket Ionization Chamber
PM	-	Project Manager
PMT	-	Photomultiplier Tube
PPE	-	Personal Protective Equipment
PRP	-	Potentially Responsible Party
PRS	-	Portable ratemeter/scaler
PVC	-	Polyvinyl chloride
QA	-	Quality assurance
QC	-	Quality control
R	-	Roentgen
RA	-	Restricted (radiation) area
rad	-	Radiation absorbed dose
RAS-1 -		Kurz air sampling pump flow calibration kit
REM	-	Roentgen equivalent man
RHSC	-	Radiation Health and Safety Committee
RSO	-	VISTA Radiation Safety Officer
RWP	-	Radiation work permit
SAP	-	Sampling and Analysis Plan
SCBA	-	Self-contained breathing apparatus
SRD	-	Self-reading dosimeter
TODE	-	Total Organ Dose Equivalent
TLD	-	Thermoluminescent dosimeter
TWA	-	Time-weighted average

1. AS LOW AS REASONABLY ACHIEVABLE

1.1. Scope

Maintaining radiation exposures As Low As Reasonably Achievable (ALARA) is based upon cost versus benefit analysis and in strict compliance with the requirements of 10 CFR 20, "Standards For Protection Against Radiation", 10 CFR 835, "Occupational Radiation Protection", and Nuclear Regulatory Commission (NRC) Regulatory Guide 8.8, ""Information Relevant to Ensuring that Occupational Radiation Exposures Will Be As Low As Reasonably Achievable", and NRC Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Reasonably Achievable". Worker protection from exposures to ionizing and non-ionizing radiation in the United States is controlled under regulations that establish exposure limits. However, regardless of quantitative limits incorporated into Vista Corporate standards, pertinent regulations require that no ionizing and non-ionizing radiation dose be permitted that is practical and reasonably avoided. This principle, called the ALARA concept, is the keystone of contemporary ionizing and non-ionizing radiation exposure reduction efforts.

The ALARA concept means that all operations associated with ionizing and non-ionizing radiation should be conducted such as to ensure that exposures are kept ALARA. ALARA involves both a philosophical approach to ionizing and non-ionizing radiation protection and a defined set of technologies that minimize exposure at acceptable cost. ALARA is a moving target; as improved methods emerge or as ionizing and non-ionizing radiation protection practices are developed further, lower exposures may be attained. The ALARA program applies to all Vista personnel on field operations.

1.2. Purpose

The purpose of this procedure is to implement ALARA commitments. This procedure and subordinate operating procedures satisfy the requirements of Regulatory Guide 8.8 and are consistent with the ALARA principles and requirements in applicable NRC Regulations, including 10 CFR 20.

1.3. Policy

It is Vista's policy to control ionizing and non-ionizing radiation exposures of personnel to ALARA levels. This policy is accomplished by controlling external and internal ionizing and non-ionizing radiation health and safety hazards by implementing feasible engineering, work practice, and administrative control measures. These controls include the following:

- Shielding or isolating the radioactive source materials and/or radioactive contamination from potentially exposed personnel;
- Designing the task to minimize the duration personnel are potentially exposed and to increase the distance of personnel from the source material; and
- Wearing Personnel Protective Equipment (PPE), complying with radioactive decontamination procedures, and using good personal hygiene practices.

Note: For the purposes of this document Ionizing Radiation includes Non-Ionizing Radiation

Real-time measurement of personnel ionizing and non-ionizing radiation exposures and work area radiation levels are used to implement work practice and administrative controls. Personnel monitoring and bioassays are used to verify the effectiveness of the control measures instituted to limit personnel exposures to ALARA levels.
Records listed in Procedure 24.0, "Records and Reports," are maintained of these ALARA activities and routinely reviewed to identify any trends of higher-than-expected personnel ionizing and non-ionizing radiation exposures associated with certain work areas or tasks, so that additional or alternative control measures may be instituted.

1.4. References

- 10 CFR 20, "Standards for Protection Against Radiation"
- NRC Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures Will Be As Low As Reasonably Achievable",
- NRC Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Reasonably Achievable".

1.5. Precautions and Limitations

The ALARA program is measured with the benefit of reductions in individual and/or collective exposures to workers and/or the general public. While ALARA has no limitation other than the derived benefit versus actual cost, the application of ALARA techniques need individual consideration for the safety and comfort of the worker.

1.5.1 Shielding

- Shielding for gamma rays composed of high-density and high atomic number materials should be handled carefully. Injury may result from improper handling of lead;
- Shielding should be inspected frequently to ensure its original configuration is maintained and should be surveyed periodically;
- Shielding should not impede work evolution;
- The exposure saved by shielding may be spent by longer work periods;
- Shielding should be installed based upon seismic considerations;
- Lead is classified as a hazardous material due to its toxicity. Precautions for handling lead should be exercised during use;
- Shielding should be evaluated for weight considerations. Shielding may damage or destroy equipment if load limits of supports are exceeded;
- Shielding should be protected by plastic wrapping when used in loose contamination areas;
- Shielding for neutrons uses both high and low atomic number composite layers;
- Radioactive sources should be stored in shielded containers and kept shielded at all practical times during use

- Shielding should be evaluated for compatibility with the area in which it is to be used. For example, lead shot should not be used in areas where loose materials may cause damage to equipment;
- Temporary shielding is particularly effective against small, localized hot spots and should be used when possible;
- Consider the installation of permanent shielding. The estimated exposure for installing the shielding must be weighed against the expected exposure reduction; and
- Many different types of shielding are available for use. Consider the following:

  - Lead blankets, bricks, sheets, matting, lead glass;
  - Water;
  - Plastic and wood materials; and
  - Aluminum; and
  - Composite layers of various high and low atomic # materials

1.5.2 Remote Handling Devices

- Remote handling devices should be used by personnel familiar with their operation. Loss of control of highly radioactive material may occur if handling devices are used improperly;
- Remote handling devices should be inspected prior to use and periodically to ensure they are in good condition;
- Care should be exercised to prevent cross contaminating handling devices; and
- Cranes used to remotely handle radioactive material shall be operated ONLY by trained and qualified operators.

1.5.3 Temporary Confinements/Containment's

- Temporary confinements/containment's used to limit the spread of contamination should be constructed of fire proof or fire retardant materials;
- If the possibility of system leakage exists inside temporary confinements/containment's, an appropriate drainage path to radioactive drain collecting systems should be installed; use berms in areas where no drains are available;
- Air quality in temporary confinements/containment's should be evaluated frequently for habitability and levels of contaminants;
- When ventilation systems are used with temporary confinements/containment's, it is important to balance the supply and exhaust air flows to prevent damage to confinement/containment;
- Temporary confinements/containment's used outside should be constructed to withstand adverse environmental conditions. It is particularly important to provide roof drainage in the event of rain; and
- Temporary confinements/containment's should be constructed with clear plastic windows or electronic viewing system to allow outside personnel to view activities

inside the confinement/containment. This is important in the event of an incapacitating injury to personnel inside the confinement/containment.

1.5.4 Worker Comfort

- The comfort of the worker is extremely important to the ALARA philosophy. Job performance is directly proportional to the degree of comfort a worker feels;
- Bubble hoods should be used instead of airline full face respirators when possible;
- The minimum amount of protective clothing required should be determined and only this amount should be used;
- Heat stress should be considered and monitored during work. Counter measures should be used to reduce this possibility (e.g.,, fluid intake, stay times, or ice vest, etc.);
- Awkward working positions should be avoided when possible;
- Unsafe conditions are a distraction to workers. Unsafe conditions should be removed/corrected from a work area;
- Good lighting is essential to worker comfort. A brightly-lit work area is important to the psychological well being of a worker. A brightly lit work area should be considered whenever possible;
- Low dose areas should be designated in work areas where personnel may take rest breaks without removing protective clothing/equipment; and
- Methods to adjust humidity and temperature in the work area should be considered.

It is comforting to workers to know they are being watched and help is immediately available in the event of an emergency. An outside person(s) shall ALWAYS be available to assist workers inside high hazard (high radiation, high contamination, airborne, confined spaces, etc.) areas.

1.5.5 Communications

- Headphones and microphone systems should be considered;
- Hand signals should be understood by all personnel before starting work;
- A pre planned reliable communication system shall be employed. Poor communication results in more exposure; and
- A reliable two-way communication system shall be required when personnel are working in areas where:
  - Time keeping will be in effect;
  - General area exposure rates require constant communication;
  - Line of sight cannot be maintained in confined spaces;
  - Frequent monitoring is required; or
  - Communication is required to meet an ALARA commitment.

1.5.6 Decontamination

- Consider decontaminating the work area, or equipment prior to the commencement of work. In addition to exposure reduction due to the removal of the contamination, decontamination may allow work crews to forego protective clothing and/or respirators thereby increasing their productivity and reducing their exposure; and
- The estimated exposure for decontaminating shall be weighed against the expected exposure savings.

1.5.7 Removal of Sources or Relocation of Work

- Consider flushing systems, piping, tanks, valves, etc., prior to commencement of work, and after performing a typical nuclear criticality analysis;
- Consider removing unused equipment in the work area, if equipment is a radiation source;
- Consider storage of radiological sources in another area beside the work area; and
- Consider moving the equipment that is to be worked on to an area with lower radiation levels.

1.5.8 Improve Access

- Consider the improvement of access to work areas by the installation of scaffolding, removal of interference, establishing different access control points; and
- Care should be exercised in the location of control points. Personnel should not be required to remain in a radiation area while awaiting their turn at the step-off-pad.

1.5.9 Special Tools and Fixtures

- Consider obtaining or fabricating and using special tools or fixtures;
- Tools, such as a long handled retriever can significantly reduce dose; and
- Fixtures, such as a temporary confinement/containment with forced ventilation through High Efficiency Particulate Air (HEPA) filters should be considered for contamination control when applicable.

1.5.10 Mock-Up Exercises

- Consider mock-ups or dry runs to make certain each individual is familiar with their role in the operation. Mock-up exercises can also help identify problems and solutions with little or no exposure.

1.6. Responsibilities

1.6.1 Radiation Safety Officer

The following are the RSO's responsibilities:

Note: For the purposes of this document Ionizing Radiation includes Non-Ionizing Radiation

- Promote the ALARA philosophy;
  - While maintaining ALARA principles, shall ensure that the use of respiratory protection is reduced to the minimum practicable by implementing engineering controls and work practices to contain radioactivity at the source;
- Shall implement ALARA through the Radiation Work Permit (RWPs) in full compliance with the Vista ALARA Program including all goals and procedures;
- Review work environments, procedures, and equipment to minimize work crew exposures consistent with the Vista ALARA Program goals, procedures, and applicable RWPs;
- Actively promote the ALARA philosophy by establishing high standards for the performance of radiological controls. These standards and management expectation should be frequently communicated to the work force;
- Shall monitor their subordinates year-to-date radiation exposures; and
- Should establish working conditions that encourage improved radiological controls. This includes temperature, humidity, and lighting as well as the more difficult consideration of accessibility. Work conditions should be considered in planning work.
- Shut down any operation <u>immediately</u> that does not adhere to ALARA principles;

1.6.2 Vista Personnel

Vista personnel responsibilities include the following:

- Review work environments, procedures, and equipment to maintain exposures consistent with the Vista ALARA Program goals, procedures, and applicable RWPs;
- Shall maintain their own exposures ALARA consistent with the Vista ALARA program, goals, procedures, and applicable RWPs;
- Should make suggestions to improve the ALARA program;
- Shall follow all procedures and work instructions;
- Shall attend ALARA briefings;
- Shall obey promptly "stop work" and "evacuate" instructions by the Vista On-site Radiation Protection Officer (ORPO);
- Shall keep track of his/her individual radiation dose and avoid exceeding dose control levels and limits;
- Shall wear dosimetry equipment as required by procedures, RWPs, or as directed by the RSO;
- Shall remain in as low a radiation area as practical to accomplish work;
- Shall leave radiation areas or airborne radioactivity areas when not working, and use "wait areas" as designated;
- Shall NOT SMOKE, EAT, DRINK, CHEW GUM OR TOBACCO, OR SNUFF in controlled areas, or bring open containers of smoking, eating, drinking, or chewing materials into controlled areas;

- Shall wear protective clothing and respirators whenever required by signs, RWP, RSO, procedures and instructions;
- Shall remove protective clothing and respirators properly to minimize the spread of contamination;
- Shall minimize the spread of a known or possible radioactive/hazardous material spill and notify the Vista ORPO promptly;
- Shall avoid unnecessary contact with contaminated surfaces;
- Shall limit the amount of waste requiring decontamination or disposal as radioactive waste;
- Shall place contaminated tools, equipment, and solid waste on disposable surfaces (for example, sheet plastic) when not in use, and inside plastic bags when work is finished;
- Shall control the amount of materials brought into radiologically controlled areas to minimize radioactive waste;
- Shall report unsafe or non compliance situations promptly;
- Shall report the presence of treated or open wounds to the Vista ORPO before work in areas where radioactive/hazardous contamination exists, and exit immediately if a wound occurs while in such an area;
- Shall report prior or concurrent occupational radiation exposure; and
- Should report known or suspected pregnancy to the Vista RSO and Vista ORPO promptly.

1.7. ALARA Procedures

The considerations provided in this Procedure play a major role in preparing all individuals in the practices of ALARA. When dealing with possible radiation exposure to personnel, review of these sections will ensure preparedness. ALARA considerations, once approved, become requirements of the RWP.

1.7.1. ALARA Considerations

A RWP will be completed by the Vista RSO for every job where the following conditions are anticipated:

- High Radiation/Very High Radiation Area entry;
- A potential radiation exposure > 50 mrem individual whole body or > 500 mrem collective whole body exposure;
- High Contamination or Hot Particle controls;
- Use of temporary shielding;
- When required by another procedure; and
- Respiratory protection usage or when measures are taken in lieu of respiratory protection, e.g., Derived Air Concentration (DAC) hour tracking, glove bag, etc.

The RWP will be reviewed and approved in accordance with the ionizing and non-ionizing radiation dose limits indicated in the table below:

Table 1-1 - Ionizing and Non-Ionizing Radiation Dose Limits

ESTIMATED WHOLE BODY EXPOSURE*		**REQUIRED APPROVAL**
Individual	Collective	
> 50 mrem	> 500 mrem	Radiation Safety Officer
> 500 mrem	> 5,000 mrem	Radiation Safety Officer Project Manager

* Internal and/or External Exposure

1.7.2. DAC-Hour Tracking

1.7.2.1. Scope

This procedure applies to all individual accounting of DAC-hrs accrued by Vista personnel on field projects.

1.7.2.2. Purpose

The purpose of this procedure is to provide standardization of the documentation and management of data from the assessment of airborne radioactivity concentrations for personnel protection.

1.7.2.3. References

- 10 CFR 835, "Occupational Radiation Protection"
- 10 CFR 20, "Standards for Protection Against Radiation"

1.7.2.4. Limitations

The Vista RSO will determine if an individual has received DAC-hrs at another facility prior to receiving any internal exposure at Vista project sites. An effective dose equivalent or committed dose equivalent, recorded as legal dose on NRC Form-4 (or equivalent) accounting for internal exposure is acceptable. If the effective or committed dose equivalent has not been determined due to the other facility using Maximum Permissible Concentration values, the prior MPC-HR total for the year from the other facility will be obtained and used to determine the annual effective dose and committed 50 year dose equivalent.

1.7.2.5. Precaution

The most restrictive (lower numeric quantity) value for DAC will be used, unless the specific form of the material is known, in which case the actual DAC for that form will be used.

Note: For the purposes of this document Ionizing Radiation includes Non-Ionizing Radiation

1.7.2.6. Procedure

DAC-hrs will be documented and maintained if:

- The individual is exposed to airborne radioactivity greater than the amount equal to 10% of the DAC value for specified isotopes;
- There is a possibility that the individual could receive during the year 10% of the ALI; and
- The individual has received internal exposure at another location, such as a power reactor during the current year, and that exposure is recorded as part of the annual effective dose equivalent or 50-year committed effective dose equivalent.

Once assessment of an individual's DAC-hrs has been commenced, all assessments to exposure to airborne radioactive material will be included, as follows:

- Upon receipt of the isotopic printout, determine the Lung Retention Class (LRC) for the identified isotopes (DAILY, WEEKLY, or YEARLY), if the specific form is known (oxide, etc.) from Appendix B of 10 CFR 20. In the event a radionuclide has two LRCs, use the one with the most restrictive DAC value unless the chemical form of the isotope is known in which case the actual LRC is used;
- For mixtures in which there are isotopes at values less than 10% of the DAC value, the isotope may be disregarded if the total of the disregarded isotopes is less than 30% of the total DAC value for the mixture. If the total of the disregarded isotopes is greater than 30% of the total for the mixture, the radionuclide with the largest percent DAC should be included first. If the remaining disregarded radionuclides are less than 30% of the new total for the mixture, no further action is required. If the remaining total of disregarded radionuclides is still greater than 30% of the new total for the mixture, include the next highest disregarded isotope in the mixture, and so on, until the <30% value is met;
- Use Attachment 53 to determine and record the DAC value for each isotope from the sample;
- In the event DAC's are determined using alpha-beta counting systems (Ludlum Model 2929 or equivalent), the most restrictive DAC value will be used for the job site's radionuclide(s) of concern to calculate the number of DAC-hrs.
- Calculate and record the DAC-hrs in accordance with Section 1.7.2.7 of this procedure;
- When isotopic results are obtained, correct the entry to reflect the actual DAC-hrs;
- The gamma spectroscopy system may calculate the DAC value and report results on the printout in DACs or %DAC. If so, use this value to calculate DAC-hrs;
- DAC-HR data will be recorded, on the Individual DAC-HR Accounting Form (Attachment 54) and a running total will be retained for the duration of the project and/or year;
- The Vista ORPO will review the DAC-HR data and forward to RSO on an necessary basis; and
- The RSO will update the individual's exposure record at the end of the project and/or year.

1.7.2.7. DAC-HR Calculations

Obtain data from Attachment 55, Air Sample Data and Analysis. Air sample data is obtained in accordance with Air Radiological Sampling (Procedure 16.0).

*Percent DAC.
*Time of Exposure (expressed in hours).

a) Calculate DAC-hrs using the following equation:

DAC-hrs = [(% DAC)(Time of Exposure)]/100%

For Example:

% DAC = 200
Time of Exposure = 8 hours

16 DAC-hrs = [(200% DAC)(8 hrs)]/100%

Calculate for each isotope requiring documentation.

If respiratory protection is worn, the respirator's protection factor (PF) will be used to calculate the DAC-hrs.

DAC-hrs = [(% DAC)(Time of Exposure)]/[(100%)(PF)]

b) Document DAC-hrs on Attachment 54 with the following information:

* RWP #
* Vista #
* Project/Location
* Calculate Running Total

1.7.3. ALARA Pre-Job Planning

ALARA pre-job planning should be included in the initiation of the work plan and RWPs. The intent of ALARA Pre-Job planning is to provide an objective view of the proposed activity that may not be readily apparent to the author. ALARA Pre-Job planning should consider the following:

- A specific description of the job (including location);
- The original dose equivalent estimate for completing the job;
- Resources required (equipment, supplies and personnel);

Note: For the purposes of this document Ionizing Radiation includes Non-Ionizing Radiation

- Radiological conditions;
- Identify persons performing work;
- Job assignments;
- Training requirements, mock-up, dry run;
- Time required to complete the job;
- Consideration of exposure reduction techniques;
- Consideration of the RWP requirements;
- Any special or unusual hazards;
- Current radiation effective dose equivalent (available status) of radiation workers; and
- Other qualifications (Example-current respirator use, medical, etc.) of workers.

1.7.4. Pre-Job Briefing

Pre-job briefing shall attempt to insure that all individuals involved in a specific task are working toward a common goal and are aware of radiological conditions and methods of minimizing exposure.

1.7.5. Post Job Review

The RSO or his or her designee should conduct a debriefing meeting upon conclusion of jobs involving collective dose equivalent of greater than 100-person mrem. Debriefings should include the following:

- Identification of any problems encountered and the resolution of the problem;
- Suggestions for improving the future performance of similar tasks, including techniques for further reducing exposures; and
- Comparison of the actual dose equivalent to the estimated dose equivalent.

ATTACHMENTS

DAC DETERMINATION

SAMPLE DATE:	SAMPLE TIME:
SAMPLE PERFORMED BY:	DAC CALCULATION PERFORMED BY:
LOCATION / PROJECT:	

ISOTOPE	LRC	DAC	CONCENTRATION	SAMPLE % DAC

REVIEWED BY HPS:	DATE:

ATTACHMENT 54

INDIVIDUAL DAC-HR ACCOUNTING

Current Year: ________ Page ______ of ________

NAME		SSN		EMPLOYER	
PREVIOUS DAC-HR TOTAL THIS YEAR:			DAC-HRS RECEIVED AT:		
JOB LOCATION / PROJECT:					
DATE	# DAC-HRS RECEIVED	RWP #	VISTA#	TOTAL	COMMENTS
TOTAL DAC-HRS THIS PAGE					
REVIEWED BY HP SUPERVISOR					
COPY FORWARDED TO INDIVIDUAL'S RECORDS BY:					
					DATE
					DATE

AIR SAMPLE DATA AND ANALYSIS

INSTRUCTION 1: Complete the following information concerning the sample:

Project/Location:

A/S ID Number:________ RWP Number:_______ VISTA Number:___________

Date Start:___________ Date Stop:

Time Start:___________ Time Stop:_________ Total Time:______ minutes

Sample Location:____

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

Comments:____

Technician Performing Sample:_________________________________ Date:___________

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

Type Sampler:___________________________
Sampler I.D.:___________________________
Cal. Date:______________________________
Cal. Due Date:__________________________
Flow Rate Start:_____________ cfm
lpm

Flow Rate Stop:_____________ cfm
lpm

Average Flow Rate:___________ cfm
lpm

Type Counter:_______________________
Counter I.D.:_______________________
Probe I.D.:_________________________
Cal. Date:__________________________
Cal. Due Date:______________________

Count Time:_____________minutes
Alpha Eff:____________________

Beta/Gamma Eff:_______________

Alpha Background:______________
Beta/Gamma Background:__________

Technician Performing Count:________________________________ Date:______________

INSTRUCTION 3: Calculate the alpha MDA values (Note: Background counting to determine the background count rate must be sufficient to collect a minimum of 100 counts)

α MDA dpm_ = (2.71 + 4.65 √Total Bkgrnd Counts)/((Inst.Eff.) (Bkgrnd Count Time))

= (2.71 + 4.65 √)/( )( )

= dpm

Technician Performing Calculation:________________________ Date:____________________

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	cts	min	cpm	cpm	cpm	.67		2.22E+6	µCi
βτ	cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing Initial Count:________________________ Date:

INSTRUCTION 5: Calculate the Total Sample Volume:

Total Sample Run Time | Sample Average Flow Rate | Total Volume

_________ minutes X _____ cfm X 2.83E+4 = ________ml

_____ 1pm X 1.0E+3

Technician Performing Calculation:________________________ Date:____________________

INSTRUCTION 6: Determine the Initial Airborne Concentration

Initial Activity | Volume | Initial Activity

α _____ µCi X FR ÷ ______ml = __________ µCi/ml α

βτ _____ µCi X FR ÷ ______ml = __________ µCi/ml βτ

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

Technician Performing Calculation:________________________ Date:____________________

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
βτ	cts	min	cpm	cpm	cpm	.95		2.22E+6	μCi

Technician Performing 3 Hour Count:______________________________ Date:

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

βτ _________ μCi X FR ÷ _________ml = ______________μCi/ml

Technician Performing Calculation:______________________________ Date:________________

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

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

t = elapsed time between counts in minutes

t½ α = ________________

t½ βτ = ________________

Technician Performing Calculation:______________________________ Date:

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
βτ	Cts	min	cpm	cpm	cpm	.95		2.22E+6	µCi

Technician Performing 20 Hour Count:______________________ Date:______________

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

$$A_{LL} = \frac{A_{20}\alpha - A_{3}\alpha\,(e^{-0.0655(\Delta T)})}{1 - e^{-0.0655\,(\Delta T)}}$$

where:

$A_{LL}\ \alpha$	=	long-lived activity which emits alpha
$A_{20}\ \alpha$	=	20 hour decayed activity due to alpha
$A_{3}\ \alpha$	=	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

$$\alpha\ A_{LL}\mu Ci = \frac{A_{20}\mu Ci - A_{3}\mu Ci\,(e^{-0.0655\,(hrs)})}{1 - e^{-0.0655\,(hrs)}}$$

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

$$= \_\_\_\_\_\_\_\_\mu Ci$$

Technician Performing Calculation:______________________ Date:______________

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

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

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:______________________ Date:______________

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

$\frac{A_{LL\alpha}\ \mu Ci}{\text{volume}} =$ __________ $\mu Ci/ml\ [A_{LL}\ \alpha]$

$\frac{A_{LL}\beta\ \mu Ci}{\text{volume}} =$ __________ $\mu Ci/ml\ [A_{LL}\ \beta]$

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:______________________ Date:______________

ORPO Review:______________________ Date:______________

NRC FORM 4 (9 /1998) 10 CFR PART 20	U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0005	EXPIRES: 09/30/2001

CUMULATIVE OCCUPATIONAL DOSE HISTORY

1. NAME (LAST, FIRST, MIDDLE INITIAL)	2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX: MALE ☐ FEMALE ☐	5. DATE OF BIRTH (MM/DD/YYYY)

6. MONITORING PERIOD (MM/DD/YYYY - MM/DD/YYYY)	7. LICENSEE NAME	8. LICENSE NUMBER	9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐

11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE

6. MONITORING PERIOD	7. LICENSEE NAME	8. LICENSE NUMBER	9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐

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11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE

19. SIGNATURE OF MONITORED INDIVIDUAL	20. DATE SIGNED	21. CERTIFYING ORGANIZATION	22. SIGNATURE OF DESIGNEE	23. DATE SIGNED

VISTA Technologies, Inc.
Radiation Safety Program

PROCEDURE - 7

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