VISTA Technologies, Inc.

Radiation Safety Program

PROCEDURE - 8

RADIATION PROTECTION

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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

RADIATION PROTECTION

1. CONDITIONS OF EXPOSURE

The basic safety standards for Ionizing and Non-Ionizing radiation protection recognize two distinct conditions of exposure: (1) conditions by which the occurrence of exposure is foreseen and can be limited by control of the source and by the application of the system of dose limitations; and (2) conditions by which the source of exposure is not subject to control so that any subsequent exposure can be limited, if at all, only by remedial actions.

The following sections discuss the system of dose limitations and annual dose equivalent limits for Ionizing radiation.

2. SYSTEM OF DOSE LIMITATIONS

Doses resulting from sources and practices involving exposure to Ionizing radiation or to radioactive substances will be restricted by a system of dose limitations, that will include justification of the practice, optimization of Ionizing radiation protective measures, and limitation of annual dose equivalent.

The following sections discuss justification of the practice, optimization of Ionizing radiation protective measures, and dose limitations.

2.1.Justification of the Practice

In order to prevent unnecessary exposure, no practice involving exposure to Ionizing radiaiton will be authorized unless the introduction of the practice produces a positive net benefit.

2.2.Optimization of Ionizing Radiation Protective Measures

All practices with sources of Ionizing radiation will be performed in a manner to ensure that exposures are ALARA, with due consideration to applicable economic and social factors.

2.3.Dose Limitations

Limits and reference levels are two different concepts in Ionizing radiation protection. A limit is a value that must not be exceeded. A reference level is the value that is used to determine a particular course of action. A reference level is not a limit.

2.3.1. Primary Dose Equivalent Limits

Primary dose equivalent limits relate to the dose equivalent, effective dose equivalent, committed dose equivalent, or committed effective dose equivalent, depending on the exposure circumstances. These limits apply to an individual or in the case of exposure to the public, to the critical group.

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

2.3.1.1. Secondary Limits

Secondary limits are needed when the primary dose limits can not be applied directly. In the case of external exposure, secondary limits may be expressed in terms of dose equivalent index. In the case of internal exposure, secondary limits may be expressed in terms of ALI.

2.3.1.2. Derived Limits

Derived limits are related to the primary limits by a defined model such that the derived limits are observed. It is likely that the primary limits also will be observed.

2.3.1.3. Authorized Limits

Authorized limits are limits of any quantity specified by the competent authority for a given radiation practice or source. They are generally lower than the primary, secondary, or derived limits.

2.4.Annual Dose Equivalent Limits

No individual should be exposed, as a result of controlled sources and practices, in excess of these limits. There are separate limits for workers and for members of the public. The system of dose limitations is founded on the present knowledge of the biologically deleterious effect of Ionizing radiation exposure on living beings, especially man, on his progeny, and/or mankind as a whole.

The following sections discuss somatic stochastic effects and non-stochastic effects of exposure to Ionizing radiation.

2.4.1. Somatic Stochastic Effects

When a population is exposed to Ionizing radiation, stochastic effects will appear in some individuals only, apparently at random; therefore, the name stochastic effects. The limits for somatic stochastic effects are expressed in terms of effective dose equivalent. Somatic stochastic effects, usually malignant disease and heredity effects, are considered stochastic at the dose range involved in Ionizing radiation protection.

The magnitude of the dose received does not affect the severity of stochastic effects. Finally, stochastic effects are always delayed. Time is required for the appearance of genetic effects, since they express themselves in offspring and for malignant diseases a span of years can elapse between the exposure and the appearance of the disease. There is no known method for reducing the probability of the occurrence of somatic stochastic effects from doses already received.

2.4.2. Non-Stochastic Effects

Limits for the prevention of non-stochastic effects are expressed in terms of dose equivalent. Non-stochastic effects are characterized by the relationship between dose and effect. The effects occur when the dose received exceeds a certain threshold value and are unlikely to occur below such values. For doses above the threshold, the severity of

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the damage will be related to the dose. The larger dose, the more serious the effect. The non-stochastic effects are generally not long delayed.

2.5.Limits of Exposure to Ionizing Radiation

External Ionizing radiation exposure is exposure to a radioactive source external to the body and where the Ionizing radiation is capable of penetrating the skin. The major source of external Ionizing radiation that may be found at a Vista project work site is γ ray radiation.

The following sections discuss the limits for external exposure to ionizing radiation, limits for internal exposure, and administrative controls.

2.5.1. Limits for External Exposure

The following sections give the limits for external exposure to ionizing radiation for basic permissible dose, skin of the whole body, extremities, eyes, planned special exposures, pregnant women, minors and the public. The following annual effective dose limits, based on 10 CFR 20, will be applied to external ionizing radiation exposures to individuals working on Vista project work sites.

2.5.1.1. Basic permissible Whole Body Dose

The total annual whole-body effective dose equivalent from internal plus external exposure should be less than 5 rems (0.05 Sievert).

2.5.1.2. Skin of the Whole Body

The annual effective shallow-dose equivalent for the skin of the whole body should be less the 50 rems (0.5 Sievert).

2.5.1.3. Extremities

Extremities are defined as elbow to hand, hip to toe. The annual effective shallow-dose equivalent for any extremity should be less than 50 rem per year (0.5 Sievert). Extremity monitoring shall be provided when necessary as described in the specific Radiation Work permit (RWP).

2.5.1.4. Eyes

The annual effective dose equivalent to the lens of the eye should be less than 15 rems (0.15 Sievert)

2.5.1.5. Planned Special Exposures

10 CFR 20.1206 permits exposure of individuals in excess of 5 rem (0.05 Sievert) per year in accidents, emergencies, and planned special exposures. Planned special exposures will not be authorized for an exposure where all doses received will exceed the numerical values of any of the dose limits or will exceed five times the annual dose limits discussed in this Procedure during the individual's lifetime. Conditions where planned special exposures may be required are not expected to exist on Vista project work sites.

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2.5.1.6. Pregnant Women

The annual effective dose equivalent to the fetus due to occupational exposure should be less than 0.5 rem (0.005 Sievert) during the entire pregnancy. This applies to declared pregnancies only.

2.5.1.7. Minors

The annual effective dose to minors under age 18 should be 10 percent of the annual dose limits specified for adult workers per year.

2.5.1.8. The Public

The annual effective dose equivalent to the whole body for members of the public should be less than 0.1 rem (0.001 Sievert)

2.6.Limits for Internal Exposure

The inhalation or ingestion of radioactive materials and/or radioactive contamination leads to initial ionizing radiation exposure by deposition into the lungs and gastrointestinal tract and the subsequent translocation to other body organs. This phenomenon is dependent on the physical and chemical form, and of the solubility of the radioactive material and/or radioactive contamination where initial deposition occurs. Of the various types of ionizing radiation, α particles are usually considered the greatest internal hazard.

When radioactive materials and/or radioactive contamination are taken into the body, the internal organs may be exposed to α and β particles as well as γ ray radiation. Exposure to low energy α and β particle radiation is significant when the source is internal because the ionizing radiation does not need to penetrate the skin to reach internal organs. 10 CFR 20 requires that internal and external ionizing radiation doses be combined.

The following sections discuss inhalation limits and ingestion of radioactive material limits for internal exposure to ionizing radiation.

2.6.1. Inhalation

Column 3, Table 1 of Appendix B to 10 CFR 20 specifies the DACs of radioactive materials in air for a RA. The DAC is the maximum concentration of an airborne radioactive material that an occupational worker may be exposed to for 40 hours per week and 50 weeks per year.

2.6.2. Ingestion of Radioactive Materials

No individual in a RA is to knowingly ingest, or cause others to ingest, radioactive materials in amounts exceeding the limiting values provided in column 1, Table 1 of Appendix B to 10 CFR 20.

2.6.3. Soluble Uranium Intake

Vista will limit the soluble uranium intake by an individual to 10 milligrams in a week in consideration of chemical toxicity.

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2.7.Administrative Controls

Administrative controls are applied to reduce exposures to ALARA and to maintain them below regulatory limits. The following sections discuss radioactive contamination control, airborne radioactivity, and air sampling and bioassay.

2.7.1. Radioactive Contamination Control

Release of personnel, equipment, and articles contaminated with radioactive materials off of a Vista project work site will be based on the values provided in 10 CFR 20. Direct and transferable survey techniques with portable α particle, β particle, and γ ray survey instruments are used for radioactive contamination control. The radioactive contamination control limits are as follows:

Personnel – Non-detectable above background

Equipment and Articles – as indicated in the table below

Table 2-1 Radioactive Control Limits

Equipment & Articles	Level
Removable β particle/γ ray surface contamination	1000 DPM per centimeters
Fixed β particle/γ ray surface contamination	100 per square centimeters
Removable α particle surface contamination	$50/dm^2$
Fixed α particle surface contamination	$500/ dm^2$

2.7.2. Airborne Radioactivity

Use of a respirator is required when airborne radioactivity concentrations exceed 25% of DAC values listed in 10 CFR 20. Administrative and engineering controls will be used where feasible to prevent inhalation exposures from exceeding 40 DAC-hr in any seven consecutive days. Approved respiratory protective devices can be used as a last resort to control exposures in instances where these controls are insufficient or impractical. When calculated if DAC-hr is greater than or equal to two, in one-day, or ten in any seven consecutive days, the airborne radioactivity concentrations should be recorded. Exposures exceeding these guidelines will be evaluated by bioassay. The results of bioassay will be recorded.

2.7.3. Air Sampling and Bioassay

Air sampling and bioassay programs will be in effect whenever exposures of 4 DAC-hr/week may occur during field activities. Air sampling procedures are discussed in Procedure 16, "Air Radiological Sampling".

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